Karsten Lambers

The geoglyphs of Palpa, Peru: documentation, analysis, and interpretation

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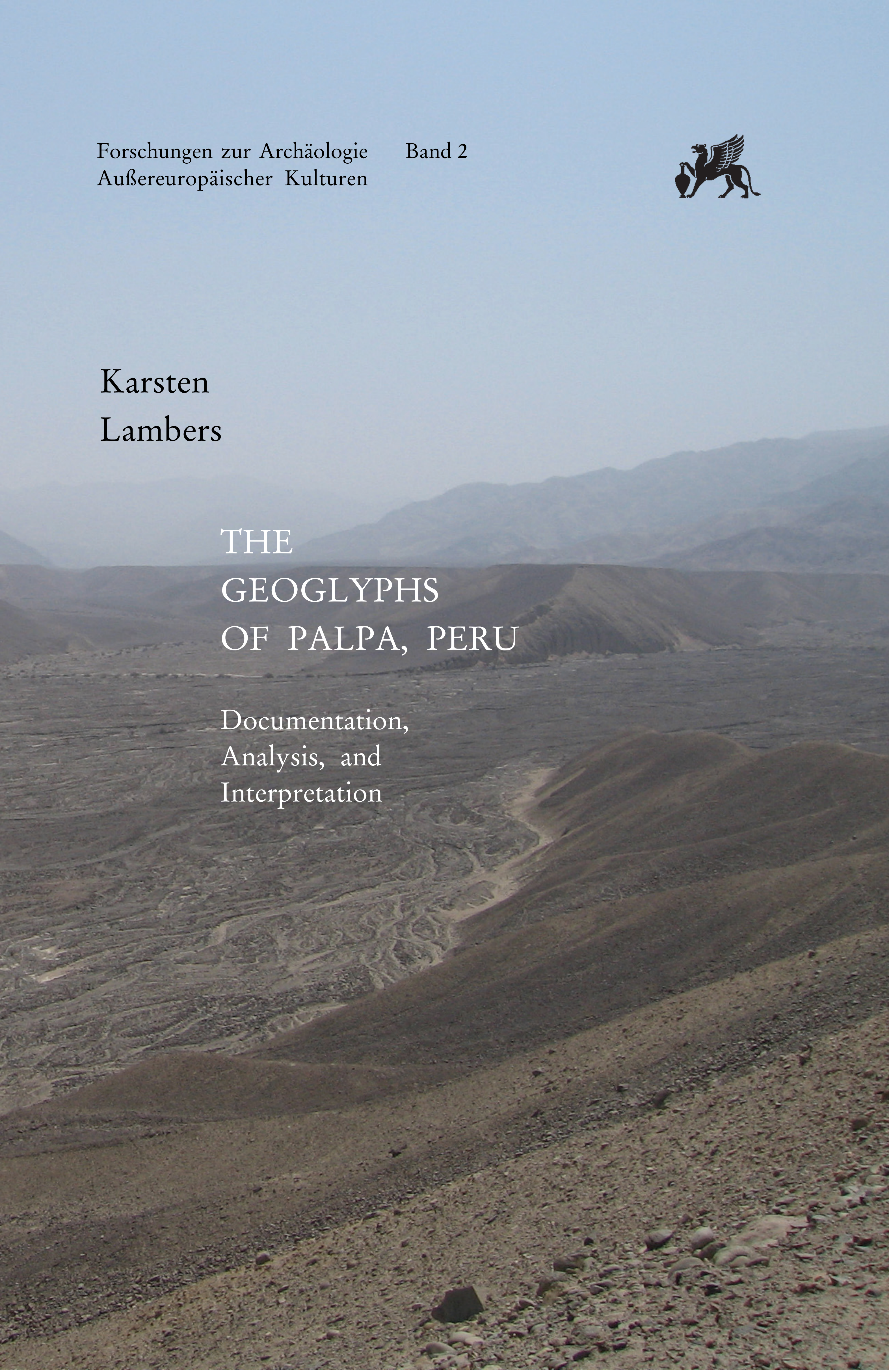

Forschungen zur Archäologie Außereuropäischer Kulturen Band 2

Karsten Lambers

THE GEOGLYPHS OF PALPA, PERU

Documentation, Analysis, and Interpretation

F A A K 2

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Forschungen
zur Archäologie
Außereuropäischer
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Karsten
Lambers

THE GEOGLYPHS OF PALPA, PERU

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Editorial

(Deutsch)

Im Verlauf der nunmehr fünfundzwanzigjährigen Geschichte unserer Forschungseinrichtung sprachen uns in- und ausländische Kollegen wiederholt auf die inhaltliche Unschärfe des Namens „Kommission für Allgemeine und Vergleichende Archäologie“ an. Wenn das Beschlussgremium unserer Kommission und die Zentraldirektion des Deutschen Archäologischen Instituts jüngst der nun wirksam gewordenen Umbenennung in „Kommission für Archäologie Außereuropäischer Kulturen des Deutschen Archäologischen Instituts“ (KAAK) zugestimmt haben, so vermag dies die Praxis unserer bisherigen Forschungen, die Umsetzung unseres kulturpolitischen Auftrages und auch die Definition von Forschungsgebiet und -gegenstand der Kommission deutlicher als bisher zu umschreiben.

Zumindest hinsichtlich der Publikationspolitik unseres Hauses musste die Namensänderung ganz erhebliche Veränderungen und Anpassungen nach sich ziehen. Nicht nur haben wir den Zeitpunkt genutzt, zwei unserer Publikationsreihen – die „Kolloquien zur Allgemeinen und Vergleichenden Archäologie“ und die „Materialien zur Allgemeinen und Vergleichenden Archäologie“ – einzustellen, sondern auch die bisherigen „Beiträge“ und „Forschungen“, umbenannt in „Zeitschrift für Archäologie Außereuropäischer Kulturen“ (ZAAK) und „Forschungen zur Archäologie Außereuropäischer Kulturen“ (FAAK), als neue Zeitschrift bzw. als alleinige Monographienreihe neu zu etablieren. Beide Reihen werden wir mit einer neuen Zählung beginnen. Maßgeblich für die Straffung des Publikationsprogramms sind nicht nur Umstrukturierungen in der redaktionellen Betreuung angenommener Manuskripte, sondern auch die allgemeinen Sparzwänge.

Während sich der erste Band unserer neuen „Zeitschrift für Archäologie Außereuropäischer Kulturen“ in der redaktionellen Endbearbeitung befindet, ist der Band 1 der „Forschungen zur Archäologie Außereuropäischer Kulturen“ bereits im Sommer 2005 erschienen. Er enthält die Akten der *17th International Conference on South Asian Archaeology*, die unsere Kommission gemeinsam mit der Eurasien-Abteilung des Deutschen Archäologischen Instituts 2003 in Bonn ausrichtete. Angesichts des Inhaltes und auch des nicht unbeträchtlichen Umfangs des Bandes haben wir bewusst darauf verzichtet, ein Editorial aufzunehmen, das die neue Publikationsstrategie unserer Kommission skizziert. Dies sei hiermit nachgeholt.

Der hiermit vorgelegte Band 2 der „Forschungen“ zu den Geoglyphen der Nasca-Kultur ist die leicht überarbeitete Version einer mit einem Forschungspreis ausgezeichneten Dissertationsschrift, mit der Karsten Lambers 2004 an der Universität Zürich promoviert wurde. Als langjähriger Mitarbeiter des KAAK-Forschungsprojektes im Raum Palpa/Nasca unter der Leitung von Markus Reindel legt er hier die Untersuchungsergebnisse zu einem herausragenden Teilaspekt der Unternehmung vor, nämlich die erste umfassende und systematische Dokumentation und archäologische Analyse der weltweit bekannten Bodenzeichnungen an der Südküste Perus.

Die Lösung einer solch komplexen und anspruchsvollen Aufgabe wie der Kartierung eines der wichtigsten Bodendenkmäler des amerikanischen Kontinentes auf einer Fläche von nahezu 100 Quadratkilometern wäre noch vor wenigen Jahren kaum denkbar gewesen. Erst durch den Einsatz modernster photogrammetrischer Technologien und computergestützter Auswertemethoden konnten die umfangreichen Kartierungsarbeiten mit vertretbarem zeitlichen und finanziellen Aufwand und gleichzeitig mit hervorragender Genauigkeit bewältigt und so die Grundlage für archäologische Auswertungen geschaffen werden.

Mit ihrer Einbindung in ein multidisziplinär konzipiertes Forschungsvorhaben ist die vorliegende Arbeit an der Schnittstelle zwischen Archäologie, Naturwissenschaften und Ingenieurwissenschaften angesiedelt und damit beispielhaft für moderne archäologische Forschung, in der in zunehmendem Maße neue Technologien Eingang finden. Diese Forschungsergebnisse unterschiedlichen Fach- und Interessentenkreisen zugänglich zu machen ist gleichermaßen Anliegen und Auftrag unserer Monographienreihe. Der Inhalt und die aufwändige graphische Gestaltung erforderten eine durch eine beiliegende DVD erweiterte Präsentation, die auch nach unseren bisherigen Maßstäben insgesamt als ungewöhnlich zu bezeichnen ist. Dass dies trotz alledem zu einem günstigen Kosten-Nutzen-Verhältnis bewerkstelligt werden konnte, ist vor allem dem großen Engagement des Verfassers, unseres Graphiker H.-P. Wittersheim und des LINDEN SOFT Verlages zu verdanken.

Wir hoffen, auch weiterhin solche grundlegenden und zugleich innovativen Forschungen in unserer Publikationsreihe veröffentlichen zu können. Auf diese Weise wird es uns möglich sein, im Rahmen der Aktivitäten unseres Instituts die Entwicklung neuer Methoden in der archäologischen Forschung voranzutreiben und wesentliche neue Erkenntnisse zur Kulturgeschichte jener Regionen zu liefern, denen unser Forschungsinteresse gilt.

Bonn, Herbst 2005

Burkhard Vogt
Josef Eiwanger

Editorial

(English)

During the 25 year history of our research institution, colleagues both from Germany and abroad repeatedly drew our attention to the ambiguous meaning of the name *Kommission für Allgemeine und Vergleichende Archäologie* (*KAVA,* "Commission for General and Comparative Archaeology"). Our Commission and the *Zentraldirektion* of the German Archaeological Institute recently decided to change the name to *Kommission für Archäologie Außereuropäischer Kulturen des Deutschen Archäologischen Instituts* (*KAAK*; "Commission for Archaeology of Non-European Cultures of the German Archaeological Institute"). The new name is hoped to paraphrase more clearly the practice of our current research, our politico-cultural mandate and the definition of the research area as well as the topic of our institution.

The implementation of this decision also includes major changes and modifications with respect to our publication policy. We took the opportunity to terminate two publication series – the *Kolloquien zur Allgemeinen und Vergleichenden Archäologie* and the *Materialien zur Allgemeinen und Vergleichenden Archäologie*. We also re-established the former *Beiträge zur Allgemeinen und Vergleichenden Archäologie* (*BAVA*) and *Forschungen zur Allgemeinen und Vergleichenden Archäologie* (*AVA-Forschungen*) under the titles *Zeitschrift für Archäologie Außereuropäischer Kulturen* (*ZAAK*; "Journal for Archaeology of Non-European Cultures") and *Forschungen zur Archäologie Außereuropäischer Kulturen* (*FAAK*; "Studies in Archaeology of Non-European Cultures") as our new journal respectively our exclusive monographic series. A re-organisation of the editing process and budgetary reasons necessitated the re-focusing of our publication program.

While the first volume of our new *Zeitschrift für Archäologie Außereuropäischer Kulturen* is in its final stage of editing, volume 1 of the *Forschungen zur Archäologie Außereuropäischer Kulturen* already appeared in summer 2005. It contains the proceedings of the 17th International Conference on South Asian Archaeology, which was jointly organized in Bonn 2003 by our Commission and the Eurasia Department of the German Archaeological Institute. Mindful of its special purpose and the considerable size of the volume, we deliberately refrained from including an editorial-contribution to outline our new publication strategies.

We herewith introduce volume 2 of the *Forschungen zur Archäologie Außereuropäischer Kulturen*, which deals with the geoglyphs attributed to the Nasca culture. It is a slightly modified version of a Ph.D. dissertation, which Karsten Lambers submitted to the University of Zurich, Switzerland, in 2004 and which received a research award the following year. A longtime member of the KAAK research project in the Palpa/Nasca area under the direction of Markus Reindel, Karsten Lambers presents here his investigations of one of the major aspects of the project, *i.e.* the first comprehensive and systematic documentation and archaeological analysis of the world-renowned geoglyphs in southern Peru.

A brief few years ago it would have been unthinkable to handle such a complex and ambitious task such as the survey of one of the most outstanding monuments of the American continent. Confining his studies to a representative research area of about hundred square kilometers, Karsten Lambers applied the most recent photogrammetric and GIS technologies as well as computer-based analytical methods to the task. Accomplishing the extensive mapping with utmost precision and with an affordable investment both of time and expenditures, he created a sound basis for archaeological assessment.

Integrated into multidisciplinary research, Lambers' report interfaces archaeology, natural and engineering sciences, thus setting an example for a progressive archaeology which increasingly adapts modern technologies. It is both the intention and purpose of our monographic series to bring its scientific results to the attention of scholarly circles and other interested readers. Its written and graphic content, complemented by a DVD, enables an enlarged presentation which is unusual by present-day standards. All this was achieved for an affordable sales price owing to the efforts of the author, our graphic designer H.-P. Wittersheim and the publisher, LINDEN SOFT.

In the future we hope to publish in our series similar basic and innovative research. Within the framework of our institute's activities, this will enable us to advance the development of new methods in archaeology and to contribute new significant data for the cultural history in our emphasis areas.

Bonn, autumn 2005

Burkhard Vogt
Josef Eiwanger

Editorial

(Español)

Durante los 25 años de la existencia de nuestro instituto de investigación, varios colegas alemanes y extranjeros nos reiteraron su preocupación por la imprecisión del contenido del nombre *Kommission für Allgemeine und Vergleichende Archäologie* (*KAVA*, „Comisión para la Arqueología General y Comparada"). Si el gremio de nuestra comisión y la dirección central del Instituto Arqueológico Alemán han aceptado el cambio de nombre en *Kommission für Archäologie Außereuropäischer Kulturen des Deutschen Archäologischen Instituts* (*KAAK*, „Comisión para Arqueología de Culturas Extraeuropeas del Instituto Arqueológico Alemán"), que ahora ya es realidad, lo hicieron con la intención de describir mejor, y en forma más precisa que antes, la práctica de nuestras investigaciones realizadas, la realización de nuestro cometido político cultural, así como la definición de nuestra área y nuestro objetivo de investigación.

Este cambio de nombre, por necesidad, tuvo sus consecuencias en cambios y adaptaciones considerables, al menos en el campo de la política de las publicaciones de nuestro instituto. Aprovechamos esta coyuntura para suprimir dos de nuestras series: los *Kolloquien zur Allgemeinen und Vergleichenden Archäologie* („Coloquios para la Arqueología General y Comparada") y los *Materialien zur Allgemeinen und Vergleichenden Archäologie* („Materiales para la Arqueología General y Comparada"). Además se ha cambiado el nombre de la revista *Beiträge zur Allgemeinen und Vergleichenden Archäologie* (*BAVA*) que ahora se titula *Zeitschrift für Archäologie Außereuropäischer Kulturen (ZAAK*, „Revista para la Arqueología de Culturas Extraeuropeas"). Igualmente el nombre de la serie monográfica *Forschungen zur Allgemeinen und Vergleichenden Archäologie* (*AVA-Forschungen)* fue cambiado en *Forschungen zur Archäologie Außereuropäischer Kulturen* (*FAAK*, „Investigaciones para la Arqueología de Culturas Extraeuropeas"). Esta racionalización del programa de publicaciones no se debe sólo a la reestructuración del cuidado de la redacción de los manuscritos aceptados sino también a las necesidades generalizadas de reducción de gastos.

El primer tomo de nuestra nueva *Zeitschrift für Archäologie Außereuropäischer Kulturen* se encuentra en la fase final de su redacción, pero ya se publicó, en el verano de 2005, el primer tomo de las *Forschungen zur Archäologie Außereuropäischer Kulturen*. Se trata de las actas de la *17th International Conference on South Asian Archaeology* que fue organizada en Bonn, en 2003, por nuestra comisión junto con el Departamento de Eurasia del Instituto Arqueológico Alemán. Debido a su contenido y al volumen considerable de este tomo no incluimos una nota editorial que esbozara la nueva estrategia de publicaciones de nuestra comisión. Remediamos esta omisión en esta ocasión.

El presente tomo 2 de las *Forschungen zur Archäologie Außereuropäischer Kulturen*, dedicado a los geoglifos de la cultura Nasca, es una versión ligeramente modificada de la premiada tesis doctoral con la que Karsten Lambers, de la Universidad de Zurich, obtuvo su promoción. El autor se está desempeñando como colaborador del proyecto de investigación de la KAAK en el área de Palpa/Nasca, bajo la dirección de Markus Reindel, desde hace muchos años y presenta, en este trabajo, los resultados de unos de los más destacados aspectos de este proyecto: la primera y sistemática documentación y el análisis arqueológico de los geoglifos de la costa sur del Perú los que gozan de fama mundial.

Emprender una tarea tán compleja y exigente como la de producir mapas de uno de los monumentos prehispánicos más importantes del continente americano, hubiera sido imposible hasta hace pocos años. Limitando sus estudios a un área de casi 100 kilómetros cuadrados Karsten Lambers aplicó las más modernas tecnologías fotogramétricas y SIG apoyadas por métodos analíticos computarizados. El mapeo extensivo del área que de esta manera fue ejecutado con la mejor precisión posible y dentro de un razonable despliegue en cuanto a costos y tiempo involucrados, constituye la base para los análisis arqueológicos.

El presente trabajo se ubica en la intersección entre la arqueología, las ciencias naturales y las ciencias de ingeniería, gracias a su inserción en una investigación de concepción multidisciplinaria. De esta manera se constituye como ejemplo para la moderna investigación arqueológica en la que se están introduciendo nuevas tecnologías en proporciones crecientes. El propósito y el cometido de nuestra serie monográfica se centran precisamente en hacer asequible este tipo de resultados de investigación a círculos diversos de colegas y de personas interesadas. El contenido y el complejo diseño gráfico implicaron la necesidad de una presentación más amplia por medio de un DVD adjunto, la cual, desde el punto de vista de nuestras normas establecidas, resulta extraordinaria. El hecho de haber realizado esta tarea exigente con una proporción ventajosa entre costo e utilidad, se debe, ante todo, a los grandes esfuerzos del autor, de nuestro experto gráfico H.-P.Wittersheim y de la editorial LINDEN SOFT.

Esperamos seguir publicando en nuestra serie este tipo de investigaciones fundamentales y, a la vez, innovadoras. De esta manera será posible impulsar el desarrollo de nuevos métodos en la investigación arqueológica, en el marco de las actividades de nuestro instituto, así como proporcionar nuevos conocimientos para la historia cultural de las regiones a los que dedicamos nuestro interés de investigación.

Bonn, otoño de 2005

Burkhard Vogt
Josef Eiwanger

Technical notes

This study consists of two parts: the main volume with text and illustrations, and a supplement that includes a set of large format maps and a DVD. The DVD contains a database with the geoglyph data on which the results of this study are based, and a video of a virtual flight over the geoglyphs of Palpa.

All maps in this study are oriented towards true north. Coordinates, where present, are given in UTM projection, zone 18 S, WGS 84.

On some photos taken in the field, geoglyph and site numbers are shown according to a preliminary system used for fieldwork. During analysis, the numbering system has been changed. Definite geoglyph and site numbers are given in the figure captions.

The geoglyph database in MDB format on the accompanying DVD can be opened in MS Access 2003. The same database in XML format can be imported into standard database programs or viewed with current versions of standard web browsers.

The virtual flight over the Palpa geoglyphs is available on the DVD in AVI and in MPEG4 format. Due to its size, it is recommended to copy the AVI file to your hard drive before opening it.

The DVD contains also a text file with further instructions. It is strongly recommended to read the instructions before opening the database or the video.

Acknowledgments

The present study is a revised version of my doctoral dissertation that was accepted in 2004 by the Faculty of Arts of the University of Zurich. The work described in this thesis was part of a long-term research project and could not have been accomplished without the help of many people and institutions.

I want to express my gratitude to my thesis supervisor Philippe Della Casa, head of the Department of Pre- and Protohistory of the University of Zurich, for his interest, support and guidance. My second supervisor, Armin Grün, of the Institute of Geodesy and Photogrammetry (IGP) at the Swiss Federal Institute of Technology (ETH) Zurich and head of the photogrammetric part of the Nasca-Palpa Project, is to be thanked for employing an archaeologist at IGP and for consequently supporting my interdisciplinary approach.

Markus Reindel, head of the archaeological part of the Nasca-Palpa Project, is thankfully acknowledged for being responsible for my involvement in the project in the first place and for facilitating my research in numerous ways. His contributions were essential for the success of this study. This is also true for Johny Isla, co-director and, in many respects, backbone of the Nasca-Palpa Project, who contributed his vast knowledge of Nasca archaeology to my research and helped to resolve many practical issues.

At IGP, my colleague Martin Sauerbier provided me with all those helpful tools archaeologists usually only dream of, and showed great skills and patience when simple geomatic matters became complicated by unusual archaeological requirements. The importance of his efforts for the success of this study cannot be overestimated, and his PhD research is in many respects complementary to mine. Sabine Beutner is likewise thanked for her collaboration in an earlier stage of the project. Simon Bär, Jana Niederöst, Beat Rüedin, Jochen Willneff, Fabio Remondino, Henri Eisenbeiss and other colleagues at IGP contributed their time and expertise to the present research and always provided an inspiring and convivial atmosphere, as did Martin Trachsel, Emanuela Jochum, Ursula Kunnert, Peter Fux and others at the Department of Pre- and Protohistory.

In Palpa, Juan Carlos De La Torre, Alfredo Bautista and Alejandra Figueroa worked with me in the field survey. Without their valuable contribution, this work would simply not have been possible. José Palomino is warmly thanked for feeding data of almost 1,000 feature sheets into a database. Don Oscar Tijero Ríos was always a generous host when we stayed in his pleasant house in Jauranga and accompanied us on several occasions into the desert. Fieldwork in Palpa was carried out under different permits issued by the Peruvian cultural authority, the *Instituto Nacional de Cultura* (INC, Lima). Rubén García (INC Ica) acted as local supervisor and visited me on several occasions in the field.

Research in Palpa was generously supported by the Swiss-Liechtenstein Foundation for Archaeological Research Abroad (SLSA) and by ETH Zurich. Eberhard Fischer, general secretary of SLSA, always followed the progress of the project with great interest. The writing of this thesis was made possible by a grant from the research commission of the University of Zurich. Further funding was provided by the German Archaeological Institute (DAI), Berlin, the German Academic Exchange Service (DAAD), Bonn, and Avina Foundation (Hurden). After its approval, this study was then awarded the *Jahrespreis 2005* by the Faculty of Arts of the University of Zurich for the best thesis of that year. I gratefully acknowledge that this study was made possible because of the generous support of all these institutions.

Since my native language is German, I needed assistance in the writing of the original thesis in English, and for the many revisions in preparation for publication. First there was my virtual writing assistant named LEO who can be visited at http://dict.leo.org/. As much as I appreciate the help of LEO, I would like to mention the following people who were of great assistance.

First I would like to thank Helaine Silverman who read the original version. I appreciate her many insightful comments. Then I am extremely thankful to Lawrence G. Desmond who invested a lot of time, effort, and patience helping me to improve the original text for publication. Peter Kaulicke translated the Spanish summary, while Hans-Peter Wittersheim contributed the excavation drawings. Jörg Lindenbeck, Heiko Prümers, Burkhard Vogt and Josef Eiwanger guided me through the editing process. I want to express my gratitude to all these people who helped me to get this thesis published. All remaining errors are my own responsibility.

Finally, I want to thank my parents wholeheartedly for the support I could always count on.

Karsten Lambers

1. Introduction

Fig. 1. The study area on the south coast of Peru.

The geoglyphs on the Nasca *pampa*, a flat plateau in the desert on the south coast of Peru, rank high among the most famous cultural heritage sites in the world. Thousands of tourists visit Nasca every year, and a wide variety of literature on the Nasca geoglyphs (often simply called "Nasca lines") is available in bookshops around the world. So why another book? Persis Clarkson, one of the few archaeologists who has conducted major fieldwork on the Nasca *pampa*, states that

> "[. . .] much of the literature on the Nazca geoglyphs is shrouded by presuppositions that have not been adequately verified in the field." (Clarkson 1990: 117)

The present study is the result of extensive fieldwork to investigate the geoglyphs of the Palpa region which is located in the northern part of the Nasca drainage (frontispiece, fig. 1). The number of geoglyphs in the vicinity of Palpa is second only to the Nasca *pampa*. They are located on the slopes and plateaus along Río Grande, Río Palpa, and Río Viscas. This investigation of the Palpa geoglyphs is intended to fill some of the many large gaps in our scientific knowledge of the geoglyphs in the Nasca region.

Since the 1940s researchers and others have used astronomical hypotheses to interpret the geoglyphs. German-born mathematician Maria Reiche, life-long keeper of the geoglyphs, promulgated the idea that lines were oriented towards points on the horizon where the sun or certain stars rose or set on significant dates, and that figures represented astral constellations. Since 1980, however, a new hypothesis has emerged from archaeological, anthropological, and ethnohistorical research in the Nasca area and elsewhere.

The Nasca geoglyphs are now understood as manifestations of persistent Andean traditions of social organization, religious practices, and cultural concepts. They are interpreted as sacred spaces made and maintained by social groups in common labor who performed rituals on the geoglyphs in the framework of a mountain, water, and fertility cult. However, archaeological evidence from geoglyph sites to support this new interpretation is still sparse. The investigations at Palpa provided a good opportunity to confront this recent model with archaeological data.

In order to test this recent hypothesis a large amount of data about the geoglyphs had to be systematically collected. A basic problem encountered by anyone who intends to study the Nasca geoglyphs is the lack of a good documentation. Most available geoglyph maps do not meet the standards for the recording of archaeological features. Furthermore, only a small fraction of existing geoglyph sites are covered. Thus, the documentation of the geoglyphs was of crucial importance before any new interpretation could be attempted. Since previous efforts had largely failed, a new approach to document the geoglyphs was indispensable. By applying current methods of analytical aerial photogrammetry at a large scale, it was possible to produce a detailed, accurate, and complete 3D recording of more than 1,500 geoglyphs in the Palpa area. Solving the problem of documentation methodology thus constituted a significant part of the research described in this study.

The Palpa area of the Nasca basin has been largely ignored by archaeological researchers as have the Palpa geoglyphs, even though they are comparable in quality and complexity to the better known ones on the Nasca *pampa*. There has also been a lack of public interest in them, and worse yet, little or no protection. Such negligence notwithstanding, Palpa provided an excellent starting point to learn more about the geoglyphs, and the Nasca culture in general.

In 1997, the Swiss-Liechtenstein Foundation for Archaeological Research Abroad (SLSA) in Zurich started a long-term archaeological research project at Palpa that provided the framework for the research described in the present study (see section 4). It comprised three main fields of activity. Firstly, a regional settlement survey of the middle and lower parts of Río Grande, Río Palpa and Río Viscas was undertaken to register all prehispanic sites in the vicinity of Palpa. Secondly, extensive excavations were carried out at Los Molinos and La Muña, two Nasca sites along Río Grande, as well as at several other sites. The third field of activity, which is the one described here, was the detailed documentation, analysis, and interpretation of the geoglyphs of Palpa.

The SLSA project was jointly directed by Markus Reindel, of the Commission for Archaeology of Non-European Cultures (KAAK, Bonn) of the German Archaeological Institute (DAI, Berlin), Johny Isla, of the Andean Institute of Archaeological Studies (INDEA, Lima), and Armin Grün, of the Institute of Geodesy and Photogrammetry (IGP) at the Swiss Federal Institute of Technology (ETH, Zurich). The geoglyph study was undertaken between 1999 and 2004 by the author as part of his PhD research at the Department of Pre- and Protohistory of the University of Zurich. It was jointly supervised by Philippe Della Casa, head of that department, and Armin Grün, head of IGP[1].

The study area around Palpa encompassed approximately 89 km^2 (frontispiece). It was defined by the limits of a series of aerial images taken especially for the intended geoglyph research (supplements 1–4). This zone comprises in its center the wide floodplain formed by Río

1 The second phase of the Nasca-Palpa Project started in 2002 and is now co-sponsored by SLSA, ETH Zurich, and the German Federal Ministry of Education and Research (BMBF, Bonn). The project currently comprises four major fields of activities: (1) Excavations at Paracas sites in the Palpa area, (2) Investigations of the paleoclimate and ecology of the Nasca region, (3) The application and improvement of new methods of archaeological prospection and chronometric dating of archaeological remains, and finally (4) The study of the geoglyphs on the Nasca *pampa* using and enhancing the latest digital photogrammetric technologies (for an overview see Reindel/Wagner eds. 2004). People in charge of the second phase of the project include, in addition to the above mentioned researchers, Günther Wagner, of the Archaeometry Research Group of the Heidelberg Academy of Sciences, and Bernhard Eitel, of the Institute of Geography of the University of Heidelberg. The second phase of the Nasca-Palpa Project will not be concluded before 2007. The present study therefore refers mainly to results of the first phase.

Palpa and Río Viscas shortly before they join Río Grande. This is also where the modern town of Palpa is situated. The alluvial plain is bounded to the northwest by Cresta de Sacramento, to the northeast by Cerro Carapo, and to the southeast by Pampa de San Ignacio and Pampa de Llipata. To the southwest, Río Grande flows along a steep undercut slope towards its junction with Río Ingenio, after having been joined by both Río Palpa and Río Viscas. The aerial images covered all of the above mentioned ridges, plateaus, dry valleys and areas between the valleys where geoglyphs are located.

The geoglyphs of Palpa were the actual object of investigation of the present study (maps 1–13). They are part of the same cultural phenomenon as the famous lines and figures on the Nasca *pampa*. The geoglyphs in both areas share the basic shapes, motifs, and construction techniques. Interestingly, however, there are some peculiarities in the Palpa geoglyph repertoire. For example, on Pampa de San Ignacio there is probably the densest concentration of geoglyphs, and at the same time the largest trapezoid known in the whole Nasca drainage. There are considerably less zoomorphic figures in Palpa than in Nasca, but many more small anthropomorphic figures. Due to the topography of the Palpa area which lacks the vast plain of the Nasca *pampa*, the geoglyphs are mainly located close to the valleys, *i.e.* in conjunction with settlements from the same epoch. This factor makes Palpa an easier place to study the relationships between the two classes of cultural remains than Nasca, which was one reason why Palpa was chosen for new archaeological investigations.

As a first step of the work in Palpa, all geoglyphs were recorded photogrammetrically by using the high resolution aerial images mentioned above. Later, most of the geoglyphs were documented by on site field observations. This work resulted in a comprehensive geoglyph database containing 3D models, 2D maps, as well as detailed descriptions of the geoglyphs. All data was then integrated into a geographic information system (GIS). That accomplished, the actual archaeological analysis was undertaken, combining standard archaeological methods with database and GIS computer analysis. Spatial analyses were performed to understand the role of the geoglyphs in the Nasca cultural landscape, and recent hypotheses on geoglyph function were confronted with the archaeological record of Palpa. The result of this investigation is a cultural historical interpretation of the geoglyphs of Palpa solidly based on archaeological evidence.

When compared to other recent investigations of the Nasca geoglyphs, the research presented here has several new methodological contributions. Apart from studying the Palpa geoglyphs for the first time, three new approaches were pursued:

- The consistent application of modern aerial photogrammetry to Nasca archaeology which allowed for the first time the generation of a comprehensive geoglyph database
- The testing of a recent hypothesis that tries to explain the Nasca geoglyphs in terms of Andean traditions of social organization and religious practices
- The first-time use of GIS technology that integrates all available information on a multi-data platform in order to investigate the ordering principles that guided the making and use of geoglyphs.

The structure of this study is as follows. In section 2 the Nasca area and the geoglyphs are described, and a brief overview of their cultural background is given. In section 3, basic issues are identified that have to be addressed when investigating the Palpa geoglyphs. This is accomplished by reviewing recent contributions to Nasca geoglyph research. The approach pursued in the present study is then detailed. In section 4 the aims and scope of the Nasca-Palpa Project are summarized. This is followed in section 5 by a description of the documentation of the geoglyphs. Section 6 is dedicated to the archaeological analysis of the Palpa geoglyphs and the corresponding results. In section 7 the results are then discussed and interpreted in the light of current knowledge on the Nasca geoglyphs. In section 8 results as well as applied methods are summarized and reviewed. Detailed descriptions of archaeological contexts are grouped in a final appendix (section 9). This is followed by a Spanish summary.

2. The geoglyphs in the Nasca region

In this section, the geoglyphs and their environment are described, and current knowledge regarding their cultural context is briefly summarized.

2.1 Definition and description

The commonly used term "Nasca lines" refers to ground drawings or markings that cover many slopes and plateaus in the desert of the Nasca drainage along the foothills of the Andes (fig. 2). Archaeologically these features are called "geoglyphs", a modern composite based on Greek *gē* = "earth, ground" and *glyphō* = "carve, cut out, engrave" (Liddell/Scott 1996: 347, 353). Thus, literally "geoglyph" means "ground carving". As will be shown later, this designation is not altogether fitting, since most geoglyphs were not actually carved into the ground surface. Nevertheless, the term is widely used nowadays and is at any rate more appropriate than the term "Nasca lines" that misleadingly implies a linear shape of all geoglyphs.

Geoglyphs can be found in many arid environments along the pacific coast of the American continent, from California to northern Chile (Clarkson 1999). However, the densest concentration and the highest number of geoglyphs is located in the Nasca area on the south coast of Peru. In this study, the term "Nasca geoglyphs" is used to denote all prehispanic ground drawings in the Nasca drainage, while "Palpa geoglyphs" refers to the subset of the Nasca geoglyphs located in the vicinity of the modern town of Palpa.

Geoglyphs are usually located in a rocky desert environment, which is due to require-

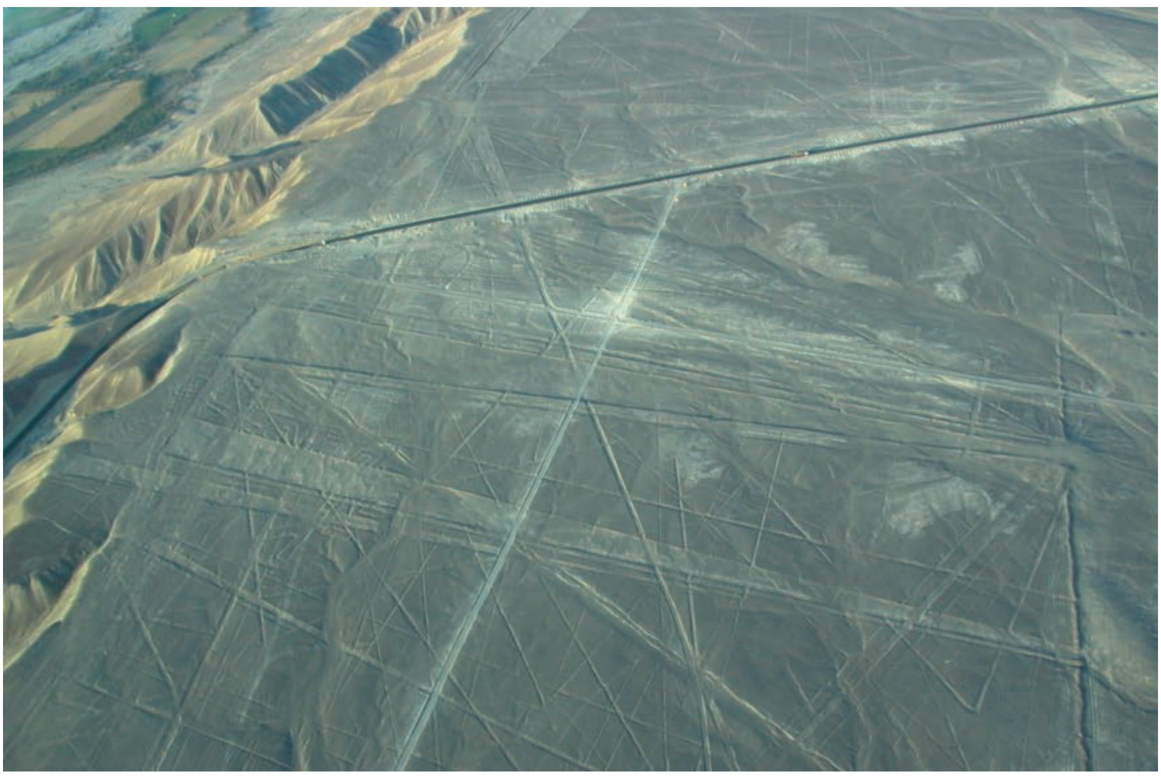


Fig. 2. Geoglyphs along the northern edge of the Nasca *pampa* (center: Panamerican Highway, upper left: Río Ingenio).

Fig. 3. A straight line marked into the desert pavement of the Nasca *pampa*.

Fig. 4. A geoglyph complex on the northeastern edge of the Nasca *pampa*.

ments imposed by their construction technique (fig. 3). The Nasca drainage provides many suitable spots to place geoglyphs. It is circumscribed by the foothills of the Andes to the northeast and the coastal cordillera to the southwest (Eitel et al. 2005). This coastal cordillera is a unique topographic feature which distinguishes the Nasca area from other coastal valleys to the north and south. Its presence led to the development of a large basin that was filled in during the Pleistocene with alluvial sediments composed of sands of different grain size, small to middle-sized stones and rocks, and large boulders. During the Upper Pleistocene, this pediment was cut by rivers running from the Andes to the sea, forming the green oases still visible today. Since the coastal cordillera blocks the rivers from reaching the sea, they join together on its eastern flank to form Río Grande. This is the only river in the Nasca basin with perennial runoff and therefore the only one that cuts through the coastal cordillera.

The beige ridges and plateaus that form a sharp contrast to the green river oases are usually called *pampas*. On their surface, the loose sand between the stones has been blown away by wind erosion, leaving behind a thin, but dense layer of oxidized stones called desert pavement. The vast *pampas* covered by this pavement are ideal drawing grounds that allow the construction of geoglyphs. Thus, the dense concentration of geoglyphs in the Nasca basin, in contrast to other valleys to the north and south, can be explained in part by the unique topographic setting in that region.

To construct a geoglyph on the flat plateaus, the stones of the desert pavement were removed from one place thereby revealing the bright sandy layer below. Piling the dark stones up at another place, usually along the outlines of the cleared areas, further enhanced the contrast in color and brightness between the original and the altered surface. On the valley walls, where the rivers have cut through the sediments, the construction of geoglyphs often required more labor investment since the stone cover is in many cases discontinuous. Here, in order to make a geoglyph, sometimes a part of the sediment had also to be removed – which comes closer to engraving or carving than the geoglyphs on the plateaus – and the excavated melange of sand and stones was heaped up along the furrow.

In any case the making of a geoglyph was technically a relatively simple task requiring only an investment of labor. That is why smaller geoglyphs are still made today. The most prominent, found along the valleys, are advertising drawings promoting private companies, political parties, or government agencies. The plateaus close to the valleys are equally covered with modern graffiti such as the names of individuals, imitations of ancient geoglyphs, etc. Those modern geoglyphs are easily distinguishable from the prehispanic ones.

The predominate kind of prehispanic geoglyph found on the large flat plateaus is a cleared area often in trapezoidal or rectangular form. It is in most cases accompanied by lines running straight or bending several times, forming zigzags, meanders or spirals (figs. 2, 3). Lines and (smaller) trapezoids are also common features on the slopes of valleys and hills. Biomorphic figures like birds, whales, human beings, etc. constitute by far the smallest fraction of the whole corpus, yet at the same time they are the most famous geoglyphs. Larger, zoomorphic figures are usually found on flat plateaus, while smaller, anthropomorphic figures are mostly located on slopes. A common trait of the majority of geoglyphs is that they occur together in complexes, often crosscutting each other, with older geoglyphs obliterated by more recent ones (fig. 4).

The geoglyphs are located in a relatively stable environmental setting. The desert pavement exists unchanged, if not anthropogenically altered, since the Upper Pleistocene (Eitel et al. 2005). When a geoglyph was constructed the underlying sandy layer was exposed allowing the silty elements of this layer along with humidity to cause a thin crust to develop on top of this layer. Such a crust, which is able to largely prevent wind erosion of the exposed surfaces, can only develop, however, if the surface remains undisturbed over a long period of time, *i. e.* after human activity on the *pampas* had ceased. Thus, the abandonment of the geoglyph sites permitted their preservation. This is why many geoglyphs are still easily visible today.

Modern anthropogenic activity on geoglyph sites, or on the *pampas* in general, is hence the major threat to which the geoglyphs are exposed. Geoglyphs close to inhabited zones are today often affected by houses or roads built along the valley margins, by corrals constructed on slopes, or by informal soccer fields built on trapezoids, etc. This is the case at least in areas where the geoglyphs are not protected.

Thus far, only the Nasca *pampa* between Río Ingenio to the north and Río Nasca to the south and west has been declared *zona intangible* by

End Date	Period	Archaeological Culture	Phase
1532 AD	Late Horizon	Inca	
1400 AD	Late Intermediate Period	Ica / Chincha	
1000 AD	Middle Horizon	Wari	
600 AD 450 AD 250 AD	Early Intermediate Period	Nasca	Late Middle Early
1 BC		Initial Nasca	
200 BC 400 BC 600 BC	Early Hoizon	Paracas	Late Middle Early
800 BC	Initial Period		
1800 BC	Archaic		

Table 1. Chronology and cultural history of the Nasca basin (dates based on preliminary results of the Nasca-Palpa Project).

the Peruvian government, and later placed on the list of World Cultural Heritage sites by UNESCO. In most other parts of the Nasca area, access to geoglyph sites is unrestricted. That means today many geoglyphs close to modern settlements are in imminent danger of being destroyed, and old aerial photos indeed reveal that many have already disappeared during the last few decades (Aveni ed. 1990: appendix II fig. 6; Fischer/Künstle 1999).

The geoglyphs on the Nasca *pampa*, specifically those along the south bank of Río Ingenio, are now world famous and are constantly flown over by tourists in small airplanes starting from the Nasca airstrip. Thus, the geoglyphs have become an important economic factor in the city of Nasca where many hotels and restaurants have been established in recent decades to host tourists from all over the world. However, geoglyphs in other zones of the Nasca basin are often poorly known, in many cases not even by the local population. They are therefore usually not cared for. Most of the stone cairns associated with geoglyphs have been looted. In general, protecting the geoglyphs outside the Nasca *pampa* is a problematic task since they are distributed over a wide area, difficult to access, and are not easily discernible on the ground. Furthermore, today's population is claiming parts of the terrain covered by geoglyphs as building zones, quarries, waste dumps or agricultural zones.

All in all, the Nasca geoglyphs remain today a prominent feature in the Nasca landscape, but their preservation is a challenging task. The Peruvian national cultural authority (*Instituto Nacional de Cultura*, INC, Lima) has recently commissioned a study of this issue in close cooperation with UNESCO. In that study (Lumbreras 2000), the geoglyphs, their preservation, their history, their investigation, their importance today, and the threats they are exposed to are surveyed. A master plan has been proposed that aims at the protection and sustainable use of this important cultural resource. Since this master plan is new, it has had as yet only limited impact, but the geoglyph research in Palpa described in this study follows its guidelines closely.

2.2 Chronology and cultural context

The geoglyphs are generally associated with the Nasca culture (table 1) which flourished between the 2nd century BC and the 7th to the 8th century AD in the Nasca region and in the Ica valley further to the north (Rickenbach ed. 1999; Silverman/Proulx 2002). It emerged out of the preceding Paracas culture (Paul ed. 1991) in what appears to be a rather smooth transition marked mainly by technological and stylistic innovations reflected in ceramics and textiles.

Ceramics and textiles are still the best known manifestations of both cultures, and a good part of what we know today of Paracas and Nasca is still primarily based on stylistic, technological and iconographical studies of ceramics and textiles distributed over museums around the world[2]. Another source of information are excavations of cemeteries of both cultures undertaken early in the 20th century[3].

[2] Kroeber 1956; Rowe 1960; Menzel et al. 1964; Sawyer 1997.

[3] Uhle 1913; Tello 1959; Tello/Mejía 1979; Kroeber/Collier 1998; Isla 2001a; Mejía 2002.

For a long time, practically no solid information was available on both Paracas and Nasca other than what was learned from the cemetery excavations of the last century. In recent years, however, a growing number of research projects have been undertaken, including regional settlement surveys covering all tributaries of the Nasca drainage[4] and further valleys to the north and south[5], as well as excavations at important sites like Cahuachi, the biggest site from the Nasca period (Silverman 1993a; Orefici/Drusini 2003), and several smaller sites[6]. Data from many of these projects is still under study, but the results have been limited thus far. However, significant new contributions for both cultures can be expected for the next few years.

Based on current research, during its development the Nasca culture was little affected by foreign influences other than in the late phase. However, it did maintain far reaching trade connections, and its influence can be found in the material culture of adjoining regions, like Pisco and Chincha to the north, Acarí to the south, and the highlands to the east (Moseley 2001: 197 ff).

Nasca economy was essentially based on agriculture which was supported by a highly developed water management system in the valleys (Schreiber/Lancho 2003). Field crops and food procurement played a prominent role in Nasca iconography as depicted on fineware ceramics, along with a pantheon of mythical beings that often showed a combination of human and animal traits (Makowski 2000).

During the course of its evolution, Nasca society was always complex with social and economic hierarchies clearly discernible in the archaeological record. The level of complexity, however, changed through time. In the Early Nasca period, Cahuachi in the middle Nasca valley became the spiritual and ritual, if not political center of the Nasca drainage (Silverman 1993a). Later, the Nasca sociopolitical landscape became more fragmented. During this period, an increasing concern with internal and external warfare, foreign influence, and changing climatic conditions becomes evident in the archaeological record.

Through all these changes, the inhabitants of the Nasca region maintained a high technological level in irrigation and water management, production of fineware ceramics, adobe architecture, etc.[7]. When at the end of the Early Intermediate Period the Wari empire from highland Ayacucho (Schreiber 1992) extended its area of influence to the south coast, the transition from Nasca to Wari seems to have caused more disruptions than the previous transition from Paracas to Nasca, although some cultural traits seem to have persisted well into the Middle Horizon (Isla 2001b).

Whether the geoglyph tradition continued during the Middle Horizon is still a matter of debate. This cultural phenomenon is generally closely associated with the Nasca culture, while its origins, like that of many Nasca cultural traits, are traced back to the preceding Paracas culture (Silverman/Browne 1991). This cultural affiliation is based on iconographic parallels between biomorphic figures and motifs on ceramics and textiles and potsherds found on geoglyphs. Some geoglyphs, mainly lineal and trapezoidal, have also been tentatively dated to the Middle Horizon or even to the Late Intermediate Period (Clarkson 1990). However, there is little evidence to support this. Thus, there is a general consensus that most of the Nasca geoglyphs were made during the time of the Nasca culture and by the society that sustained that culture.

4 Browne 1992; Schreiber 1999; Silverman 2002a.

5 Massey 1992; Cook 1999; Velarde 1999; Valdez 2000.

6 Isla et al. 1984; Vaughn/Neff 2000; Vaughn 2004.

7 Carmichael 1994; Clarkson/Dorn 1995; Orefici 1999; Biermann 2001.

3. Geoglyph research in the Nasca region

In this section, previous research of the Nasca geoglyphs is summarized and critically reviewed in order to define a baseline for the present study. Starting from the premise that a precise documentation is a prerequisite for any analysis and interpretation, both fields of work will be treated here in separate subsections. For both documentation and analysis/interpretation, starting points for investigating the Palpa geoglyphs are identified, and this researcher´s approach is shown to be built on previous research and additional premises. The research in Palpa will then be described in the following sections.

3.1 Geoglyph documentation

3.1.1 Previous research

Anyone who intends to study the Nasca geoglyphs will soon discover that finding suitable data about them is a difficult task. This is somewhat surprising, considering the amount of available literature on the topic. However, as Anthony Aveni, who directed an important research project on the Nasca *pampa* in the 1980s, rightly states,

> "[...] much that has been written about the Nazca lines is too long on speculation and too short on documentation." (Aveni ed. 1990: iii)

Indeed, descriptive data on specific geoglyphs is rarely presented in the literature (*e. g.* Ravines et al. 1995), and photos as well as sketches of geoglyphs are often shown without information about their precise location. The situation is somewhat less problematic with regard to maps of the geoglyphs, because a fair number are available. However, the quality of most of the maps is far below professional standards for the documentation of archaeological features.

The maps can be grouped into five categories:

- Overview maps that show the general location of geoglyphs in a large area, but not the precise shape and location of specific geoglyphs [8]
- Maps that show some, but usually not all geoglyphs of a certain area. They are based on terrestrial measurements of the orientation and length, but not the precise shape of selected geoglyphs (Kern/Reiche 1974: figs. 4, 37; Reiche 1993: *passim*)
- Sketch maps of geoglyph sites usually based on aerial images and/or observations made in the field that often show the basic components of geoglyph complexes, their relation to each other and to their environment, but neither their precise shape nor their exact location [9]
- Maps that show as completely as possible the geoglyphs existing in a certain area. They are based on a photogrammetric analysis of aerial images with the completeness of the map constrained by the scale of the images used [10]
- Compilations of maps that combine data from several of the above mentioned sources (Reiche 1993: encarte 9.1; Reinhard 1996: hojas 2–6) or for which no sources are detailed (Lumbreras 2000: *passim*).

As the overview indicates, all available maps of geoglyphs have certain deficiencies with regard to their accuracy or completeness. This becomes especially evident in the case of the northern part of the Nasca *pampa* for which several maps from different sources are available. These maps show differences not only in scale, coordinate system and graphic rendition, but also in content [11]. Their suitability for archaeological research is therefore limited. Many other parts of

[8] Kern/Reiche 1974: figs. 1–3; Aveni ed. 1990: fig. II.1b; Reiche 1993: 568–569; Reinhard 1996: hoja 1; Lumbreras 2000: 142.

[9] Silverman 1990b: figs. 11–17; Aveni 1990b: fig. II.3; Lumbreras 2000: *passim*; Mejía 2002: fig. /P8:3200(1)/.

[10] Hawkins 1974: figs. 3–6; Instituto Geográfico Nacional 1993; Nikitzki 1993.

[11] Some of these maps are in error. For example, on Nikitzki's map some well known figural geoglyphs that are actually located outside the area covered by the map are depicted in arbitrary places among correctly mapped geoglyphs (Nikitzki 1993).

the Nasca drainage are not covered by archaeological maps. Thus, the state of documentation of the geoglyphs is insufficient. A review of the techniques employed to map the geoglyphs will illustrate the reasons for this unsatisfactory situation.

Terrestrial measurements

The first one to map geoglyphs on the Nasca *pampa* was Maria Reiche. Starting in the late 1940s, she used measuring tape and a compass for surveying (Reiche 1993). Later, she also measured arcs of lines with paper templates (Reiche 1993: fig. 11.5). Her main tool, however, was a theodolite, which she used for mapping the outlines of figural geoglyphs (Reiche 1993: 467 ff). Theodolites have furthermore been used by Reiche and others to determine the azimuth orientation of straight features such as lines, straight sections of figures, or borders of trapezoids[12]. On the resulting maps geoglyphs surveyed this way are usually depicted as standardized lines without information about their precise width, length, or shape. It is generally possible to measure the location, shape and size of a geoglyph using a theodolite (*e. g.* Reindel et al. 1999: figs. 11–13). However, the amount of work is prohibitive when one considers the number of existing geoglyphs. This is why the use of theodolites has largely been restricted to determining the orientation of the geoglyphs.

Aerial photography

Aerial imaging is a common tool for archaeological research on the Peruvian coast. Due to the lack of vegetation in the coastal desert, archaeological remains lay open on the surface and can be recognized to a certain degree in aerial images (depending on image scale). The aerial photographic service of the Peruvian air force (*Servicio Aerofotográfico Nacional*, SAN, Lima) has systematically produced high quality aerial photos of many parts of the country since the 1940s. All coastal valleys have been photographed several times at different image scales during the last decades.

The images were usually taken for cadastral, agricultural, or planning purposes. Therefore, often only inhabited or economically developed zones are covered such as the irrigated and settled valley floors. Desert zones that are not economically developed are usually covered by high altitude flights resulting in small scale pictures. The images can be purchased at reasonable prices from the SAN or IGN (*Instituto Geográfico Nacional*) offices in Lima.

Since SAN images are easily available and affordable for archaeological projects, many researchers use them as a natural starting point for their investigations. In the Nasca region, the SAN was furthermore commissioned on several occasions to perform special flights to take photos of geoglyph concentrations on the Nasca *pampa* (*e. g.* Reiche 1976: 21; Hawkins 1974). Many well known and often published photographs of Nasca geoglyphs have been taken during these flights. Thus, SAN aerial images are a widely used tool in Nasca archaeology. Archaeological sites are located, and sometimes classified, based on what can be discerned in the SAN photos. Often, sketch maps are produced with the aid of these images, and they are used in publications to illustrate archaeological contexts.

However, in spite of these efforts SAN images do not cover all areas with geoglyphs, nor at a scale that enables the recognition of the narrow lines. Therefore, additional aerial images were taken by some projects. In 1984, within the framework of Anthony Aveni's project (see section 3.2.1), an unmanned, tethered balloon to which a small format camera was attached was used. The aim was to take low altitude, vertical images of several line centers. However, only one picture of a line center in the southern part of the *pampa* could be taken due to technical problems (Johnson et al. 1990: 278, fig. VII.2, 4; Aveni 2000a: 156–159, figs. 40, 41). Thus, the contribution of balloon photography to the documentation of geoglyphs is so far quite limited[13].

In Aveni's project, after balloon photography had largely failed to deliver the desired results, it was decided to rent a small aircraft to take a series of vertical aerial images of a part of the Nasca *pampa* with an aerial camera (Johnson et al. 1990: 278). The image flight covered the northern bank of Río Nasca well into the *pampa*. The resulting images had a scale of 1:24,000 and were combined into a photomosaic (Aveni ed. 1990: supplement). However, the film supply, originally calculated only for a limited number of shots to complement the balloon flights, was not enough to cover the whole *pampa*, to achieve a greater scale, or to allow a general overlap of the images that would have

[12] Reiche 1976; Hawkins 1974; Aveni 1990b.

[13] Balloon photography has also been used outside the Nasca area by Rodríguez to document a figural geoglyph in the Chillón valley (Rodríguez 1999: figs. 7, 8, 16).

enabled full stereo processing (Gerald Johnson, personal communication 2003). Thus, while being helpful for general orientation in the southern section of the Nasca *pampa*, the photomosaic allows only the largest geoglyphs to be discerned.

Photogrammetry

Aerial photography is normally used for orientation and illustration. Some researchers, however, have analyzed aerial images using photogrammetric means. Photogrammetry allows accurate 3D measurements of objects based on two or more images of them. Its application is therefore a qualitative step further compared to the simple sketch maps produced from single aerial images.

In the Nasca area, there are three published geoglyph maps developed using photogrammetric methods (see above). All of them cover the same area: the northern edge of the Nasca *pampa* along the left bank of Río Ingenio, *i. e.* the area with the largest concentration of geoglyphs and with most biomorphic figures. British-American astronomer Gerald Hawkins was the first to apply photogrammetry to Nasca archaeology. His map is the only one for which specific information on the database is given:

> "We decided to extend the stereographic and standard photogrammetric method used at Stonehenge and Callanish in Britain. This method provides contours above mean sea level and a rapid and accurate mapping of all surface features. We cooperated with the Geophysical Institute of Peru and the Servicio Aerofotográfico Nacional (SAN) of the Peruvian Air Force. On August 1, 1968, SAN obtained 30 overlapping, high-resolution photographs of the area. These were used to make a ground plan to the scale of 1:2000, so that 10 centimeters on the chart represented 200 meters on the ground." (Hawkins 1974: 125)

Unfortunately, no information as to the scale of the aerial images is given in Hawkins' report. The map is published at a reduced scale, and the geoglyphs are depicted as dashed lines which seriously affects interpretation of the map. According to Hawkins, all geoglyphs wider than 30 cm are depicted, but the narrowest lines encountered in the field had a width of 10 cm (Hawkins 1974: 119, 125). Thus, Hawkins' map is an important step forward in the documentation of the geoglyphs, but it still has certain deficiencies.

After Hawkins' efforts, two other maps were elaborated with photogrammetric methods (Instituto Geográfico Nacional 1993; Nikitzki 1993). They were published without accompanying notes, and no information about the photos for either of them is given. It seems possible that both maps were based on the same set of aerial images used by Hawkins. However, the three maps have different scales, very different graphic styles, and show discrepancies in their content, *i. e.* the geoglyphs depicted on them. It is not clear if archaeologists contributed their expertise to the making of either of the three maps.

3.1.2 Review of documentation methodology and research approach

Considering how fragile the geoglyphs are today, their documentation is utterly important in terms of their long-term preservation. Moreover, without good documentation any attempt at cultural historical analysis or interpretation will be problematical. Hence, any new study of the geoglyphs has necessarily to start with reliable and accurate documentation.

The maps that are available have considerable deficiencies because the focus of most research projects has thus far been on explaining the geoglyphs rather than on recording them. And as mentioned previously, applied methods of geoglyph recording have not proven efficient enough. In order to overcome these shortcomings, it is necessary to take advantage of the diverse tools offered by modern mapping methodology.

Topographical surveys are today usually based on remote sensing techniques. In remote sensing, information about an object – in this case, the geoglyphs on the earth's surface – is obtained by sensors that capture electromagnetic radiation emitted or reflected by the object, *e. g.* sunlight or radar rays. Different types of sensors allow the geometry, composition, temperature, use, etc. of the earth's surface or objects upon it to be recorded. To document the Nasca geoglyphs, optical airborne or spaceborne sensors are possible candidates since they provide information about the location, size, and shape of the geoglyphs, as well as the surrounding terrain.

Satellite remote sensing

So far, data obtained by spaceborne sensors has not been used for documenting the Nasca geoglyphs, because high resolution satellite imagery has become available only recently. The level of

Satellite / Sensor	Swath width	Spectral Band Pan	Spatial Resolution	Website
COSMOS KVR-1000	40.0 km	0.51-0.76 µm	2.0 m	www.sovinformsputnik.com
EROS-A	13.5 km	0.50-0.90 µm	1.8 m	www.imagesatintl.com
IKONOS	11.3 km	0.45-0.90 µm	1.0 m	www.spaceimaging.com
ORBVIEW-3	8.0 km	0.45-0.90 µm	1.0 m	www.orbimage.com
QUICKBIRD-2	16.5 km	0.45-0.90 µm	0.61 m	www.digitalglobe.com

Table 2. Satellites and sensors that provide high resolution panchromatic imagery (as of May 2004).

detail visible in an image depends on its spatial resolution, which can be expressed in pixel size. A resolution of 1 m pixel size means that a square of 1 m edgelength on the ground has a unique color, or gray value, in the digital image. In Palpa where all geoglyphs are to be recorded, imagery is needed that allows detection of even the narrowest lines, which have a width of approximately 10 cm. To show such geoglyphs with enough detail to map them accurately the pixel size should at least come close to their minimal width. Ideally, it should be even smaller.

Such high spatial resolution is so far not commercially available from spaceborne sensors, even though over the past few decades image resolution has increased considerably. When the last well documented fieldwork on the Nasca *pampa* was carried out in 1984 under the direction of Anthony Aveni, the best available images were those taken by NASA's analog Large Format Camera (LFC) mounted on the Space Shuttle during mission STS-41G (Doyle 1985). Depending on orbit, film, and atmospheric conditions, spatial resolutions from approximately 5 to 20 m were achieved. Furthermore, images taken by the Landsat 4/5 Thematic Mapper sensor with a spatial resolution of 30 m were available at that time (Lillesand et al. 2004: tables 6.1, 6.2).

In 1997, when the first photo flight over Palpa and Nasca was performed within the framework of SLSA's project with airborne sensors, the best available resolution of civil spaceborne sensors was 5.8 m which was provided by the Indian IRS-1C and D satellites (Lillesand et al. 2004: table 6.8). By then, the Russian government had made available selected images taken by the analog KVR-1000 camera mounted on several satellites of the military COSMOS series (Lillesand et al. 2004: 463). These panchromatic images offer a spatial resolution of 2 m, but cover mainly parts of Europe, Asia, and North America.

At the time of writing (2004), panchromatic sensors mounted on satellites launched by private companies capture imagery with a spatial resolution that comes closer to the useful range for geoglyph mapping yet is still not high enough. The recently launched EROS-A satellite provides digital imagery with a spatial resolution of 1.8 m. The IKONOS 2 as well as ORBVIEW 3 satellites deliver a spatial resolution of 1 m, while QUICKBIRD 2 even achieves 0.61 m pixel size (Lillesand et al. 2004: table 6.14). As of May 2004, the Nasca *pampa* was covered by four QUICKBIRD images and several series of IKONOS images, whereas no high resolution EROS A or ORBVIEW images have thus far been taken over that area. For Palpa, only one QUICKBIRD image covering the eastern half of the area of investigation is currently available[14].

In the years to come, new civil sensors with a panchromatic resolution of 0.5-0.4 m are likely to be launched[15]. It is to assume that in the military realm the best available spatial resolution is already much higher, probably in the centimeter range. However, due to legal and other constraints (Fritz 1999), such imagery is unlikely to become available to civil users in the foreseeable future[16].

Table 2 gives an overview of the characteristics of several sensors that currently offer the highest available spatial resolution in panchromatic imagery. The actual availability of images over specific areas can be checked via the company websites.

[14] Information based on survey of online image databases of the respective companies conducted on May 13, 2004. For up-to-date results see company websites as given in table 2.

[15] See press releases "DigitalGlobe unveils plans for next-generation spacecraft constellation" (March 23, 2004) at www.digitalglobe.com and "Space Imaging reacts to new White House remote-sensing policy" (May 13, 2003) at www.spaceimaging.com (accessed May 13, 2004).

[16] See also fact sheet on "U.S. commercial remote sensing policy" (April 25, 2003), available as PDF at www.licensing.noaa.gov (accessed May 13, 2004).

All in all, imagery from spaceborne sensors is currently not available at a spatial resolution that would allow a detailed recording of the Nasca geoglyphs including the narrowest lines which was the aim of the Nasca-Palpa Project. Nevertheless, if the focus is put on other aspects then data provided by satellite sensors can be helpful in many ways. For example, a partial geoglyph mapping may be accomplished using satellite images. Virtually all areal geoglyphs, like trapezoids and rectangles, as well as the wider lines (yet not the famous biomorph figures) are visible in existing IKONOS and QUICKBIRD images. Mapping these larger geoglyphs would provide a basic documentation which for many geoglyph sites is not yet available. Satellite images can be ordered in georeferenced form and used for mapping in 2D or even stereoscopically in 3D if stereo images are available. Considering the need for conservation and protection of the geoglyphs today, such an approach would already be helpful in many cases, and the resulting maps could be used as starting point for further studies.

The generation of digital terrain models (DTMs) or maps of large areas, *e. g.* the whole Nasca basin, is another task for which satellite sensors offer suitable data. In Peru, governmental agencies like SAN or IGN use combinations of images taken by airborne and spaceborne sensors to produce and update maps and digital terrain models of the whole country, though so far only at small scales. Other sources offer DTM data based on spaceborne sensor imagery as well. As an example, stereo imagery acquired by NASA's ASTER sensor mounted on the TERRA satellite (Lillesand et al. 2004: 481 ff, table 6.21) is used to generate DTMs with up to 7 m horizontal accuracy. Stereoscopic imagery with different resolution from other sensors (SPOT, JERS-1, ADEOS, IKONOS etc.) is likewise suitable for DTM generation.

Another source for height information of the earth's surface is synthetic aperture radar (SAR) interferometry. The phase difference of microwaves emitted and received by two radar sensors arranged along a known baseline allows the elevation of the point on the surface from which the waves are reflected to be calculated. A large-scale application of this method to generate DTMs was NASA's Shuttle Radar Topography Mission (SRTM) flown in 2000. During this mission, approximately 80% of the surface of the earth was recorded by radar interferometry. SRTM data enables the generation of DTMs with an accuracy of better than 20 m (horizontal) and 16 m (vertical) (Lillesand et al. 2004: 712 ff).

From 1997 to 1999, SAR interferometry has been applied to detect geomorphological change in the desert surface of the Nasca *pampa* (Lefort et al. 2003, 2004). Although the results show that a good part of the vast plain is relatively stable and does not show any change, erosion channels coming out of the foothills of the Andes and crossing the *pampa* are clearly visible. The monitoring of geoglyph sites and especially the identification of areas where natural erosion is likely to occur is important for efficient geoglyph preservation (cp. Lumbreras 2000).

Aerial photogrammetry

The many benefits of satellite imagery notwithstanding, aerial images are still the best choice if an accurate and complete 3D mapping of all geoglyphs of a given area is needed. They potentially offer a spatial resolution high enough to identify even the narrowest lines. Depending on flight height, the camera used, and the area to be covered, images at a scale of up to 1:2,500 can easily be obtained during standard photo flights. The larger the scale the more images are required to cover a given area.

3D object extraction and DTM generation require the taking of overlapping images in order to obtain stereopairs suitable for a photogrammetric analysis. In order to map the Nasca geoglyphs in the Palpa area, it was decided to focus on an analytical photogrammetric analysis of large scale aerial images. Photogrammetry has seldom been applied to Nasca archaeology, and the results are rather mixed. This, however, seems largely because the scale of the images used did not allow a complete mapping that would have included the many narrow lines. Furthermore, the mapping efforts seem to have been accomplished largely without archaeological expertise.

Thus, the potential of modern photogrammetry for geoglyph recording should not be judged from previous efforts alone. Rather, a survey of recent applications in cultural heritage recording shows that modern analytical and/or digital photogrammetry is a powerful tool if applied correctly. In Europe, Asia, and Australia, photogrammetry has successfully made its way into every-day archaeological research. In New World archaeology, however, it has rarely been employed. Some recent exceptions include the documentation of Maya architecture in Honduras and Mexico (Gray/Boardman 2002; Desmond/Bryan 2003), the recording of monumental *adobe* architecture on the Peruvian north coast (Reindel 1993; Sauerbier et al. 2004), and the documentation of terraces and other structures in the northern Peruvian Andes (Capra et al. 2002).

Photogrammetry, like laser scanning, allows for high accuracy 3D recording at relatively low cost. In the following part, the potential, the procedures, and the requirements of photogrammetry are briefly outlined. Detailed introductions about the principles of photogrammetry are available elsewhere[17].

The American Society for Photogrammetry and Remote Sensing (ASPRS) defines photogrammetry as follows:

> "Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment, through processes of recording, measuring and interpreting images and patterns of electromagnetic radiant energy and other phenomena." (www.asprs.org/asprs/society/about.html, accessed May 27, 2004)

In other words, photogrammetry allows the acquisition of metric information about the size, shape, and position of a given object – *i. e.* data that allows the geometric reconstruction of that object – by measurements of the object in images, thus eliminating the need to measure the object itself. In this sense, photogrammetry is a subfield of remote sensing, where information about an object is obtained by sensors that do not touch the object itself, but rather record electromagnetic radiation emitted by the object. In photogrammetry, optical sensors like cameras are used to capture lightwaves reflected by the object from which an image is generated. This accomplished,

> "[t]he fundamental task of photogrammetry is to rigorously establish the geometric relationship between the image and the object as it existed at the time of the imaging event. Once the relationship is correctly recovered, one can then derive information about the object strictly from its imagery." (Mikhail et al. 2001: 1)

Photogrammetry allows a wide range of objects to be surveyed and measured from microscopic particles to whole planets (see Luhmann 2002 for an overview of recent research). In the case of cultural heritage, the advantages of measuring in images instead of at the actual object become readily evident:

- Taking images of an object is usually faster and easier than physically measuring it
- In the case of delicate objects, measuring in images helps avoiding potential damage caused by surveying activities
- An object can be measured even if it has disappeared or considerably changed since the images were taken.

Photogrammetric measurements in images basically require suitable images, information about the camera, and 3D survey control data:

- Images: From a single image of an object, only 2D data can be easily derived. For measurements that aim at the recovery of metric 3D data, at least two different images of the object are usually needed. Similar to the way human vision works, two views of an object from slightly different viewpoints allow the object to be seen in 3D. This basic procedure of photogrammetry is called stereoscopic viewing. In order to record an object in 3D, a series of images has to be taken in a way that every part of the object is covered by at least two adjoining images. The overlapping areas of the images allow not only stereo viewing, but also 3D measurements.
- Camera: The way an image of a real-world object is generated depends on technical characteristics of the camera like focal length, lenses used, etc. These parameters determine the distortion of the image when compared to the object. The technical characteristics of the camera can be calibrated by taking photos of a test field of points whose spatial positions have been measured.
- Control data: To enable the correct scaling and positioning of recorded objects, the precise location of certain points, or the precise length of certain ranges visible in the images needs to be established by independent measurements.

Thus, images and control data have to be acquired at the object itself while camera calibration data can either be obtained in the office or simultaneously during the process of image acquisition (self calibration). The time necessary to acquire data is usually much shorter than data processing and analysis which has to be carried out in the office.

[17] Mikhail et al. 2001; Lerma 2002; Luhmann 2003; Kraus 2004.

Once the camera has been calibrated the images can be oriented relatively to each other. Using control data they can then be oriented absolutely in space. In the overlapping area of two adjoining and oriented images (stereopairs) 3D measurements can be carried out. The results of the measurements are then digitally recorded. Based on this data, the geometry of the object can be reconstructed in a virtual computer environment. If photorealism is needed, texture is generated from the images and draped over the geometric model. Different products can be derived from the model, like maps and plans. The digital 3D data is especially well suited to be integrated on a GIS platform where it can not only be managed and edited, but also analyzed as for inherent spatial relations between its components.

If these prerequisites are complied with modern aerial photogrammetry seems a powerful tool to accurately record the Nasca geoglyphs in 3D. The geoglyphs are distributed over wide, largely flat terrain and lay open on a surface not covered by vegetation. These are ideal conditions for aerial photogrammetry since the geoglyphs can be completely recorded by taking vertical aerial images organized in parallel strips with a calibrated aerial camera mounted on an aircraft flying at low altitude. Today control data can easily be obtained by determining the absolute position of certain points clearly identifiable in the aerial images with the global positioning system (GPS). That way, the photogrammetric fieldwork can be reduced to a photo flight and some GPS measurements. The actual mapping and drawing of the geoglyphs can then be done in the office using photogrammetric hardware and software.

Complementary archaeological fieldwork

The great potential of photogrammetry notwithstanding, it cannot substitute archaeological fieldwork. The geoglyphs were made, used, and perceived on the ground and should also be studied on the ground. Ground level contact with the geoglyphs allows them to be correctly identified and mapped using aerial images. And, verification of the resulting maps in the field allows an assessment of the quality of the mapping procedure. Also certain aspects of the documentation of the geoglyphs cannot be captured by image based recording. For example, cultural remains like ceramics or lithics, stratigraphic relationships between geoglyphs, and alterations of geoglyphs are important aspects that can hardly be documented in images alone. Thus, photogrammetric recording should be combined with thorough archaeological recording. Since the actual mapping of the geoglyphs can be done in the office fieldwork can be dedicated entirely to the description of geoglyphs and any associated cultural remains which is an important advantage.

Geographic Information System (GIS)

To store, manage, analyze, and visualize hybrid data in an efficient and sustainable way geographic information systems (GIS) are especially suitable. GIS has become an important tool in archaeological research since the 1990s[18]. This is due to the capability of GIS to make use of the inherent spatial component of archaeological data, as stressed by the authors of the recently published first textbook on archaeological applications of GIS:

> "Artefacts, features, structures and sites, whether monument complexes, chance finds of individual objects, scatters of ploughsoil material or rigorously excavated structural and artefactual remains, are all found *somewhere*. As well as the position of the feature or artefact itself there may also be a series of *relationships* between the locations of features and artefacts, revealed by significant patterns and arrangements relative to other features and things." (Wheatley/Gillings 2002: 3; emphasis in original)

A strong point of GIS is that it allows the placing of archaeological features and finds in a topographic and environmental context, and to systematically analyze patterns and interdependencies between different types of data. This ability is partially responsible for the increased focus on landscape archaeology in recent years[19]. However, GIS is a useful tool not only on a regional scale, but also at the site level for managing and analyzing data resulting from geophysical prospection or excavation (Neubauer 2004).

A geographic information system is mainly composed of tools for data storage, analysis, and visualization (cp. Wheatley/Gillings 2002: fig. 1.2). Its core is a database management system (DBMS) in which archaeological as well as other data is stored (Ryan 2004). A careful structuring of the database is decisive for effi-

[18] Baena et al. 1997; Kvamme 1999; Gourad 1999.

[19] Gramsch 1996; Gillings et al. eds. 1999; Anschuetz et al. 2001.

cient data retrieval, editing, and querying. A second element of a GIS is the one which is often regarded as the GIS itself: it has tools for manipulating and analyzing the stored data and for interrelating different types of data. A third and final important element is the visualization and output of data and results of analysis, be it on-screen or in other forms, *e. g.* as maps.

In the Nasca region, the capabilities of GIS could not yet be exploited because of a lack of suitable data. Concerning the geoglyphs which occupy a prominent place in the Nasca landscape, a GIS-based analysis has been needed for some time to help understand the ordering principles that guided their construction:

> "In the future, perhaps GIS analysis will reveal systematic spacing of geoglyphs that we do not perceive from ordinary examination of aerial photographs and maps." (Silverman/Proulx 2002: 179)

The intended photogrammetric analysis of the Palpa geoglyphs in combination with their thorough recording in the field was expected to result in exactly the kind of hybrid data GIS is designed to analyze. Thus, GIS was utilized for data storage, analysis, and visualization as important complement of fieldwork from the beginning of the project.

All in all, in order to document the geoglyphs of Palpa in an efficient and accurate way a new approach combining procedures of modern aerial photogrammetry, archaeological field survey, and GIS technology seemed most promising. Such an approach would allow the establishment of a suitable database indispensable for any further cultural historical investigation into geoglyph function and meaning.

3.2 Geoglyph analysis and interpretation

3.2.1 Previous research

The search for the function and meaning of the Nasca geoglyphs has been the driving force behind their investigation since they were first spotted from a hill east of Nasca by Peruvian archaeologists Julio C. Tello and Toribio Mejía in 1926 (Mejía 2002: 182). Many people, but surprisingly few archaeologists, have since contributed to the topic. The most prominent hypothesis in the popular literature is still that of Paul Kosok and Maria Reiche who considered the geoglyphs "[. . .] the largest astronomy book in the world" (Kosok 1965: 49). To the present day the notion that lines point toward stars and figures depict astral constellations is repeated in newspaper articles and tourist guidebooks. The main reason for the persistence of this explanation is that Maria Reiche, supporter of the astronomical hypothesis, had for many years a quasi monopoly on the interpretation of the geoglyphs and was a media favorite. Although the geoglyphs were first associated with astronomy by American geographer Paul Kosok in 1941, it was Maria Reiche who then promulgated and expanded his explanation.

The origin of the astronomical hypothesis and its basic elements have been described in a series of publications by its main protagonists[20]. They are well known and will not be repeated here. The main aspect of the hypothesis, *i. e.* the alleged orientation of lines or straight sections of geoglyphs towards the rising, setting, or zenith point of the sun and other stars on calendrically important dates (*e. g.* solstice or equinox days), has been thoroughly tested on several occasions by astronomers and other researchers[21]. While the premises and methods of these tests differed, and their results are not identical, all of them show that astronomical orientation can be ruled out as main ordering principle of the Nasca geoglyphs. In spite of these results, the astronomical hypothesis remains today the starting point of current research, such as the project directed by geodetic engineers from Dresden, Reiche's hometown[22]. Therefore, a few critical comments on some often overlooked aspects of Kosok's and Reiche's hypothesis seem appropriate.

The famous story of Kosok being " . . . struck with the thought that these remains could have had some connection with early calendrical and astronomical observations" (Kosok 1965: 52) is often associated with a picture of him standing beside a line that points to the sunset above the flat horizon. This picture, which is not, although sometimes cited as such, reproduced in his 1965 publication, was reportedly taken by his wife Rose (Aveni 2000a: 91) probably someplace on the Nasca *pampa*. If this is true, then it cannot have been taken on June 22, 1941 because on that day Kosok and his wife were standing on the edge of a plateau near Llipata in the vicinity of Palpa, as clearly stated in Kosok's original report (Kosok/Reiche 1947: 202).

[20] Kosok/Reiche 1947, 1949; Kosok 1965; Reiche 1976, 1993.

[21] Hawkins 1974; Aveni 1990b; Ruggles 1990.

[22] Teichert/Richter 2001, 2003; Teichert et al. 2002.

The specific line that pointed to the sunset on that day, a photo of which is shown in the report, runs down the hill and crosses a wide *quebrada* that opens up to the Grande valley. The line is part of a set of lines radiating out in different directions from the point where Kosok was standing, an arrangement today called a line center. To the west, it ended in a large trapezoid (now destroyed) on the left bank of Río Grande. On the right bank of Río Grande a range of rocky hills sharply rises forming a jagged horizon high above the valley. Thus, from where Kosok was standing the line can only roughly indicate a point on the horizon since the horizon is on a considerably higher level than the visible end of the line[23].

What Kosok saw on that decisive day was not a flat horizon where the sun could neatly set over the distant end of a line, but instead a high range of hills, its characteristic peaks and gullies clearly visible against the setting sun. It has been cogently proposed by other researchers that such a setting could have easily served for astronomical observations, since the sunset can be observed over different and easily distinguishable points during the course of the year (Reinhard 1996: 32, fig. 29). For reliable calendric observations in such a setting a fixed viewpoint for comparable observations is the only requirement. Lines or markings on the ground, however, are not needed in such a scenario. Thus, although astronomical observations may have been undertaken, there is little reason to assume that the geoglyphs were related to them – at least not in the way proposed by Kosok.

It may be argued that in a setting lacking a distinctive row of hills, like the Nasca *pampa* as visible in the famous photograph mentioned above, lines served as substitutes for hills that indicated the position of the sun and starts on important dates. If this was true there should be an observable difference in the repertoire of geoglyphs between areas with a flat horizon and others with a hilly horizon. On the basis of available data this question cannot be decided, but there seems to be a high degree of similarity between geoglyphs of different parts of the Nasca region.

According to the astronomical hypothesis lines are not only associated with sunsets, but also with the position of certain stars in the night sky. If this was the case, then ancient observers on the *pampa* would have encountered a practical problem that has rarely been mentioned. The lines on the ground are hardly visible by night, if at all. They could therefore not have fulfilled their alleged function. So far there is no evidence whatsoever that the course of the lines was being illuminated. Such an illumination, on the other hand, would have affected the visibility of the stars. Even in the daytime, the visibility from the ground along a line towards the horizon is often limited, for example due to afternoon haze that makes the horizon appear fuzzy.

Thus, from a practical point of view lines could most likely not have indicated the position of stars and do not even seem especially well suited to indicate sunsets over flat terrain. Furthermore, though lines may be clearly visible over a certain distance, they are in many cases much longer than observable from a ground perspective, a fact that cannot be explained by astronomical observations. Besides, especially on the Nasca *pampa*, a major part of lines are organized around line centers from which they radiate in all directions. Thus, the existing range of line orientations covers practically the full circle. If specific points on the horizon were to be highlighted by the orientation of lines, such an arrangement would not have made any sense[24].

All in all, lines on the ground seem of little value for celestial observations due to practical considerations. This questions the plausibility of the astronomical hypothesis even without addressing the issue of prehispanic astronomical knowledge. Astronomy may well have played an important role in the Nasca region. It seems, however, misleading to relate astronomical activities to geoglyphs. The often repeated notion that the Nasca geoglyphs can only be understood when viewed from above does little to further an understanding of the geoglyphs, nor does the equally well known proposal that looking up into the sky from the *pampa* help

[23] Kosok´s view on that day can be appreciated in pictures published by Morrison (1987: 39) and Moseley (2001: fig. 67). The combination of lines and trapezoids south of Llipata on which Kosok was standing has since been sketch-mapped by Horkheimer (1947: fig. 11; cp. fig. 5) and Rossel (1977: fig. 44) and was interestingly labeled "Línea Sirius" by Reiche (1993: 568–569). It has also been mapped by the Nasca-Palpa Project (supplement 2).

[24] The objections mentioned here address straight lines which Kosok and Reiche originally based their reasoning upon. Apart from straight lines, Reiche and others also checked borders of trapezoids and rectangles, as well as straight portions of bended lines and figures for possibly meaningful orientations. The above mentioned issues apply to them as well.

to understand them. A ground perspective, that is, viewing the geoglyphs from the ground seems the most promising location from which we will be able to learn more about the geoglyphs.

The astronomical hypothesis plays only a marginal role today, at least in scientific research, because it has been tested and largely rebutted. The aforementioned practical issues further bring into question its plausibility. However, fifty years ago, following Kosok's and Reiche's early publications, the notion of advanced astronomical knowledge in prehispanic times manifested by spectacular drawings in the desert made the Nasca geoglyphs world famous. By the 1960s, they attracted *aficionados* from all over the world who tried to explain the geoglyphs from very different viewpoints that were often only loosely, if at all, related to Andean cultural history. Some of these hypotheses are listed in recent reviews (Aveni 1990a; Silverman/Proulx 2002: chapter 7). Rostworowski comments that

> "[a]lgunas hipótesis son extravagantes por la necesidad humana de buscar lo maravilloso, que desligue a la persona de su monótono diario vivir y la haga soñar con extraterrestres y un aeropuerto espacial." (Rostworowski 1993: 190)

Hence, we face a wide range of hypotheses concerning the function of the geoglyphs, running the gamut from landing strips for spacecraft to Olympic runways or pieces of art. Of all these ideas, however, relatively few are based on actual scientific research in, or into, the Nasca region.

The situation has fortunately changed since 1980. In the last two decades several serious investigations of the Nasca geoglyphs have been carried out that have brought about an actual paradigm shift in their interpretation. A review of the results of these recent efforts shows that a general consensus has emerged from them concerning the basic function and significance of the Nasca geoglyphs. For the purpose of the present work, it seems therefore fruitful to review these recent serious contributions in order to identify a starting point for the research presented here. Several overviews of the long history of geoglyph research since 1926 have been written by a number of authors[25]. It is recommended that they be consulted as background information. The following are short summaries of important investigations of the Nasca geoglyphs carried out since 1980 and the implications of that research for this project.

Johan Reinhard

American anthropologist Johan Reinhard studied the Nasca geoglyphs in the early 1980s as part of a broader ethnographic and archaeological investigation into Andean religious concepts and practices (especially mountain worship). His fieldwork in Nasca was limited to the locating of shrines on mountain tops around Nasca (Reinhard 1988, 1996). Basing his arguments on historic sources and ethnographic reports, Reinhard shows that in Andean religious traditions mountain deities played a prominent role and were closely associated with water, weather, and fertility, while their veneration often involved ritual processions along straight lines. Since oral traditions in the Nasca region also speak of mountain deities (namely associated with Cerro Blanco, on the left bank of Río Nasca), he relates the lineal geoglyphs to mountain worship and a cult revolving around water and fertility. It is also a context into which the motifs of the figural geoglyphs fit neatly (Reinhard 1996: 36 ff). According to Reinhard,

> "[. . .] lines played a role in a water ritual by connecting a central place of worship (the mound) with critical places in the irrigation system [. . .]" (Reinhard 1996: 25)

He assumes that lines were made by kin groups which would explain their great number, and that line centers on elevated points were locations where offerings were placed (Reinhard 1996: 29 f).

Reinhard's attempt to interpret the geoglyphs on the basis of Andean religious traditions marks, together with the research undertaken by Aveni and his team (see below), the beginning of a reconsideration of the cultural background of the geoglyphs that had long been neglected. He shows that persistent Andean religious concepts and social organizing principles can potentially explain the Nasca geoglyphs. However, the archaeological evidence that Reinhard offers to support his view is largely restricted to nonspecific references to common finds on and around lines like ceramic vessels or seashells.

Anthony Aveni

American astronomer Anthony Aveni has investigated a wide range of archaeological contexts throughout the Americas with regard to their astronomical significance (for an overview see Aveni 2003). His interest in the Nasca geoglyphs

[25] Morrison 1987; Aveni 1990a, 2000; Lumbreras 2000; Makowski 2001; Silverman/Proulx 2002.

was sparked when he noticed similarities between the geoglyphs and the *ceques*. *Ceques* are imaginary connecting and dividing lines from the Inca period found in highland Cusco and described by Spanish chroniclers (Zuidema 1964; Bauer 2000). Aveni had been investigating them together with Tom Zuidema before he began his work on the Nasca geoglyphs.

In the early 1980s, Aveni led a team of archaeologists, anthropologists and astronomers to study the lineal geoglyphs on the Nasca *pampa* that until then had received less attention than the figural ground drawings[26]. They found that on the Nasca *pampa* more than 700 straight lines are grouped around approximately 70 line centers from where the lines emanate radially, many of them interconnecting several such centers. Thus, a possible order in the lineal geoglyphs on the Nasca *pampa* became discernible (Aveni 1990b). According to Aveni, the radial character of the system of lines that connect centers established on naturally elevated points bears strong structural, and possibly functional resemblance with the Cusco *ceque* system. The radial *ceques* divided and organized the terrain, connected places of religious importance (*huacas*), and were often walked upon in spite of their straightness in rugged terrain. Aveni and his team found ample evidence that the Nasca lineal geoglyphs were equally walked upon, that many of them showed signs of having been used as footpaths, and that they connected

> "[...] important points that delineate the flow of water across the pampa: e. g., bends in rivers, dunes overlooking the banks of the rivers and their tributaries, or the last hill by which one descends down onto the pampa as one approaches from the Andes." (Aveni 1990b: 110)

Taking even further the analogy to *ceques* and *huacas* which in highland Cusco were closely associated with certain social groups (*ayllus*), Aveni speculates that Nasca social organization may be reflected in the Nasca line system (Aveni 2000a: 180).

Concerning a possible orientation of certain lines towards astral constellations, Aveni and Ruggles put the astronomical hypothesis to a rigorous statistical test (Aveni 1990b; Ruggles 1990). As a result, they suggest that astronomy might have played a certain role in the construction of some lines, but clearly rule out that it could have served as general organizing principle underlying the system of lines. Summarizing his team's research, Aveni concludes that

> "[...] the Nazca lines [...] were intended, at least in part, to be walked over in some complex set of rituals that pertained most likely to the bringing of water to the Nazca valley and perhaps to associated mountain worship." (Aveni 1990b: 112)

As already mentioned, the work accomplished by Aveni and his team marks, together with Reinhard's and Silverman's research, the beginning of a new era of scientific investigation into the Nasca lines after the dominance of Maria Reiche's ideas. They have redirected the research agenda toward an Andean cultural framework for interpretation of the geoglyphs. Aveni´s fieldwork showed that a thorough investigation of the lines on the ground, hardly attempted before, can reveal important insights into the nature of the Nasca geoglyphs. However, some shortcomings should not be overlooked.

His research on the *pampa* did not help establish the missing link to the largely unstudied settlements in the valleys – probably one of the reasons why Aveni relies heavily on ethnohistoric and ethnographic parallels to interpret the geoglyphs. Furthermore, like many of his colleagues, he tends to treat the alleged system of lines as a single context, without differentiating chronologically. Finally, he does not present any specific evidence recovered in the field that would clearly support the idea of rituals being performed on the geoglyphs. The same applies to his references to Nasca social organization. Nevertheless, the publication of the results of the investigations of Aveni's team (Aveni ed. 1990) is still the most comprehensive study on the Nasca geoglyphs available.

Persis Clarkson

Canadian archaeologist Persis Clarkson has specialized in geoglyph research in the Americas. Her areas of interest range from the southwestern US to southern Peru and northern Chile (Clarkson 1999). In the early 1980s she took part in Aveni's project, conducting an extensive survey of cultural remains on the Nasca *pampa*. She documented archaeological features like stone circles, cairns, structures and artifacts on and nearby the ground drawings. She tried to establish a cultural and environmental framework for the study of the geoglyphs (Clarkson 1990). Later she continued with her own geoglyph research (Clarkson 1996, 1998).

[26] Aveni ed. 1990; Aveni 1990a, b, 1999, 2000a, b.

Among other things, she investigated the relative and absolute chronology of the geoglyphs (Clarkson 1996; Clarkson/Dorn 1991). Originally she suggested that only the biomorphic figures were from the Nasca period, whereas lineal geoglyphs dated to the Middle Horizon and the Late Intermediate Period (Clarkson 1990: 170). This result did not fit in well with the results of other researchers and was the cause of considerable debate. Based on subsequent fieldwork and chronometric datings Clarkson later changed her point of view[27]. She now agrees that in certain areas lineal geoglyphs also date to the Nasca period.

Concerning the function of the geoglyphs, Clarkson emphasizes that they were walked upon, either in a ritual or profane way. This is suggested by footpaths on the geoglyphs or by the many artifacts found on or nearby them. Clarkson points out that the making of the geoglyphs was an important aspect in itself (Clarkson 1990: 170f). She interprets stone circles and utilitarian ceramic vessels as associated with people working on the construction of the geoglyphs, and suggests that pots of fineware ceramics were intentionally smashed in a ritual context (Clarkson 1990: 140).

Clarkson was the first researcher after a long hiatus to draw attention to archaeological remains closely associated with the geoglyphs that had been virtually forgotten since Mejía and Horkheimer mentioned them in their early reports (Mejía 2002; Horkheimer 1947). Her investigations helped to get a clearer picture of the cultural context of the geoglyphs on a local level, even though not all of the contexts discussed by her seem to be associated with the Nasca geoglyphs. She was also the first researcher to try to date the geoglyphs chronometrically.

Gary Urton

American anthropologist Gary Urton has investigated social and ritual behavior in contemporary communities in both highland and coastal Peru. He has also studied historical sources and recorded oral traditions to trace the observed phenomena back in time. Urton participated in Aveni´s fieldwork on the Nasca *pampa* and contributed important insights from his ethnographic and ethnohistoric research to reconstruct the social background of the people who made and used the Nasca geoglyphs (Urton 1990). He put his focus on patterns of social organization revealed when social groups come together on certain occasions (prescribed by a religious calendar) to maintain public structures. Urton worked back in time from ethnographic reports about contemporary highland communities to ethnohistoric sources that describe the situation in the Nasca region in the 16th century and further on to archaeological evidence from Inca times. He argues that pre-conquest Nasca society was structured in a three level hierarchy.

According to Urton, local level *ayllus*, groups of people holding common land rights on strips of terrain, were grouped on the regional level into *suyus* or *parcialidades* while several of these middle level units were in turn grouped into moieties that were basic elements of the dual organization of pre-conquest Andean societies well documented in historic sources (Urton 1990: fig. IV.12). Concepts of social organization, like *ayllus*, were at the same time closely associated with concepts of spatial organization, like *chhiutas* or strips of land. According to Urton, the persistence of these concepts from prehispanic well into modern times (although not unaltered) favors their projection back into Nasca times. He argues that the maintenance of the Nasca lines can be understood in terms of communal labor organized along *ayllu* lines, *e. g.* to maintain an alleged trans *pampa* road. This work could also comprise ritual activities, like the cleaning of sacred spaces as prelude to ritual processions or gatherings.

Although Urton's work has little to offer in terms of archaeological evidence from the geoglyphs, it presents a coherent model of a possible social organization for the period when the geoglyphs were constructed. Furthermore, it favors, much like the contributions of other researchers described in this section, a ritual use of the Nasca geoglyphs at least in part.

Helaine Silverman

American archaeologist Helaine Silverman conducted extensive fieldwork in the Nasca region in the 1980s and has since published an important series of articles and books on a wide range of topics about the prehistory of that region. Her main projects were excavations in Cahuachi (Silverman 1990a, 1993a) and a regional settlement survey of the Ingenio valley (Silverman 1990b, 1993b, 2002b). In spite of the considerable number of excavation and survey projects in recent years, Silverman's publications are still the only final reports available on this kind of research.

[27] Clarkson 1996: 437, 1999: 169; Clarkson/Dorn 1991: cuadro 1.

Silverman's work does not focus especially on the geoglyphs. She does not treat the geoglyphs as an isolated phenomenon like many of her predecessors, but rather as an integrated part of a culture to be studied and understood only within their cultural historical context. In the vicinity of Cahuachi and also in the Ingenio valley, Silverman noticed that geoglyphs are often found in close proximity to settlements, point towards them or even interconnect them. Thus, a cultural context on the regional level could be reconstructed which the geoglyphs on the *pampa* seemed to be devoid of at first sight. Drawing upon her interpretation of Cahuachi as the spiritual, ritual, and social (albeit not political) center of Early Nasca times, Silverman understands the geoglyphs as part of a ritual complex closely related to that site. Thus, she interprets lines through the *pampa* as pathways used by pilgrims on their way to Cahuachi, as culturally domesticated space in the desert, and as locus of gatherings and ritual activities of cognatic descent groups (Silverman 1994b, 2000).

Like Urton, Silverman believes that Nasca sociopolitical organization can be understood in terms of Andean dualism. In this model, the Nasca drainage would have been divided into two moieties north and south of the Nasca *pampa* with each valley in turn split into an upper and lower moiety. The *pampa*, and with it the geoglyphs, would have served as a place or stage where people from the two moieties met, interacted, and negotiated their status. While historic documents from the early colonial period seem to support the idea of intra-valley moieties prior to the conquest (Urton 1990: appendix III), Silverman finds further support for her idea in the proposed functional division of Cahuachi, the empty ceremonial center in the Nasca valley, and Ventilla/Site 165 which is the alleged urban and administrative center in the Ingenio valley. Silverman believes that both sites were connected by a trans-*pampa* geoglyph which would again strengthen the idea of the *pampa* as connector and common ground for both moieties.

However, there are many unknowns in Silverman's equation. The geoglyph she cites in her research was built over by the *Camino de Leguía*, predecessor of the Panamerican Highway, in the 1920s before the first aerial images of the *pampa* were taken, so it is difficult to assess today if such a geoglyph ever existed. Furthermore, Ventilla/Site 165 has never been investigated in detail, and there are serious doubts concerning the purely ceremonial role of Cahuachi as proposed by Silverman (Schreiber 1998: 265). Hence, apart from historical sources mentioned by Urton and the claim that the concept of Andean dualism can be traced to Nasca times, there is still no clear archaeological evidence to back such a model.

More than other researchers Silverman emphasizes that the hypotheses proposed by Aveni, Urton, Reinhard, and herself complement each other. In her view the construction of geoglyphs was based on a ritual complex involving ritual movements along straight lines, prediction of water flow and agricultural fertility, observation of the skies and heavenly bodies, and mountain worship. She furthermore understands the geoglyphs as a mnemonic device or text seeing

> "[...] the proliferation of lines on the Pampa as the cumulative result of repetitive ritual activity, perhaps calendrically organized [...] Through this ritual activity on the Pampa the lines were made and in so doing the lines recorded ecological, climatological, hydrological, social, and political information necessary for social life and its prediction and scheduling." (in Silverman/Proulx 2002: 179)

The function of specific geoglyphs in regard to the different aspects of Silverman´s hypothesis remains vague, however. The strength of Silverman's reasoning lies in a logical model that explains the geoglyphs in a larger cultural context, but data from the archaeological record is underrepresented in her model.

David Browne

British archaeologist David Browne was the first researcher to concentrate his investigations exclusively on the then poorly known Palpa area. His survey, conducted in the late 1980s, covered the alluvial plain around Palpa, the Río Grande downriver to its junction with Río Ingenio, as well as short stretches upriver of Río Grande, Río Palpa and Río Viscas[28]. Although the geoglyphs were not the focus of his prospection (Browne 1992: 77), he describes several which he found in close proximity to sites from the Early Intermediate Period. The term *campo barrido* or cleared field used by him (Browne/Baraybar 1988: 301, 309) seems to refer in most cases to some kind of cleared *plaza* forming a part of a settlement, but in other cases it is clear that

[28] Browne 1992; Browne/Baraybar 1988; Silverman/Browne 1991; Browne et al. 1993.

Browne describes trapezoidal geoglyphs. He proposes a ritual function for the *campos*, possibly related with funeral rites, but does not explain what this assumption is based on other than some intentionally broken pots. Concerning geoglyph research in general, Browne states

> "[...] that the clues to the answers to many problems concerning the so-called Nasca lines lie in the small valleys tributary to the main drainage and that the emphasis in study should shift from the pampa to them." (Browne/Baraybar 1988: 318)

While this conclusion is important, published data on the geoglyphs in his survey area is limited.

María Rostworowski

Peruvian historian María Rostworowski has searched a vast number of historical sources for indications of pre-conquest history and religion in the Andes. Her publications constitute an important source of information on these topics. According to Rostworowski, old legends found in colonial sources indicate that a deity called Kón was venerated before the god Pachacamac rose to prominence (Rostworowski 1993). Kón is said to have changed the once fertile coastal strip into desert and to have sent rivers as substitute for rain. Thus, this deity is closely associated with the flow of water in the rivers upon which the coastal economy is based.

Kón is described as a boneless, flying being, whose origin can be traced to the south coast. Based on this evidence, Rostworowski hypothesizes that Kón may have been the principal deity in the Paracas and Nasca pantheon and that this deity probably appeared only at certain seasons of the year when the water in the rivers began to flow (Rostworowski 1993: 196, 199). She also assumes that the geoglyphs were made as places where believers awaited Kón's appearance or as signs for the god to come. Water and fertility would have been important aspects of this religious concept, not only in Paracas and Nasca but throughout the whole Peruvian coast. Rostworowski also identifies flying beings depicted on ceramics and textiles that are generally characterized as Anthropomorphic Mythical Being as Kón.

Apart from Silverman´s and Proulx´s objection that the Anthropomorphic Mythical Being is not related to flying (Silverman/Proulx 2002: 185), Rostworowski´s hypothesis has the disadvantage that there will probably never be a way to test it with archaeological means. However, it fits well into the aforementioned attempts to explain the Nasca geoglyphs in terms of Andean religious concepts and beliefs.

Aurelio Rodríguez

Peruvian archaeologist Aurelio Rodríguez has studied geoglyph sites on the coast of Peru, especially in the vicinity of Lima. In order to establish an interpretative framework for analysis, he searched historical sources from the early and middle colonial period for accounts of ritual practices during the precolonial era (Rodríguez 1999). Although the Nasca geoglyphs were not the principal focus of his study, he applied much of his results to them since they are the best known complex of geoglyphs. Rodríguez argues that the geoglyphs served as locations for what he calls *desplazamiento ritual* or ritual movement (Rodríguez 1999: 10, 13) which he subdivides further into processions/pilgrimage, ritual races, and dances. For each of his three subcategories he presents detailed accounts from colonial sources describing how these rituals were performed on marked spaces. According to his hypothesis, long straight lines served for processions and pilgrimage while ritual races were carried out on trapezoids and their adjoining lines. Ritual dances in turn would have been performed on figural geoglyphs with chains of dancers moving along the lines that form the figure.

Rodríguez' compilation of historical accounts results in a coherent picture of Andean ritual practices and seems to fit neatly to the Nasca geoglyphs which were presumably marked spaces where such rituals were preformed. Rodríguez is more specific than other researchers as to the actual activities on certain types of geoglyphs. Nevertheless, he too faces the basic problem of an 800 year time gap between the period of use of the Nasca geoglyphs and the historical accounts he cites, and he offers no specific archaeological evidence to sustain his ideas.

David Johnson

Whereas Aveni and other researchers propose a possible relationship between geoglyphs and rivers, American independent scholar David Johnson recently proposed a new hypothesis that links the geoglyphs to subterranean water sources (Johnson 1999; Johnson et al. 2002). According to Johnson, geoglyphs mark the course of aquifers that run through geological faults and intersect the valleys where water from them is captured in wells and filtration galleries.

Johnson postulates a recurrent pattern of faults, aquifers, settlements, filtration galleries, and geoglyphs occurring together (Johnson et al. 2002: 309). He even proposes some kind of "code" for the geoglyphs: trapezoids mark the course of aquifers, zigzags show places without subterranean water, etc. (Johnson 1999: 160).

Fieldwork recently conducted by American hydrogeologist Stephen Mabee to test Johnson's hypothesis shows that there is indeed strong evidence for water sources in the valleys that are independent of the rivers and are apparently supplied by aquifers carrying water from the highlands through subterranean courses towards the coast[29]. It is important to note that at least some of the ancient filtration galleries were constructed so as to tap the water from these aquifers, thereby providing an additional water supply that was certainly of great importance for the inhabitants of the valleys. It also comes as no surprise that ancient settlements are clustered around areas where reliable water sources were available.

However, the proposed relation of subterranean water to geoglyphs is not evident in the data provided by Johnson. Although he presents photos and sketches showing that some trapezoids align with faults likely to carry water, it has to be kept in mind that the desert zone close to the valley is the area where most geoglyphs are found, so any relation may be no more than coincidental. To systematically investigate a possible relation between geoglyphs and water, a detailed documentation of all existing geoglyphs is needed which Johnson fails to present. Furthermore, some aspects of his reasoning seem questionable, *e. g.* his consideration of stone circles which are most probably of modern origin. In summary, the core of Johnson's hypothesis thus far lacks support from field data. However, the work by his colleague Stephen Mabee is an important contribution to Nasca research since it helps understanding ancient water management.

3.2.2 Review of recent investigations and research approach

The above review of recent investigations demonstrates that Nasca geoglyph research has advanced considerably since 1980. Andean cultural concepts, religious practices, and social organization are now used as the basis for new hypotheses to explain the origin and the nature of the geoglyphs. These new approaches are quite distinct from that of Maria Reiche who dominated the debate on the Nasca geoglyphs, as well as the geoglyphs themselves, for several decades. When Kosok and Reiche proposed their astronomical hypothesis, they largely abandoned what was then known to researchers about Andean cultural history. Although their approach was not in itself unreasonable, their tendency to neglect the cultural context of the Nasca geoglyphs prepared the ground for many unscientific and even fantastic ideas that were proposed in the '60s and '70s to explain the Nasca geoglyphs.

The Andean model

This tendency to explain the geoglyphs using unscientific hypotheses has been clearly reversed since 1980, when Nasca geoglyph research began to look again at the Andean cultural context. The aforementioned recent approaches are interestingly quite similar to the earliest attempts to interpret the geoglyphs. For example, Mejía, one of the rediscoverers of the geoglyphs explained them as sacred pathways and was the first to compare them to the Cusco *ceques* (Mejía 1942, 2002). Horkheimer argued that the geoglyphs were manifestations of an ancestor cult that involved dances along the lines performed by kin groups (Horkheimer 1947). Clearly, both these early researchers and their present-day colleagues have been striving for embedding the Nasca geoglyphs into a broader context and for explaining them on the basis of current knowledge on Andean cultural, religious, and social traditions. It is also clear, as Aveni, Silverman and Proulx pointed out, that most of the hypotheses presented previously can be combined into a single model[30] (Aveni 2000a: 209; Silverman/Proulx 2002: 192). Such a model will be termed "Andean model" for the purpose of the present study, and it is summarized as follows:

> The Nasca geoglyphs were made by a population organized in social groups whose members shared common ancestors and/or land rights. These groups met in the desert, marking and creating space according to common concepts and beliefs deeply

[29] Johnson 1999: 159; Johnson et al. 2002; cp. summary in Silverman/Proulx 2002: 185–189.

[30] The term "model" is used in two different ways in the present study. Archaelogically, a "model" is a set of hypotheses aimed at explaining archaeological data in a wider context. In geomatics, on the other hand, the term refers to the geometric representation of a real-world object.

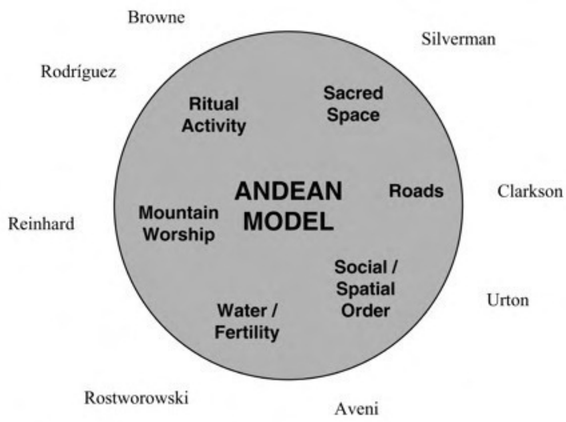


Fig. 5. The Andean model.

embedded in Andean traditions. This social interaction was important for the position of each group within a broader societal context. A cult revolving around mountain deities, water flow, and fertility, probably organized by a ritual calendar, was the background of geoglyph related activity. The geoglyphs were organized in a spatial system that reflected social order, since they were associated with social groups and determined their status. They furthermore connected sacred places and were in some way or another related to the course of water. The geoglyphs served for processions performed by the groups that made and maintained them. These movements might have been related to pilgrimage, sacred sites, or other traffic across the desert. Fineware ceramic vessels, supposedly filled with food and drinks, were ritually smashed and placed on line centers and along geoglyphs. Trapezoids were places where larger groups gathered or races were held, while biomorphic figures, whose motifs evoked the concept of fertility, were walked upon in dances. The geoglyphs marked social, cultural, and sacred space out in the desert. They symbolically expressed cultural concepts that could be understood by members of Nasca society. Superposition of geoglyphs reflected evolution of the cultural and social reality. All in all, the geoglyphs were deeply embedded in the daily life of Nasca society, and the basic concepts that guided their realization were in concordance with Andean cultural, religious, and social traditions.

For clarification, the main aspects of the Andean model as well as its contributors are illustrated in figure 5.

The Andean model, though neither designated nor formulated as such by any of the above mentioned researchers, represents the state of the art in Nasca geoglyph research. Its basic assumption is that the Nasca culture was part of a long-term cultural tradition shared throughout the Andes that evolved slowly in time and proved persistent over the centuries. It is further assumed that this Andean tradition which involves common concepts of beliefs and behaviors persisted in a somewhat altered form through the period of the Spanish conquest, and is found today in Andean communities. Following this reasoning, ethnographic and ethnohistoric studies not only allow identification of elements of this tradition, but also enable the establishment of a causal link between observed behavior and material culture. For example, Urton explains spatial division of the churchyard of Pacariqtambo, a contemporary village in the highlands, with social division of the community (Urton 1990). Aveni, basing his arguments on accounts of early Spanish chroniclers, explains the arrangement of *huacas* and *ceques* in prehispanic Cusco in terms of Inca social organization and religious practices (Aveni 1990b).

In the case of the Nasca geoglyphs, only the remains of material culture can be documented archaeologically while the cultural concepts behind them are nowhere described. However, the assumption mentioned above that a long-lasting Andean tradition is the common framework for the Nasca geoglyphs, the Cusco *ceques*, and the Pacariqtambo churchyard strips, allows the establishment of an analogy on the basis of which conclusions can be drawn about the unknown concepts behind the geoglyphs (Bernbeck 1997: chap. 5). Accordingly, Urton and Aveni, as well as Rodríguez and Silverman, use current social organization and religious practices found in ethnographic and ethnohistoric research in order to interpret the function and meaning of the Nasca geoglyphs. The result is a coherent set of hypotheses here called the Andean model that can be used to explain the Nasca geoglyphs.

Critical comments on the Andean model

How can the validity of the Andean model be assessed? In archaeological research an explanatory model cannot be proven, and while it may be capable of explaining certain archaeological contexts, other models might have the same capability as well. Thus, the model has to be assessed in terms of plausibility. This can be done in two ways. On the one hand, the analogies used to establish the model can be questioned, considering aspects like the time interval between compared phenomena and their degree of similarity. Such an approach may clarify the theoretical foundations of the model. On the other hand, archaeological fieldwork offers the opportunity to verify or contradict the material foundations of the model. As has been shown, the Nasca geoglyphs are poorly researched archaeologically. New research may either corroborate the plausibility of the model or necessitate its modification or replacement.

Concerning the plausibility of the analogies established between the Nasca geoglyphs and later contexts such as the Cusco *ceques*, it has to be kept in mind that starting from the general consensus that the geoglyphs were mainly made and used at the time of the Nasca culture, there is a time gap of almost a millennium between the last constructed geoglyphs and descriptions provided by colonial written sources. In this considerable time span the Nasca region faced several historic disruptions. Therefore, Proulx cautions that

> "[...] Nasca culture had disappeared almost eight hundred years prior to the emergence of the Inca Empire and was separated from it by the Tiwanaku/Wari religious tradition which was quite different from earlier Nasca religion, not to mention the different political context." (in Silverman/Proulx 2002: 195)

These disruptions are primarily indicated in the archaeological record by changing ceramic traditions, notably different settlement patterns, and the end of the geoglyph tradition. The Spanish conquest was yet another major historic disruption. Thus, there is no smooth continuity between the Nasca geoglyphs and the time of the earliest chronicles.

However, in spite of these disruptions there may still be a persistent tradition. The fact that certain religious practices and principles of social organization in the 20th century are similar to those described in the 16th century indicates that in spite of major historic breaks and disruptions there is a stable cultural foundation upon which Andean societies are based. Thus, to use colonial documents to try and understand the Nasca period is reasonable, although it should be kept in mind that even such a stable tradition is slowly changing. The change may be minimal over a short time span, but if at least 800 years and several major historic changes are to be bridged then it is to assume that a change in certain aspects occurred. Thus, the task remains to find out what aspects changed, and to determine the degree of change.

The usefulness of using ethnohistoric and ethnographic accounts to establish the Andean model can be assessed by considering the degree of similarity between compared phenomena. In the case of the Nasca geoglyphs it has become clear in section 3.1 that any comparison is rendered difficult due to a lack of archaeological data. In the literature, references to the actual archaeological record are sparse. Apart from some notable exceptions there is no detailed description of specific geoglyphs. Even recent projects largely have failed to produce or at least to publish a comprehensive database that would allow other researchers to get a precise idea of the properties or even the location of specific geoglyphs. Instead, common characteristics supposedly shared by the majority of the Nasca geoglyphs are often summarily described, *e. g.* the straightness and radiality of lines, the subtractive construction technique of most geoglyphs, sherds of broken pots scattered around geoglyphs, etc. These general traits are repeatedly mentioned and thus perpetuated in the literature. The fact that a serious attempt to document the Nasca geoglyphs has yet to be undertaken renders any generalization doubtful since many different geoglyphs contexts have not thus far been considered. Thus, the use of ethnographic or ethnohistoric analogy may have a weak point concerning traits that are compared with the archaeological record. Archaeological fieldwork is required to verify ethnographic and ethnohistoric analogy, and this is the focus of this study. The more geoglyphs are documented the better we will know if certain characteristics of the geoglyphs are typical or representative. These can then be compared with ethnographic or ethnohistoric contexts.

If archaeological fieldwork is aimed at assessing the Andean model, then three basic issues should be pointed out:

- The model primarily attempts to explain the geoglyphs on the Nasca *pampa* without consideration of the wide variety of existing geoglyphs
- The model does not take into account the vast time span during which the geoglyphs were made
- Several aspects of the model are not testable by archaeological methods.

Concerning the first point, the Nasca *pampa* is not only the principal destination of tourist flights, but has also attracted most scientists who worked in the Nasca region. While early researchers were quite aware that geoglyphs are a phenomenon not restricted to the Nasca *pampa*, later research focused almost exclusively on that vast plateau and, more specifically, on its northern edge. The only exceptions are Silverman and Browne who called attention to geoglyphs in other areas very different from the *pampa*. Many geoglyphs along the tributaries of Río Grande can be found in close proximity to settlements. They are part of less complex sites or even isolated from one another, and occur in different topographical settings. The Andean model, however, is largely tailored to explain the maze of geoglyphs that cover the vast, uninhabited flat *pampa*. Different manifestations of the geoglyph phenomenon in other regions of the Nasca drainage may thus not be explained by using the Andean model.

Concerning the chronology of the geoglyphs, they are generally thought of having been made over approximately 1,000 years. Over such a long time span, cultural change can be expected to affect the construction, use, perception, and physical manifestation of geoglyphs. Thus, it is already clear that the Andean model has to be improved by adding time depth. Geoglyph chronology is still fraught with uncertainties. It relies mainly on dating by using associated ceramics whose chronology has yet to be verified stratigraphically. Such indirect dating presents a constant methodological problem because in most cases the actual temporal relation between a geoglyph and the sherds found on it cannot be established unambiguously. The potential of relative chronology (based on the stratigraphic relation of one geoglyph to each other or to other cultural remains) has not been fully exploited because of a lack of a detailed record of the geoglyphs. The same applies to chronometric dating of the geoglyphs. Thus, it is not clear if different shapes and sizes of geoglyphs or different contexts and combinations can be explained chronologically rather then functionally or regionally. Furthermore, the maze of geoglyphs that we see today makes it difficult to keep in mind that most probably only a small number of them were used together at any given time. Therefore it is clear that any interpretation of the geoglyphs can only make sense if it takes into account chronological variation.

Finally, it has to be kept in mind that certain aspects of the Andean model cannot be tested by archaeological methods. For example, Rostworowski's idea that the god Kón was venerated on the Nasca *pampa* cannot be verified archaeologically. In the case of other aspects a basic question from archaeological fieldwork remains unanswered, namely: How will archaeological remains appear if predicted by the model? How can kin groups, ritual dances or mountain worship be detected by archaeological methods? What material traces of pilgrimage or a ritual calendar may be preserved? The literature reviewed above provides few clues to answer these questions.

The archaeological record is composed of material remains, and in this case the remains are geoglyphs as well as other artifacts and structures associated with them. Their study may reveal geoglyph related activity and people involved in it. Intangible concepts such as traditions or systems that motivated or induced geoglyph related activity can be assessed only indirectly. Thus, only certain aspects of the Andean model, namely those related to material culture and activities that lead to the formation of the archaeological record, can be directly tested. The main explanatory aspects of the model, *i. e.* those dealing with Andean concepts and cultural traditions, are almost impossible to test for archaeologically. However, once archaeological data becomes available, they can be assessed in a better substantiated way.

Based on these premises it was decided to analyze the Palpa geoglyph data in a series of steps. The development of the geoglyph typology of the Palpa sample helped to generate a systematic overview of the formal variation of the geoglyph repertoire. Using stratigraphic and contextual evidence a general chronological framework for the geoglyphs was then established. This step furthermore allowed the typological variety within the Palpa geoglyph sample to be examined to determine if it can be explained chronologically. Thus, variety and chronology of the Palpa geoglyphs were addressed first.

In the next step, activity related to the Palpa geoglyphs found in the archaeological record was identified. This allowed acquisition of a clear picture of what actually happened on geoglyph sites, which is a question of central concern to the Andean model. Other aspects of the model that postulate a link between the geoglyphs and their environment were then addressed by a GIS-based spatial analysis of the

Palpa geoglyphs that revealed ordering principles for geoglyph placement, shape, etc.

3.3 Summary: Geoglyph research in the Nasca region

The above review shows that previous research on the Nasca geoglyphs has resulted in a comprehensive hypothetical model to explain the geoglyphs. This model should be tested with archaeological data, and as the review indicates, any new attempt to study the geoglyphs only makes sense if it includes the acquisition of a fresh body of field data. The Nasca-Palpa Project was intended to address some of these research problems by a comprehensive documentation of the Palpa geoglyphs and by comparing archaeologically testable aspects of the Andean model with the data obtained.

4. The Nasca-Palpa Project

The purpose of SLSA´s Nasca-Palpa Project was to carry out a broad study of the Nasca culture including the geoglyphs of Palpa. The Palpa area is one of the most agriculturally fertile zones of the Nasca drainage (frontispiece). The first phase of the project (1997–2002) comprised three main activities[31]:

- A regional settlement pattern survey with more than 700 prehispanic sites located, recorded, and classified (Reindel et al. 1999, 2003a)
- Extensive excavations at Los Molinos and La Muña – two large sites along Río Grande with public architecture from Early and Middle Nasca times, respectively (Reindel/Isla 2001; Reindel et al. 2002)
- A complete recording and analysis of the geoglyphs that cover the slopes, ridges and plateaus of the Palpa region[32].

The Palpa area was in many respects a good place for this study. The geoglyphs on the slopes and hills along the valley margins (figs. 6, 7; maps 1–13) are easily comparable to the geoglyphs on the Nasca *pampa*, but have so far received very little attention.

That such little research has been carried out in the Palpa aera is somewhat surprising since in the early years of Nasca geoglyph research the Palpa area played a prominent role. As mentioned previously, Paul Kosok was standing on a hill near Llipata, to the south of Palpa, when he was struck by the idea that the geoglyphs constitute "[...] the largest astronomy book in the world"[33]. In the following years Maria Reiche also worked in the Palpa area. This is evidenced by various pictures, sketch maps, and other references in her publications (Reiche 1976, 1993). However, she left no detailed account of her activities in Palpa. At about the same time, Hans Horkheimer studied the Palpa geoglyphs and took photos and sketches of several of them including the famous *reloj solar* or sun dial north of Palpa (Horkheimer 1947: figs. 7–9) and also the combination of lines on which Kosok had had his inspiration some years before, near Llipata (Horkheimer 1947: figs. 5, 11).

Thereafter for many years, however, the focus of Nasca geoglyph research shifted almost completely to the Nasca *pampa*. Strong passed through the Palpa area and Mejía conducted excavations there, but neither of them worked on geoglyph sites (Strong 1957; Mejía 1972, 1976). The Palpa geoglyphs were mentioned again by Rossel (Rossel 1977: chapter X) and Browne (Browne/Baraybar 1988; Browne 1992), but were never studied in detail. It was only known that

> "[...] the valleys north of the *pampa* are also full of ground markings which were constructed in the same manner, and have forms identical to those on the *pampa.*" (Silverman/Browne 1991: 208)

Thus, a systematic investigation seemed a promising strategy. Other factors favored a study of the Palpa geoglyphs as well. They are situated close to densely settled zones along the valley floors. There are various sites where geoglyphs occur together with contemporaneous public and habitational architecture as part of the same site which is not the case on the Nasca *pampa*. Another decisive point for choosing the Palpa area was that in this area the geoglyphs are not protected. Since they are located in openly accessible terrain close to modern settlements, many of them have already been damaged or destroyed without having been recorded or studied. Hence, the work was considered a first step towards an effective protection and preservation of the Palpa geoglyphs.

The study of the Palpa geoglyphs started along with the regional settlement pattern study in 1997 when the first flight was conducted in order to obtain aerial images suitable for photogrammetric analysis. A second flight was carried

[31] See also the project websites available at www.dainst.org, www.photogrammetry.ethz.ch, and www.slsa.ch (accessed August 22, 2005).

[32] Reindel et al. 2003b; Grün/Lambers 2003; Sauerbier/Lambers 2003.

[33] Kosok 1965: 49; Kosok/Reiche 1947: 202; Kosok in Reiche 1993: 137.

out in 1998. The processing and analysis of the resulting images allowed the start of archaeological fieldwork on geoglyph sites in 2000. It was continued in three field seasons until 2001. Analysis of the data was largely conducted from 2002 to 2004 and resulted in the present study. Following the structure of section 3 in which previous research was reviewed, the documentation of the Palpa geoglyphs and the analysis and interpretation of the resulting data are described separately in the following sections 5 and 6.

Fig. 6. Aerial view of Cresta de Sacramento (left: Río Viscas and Río Palpa, right: Río Grande).

Fig. 7. Aerial view of Cerro Carapo (right: Río Viscas).

5. Documentation of the Palpa geoglyphs

In this section, the investigation of the Palpa geoglyphs within the framework of SLSA's Nasca-Palpa Project is described in detail. The different steps of data acquisition and processing are outlined, and the applied archaeological and photogrammetric methods are explained.

Before fieldwork in Palpa started, a review of potentially suitable aerial photographs was undertaken in order to determine if existing imagery could be used for the planned photogrammetric documentation of the geoglyphs. As for most other coastal valleys, vertical aerial photographs of the Palpa area had been taken in previous decades by Peruvian governmental agencies. Images available prior to the start of the project are listed in table 3.

Of these images, only the series taken in 1944 (1:5,000) and in 1970 (1:10,000) were acquired from the SAN office in Lima since the scale of the other series would not have given enough detail to map the geoglyphs. No information on the camera used in either of the two flights was available. The 1944 images which covered only the central part of Cresta de Sacramento could not be oriented satisfactorily, most likely because there was a lack of camera calibration data (Fischer/Künstle 1999). They could therefore not be analyzed stereoscopically. The 1970 images could be oriented but were partially damaged and their scale did not give enough detail. Thus, it was decided to base the work in Palpa on a new series of images to be taken within the framework of the Nasca-Palpa Project. These images were especially designed to meet the requirements of a 3D documentation of the geoglyphs.

In order to deliver the desired results, the application of photogrammetry to record the Palpa geoglyphs required close cooperation between geomatic engineers and archaeologists. While the former provided the technological expertise and carried out the technical aspects of the work, the latter contributed the archaeological expertise and conducted the actual recording of the geoglyphs. A combined workflow was devised that integrated both archaeological and photogrammetric procedures in order to get from the real-world geoglyphs to digital records of them. The steps of the workflow, shown in figure 8, are described in detail below. As the flowchart clearly indicates, the different steps of the workflow were highly interwoven so that the sequential description given in the following can characterize it only inadequately[34].

5.1 Flight planning

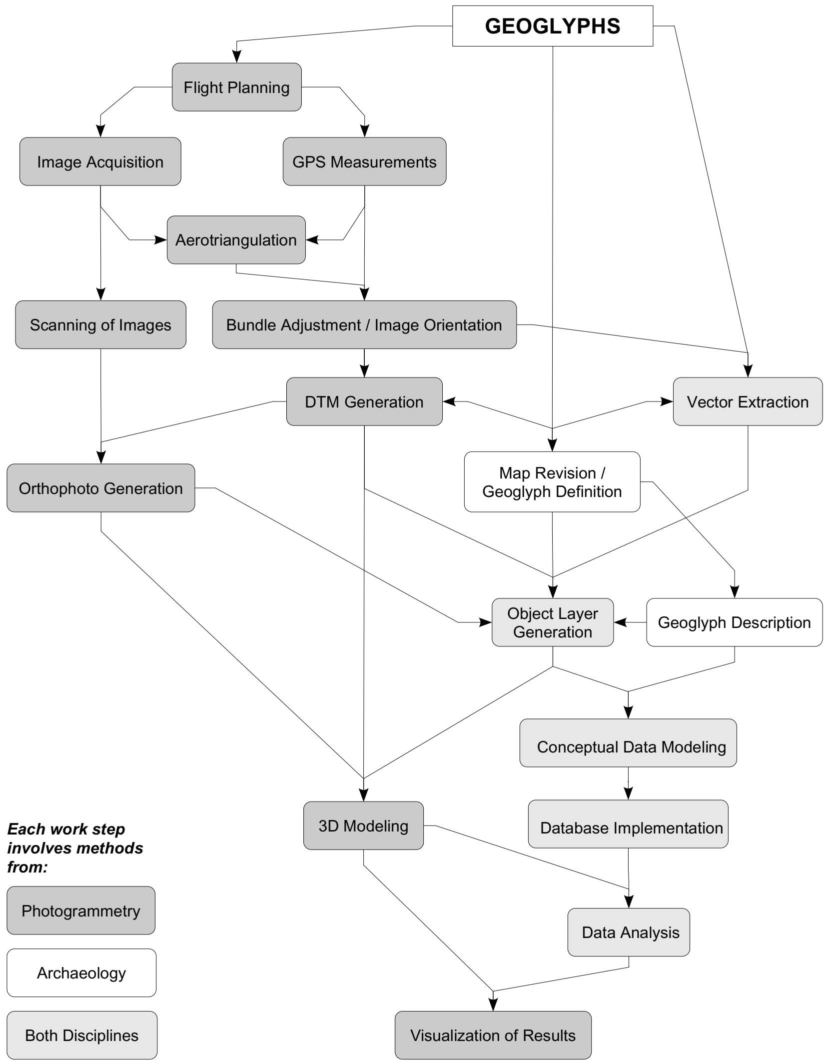
In the course of the project, two roughly rectangular areas or blocks were defined over the Palpa area where aerial images were to be taken (fig. 9). Both rectangles were laid out to include the areas with geoglyphs on the ridges and plateaus along the valleys. The smaller block covered Cresta de Sacramento, a low ridge northwest of Palpa between Río Grande and Río Palpa that was the main focus of the archaeological investigations in the first field season in 1997[35]. The flight was planned so as to yield vertical aerial images at a scale of 1:5,000, organized in parallel strips with a 60% overlap in both directions in order to allow full stereo-processing.

The original plan was to take color photographs, but when the 1997 flight over Sacramento did not deliver results good enough for our purposes, it was decided to commission a second flight one year later in order to take black-and-white photographs of the same area using the same flight characteristics. By the time the second flight was to be carried out it had become clear that the *pampas* of San Ignacio and Llipata to the southeast of Palpa were also to be included in the archaeological project. Thus, a second area to be photographed was defined

[34] The following description does not coincide in all technical details with previous, preliminary reports. Where differences occur, information given in the present study should be regarded as definite.

[35] Grün/Brossard 1998; Grün 1999; Reindel et al. 1999.

Fig. 8. Workflow of geoglyph documentation, analysis, and visualization that combines photogrammetric and archaeological methods.



Year	Agency	Nominal Scale	Area Covered	Remark
1944	SAN	1:5,000	Sacramento, San Ignacio	only partial coverage
1944	SAN	1:12,000	Sacramento	scale probably 1:15,000
1955	IGN	1:60,000	whole Palpa area	
1970	SAN	1:10,000	whole Palpa area	
1986	IGN	1:70,000 1:80,000	whole Palpa area	
1992 to 2002	IGN	1:30,000 1:60,000 1:80,000	whole Palpa area	

Table 3. Aerial imagery of the Palpa area available from Peruvian governmental agencies (based on review of SAN archive, Lima, and IGN website: www.ignperu.gob.pe, accessed May 2004).

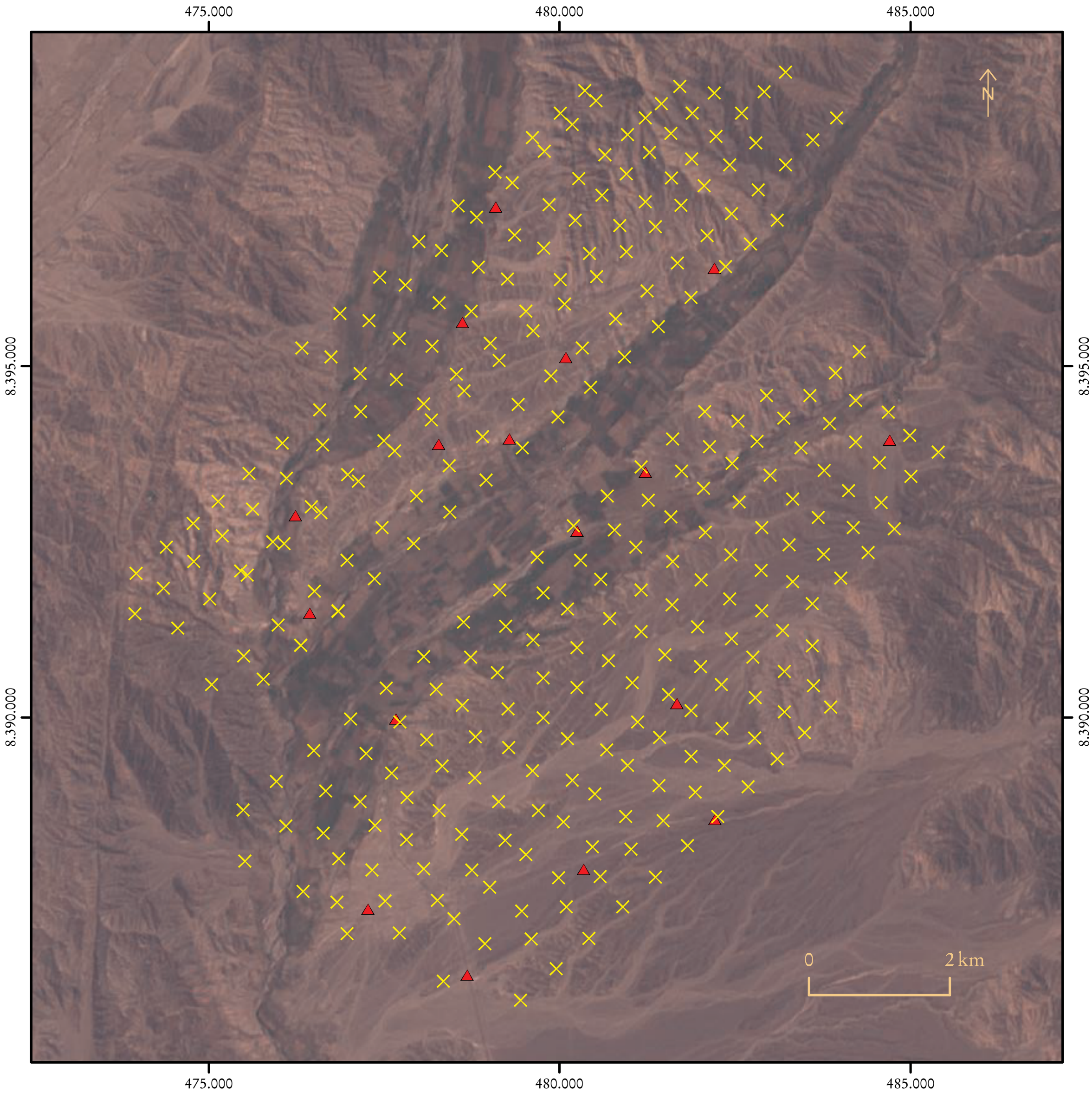


Fig. 9. Landsat 5 TM image of the Palpa area with projective centers of 1998 black-and-white aerial images (yellow crosses) and ground control points (red triangles).

over that area that was to be covered during the same flight. For each flight the flying height was defined according to the desired image scale, and the positions of the intended projective centers were marked on a topographic map. This data was then passed on to Horizons Inc.[36], Rapid City, SD in the United States and they carried out the actual flights.

[36] See company website at www.horizonsinc.com (accessed August 22, 2005).

5.2 Image acquisition

On May 1, 1997, the first photogrammetric flight was performed over Cresta de Sacramento. The flying height was approximately 750 m above ground. Using a calibrated Zeiss RMK A15/23 aerial camera with a focal length of 152.994 mm, 212 color photos were taken along eight parallel strips. After the flight the images turned out to be partially scratched and blotchy. Furthermore, their color was not ideal for identification of the geoglyphs, and an intensity falloff was visible towards the image edges.

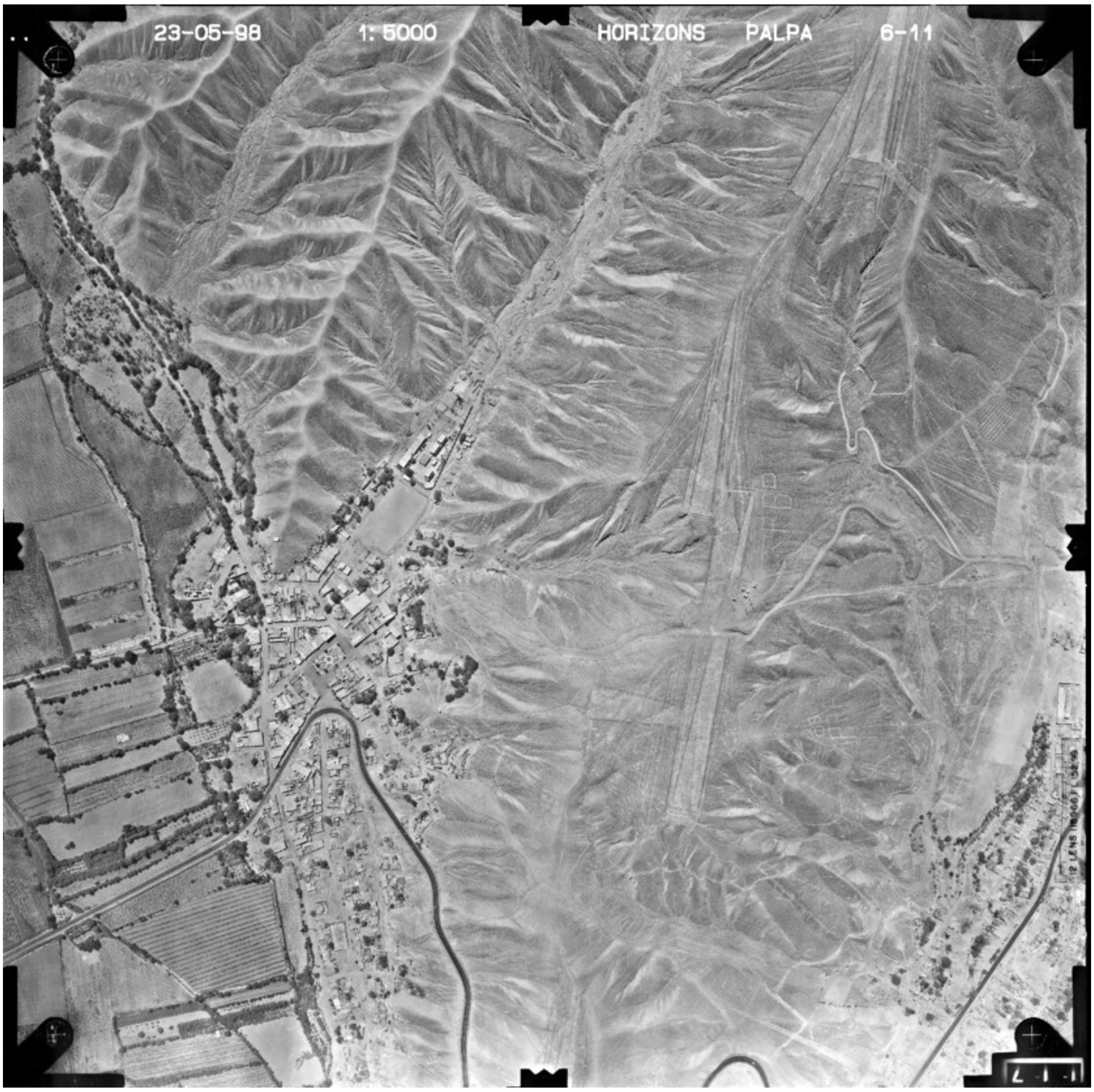


Fig. 10. Black-and-white vertical aerial image of the central part of Cresta de Sacramento (left: Río Grande).

Therefore, a second photo flight was undertaken the following year by the same company.

On May 23, 1998, 169 images along eight strips were taken over Cresta de Sacramento, this time in black-and-white (fig. 10). During the same flight the second area over the *pampas* of San Ignacio and Llipata was also covered. It comprised the area southeast of Palpa approximately 4.5 km into the desert from Río Viscas. Two hundred and fifteen images along eleven strips were taken over the second area with the same characteristics as the images of the first block[37]. Since Cerro Carapo, to the northeast of

[37] Along with the acquisition of the Palpa images, another series of aerial images was taken over the Nasca *pampa*. These images have a nominal scale of 1:10,000 due to the larger area covered and were taken in 1997 (439 color images) and 1998 (401 black-and-white images), respectively. The Nasca images have not been analyzed during the first phase of the Nasca-Palpa Project, in which all efforts were focused on the Palpa region. Only some images of the northern edge of the Nasca *pampa* have been used by the Nazca Project of HTW Dresden (Teichert/Richter 2001, 2003). In the framework of the second phase of the Nasca-Palpa Project, the Nasca image series is now being analyzed at IGP in order to map the Nasca geoglyphs as well. That work will be reported on in a later study. See Sauerbier (2004) for some preliminary results.

Palpa between Río Palpa and Río Viscas, had also to be included in the photographed area, the first strips of the second block also covered a good part of the floodplain and the town of Palpa (fig. 9). Thus, although not intended at the beginning, the photos of both photographed areas actually overlapped slightly in the central part of the flown area (approximately 20% decreasing in northeasterly direction) which was very advantageous during analysis since it allowed the merger of the two areas into one (Sauerbier/Lambers 2003).

All in all the black-and-white aerial images taken in 1998 covered a roughly rectangular, southweast to northeast oriented area of approximately 89 km^2 around the town of Palpa (frontispiece, supplements 1, 2). The average image scale that was intended to be 1:5,000 turned out to be approximately 1:7,000 which was still sufficient for our purposes. Unlike the color photographs, the contrast of the black-and-white images allowed the detection of even narrow lines, and the image quality was generally good. Thus, it was decided to use the 1998 images for analysis.

5.3 GPS Measurements

In order to obtain control data to orient the images spatially, GPS was used in two different modes. In 1997, when the area over Cresta de Sacramento was flown for the first time nine signalized ground control points were evenly distributed over the terrain whose position had been determined with differential GPS[38]. Furthermore, kinematic GPS measurements were performed onboard the plane that could serve as approximations for the positioning of the projective centers (fig. 9). In 1998 when both areas were flown, kinematic GPS could not be used, and the signalized points in the Sacramento area were no longer available. The latter problem could be solved by performing a joint bundle adjustment of both the 1997 color images and the 1998 black-and-white images of the first area (see below). In the second area over San Ignacio and Llipata, however, no ground control points had been prepared. Therefore, in 1999 nine natural points – *i. e.* points clearly discernible in the aerial images without having been marked on the ground – were measured in the San Ignacio block again using differential GPS (Grün et al. 2000a; Grün/Beutner 2001). That way, solid GPS control data for both areas was available for image orientation.

All GPS coordinates were transformed into UTM zone 18 S projection which is the basis for the IGN topographical maps of the area. It should be noted here that during fieldwork a horizontal shift of several hundred meters was detected between the UTM coordinates obtained by GPS measurements and those taken from available maps. This was because the topographic maps used during the first field seasons (scale: 1:50,000 and 1:100,000, respectively) referred to the Provisional South American Datum 1956 (PSD 56) based on International Ellipsoid 1924. In the GPS measurements the World Geodetic System 1984 (WGS 84) provided both ellipsoid and datum. A later comparison showed that current versions of the same IGN maps refer to WGS 84 also, so that the shift between GPS coordinates and map coordinates is now eliminated.

5.4 Aerotriangulation

The first step in image processing was the orientation of images relative to each other. For this purpose five to ten tie points clearly identifiable in the overlapping area of two adjoining images had to be measured. Image matching is today usually performed in an automated mode. However, the Palpa aerial images show largely the desert surface which is very homogeneous in texture and provides little contrast. As several tests showed, matching algorithms implemented on different commercial systems failed to produce acceptable results due to this lack of texture (Grün et al. 2000b; cp. Sauerbier 2004 for up-to-date results). Thus, the measurement of tie points had to be done manually on the analytical plotters available at IGP (Wild AC3 and S9). In the Sacramento flight area not only tie points to link images within the black-and-white series had to be measured, but also tie points to link the black-and-white images to the color images in which the signalized ground control points were visible. Two hundred and eleven images (134 black-and-white and 77 color images) were triangulated in the Sacramento block. In the San Ignacio flight area tie points and natural ground control points were measured within the black-and-white image series. Here, 168 out of 215 images were triangulated. The lower number of images used for triangulation as compared to the existing images is due to the fact that on the

[38] Grün/Brossard 1998; Grün et al. 2000a; Grün/Lambers 2003.

Block	Images Used	Control Points	Kinematic GPS	σ_0	Ground Accuracy
Sacramento	134 b/w and 77 color	8 signalized	yes	13.3 μm	9.3 cm
San Ignacio	168 b/w	9 natural	no	9.5 μm	6.7 cm

Table 4. Triangulation characteristics of the two image blocks over the Palpa area.

margins of the flight zones mountainous areas without geoglyphs were omitted for the sake of efficiency.

5.5 Bundle adjustment and image orientation

Once all images had been tied together via tie points and linked to the ground control points, a joint bundle adjustment for each area was performed using BUN which is in-house software developed at IGP. The orientation of each image with respect to each other image and UTM coordinates for each image point were calculated. As a result, all images were provided with orientations relative to each other and absolute in the UTM zone 18 S coordinate system. Table 4 summarizes the triangulation characteristics of both areas.

The achieved ground accuracy was good enough for the intended purpose. As a result of the bundle adjustment oriented images were obtained that could then be used in pairs of two neighboring, overlapping images (also called stereopairs or models) for 3D measurements.

5.6 Digital terrain model generation

As a prerequisite for the intended geoglyph study, a highly accurate digital terrain model (DTM, a geometric model of the topography) was needed before the recording of archaeological objects could start. The matching problems described above meant that automatic DTM generation was not feasible. Therefore, the measurements were undertaken again on analytical plotters. The manual measurement offered the advantage that a very good DTM, describing the actual terrain, could be measured while automated measurements would have led to a digital surface model (DSM) that would have described the surface including buildings, trees, etc. with lower accuracy.

The terrain was measured in the stereopairs, and 72 models from the Sacramento area and 94 models from the San Ignacio area were used for these measurements. Points were obtained along parallel profiles that had a distance of 20 m from each other. Along these profiles the distances between measured points depended on terrain shape. In flat areas, less points were measured than in mountainous terrain. Special attention was paid to zones with geoglyphs. In addition to profiles, breaklines were measured along abrupt changes in the terrain in order to map the terrain more accurately. Unlike the profiles, the breaklines were measured as continuous vectors, whereas points measured along profiles were treated as isolated points not connected to each other. In the first iteration, only the actual terrain surface was measured. Later on, points measured during vector extraction were added in order to enhance point density especially in areas with geoglyphs. All in all approximately 1.4 million points were measured in an area of roughly 89 km^2 giving an average density of 1.6 points/100 m^2.

Based on this data a regular grid DTM was calculated with a grid spacing of 2 m. This was done in two iterations: firstly, a preliminary DTM was generated based on the corresponding measurements alone. After the revision of the resulting maps in the field the digital dataset was corrected, so that the final DTM could be produced (fig. 11). The DTM was generated using DTMZ which is another in-house software that performs Delauney triangulation and bicubic finite element interpolation. Neighboring points were connected by edges of triangles resulting in an approximation of the actual shape of the terrain surface. The breaklines were not bridged in the triangulation process to ensure that abrupt changes in the terrain were reproduced correctly in the DTM. Originally, two separate DTMs were generated that corresponded to the two original image areas over Sacramento and San Ignacio. Since the DTMs overlapped slightly, they could later on be merged into a single, continuous DTM. The file size is approximately 480 MB in ASCII xyz-format. The wire-frame model can be used as a base for 3D modeling. Various byproducts such as shaded reliefs or contour maps can be derived from the wire-frame model.

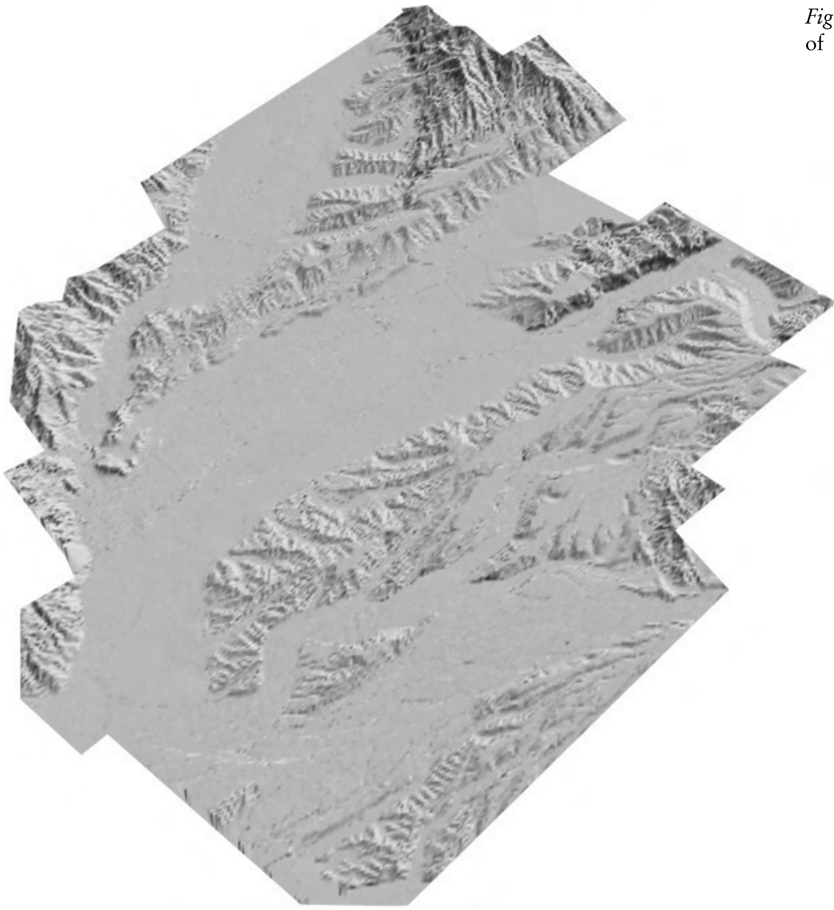


Fig. 11. Digital terrain model (DTM) of the study area as shaded relief.

5.7 Scanning of images

Along with the analysis of the stereopairs, the analog images acquired during the photo flight were scanned at high resolution in order to produce an easily accessible photographic record of all geoglyphs and to generate an orthoimage as texture for the DTM. To enable the latter the scanning had to be done on calibrated photogrammetric scanners that allowed high resolution scans with high geometric fidelity. The images of the Sacramento area were scanned at a resolution of 21 µm pixelsize using an Agfa Horizon image scanner at IGP (fig. 10). The images of the San Ignacio area were scanned at the same resolution on a Zeiss SKAI scanner at the Swiss Federal Office of Topography (Swisstopo, Wabern). The ground resolution is 15 cm, which ensured that even the most narrow lines were still visible. Like the DTM measurements, images on the margins of the flight areas that showed only mountainous areas were omitted for the sake of efficiency. The images were stored in TIFF format with an overall file size of about 2.15 GB.

5.8 Orthophoto generation

The scanned images could be oriented based on the bundle adjustment. With the DTM as geometric reference they were combined into an orthomosaic using Socet Set on the Leica/Helava digital photogrammetric workstation (DPW) 770. The mosaic contains the rectified scanned images, *i. e.* images corrected so as to omit relief displacements caused by the central perspective of the original images, with smooth transitions between adjacent images. The result is a complete picture of the whole area covered by aerial images with each pixel provided with coordinates (supplements 3, 4). Like the DTM, the orthophoto was initially generated in two parts corresponding to the two original areas photographed. Later, when all necessary data had become available a complete orthophoto was generated that covered the whole area of investigation. According to different requirements several orthomosaics with a resolution ranging from 25 cm to 2 m pixel size were generated.

5.9 Vector extraction

Once the DTM had been generated, the actual feature extraction, *i. e.* the 3D mapping of the geoglyphs, could begin. This was done once again on analytical plotters using the XMAP software by Aviosoft. In each oriented stereopair, outlines of visible geoglyphs were marked with 3D vectors that could be digitally stored. Only actually preserved borders and borders that could be reasonably assumed to have once existed based on circumstantial evidence were mapped. Like the DTM, after a first iteration the vector data was revised in the field and then corrected and complemented in a second iteration. That way, 33,243 3D vectors, corresponding to roughly 1,500 geoglyphs, were produced.

As these numbers show, a peculiarity of this dataset is that in virtually no instance a given vector represents the entire outline of a single geoglyph; rather, it usually shows only a small part of its border (Sauerbier/Lambers 2004). This is due to the state of preservation of the geoglyphs: Many borders are interrupted where erosion had washed them away or where geoglyphs had been partially covered by other geoglyphs or footpaths. Furthermore, many geoglyphs do not have clearly defined borders on all their sides even if they are well preserved. For example, many trapezoids have an open narrow end without a clear margin. Thus, the result of the vector extraction was a huge number of unconnected 3D vectors. Based on this data, a vector layer was generated that could be exported into DXF format for further processing. The file size of the vector layer is about 20 MB.

In a separate step, all modern man-made elements visible in the stereopairs were also mapped in order to allow easier orientation. This was done in a generalizing way since the focus of the project was on the geoglyphs. The outlines of modern buildings, roads, etc. were marked and stored in a separate dataset. This dataset needed not to be revised in the field since all modern elements were clearly visible in the stereopairs, and did not constitute the focus of our investigation. The DXF file containing the modern elements has a size of about 9 MB.

5.10 Map revision and geoglyph definition

As indicated above, maps resulting from image analysis were revised in the field in order to improve their quality. The digital datasets were then revised accordingly. Map revision was accomplished during the field seasons. Due to the photogrammetric mapping, prior to archaeological fieldwork it was already fairly clear what to expect in the field. Reliable, though preliminary maps were available such that no surveying work had to be undertaken. Rather, in contrast to previous projects, the limited available time during fieldwork could be dedicated to the actual archaeological recording of the geoglyphs.

The first of three seasons of archaeological fieldwork was started in 2000. The fieldwork lasted eight months all in all. Out of the approximately 1,500 geoglyphs that had been mapped with photogrammetric means, all 639 geoglyphs located on Cresta de Sacramento, Cerro Carapo, and the area around La Muña on the right bank of Río Grande were recorded[39]. These are the geoglyphs considered in the present study (supplement 5b). Due to time constraints, only a small fraction of the San Ignacio and Llipata geoglyphs (226 geoglyphs at five sites) could furthermore be recorded which is why their overall number cannot be given here. The map could be corrected for some of the additional sites in the area of densest concentration of geoglyphs on the first plateau above the Viscas Valley. The remaining majority of geoglyphs of San Ignacio and Llipata, however, were mapped by photogrammetric means alone (supplement 2). Although this procedure was not as reliable as the combined one employed on Cresta de Sacramento and Cerro Carapo, the San Ignacio and Llipata geoglyph maps can still be considered comparatively reliable. The geoglyphs in that area are generally better preserved, and their mapping was undertaken when experiences from earlier field seasons allowed geoglyph shape to be reliably identified in the aerial images.

Fieldwork required the making of paper maps based on digital data. In order to produce them different datasets were combined. Contour lines with an equidistance of 10 m were derived from the DTM and shown as background of the geoglyph outlines. Furthermore, modern elements were added to allow easier orientation in

[39] Geoglyphs 1 – 646, out of which numbers 246, 285, 362, 374, 420, 461 and 511 were not assigned to geoglyphs due to technical reasons. Different geoglyph numbers given in preliminary reports are due to geoglyph renumbering in the course of analysis, during which several geoglyphs originally recorded separately in the field were combined and others omitted (see geoglyph database on DVD).

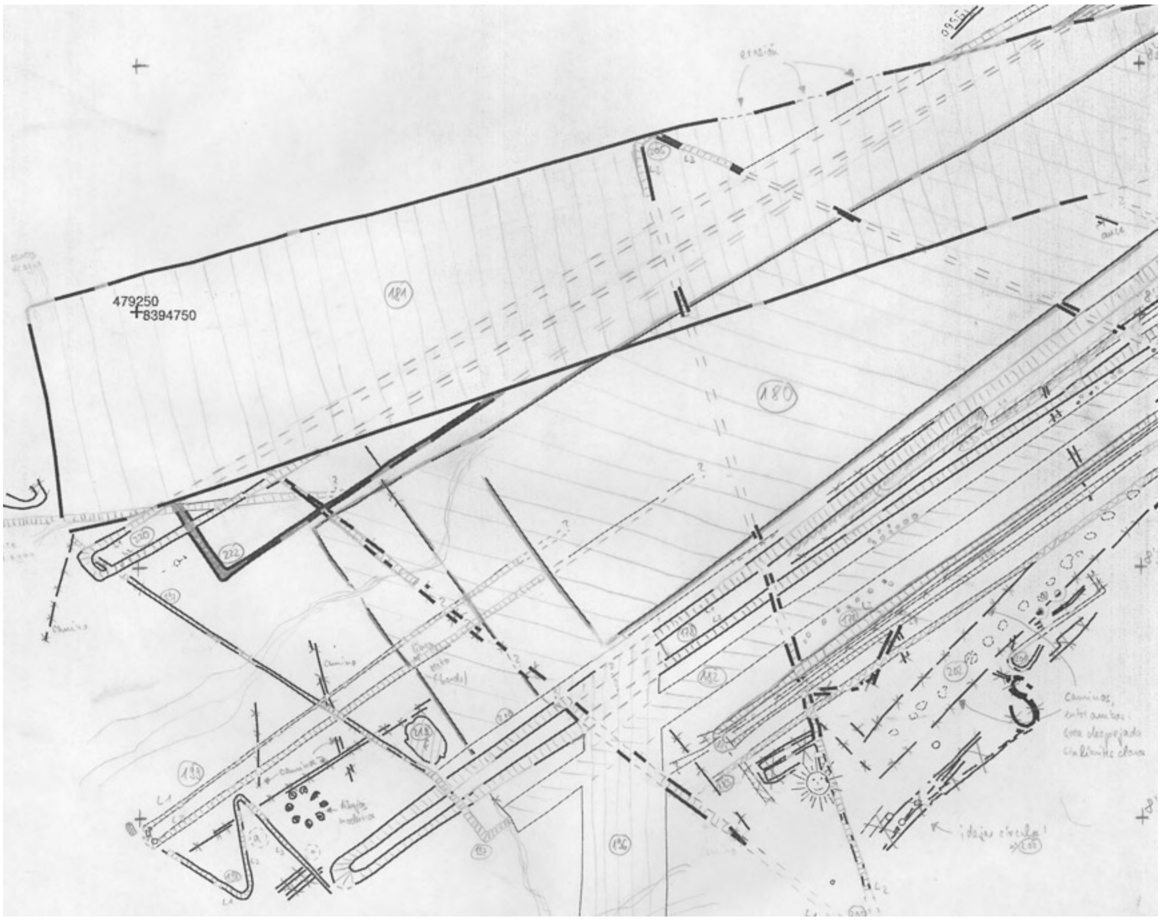


Fig. 12. Preliminary map of the southwestern portion of site PV67A-47 corrected during fieldwork.

the field. The datasets were combined in ArcView 3.2 and complemented with a coordinate frame. Using the layout tool, paper maps in A3 format could easily be laid out and printed in any desired scale.

The fieldwork allowed the detection of some minor errors in the DTM, but the main focus was on the revision of the vector dataset. Maps at scales ranging from 1:1,000 to 1:100 were taken into the field. Each geoglyph was located with the aid of these maps. Since the maps showed only disconnected sections of borders, vectors belonging together as part of a single geoglyph had first to be determined. Once the context was established, each geoglyph was assigned a consecutive code number or ID that allowed its unambiguous identification. This number was marked in pencil on the paper maps.

Each geoglyph was then walked over in order to determine if the mapping was correct. Although many details had been visible in the stereopairs during the mapping process, there was still more to be seen on the ground. Badly preserved parts of geoglyphs like eroded edges, sections covered by other geoglyphs or modern features and geoglyphs on sandy terrain were usually better discernible on the ground. Furthermore, footpaths and erosion gullies erroneously identified as geoglyphs in the photos could be distinguished from actual geoglyphs in the field. Thus, additional information was obtained that could be used to improve the quality and reliability of the maps. The maps were revised accordingly, and corrections were marked on them in pencil (fig. 12).

Once the paper maps had been revised they were taken back to the laboratory. During a second review of the stereopairs on an analytical plotter, incorrect 3D vectors were deleted and missing 3D vectors added. Although these sections of geoglyphs had not been detected during the first review of the stereopairs, they could, in most cases, easily be discerned in the images once it was clear from observations made in the field what was to be looked for. The quality of the 3D recording could that way be enhanced considerably. The revision of maps provided a good starting point for the geoglyph description described in the following section. On the *pampas* of San Ignacio and Llipata the revision of the preliminary maps constituted the main activity since only a small number of the geoglyphs were recorded archaeologically because of time constraints.

5.11 Geoglyph description

The description of each mapped and defined geoglyph absorbed most of the time during fieldwork. The geoglyph ID was marked on a feature sheet. Each geoglyph was described in detail on such a sheet with standardized categories that helped to register all geoglyphs in a comparable way. The categories included were: Description of the geoglyph itself, its surroundings, orientation, size, shape, stratigraphy, associated cultural remains, state of preservation, etc. Of course, not all categories applied in all cases. If necessary, textual descriptions were complemented by sketches. The feature sheet was designed so as to structure the data as far as possible to allow its import into a database and query analysis. However, the category "general description" also allowed a comprehensive textual description of the geoglyph in cases where the structured categories could not cover all aspects. Once the geoglyphs had been recorded in the field, the descriptive data was fed into a preliminary MS Access 2000 database which allowed easy data management during fieldwork[40]. Each record followed the structure of the feature sheets. For some categories, predefined pop-down menus allowed only a limited selection of values. Thus, the data format was as standardized as possible.

During recording, finds on or close to geoglyphs were surveyed, recorded, and classified. Typical archaeological finds consisted of potsherds, while lithics, textiles, and bones constituted a considerably smaller part of the whole repertoire. General remarks on the nature, composition, cultural affiliation, and location of the finds on each geoglyph were noted on the feature sheet. Unfortunately it was not possible to systematically sample the cultural materials. The available time and manpower was too limited to pursue such an approach, and the permits issued by INC differed for each field season, so that fieldwork had to be carried out under different legal conditions. For example, in the first field season in 2000 it was not permitted to collect finds, so that they could only be briefly described. Fortunately, even for geoglyphs recorded during that field season limited samples were available since they had been recorded before at the site level in the course of the site survey of 1997 when the INC permit had included the right to collect finds (Reindel et al. 1999). However, during the site survey the focus had been on datable materials, so fineware ceramics are overrepresented in that sample. In the second and third field season we were permitted to collect finds, but did so only to a limited degree due to time constraints. However, we tried to collect samples from the most important geoglyphs that were representative not only with respect to the fineware ceramics, but also to undecorated pots.

The extensive fieldwork to document the Palpa geoglyphs was dedicated exclusively to describing the geoglyphs in detail. No measurements had to be undertaken. The same is true for photos since the aerial images already constitute a complete photographic record of all geoglyphs. Thus, only a few photos were taken in the field in order to show ground views of types of different geoglyphs.

5.12 Object layer generation

After the revision of geoglyph vectors, the vectors represented only the preserved borders of the geoglyphs, and borders that could reasonably be assumed to have once existed based on circumstantial evidence, but not the geoglyphs themselves. Thus the next step was to digitally combine vectors marking the outline of each of the geoglyphs defined during fieldwork into a closed polygon that represented the most likely original shape of that geoglyph, as far as it could be reconstructed on the basis of photos

40 Since a good part of the data was obtained and processed by Spanish speaking team members, and Spanish was the working language during field seasons, all records were kept in that language. José Palomino (Los Molinos) and Alejandra Figueroa (Lima) entered most of the data. The whole database was then revised by Alejandra Figueroa to correct language errors, and by the author, to correct content errors. After fieldwork, the corrected datasets were integrated into the definitive Oracle database along with additional data (see sections 5.14 and 5.15). An extract of this data complemented by additional information obtained during data analysis is available on the DVD that accompanies this study.

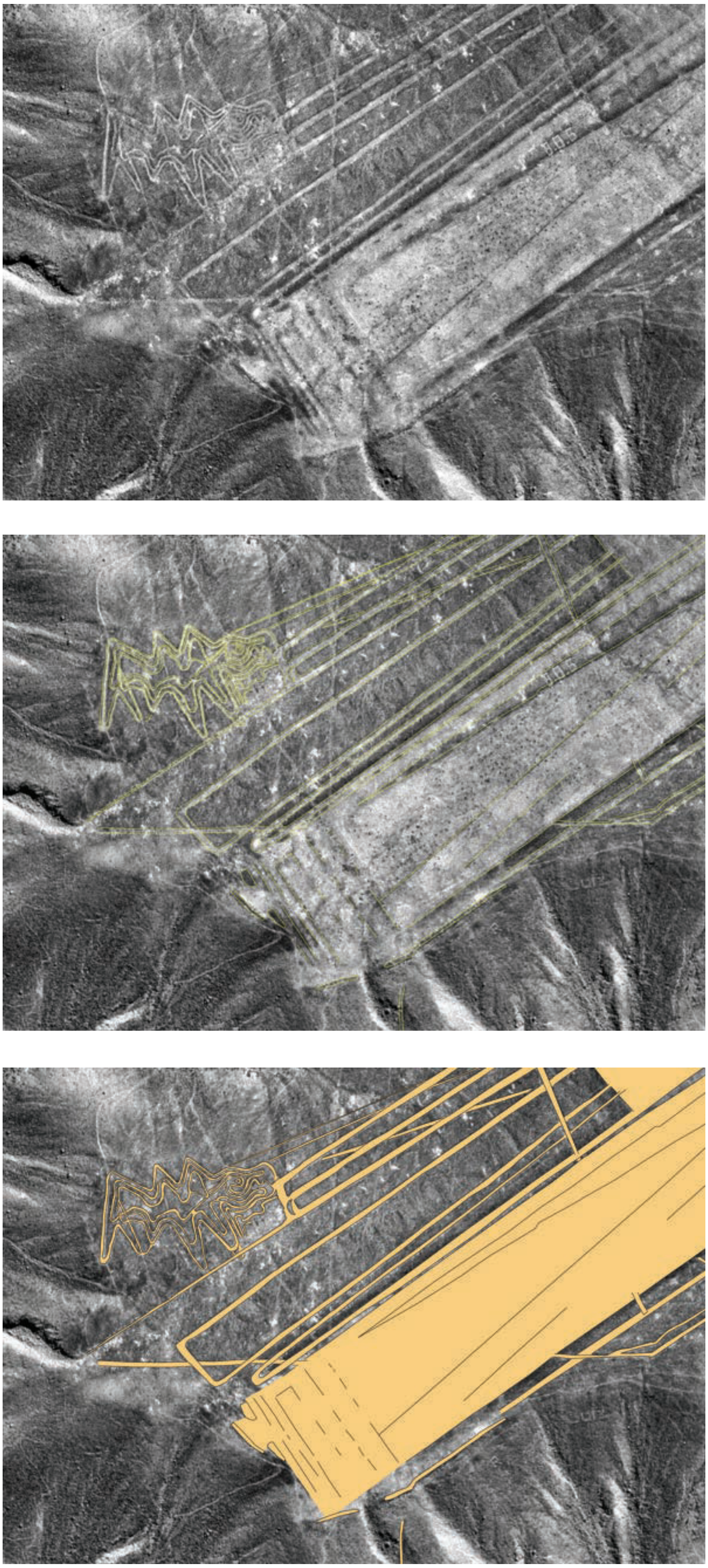


Fig. 13. Photogrammetric geoglyph mapping: Geoglyphs as visible in aerial images (top), vectors marking geoglyph outlines (center), polygons representing geoglyphs as defined from vectors (bottom).

Fig. 14. 3D model composed of DTM (upper center), orthoimage (left) and polygon layer (right).

and field data. The goal was to generate digital 3D objects that represented the geoglyphs and could therefore be linked with the corresponding description.

In a first step it was tried to convert the vectors into polygons in ArcView 3.2 (Sauerbier/Lambers 2004). However, this procedure did not yield satisfactory results. The task could better be accomplished in ArcMap, a module of ArcGIS 8.3. Here, the revised vector layer was displayed with a high resolution orthoimage in the background. Based on what was visible in the orthoimage and what was known about the geoglyphs from fieldwork, existing vectors were connected and complemented in such a way that the most likely original outline of the geoglyph was marked by a continuous line. Using the topology tools available in ArcMap, polygons could then be automatically generated from these polylines. The resulting polygons, however, still did not represent specific geoglyphs for the following reasons:

– During automatic calculation, all possible polygons were calculated, *i. e.* not only those pertaining to actual geoglyphs, but also unaltered areas completely surrounded by geoglyphs
– In all cases where geoglyphs overlapped, each polygon represented only a part of a given geoglyph or, in other words, each geoglyph consisted of several (often many) polygons
– For the same reason, some polygons pertained to several geoglyphs at the same time. Where one geoglyph crossed another one, the overlapping area corresponded to both geoglyphs.

In order to define which polygon pertained to which geoglyph, each polygon was assigned the corresponding geoglyph IDs adopted from the feature sheets. This part of the work had to be done manually. Where geoglyphs overlapped the corresponding polygons were assigned two (or even more) geoglyph numbers. Finally, all redundant polygons, *i. e.* polygons not belonging to any geoglyph, could be automatically deleted. The result was a data layer with polygons clearly identifiable as pertaining to specific geoglyphs (fig. 13).

The process of object definition was accomplished in ArcMap. The 3D vector layer in DXF format was converted into a 2D shapefile. The newly generated polygons were stored in a separate 2D shapefile (file size: 2 MB). By intersecting them with the DTM, the height

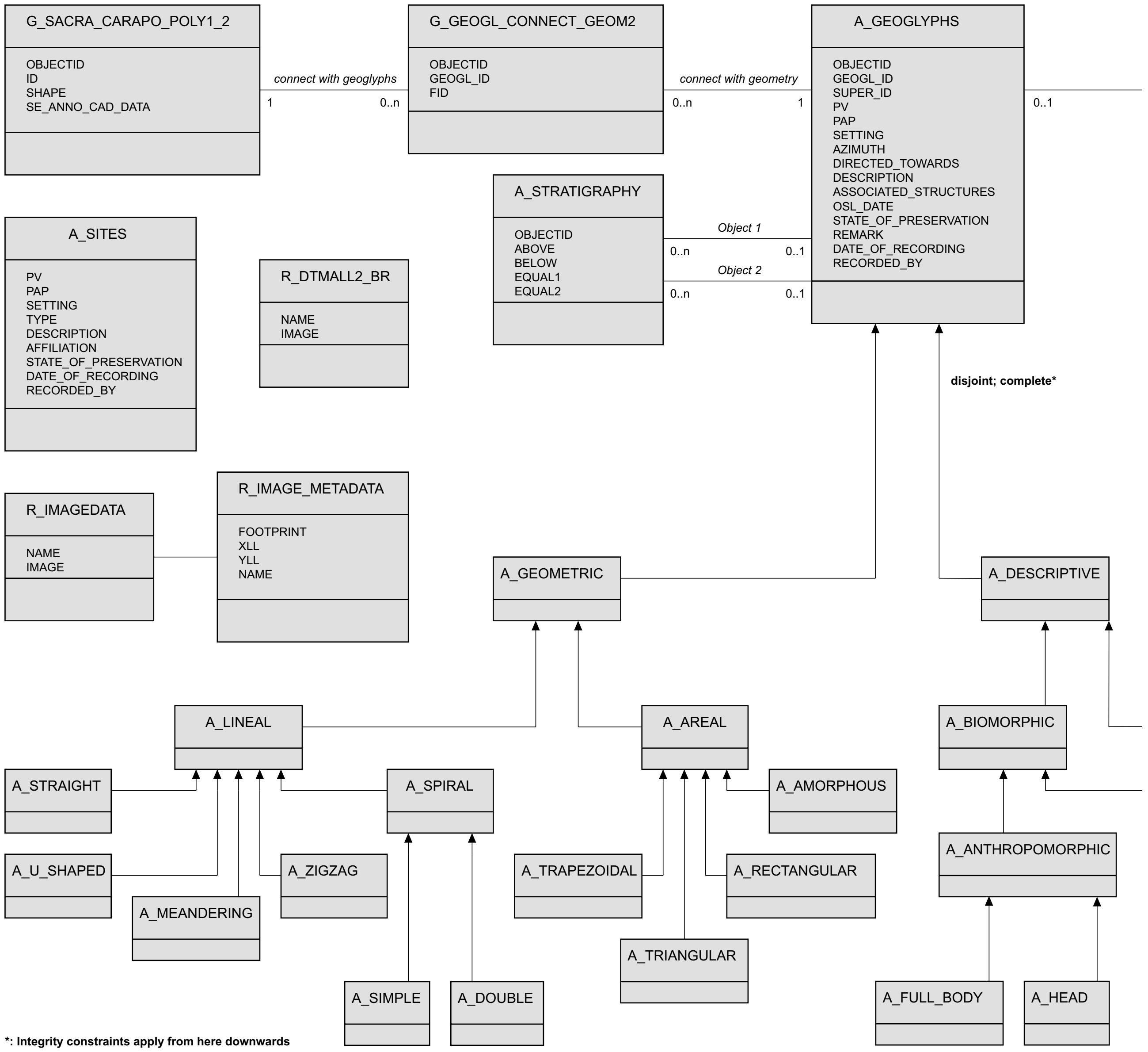


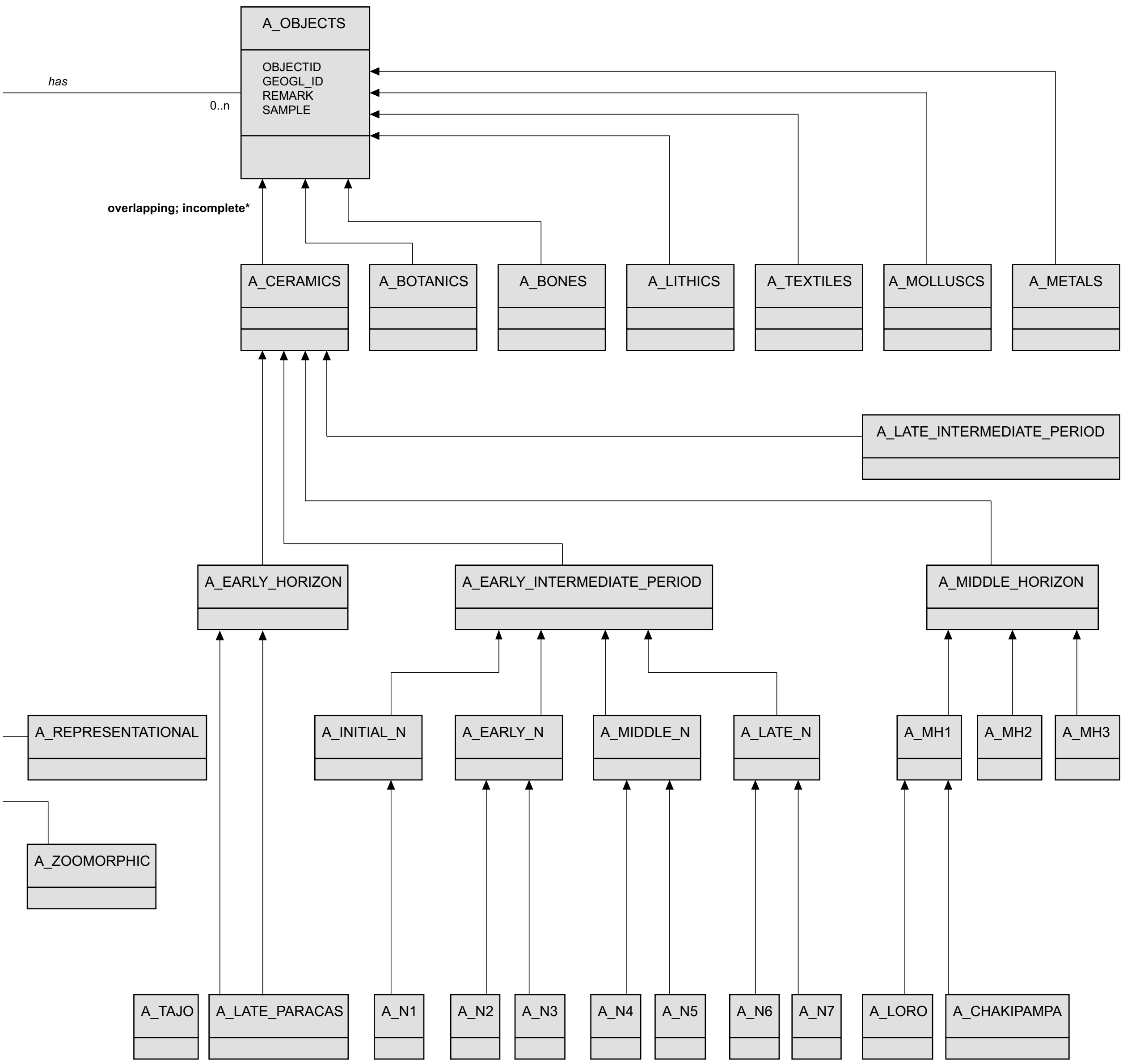
Fig. 15. UML class diagram of the conceptual data model.

dimension was added to the polygons. Since vectors and polygons are stored in different layers, the geoglyphs can be visualized (on maps or on-screen) in such a way that the provenience of the data is always transparent. The areal polygons, depicted for example as shaded in gray, represent the most likely original shape of the geoglyphs based on aerial images and field data. The lineal vectors displayed for example as black lines on the shaded polygons represent the preserved or assumed border sections of the geoglyphs, *i. e.* the actual information on which the reconstructed geoglyphs are based (maps 1–13).

5.13 3D Modeling

One aim of the documentation of the Palpa geoglyphs was to produce a highly accurate and detailed virtual 3D model of the geoglyphs and their environment that would allow navigation through it in real-time, and in which each geoglyph would be shown as a 3D object. Four different elements were used to generate the 3D model:

– The DTM showing the topography of the area around Palpa



- The orthomosaic as photorealistic texture showing the environment
- The vector layer showing the preserved outlines of the geoglyphs, and/or
- The polygon layer showing the most likely original shape of the geoglyphs.

The actual modeling process was accomplished using different commercial systems (*e. g.* ERDAS Imagine Virtual GIS 8.4, Skylinesoft Terra Explorer 3.0, cp. section 5.17). The 3D model integrating the different layers (fig. 14) constitutes a complete, digital documentation not only of the geoglyphs, but also of their environment as of 1998 when the aerial images were taken.

5.14 Conceptual data modeling

Once the revised geoglyph descriptions and the object data layer representing the most likely original shape of the geoglyphs had become available, the first analytical step was the elaboration of a descriptive typology based on all recorded geoglyphs of Cresta de Sacramento, Cerro Carapo, and the area around La Muña. Formal criteria, described in detail in section 6.1.1, were used to sort geoglyphs sharing common attributes into hierarchical categories. In the process, it became clear that several geoglyphs originally defined separately in the field were single geoglyphs. Therefore while assigning each geoglyph to a type, they were renumbered at the same time with a super ID (as opposed to the original geoglyph ID).

Descriptive data that resulted from archaeological recording of geoglyphs in the field had initially been stored in a preliminary, relational MS Access 2000 database. The final objective, however, was a more complex, object-relational database in which all data available for a given geoglyph – *i. e.* not only its textual description, but also its 3D geometry, images etc. – should be accessible via its super ID. This hybrid database was thought of as the central data storage and management facility for all later work. Such a storage and management system should allow data editing and retrieval from different platforms using standard procedures like structured query language (SQL), and its structure had to be flexible enough so as to allow the incorporation of additional data resulting from analyses of the original data. The database was furthermore to serve as core of the intended GIS. Due to its versatile capabilities it was decided to use an Oracle 9i database management system (DBMS).

In order to ensure a careful structuring of the database beforehand, a conceptual data model was developed using the object-oriented unified modeling language (UML[41]) (Lambers/Sauerbier 2003). The object-oriented approach allowed all available data to be structured in such a way that the real-world situation was reproduced in a simplified but accurate data model. Different types of data, *e. g.* spatial, textual, or image data, could be integrated into the model. The commercial software program Rational Rose 2002 was used for conceptual data modeling since it allowed data to be graphically structured on-screen. Furthermore, the resulting class diagram could then be directly converted into the logical Oracle database. In the following, the principle elements of the class diagram of the Palpa geoglyphs as shown in figure 15 are briefly described.

The core of the class diagram is the supertype A_GEOGLYPHS around which all information is structured. The central part of the class box features a series of attributes potentially shared by all geoglyphs. All subtypes inherit these attributes yet may have additional ones. The lower part of the box usually contains methods associated with an object that could likewise be inherited. In our case, this option was not used. Each geoglyph is represented by a series of polygons stored as Oracle spatial data objects (SDO), here represented by the class G_SACRA_CARAPO_POLY1_2. The link between geoglyphs and polygons is established by the class G_GEOGL_CONNECT_GEOM2 that connects both classes via the attributes GEOGL_ID, identifying a geoglyph as primary key, and FID, identifying a polygon as primary key, respectively. The cardinalities "1" and "0..n" describe the fact that one polygon may be part of more than one geoglyph. Each geoglyph may furthermore have a stratigraphic relationship with other geoglyphs, which is described by the class A_STRATIGRAPHY, the options being above, below, equal1 (equal) and equal2 (contemporaneous). The cardinalities are "0..1" on the A_GEOGLYPHS side, since not all geoglyphs are stratigraphically related to others, and "0..n" on the A_STRATIGRAPHY side, since a geoglyph may be superimposed by 0 up to n others.

The actual manifestations of the geoglyphs are represented by subtypes corresponding to the types defined in the descriptive typology (see section 6.1). Since the geoglyph typology is hierarchical in nature, it could easily be modeled in UML. Each geoglyph can be assigned to a subclass within this typological structure, so that the integrity constraints "disjoint; complete" can be established.

Each geoglyph may have finds associated with it that are represented here by the class A_OBJECTS. While this class contains attributes applicable for all kinds of finds, the different find categories are again modeled as subtypes with their own attributes. The chronological classification of the geoglyphs is modeled as related to the find subtype A_CERAMICS since in fact only objects from this find category can be stylistically assigned to a time period. The subtypes representing chronological phases are hierarchically structured similar to the geoglyph typology. However, since datable ceramics were not found on all geoglyphs, whereas on others ceramics from different time periods were present, the integrity constraints are less strict ("overlapping; incomplete").

Further data not directly related to single geoglyphs but nevertheless stored in the database and used for analysis are here shown as unconnected classes. A_SITES contains data on all prehispanic settlements, cemeteries, and other sites obtained during the regional settlement

[41] UML™ by the Object Management Group, see UML resource page at www.uml.org (accessed July 9, 2004).

pattern survey. R_DTMALL2_BR represents the DTM with a mesh size of 2 m, whereas the class R_IMAGEDATA stands for orthoimages which are stored in Oracle raster format in the database. While metadata for the DTM is automatically generated during the import process, for photogrammetrically processed image data metadata like the attributes listed in R_IMAGE_METADATA has to be acquired separately.

Thus, the conceptual data model developed using UML proved to be an efficient way to ensure a useful data structure as well as data integrity. It is furthermore a helpful tool to visualize relationships and interdependencies between different kinds of data.

5.15 Database implementation

The conceptual data model was converted into a logical database using an object-relational Oracle 9i DBMS that should also serve as the basis of the intended GIS. Since ArcGIS 8.3 was chosen as the GIS tool, the link to the database could be established using ArcSDE, ESRI's server application that allows ArcGIS to be connected to different DBMS. The object-oriented data structure based on the conceptual data model was implemented in an object-relational tablespace using SQL data definition language (DDL). The archaeological data was then stored into the defined tables by first importing the MS Access tables into Oracle 9i, and then distributing the attribute data into the table structure. Similarly, tables containing additional data like super ID, type, etc. were integrated into the database. For the import of geometric data ArcGIS toolbox was used to generate Oracle spatial data objects from the 2D polygon shapefile as well as DTM (2.5D) and images in Oracle raster format. To establish the predefined relations between geometric and archaeological data, as well as for visual error checking, scripts were developed in Visual Basic for Applications (VBA) that allowed convenient data editing via the graphical user interface of ArcGIS.

5.16 Data analysis

The first analytical step had already been accomplished in the process of data modeling. This involved the elaboration of a descriptive typology that allowed an initial sorting and easy handling of the geoglyphs, and served as basis for their definitive numbering. Once the structured data was accessible in the Oracle DBMS it could then be analyzed in different ways:

- Using scripts developed in Visual Basic, additional information on the geoglyphs was generated from their geometry, *e. g.* by calculating their surface area and orientation. The results were stored in the database.
- Using SQL, the database was queried for specific information. That way, quantitative data on the distribution of geoglyph types and datable ceramics on geoglyphs became available and could be graphically displayed in charts (figs. 26, 28, 32).
- Using tools for spatial analysis available in ArcGIS 8.3, geoglyph data and terrain data were related and analyzed. Distribution maps of geoglyphs and contemporaneous sites were produced for different time periods in order to study the development of geoglyph sites on a regional scale through time (supplement 5 to 10). Analyzing the topography of the terrain in which the geoglyphs are located, their accessibility, visibility, and orientation were investigated and displayed on maps.

The specific analyses as well as their archaeological results are described in detail in section 6.

5.17 Visualization of results

The visualization of results was the final step in the workflow as illustrated in figure 8. It comprised the visualization of the 3D model composed of the layers mentioned above and the illustration of results of analyses. The virtual 3D model of the Palpa region has been visualized in different ways completely or in parts: Virtual 3D views (either static or dynamic), 2D paper maps, and finally a physical 3D model. Furthermore, 3D views and paper maps were used to show results of data queries and other analyses.

The most advantageous way of visualizing a 3D model is the generation of virtual, on-screen views of it. A virtual 3D model allows the review of every given part of the study region on-screen, *i. e.* in the office during analysis. A major constraint is the amount of data to be processed. In the case of the Palpa model, due to the large amount of photo texture about 2.7 GB of data had to be visualized. The aim was to achieve this on a standard PC platform.

To generate synthetic still views of subsets of the 3D model in high resolution, ERDAS

Fig. 16. Virtual view of the central part of Cresta de Sacramento generated using ERDAS Imagine Virtual GIS 8.4.

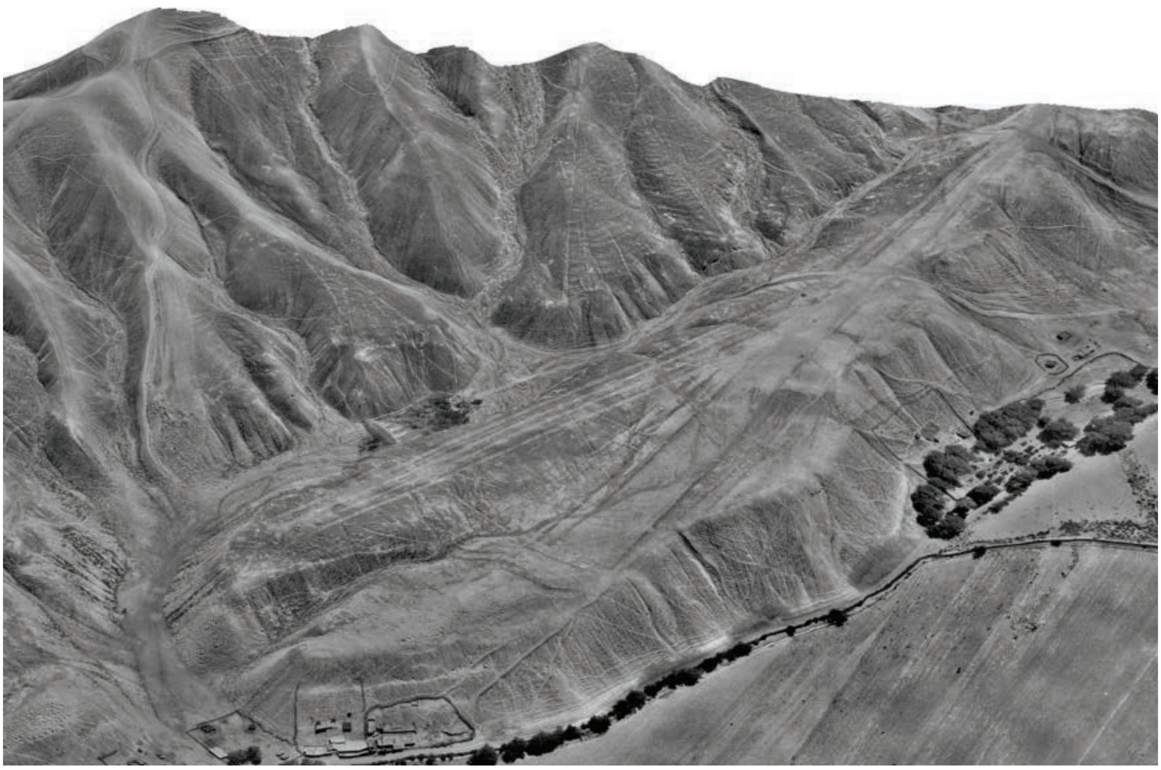


Fig. 17. Virtual view of site PV67A-22 generated using ERDAS Imagine Virtual GIS 8.4.

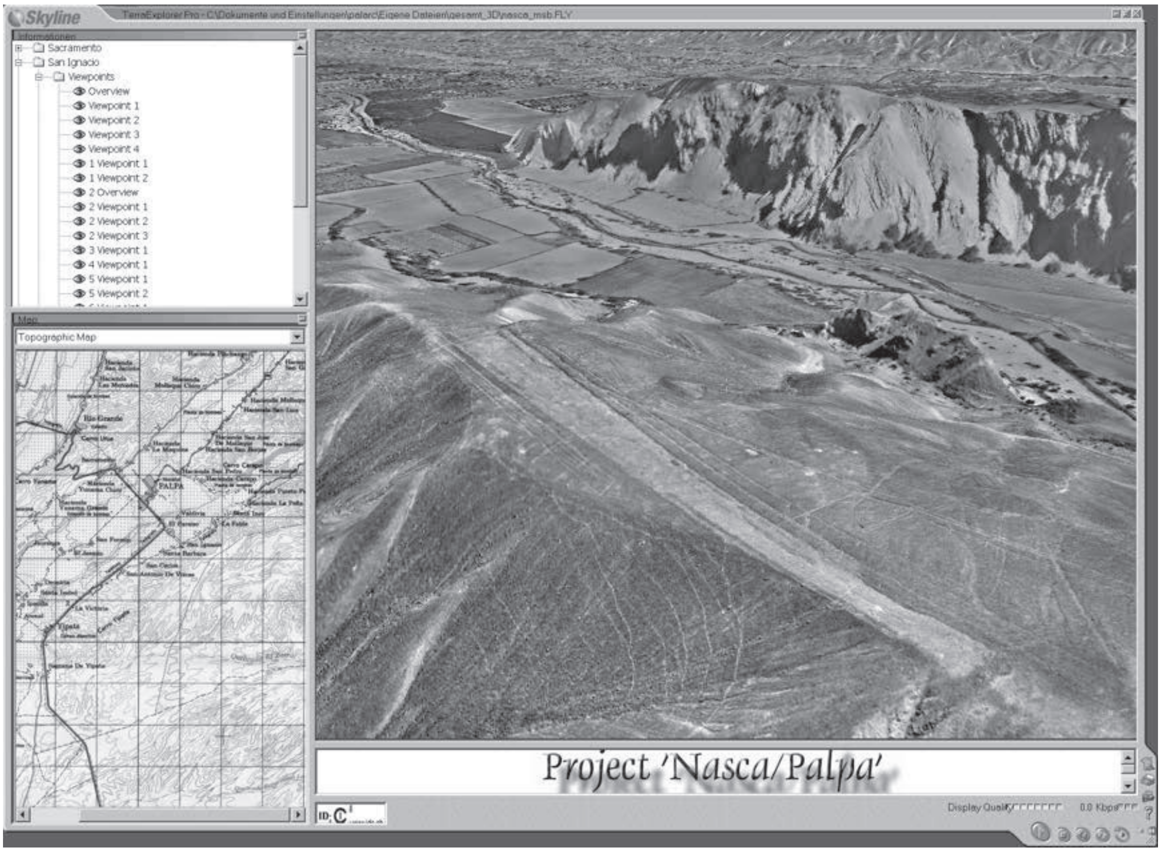


Fig. 18. Terra Explorer user interface with a virtual view of Cerro Carapo as seen from east (upper right), predefined viewpoints (upper left), topographic map indicating location of viewer (lower left), and project website (lower right).

Imagine Virtual GIS 8.4 by Leica Geosystems was mainly employed (figs. 16, 17). This software yields good quality results for photo texturing. The integration of vector and polygon layers is possible, but there can be problems. If they are integrated as 3D data, they do not coincide exactly with the interpolated DTM surface which is why some sections of lines or areas might disappear. If they are integrated as 2D data and mapped onto the DTM surface, they are dissolved into the pixel structure of the textured surface. While polygons are displayed in acceptable quality this way, thin lines are usually blurred. Therefore, most synthetic views produced for the Palpa area contain the DTM and photo texture only. Furthermore, the capabilities of ERDAS Imagine Virtual GIS 8.4 to process large datasets are rather limited. On the other hand, it allows the generation of short fly-throughs and offers some basic GIS functions such as viewshed analysis.

In order to visualize the Palpa 3D model in its entirety in real-time, *i. e.* allowing interactive navigation through the model, high-end visualization software with Level-of-Detail capability (LoD) was needed. LoD means that in every frame of an image sequence only the foreground portion (*i. e.* close to the viewpoint) is shown at highest resolution, while the background is displayed at lower resolution. That way the amount of computations necessary to render each frame is reduced considerably. A prerequisite for such an approach is the generation of data pyramids (vector and raster data) based on the input data. For the Palpa model, commercial software with LoD capability was used for real-time visualization.

In Terra Explorer 3.0 by Skylinesoft[42] (fig. 18) the hybrid input data (2.15 GB of photo texture plus DTM, vector, and polygon data) was compressed to a single file of roughly 600 MB. The model can be edited by the user, and additional data (predefined 3D objects, tabular data etc.) may be integrated. The user interface allows the lateral incorporation of further elements, like

[42] See www.skylinesoft.com (accessed May 13, 2004).

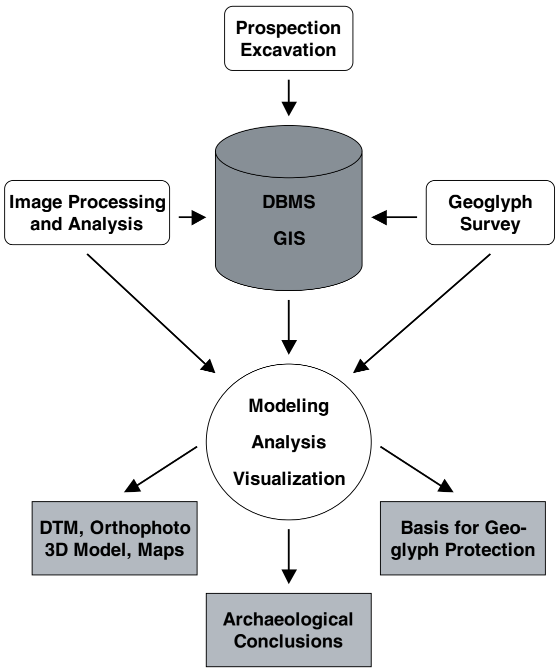


Fig. 19. Project design.

overview maps or the project website. Free navigation through the 3D model is possible via keyboard or joystick control. Fixed viewpoints can be defined and automatically approached, *e. g.* over certain geoglyphs. Flights through the model can be interactively defined and recorded to an export file, *e. g.* in AVI format. An example of a video produced this way is given on the DVD that accompanies this study. It features a virtual flight over the entire area around Palpa covered by the 3D model.

A problem concerning the Palpa model was that image resolution was not as good as input data would allow, and in recorded flights the limits of the area shown in highest resolution were clearly visible against areas displayed in lower resolution. Another major disadvantage was that objects from the vector layer were either blurred or not correctly mapped onto the surface due to the same issue described above for the ERDAS software. On the other hand, an advantage of Terra Explorer is that it allows the integration of self-defined objects into the model, *e. g.* in the Palpa case virtual posts like those found in excavations (see appendix 9.2.2). All in all, the Skyline software is a good tool for interactively exploring the photorealistic 3D model, but with certain limitations. A viewer without editing functionality is freely available for download from the provider website, so that the model can easily be distributed to interested persons. The pros and cons of the Skyline software have been discussed in more detail elsewhere (Sauerbier, Lambers 2003).

Another way to visualize the 3D model is the generation of 2D paper maps derived from 3D data. Although maps clearly do not tap the full potential of the available data, the fact that reliable maps of the Palpa geoglyphs can be easily generated is a major step forward in Nasca archaeology. The Palpa data is available in digital form and organized in layers with different content. This allowed free data scaling and the combining of different layers. While geoglyph layers (polygons and vectors) and the layer containing modern elements (roads, buildings, etc.) can be shown largely unaltered on a map, the DTM may be replaced by a contour line layer derived from it (supplements 1, 2). The orthophoto layer may also be integrated into the map design (supplements 3, 4). Both ArcView and ArcMap offer user-friendly tools for easy map production. The combined layers were laid out on a map and complemented with coordinate frames, legends, scale bars, etc. Not only entire datasets, but also selections based on queries were generated using predefined map templates in order to ensure comparable results. That way only geoglyphs of a certain type or time period could be automatically selected to be shown on the map. Labels, charts, symbols, etc. were then added to explain the illustration. For printout, files were exported to standard raster or vector file formats like EPS, TIFF, etc. While maps used during fieldwork were produced in ArcView, all maps in the present study have been generated in ArcMap.

A less common way of visualizing the 3D model was the production of a physical model. For the newly established local archaeological museum in Palpa, a 3D model of Cresta de Sacramento was made using modern casting facilities of the General Command of Mapping, Ankara, Turkey[43]. First, a mold was produced using an ASCII file containing the DTM data. In this mold a plastic model (scale 1:4,000, vertical exaggeration 1.5) was then cast. The high resolution photo texture derived from a Geo-TIFF file was automatically applied to the model surface during the casting process. Due

[43] Prof. Orhan Altan, head of the Division of Photogrammetry of the Faculty of Civil Engineering at Istanbul Technical University, is warmly thanked for his help in this matter.

to the length of Cresta de Sacramento two separate blocks had to be cast which could then be joined to form the complete model. Once the molds had been created further casts could easily be produced. It is hoped that the Sacramento model now on display in a showcase in the entrance hall of the Palpa museum will become a major attraction.

All in all, different ways of visualizing the 3D model proved fruitful for different purposes. The production of 2D maps was important for fieldwork, but also for illustration of results and in the new Palpa museum where the physical model is a further attraction. On-screen visualizations of the virtual model were not only used as tool for presentation, but also for research since a detailed reconstruction of the study region was constantly available during analysis.

5.18 Summary: Documentation of the Palpa geoglyphs

The combination of archaeological fieldwork and analysis with photogrammetric and GIS techniques of data capture, processing, modeling, and visualization allowed for the first time the establishment of a comprehensive, digital database containing hybrid data on a large sample of geoglyphs. Products generated during the process include:

- DTMs of the Palpa area with up to 2 m mesh size
- Orthomosaics of the same area with a highest resolution of 25 cm on the ground
- A hybrid database linking geometric representations of the geoglyphs with descriptive, structured attributes
- A virtual, interactive 3D model of the Palpa region and the geoglyphs
- Geoglyph maps at different scales and with different content.

Figure 19 summarizes the project design including input data, data processing and analysis, and output results. It shows the integration and interdependence of archaeological and geomatic methods, and the central role of the database and GIS for the joint management and analysis of both kinds of resulting data. The available data on the Palpa geoglyphs resulting from this integrated approach is of unprecedented scope and detail in the context of Nasca archaeology. Analysis as described in the following section is an important qualitative step forward in geoglyph research. Furthermore, the digital archive of the Palpa geoglyphs can now serve as starting point for their protection and long-term preservation[44].

[44] After the conclusion of the present study, the Palpa geoglyph map was put at the disposal of INC Lima. It is planned to use the map to define in close cooperation with UNESCO an extension of the existing protected geoglyph zone on the Nasca *pampa* in order to include the Palpa geoglyphs.

6. Archaeological analysis of the Palpa geoglyphs

For reasons explained in section 5.10, all 639 geoglyphs of Cresta de Sacramento, Cerro Carapo, and the area around La Muña were considered for analysis (supplement 1), yet not the only partially documented geoglyphs on the *pampas* of San Ignacio and Llipata (supplement 2). Archaeological analysis was undertaken in four steps. Firstly, a descriptive typology was established in order to sort the geoglyphs into manageable categories that served as basic units during subsequent steps of analysis. Secondly, information on the chronology of the geoglyphs was compiled, since their dating was a prerequisite for any interpretation. Thirdly, activity on geoglyph sites as manifest in the archaeological record was identified. Fourthly, the spatial and contextual setting of the geoglyphs was investigated and tested for recurrent patterns. The implications of the results of this analysis for the Andean model and the cultural history of the Palpa region are discussed in section 7.

6.1 Geoglyph typology

In order to enable an efficient management and analysis of the 639 geoglyphs that are considered in the present study, they had to be revised and sorted. The first step in data analysis was therefore the development of a geoglyph typology[45]. Archaeological typology is here defined as the sorting of artifacts into abstract categories based on shared attributes that are chosen and weighted according to a previously defined purpose. Hence, such a typology is composed of etic artifact categories (*i. e.* categories defined from an outside view) that may just by chance coincide with the emic or native peoples' definitions of the categories. The geoglyph typology as established here should be understood to be a tool for archaeological research rather than revelation of original cultural concepts (Eggert 2001:142f). Its purpose is to enable efficient data management. Whether the established descriptive types bear any chronological, functional or other significance will be tested during subsequent steps of the analysis.

Like all archaeological artifacts, each geoglyph features certain properties. Some of them may be alike on all artifacts of a given assemblage (invariant), while others vary and can therefore be used for differentiation (variable). The different values the variables can assume are here termed attributes[46]. A typology is established by choosing certain variables and grouping all artifacts that share the corresponding attributes together into one category: a type. This can be accomplished on different levels. For example, if only one variable is considered, the number of artifacts sharing identical attributes and therefore being grouped together is relatively high. Further subdivisions can be achieved by considering additional variables. Since fewer artifacts are likely to share corresponding combinations of attributes, the number of artifacts in each category decreases or, in other words, the typology gets more fine-grained.

The number of levels is determined, among other things, by heuristic considerations. A too fine-grained typology in which each individual artifact ends up in its own category is of no practical value, so each category should represent a certain minimum number of artifacts. On the other hand, the consideration of too few variables necessarily leads to artifact categories with considerable inherent variation. Usually, a hierarchical typology is useful with each level having a different significance and use. Although each category on each level is actually a type as defined above, they are usually not termed so for practical reasons. For example, a three-level typology may consist of groups on the upper level that are subdivided into types on the

[45] If not noted otherwise, the following remarks and definitions are largely based on the rather practical approach to artifact typology by Adams/Adams 1991. The typology outlined here replaces preliminary typologies presented in earlier reports (Reindel et al. 2003b: 193ff, 216ff; Lambers/Sauerbier 2003: fig. 3).

[46] The term "variable" as used here corresponds to the term "attribute" in the context of conceptual data modeling (see section 5.14). There, the potential range of "attributes" in the sense of archaeological typology is termed "domain".

middle level with the types being further subdivided into varieties on the lower level.

The choosing and weighting of variables is determined by foreknowledge of the artifacts and by the intended purpose of the typology. A certain familiarity with the artifacts to be analyzed is necessary to tell invariants from useful variables, and to understand which variables are significant for which problem. The purpose of the intended typology then determines which variables are chosen and combined to define types. For example, for a chronological typology, variables that are likely to bear chronological significance will be considered more important than other variables. Since in the case of the Palpa geoglyphs a descriptive typology is aimed at, descriptive variables are considered primarily.

6.1.1 Definition of geoglyph types

In the course of the archaeological as well as photogrammetric recording of the Palpa geoglyphs a wide range of variables were registered. However, the only variables whose attributes are unambiguously known for all geoglyphs are construction technique and shape. Other variables recorded in the field are orientation (towards landscape features), topographical setting, stratigraphic relationships, associated structures, associated finds, indirect dating obtained through chronological classification of associated finds, and state of preservation. Information on additional variables was derived from photogrammetrically obtained 3D data. This includes size, orientation (azimuth), and slope degree of the terrain covered by a certain geoglyph. However, some of these additional variables are either not available or not applicable for all geoglyphs (orientations, stratigraphy, associated structures, associated finds, indirect dating) or they are often not clearly definable (topographical setting, stratigraphy, associated structures, associated finds, slope degree). Yet other variables yield information that should ideally be further structured to make sense (size, which should be subdivided into length and width) or they are irrelevant for an archaeologically meaningful classification (state of preservation). Nevertheless, some were used in later stages of analysis.

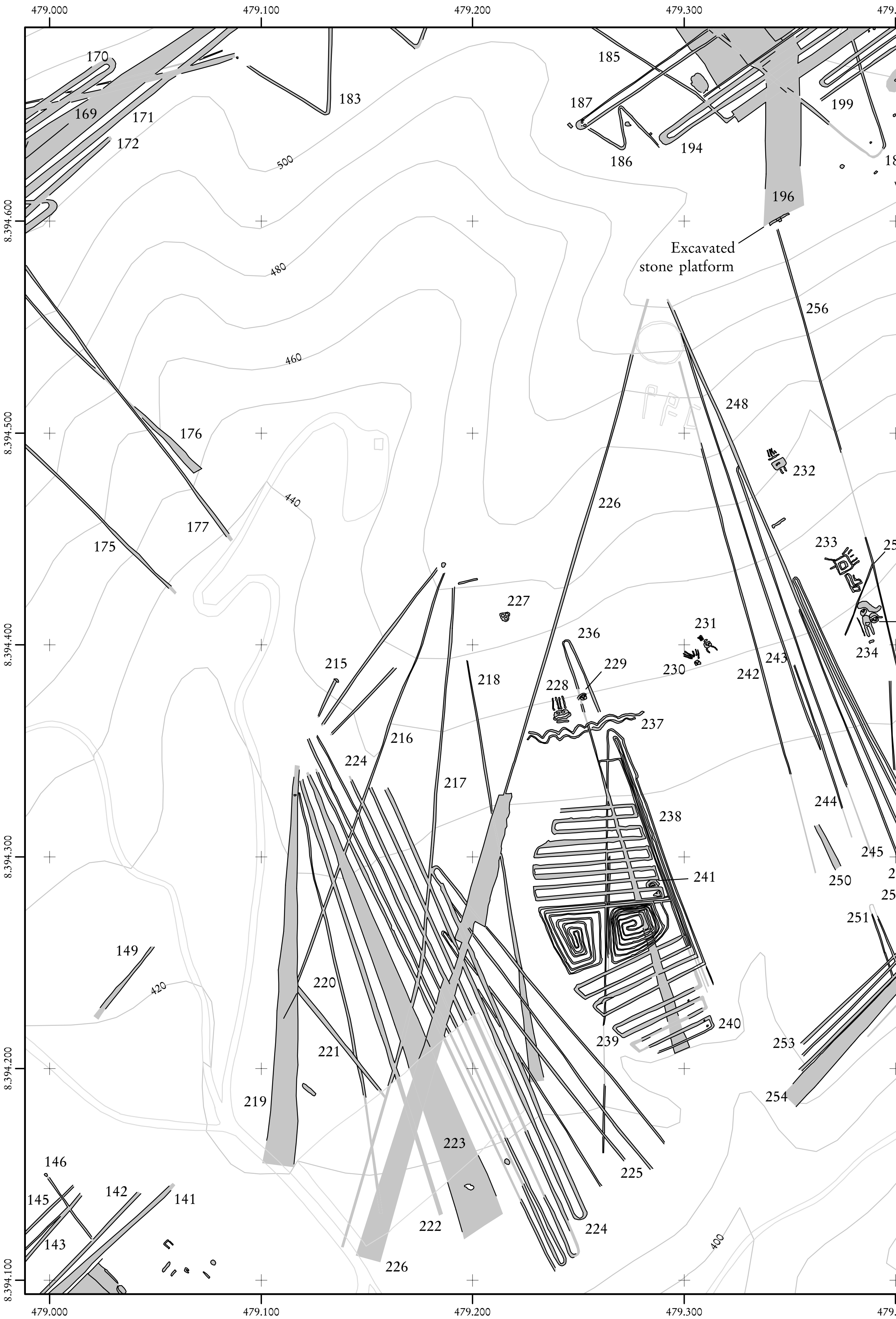
Thus, because of the defined purpose and the availability of information for the Palpa geoglyphs, construction technique and shape were the basic variables used in an initial sorting. The resulting typology as shown in figure 20 is described in detail below.

The construction technique of the Palpa geoglyphs is largely determined by the environment in which they are situated. It shows only limited variability and is therefore used here for the first step in the sorting process. The geoglyphs are located in a rocky desert. Each of them is the visible result of an alteration procedure of the desert surface. To construct a geoglyph, the more or less regular original desert pavement was disturbed by moving stones from their original location to a new one. Thus the procedure always included a subtractive as well as an additive activity. Sometimes unaltered parts of the original surface were also incorporated into the geoglyph design. The difference in construction technique is determined by which element of a given geoglyph is made up of cleared, heaped, or unaltered parts.

The "positive" technique means that a geoglyph consists of a cleared inner space framed by heaped borders. This is, by far, the most common construction technique of the geoglyphs[47]. This is probably due to the fact that the visible difference between geoglyph and original surface is most clearly seen that way. Certain variations of this technique are observable. The borders were not always continuously heaped. Where not enough stones were available, unaltered parts of the desert surface were incorporated as sections into the otherwise heaped border. The visual appearance of the positive technique was only marginally affected by this change. The same is true for a variation concerning the cleared interior spaces. While only stones of the desert pavement were usually removed, in some cases a part of the sediment beneath was also excavated. However, these sections were never very deep (and may have been deepened by erosion since their original construction), and they often made up only a part of a cleared area.

The second construction method, called the "combined" technique, is more varied. The combined technique is easily distinguishable from the positive technique. The main difference is the interior part of a geoglyph which is not just a cleared area, but incorporates other elements as well. Geoglyphs rendered in the combined technique feature some unaltered or heaped elements enclosed in the cleared area, along with heaped or unaltered borders and cleared interior parts which they share with

[47] Quantitative data on the Palpa sample is presented in the following section.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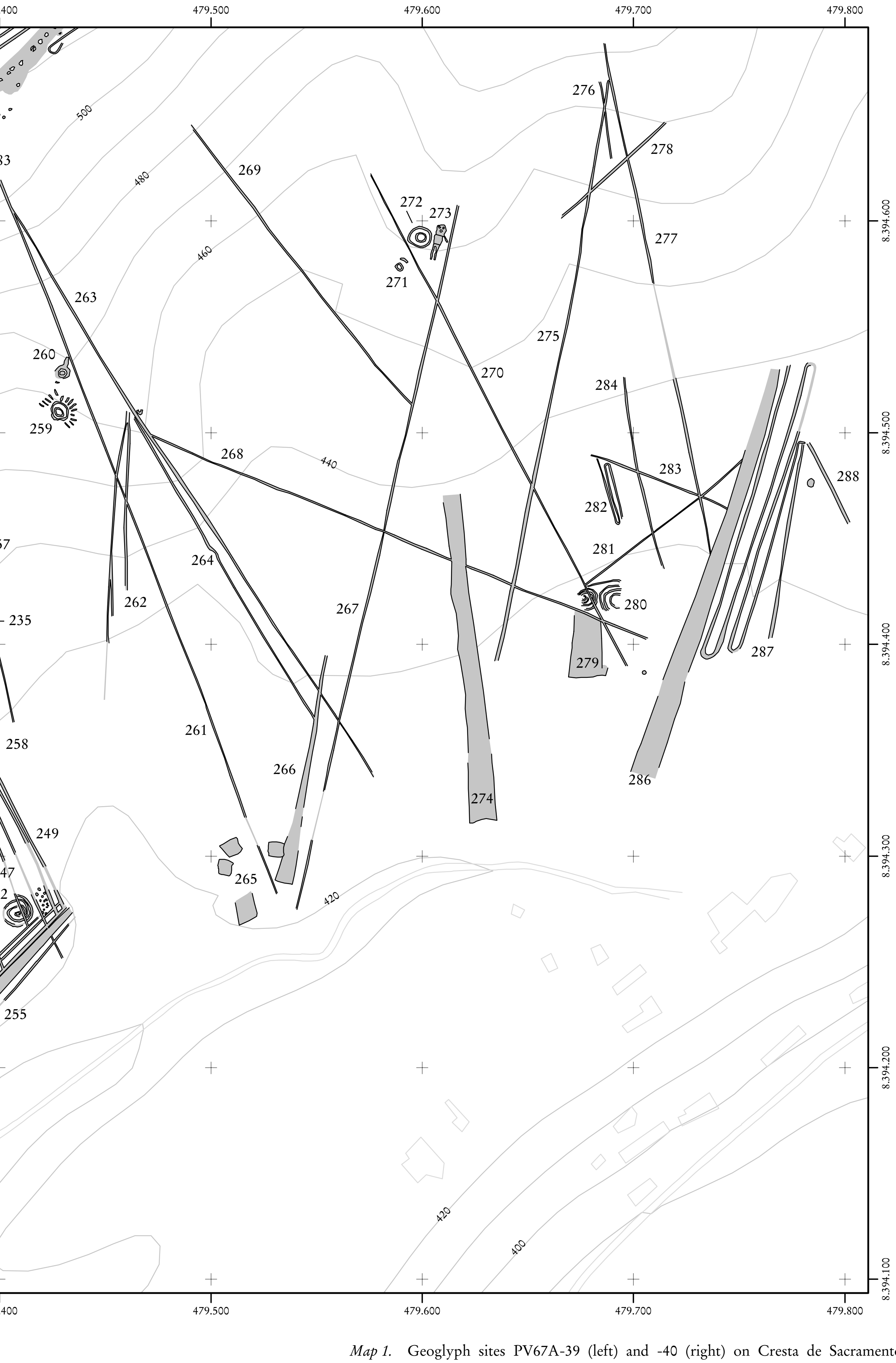


Map 1. Geoglyph sites PV67A-39 (left) and -40 (right) on Cresta de Sacramento.

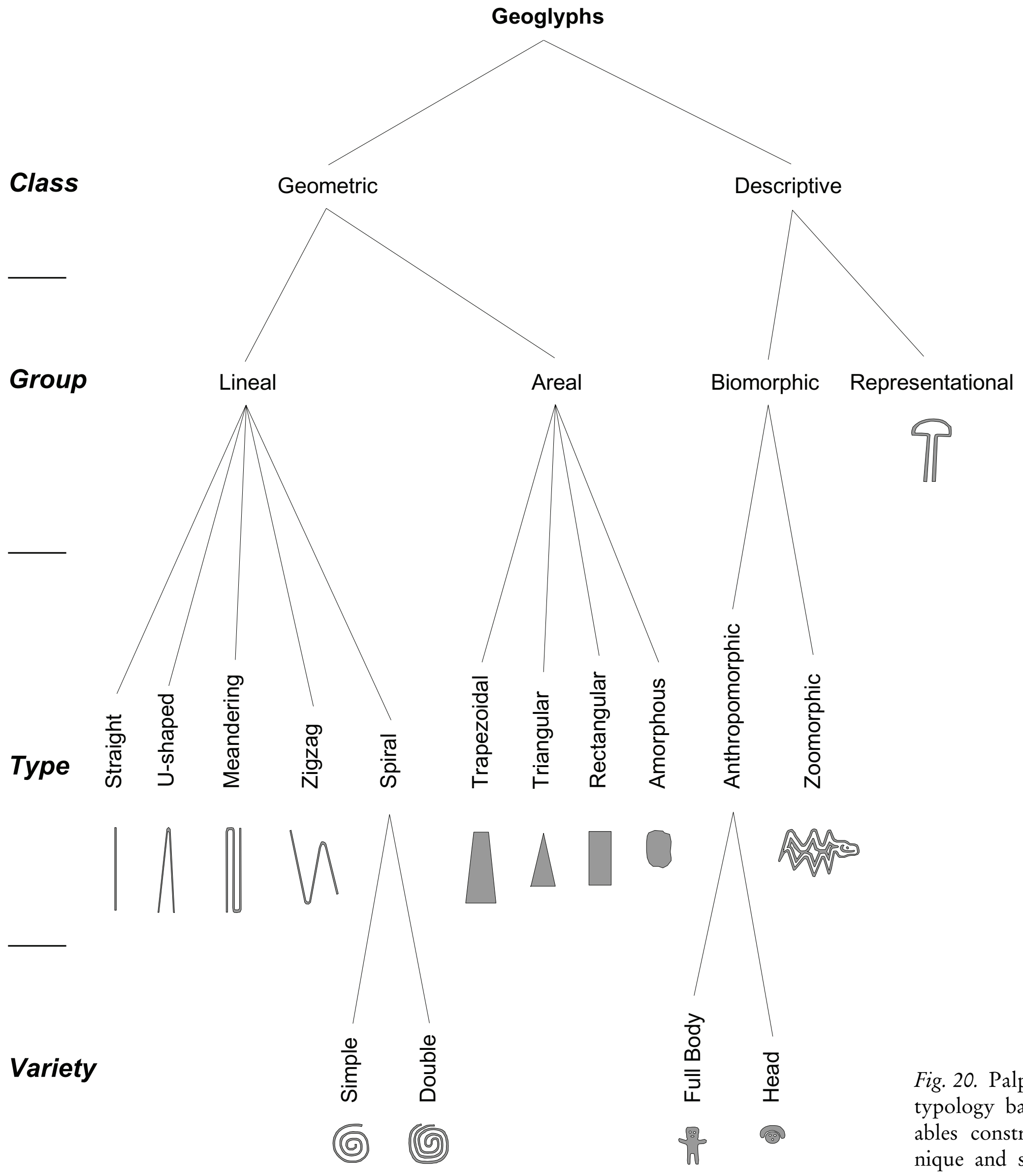


Fig. 20. Palpa geoglyph typology based on variables construction technique and shape.

geoglyphs made in the positive technique. In rare cases, the unaltered or heaped areas of geoglyphs made in the combined technique even form the central element of the geoglyph, being surrounded by cleared areas defining the geoglyph outline. Geoglyphs rendered in the combined technique are very multi-faceted, although they make up a smaller part of the overall Palpa sample.

Thus, the variable construction technique with its two attributes defines two basic categories of geoglyphs: those made in the positive technique and those made in the combined technique. These categories can be differentiated further by considering an additional variable, which is shape. This variable shows a much greater variety, or in other words, more attributes associated with it on different levels. Shape is understood here in a rather descriptive or subjective sense. Though some of the terms used for type labeling were borrowed from geometry, no geoglyph actually matches exactly any geometric form. This is prevented by the intrinsic irregularities of the construction process. Furthermore, each and every geoglyph is unique with regard to its specific shape. However, all these manifestations can be easily traced back to a relatively small repertoire of basic shapes.

The basic distinction between different geoglyph categories of the variable shape coincides with the distinction based on construction technique: all geoglyphs made in the positive technique feature geometric shapes in the widest

Fig. 21. Lineal geoglyphs on the southern hillside of Cresta de Sacramento: Straight line 248 on site PV67A-39 (left), turning point of U-shaped line 249 on the same site (right) (cp. map 1).

sense (straight lines, rectangles, etc.), whereas all geoglyphs made in the combined mode depict real-world objects recognizable to the modern observer as human or animal figures. Of course, geoglyphs of the first class may just as well represent objects or phenomena in a symbology that we do not understand. This question, however, is of no relevance in this sorting. Hence, two basic classes of geoglyphs can be defined on the uppermost level of the typology: geometric geoglyphs rendered in the positive technique, and descriptive geoglyphs rendered in the combined technique.

The diversity of the variable shape allows a further grouping of the geoglyphs into groups, types, and varieties. In the geometric class there are two groups: lineal geoglyphs and areal geoglyphs. Geoglyphs of the lineal group are made up of lineal cleared elements that are much longer than wide. Geoglyphs of the areal group, on the other hand, have a wide cleared interior and are usually much more spacious than the lineal geoglyphs. Though theoretically desirable, it is not practical to define a certain length-to-width ratio to distinguish areal from lineal geoglyphs because the parameters length and width are in most cases difficult to determine. Empirically, however, it is relatively easy to decide whether a geoglyph pertains to the lineal or the areal group.

In the descriptive class geoglyph shape is largely determined by depicted motifs. These shapes can be classified into two groups. Biomorphic geoglyphs depict animate beings, including humans and animals. Representational geoglyphs depict inanimate objects such as tools or other objects or phenomena.

Thus, on the second level of the typology we have four groups of geoglyphs: lineal and areal geoglyphs in the geometric class, and biomorphic and representational geoglyphs in the descriptive class. Most of these groups can be subdivided further into types, and some into varieties, according to their specific shape.

Geoglyphs from the lineal group are basically formed by a single line. According to the shape of this line, they can be classified into five types that occur frequently in the Palpa sample: straight lines, U-shaped lines, meandering lines, zigzag lines, and spirals. Purely or basically straight lines are a common type while many others bend and turn frome once to several times (fig. 21).

Lines turning once and featuring two straight sections are classified here as pertaining to the U-shaped line type. Lines turning twice or more often are classified depending on the relation of their three or more straight sections to each other: if they are parallel, they are of the meandering line type, if they are not, their type is termed zigzag line. A type of lineal geoglyphs with no straight section at all is the spiral shape. There are two varieties of spirals. In the more common, double one, the spiral is formed by

Fig. 22. Spiral 336 on site PV67A-49 (cp. map 8).

Fig. 23. Trapezoid and flanking lines (geoglyph 16) on site PV66-72 in a dry valley northeast of Los Molinos (cp. map 10).

a line that runs to the center of the spiral, turns, and leads back out of the spiral (fig. 22). The less common, simple variety is formed by a line ending in the center of the spiral.

Areal geoglyphs can be classified into four types: trapezoids, triangles, rectangles, and amorphous areas. The most common type of areal geoglyph is usually called a trapezoid (fig. 23). Trapezoidal geoglyphs have two non-parallel borders that are usually longer than the two parallel borders. It should be noted that the parallel borders of trapezoidal geoglyphs are often hardly defined which makes the term trapezoid somewhat inappropriate. However since it is widely used, and alternative descriptions such as truncated isosceles triangle are rather cumbersome, we will continue to use the term. Trapezoids make up by far the largest portion of areal geoglyphs. Triangles are a rarer type, similar to the trapezoids but with a well defined, pointed end. Likewise, geoglyphs of the rectangular type are similar to trapezoids, but the difference is that the longer borders are roughly parallel. Finally, another common type of areal geoglyph is a shapeless area that is amorphous but clearly man-made.

Geoglyphs of the biomorphic group can be classified into two types: anthropomorphic and zoomorphic figures. The anthropomorphic type features images of human-like bodies or parts of them, often with additional features like headdresses or objects held in their hands.

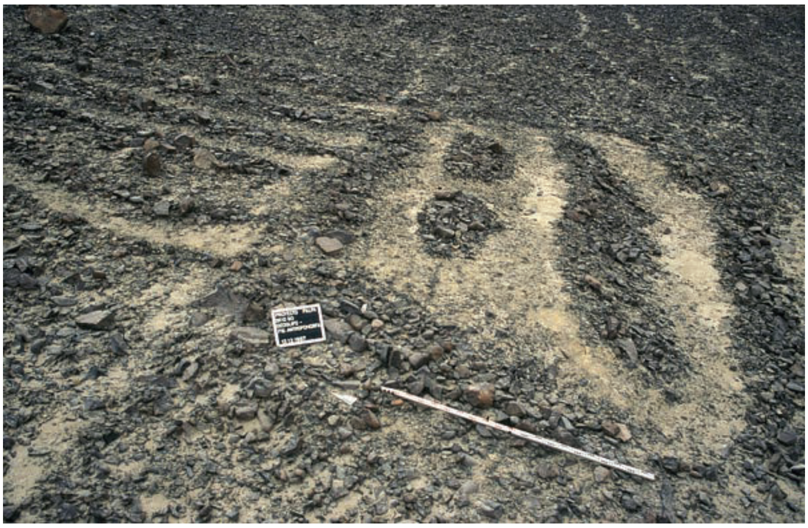


Fig. 24. Anthropomorphic geoglyph 228 (head variety) on site PV67A-39 (cp. map 1).

Fig. 25. Geoglyph 31 (tumi) on site PV66-73 on a hillside in a dry valley northeast of Los Molinos. Also note unfinished trapezoid 33 (lower left) (cp. map 10).

Geoglyphs of the anthropomorphic type can be further classified into two varieties: full bodies and heads. The body of the full body variety is usually shown in front view with side-face views less common. Heads are always shown in front view in either variety (fig. 24). Another category in the biomorphic group is the zoomorphic type. Depicted animals are basically made up of lines that define the outlines and sometimes additional features of the figures (fig. 34).

Geoglyphs of the representational group are rare and are not further classified into types or varieties here. In the wider Palpa area there are several geoglyphs showing *tumis*, one of them located on Cresta de Sacramento (fig. 25). *Tumis* are tools that are well known from archaeological contexts throughout the Andes. They are usually interpreted as ceremonial knives. Other geoglyphs may represent the sun.

However, representational geoglyphs are generally rare. In this typology, new categories on the type level are only defined if there is a certain number of actual geoglyphs that represent the type, whereas single geoglyphs are not used to define additional types. This may be done later once similar geoglyphs have additionally been recorded. Until then, the hierarchical structure of the typology presented here allows to simply place single geoglyphs on a higher, more general level, *e. g.* into a group. That way, all geoglyphs are covered by the typology, though not all of them can be placed on the same level. This is especially evident on the lowest level since varieties are only defined for a few types.

It has to be stressed that this typology was developed for the Sacramento/Carapo sample from Palpa. It is not necessarily applicable to geoglyphs from other areas. For example, no phytomorphic type has been defined to accommodate the well known plant-like figures from the Nasca *pampa* since no such geoglyph has been recorded in the area covered by the present study. However, such a type could easily be integrated into the typology described here.

6.1.2 Distribution of geoglyph types

In the present study, all 639 geoglyphs located on Cresta de Sacramento, Cerro Carapo, and the right bank of Río Grande around La Muña have been assigned to one of the categories of the typology defined above. Their typological distribution, established by querying the database and illustrated in figure 26, clearly shows a preference by the builders for certain geoglyph construction techniques and shapes.

On the class level, 597 geoglyphs (93.4%) are in the geometric class, compared to only 42 (6.6%) in the descriptive class. Thus, the vast majority of geoglyphs in the Palpa sample were made using the positive technique, including cleared areas and heaped borders, but without interior heaped or undisturbed areas.

Within the geometric class, 404 geoglyphs (63.2% of the overall sample) are in the lineal group, out of which 298, or 46.6%, are straight lines. That means that nearly half of all registered geoglyphs in the Palpa sample are straight lines[48]. In descending order, the next frequent types are U-shaped lines (48 or 7.5%), meandering lines (19 or 3.0%), and zigzag lines (nine or 1.4%). Of the ten spirals (1.6%), two are of the simple variety, five are double spirals, and three could not be classified further. Likewise, 20 lineal geoglyphs (3.1%) could not be assigned to specific types.

Within the group of 192 areal geoglyphs there is again a predominant type that outnumbers all others. 133 of them or 20.8% of the overall sample are of the trapezoidal type. Only two geoglyphs have been classified as triangles (0.3%) while there are 21 rectangles (3.3%) and 16 amorphous geoglyphs (2.5%)[49]. Twenty areal geoglyphs or 2.5% could not be classified further into types. All in all, in the geometric group and in the entire Palpa sample, straight lines are predominant, followed by trapezoids. All other geometric types or varieties are present in much lower numbers.

In the descriptive class, 31 out of 42 geoglyphs (4.9% of the overall sample) have been classified as pertaining to the biomorphic group. The majority of them (28 or 4.4%) show anthropomorphic figures. These figures can more or less be evenly divided into the full body (13) and head variety (11) while four anthropomorphic geoglyphs (0.6%) could not be identified further. Only two zoomorphic geoglyphs, a whale figure and possibly a largely destroyed bird figure (both of them on Cresta de Sacramento) have been identified in the Palpa sample. Ten descriptive geoglyphs (1.6%) could not be classified further. There is one representational geoglyph in the Palpa sample which is the elaborated figure of a *tumi* (a tool with handle and semicircular adorned blade) in a dry valley close to Los Molinos. All in all, among the relatively few descriptive geoglyphs, anthropomorphic figures occur most often while most others are not easily classifiable into types.

6.1.3 Summary: Geoglyph typology

The Palpa geoglyph repertoire shows a considerable formal variety. The head of an anthropomorphic figure only few meters in diameter on a slope of Cresta de Sacramento seems to have little in common with a 600 m long trapezoid on the plateau directly above the figure. Each and every geoglyph is unique with regard to its specific shape. Yet the variety can be traced back to a relatively simple system of basic shapes. Within this scheme, there is a clear preference for straight lines and trapezoids, both of which are predominant features on the hillsides and plateaus in the vicinity of Palpa. This is worth mentioning because in public perception biomorphic geoglyphs are the most famous ones, and many hypotheses about geoglyph function and meaning use them as their basis. For the Palpa area this would clearly mean an overestimation of the importance of biomorphic geoglyphs since they constitute only a small fraction of the whole geoglyph sample (4.9%). Thus, the attention clearly should shift to lineal and areal geoglyphs.

48 The actual number of straight lines is even higher since in several instances parallel lines that apparently were created at the same time as part of a single design were recorded, for efficiency sake, as one geoglyph.

49 Here again, in some cases several amorphous geoglyphs close to each other were recorded under a single ID.

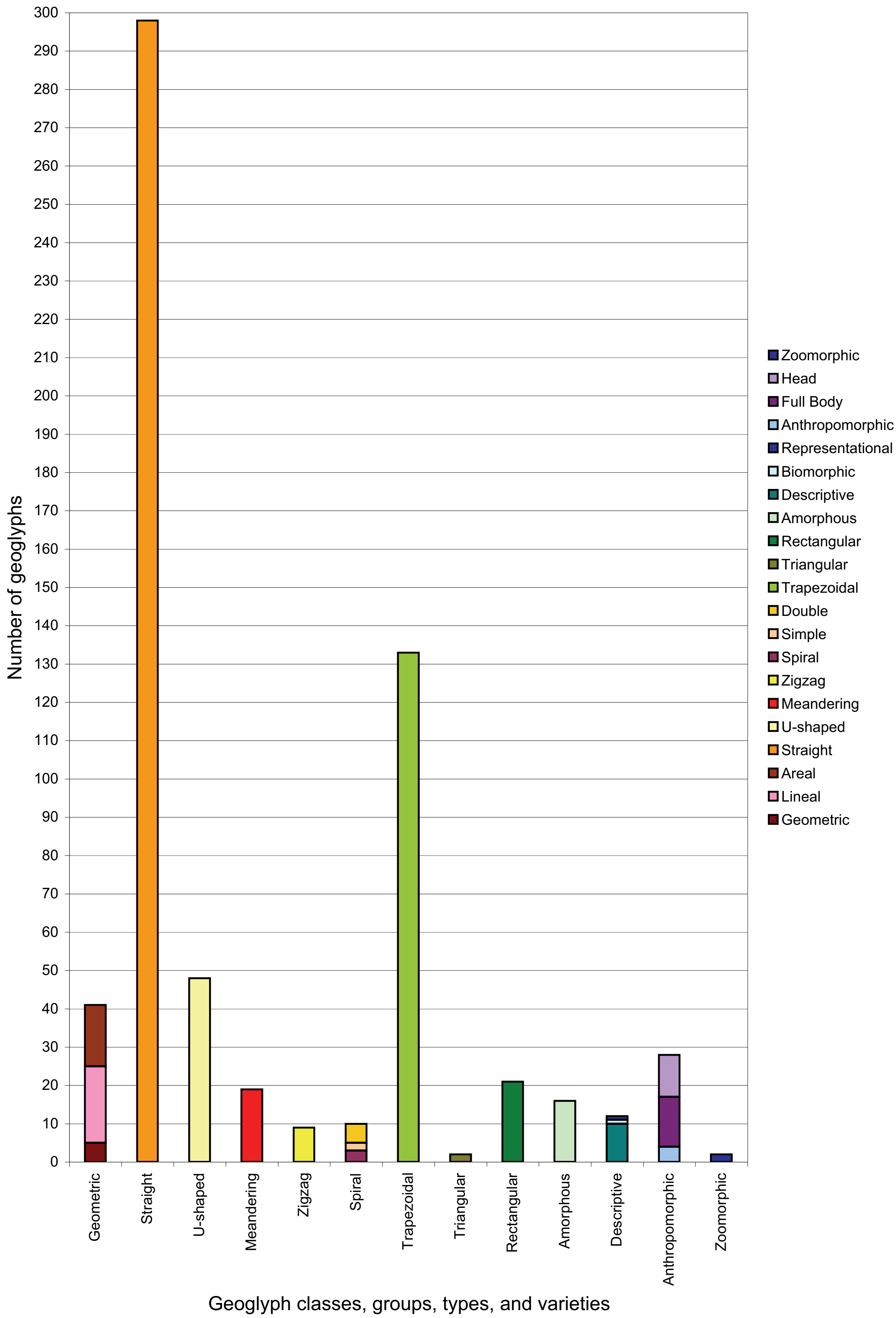


Fig. 26. Number of geoglyphs per typological category.

6.2 Geoglyph chronology and cultural affiliation

In general, there are four potential sources of information on the chronological placement of geoglyphs for both a relative and absolute chronology (cp. Clarkson 1996: 430 ff):

- Direct chronometric datings obtained using scientific methods
- Relative datings using the stratigraphic relationships of the geoglyphs to other geoglyphs and to cultural remains
- Chronological classifications of associated finds
- Iconographic parallels correlated to dated materials from other artifact categories.

For the Palpa sample, chronological data is available only from stratigraphy, dated finds, and iconography, whereas direct chronometric dating has so far been obtained only on a limited scale. More of this type of dating is planned for the near future.

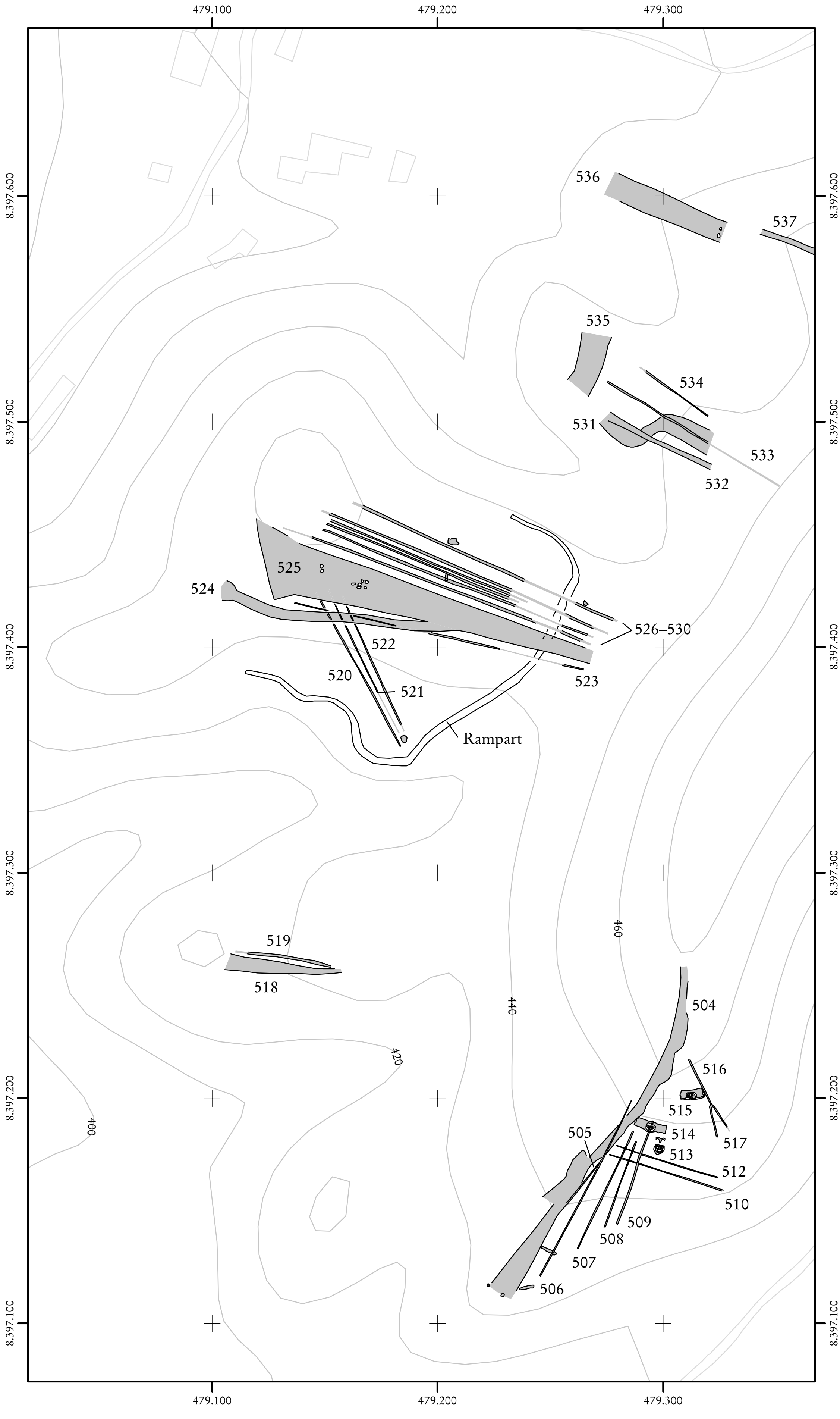
Previous attempts to directly date geoglyphs in the Nasca basin with scientific methods focused on desert varnish. This is a patina that begins to form on formerly unexposed stone surfaces once the stones are removed from their original position during the construction process of a geoglyph. Microscopic organic material enclosed between stone surface and desert varnish can be dated by accelerator mass spectrometry radiocarbon dating (AMS; Clarkson/Dorn 1995: 59). Several geoglyphs on the Nasca *pampa* and other parts of the Nasca region were dated this way during the 1980s and 1990s by Ronald Dorn and Persis Clarkson who chose stones from heaped borders of lines and trapezoids that had likely remained undisturbed since their exposure during the construction of the geoglyph (Clarkson/Dorn 1991; Clarkson 1996). AMS dating confirmed a Middle to Late Nasca date for the chosen geoglyphs. However, the results were later questioned due to indications that some of the used samples may have been contaminated. This controversy (Dorn 1998 *vs*. Beck et al. 1998) led to the abandonment of desert varnish dating in Nasca archaeology.

Within the framework of the second phase of the Nasca-Palpa Project a new method of chronometric geoglyph dating is currently being developed and tested. Feldspar and quartz crystals directly underneath the surface of granitic rocks emit measurable optically stimulated luminescence (OSL; Wagner 1998: 262 ff). During exposure to light this latent signal is stopped. Once the bleaching is stopped, *e. g.* when a stone is covered or buried in a heaped border during the construction of a geoglyph, the OSL signal starts to build up again. Given that the increase rate is known, the intensity of the measured OSL signal can be used to date the event of last light exposure. Thus, while desert varnish dating requires stone surfaces exposed during geoglyph construction, high resolution OSL dating is based on stone surfaces covered in the process. At the time of writing (2004), this novel method is still being tested, and no firm dates are so far available for the geoglyphs considered in the present study. However, OSL dating is likely to become available for several Palpa geoglyphs in the near future (Greilich et al. 2005) offering the chance to check some of the chronological results obtained from other sources.

The same is true for radiocarbon dating of organic materials recovered during excavations of stone structures associated with geoglyphs. On several sites on Cresta de Sacramento and Cerro Carapo such structures have been excavated in the course of the Nasca-Palpa Project (see appendix 9.2). Datable organic materials from deposits on these stone platforms as well as wooden posts could be recovered. However, the temporal relation of posts and organic materials to the respective geoglyph was not always easy to establish, so that the expected dates can only serve as approximations for geoglyph dating. Radiocarbon dating of wooden posts on geoglyphs has occasionally been mentioned[50], but the exact context was never clearly stated so that the resulting dates cannot be associated with specific geoglyphs. As for the Palpa geoglyphs, at the time of writing (2004), only one of the recovered samples had been dated. A wooden post associated with a stone structure on trapezoid 52 (site PV67A-15) yielded a corrected date of AD 603–644 (see detailed description in appendix 9.2.2). After this date, the structure was remodeled and continued in use for some time. The associated ceramics cover the time span from Early Nasca to the Early Middle Horizon.

Apart from this sample, radiocarbon dating cannot yet be included in this study but will become available in the near future. Thus, the other sources mentioned above – stratigraphy, datable finds, and iconography – here provide the starting point for a chronological placement of the Palpa geoglyphs. The available evidence

[50] Strong 1957: 46; Morrison 1987: 56; Aveni 1990a: 21.



Map 2. Geoglyph site PV66-122 above Río Grande.

Fig. 27. Broken Nasca ceramic vessels between stones of the desert pavement.

is discussed in two steps. Firstly, a general chronological framework is established in order to determine the beginning, duration, and end of the geoglyph phenomenon. This framework is based on an overview of datable fineware ceramics, as well as stratigraphic relations of geoglyphs to other cultural remains. In a second step, it will then be determined if the established types have any chronological relevance, *i. e.* if they only occur during a certain time span within the general chronological framework. This investigation will largely draw on the distribution of dated fineware ceramics per type, as well as on stratigraphy and iconography.

6.2.1 General chronological framework

Associated finds

Of the many categories of finds on or nearby the Palpa geoglyphs (ceramics, lithics, textiles, bones, shells), only decorated fineware ceramics can so far be assigned to stylistic phases tied to a chronological sequence. These fineware sherds have been the most important vehicle for previous attempts of geoglyph dating[51]. A methodological problem arises here because datable surface finds can only provide a *terminus ante quem* or minimum age of the geoglyph, and the elapsed time between the construction of the geoglyph and the placing of the find upon it is unknown. A long lasting construction process (discussed in section 6.3) and the possibility that the geoglyphs may have been kept clean during their time of use (Urton 1990) adds further to the inherent uncertainty of this approach. However, recurrent patterns in large samples can partially compensate for these shortcomings, and this is how the method has been applied in this and previous projects. While for the Palpa sample stylistic dating of associated finds was only one method, it was the most important avenue for obtaining information on the chronological placement of the geoglyphs.

During fieldwork in Palpa ceramic fragments were classified according to the established sequence for Early Horizon to Late Intermediate Period pottery (table 1). Because of the constraints explained previously (see section 5.10), ceramic finds could not be sampled systematically, so that most finds were classified in the field and were left where they were found. The accuracy and reliability of the classification was dependent on the state of preservation of the sherds. Some sherds with an eroded surface could only be classified based on vessel shape. For example, some sherds were classified as Early Nasca without further distinction between Nasca 2 and Nasca 3. On the other hand, some bias was introduced into the sample because the field staff (including the author) were more familiar with earlier than with later ceramics. This is why no distinction was made between different phases of the Late Intermediate Period. In spite of these shortcomings, a review of the

[51] Hawkins 1974; Clarkson 1990; Silverman/Browne 1991.

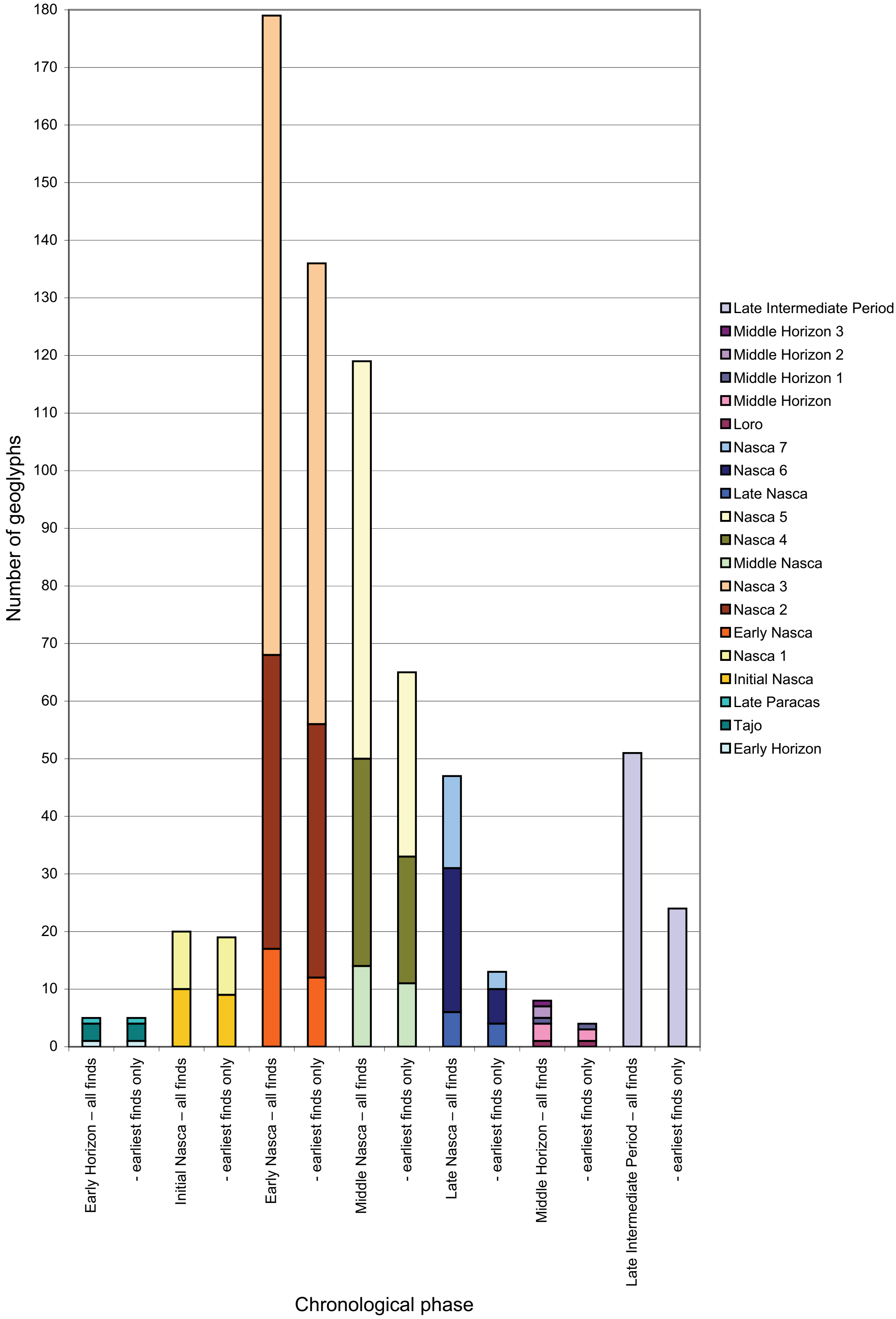
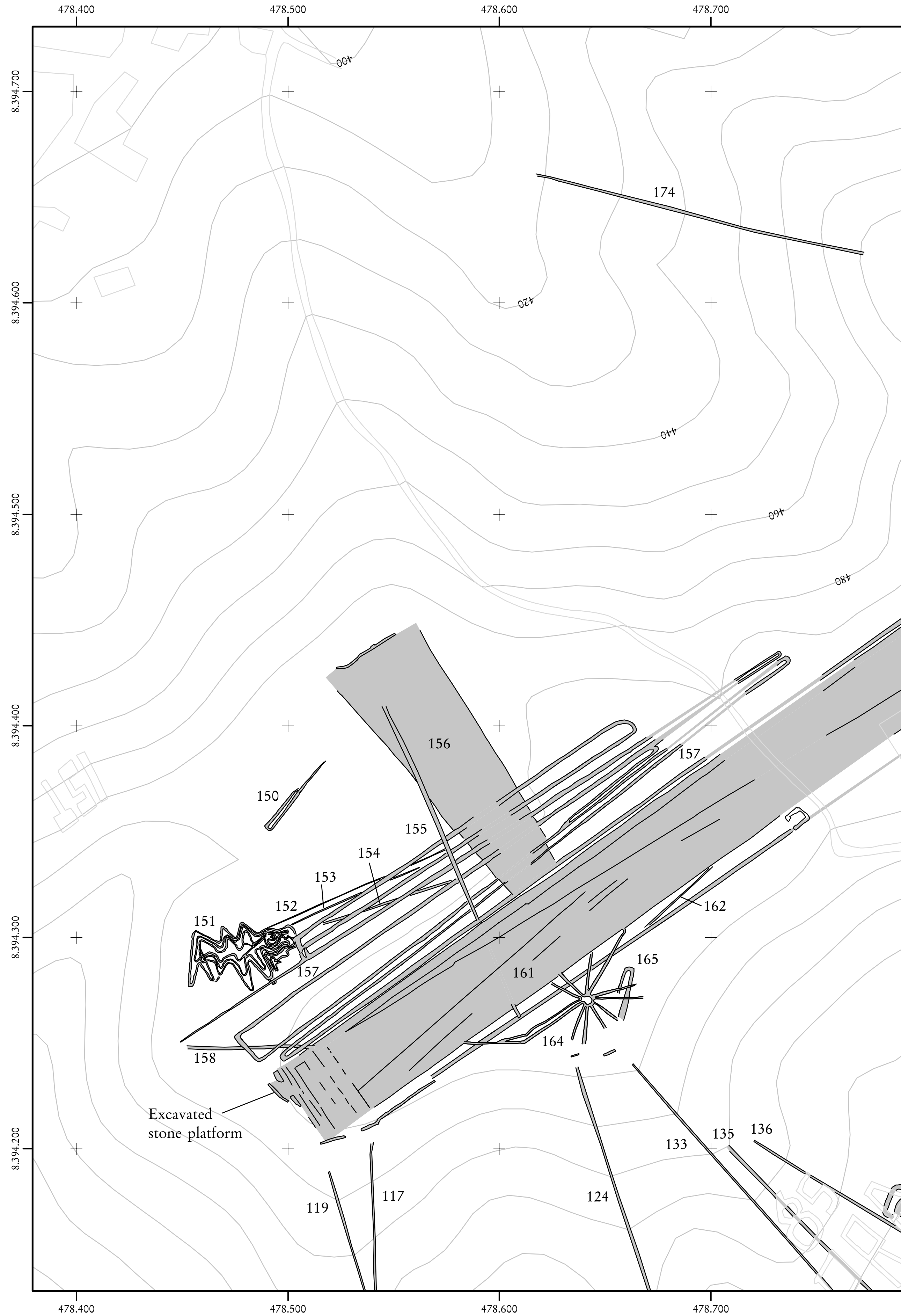


Fig. 28. Number of geoglyphs with associated fineware ceramics per chronological phase. For each time period the left column gives the total number, the right column the number of earliest finds only.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460
480
174
156
157
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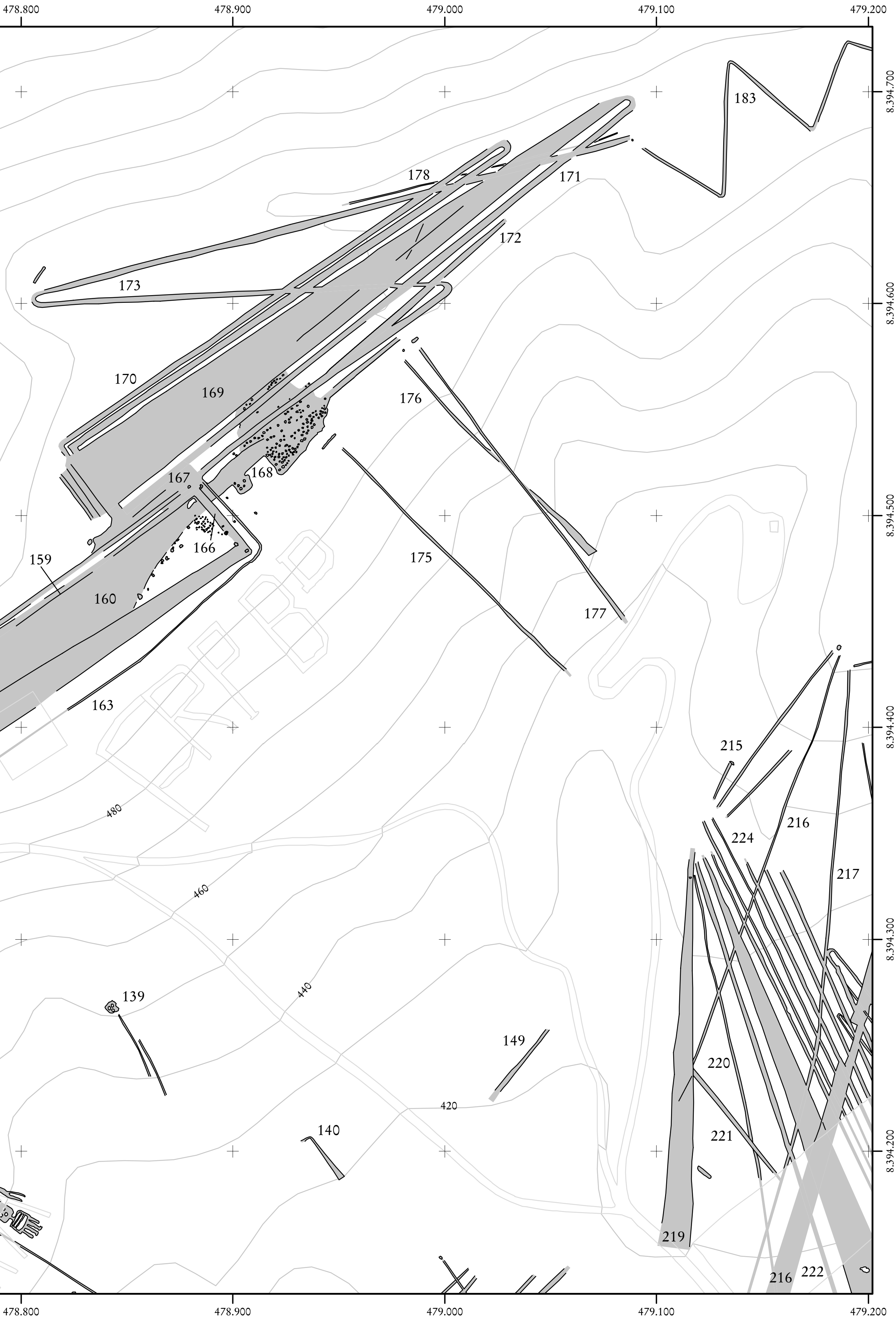
165
164
Excavated
stone platform
133
135
136
119
117
124



Map 3. Geoglyph site PV67A-35 on Cresta de Sacramento.

chronological distribution of finds revealed interesting insights into the history and development of the Palpa geoglyphs.

During fieldwork, ceramics were found associated with 398 of the 639 geoglyphs considered here (63.3% of the overall sample). Painted fineware ceramic fragments (fig. 27) constitute the majority of these materials. Plainware fragments are slightly less common, but nevertheless are present in significant numbers. Since they cannot yet be classified chronologically, the following discussion will focus on datable fineware ceramics.

Fineware ceramics were found on 264 geoglyphs (41.3%), meaning that this kind of chronological information is available for less then half of the Sacramento/Carapo geoglyph sample. In the following, the number of recorded finds per phase is listed and then only earliest finds on their respective geoglyphs because the latter ones are indicators of first-time use of the geoglyphs. Both distributional patterns were elaborated by querying the database using SQL, and the results are illustrated in figure 28. Designation of time periods is given as recorded in the field. Minor inconsistencies are due to slightly differing classification criteria used by different members of the field crew.

On five geoglyphs, or 0.8% of the total sample, diagnostic sherds dating to the Early Horizon were observed. On three geoglyphs the sherds were classified as Tajo[52], one as Late Paracas, and for another no classification was available. All of them were the earliest finds associated with their respective geoglyphs.

Ceramics dating to Initial Nasca (the Paracas-Nasca transitional period) were found on 20 geoglyphs, or 3.1% of the total sample. Except for one, all were determined to be the earliest finds in their context.

The great majority of ceramics found on Palpa geoglyphs date to the Early Nasca period. On 179 geoglyphs (28%) Early Nasca ceramics were observed with 51 finds classified as Nasca 2, 111 as Nasca 3, and the remaining 17 as Early Nasca. Counting only the geoglyphs where Early Nasca sherds were the earliest finds the numbers are lower. This was the case on 136 geoglyphs (21.3%) with 44 fragments classified as Nasca 2, 80 as Nasca 3, and twelve as Early Nasca.

The second highest number of ceramic sherds on the Palpa geoglyphs date to the Middle Nasca period. On 119 geoglyphs (18.6%) Middle Nasca ceramics were found with 36 finds that dated to Nasca 4 and 69 to Nasca 5 while 14 were classified as Middle Nasca. Considering only the earliest finds, the numbers are again significantly lower: all in all 65 geoglyphs (10.2%) had Middle Nasca ceramics out of which 22 were identified as Nasca 4, 32 as Nasca 5, and the remaining eleven as Middle Nasca.

The numbers of geoglyphs with datable ceramics decrease further during the Late Nasca period. Late Nasca ceramics were found associated with 47 geoglyphs (7.4% of the total sample). Twenty-five of them were classified as Nasca 6, 16 as Nasca 7, and six as Late Nasca. However, Late Nasca ceramics were the earliest finds on only 13 geoglyphs (2%). The sherds on six of the 13 geoglyphs were classified as Nasca 6, four as Nasca 7, and three as Late Nasca in general.

For the Middle Horizon, numbers of geoglyphs with datable ceramics drop to very low levels. Ceramics dating to that epoch could only be found on eight geoglyphs or 1.3% of the total sample. One of these finds was classified as Middle Horizon 1, one as Loro, two as Middle Horizon 2, one as Middle Horizon 3, and three as Middle Horizon. Out of these, four finds were the earliest on their respective geoglyphs (0.6%): one was Middle Horizon 1, one Loro, and two Middle Horizon.

Ceramics from the Late Intermediate Period were found on 51 geoglyphs, or 8% of the Palpa sample. However, less than half of them (24 or 3.8%) were found on geoglyphs without earlier finds[53].

All in all, as figure 28 clearly shows, there is a peak in the chronological distribution of datable finds in the Early Nasca period, especially in Nasca 3. The beginning of geoglyph making and use during the Early Horizon is difficult to define on the basis of associated finds alone since many apparently early geoglyphs have no pottery associated with them, while others have likely been disturbed or obliterated in Nasca times when geoglyph related activity reached its peak in the Palpa area. Geoglyph

[52] For a definition of Tajo see Silverman 1994b. This designation was only used in an early stage of our fieldwork and later abandoned in favor of the Ocucaje sequence (see Isla et al. 2003 on Paracas ceramics in Palpa).

[53] The quantitative information on chronological geoglyph distribution as given above was used again for the generation of distribution maps illustrating the spatial development of geoglyph sites on the regional level through time (supplements 6a–10b). That aspect is discussed in section 6.4, whereas here a general chronological framework is established.

numbers increase constantly from the late Early Horizon to Nasca 3, with a sharp rise especially from Nasca 2 to Nasca 3. In Nasca 4, geoglyph numbers decrease considerably, but increase in Nasca 5. There are more geoglyphs assigned to Nasca 5 than to the earlier period Nasca 3, though their numbers are lower when only earliest finds are taken into account. Late Nasca sees again a considerable decrease of ceramics associated with geoglyphs. Still, some of these sherds are the earliest finds on their respective geoglyphs. The same is true for the Middle Horizon, although overall numbers drop to very low levels during that time. Another peak is reached during the Late Intermediate Period, yet lower in numbers than during Nasca times, and less than half of these finds are the earliest ones associated with the geoglyphs. This second peak, which runs contrary to the overall tendency of chronological geoglyph distribution, can be explained by the presence of buildings from the Late Intermediate Period on geoglyph fields as discussed in the following section.

Stratigraphy: Geoglyphs and buildings

Apart from stone structures clearly associated with geoglyph construction such as stone platforms on trapezoids or at the end of straight lines (see appendix 9.2), stratigraphic relations between geoglyphs and stone buildings can only be established in relatively few instances in the Palpa region. Most common are stone buildings built upon geoglyphs. They occur mainly on flat plateaus (sites PV67A-84, PV67A-47), but also at the foot of the southern flank of Cresta de Sacramento (site PV67A-45). A good example is site PV67A-89, one of the easternmost geoglyph sites of the flat plateau on Cresta de Sacramento (map 11). It consists primarily of two large trapezoids successively constructed along the southern edge of the plateau (geoglyphs 350/351). On the western end of the later trapezoid 350, two large rectangular stone enclosures were built upon the geoglyph. They are part of Los Batanes (PV67A-84), a large settlement located further to the southwest. The heaped borders of the geoglyph were destroyed, its outlines obliterated, and its western end is today almost unrecognizable. Similar examples occur on sites PV67A-47 (map 5), PV67A-80 (map 8) and PV67B-55 (map 13).

Wherever such a situation is present – stone buildings built on, and thus later than the geoglyphs – associated ceramics date the buildings (walled enclosures and houses on plateaus, platforms on slopes) to the Late Intermediate Period (LIP). LIP sites are easily recognizable in the archaeological record of the Palpa region due to the following characteristic features:

- They are usually located far from the irrigated valley floor, *e. g.* on slopes, in nowadays dry valleys, on plateaus or even close to hilltops
- They are quite large and often densely clustered with well preserved stone architecture
- Great amounts of broken pottery are usually scattered among the ruins.

Their distinct distribution pattern, architecture, and pottery clearly sets sites from the Late Intermediate Period apart from earlier settlements. Important sites are located on top of flat plateaus or on rock outcropings on their margins, like sites PV67A-47 and PV67A-84 on Cresta de Sacramento and site PV67B-54 on Cerro Carapo (fig. 7). The amazing amount of broken pottery on these sites has its counterpart in apparently contemporaneous footpaths crossing the plateaus, along which a great number of LIP ceramic sherds can also be found.

The association of LIP architecture, LIP pottery, and geoglyphs on flat plateaus seems to indicate that they are contemporaneous at first glance (cp. Clarkson 1990: 167f; Silverman/Proulx 2002: 175). However, in the Palpa area stone buildings from the Late Intermediate Period were clearly constructed without consideration of the geoglyphs which were largely destroyed in the process. Furthermore, footpaths with LIP ceramics on the plateaus cross the geoglyphs just like modern paths. They make use of cleared surfaces wherever possible, but without following their spatial order. Thus, rather than indicating that they are contemporaneous, all available evidence of LIP dwelling and other activities on geoglyphs in the Palpa area indicates that the geoglyphs were no longer important or cared for in the Late Intermediate Period (cp. Horkheimer 1947: 53, 56).

Another case where constructions are superimposed on geoglyphs has been documented in La Muña (PV66-49), the great site from the Middle Nasca period on the right bank of Río Grande close to its confluence with Río Palpa (Reindel/Isla 2001). The site, comprising a settlement zone, public architecture, and a cemetery is located in a short, but wide dry valley (fig. 29). To the southeast this *quebrada* opens towards the valley floor. On the northeast and southwest the site is framed by rocky hills. The terraces on which the main part of the site is located rise from the valley floor in northwest-

Fig. 29. La Muña (site PV66-49) overlooking the Palpa valley (left: geoglyphs cut by terraces, right: central part of the site with enclosed shaft graves and habitational zone on the lowest terrace).

erly direction, ending in a short spur above the settlement zone on which a trapezoid flanked by several straight lines is located (geoglyphs 634–639). The lower, northeastern end of this spur was converted into a series of semi-artificial platforms, possibly during the main occupational phase of the site which was Nasca 5.

The four terraces on the spur were not built at the same time. Although the stratigraphic sequence is not altogether clear, it seems that the lowest terrace was the earliest one to be constructed, whereas the upper terrace and maybe the middle ones were never finished. Prior to the construction of the terraces, the surface of the sloping ridge had to be leveled. During this process the wide ends of the trapezoid and its flanking lines were cut off. The dating of this event is difficult. On the trapezoid very few diagnostic ceramic fragments were found. Among those found were Nasca 3 fragments corresponding to ceramics encountered in the earliest layers of the settlement zone. On the platforms, slightly more sherds were present dating from Nasca 3 to Nasca 5. Thus, it seems that already in Nasca times geoglyphs were also built over.

The interpretation is difficult. It seems clear at first glance that the partial destruction of the geoglyphs for construction of the terraces put an end to their use. On the other hand, the resulting terraces were structurally similar to the earlier trapezoid. They were wide spaces with clearly defined boundaries above the central part of the site. Thus, we may simply face a remodeling event easily comparable to other alterations so frequently occurring on geoglyph sites (see section 6.3), although in La Muña this remodeling had a somewhat different shape.

While buildings on geoglyphs sometimes occur in the Palpa area the reverse situation is extremely rare. The only clear example of geoglyphs superimposed upon earlier structures can be observed on site PV66-122 (map 2, fig. 30). Here, several terraces facing the valley were built on a low hill on the northern flank of Cresta de Sacramento. Associated ceramics date these structures to the Initial Nasca period. Towards the ridge, the hill and the terraces were enclosed by a defensive wall made of large boulders,

Fig. 30. Trapezoid 523 superimposed on rampart on site PV66-122 above the Grande valeey (cp. map 2).

gravel, and layers of vegetation. Later, this construction fell out of use, and a trapezoid flanked by a series of parallel lines (geoglyphs 523, 526–530) was marked on the slope. It has a wide base located on the hill and its upper part crosses the partly collapsed wall. Early Nasca ceramics were found on the geoglyphs. It is not clear whether the terraces were still in use by the time the geoglyphs were constructed.

All in all, geoglyphs and buildings or other structures rarely have well defined stratigraphic relations to each other. Of the few cases described above, only the first case (buildings from the Late Intermediate Period on geoglyphs) seems to allow general conclusions about the temporal relationship between both kinds of features – in this case, that geoglyphs had lost their importance in the Late Intermediate Period. The other situations described above seem to be special cases from which no general conclusions should be drawn until a similar situation is found elsewhere.

Summary: General chronological framework

Available chronological evidence from Palpa suggests that the earliest geoglyphs date to the Early Horizon, although the precise starting date remains unclear. Geoglyph related activity is in any case present in Late Paracas and increases in Initial Nasca, reaching its peak in the Early Nasca period. Afterwards, it decreases continuously through Middle and Late Nasca and finally ceases during the Middle Horizon[54]. At that point the numbers of finds drop to a very low level which is comparable to the Early Horizon. Again, the precise ending remains inconclusive. The considerable amount of ceramics from the Late Intermediate Period found on geoglyphs is most probably due to the use of plateaus as dwelling places during that period.

Thus, in the Palpa area geoglyphs were made and used at least from the late Early Horizon through to some point in the Middle Horizon which would date to about 400 BC to 800 AD – a time span of approximately 1,200 years. The chronological distribution of different categories of geoglyphs within this time span is discussed in the following section.

6.2.2 Typochronology

Associated finds

In order to test if the descriptive types based on the variables of construction technique and shape have a chronological significance, the distribution of datable finds (fig. 31) per type can serve as indicator (fig. 32). In the following overview only the earliest finds, presumably providing the *terminus ante quem* or minimum

[54] The lower number of geoglyphs assigned to Nasca 4 as compared to Nasca 3 and Nasca 5 (fig. 28) does not mean that the geoglyph phenomenon sharply declined from Nasca 3 and then regained importance by Nasca 5. Rather, this seems due to a much shorter duration of Nasca 4, a phase which is generally still poorly understood.

Fig. 31. Sample of Nasca pottery sherds found on the surface of geoglyph site PV67B-55.

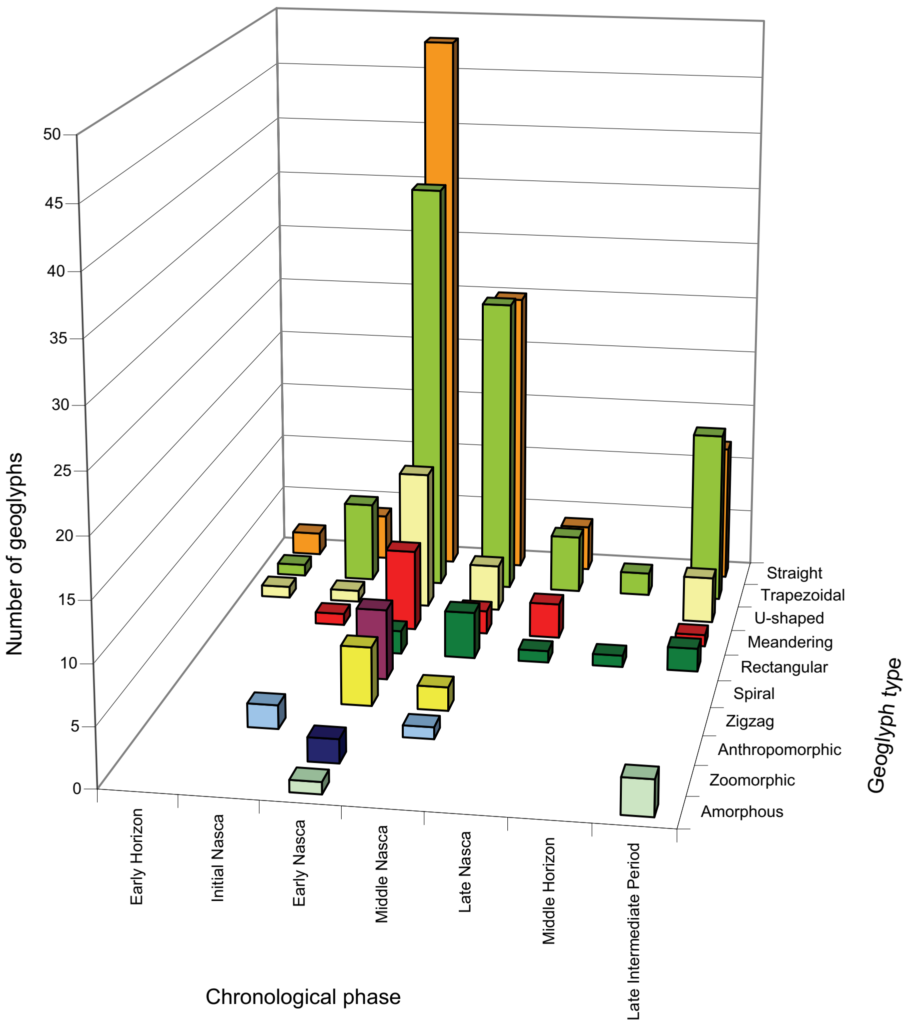


Fig. 32. Distribution of datable fineware ceramics per geoglyph type (earliest finds only).

age for the construction of the corresponding geoglyphs are considered. As before, this data was obtained by running SQL queries against the database.

Starting with the predominant type, out of the 298 straight lines only 82 had datable ceramics associated with them. The following is a summary of the earliest finds per cultural phase: Finds from two lines date to the Early Horizon, four to Initial Nasca, 48 to Early Nasca, 25 to Middle Nasca, four to Late Nasca, and twelve to the Late Intermediate Period. This indicates that straight lines were constructed from the Paracas to the Late Nasca period. The peaks in Early and Middle Nasca times correspond to the general frequency of geoglyphs. Thus, the straight line type does not seem to be a chronological indicator.

The next frequent geoglyph type in the Palpa sample is represented by 133 trapezoids, out of which 85 had datable ceramics on their surface. On one geoglyph, Early Horizon sherds were the earliest finds while seven had Initial Nasca on them. The majority of earliest finds (found on 36 geoglyphs) date to Early Nasca. Almost as many earliest finds (26 geoglyphs) date to Middle Nasca, while on five geoglyphs Late Nasca ceramics were the earliest. Two trapezoids had Middle Horizon ceramics on them and 15 Late Intermediate Period ceramics. Thus, here again the distribution of earliest finds corresponds more or less to the general chronological distribution which is why trapezoids seem to have been constructed during the whole period of time of the geoglyph phenomenon. In this regard they are similar to the straight lines, but may have a slightly later component as indicated by the Middle Horizon finds.

Forty-eight U-shaped lines represent the next frequent type and 21 of them had datable ceramics on them. Based on chronological evidence provided by the earliest sherds found on these geoglyphs, they are dated as follows: One dates to the Early Horizon, another one to Initial Nasca, twelve to Early Nasca, four to Middle Nasca, and four to the Late Intermediate Period.

Concerning the 28 anthropomorphic figures, datable ceramics were associated with only three of them. Two of these sherds date to Initial Nasca and one to Middle Nasca.

Of the 21 rectangles, ten had datable ceramics. Two of these finds date to the Early Nasca period, four to Middle Nasca, one to Late Nasca, one to the Middle Horizon, and two to the Late Intermediate Period.

Datable ceramics were found on 13 of 19 meandering lines. On one of these geoglyphs the earliest find was Initial Nasca, seven were Early Nasca, two were Middle Nasca, three were Late Nasca, and one dated to the Late Intermediate Period.

Four out of 16 amorphous areal geoglyphs had datable ceramics associated with them. One of these sherds dated to Early Nasca and three to the Late Intermediate Period.

Of the ten spirals, six had datable ceramics and all of them dated to Early Nasca.

The ceramics found on seven of nine zigzag lines date predominantly to Early Nasca times (five) while two finds are Middle Nasca.

Both zoomorphic figures located on Cresta de Sacramento were associated with Early Nasca ceramics.

A review of the previous data has provided the following conclusions:

- Since the chronological distribution of ceramics on straight lines coincides largely with the overall distribution of all geoglyphs, geoglyphs of this type seem to have been constructed during the whole time span of the geoglyph phenomenon and cannot serve as chronological indicator. This is corroborated by stratigraphic evidence from different sites (cp. appendix 9.1).
- The results are similar with trapezoids, but two finds of Middle Horizon ceramics indicate a slightly later component. This is also true for the rectangles, although the numbers of geoglyphs with Middle Horizon ceramics are generally very low.
- Meandering lines have slightly more Late Nasca than Middle Nasca ceramics, although the peak is again in the Early Nasca period. Nevertheless, they and some areal geoglyphs may have been more important in late phases of the geoglyph complex.
- Both zoomorphic figures and spirals date consistently to Early Nasca times. But the sample may be too small to be representative, especially in the case of spirals.
- There is no indication of U-shaped or zigzag lines having been constructed later than Middle Nasca. Thus these line types seem to be another early component of the geoglyph complex.

Iconography

Iconography is discussed here only in regard to possible cross-dating of geoglyphs via dated objects from other artifact categories. A direct comparison of iconographic styles requires common motifs on different media. Geoglyphs can be compared mainly to depictions on fineware ceramics and decorated textiles. However, this is true only for a small subset of geoglyphs. Neither trapezoids nor common line types seem to be depicted on Paracas, Nasca, or Wari ceramics or textiles. It is basically the biomorphic figures that have their counterparts on textiles and ceramics.

The head and body of anthropomorphic geoglyphs (fig. 33, maps 1–2, 4, 6, 12) are always shown in front view, while legs may be depicted in profile. However, erosion often makes it difficult to determine how the figures are oriented. The full body variety normally consists of a head with eyes and mouth, a body, and legs. Arms and feet are not always present. Optional features are headdresses (fig. 24) and objects held in hands. Headdresses are composed either as concentric rays or crest shaped headpieces or a combination of both. The execution is always simple with head and body formed by cleared areas, and stone heaps showing the eyes and the mouth. The legs and ray like headdresses are shown by lines.

The motif, its attributes, and the way it is depicted closely resemble anthropomorphic figures on Paracas Necrópolis textiles (Tello 1959; Paul 1999: figs. 56, 58; Schindler 2000: 39, 43, 45). These depictions show considerably more detail than the geoglyphs and help with an understanding of some of their features. Crescent shaped headpieces seem to represent long caps, while ray like features may have been feathered headdresses. Elongated objects held by the figures may represent serpents or some kind of staff. Other figures hold trophy heads in their hand or wear them attached to their belts. The geoglyph 235, a head figure next to the body of geoglyph 234 on site PV67A-40 (fig. 33, map 1) therefore seems to be part of the same design. Thus, anthropomorphic geoglyphs closely resemble anthropomorphic depictions on Paracas Necrópolis textiles in motif and style, and are therefore likely from that period. This makes them the earliest geoglyphs in the Palpa region.

Of the two zoomorphic figures on Cresta de Sacramento, the possible bird figure (geoglyph 389 on site PV67A-90, see map 11) is too heavily destroyed to judge its style. Geoglyph 151 on site PV67A-35, however, is well preserved and only on one end is it disturbed by later lines (figs. 13, 34, 48, map 3). This figure has usually been identified as a whale. Kosok is the only researcher to call it "cat-demon" (Kosok 1965: fig. 13). Aveni has argued that the better known whale figures on the Nasca *pampa* likely depict sharks rather than whales because of certain anatomical details (Aveni 2000a: 199; cp. Schindler 2000: 69). This may be true for the Sacramento figure as well since its tail fin seems to be vertical, and not horizontal like a whale.

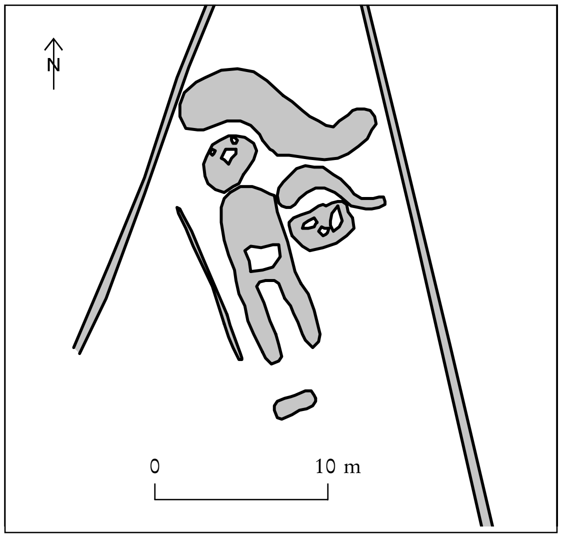


Fig. 33. Anthropomorphic geoglyphs 234 and 235 on site PV67A-40 (cp. map 1).

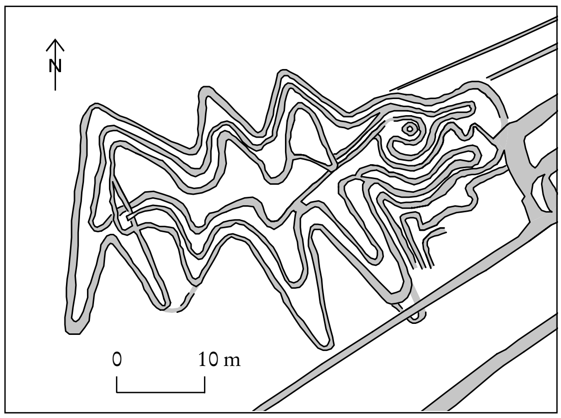
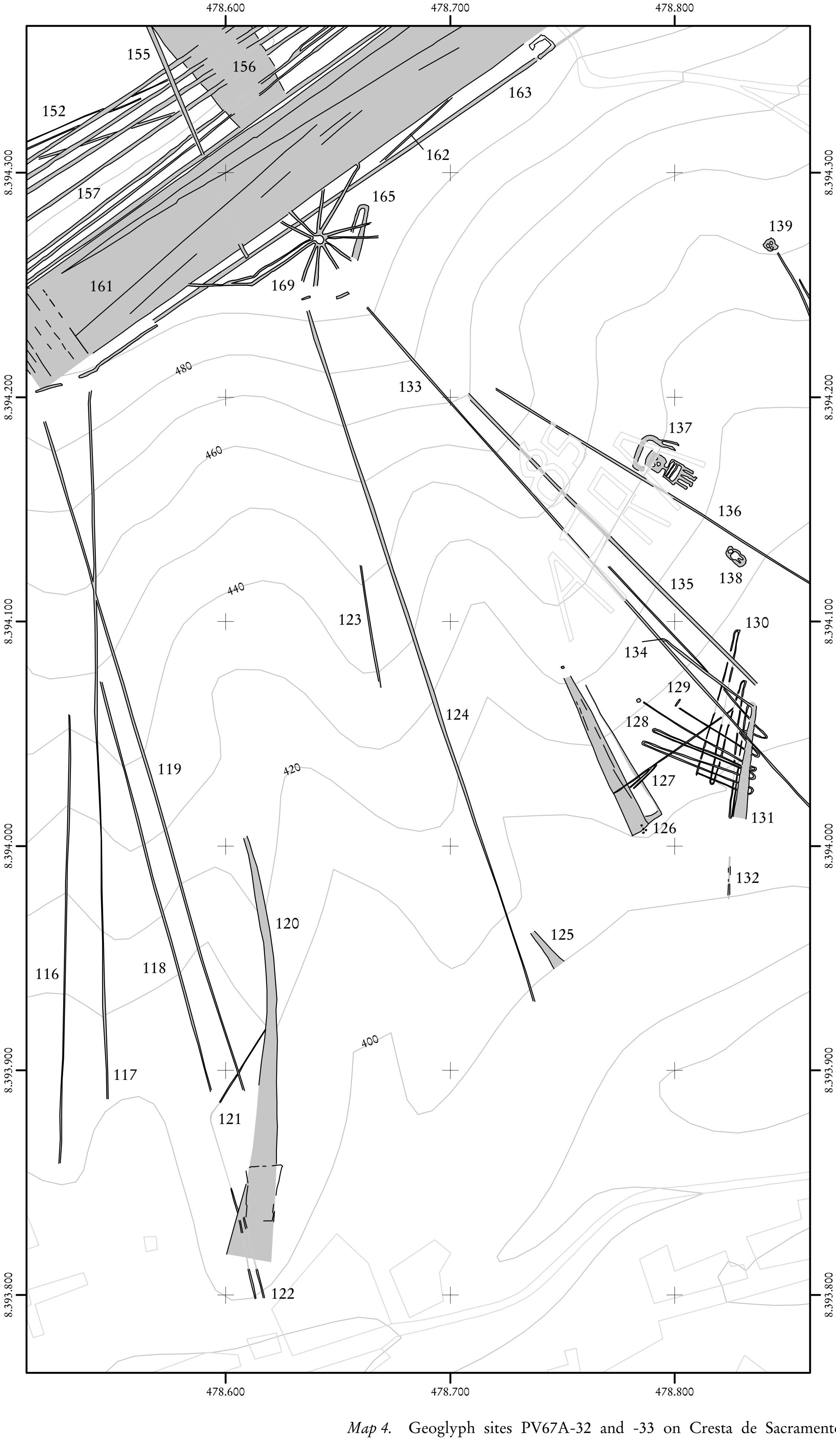


Fig. 34. Zoomorphic geoglyph 151 on site PV67A-35 (cp. map 3).

Stylistically, the figure is composed of several lines forming a profile view of body, head, and fins. Not only the outline and the eye are formed by lines (the eye center being marked by a small stone heap) like some Nasca *pampa* figures, but the body is also adorned with lines roughly following the body outline. The presence of different lines is partially due to a remodeling of the original figure, though the



Map 4. Geoglyph sites PV67A-32 and -33 on Cresta de Sacramento.

Fig. 35. Border of trapezoid 188 (left) crossing border of trapezoid 189 (right) on site PV67A-47 (cp. map 5).

geoglyph never consisted only of a single line. The area below the eye shows several lines that because of later disturbances are not clearly recognizable. Most probably, an open mouth was depicted here. Iconographically, the motif is known as Mythical Killer Whale. It is frequently depicted on or even modeled in Nasca ceramics[55]. The Sacramento figure does not have a protruding arm carrying a trophy head or other objects like many whale figures on Middle Nasca pottery. It rather resembles earlier, more naturalistic depictions. This is confirmed by ceramics found associated with it of which the earliest date to Nasca 2.

Stratigraphy: Geoglyphs and geoglyphs

Geoglyphs affected by later alterations are common in the Palpa area, and most of all in complex sites comprising many geoglyphs. Most of this remodeling occurred when a geoglyph was enlarged or built over by a new geoglyph (fig. 35). These processes are discussed in more detail in section 6.2.1. Stratigraphic relations between older and younger geoglyphs are usually not easy to define for a number of reasons:

- The construction technique of geoglyphs often does not allow a clear understanding of when stones were moved
- New geoglyphs were frequently added to existing ones in such a way that older geoglyphs were not built over, but rather incorporated into the ensemble
- Geoglyphs found today are often the result of several working steps: lateral enlargements, repeated surface clearing, redrawing on the same spot, etc.

Due to these constraints, stratigraphic relations between different geoglyphs in the Palpa sample often remained ambiguous. Nevertheless, on some of the most complex geoglyph sites on Cresta de Sacramento and Cerro Carapo the study of stratigraphic relationships resulted in a relatively clear picture of the construction sequence of the geoglyphs. Detailed sequences are presented in appendix 9.1. On many other sites overlap between two or more geoglyphs could be documented. This information is available in the geoglyph database that accompanies this study on DVD. A review of stratigraphic relations among the Palpa geoglyphs reveals a few trends that show the geoglyph types are either chronologically relevant or not.

[55] Eisleb 1977: plate 72; Aveni 2000a: fig. 50b; Wieczorek/Tellenbach eds. 2002: 122.

On hillsides, straight lines and anthropomorphic figures often occur in close proximity (maps 1, 2, 4, 6, 12). In the few instances where stratigraphic relations between the two types of geoglyphs can be established (geoglyphs 95/96, 509/514, 574/576), lines always cut through figures. Thus, lines on slopes tend to be younger than anthropomorphic geoglyphs in similar settings.

Another clear case is the relationship between trapezoids and zigzag lines on plateaus (maps 5, 7, 13). Both frequently occur together, and wherever this is the case, trapezoids cover lines (*e. g.* geoglyphs 81/78, 189/183, 591/616). At first glance, the true sequence often does not reveal itself easily, though, since in most cases the heaped borders of trapezoids do not cross lines but have gaps, so that the line seems to cut through the border. However, upon careful examination it becomes clear that the border of the trapezoid was intentionally left discontinuous when it covered parts of the zigzag in order to allow access to the line during the building process (see section 6.3). Remnants of the largely removed original borders of the line within the trapezoid clearly indicate in this case that the zigzag line was constructed first.

Meandering lines flanking geoglyphs are another case where a recurrent stratigraphic relation can be observed (map 3). Wherever a geoglyph flanked by a parallel meandering line was enlarged laterally, the meandering line was partially covered (*e. g.* geoglyphs 109/110, 480/481). The reverse case has nowhere been found. However, unlike zigzag lines, meandering lines are frequently oriented parallel to trapezoids, and both seem to have been constructed as part of a larger complex (maps 1, 5, 9, 13). Also, the subsequent partial covering by the trapezoid often has left large parts of the meandering line intact. Thus, though stratigraphically earlier, meandering lines seem frequently to have functioned together with trapezoids.

Straight lines, though usually among the earliest geoglyphs, tend to occur during all phases of the construction sequence of geoglyph complexes. This is confirmed by associated finds. A similar stratigraphic tendency is evident in the case of trapezoids, with a slightly later component. They are usually not the first geoglyph in a given complex, but on several occasions they are the last one.

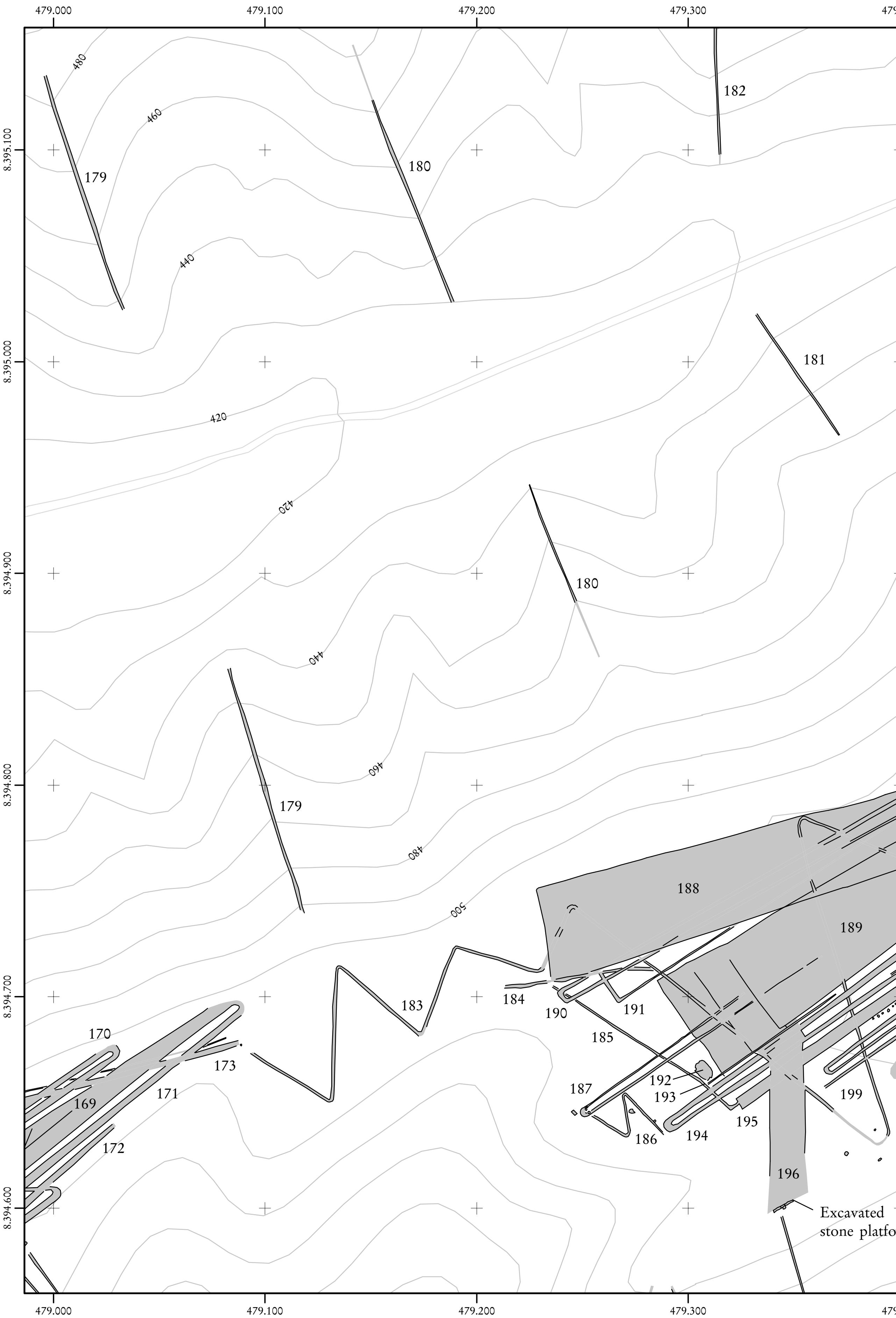
All in all, recurrent stratigraphic relations between geoglyphs pertaining to different types in the Palpa sample seem to indicate that anthropomorphic figures are earlier than straight lines and that zigzag lines are earlier than trapezoids. Meandering lines, though often partially covered by trapezoids, rather seem to be contemporaneous with them. Stratigraphy further corroborates that straight lines and trapezoids were made during all phases. No other general trend can be deduced from stratigraphic relationships observed in the Palpa sample.

Summary: Typochronology

Unfortunately, the most frequent geoglyph type, the straight line, has no chronological relevance since it covers the whole time span of the geoglyph phenomenon. A similar case is the second most numerous type, the trapezoid, although some trapezoids are among the latest registered geoglyphs. In general, geoglyph variety was greatest in the Early Nasca period when all kinds of geoglyphs were made and used. Anthropomorphic figures, probably the earliest geoglyphs, were common up to Early Nasca when spirals, biomorphic figures, and different line types coexisted with trapezoids and rectangles. Later, in Middle Nasca diversity was reduced to certain line types (straight, U-shaped, meandering) alongside trapezoids and rectangles. By Late Nasca times, only straight and meandering lines and large areal geoglyphs had survived. Thus, straight lines and trapezoids were not only the most common types throughout all phases of the geoglyph phenomenon, but represented also the quasi standard to which the geoglyph repertoire was finally reduced towards the end of the geoglyph phenomenon.

6.2.3 Summary: Geoglyph chronology and cultural affiliation

Both in terms of relative and absolute chronology the earliest geoglyphs in the Palpa sample are anthropomorphic figures. Their style and motifs clearly indicate an Early Horizon origin, probably dating to Late Paracas. It is interesting to note that all these early geoglyphs are located on hillsides. This is also where petroglyphs can be found. Contrary to Clarkson's statement that in the Nasca region there are no adequate sites for rock art close to geoglyphs (Clarkson 1996: 435), in the valleys of Palpa there are many single large boulders on slopes and in *quebradas* covered with engravings (circles, anthropomorphic and zoomorphic figures) presumably from the Paracas period. Hence, petroglyphs and earliest geoglyphs are not only similar with regard to their motifs and iconography, but also share the same settings in the landscape. Thus,



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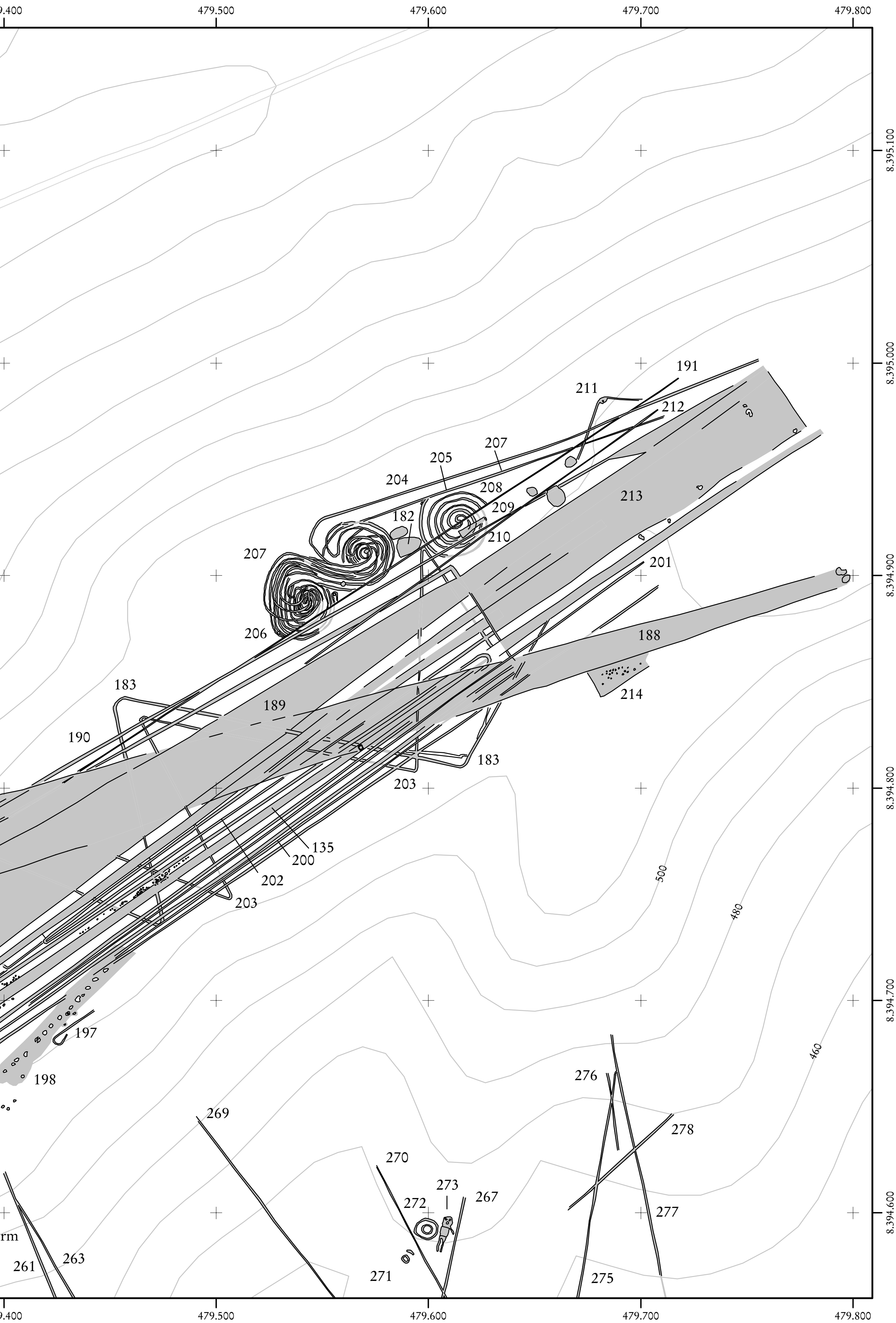


Map 5. Geoglyph site PV 67A-47 on Cresta de Sacramento.

it seems likely that geoglyphs developed out of petroglyphs by transferring common motifs from one medium to another one close-by.

The first geometric geoglyphs (straight lines and trapezoids) were also constructed in Late Paracas. Probably this new, formally distinct development also originated on slopes in the setting where the first geoglyphs were constructed. Maybe the possibilities of the new medium fostered the experimentation with new shapes and motifs.

The first geoglyphs on plateaus date to Initial Nasca. Geoglyphs on plateaus are thus slightly later than those on slopes, though geoglyphs in both settings occur together during most stages. On the plateaus with their new possibilities regarding accessibility and available space, the geoglyph phenomenon reached its peak in the Early Nasca period. A wide variety of geoglyphs was constructed during this phase, out of which biomorphic figures, spirals, and zigzag lines seem more frequent than in earlier or later phases. Straight lines, trapezoids, and meandering lines were also constructed in Early Nasca. These types, however, became more prominent in Middle and Late Nasca times. By then, apparently no more biomorphic figures and spirals were constructed. All in all, variety decreased towards the end of the geoglyph tradition with only some types out of the geometric class surviving till the end. The latest evidence of geoglyph related activity was found on large trapezoids during the early stages of the Middle Horizon. However, there is no clear indication of new geoglyphs still being added by then.

Concerning geoglyph dating in general, although much detailed information on the chronological placement of geoglyphs could be given in this section, it is still not possible to date a geoglyph unambiguously only on the basis of what is visible in the field. Clearly, there is need for reliable methods of scientific dating of geoglyphs, the results of which may then become transferable to similar geoglyphs once a representative number of dates becomes available. It is hoped that the attempts to date Palpa geoglyphs using high resolution OSL will help advance geoglyph chronology.

6.3 Activity related to geoglyphs

As discussed in section 3, the material nature of the archaeological record allows a certain degree of reconstruction of recurrent activities that led to its formation. Such activities on geoglyphs are one of the few aspects where the Andean model can be directly tested by archaeological data. Therefore, a careful review of data pertaining to Palpa geoglyphs will be undertaken in this section.

6.3.1 Geoglyph construction, remodeling, and maintenance

The first activity related to geoglyphs that can be identified unambiguously in the archaeological record is their construction. At least 639 geoglyphs have been constructed on Cresta de Sacramento, Cerro Carapo, and around La Muña in the course of time, implying a considerable amount of labor investment. Out of the whole sample, 15 geoglyphs seem to have remained unfinished[56], while the evidence is less clear in several additional cases. All apparently incomplete geoglyphs pertain to the areal group. These geoglyphs in various stages of completion allow a detailed reconstruction of their construction process. This, in turn, allows conclusions to be made on the way the work was organized, and the different social groups that were involved.

Common features of presumably unfinished areal geoglyphs (most of them trapezoids) are precisely marked yet unfinished outlines, partly uncleared interior spaces, and small stone heaps dotting areas where the clearing process was abandoned before completion. Geoglyph 33 on site PV66-73 is a typical example of a presumably unfinished trapezoid and will therefore be described in detail.

Trapezoid 33 was laid out at the end of the dry valley leading in a northeasterly direction from Los Molinos. Close to the *tumi* figure (31), it occupies a depression between two low hills (figs. 25, 36, map 10). Only its wide base is clearly defined by borders made of heaped stones and a cleared interior. The borders are not very high, however, and only the interior area close to them is clear of stones. Towards the center, many small stone piles dot the partially cleared interior. Towards the upper narrow end, the heaped borders end after approximately one third of the trapezoid length. The rest of the outline is marked merely by middle-sized stones driven into the ground at varying distances in an upright position. The interior is cleared only along the heaped stretches of the borders, whereas the upper two thirds

[56] Geoglyphs 6, 33, 77, 89, 103, 126, 160, 168, 198, 214, 297, 366, 492, 605 and 632.

Fig. 36. Unfinished trapezoid 33 on site PV66-73 (cp. map 10).

of the geoglyph interior consists of the original, unaltered desert pavement.

The evidence suggests the following construction process:

– Once a place for the future geoglyph had been chosen and its shape determined, its entire outline was marked with upright stones several meters apart from each other.
– Starting on the wide base, this outline was then marked by a continuous row of small stones picked up for that purpose along the interior side of the future border from a narrow strip less than a meter in width. This initial border was even and straight.
– While border marking was still in progress, clearing of the interior area started again near the wide end of the trapezoid. Stones of the desert pavement were accumulated on small piles at a distance of less than 1 m from each other. Apparently, stones in easy reach from a crouched position were gathered before starting the next pile.
– Once a certain number of stone piles had been accumulated, they were then removed and transported to the geoglyph border. There, the stones were piled up onto the already marked border, making it higher, wider, and more irregular. That they are irregular suggests that the stones were simply dumped onto the border from some kind of container.

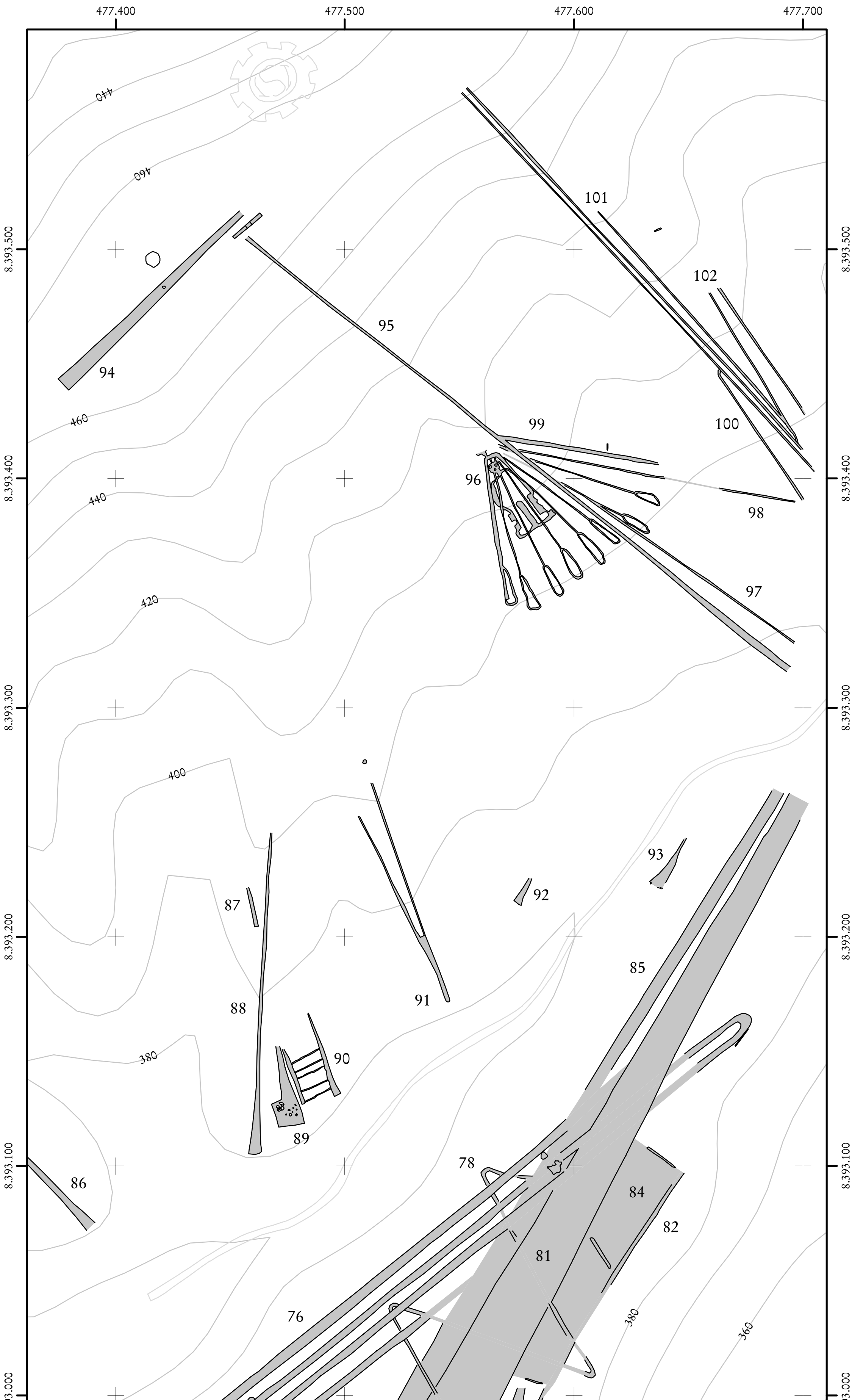
Of these four steps, the first one – geoglyph outlining – had to be accomplished prior to the other three steps which were at least partially conducted simultaneously. The first step was furthermore distinct from the other steps because of different requirements. Before a geoglyph could be traced on the ground, it had to be decided where to place it and what shape to give it. This required not only knowledge of the concepts underlying the geoglyph phenomenon, but also the authority to make such a decision. Furthermore, groups of people had then to be motivated in some way to carry out the actual construction of the geoglyph. These requirements point towards specialists with special knowledge and authority who conducted the initial step in geoglyph construction.

The remaining working steps required mainly coordinated group labor in order to convert the blueprint defined in the first step into a real geoglyph. While some people would make their way along the geoglyph borders marking them with straight lines of stones, the majority of people involved would pile up stones in the interior and remove them in order to accumulate them on the already marked borders. This work did not require special skills and involved on the technical side basically the use of some kind of container to transport stones to geoglyph borders. It is to assume that this work was accomplished by non-specialists, possibly guided or organized by the specialists responsible for the first step in the working process.

This reconstruction of the construction process of geoglyph 33 is in concordance with what can be observed at other presumably unfinished areal geoglyphs and seems typical for the construction of areal geoglyphs in general. Concerning other types of geoglyphs, no evidence of unfinished lineal or descriptive geoglyphs has been observed or recognized in Palpa. This might be due to the fact that many endpoints of lines, especially on slopes, are totally eroded, and hardly any original endpoint of a line could clearly be identified in the Palpa sample. Thus, while unfinished lines may be present, they are hard to identify because most endpoints of lines are badly preserved, and line construction did not involve easily recognizable stone piles. The same is true for anthropomorphic figures of which no apparently unfinished examples were recorded in Palpa. It should be noted that the head variety is not just an unfinished version of the full body variety, because in that case one would expect to find headless torsi as well. All in all, for geoglyph types other than the areal one there is no clear evidence of their construction process.

Returning to areal geoglyphs, there are other observations that allow further insights into the process of their construction. This work apparently did not end once an area with heaped borders had been cleared. Instead, many geoglyphs were enlarged, remodeled or otherwise altered after their initial construction sometimes more than once. For example, trapezoids 81, 109, and 411, as well as several other geoglyphs, were laterally enlarged, as indicated by old, only partially removed former lateral borders in their interior (map 7). In some instances, *e. g.* geoglyphs 109 and 480, straight sections of lateral meandering lines were covered in this process. The meandering lines 55 and 56, together forming one of the longest line complexes accompanying a trapezoid (geoglyph 52), were converted into a huge rectangle (57) by clearing the surface between the lines (map 9). The whale figure (151) was altered on several occasions and included in its final stage many different line elements (fig. 34). A special case is the S-shaped double spiral (206/207) on site PV67A-47 (map 5, fig. 49) whose shape was not suitable for enlargement. Instead, the spiral was redrawn on the same spot, obliterating the original design without taking into consideration that it would no longer be easily recognizable. Hence, apparently completed geoglyphs could be remodeled, so that the terms "finished" or "unfinished" may be inappropriate. Rather, there seems to have been a kind of constant construction process on geoglyph sites.

This result is consistent with other observations from geoglyph sites in the Palpa region indicating that the construction of a geoglyph was quite a slow process. Calculations based on empirical data to assess the labor investment required to construct a geoglyph (*e. g.* Hawkins 1974: 120; Aveni 1990a: 25) suggest that less time and manpower was necessary than one would expect. Yet these calculations, although not wrong, may be misleading. The implicit assumption seems to be that a geoglyph was constructed in an efficient, continuous process without major breaks. Evidence from the Palpa geoglyphs, however, suggests that the construction of a new geoglyph lasted longer than expected if it was just a matter of moving the stones. On several sites (*e. g.* PV66-99 and PV67A-22) new areal geoglyphs were constructed covering older, lineal ones. In these cases, the original lines were carefully kept free of stone piles. Furthermore, heaped borders of new geoglyphs did not simply cross the older line, but were accumulated such that the original line was meticulously kept open and thus accessible (*e. g.* trapezoid 156 covering meandering line 157, map 3). Had the line been replaced by the areal geoglyph in an uninterrupted, fast working process, there would have been no need to keep it accessible during the working process. This indicates that the process of constructing the new geoglyph lasted a certain amount of time. During this time the original line continued in use which presumably involved walking along its course as described in the following section. Thus, there was no



Map 6. Geoglyph site PV67A-22 (northern portion) on Cresta de Sacramento.

continuous, fast construction process, at least in the case of areal geoglyphs. Rather, construction, as well as other geoglyphs related activity, occurred at the same time or alternated.

This is true on the site level as well. Geoglyphs tend to occur in complexes, not isolated from each other. Once a geoglyph had been constructed on a certain spot, new geoglyphs were frequently added, either next to the original one or crossing or even partially covering it (see appendix 9.1). Some geoglyph sites grew considerably over time, and the original geoglyphs were often largely obliterated at the end of this long construction process. This observation further strengthens the impression of a long lasting, nearly constant construction activity on geoglyph sites. Within this process, the geoglyph site always incorporated what seems to be completed, remodeled, and incomplete geoglyphs.

It is interesting to note in this context that apparently unfinished trapezoids are not necessarily the latest geoglyphs on their respective sites. For instance, geoglyph 214 on site PV67A-47, an unfinished areal geoglyph, is partially covered by the later (completed) trapezoid 188 (map 5, see appendix 9.1.2). Furthermore, some geoglyphs, though not entirely cleared (*i. e.* with some remaining stone piles on an otherwise cleared surface) show clear signs of having been walked over just like finished geoglyphs. Thus, incomplete trapezoids do not seem to mark the abrupt end of the geoglyph tradition as was previously assumed (Silverman/Browne 1991: 218; Silverman/Proulx 2002: 282). Rather, it seems that no geoglyph could ever be considered finished. It could be used in a variety of ways even before it was entirely outlined, and it could be remodeled after its initial use. The long duration of geoglyph construction implies that different people were involved on different occasions over time.

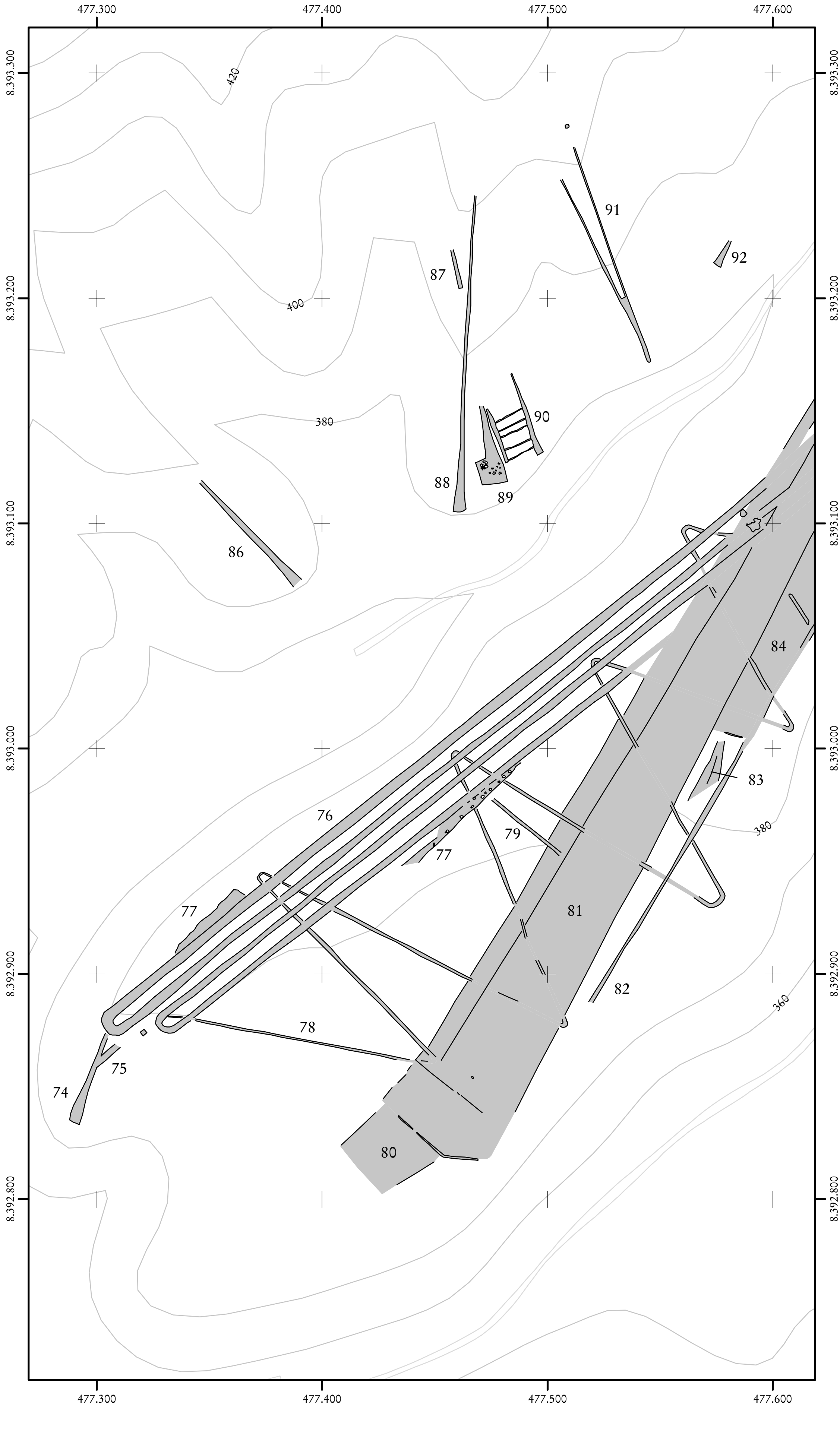
During the construction process, other activities occurred on the geoglyphs as well. Hence, the distinction between construction and use of geoglyphs may be misleading. Rather, it seems that both were part of a single activity complex which may also have included geoglyph maintenance. It has been suggested that geoglyphs were kept clean by sweeping them at regular intervals (Urton 1990). According to Urton, this would have allowed social groups to interact and negotiate their status. Whatever the social function, the traceable result of such an activity would probably be a higher density of cultural materials outside the geoglyphs than in their interior.

Fig. 37. Broken Nasca ceramic vessel found on site PV67B-55.

On the Palpa geoglyphs, density of ceramic finds indeed tends to be higher on, or close to, geoglyph borders. This evidence, however, is not necessarily the result of sweeping the geoglyph interior. Another possible explanation would be that fragments removed from the original surface during geoglyph construction may have been heaped along the borders just like removed stones. Furthermore, heaped borders seem to have been favored places for placing whole vessels since many sherds on borders are parts of complete vessels. Thus, there is no clear evidence that geoglyphs were swept on a regular base. A further argument against such a procedure is a practical one. The exposed sandy layer that formed the cleared interior surface of a trapezoid was not suitable for sweeping, since it was not hard enough. This does not exclude other means of geoglyph cleaning, like picking waste materials from the surface. The case is different for lines. Lineal geoglyphs on plateaus generally show clear signs of compaction of the exposed sandy layer. This leads to the next identifiable activity on the geoglyphs which is walking on them.

6.3.2 Walking on geoglyphs

In the Palpa sample, most lineal geoglyphs on flat terrain show clear indications of having been walked on regularly. The exposed sandy layer is heavily compacted on many lines forming



Map 7. Geoglyph site PV67A-22 (southern portion) on Cresta de Sacramento.

shallow depressions. This can be observed on all types of lines on flat terrain that are rather narrow and therefore predefine the walker's path. Lines in straight, U-shaped, zigzag, meandering, and spiral shape were likewise walked on.

The evidence is less clear in the case of wide lines and even less on areal geoglyphs. Both do not offer predefined pathways, so movement over them may have been rather evenly distributed leaving less traces. The largely uncompacted, exposed sandy layer of a trapezoid or a wide line remains stable in spite of prevailing winds because of air humidity which causes the formation of a thin crust on the surface. Such a process, however, requires a long time period without disturbance. Human activity on trapezoids and similar geoglyphs obviously was not intense enough to compact the whole surface regularly, but based on the presence of ceramic finds it certainly has taken place. Activities on geoglyphs that involved the movement of a large number of people over the surface of areal geoglyphs likely caused a cloud of dust. The only clear evidence of compaction on trapezoids is found near stone platforms (see appendix 9.2.2). All in all, there is evidence of people walking regularly over cleared spaces on lines and on certain parts of trapezoids on flat terrain.

The situation is different on hillsides. Geoglyphs on sloped terrain, though often sharing common shapes with their plateau counterparts, are often not suitable for walking on or even nearby them due to steep, stone covered or sandy terrain. Lines on slopes are often furrowed and do not lend themselves for walking on them. The fact that most of them are heavily eroded indicates that their interior surface was not compacted. Trapezoids on slopes are often easier to walk on, but are equally difficult to access over sloping, stone covered terrain. The same is true for anthropomorphic figures. Walking on or near them seems unsuitable. As mentioned earlier, this is corroborated by the fact that geoglyphs on slopes, especially anthropomorphic figures, have much less ceramics associated with them than geoglyphs on plateaus (see following section). Thus, there is a functional difference between geoglyphs on slopes and those on flat terrain (plateaus or *quebrada* floors) even though their shapes are similar. Walking mainly occurred on the latter ones.

6.3.3 Vessel placement

As mentioned in section 6.2.1, finds documented on geoglyph sites are not necessarily related to geoglyphs. Rather, *a priori* it is unknown how long after the construction that the finds were placed on the geoglyphs. However, geoglyphs are the only unambiguous indicators of human presence out in the desert (apart from some inter-valley footpaths and settlements from the Late Intermediate Period that are restricted to well defined areas). It is therefore plausible to assume that finds found on or near them are in some way related to them, and all the more so if there is a recurrent pattern of geoglyphs and certain artifact categories occurring together.

This is the case with ceramic fragments which make up the vast majority of surface finds associated with the Palpa geoglyphs (figs. 27, 31, 37). Other artifact categories occur in very low numbers (< 10 each on 639 geoglyphs) and include stone tools (chert and obsidian blades), spindle whorls, and textile fragments. They are not considered here because their association with geoglyphs is less clear. Further categories of materials not found on open geoglyph surfaces have been recovered from excavated stone structures built upon geoglyphs. These are mentioned in appendix 9.2.

On the geoglyphs of Sacramento, Carapo, and La Muña, only fragments of pottery have been found. However, there are in several instances dense clusters of sherds from single vessels that could almost totally be reconstructed. These vessels seem to have been intentionally broken on the spot where they were found. Others may simply have been placed on the ground unbroken and were damaged later. Fragmented vessels have been found in a variety of locations, but the majority are located close to or on heaped borders of lineal geoglyphs (*e. g.* geoglyphs 101, 157, 603) or at bending points of zigzag or meandering lines (*e. g.* 319). On trapezoids fragmented vessels are normally found along heaped borders, mostly closer to the wide base than to the narrow end (*e. g.* 88, 284, 480). Further findspots, often several close to each other, have been documented between lines of larger geoglyph complexes (*e. g.* close to lines 144, 164, 643). Thus, intentionally placed vessels tend to occur where there are also the clearest indications of walking on geoglyphs such as on lines and near wide ends of trapezoids. Both kinds of activity seem thus closely related.

The remainder of fragments found during fieldwork are isolated sherds scattered over the surface. Although find density varies, and no order is easily recognizable, these isolated sherds tend to occur more frequently along heaped borders of geoglyphs or around stone structures

Fig. 38. Stone platform on site PV67A-47 overlooking site PV67A-39 (cp. maps 1 and 5).

upon them (*e. g.* geoglyphs 1, 43, 113, 468, 540). While the origin of these finds is difficult to explain, they are unlikely to have been placed on the ground intentionally.

Since ceramics could not be sampled systematically as explained earlier, no quantitative information is available on the distribution of vessel decoration and shape within the ceramic sample on the Palpa geoglyphs. The overall impression from fieldwork is that painted fineware ceramics are present in only slightly higher percentages than plainware ceramics. Fineware ceramics comprise plates, bowls, goblets, vases, as well as – in lesser frequency – head jars and double-spout-and-bridge bottles. No whole or fragments of ceramic musical instruments were found. The percentage of open fineware vessels is much higher than that of closed vessels. For plainware ceramics, however, this ratio is reversed, with large jars predominating.

No vessel recovered on the desert surface contained recognizable remains of its potential former content. This is either due to their fragmented state or vessels did not contain anything when placed on the ground. Considering possible vessel function based on shape, fineware ceramics found on geoglyphs were mainly suitable for serving and consuming food. Plainware ceramics, on the other hand, were suitable for preparing food and transporting it to the geoglyphs. Thus, there is indirect evidence hinting at food consumption and deposition on geoglyph sites.

All in all, as far as geoglyph associated activity is concerned, there is evidence that ceramic vessels were placed on geoglyphs, and some of them were apparently smashed. Their presence indicates food consumption and placing. Additional activity deduced from artifacts recovered during excavations of stone structures on geoglyphs is discussed next.

6.3.4 Construction and use of stone structures on geoglyphs

Work on the geoglyph sites comprised not only construction of the geoglyphs, but also stone structures associated with them. Several of them were excavated on Cresta de Sacramento and Cerro Carapo. While detailed descriptions of the structures excavated on sites PV67A-16, -35, -47, -62, -80, and -90 are presented in appendix 9.2, the main characteristics of these stone structures are summarized below.

Two types can be distinguished. Firstly, there are low, narrow, elongated, platform-like stone structures that are in most cases located along the wide end of a trapezoid or on the edge of a plateau marking the upper end of a line on the slope (fig. 38). These low platforms are constructed in a simple way, without mortar, using stones of the desert pavement that were removed during the clearing of a new geoglyph. Larger stones were put in the ground in upright position, forming a retaining wall that was then refilled with smaller stones. Only rarely do these platforms have a second row of stones. Many show internal subdivisions, or chambers. Most platforms are 1–1.2 m wide and 0.3–0.4 m high, while the length varies from 1 m up to 42 m.

Fig. 39. Pair of rectangular stone structures on trapezoid 333 on site PV67A-80 (cp. map 8 and figs. 58, 60).

Several of these platforms have lateral chambers. Some platforms bend or show other irregularities, mostly where chambers abut. This suggests that these platforms were often not constructed all at once, but in several steps. Thus, they are clearly related to geoglyph construction. The materials used to build these structures come from the geoglyphs, and like them in some cases their building process seems to have been discontinuous. Concerning finds, there is no clear evidence of objects placed on this kind of platforms, though find density tends to be higher around them than elsewhere.

Secondly, there are stone structures inside cleared areas of trapezoids and rectangles, located in a central position between the lateral borders close to one end of the geoglyph. Typically but not always, a pair of two structures is located close to the narrow end (fig. 39), while a single structure is placed on the wide end. These structures have been looted almost without exception and therefore at first glance give the impression of simple, round stone cairns with a depression in the center. However, all but one structure excavated on Cresta de Sacramento and Cerro Carapo consisted of carefully constructed stone buildings. While some of them formed walled, accessible enclosures in a first building phase, all of them assumed the shape of platforms at least in their final building phase. The majority of platforms were rectangular in shape with a retaining wall of large stones or slaps, mostly just one row high. Mud mortar or *adobe* bricks were rarely used in both the outer walls and the interior fill. Several of these structures showed different construction phases or later additions. In most cases, the upper surface was not well enough preserved to determine how the interior fill was capped, but it was presumably sealed by a mud layer. From the debris covering the platforms a variety of materials were recovered that were likely placed on the platform surface. These included ceramic vessels, *Spondylus* seashells (whole shells, fragments, and fragments worked into pendants, see fig. 40), maize cobs, some of them wrapped in cloth, crawfishes, and chrysocole fragments.

In some cases, the structures were associated with wooden posts, either groups of small ones or thick large ones that presumably stood alone. Below some of these posts well preserved guinea pigs were found – apparently placed there as offering. Single, high wooden posts placed on trapezoids on the flat terrain could be seen from far away. It is not known what height these posts actually reached or if anything was attached to them. In any case they must have been visible from a considerable distance. Wooden power poles erected on Cresta de Sacramento in recent years, though probably higher than the ancient posts, are visible along the whole ridge and even across the valley from Pampa de San Ignacio. Thus, ancient wooden posts could have served people moving through or into the desert zone for orientation in order to locate the geoglyphs and stone structures.

Concerning the context of the stone structures, although they are clearly associated with the trapezoids, evidence from datable finds

Fig. 40. Objects found on stone structures on trapezoid 52 on site PV67A-16 (cp. map 9).

suggests that some of them may have been constructed considerably later than the geoglyphs on which they are standing. Others are clearly located in such a position that they could have been built only after enlarging the original geoglyph (map 9). Thus, these stone structures indicate a long-term use of the geoglyph after its initial construction. There is some evidence that platforms may have been intentionally covered after their abandonment.

All in all, evidence from stone platforms indicates that activity related to them covered a considerable time span. After their initial construction they were remodeled, repeatedly used as a place for offerings, and some of them may have been buried when they were abandoned.

6.3.5 Summary: Activity related to geoglyphs

For the following kinds of activity direct evidence could be found on the geoglyphs of Sacramento, Carapo and La Muña:

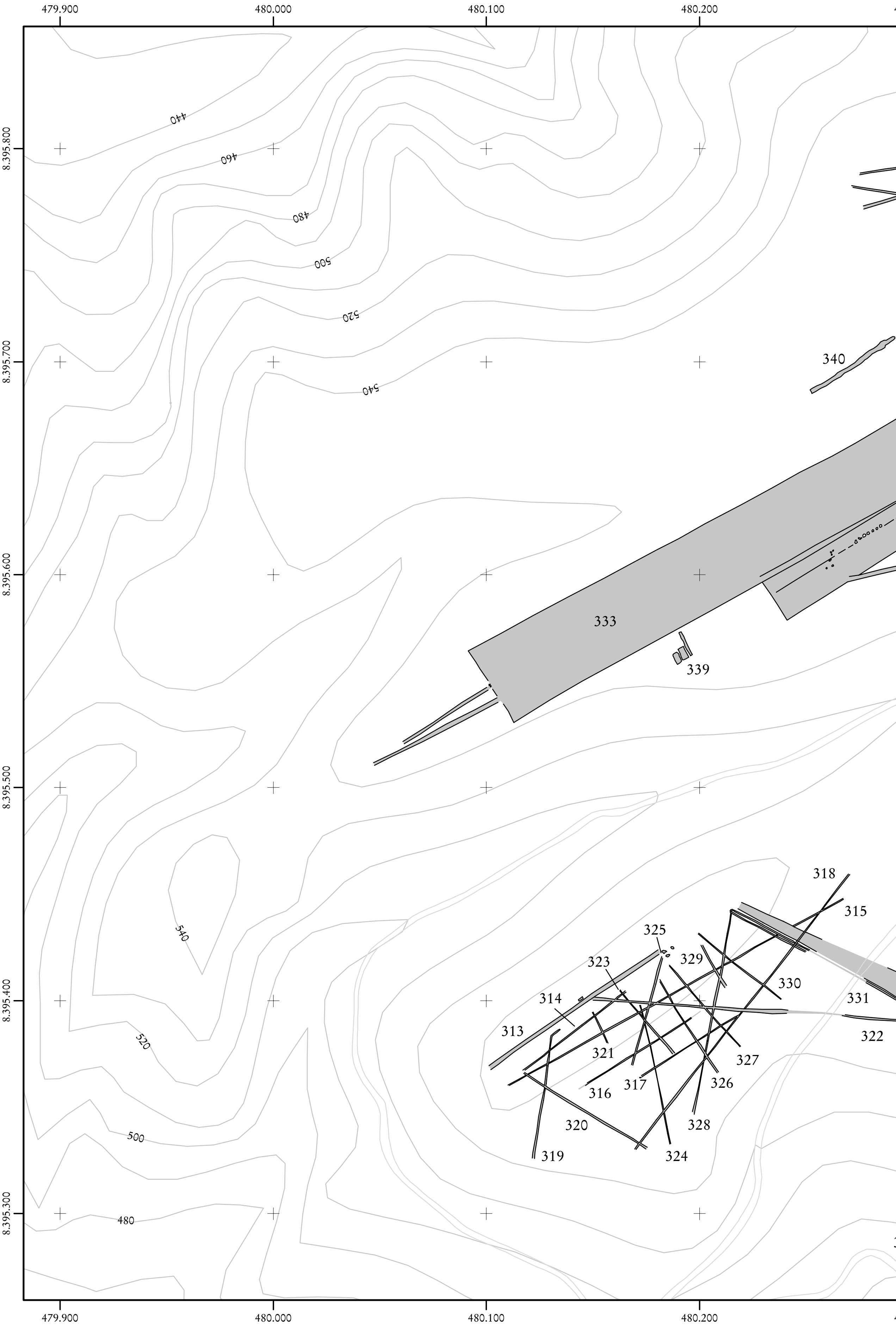
- Construction and remodeling of geoglyphs and stone structures
- Walking on lineal geoglyphs and around stone structures on areal geoglyphs
- Placing (including intentional breaking) of pots on or along borders of lines and trapezoids
- Placing of vessels, field crops, *Spondylus* shells, and other objects on stone structures
- Erection of high wooden posts on areal geoglyphs close to stone structures, occasionally accompanied by placing of offerings in the excavated pit.

Indirect or ambiguous evidence was observed for:

- Food consumption and placing
- Cleaning and maintenance of geoglyphs
- Burying of stone structures at the end of their use.

The high degree of integration of various activities has already been emphasized. The construction and use of the geoglyphs and their associated structures were not neatly separated, but were considered as parts of an integrated whole. Available evidence suggests that many groups of people were involved in geoglyph related activity over a long period of time. The construction, remodeling, and maintenance of geoglyphs, *i. e.* the part of the activity complex which required most labor investment, was probably carried out by non-specialists. Thus, large percentages of the ancient population of the Palpa region may have participated in some way or another in geoglyph related activity. The activity complex seems designed so as to involve as many people as possible, though not necessarily in large groups. Activity was clearly initiated by specialists sharing common concepts and specialized knowledge. This is indicated by the uniformity of the shape and construction technique of the geoglyphs and stone structures that changed only gradually over time.

The many breaks in the construction of a geoglyph, and the number of people involved, may explain why some geoglyphs were left in an apparently unfinished state after some initial work had been carried out. Differently com-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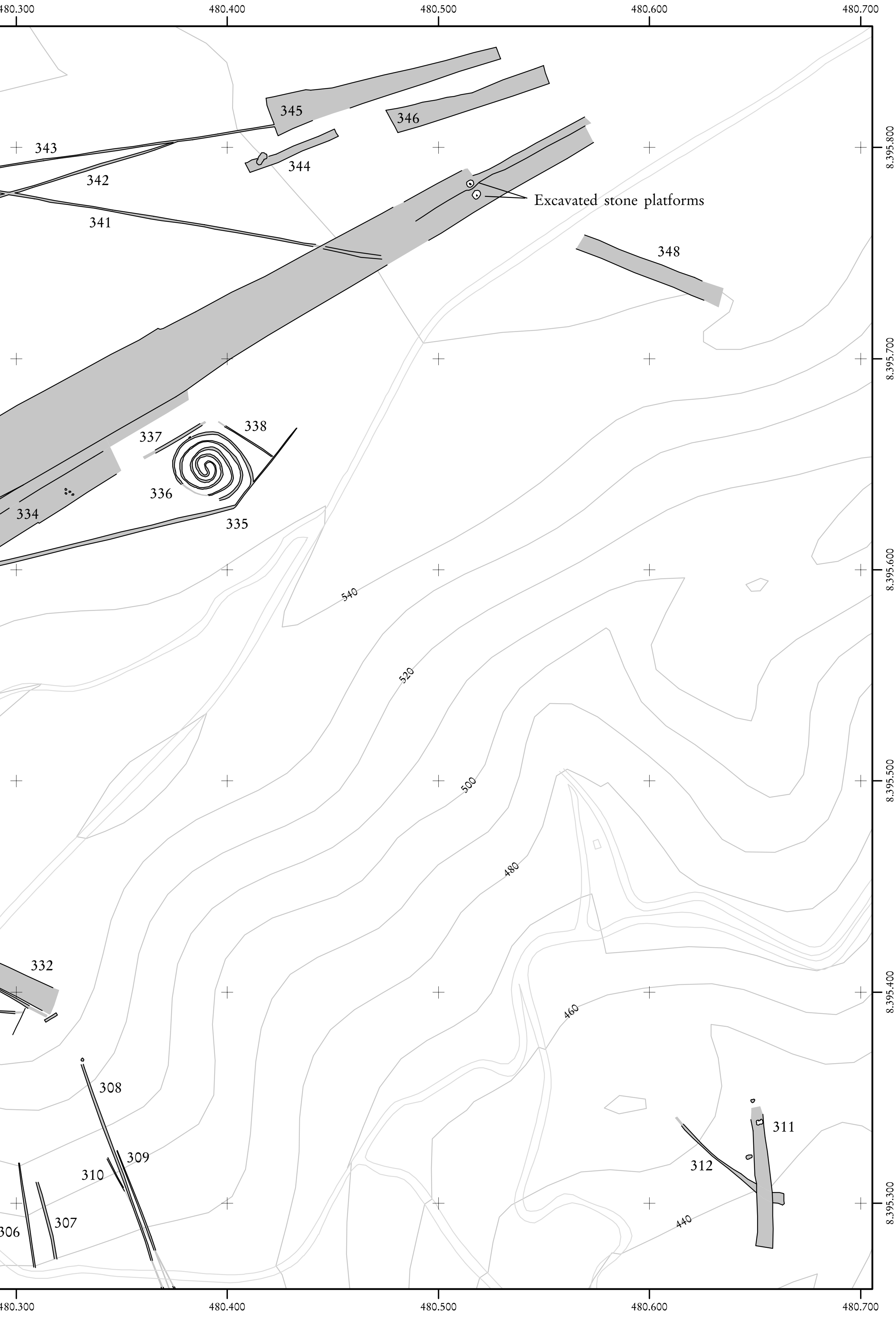


Map 8. Geoglyph site PV67A-80 on Cresta de Sacramento.

posed groups of people working on the geoglyph in successive construction stages or other kinds of changing circumstances may have brought about a preference for starting a new geoglyph rather than continuing to work on an existing one. The successive working steps in the construction of a trapezoid may be marked by different chambers of associated elongated platforms. The construction of different chambers at different times by different people, each group setting some stones apart to be used for the platform, may account for the irregularities in some of theses structures.

The possible consumption of food and drinks may have been related to geoglyph construction (which would explain the many isolated sherds of plain- and fineware ceramics), but also to activity related to stone structures and vessel deposition. Walking along lineal geoglyphs involved the placement of ceramic vessels along geoglyph borders, either intact or broken. These vessels may have contained food or beverages. Geoglyph walking was a repetitive activity, as clearly indicated by the heavy compaction of line surfaces. It must have included many people, though again not necessarily at the same time. Similar human activity may have taken place on trapezoids, although there is no clear evidence for frequent gatherings of very large groups of people.

The above summary of geoglyph related activity refers mainly to geoglyphs on plateaus. On slopes, there is little evidence for any kind of activity after the initial construction of a geoglyph, though some broken vessels have also been found along lines on slopes. The degree to which this divergent picture is due to different conditions of preservation on plateaus and hillsides is difficult to assess.

6.4 Geoglyph setting and order

On Cresta de Sacramento, Cerro Carapo, and around La Muña geoglyphs are located in many different settings with regard to topography and settlement patterns. A study of the internal order of geoglyphs in complex sites, as well as the external order of geoglyph sites in their environment reveals certain criteria that may have been important for geoglyph placement.

6.4.1 Order on the site level

Though geoglyph complexes often seem chaotic at first glance with numerous elements, there is a certain inherent order that can be recognized. On several sites, the same types of geoglyphs are found together in the same construction sequence.

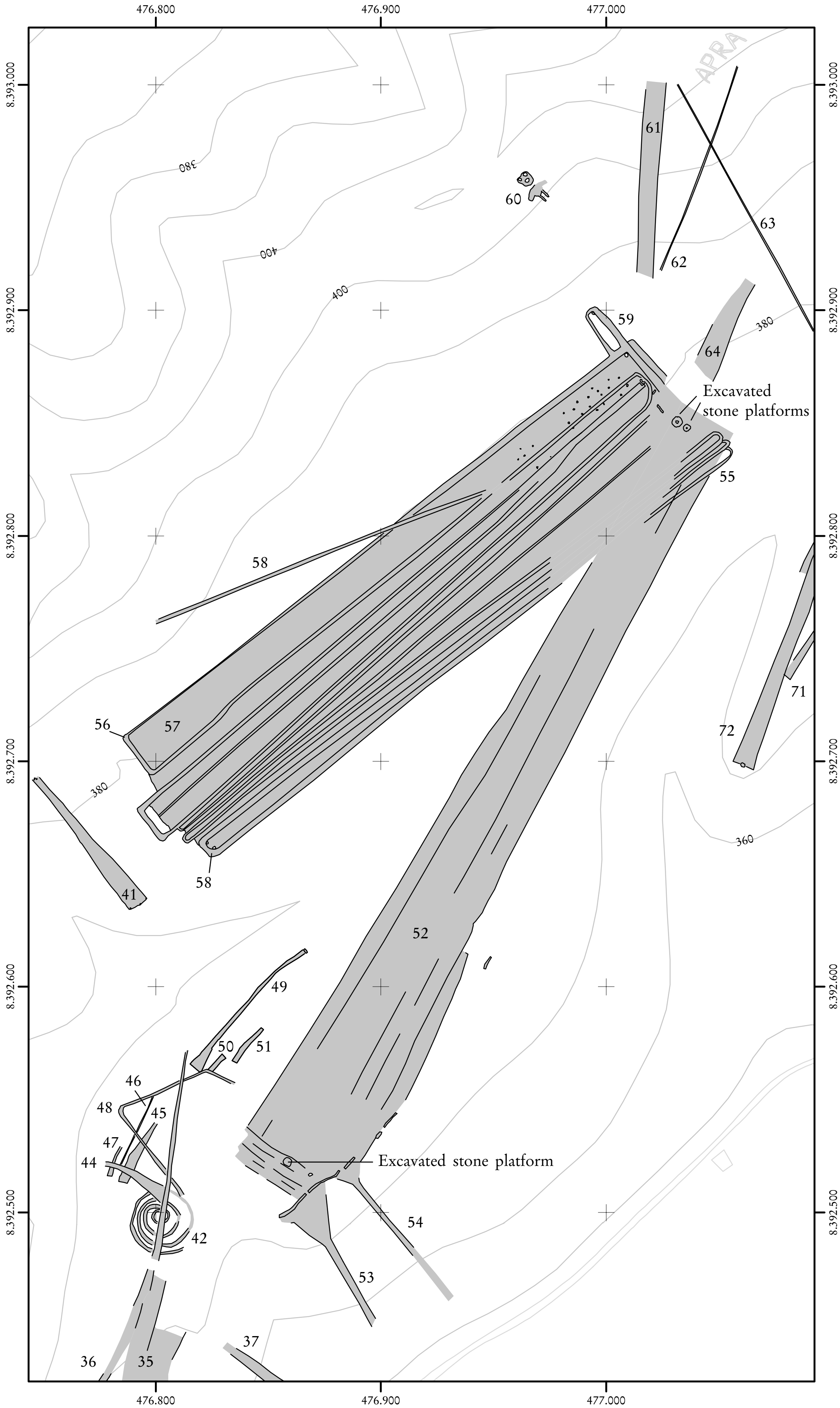
On sites PV67A-47 (map 5) and PV67B-55 (map 13) a zigzag-line is covered by a trapezoid (geoglyphs 183/188 and 616/591, respectively). On site PV67A-15 (map 9) a meandering line (55) is crossed on one end by the narrow end of an obliquely collocated trapezoid (52). Both situations occur on site PV67A-22 (maps 6, 7). Here, a zigzag-line (78) is partially covered by a meandering line (76) which in turn is crossed by an oblique trapezoid (81), the main body of which covers also a part of the zigzag. Thus, three frequent types in the Palpa geoglyph repertoire occur together on several occasions in the same construction sequence: zigzag line, meandering line, and trapezoid.

Other combinations observed on more than one site are:

- A trapezoid flanked by parallel straight or meandering lines – probably the most frequent combination (observed *e. g.* on sites PV66-72, PV66-86, PV67A-40)
- A trapezoid accompanied by a spiral which may or may not be framed by a wide-angled U-shaped line (observed *e. g.* on sites PV67A-47, PV67A-80, and PV67A-32, where the now destroyed spiral is still visible in old aerial images)
- Straight lines crossing each other or branching off from another straight line (observed *e. g.* on sites PV67A-23, PV67A-32, PV67A-40).

Thus, certain patterns are evident even though on all mentioned sites there are additional geoglyphs of varying numbers and kinds, making each site a unique complex.

The combination and sequence of geoglyphs may have been determined by a prescribed kind of activity that required certain geoglyph types. Changes in the composition of these complexes – *e. g.* the addition of an areal geoglyph to lineal ones – may have been due to changes in the rules that guided these activities. As indicated by stratigraphic and other chronological evidence, zigzag and meandering lines tend to be earlier than trapezoids. They served for walking and vessel placement and initially apparently functioned alone. The later addition of a trapezoid to the complex may have been due to new or additional kinds of activity carried out on the geoglyphs, even though walking on lines continued. Though these new activities also included vessel placement, it is not clear what other



Map 9. Geoglyph sites PV67A-15 (bottom) and -16 (top) on Cresta de Sacramento.

activities were carried out on trapezoids. In any case not all of them were related to stone structures since many trapezoids did not have them, and even those on which stone structures were built initially functioned without them.

In any case, the composition of geoglyph complexes followed at least in part certain rules. These seem to have been adhered to even though the formation of geoglyph sites and complexes lasted a considerable amount of time. This confirms the notion of stable, only gradually changing concepts underlying the whole process that were shared by specialists who preserved their knowledge over time.

Certain types of geoglyphs seem to follow certain rules with regard to local topography as well. It has already been mentioned that anthropomorphic geoglyphs have only been found on sloped terrain, while all zoomorphic figures occupy flat terrain as do zigzag lines. Lines on hillsides are in most cases oriented along the slope direction (*e. g.* on minor ridges, map 4), although a minority of lines clearly crosscut these given directions (map 1). Concerning trapezoids, the vast majority of them, whether on slopes or on plateaus, have their wide base on a lower level than the narrow open end. There are, however, exceptions to this rule. For example, on site PV67A-89 the trapezoid 351 was originally oriented from northeast to southwest. It was later covered by trapezoid 350 that is oriented from southwest to northeast (map 11).

The precise orientation of areal geoglyphs seems mainly determined by efforts to make the best possible use of the given terrain. This is especially evident where large geoglyphs were added to complexes of many previously constructed geoglyphs like trapezoid 188 on site PV67A-47 (map 5), and rectangle 591 on site PV67B-55 (map 13). Both were oriented such that the last remaining large portions of free surface were used for the new geoglyphs while parts of older ones were partially covered.

Summarizing the available evidence, it is obvious that when new geoglyphs were added to existing complexes, certain rules guided the choice of shape and place for the new ones. Existing geoglyphs were often incorporated into the new design and continued in use. This did not prevent them from being partially covered. Such changes, however, are found on most geoglyphs.

6.4.2 Order on the regional level

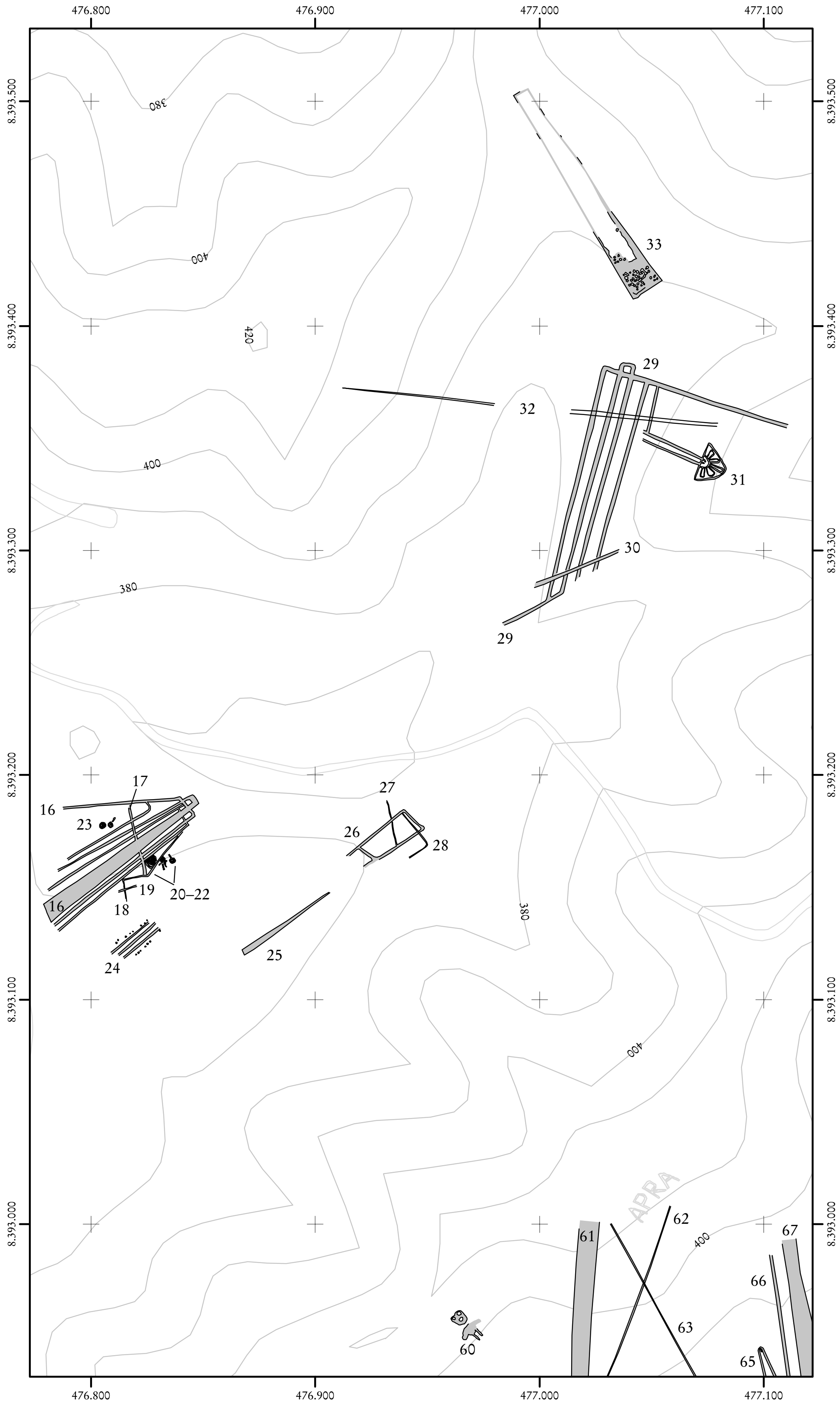
All major plateaus in the study area are today densely covered by geoglyphs, so that a search for distribution patterns may seem futile at first glance. However, the chronological order shows preferences for certain locations over time. This is especially evident when compared to distribution patterns of sites that were contemporaneous with the geoglyphs.

Geoglyph distribution patterns and accessibility through time

Geoglyphs were located in a desert environment that was not used for habitation or for agricultural or other production purposes. The question is how this portion of the landscape was organized. In order to study geoglyph distribution through time and the potential relationships between geoglyphs and settlements, distribution maps were generated for each time period (supplement 5a–10b). They comprise also possible access routes from sites to geoglyphs. Three datasets were combined on these maps:

- Sites: Data on site distribution and cultural affiliation is based on results of a regional settlement survey conducted from 1997 to 2003 by Johny Isla within the framework of the Nasca-Palpa Project. Survey data is still under study and will be published elsewhere. For the present study, a preliminary site database was available. Time constraints of the present study permitted only site location and cultural affiliation (based on dated artifacts) to be considered, but not type (settlements, cemeteries, geoglyph sites, etc.) and rank. All sites on which ceramics from a certain time period were found are symbolized by dots on the respective maps. Thus, every dot indicates some kind of human activity during a certain time period. This may range from an isolated find spot to a settlement in the heyday of its development. Thus, in this analysis not all, but most sites are settlements[57].
- Geoglyphs: All geoglyphs on which ceramics of a certain phase were found are shown in

[57] Discrepancies between site data as presented here and in a preliminary report (Reindel et al. 1999) are due to different stages of analysis. Furthermore, site numbering has since been changed from an internal system to the “Peru valley” system (PV66: Río Grande, PV67A: Río Palpa, PV67B: Río Viscas; with site numbers ascending from coast to highlands; see supplement 5a).



Map 10. Geoglyph site PV66-73 on Cresta de Sacramento.

gray. The geoglyphs have been compiled by querying the database for finds on geoglyphs per phase. It should be noted that less than a half of the geoglyphs are displayed on the maps because datable ceramics were found only on 41.3% of them (see section 6.2.2). During every given time period there were likely more geoglyphs in use than shown on the maps, among them additional geoglyphs constructed during that time as well as older ones still being used. Many of the geoglyphs formed geoglyph sites or complexes which the maps show only inadequately.

– Access routes: Possible access routes to geoglyph complexes are shown on the maps as dashed lines leading from sites to geoglyphs. These routes were calculated in order to understand how geoglyphs and other sites were organized in relation to each other during a given time period. Using the cost surface tool in ArcMap 8.3, least cost pathways leading from sites to geoglyphs were calculated based on economic premises. Slope degree was considered the main factor in determining direction of movement because possible paths lead mainly through a desert environment without vegetation. Slope degree was derived from the existing DTM of the Palpa area[58] and used to calculate a cost surface (van Leusen 1999; Wheatley/Gillings 2002: 151 ff). The effort necessary to cross a terrain cell was calculated using the formula $C = e^S$, with C being the cost and S the slope degree in radiant. The exponential function ensured that the steepest parts of the terrain would not be crossed by the derived pathway. Once the cost surface had been generated, a cost weighted surface was then calculated as a grid, depending on the predetermined starting point of a possible access route. Furthermore, a direction grid was generated showing for each cell the easiest direction to get to the starting point. A least cost pathway was then calculated from these grids, aiming at a minimization of the required effort to get from starting to end point. It should be noted that the resulting pathways are determined by economic considerations without taking into account cultural parameters. It is not known if any of these routes were ever actually chosen by people living during the corresponding time periods. Nevertheless, as possible access routes the least cost pathways serve the purpose of illustrating the spatial interdependency of geoglyphs and other sites.

The resulting maps (supplements 6a–10b) have to be assessed with caution since each dataset introduces certain biases. None the less, certain trends in geoglyph distribution are clearly evident when compared to the settlement history of the study region as summarized in an earlier report (Reindel et al. 1999). In the following discussion, dates and the length of time periods are given according to preliminary results obtained by the Nasca-Palpa Project. They will probably be subject to readjustment once more chronometric dates become available.

All phases of the Early Horizon (supplement 6a) are lumped together since for the geoglyph dataset there is not enough data available to distinguish individual phases. However, judging from finds, most sites and geoglyphs date to the late phase of the Early Horizon (approximately 400–200 BC). Sites from this time period tend to be grouped on the foothills of Cerro Pinchango on the right bank of Río Palpa. Few sites are located on Cresta de Sacramento proper, and usually not directly along the margins of arable land but slightly further uphill. Geoglyphs from this time do not correlate with the site distribution pattern since they are located on the lower part of Cresta de Sacramento. Consequently, relatively large distances had to be covered to reach a geoglyph site from a settlement, at least when compared to later phases. No geoglyphs are located close to the densest concentration of sites. Thus, during the Early Horizon geoglyphs and other sites were located in rather remote locations from each other.

This picture changes only gradually during the Initial Nasca period (approximately 200–1 BC; supplement 6b), but site density increases considerably. Sites now dot most parts of the valley margins, except for some stretches of the lower left bank of Río Grande, and some initial activity is evident on more elevated parts of the ridge. During this time, geoglyphs continue to occupy mainly sites on the middle and lower parts of Cresta de Sacramento, and for the first time geoglyphs are placed in remote locations on the foothills of Cerro Pinchango as well as on Cerro Carapo. However, apart from some

[58] Slope degree was calculated for a DTM with 10 m mesh size. The best available DTM resolution (2 m meshsize) was not used because tests showed that too small a cell size leads to unreasonable small-scale twists and turns of the resulting least cost pathway in flat terrain, so that some degree of generalization seemed appropriate. Furthermore, the time required to calculate the cost surface could that way be reduced considerably.

small lines and trapezoids, the largest plateaus remain untouched. Though site density is now more evenly distributed over the study area, geoglyphs still seem to follow a distinct distribution pattern save for a cluster of geoglyphs and other sites towards the southwestern end of Cresta de Sacramento.

During Nasca 2 (approximately 1–100 AD; supplement 7a) site density is generally lower than before, especially on Cerro Carapo and the opposite flank of Cresta de Sacramento. On the other hand, some stretches on the lower left bank of Río Grande are occupied for the first time. Geoglyph sites, however, are still sparse along Río Grande, and access to the Sacramento plateaus is generally easier from the Río Palpa side. During this time some of the largest trapezoids in the study area are constructed, and the main plateau in the middle section of Cresta de Sacramento is converted into an impressive geoglyph complex. Other parts of Cresta de Sacramento closer to Cerro Pinchango are still largely free of geoglyphs. On the main plateau of Cerro Carapo geoglyph density also increases. Due to higher site and geoglyph density distribution patterns seem to converge for the first time in Nasca 2 with at least some geoglyph sites (though not necessarily the major complexes) in easy reach from close-by sites on the valley margins.

Nasca 3 (approximately 100–250 AD; supplement 7b) sees a clear increase in site density to a level slightly higher than in Initial Nasca. During this time the region most probably reached a demographic peak. All valley margins are occupied, though in some cases (Cerro Carapo, some stretches along Río Grande) not as densely as during other phases. Los Molinos (PV66-63) on the left bank of Río Grande is the largest site of this time. A notable increase can be observed concerning the number of geoglyphs constructed or used. For the first time, all major plateaus of the study region show some kind of geoglyph related activity, and the first major geoglyph complexes develop on the left bank of Río Grande. Likewise, the dense cluster of sites on the right bank of Río Palpa in the foothills of Cerro Pinchango (probably the most stable region of the study area in terms of settlement) has for the first time an important complex of large geoglyphs. On the southern slopes of Cresta de Sacramento, several straight lines are constructed connecting settlement zones with geoglyph complexes on plateaus. Geoglyph complexes are easily accessible from neighboring sites. However, the somewhat marginal position of Los Molinos with regard to geoglyph sites required considerable distances to be covered to reach the major geoglyph complexes from this center. Along this route several smaller complexes are encountered. All in all, by Nasca 3 times at least some geoglyphs seem to have been established on all major geoglyph sites. In other words, on none of the more complex geoglyph sites was geoglyph related activity begun later than Nasca 3. Like in Nasca 2, site and geoglyph distribution seem to follow similar patterns, although this impression may be largely due to the fact that the whole study area was densely occupied.

During the Nasca 4 period (approximately 250–300 AD; supplement 8a) site numbers drop considerably, and large stretches along the middle part of Cresta de Sacramento seem to have been largely abandoned. Site clusters can be observed again on the upper right bank of Río Palpa and on the southern edge of Cresta de Sacramento. Existing geoglyph sites namely on plateaus continue to be used, and new geoglyphs are added, yet activity may have been restricted to fewer geoglyphs, and distances between sites and geoglyph complexes are generally larger than before. Thus, the distribution pattern of geoglyphs seems to become once again independent of site distribution.

During Nasca 5 (approximately 300–450 AD; supplement 8b) site numbers rise again, but they do not reach Nasca 3 levels. This increase can be observed especially on Cerro Carapo, around the southwestern endpoint of Cresta de Sacramento, and in the area around La Muña (PV66-49, the largest Nasca 5 site) on the right bank of Río Grande. On the other hand, large stretches along the left bank of Río Grande are left unoccupied, and site density on both flanks of the middle part of Cresta de Sacramento is generally low. The picture is different concerning geoglyphs, though. All major sites on the plateaus of Cresta de Sacramento and Cerro Carapo show significant signs of use, and (some) new geoglyphs continue to be added. Since geoglyph distribution during Nasca 5 is largely determined by sites established in previous phases, it does not correspond to site distribution. Thus, at least access routes to the main plateau were once again much longer than in Nasca 3 times.

In Nasca 6 (approximately 450–525 AD; supplement 9a) site density reaches Nasca 5 levels only around the southwestern endpoint of Cresta de Sacramento and along the right bank of Río Palpa that faces Cerro Carapo. Most other sections, namely both flanks of the middle part of Cresta de Sacramento, the whole left bank of Río Grande, and Cerro Carapo show very few sites. The large geoglyph complex on Cerro Carapo is abandoned by Nasca 6 times, just like several geoglyph sites along Río Grande. Geoglyph related activity continues on several plateaus and on the southern slope of Cresta de Sacramento, including the construction of new geoglyphs. However, the lower site density is reflected in less activity on geoglyph sites, namely on the central part of Cresta de Sacramento.

In Nasca 7 (approximately 525–600 AD; supplement 9b) the most notable change in site distribution can be observed around the southwestern end of Cresta de Sacramento where less sites are located than before, and none of them on either bank of Río Grande where site density drops almost to its lowest level. A slight increase of site numbers is observable on both banks of the upper Río Palpa. Geoglyph related activity seems now restricted to several major sites from previous phases on the middle and southern parts of Cresta de Sacramento. However, the largest trapezoid on Cresta de Sacramento was apparently constructed in Nasca 7. Important evidence of activity on geoglyphs is found in areas where no contemporaneous sites are located close-by.

The Middle Horizon (approximately 600–1000 AD; supplement 10a) left little traces in the archaeological record of the study region both in terms of sites and geoglyphs. The few documented sites are found mainly in the same areas as in Nasca 7, but in lesser density. Very few Middle Horizon ceramics have been found on Palpa geoglyphs. Most of them are broken vessels on geoglyph borders. These finds indicate a continuing use of the geoglyphs for a certain time after Nasca, although that does not seem to have included the construction of new geoglyphs. Most corresponding geoglyphs are located close to the few sites from the same period so that access required little efforts.

In the Late Intermediate Period (approximately 1000–1400 AD; supplement 10b) site density once again increases sharply, most of all on Cerro Carapo, the opposing flank of Cresta de Sacramento, and along some sections of Río Grande, whereas the southwestern end of Cresta de Sacramento is sparsely settled. Ceramics from the Late Intermediate Period are frequently found on geoglyphs, but, as was pointed out in section 6.2 this is due to the presence of large LIP settlements on plateaus, and not to a continued use of geoglyphs during that period. Access routes for this time period are therefore shown connecting major settlements. These routes clearly went through some major geoglyph fields from previous epochs, explaining the presence of LIP pottery sherds on several geoglyphs.

In summary, it has become clear that there is no parallel development of site distribution and geoglyph distribution. Rather, both developed independently over time. Settlements and production sites along the valleys were dependent on the availability of natural resources, especially water. Recent insights into the paleoclimate of the Palpa region (Eitel et al. 2005) indicate that climatic conditions fluctuated more than previously expected. Thus, sites along valley margins were short-lived in comparison with geoglyphs and more easily abandoned. Geoglyph complexes, on the other hand, did not depend on the availability of such resources. Rather, the desert itself was the main resource, offering space for easy construction of geoglyphs on a large scale. The desert remained stable in spite of any changes in the natural or political condition in the valleys. Thus, once a new geoglyph site had been established, it was not easily abandoned.

Visibility of geoglyphs

Visibility must have played an important role in the placement of geoglyphs. As mentioned in section 3.2, geoglyphs were viewed from the ground. No matter if their function was primarily symbolic or stage-like, geoglyphs needed to be seen. From close range every geoglyph is visible, although its overall form may not be recognizable. The question is then to which degree geoglyphs were visible from a distance. The situation in Palpa differs from that on the Nasca *pampa* where some effort is required to view a geoglyph. In Palpa geoglyphs on hillsides are easily visible from the valley and also from sites along the valley margins. This is not the case with geoglyph complexes on plateaus, but the situation is still different from the Nasca *pampa*. The topography of the Palpa region provides vantage points on the flanks of Cerro Pinchango from which every geoglyph complex on the plateaus of Cresta de Sacramento is visible. The lines on slopes, posts on trapezoids, and stone platforms on plateau edges served to locate the position of geoglyphs on the plateaus from a valley perspective even if the geoglyphs themselves were not visible. The topography of Cresta de Sacramento and the whole study area

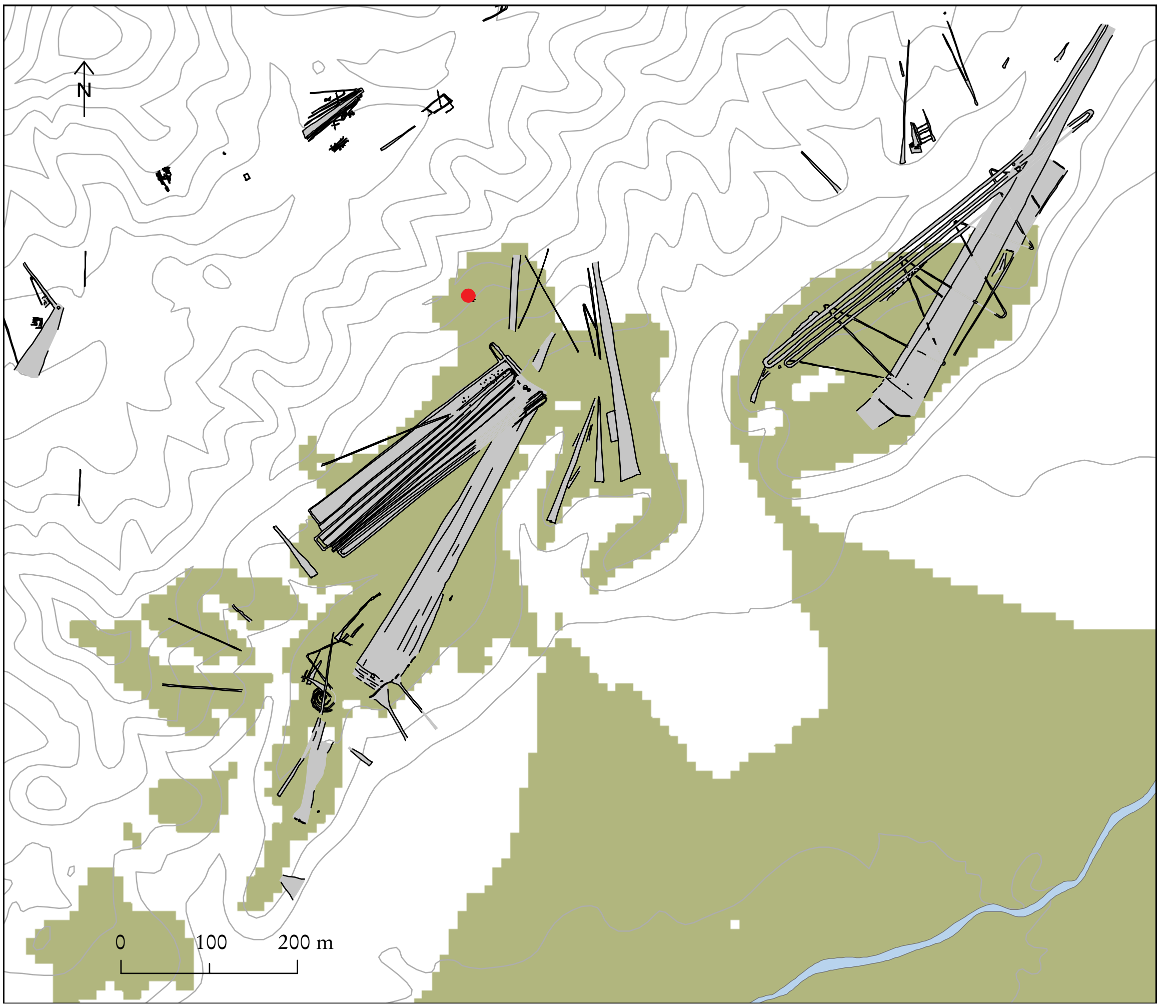


Fig. 41. Anthropomorphic geoglyph 60 on site PV67A-16 (red dot). Areas from which the figure can be seen are marked in green.

with its numerous cross- and along-valley sight lines allowed many views from one geoglyph complex to another.

Due to time constraints, the visibility and intervisibility of geoglyph sites could not be investigated systematically within the framework of the present study. Using the viewshed tool implemented in ArcMap 8.3, however, some representative points in the terrain could at least be tested for their visibility from other positions or for possible fields of visions that these points offered to observers. An anthropomorphic geoglyph, a wooden post, a viewpoint on a geoglyph on a hillside, and a naturally elevated point overlooking a geoglyph field were selected and their viewsheds calculated. This step required a precise DTM since inaccurate terrain data can render the results of sight line calculation useless (Wheatley/Gillings 2002: 201 ff). Other important parameters are height over ground of either the starting or the endpoint of a sight line, a minimum vertical viewing angle, and a maximum radius of the viewshed:

– Height: A sight line should start roughly at eye level. For the Palpa examples, a viewing height of 1.80 m above ground was adopted. Likewise, the endpoint of a sight line might be above ground if not only the geoglyphs themselves, but objects or people upon them are included. For example, in the case of a post on the lower Cresta de Sacramento, a height of 5 m above ground was assumed.
– Viewing angle: A feature located flat on the ground like a geoglyph requires a minimum viewing angle to be recognized as such. For the anthropomorphic geoglyph, a vertical angle of 30° was presumed in order to give an observer the ability to recognize the main features of the figure. For larger geoglyph

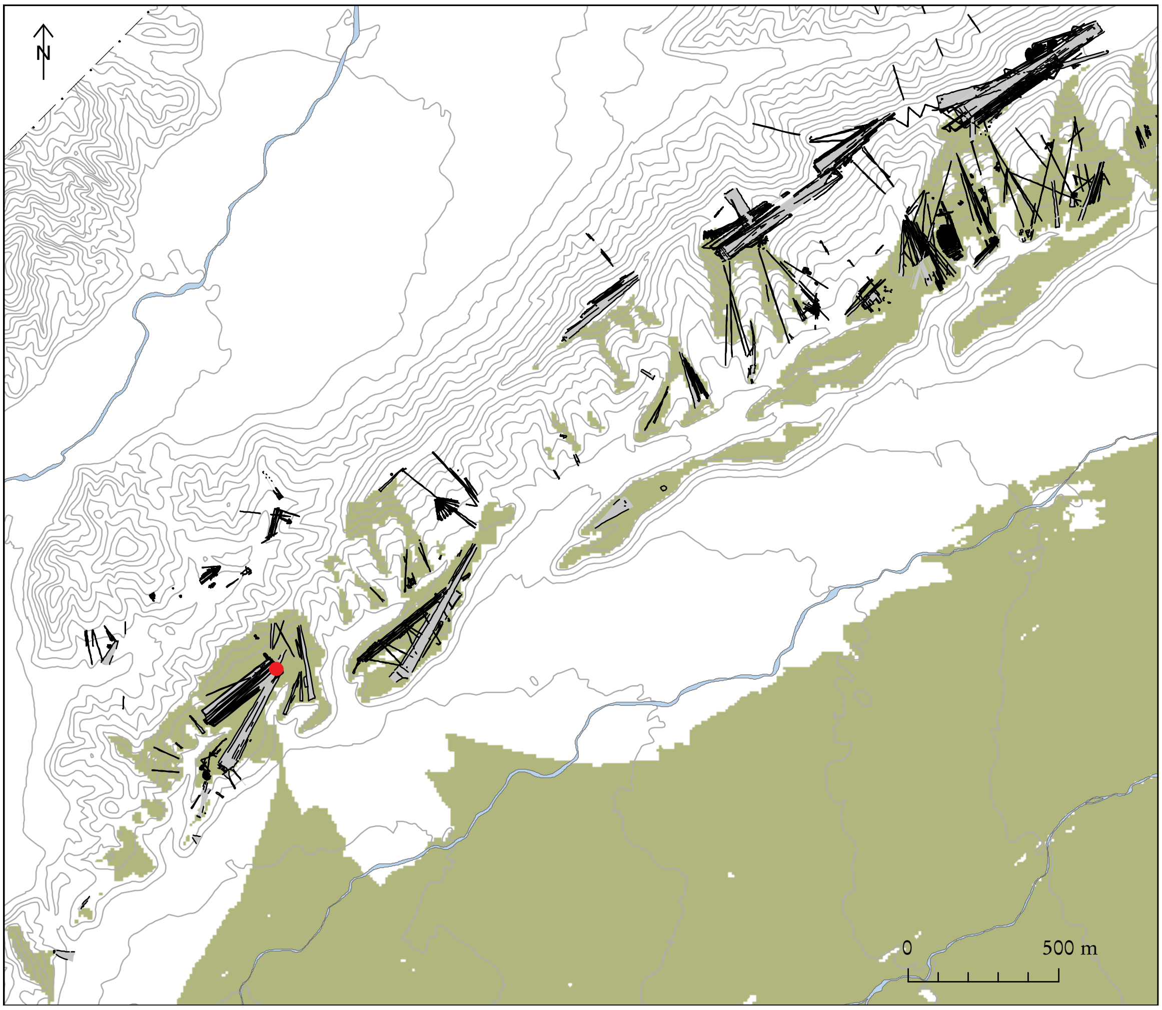


Fig. 42. Wooden post on site PV67A-16 (red dot). Areas from which the post can be seen are marked in green.

sites, viewsheds were calculated without minimum viewing angle since not only the geoglyphs, but also people moving on them are potential endpoints of sight lines.

– Maximum radius: The larger the geoglyph the easier it is to see from a distance. Small geoglyphs like the anthropomorphic figure are not visible beyond a certain distance. Based on our fieldwork, a maximum radius of 1.5 km was determined for viewshed calculations for small geoglyphs. For larger geoglyphs calculations were based on a radius of 4 km.

The resulting viewsheds are discussed below.

– Anthropomorphic geoglyph 60 on site PV67A-16 (map 9, fig. 41). This figure is located close to an impressive complex of geometric geoglyphs. The question here was how the presumably early figural geoglyph was related to the generally later geoglyph complex close-by. As figure 41 shows, the viewshed covers the main geoglyph complexes below the figure and in both directions up- and downriver along the slope as well as parts of the valley floor. Thus, the figure was possibly visible from most later geoglyphs that surrounded it. Whether this effect is coincidental or the result of a careful placement of later geoglyphs is unknown.

– Wooden post on trapezoid 52 on the same site (map 9, fig. 42). This site is located on a plateau midway in between the valley floor and the main ridge. The large trapezoids are not visible from the valley, but the post may have served as indicator of their position. The question was: From where was the post visible? As expected, the viewshed covered large parts of the valley floor, so that the post could have served as an indicator of the

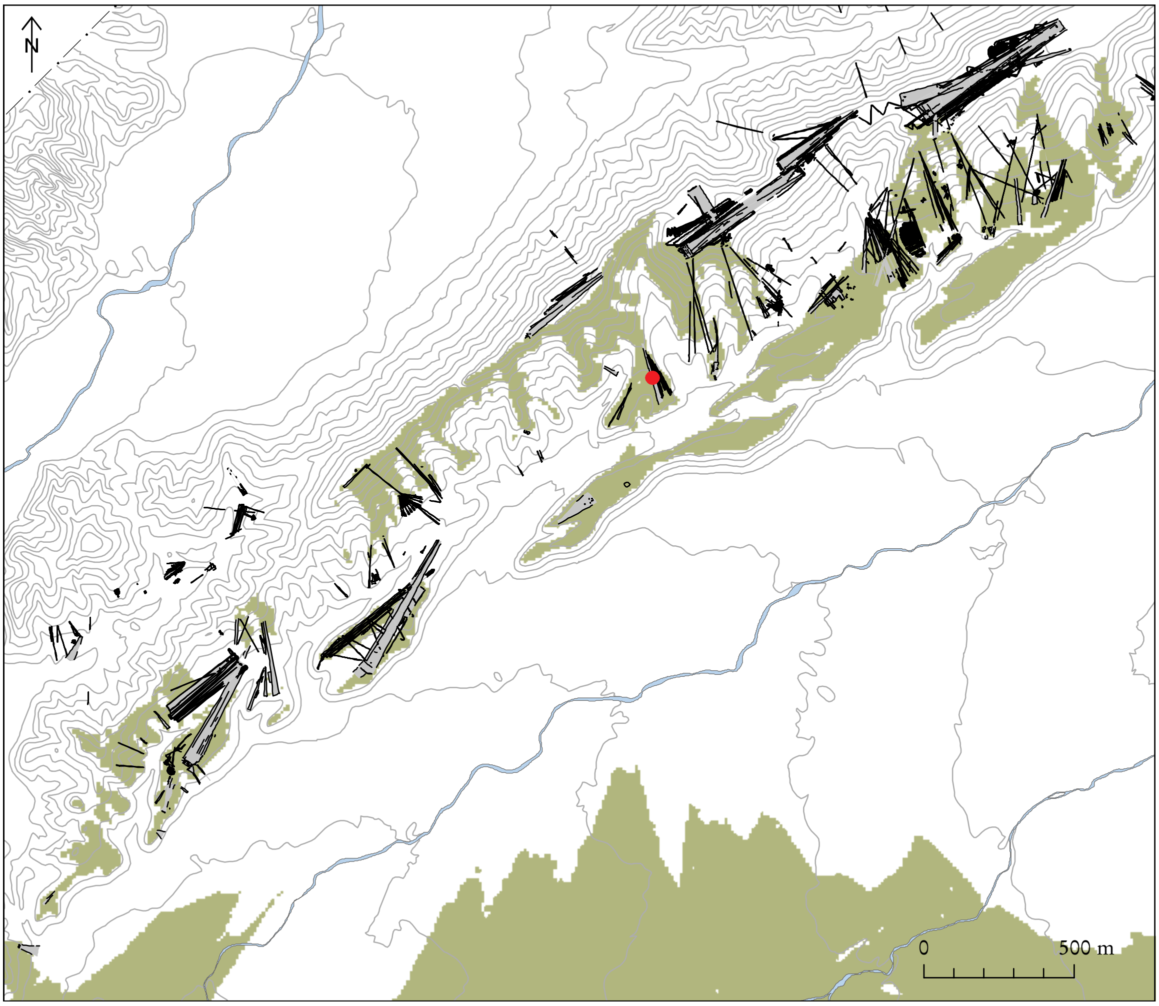


Fig. 43. Viewpoint on trapezoid 109 on site PV67A-29 (red dot). Areas visible from the viewpoint are marked in green.

geoglyphs not visible from the valley. Even more important, however, is that the viewshed along the southern flank of Cresta de Sacramento neatly coincides (in most cases) with the location of lines on slopes or geoglyph complexes on lower parts of the hillside, as well as with plateau edges where elongated stone platforms are located. Thus, intervisibility between geoglyph complexes on slopes seems to have been an important factor.

– This finding is confirmed by the viewshed of a viewpoint on trapezoid 109 on site PV67A-29 on the southern hillside of Cresta de Sacramento (fig. 43). This site is one in a row of sites dotting the slope of Cresta de Sacramento. The question here was: Was intervisibility between these sites significant? Apparently it was. Much like the post, the viewshed covered the main geoglyph sites in both directions along the slope, as well as the complexes on flat terrain at the base of the slope. However, an important difference is that due to some branches of the middle plateau of Cresta de Sacramento, the visibility of the site was blocked towards the valley floor.

– Vantage point above site PV67A-90 close to Cerro Pinchango (map 11, fig. 44). Situated on elevated terrain above a major geoglyphs complex, this possible viewpoint is marked by two converging lines and a small stone structure. The question was whether this place had deliberately been marked as a point in the landscape from which geoglyphs could be viewed. Again, there is evidence that this was the intention. Not only could neighboring sites be completely overlooked, but the viewshed also covered geoglyph complexes in rather remote locations from the vantage

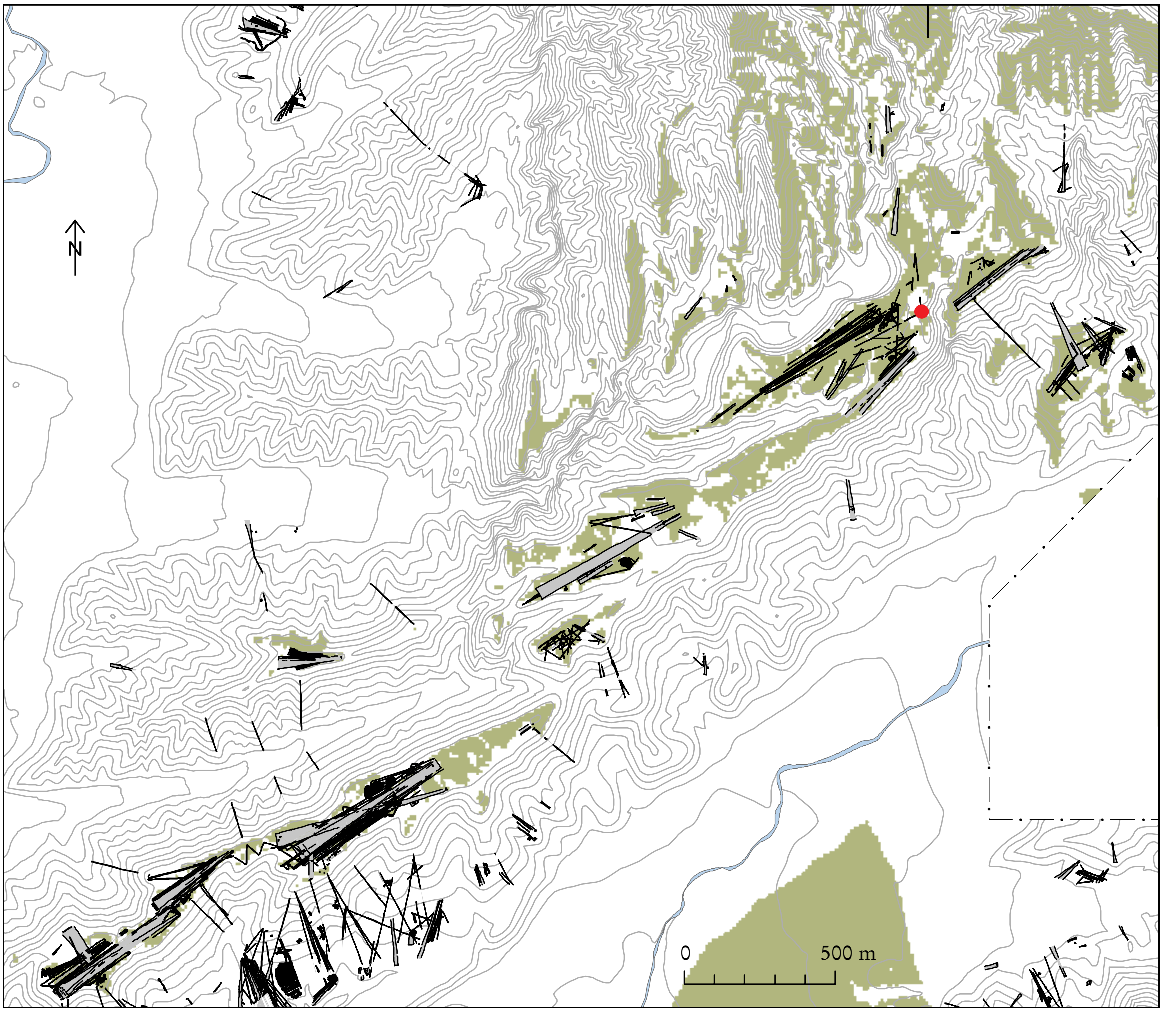


Fig. 44. Viewpoint marked by a stone structure and two converging lines above geoglyph site PV67A-90 (red dot). Areas visible from the viewpoint are marked in green.

point. Although geoglyphs may not have been discernible over that distance, people on geoglyph sites certainly could be seen. The fact that the point is marked by lines and a stone structure further strengthens the argument that this place was related in some way to activity on geoglyphs.

These results indicate that in general the visibility of geoglyphs was relatively high. Not only could certain geoglyphs be directly seen from other places, including other geoglyphs, but posts or people on geoglyph sites further enhanced their visibility. The latter aspect seems especially important since activity on geoglyph sites was most probably a near constant phenomenon, and many people went out into the desert to participate in it. Observers on remote viewpoints may have interacted in some way with people on geoglyph sites. Intervisibility from one geoglyph complex to the other may thus have been an important criteria in determining places for new geoglyphs.

Orientation of geoglyphs

The orientation of geoglyphs has for a long time been their single most discussed feature. While orientation towards celestial bodies was originally focused on, the Andean model has proposed an orientation towards landscape features like mountain tops or rivers as criteria for the spatial context of a geoglyph.

In order to shed light on the latter hypothesis, the orientations of 337 out of 639 geoglyphs on Cresta de Sacramento, Cerro Carapo, and around La Muña were calculated. This selection of geoglyphs was determined by geoglyph shape and by the applied method. The calculation of geoglyph orientation does only make sense if a given geoglyph has a dominant straight section that allows the orientation to be meaningfully

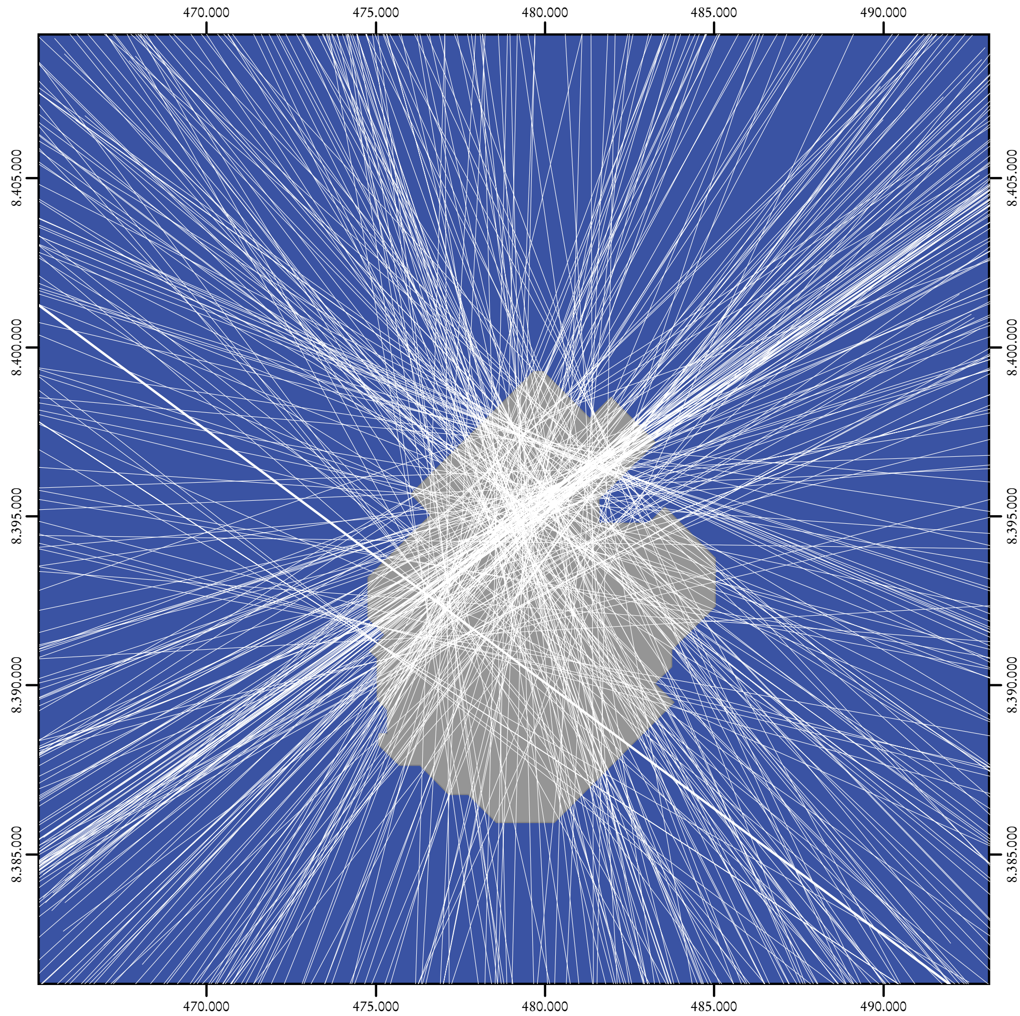


Fig. 45. Orientations of 337 geoglyphs from the Palpa sample. The area covered by the geoglyph map is marked in gray.

determined. This requirement excluded all biomorphic, amorphous, and spiral geoglyphs from the calculation. Another limitation was due to the method used to calculate orientation. The digital 3D polygons of which each geoglyph is composed (see section 5.12) served as starting point. Using the nodes that define the outlines of each polygon, the principal axis through the mathematical point of gravity was calculated for each geoglyph that had at least one polygon whose orientation was representative for the overall orientation of the geoglyph. Since the method was based on single polygons, the orientation of geoglyphs composed of many different polygons oriented in varying directions, like some of the major trapezoids, could not be calculated. Nevertheless, the orientations of 337 geoglyphs (52.7% of the total sample) are available in the geoglyph database. Every straight or near-straight geoglyph points in two directions, so that in fact 674 orientations (two for each geoglyph) are available for the Palpa geoglyph sample.

The extrapolated principle axes of 337 geoglyphs are shown in figure 45. Here, axes are geo-referenced and therefore have different center points. Some general tendencies can be observed.

Orientations cover virtually the full circle. No orientation seems to have been deliberately avoided. A majority of orientations, however, is clustered around two general directions: along the major course of Cresta de Sacramento and roughly perpendicular to it. The variation of the latter direction is greater than the former. It is clear that these main directions represent geoglyphs on the top of Cresta de Sacramento and geoglyphs on its southern flank.

A more thorough investigation of geoglyph orientation is expected to reveal additional details. A review of intersection points seems a promising avenue of reseach. Observations made in the field indicate that several geoglyphs are oriented towards Cerro Pinchango. The summit of this and other mountains was unfortunately outside the range of the DTM available for this study. Furthermore, the separate investigation of the orientations of subsets of geoglyphs, *e. g.* of a certain type or time period, seems necessary. So far, time constraints did not permit the project to pursue this approach.

6.4.3 Summary: Geoglyph setting and order

The above investigation of spatial ordering of geoglyphs and geoglyph sites, though not as complete as desirable, shows that certain rules existed that determined where new features were to be placed. Within geoglyph complexes, these rules included typical combinations of geoglyphs built in a predefined sequence. The composition of these combinations was probably determined by activity conducted on geoglyphs. Topography further determined to a certain degree the orientation of a geoglyph. On the regional level, there are strong indications that intervisibility between geoglyph complexes played an important role which strengthens the concept that geoglyphs were used as a kind of stage. Accessibility, on the other hand, was apparently no decisive factor for the placement of geoglyph sites. Of course, overall distances were never as large as on the Nasca *pampa*, so that accessibility might have been a negligible parameter in the Palpa area.

The most important result of the study of spatial ordering of geoglyphs seems to be that they do not correlate to settlement patterns. The first geoglyphs were constructed in rather remote locations away from settlements along valley margins. This changed in Early Nasca times when bit-by-bit all possible locations for settlement sites on valley margins as well as for geoglyphs on flat plateaus were used. Thus, geoglyphs sites were within easy reach of people from settlements in this densely populated area. After that time, the Palpa region was never again fully occupied, so that settlements once again were concentrated in certain areas. The use of geoglyph complexes, however, was more persistent over time. Those established during Early Nasca times continued in use in the Middle Nasca period, even though some of them were no longer easily accessible from sites along the valley margins. In Late Nasca and later occupation density dropped to very low levels. Only then seems proximity to inhabited sites to have determined which sites continued to be used.

There is no indication of important geoglyph complexes associated with specific settlements. Los Molinos and La Muña were the biggest sites in the Palpa region during Nasca 3 and Nasca 5 times (Reindel/Isla 2001). Although small groups of geoglyphs formed part of both sites, they were considerably less complex than the larger geoglyph sites on both Cresta de Sacramento and Cerro Carapo. These large complexes cannot be associated with specific settlements on the valley margins. They continued in use much longer than average sites, even when settlements close by were abandoned. Thus, whatever the settlement pattern or settlement hierarchy in the valley at any given time period, the locations of geoglyphs in the desert were largely independent of it.

7. Discussion: The Andean model and the Palpa geoglyphs

In the previous section, the Palpa geoglyphs were investigated concerning geoglyph variation (formal, temporal, and spatial) and human activity related to geoglyphs. This section is dedicated to a discussion and interpretation of the results. To that end, archaeological evidence documented on geoglyph sites on Cresta de Sacramento and Cerro Carapo is tested against the main tenets of the Andean model as defined in section 3.2.2 in order to assess the ability of the model to explain the geoglyphs. According to the model, geoglyphs expressed social and spatial order, provided places for ritual activity, were considered sacred space, were related to mountain worship and concepts of water and fertility, and were used as roads in some cases (fig. 5).

7.1 Geoglyphs as expressions of social and spatial order

As shown in section 6.3.1, the construction of a geoglyph, or a complex of geoglyphs, involved the participation of groups of people. A place was claimed by a certain group and henceforth served as a stage for collective activity including maintenance, remodeling, and use of a geoglyph or a group of geoglyphs for a variety of purposes as mentioned previously. This string of geoglyph related activity often extended over a considerable time span during which members of the group were involved in different acts, whether in larger numbers (*e. g.* for construction activity), in smaller subgroups (*e. g.* for activity related to stone structures) or maybe alone (*e. g.* for line walking and vessel placement).

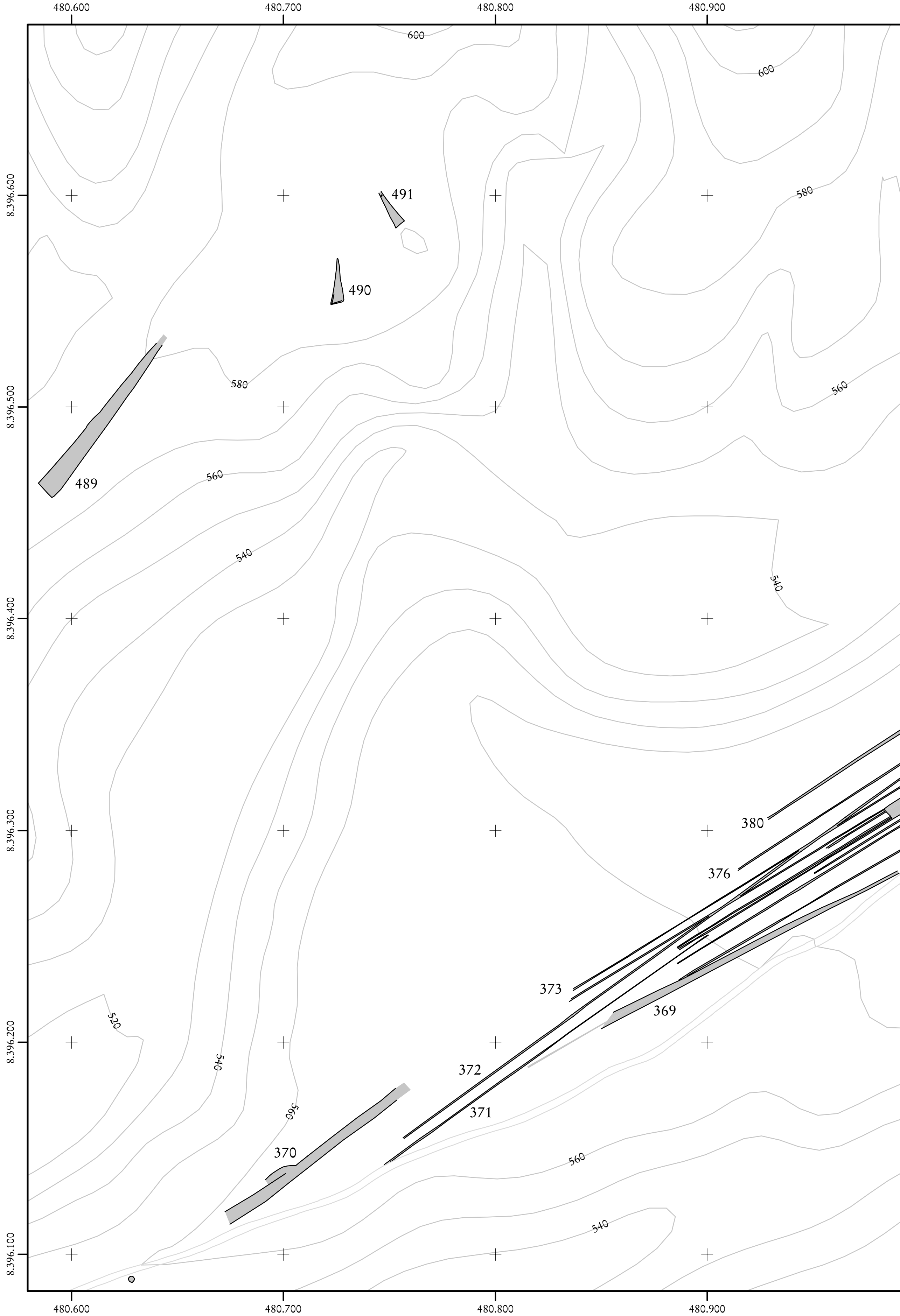
Archaeological evidence from the geoglyphs alone does not easily show the composition of social groups or how they identified themselves. Nevertheless, some conclusions can be drawn that place the geoglyphs and the social groups associated with them in a wider societal context. The geoglyphs played an integrative role involving the whole society, but they were also of special importance for subgroups within the society. Both aspects were closely related.

Geoglyphs show a noticeable uniformity through time and space. In spite of clearly observable variation described in previous sections, the basic principle of marked space in the desert that was worth the invested time and manpower and that represented important aspects of ancient world view remained largely unaltered throughout almost 1,200 years. It furthermore seems that regional variation within the drainage was minimal, though this will have to be investigated more thoroughly once comparable data from other valleys becomes available. Geoglyph distribution did not correlate directly with contemporaneous settlement patterns but rather proved more stable through time. Important changes in sociopolitical organization, like the break observable between Early and Middle Nasca[59], are rather marginally reflected in geoglyph distribution and use. The concern with water and fertility mirrored in goods placed on geoglyph sites was always important to the ancient inhabitants of the region and therefore transcended changing political circumstances which affected them. The geoglyph phenomenon was a strong link between late Paracas and Nasca culture and society, and had its roots even earlier in the Paracas petroglyph tradition. It was certainly influenced, yet not fundamentally altered by major technological, political, and other changes along the time line of the Paracas-Nasca cultural continuum[60]. In this sense, geoglyphs can literally be understood as common ground (Clarkson 1999) for all members of Late Paracas and Nasca society.

Within this common conceptual framework subgroups of Nasca society acted and interacted.

[59] Reindel et al. 1999: 372; Silverman 2002a: 167; Orefici/Drusini 2003: 89f.

[60] From this point of view, the fact that the geoglyph tradition came to an end early in the Middle Horizon is a strong indication that the Wari intrusion into the Nasca basin entailed greater change in culture and society than all disruptions suffered throughout the centuries before.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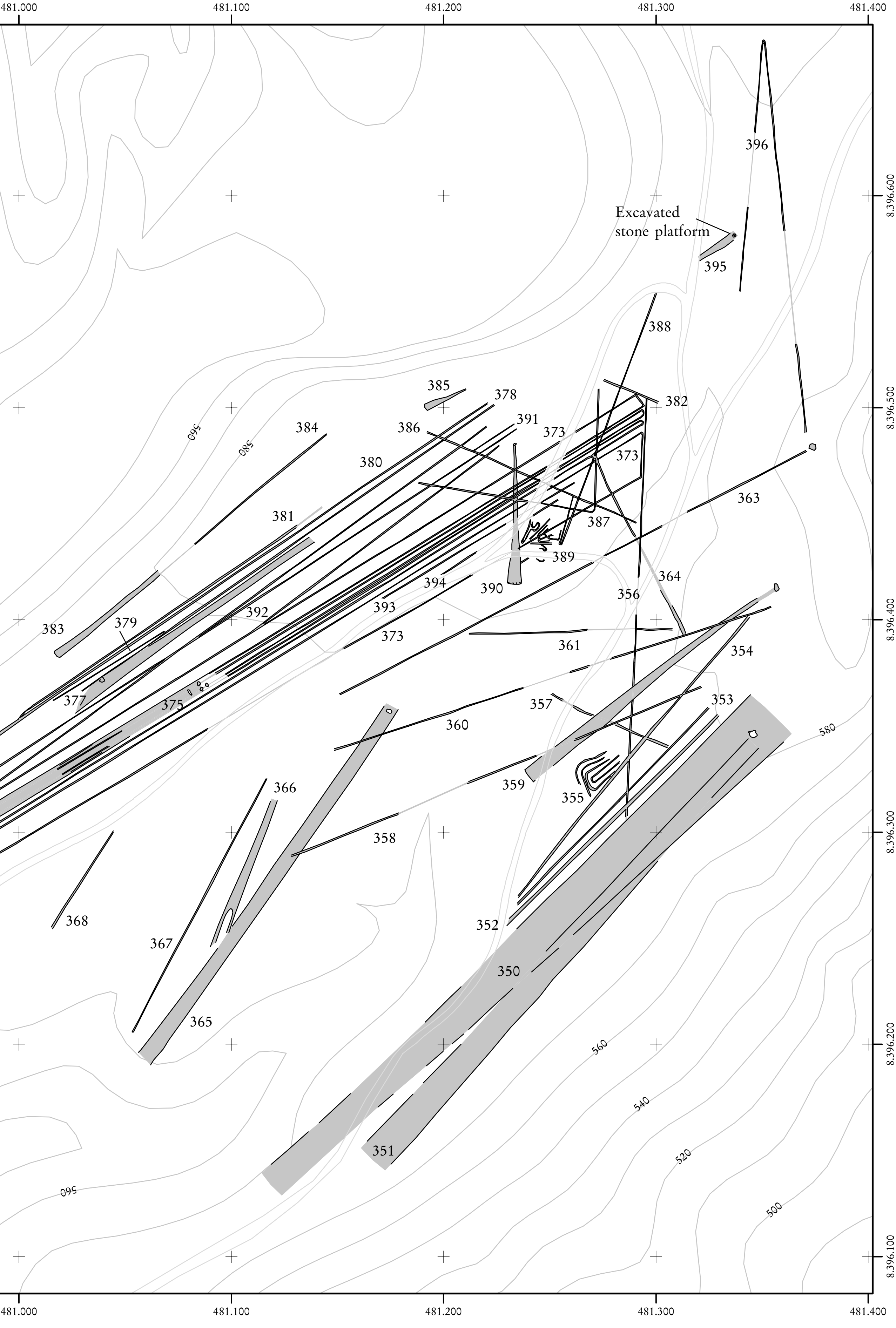


Map 11. Geoglyph sites PV67A-89 (bottom) and -90 (top) on Cresta de Sacramento.

Guided by geoglyph specialists, members of groups gathered on certain occasions in the desert to construct new geoglyphs, to remodel existing ones, or to walk along lines and trapezoids in a prescribed fashion. They placed ceramic vessels (possibly containing food or beverages), field crops, textiles, *Spondylus* shells or other goods on geoglyph borders or stone platforms. Apparently, an important aspect of this group activity was its visibility from other geoglyph sites, from vantage points on elevated terrain, and even from parts of the inhabited and cultivated valley floor. Geoglyph sites can thus be understood as a stage with actors and spectators. In this sense, the importance of group activity transcended specific groups. Awareness of group identity was raised among members as well as outsiders. Group interaction between geoglyph sites may have assumed a competitive character concerning status within a larger societal context.

In order to better understand this aspect, it is necessary to discuss how these groups may have been defined. Economic considerations are important. Group members that constructed geoglyphs spent many working hours away from other activity and had to be provided with food and water. Goods to be placed on geoglyph sites had to be produced and transported. These economic requirements, though difficult to quantify, show that geoglyph related groups must have had access to economic resources like water, arable land, clay deposits, and goods produced on the basis of these recources. Geoglyph related units of social organization may thus have coincided to a certain degree with economic units.

These economic considerations provide a link to spatial order as well. Economic resources, like arable land and water sources and access to them are fixed to a particular location to which habitational patterns of the group that utilized them likely were spatially related. Thus, though there is no direct correlation between geoglyph and settlement distribution, spatial order may have become indirectly manifest in social groups related to geoglyph sites.

The unit of ancient Andean social and economic organization best known from ethnographic and ethnohistoric sources is the *ayllu* (Moseley 2001: 53 ff). This multifaceted concept from the Inca period encompassed social, economic, and religious aspects such as kinship, land and irrigation rights, group labor, and ancestor veneration. Was ancient Nasca society organized in *ayllus*, and if so, are these *ayllus* the same as the geoglyph associated groups defined above?

Within the framework of the Andean model, Urton, applying the social organization of early colonial times in the Nasca area to prehispanic times, suggests that this was indeed the case. He argues that the maintenance of lineal geoglyphs was organized along *ayllu* lines (Urton 1990: 205). In a similar vein, Silverman suggests that Cahuachi's temple mounds can be traced back to individual *ayllus*. She defines *ayllus* as "cognatic descent groups" (*i. e.* groups claiming descent from a common ancestor) with further characteristics such as residence or redistribution of goods (Silverman 1993a: 309 f).

On the other hand, according to a stricter definition used by William Isbell, *ayllus* were linked to a specific kind of mortuary monument called by him "open sepulcher" that allowed access to, and public display of the ancestor's mummy (Isbell 1997: 136 ff). Following Isbell's line of reasoning, *ayllus* would not have been present in Nasca society since they made their first appearance in the southern Andean region centuries later (Isbell 1997: 285).

Though open sepulchers were indeed unknown in the Nasca period, there is clear evidence of other forms of an ancestor cult that may not have involved the actual mummy, but effigies representing it[61]. The posts in the Room of the Posts at Cahuachi have been interpreted in terms of ancestor worship (Silverman 1993a: 174 ff). These posts may furthermore have a parallel to those depicted on a Nasca 5 vessel on exhibit in the Museo de América, Madrid, Spain (Blasco/Ramos 1991: 231; Rickenbach ed. 1999: 325). Several posts are shown on that jar, each with a rectangular banner attached to its top and a lateral bar from which a trophy head is suspended[62]. Trophy heads, in turn, may also have been used in the context of ancestor veneration (Proulx 2001: 130, fig. 6.13). Thus, evidence for an ancestor cult involving posts, trophy heads, grave precincts, and maybe even geoglyphs is present in the Nasca archaeological record. It seems reasonable to assume, then, that social groups not unlike the *ayllu*, claiming

[61] Silverman/Proulx 2002: 214 ff, fig. 8.6; DeLeonardis/Lau 2004: 104 ff; cp. evidence of mortuary ritual in La Muña: Reindel/Isla 2001: 306, figs. 27, 30.13–14.

[62] It is tempting to view the posts erected on trapezoids in the same context. However, neither the posts shown on the Madrid vessel nor the ones of the Room of the Posts are directly linked to geoglyphs in any recognizable way.

descent from a common ancestor and being linked to economic resources, may well have been present in Nasca society, even though there is no evidence for open sepulchers.

Who led these groups? Silverman's description of *ayllu* structure suggests that leadership depended on individual capabilities and had to be negotiated and justified (Silverman 1993a: 309). If geoglyphs were the stable cultural expression of worldview or social ideology as described above, then the ability to lead a group to construct or remodel a geoglyph may have been a means of legitimation for a potential leader:

> "To the degree that ideologies are materialized, they become part of the physical world that is constructed by social labor. Thus the material nature of an ideology, essential for cultural sharing, offers opportunities for control identical to that over production of other objects." (Earle 1997: 152)

By performing a socially acknowledged act of leadership a group member may legitimate a claim to become or remain a group leader. Another observation seems to hint in this direction as well. The more Nasca society became politically fragmented from Early to Late Nasca, the more standardized became the geoglyph repertoire. If geoglyphs were the benchmark against which ephemeral group leadership was tested, then this self imposed limitation to the types that were most common through all phases – straight lines and trapezoids – may be explained by potential group leaders having to ensure their recognition by socially accepted acts. The construction of less common geoglyph types would have questioned their claims. But, it should be noted that this interpretation is highly speculative and there is clear evidence that leadership was organized in a more stable fashion during much of Nasca history (see *e. g.* the Middle Nasca elite graves at La Muña and Puente Gentil: Reindel/Isla 2001; Isla 2001a).

Summing up the available evidence, the existence in Late Paracas and Nasca society of *ayllu*-like social groups related to geoglyph complexes seems possible in the light of archaeological evidence from the Palpa geoglyphs. Thus, the Andean model provides a valid explanation for their social context. The presence or absence of such groups or of different kinds of social formations can, however, only be assessed to a limited degree based on evidence from the geoglyphs alone. Data on regional settlement patterns, internal structure of domestic sites, distribution of prestige goods, grave furniture, diet etc. may provide a broader basis on which to build conclusions about Nasca social organization. Comparative data from the Palpa sites obtained within the framework of SLSA's Nasca-Palpa Project are currently being studied. The results are expected to shed more light on the issue discussed here.

7.2 Geoglyphs as places for ritual activity

An important element of the Andean model, activity on geoglyph sites has frequently been called "ritual"[63]. This term is problematic since it is not clearly defined. In the context of the Nasca geoglyphs, the term "ritual" carries with it widely differing meanings – the most important being religious (offerings, pilgrimage, processions, worship) and social (social groups claiming space, expressing their identity, and negotiating their status). This is a rather broad concept of "ritual". Other definitions or uses of the term in anthropological as well as archaeological research are similarly multifaceted[64]. While it is often used to describe action as opposed to thought (see overview in Bell 1992: 19 ff), others define it as involving both action and the ideas and concepts by which the action is motivated (Insoll 2004: 10 ff).

Two basic problems arise when trying to identify ritual in archaeological research. The first one is practical. The archaeological record is composed of material remains that are the results of human activity[65]:

> "What we have are the acts – or more precisely, the traces of artifacts used for the acts or the place where the acts occurred and also physical results of the acts (e. g., deposits)." (Bertemes/Biehl 2001: 15)

These acts often can be reconstructed based on archaeological evidence. The more a certain kind of activity is repeated in the same place, using the same kind of objects, the clearer it becomes

[63] Urton 1990; Silverman 1990a; Rostworowski 1993; Rodríguez 1999.

[64] Merrifield 1987: 6; Bell 1992: 69 ff; Rappaport 1999: 24 ff; Sundqvist/Kaliff 2003; cp. historical review of theories on ritual in Bell 1997: part I.

[65] The cultural and environmental formation processes of the archaeological record, though important for its interpretation, are of no concern for the topic at hand and are therefore not discussed here.

in the archaeological record. Thus, activity is to a certain degree accessible with archaeological methods. On the other hand, concepts or thoughts that motivated or induced activity are more difficult to reconstruct. Usually, additional information from other sources such as written or oral histories, analogies etc. is needed. Thus, if the question is whether or not ritual activity took place on geoglyphs sites, then the answer from archaeological research can only refer to different kinds of activity as reconstructed from material remains (action), while conclusions concerning the underlying concepts (thought) require additional information.

The second issue when looking for ritual activity is a heuristic one. To what end is a certain kind of activity labeled "ritual" by archaeologists? What does the term imply about the meaning of the activity? In her critical review of the use of the term "ritual" in archaeological research, Irish archaeologist Joanna Brück identifies its – usually implicit – equalization with non-functional action devoid of rationality as most important common trait (Brück 1999). From a functionalistic viewpoint, ritual is conceived as being opposed to rational activity that is concerned with housing, subsistence, production, trade etc. Thus, by calling a certain activity "ritual", a sphere of human activity is set apart that to the modern observer has a different role than other activity, a role that may not be as easily explainable as that of other spheres. "Ritual" is thus primarily an analytical concept.

It has to be kept in mind that this analytical category did not necessarily exist in the cultural concepts of ancient societies studied by archaeologists. According to Brück, different world views may well assign causality and rationality to activity labeled "ritual" in the above described sense. In a similar vein, British archaeologist Timothy Insoll has recently proposed to view religion, which is often seen as the basis for ritual activity, not as only a sphere of life alongside other spheres like subsistence, social organization etc., but rather as a central characteristic of life that determines all spheres (Insoll 2004: fig. 2). In this sense, religion, social ideology or world view equally determine and imbue with meaning all spheres of human life and activity.

Following Brück's and Insoll's reasoning, it becomes clear why ritual and other activity are often not as neatly separable in the archaeological record as the archaeologist would wish (Marangou 2001)[66]. If the same concepts determine both ritual and non-ritual activity, and the same rationality is assigned to both, then both may be highly interwoven or take on similar expressions or manifestations. Indeed, certain traits often used to identify ritual (repetition, dedicated places, use of special objects) are equally typical for daily household activity.

Activity related to the Palpa geoglyphs included gatherings of social groups, line walking, placement of vessels and other objects along lines and on platforms, and food consumption, etc. (see section 6.3). Whether or not processions or races were held on geoglyphs cannot be determined with any degree of certainty. Geoglyph related activity required a considerable investment of time and labor. It involved large parts of the ancient population of the Palpa region organized in different social groups. These groups interacted on and across geoglyph sites. As described in the previous section, all these activities had an important social function since they determined group status and possibly group leadership.

All these acts may well be termed "ritual" in the sense as described above. Thus, the Andean model provides once again a plausible framework for archaeological evidence from the Palpa geoglyph sites. It has to be stressed, however, that the term "ritual" in itself is not an explanation, nor does it alone provide an understanding of the meaning of the discussed acts. For the people involved, it seems clear that geoglyph related activity was functional and rational within the framework of their world view, and it cannot be seen separated from other kinds of daily activity.

7.3 Geoglyphs as sacred space

Much like the term "ritual", "sacred" is equally problematic for similar reasons. As has become clear in the previous section, archaeological evidence does not alone reveal if geoglyphs were

[66] For example, it has been postulated that religious ritual be recognized as such in the archaeological record on the basis of positive traits (Renfrew/Bahn 2000: 406; Bertemes/Biehl 2001; Müller 2002), not just in a questionable *in dubio pro deo* attitude (Colpe 1970: 28) that interprets everything not otherwise explainable as religious. However, check-lists of such traits (*e. g.* Renfrew 1994: 51f) draw heavily upon belief systems known from written sources and are mainly suitable in well preserved, and well documented contexts. In less favorable circumstances, such trait lists are of little practical value.

considered sacred space. However, two aspects evident in the Palpa data suggest that geoglyph sites were considered places with a value of their own and of special importance in a wider context.

Firstly, geoglyphs were located in the desert. They were made and used in places that during large periods of time were remote from settlements. The different environment and elevation clearly set geoglyph sites apart from inhabited settlements and agricultural zones. Apart from inter-valley traffic, there was no other activity in the desert whose extent and importance came close to geoglyph related activity. Through the geoglyphs, large portions of the desert were incorporated into the cultural domain of the valley-based society (Silverman 1990b: 451). The cultural territory was that way considerably enlarged and enriched by new components. In no other time period, either before the Spanish conquest or afterwards, did the desert portion of the Nasca landscape receive such special attention than when it was marked with geoglyphs and occupied by human activity. Large amounts of labor were invested into this space over time. Thus, the culturally marked desert landscape was a valuable resource for the society.

This value proved, secondly, persistent over time. Geoglyph sites, once established, were not easily abandoned. As discussed in section 6.4, geoglyph sites developed more or less independently of the settlement pattern and often continued in use even when settled zones closest to them were abandoned. They were constantly frequented over time, even if the place where the people who used the geoglyphs lived might have changed. Thus, geoglyph sites maintained their importance even in the face of major changes in the valleys. Their special role was not short-lived, but rather represented a stable facet in the cultural history of the Palpa region for more than 1,000 years.

It is a plausible explanation to assume a sacred meaning to this special value and persistent tradition. The archaeological evidence is thus in accord with another important aspect of the Andean model. However, it should be noted that the critical comments on the term "ritual" apply to the term "sacred" as well.

7.4 Geoglyphs related to mountain worship

Reinhard and Rostworowski proposed that specific deities were venerated on geoglyphs, some of them related to mountains (Reinhard 1996; Rostworowski 1993). The results of the present study are not sufficient for an assessment of this proposition with any certainty since it is uncertain how mountain worship would become evident in the archaeological record. Probably the most obvious indicator would be orientation of geoglyphs towards mountain peaks (Reinhard 1996: 22 ff). A possible analogy hints in this direction because many line centers on the Nasca *pampa* are located on elevated terrain (Aveni 1990b: 49). As for the Palpa geoglyphs, on the narrow plateaus of Cresta de Sacramento and Cerro Carapo no line center as described by Aveni was recorded[67].

A possible orientation of lines from the Palpa geoglyph sample towards higher mountains has yet to be investigated. Observations during fieldwork suggest that some geoglyphs (among them trapezoids, straight lines, and sections of meandering lines) were directed towards Cerro Pinchango, but this could not be checked systematically by GIS since Cerro Pinchango and other prominent mountains visible from Cresta de Sacramento and Cerro Carapo were situated beyond the borders of the DTM available for the present study. Any potential relation would furthermore have to be statistically proven to be relevant.

7.5 Geoglyphs related to water and fertility

The deities mentioned by Reinhard and Rostworowski were associated with concepts of fertility. This aspect of the Andean model can better be judged on the basis of the Palpa data. Biomorphic geoglyphs depicting water related animals and plants (Reinhard 1996: figs. 46–63) are less common in Palpa than on the Nasca *pampa*. However, objects placed on stone platforms (fig. 40), the most prominent of them being *Spondylus* shells, strongly indicate that the concept of fertility played an important role in geoglyph related activity.

The presence of *Spondylus* shells along the Pacific coast is caused by warm ocean currents. During El Niño years, these currents shift, and *Spondylus* shells are found in coastal regions

[67] However, lines on slopes, some of them emanating from a common platform on the plateau edge, others branching of from a central line (fig. 21, maps 1, 4), come structurally close to line centers and may be expressions of the same concept under different topographical conditions.

where they do not occur in normal years (Marcos 1986, 2002). At the same time, rain is brought to regions where it usually does not rain. Apparently, the association of *Spondylus* shells and rain was well known throughout the regions affected by El Niño, so that the shell became a symbol of water and rain. Other objects found on stone structures carry with it a similar connotation. Crawfishes are only available when the rivers carry water, while field crops depend on the irrigation of arable land. Thus, a concern with the availability of water in the valleys and the fertility of the irrigated land is clearly reflected in objects placed on stone structures.

Apart from this rather indirect association of geoglyphs with water and fertility, a more direct relationship has been proposed by Aveni, with trapezoids being oriented parallel to river courses and lines perpendicular to them (Aveni 1990b). Although many Palpa geoglyphs indeed match this pattern, it seems coincidental. Wherever there are two or more large trapezoids in a geoglyph complex, at least one of them is not oriented alongside the river. The main criteria for defining the place and orientation of large trapezoids seems to have been the topography of the available terrain. Lines, on the other hand, are necessarily roughly perpendicular to the river course if placed on the neighboring hillside. On plateaus, however, lines point in many other directions as well, and no pattern is discernable (fig. 45).

Although not considered part of the Andean model for the purpose of this study (fig. 5), a comment seems worthwhile about Johnson's hypothesis that directly links geoglyphs to water. The Palpa geoglyphs most likely do not map subterranean water sources in the way proposed by Johnson. This assertion could not be tested against hydrological data, yet Johnson's "geoglyph code" simply does not work in Palpa. Elements of his proposed code include triangles ("pointers"), trapezoids, zigzag lines, and stone circles (Johnson 1999: 160). In Palpa, only two true triangles were found. Small trapezoids, though similar in shape, have an open narrow end and therefore do not point anywhere in the way proposed by Johnson. Johnson further proposed that zigzag lines indicate absence of water, while trapezoids map major water flows. It has been shown that both types of geoglyphs in Palpa usually occur together with the trapezoid superimposed on the line. Thus, both markers would contradict each other. Finally, the stone circles and rows mentioned by Johnson are present in Palpa, but they are of modern origin. The circles are not visible on old SAN aerial images. One stone out of a row of stones on Cresta de Sacramento was placed on car tracks. Beneath a stone of another circle in San Ignacio we found an electric cable. Thus, although the origin and function of the stone circles is unknown, they are clearly not related to prehispanic geoglyphs, and thus were not mapped by the Nasca-Palpa Project.

All in all, the Palpa geoglyphs seem indeed to be related to water, but not necessarily in terms of their placement on the landscape. Rather, objects evoking concepts of water and fertility were placed along geoglyphs. Thus, this important aspect of the Andean model finds corroboration in the Palpa data.

7.6 Geoglyphs used as roads

Based on structural similarities between geoglyphs and Inca roads (Hyslop 1984), it has been suggested that some straight geoglyphs on the Nasca *pampa* were used as roads or paths for the traffic of people and goods[68]. A review of available evidence for walking over the geoglyphs on Cresta de Sacramento, Cerro Carapo, and around La Muña indicates that in the Palpa region this activity was not related to traffic. Here, the geoglyphs did not form pathways leading from one settlement zone to another. Many of them were placed in terrain not suitable for walking. Although people traveling through the area might have used some stretches of geoglyphs as paths on occasion, this was clearly not their primary purpose. Rather, there seems to have existed a separate set of roads and paths for inter- and intra-valley traffic, although evidence is sparse due to long lasting reuse.

In the area around Palpa, some paths of prehispanic origin that are not used any longer have been found during fieldwork in several locations. They usually lead up from the valley margins to prehispanic sites on plateaus like geoglyph sites or settlements from the Late Intermediate Period. Prehispanic potsherds, in most cases covering different epochs, are scattered along their course. Unlike modern trails through the desert that are formed simply by traveling frequently over them, most of these paths tend to be wider and seem to be the result of an actual construction process. These ancient pathways have been studied in the framework

[68] Clarkson 1990; Silverman 1990a; Urton 1990.

of the regional settlement survey and will be reported on elsewhere. Inter-valley traffic routes, on the other hand, did not necessarily pass through the desert. As old maps (Mejía 2002: 209) show, the main road between Palpa and Ingenio ran alongside the rivers before the Panamerican highway was built.

The absence of evidence for a use of geoglyphs as roads includes pilgrimage routes that lead toward a ceremonial center. Silverman suggests such special kinds of travel for the Nasca *pampa* (Silverman 1990a, 1994a), and hypothesizes that the group of people shown in a famous clay model in the Museo Nacional de Antropología, Arqueología e Historia, Lima (Silverman/Proulx 2002: xx), may have been pilgrims. The Palpa geoglyphs did not serve as traffic roads, and no musical instruments like the panpipes played by the people shown in the clay model were found on them. But, this does not mean that Silverman is wrong. The topographic setting between Río Ingenio and Río Nasca suggests that the easiest way to travel between both valleys was by crossing the Nasca *pampa*. Thus, traffic across the *pampa*, be it as part of a pilgrimage or for other purposes, must have existed, and it is assumed that there was a network of paths or roads serving this purpose that may have been similar to geoglyphs. Even though a distinction between both features seems difficult on the basis of available data, a thorough documentation of the *pampa* geoglyphs may still shed light on this problem.

To sum up, the Palpa geoglyphs were not used as roads or paths through the desert. However, considering the different topography, it is plausible to assume that traffic routes (possibly used by pilgrims and others) ran through the Nasca *pampa*. This aspect of the Andean model is clearly tailored to explain the situation on the Nasca *pampa* and can be better assessed only if new field data becomes available from that area.

7.7 Summary: The Andean model and the Palpa geoglyphs

The above review shows that archaeological data from the Palpa region is generally in accord with central assumptions of the Andean model, even though it corroborates only some of them. This was to be expected, however, since not all of its aspects can be assessed by archaeological means. The purpose of an explanatory model is just to explain intangible factors missing from the archaeological record. Generally, the Andean model fulfills the purpose of explaining the Palpa geoglyphs in a wider historical and cultural context quite well. Building on Andean traditions documented by other means, for other time periods, and in other areas, a conceptual framework is established in which the archaeological evidence from Palpa can be explained in terms of function and meaning.

In spite of the Andean model´s general applicability to the Palpa data, there are also gaps and incongruities caused by the fact that the model was developed specifically for the *pampa* geoglyphs as opposed to the valley geoglyphs. As mentioned above, the existence of line centers and roads on the Nasca *pampa* is due to the specific topographical setting there with its exceptional vast plain that has no counterpart on the rather narrow ridges of Cresta de Sacramento and Cerro Carapo in the Palpa region. On the other hand, there are peculiarities in the Palpa archaeological record such as the many anthropomorphic figures that are so far largely unknown on the Nasca *pampa*. The Andean model does not cover these early manifestations of the geoglyph complex. In the framework of SLSA's Paracas Project, the Palpa figures are currently being investigated by Markus Reindel and Johny Isla in more detail than the present study.

Finally, the following is a more general assessment of the way the Andean model was developed and described by some of its main protagonists. Important terms used in the Andean model are in Quechua (like *huaca, ceque, ayllu*) and have been borrowed from historical sources that describe Inca concepts. Though some of these terms have been used in the present study as well, their use in Nasca archaeology seems generally questionable as they imply, whether intended or not, a very close relationship between societies separated from each other by several centuries, different environmental conditions, and major historical disruptions. It has rightly been cautioned that

> "[...] we run a risk of finding only Inka-analogous designs if we project Tawantinsuyu [...] too vigorously into Andean antiquity." (D'Altroy/Schreiber 2004: 255)

A possible solution would be to stay with non-Quechua terms when referring to certain concepts. Even though the concepts originate in an Inca context, it should be possible to describe them using more neutral terms. Such a procedure may prove more cumbersome, but it might facilitate alternative views on the geoglyph phenomenon.

The Andean model is useful for the explanation of most of the geoglyphs that we currently know in terms of function and significance. However, it is still an explanatory model that has to be questioned and tested once new data becomes available. The investigations conducted by the Nasca-Palpa Project offered the first chance to test hypotheses elaborated after the last major wave of geoglyph research in the 1980s and afterwards. Future geoglyph research in other regions, *e. g.* along the southern tributaries of Río Grande, is likely to reveal additional aspects of the geoglyph phenomenon that are not yet known and cannot be explained by currently available hypotheses. Clearly, further work is needed. The more evidence that becomes available the better the Andean model can be assessed.

8. Results and conclusions

Summarizing the main topics treated in the previous sections, the present study has allowed us

- to accurately document and analyze a large body of hitherto neglected geoglyphs using up-to-date geomatic technologies in combination with archaeological fieldwork
- to clarify in detail which kinds of human activity related to the geoglyphs can be inferred from the archaeological record
- to assess the coherence and plausibility of the Andean model to explain the geoglyphs in their cultural and historic context.

In this concluding section some important results of the present study are highlighted that complement the discussion and interpretation in the preceding section. This refers to the cultural-historic development of the geoglyphs, and to our present perception of them. Furthermore, the methodology applied to study the geoglyphs, in many regards a new contribution to Nasca archaeology, is critically reviewed in order to identify starting points for future research both within the Nasca-Palpa Project as well as in follow-up projects.

8.1 The Palpa geoglyphs in the prehistory of the Nasca basin

The Andean model as described in section 3.2 provides a solid framework for an understanding and explanation of the geoglyphs. According to this model, the Palpa geoglyphs were an important aspect of society and culture from the late Early Horizon to the early Middle Horizon. A marked landscape imbued with cultural meaning was created throughout this time period. The landscape markings integrated vast stretches of the desert into the cultural domain of the valley-based society, and opened up stages for activity involving large parts of the population. Social groups acted and interacted on geoglyph sites, thereby defining, demonstrating, or claiming their status within a wider social context. The near constant presence of people along with construction and other activity meant that the geoglyph landscape was very vibrant and dynamic. Construction and use of geoglyphs was highly interwoven and significant in itself. Activity on geoglyphs, which may be termed ritual, was concerned with water availability and fertility in the valleys. The scale and stability of the geoglyph phenomenon through time indicates that they were important manifestations of world view and basic cultural concepts. Change through time is observable, but it was gradual in character and showed no major disruptions unlike the settlement pattern in the valleys. While the first geoglyphs were mainly made for viewing them, activity upon geoglyphs became more important through time and reached its peak during the Early Nasca period. Later, it became less frequent and varied, until during the early Middle Horizon the last vessels were placed on trapezoid borders.

Throughout their use, and in spite of some variation, the geoglyphs were a relatively stable element in Nasca culture that proved more long-lived than political organization. Geoglyphs may therefore best be understood literally as common ground for people making, using, and perceiving them in spite of changing socioeconomic, political, or even climatic conditions. Nevertheless, some variation occurred, and a closer look at the origin, development, and end of the geoglyphs helps to give an understanding of their cultural significance through time.

The starting point of the Palpa geoglyph tradition is apparently to be found in the petroglyph tradition of the Paracas period. During the Early Horizon, petroglyphs were carved on rock faces as well as large boulders on hillsides. The best known site is Chichictara, 11 km upstream from Palpa, with more than 200 petroglyphs (Hostnig 2003: 169; Orefici/Drusini 2003: 26 ff). However, petroglyphs can be found in the lower parts of the valleys as well. Isolated large boulders on hillsides and plateaus were often carved with petroglyphs. Among the motifs are biomorphic depictions (anthropomorphic and zoomorphic figures) with clear parallels in embroidered Paracas textiles and, less common, geometric motifs (*e. g.* circles) similar to certain decorations on Ocucaje pottery. Clearly, during the Early Horizon petroglyphs were part of an iconographic repertoire applied to a variety of media.

A part of this repertoire, namely anthropomorphic figures, were at some point transferred from rocks on hillsides to a new medium – the surrounding desert surface. Just when this happened for the first time is as yet unknown because of a scarcity of associated finds that would allow cross-dating. A conservative estimate places the dating of this event around 400 B. C. during the late Early Horizon, although a much earlier date cannot be ruled out. Current investigations into Paracas and earlier (Initial Period) remains in the Palpa region directed by Markus Reindel and Johny Isla using the new high resolution OSL dating method are hoped to shed more light onto the beginning of the geoglyph phenomenon.

Whatever the exact date, the first geoglyphs remained very similar to petroglyphs with regard to their location, motif, and probable function. They were not suitable for walking, and the placement of ceramic vessels and other objects upon or near them was apparently not a part of their function. Rather, just like petroglyphs they were placed in locations such that they could be seen and perceived in their entirety from certain points in the terrain (not necessarily close-by). Contrary to later trapezoids there is no evidence that these early (mostly anthropomorphic) geoglyphs were ever left unfinished. Thus, their primary function was apparently to be seen, and to convey a message to their observers.

In spite of this initial continuity, the geoglyphs soon developed from an existing iconographic repertoire into an independent, versatile and powerful means of expressing cultural concepts. The possibilities offered by the new medium – large stretches of easily removable desert pavement – fostered this new development, although this was probably not the prime mover. New motifs and, even more important, different functions associated with the geoglyphs emerged and determined the geoglyph phenomenon throughout most of Nasca history.

Geometric geoglyphs like straight lines and small trapezoids were the first new motifs to be drawn on hillsides. The techniques necessary to draw these shapes on the surface, namely minimally carved lines and cleared areas, had already been employed earlier to render anthropomorphic figures. However, it was only when these new motifs were transferred to flat terrain – *i. e.* the plateaus above the valleys – that people began to walk upon them on a regular basis, and a new set of activities associated with geoglyphs developed. This included for the first time the construction of stone structures as well. It is this complex of interconnected geoglyph related activities (geoglyph construction and remodeling, walking on geoglyphs, placement of offerings, food consumption) that left clear traces in the archaeological record of the Nasca basin and which the Andean model is tailored to explain.

Initial Nasca and then most notably Early Nasca were the periods when the geoglyph phenomenon flourished and reached its apogee in terms of quantity and variety. This development coincided with a demographic peak at least in the Palpa region. It also coincided with the heyday of minor centers like Los Molinos (Reindel/Isla 2001) and, on a regional level, of Cahuachi (Silverman 1993a). By this time the geoglyphs had become an important symbol of what Silverman calls "Nascaness" (Silverman 2002b: 122), and large efforts went into their construction and use.

The emergence of activity taking place on geoglyphs included the placing of objects that mirror a concern with water and fertility such as ceramic vessels containing food, field crops, crawfishes, and *Spondylus* shells. These concepts remained an important aspect of geoglyph related activity throughout the remainder of the Palpa geoglyph history. Recent paleoclimatic studies in the Nasca-Palpa region (Eitel et al. 2005) indicate that during the Nasca period, and especially in the 5th to 7th centuries AD, the climate became drier over time, and the eastern margin of the desert shifted slowly up-valley. These changing environmental conditions clearly influenced, and probably motivated certain geoglyph related activities.

Nevertheless, this is not to say that everything that happened on geoglyph sites can be understood solely within the framework of a fertility cult. Such a monocausal explanation would certainly underrate the social dimension of the geoglyphs. Throughout most of their history, the geoglyphs seem to have provided a spatial framework for negotiating and symbolizing the status of certain social groups within a changing sociopolitical system. How this happened in detail, and how groups were defined cannot be assessed on the basis of evidence from the geoglyphs alone. In any case, geoglyphs were most probably no less important for social processes within Nasca and earlier societies than for responses of these societies to influences from outside like changing environmental conditions.

After its Early Nasca peak, Palpa geoglyph history entered into a slow and gradual decline. During Middle and Late Nasca times the variety of newly constructed geoglyphs was reduced little-by-little. Apparently, there was a need for standardization, and no new types were added to the existing repertoire. For the first time, certain geoglyph fields on Cresta de Sacramento and Cerro Carapo were abandoned, and new ones were not added. However, it has to be stressed that the principal characteristics of geoglyph construction, use, and social function remained intact until the Nasca/Wari transition. Important geoglyph sites from the Early Nasca period continued in use, new geoglyphs were still being added and existing ones altered and enlarged, and trapezoids were made even larger than previously. Unfortunately, geoglyph dating is so far not fine-grained enough to study this long process in detail. As for now, a constant but slow decline seems most likely.

There is no easy explanation for the end of the geoglyph phenomenon. It is still poorly understood what occurred when the social formation called today the Nasca culture came to an end. The Wari intrusion, whatever its nature, is archaeologically marked by changing settlement and burial patterns, a lower population density, and new ceramic styles (Silverman/Proulx 2002: chapter 11; Isla 2001b). It has been suggested that these changes were induced by an exchange of population (Schreiber 2001). Environmental change, specifically an increase in desertification, seems to have contributed as well to late Nasca societal stress (Eitel et al. 2005). In Palpa, there was a clear break in geoglyph related activity at some point at the beginning of the Middle Horizon, probably around the 7th or 8th century AD. Geoglyph use continued on a small scale into the Middle Horizon before it ceased altogether. Ceramic vessels (now in the new style) were still being placed on trapezoid borders at least during the early Middle Horizon. However, there is no indication that any new geoglyphs were still being constructed by that time, and Middle Horizon ceramics on geoglyphs are much fewer in number than earlier ceramics. Apparently, some parts of the population continued with the ancient traditions for a time but could not perpetuate them so they were lost. Settlements from the Late Intermediate Period were placed on geoglyph fields of the plateaus of Cresta de Sacramento and Cerro Carapo, thus using them for totally different purposes. That these settlements obliterated and destroyed the ancient geoglyphs is a clear sign that already in pre-Inca times the geoglyphs were no longer valued or understood.

8.2 Geoglyph perception and understanding

Geoglyph construction and use during more than 1,000 years has changed the landscape in the Nasca basin on a large scale and forever. Large stretches of the desert were converted into cultural space. Yet this enormous and impressive work bears in itself the reasons why it is often misunderstood.

In order to understand the meaning that the geoglyphs had during the Nasca period a change of perspective is required. Our current perception is shaped by an aerial perspective. Tourists as well as scholars usually see the geoglyphs from above, and photos taken from an airplane are the dominant means of illustration in the literature. This modern perspective, however, is misleading since it disguises important aspects of the geoglyph phenomenon:

- Aerial photographs show even very large geoglyphs (*e. g.* trapezoids on the Nasca *pampa*) in their entirety, allowing a complete overview of the geoglyphs and their context. Such a view was not possible in Nasca times. Most lines and trapezoids on flat terrain were only partially visible from a ground perspective. Though the limited repertoire of basic forms and distinguishing constructional features allowed recognition of the overall shape of a geoglyph even on the basis of certain elements (*e. g.* parallel heaped borders), the entire form was usually not visually perceivable.
- Furthermore, what we see today on the desert surface is the static final result of many centuries of geoglyph construction and use. The geoglyph conglomerate as visible today is not, however, the outcome of a master plan that aimed at the resulting picture from the beginning. Rather, it is the final stage of a long lasting construction process during which the whole complex of drawings was constantly added to, and its elements were remodeled, obliterated, or changed by use.
- Aerial photographs furthermore show empty geoglyphs in the desert far away from inhabited zones. In the Nasca period, in contrast, there was an almost constant activity going

on upon and around the geoglyphs as groups of people frequently moved over the geoglyphs, performing codified acts meaningful to them and others. People and activities were integral parts of the ancient geoglyph reality that have since disappeared. They were easily visible from other geoglyph sites or from the valley. In fact, people on geoglyphs, rather than geoglyphs themselves, may well have been the main focus of common perception at least during the Nasca period. Without this dynamic element the geoglyphs cannot be understood.

These concepts have to be kept in mind when trying to interpret the geoglyphs. Only a small part of the geoglyphs were meant mainly as symbols, or signs, to be viewed and understood from far away. These were primarily the early anthropomorphic geoglyphs on hillsides. They were visible from a certain distance and repeated motifs known from other media (textiles, ceramics). They did not show signs of human activity around them, and they remained largely unchanged once drawn.

In contrast, many later geoglyphs in large complexes on plateaus were not visible in their entirety, their shapes were not repeated on other media, and they were constantly remodeled and otherwise used and altered. These geoglyphs cannot be understood as mere visual signs. Geoglyphs by themselves were probably not able to symbolize or convey certain cultural concepts. This is true at least for the geoglyphs from the Nasca period. Rather, they only made sense as an integrated part of a dynamic complex involving people and activities. All of these elements were indispensable parts of the geoglyph phenomenon. Any serious study of the geoglyphs has to keep this perspective in mind.

8.3 Geoglyph documentation: Review of applied methods

The present study introduces several new approaches into Nasca archaeology. Modern aerial photogrammetry, 3D modeling, database and GIS technologies enabled for the first time the complete recording, visualization, and detailed analysis of a corpus of geoglyphs that had previously received little attention. The new dataset was used to test to what extent a recent model developed to interpret the geoglyphs was able to explain the archaeological evidence. New insights into the formal, temporal, and spatial variety of geoglyphs were gained. It is hoped that the documentation carried out in this project will be used in the future to facilitate the protection and long-term preservation of the Palpa geoglyphs.

In spite of or possibly due to the novel approach pursued by this study, the work was not without methodological problems.

The geoglyphs of San Ignacio and Llipata, including the most complex geoglyph site in the Palpa area and the largest known trapezoid, could not be considered in the present study since time constraints did not permit documentation of them at the same level of detail as the geoglyphs north of Palpa. Although the photogrammetric mapping of the area south of Palpa was completed (supplements 1, 2), and some sites in that area were fully or partially documented in the field, it soon became clear that the available time and manpower to cover the whole area had initially been underestimated. Nevertheless, data already obtained from that area by this project may serve as starting point for future research.

Geoglyph mapping based on vertical aerial images offered the opportunity to document all Palpa geoglyphs at a high level of detail and accuracy. However, this approach reached its limits when it came to figural geoglyphs on hillsides. Although most of them could be detected in the stereopairs, they were usually not clearly visible to be mapped accurately. Verification on the ground often did not help to solve the problem since additional details found in the field could in many cases not be reproduced with an analytical plotter. The best way to document figural geoglyphs on slopes is with oblique aerial photographs in combination with field survey. This is currently being carried out within the framework of SLSA's Paracas Project. Thus, new insights into this important subset of geoglyphs can be expected in the near future. This will certainly complement and reshape some of the ideas set forth in this study.

Concerning data recorded in the field, a major shortcoming of the present study is the lack of a systematic recording or sampling of surface finds. This was at least partially inevitable due to legal constraints, but also due to limitations of time and manpower. In any case, the lack of quantitative information about ceramics impeded the investigation of several potentially interesting problems. These include the ratio of fineware to plainware ceramics, the percentage of various vessel shapes, a comparison of find inventories from geoglyph and other sites, and how these parameters changed over time.

The functionality of the GIS could not be fully exploited in this study. This was due to the thesis completion deadline, and other features to which the geoglyphs may be related have not yet been studied in enough detail to be included in the present study. This refers to excavation and survey data from settlements and other sites in the Palpa region. The analysis of these datasets is underway, however, and it is hoped that they will be integrated into the GIS at a later date.

8.4 Summary and conclusions

This project has pursued a rigorous archaeological approach to investigate the so called "mysterious" Nasca lines. Techniques from other scientific disciplines were employed that helped to get a deeper understanding of these fascinating ancient monuments. This approach demonstrates that it is still possible to learn more about the geoglyphs in spite of all that has been written about them during the last few decades.

A great amount of credit should be given to the serious investigations by researchers cited in the present study that have led the way in recent years. A coherent explanatory model, though not as simple and straightforward as many a geoglyph *aficionado* would wish, is now available that provides a good starting point to understand the geoglyphs. A few methodological shortcomings notwithstanding, it is hoped that the results of this study will show that a serious investigation of the geoglyphs, laborious as it may seem, is worthwhile. There are still many geoglyphs in the Nasca region that have not received the scientific attention they deserve.

9. Appendix

In the appendix detailed descriptions of specific archaeological contexts (stratigraphy, excavations) in the Palpa area are provided from which some results in section 6 are derived.

9.1 Development of complex geoglyph sites

For some rather complex sites (> 20 geoglyphs) on Cresta de Sacramento and Cerro Carapo stratigraphic sequences could be reconstructed that allowed the study of site development in some detail. Two sites (PV67A-39 and -40) on sloped terrain can only be described in summary here because they are not very well preserved. But, three sites on plateaus (PV67A-35 and PV67A-47 on Cresta de Sacramento and site PV67B-55 on Cerro Carapo) offered detailed stratigraphies that were visualized using the Harris matrix[69]. Stratigraphic relationships of geoglyphs on other sites are reported in the database on the DVD.

9.1.1 Geoglyph sites on sloped terrain

Geoglyph sites on hillsides generally lack the complexity of sites on plateaus, since geoglyphs are usually placed further apart from each other. On the other hand, they are more difficult to date both in terms of relative and absolute chronology. Wherever geoglyphs on slopes cross other geoglyphs, erosion has usually long since washed away any clear signs of a stratigraphic sequence. Datable ceramics are associated with geoglyphs on slopes in lower numbers and less unambiguously than with geoglyphs on plateaus. On the most complex and most interesting site featuring the famous *reloj solar* or sun dial geoglyph (240), site PV67A-39, all stratigraphic evidence was destroyed when the geoglyphs were cleaned and reconstructed in the 1980s by a local schoolteacher (fig. 46). However, the placement of different geoglyph types on slopes indicates site development over time. Two neighboring sites on the southern flank of Cresta de Sacramento can serve as an example.

Sites PV67A-39 and -40 (Cresta de Sacramento)

On these two neighboring sites (map 1), anthropomorphic figures are usually placed on the steepest part of the slope, although at different levels. Sometimes, two figures are placed close to each other. Wherever they occur together with lineal geoglyphs the latter cut the former (240/241, 236/229). Thus, anthropomorphic figures were the earliest geoglyphs on hillsides. Most other types of geoglyphs found on sloped terrain are from all time periods of the geoglyph complex and are therefore not datable on the basis of shape alone. Most probably they were made over a long period of time, from Initial Nasca to Late Nasca.

Groups of lineal geoglyphs on slopes have common points of origin on the edge of the plateau (226/242/248, 261/263), or they branch off from a main line running downhill (248/243/245/247, 263/264/268, 277/275). This indicates that new lines were adapted to existing ones, adding one line after another over a long period of time. Trapezoids on hillsides, considerably smaller than their plateau counterparts, were placed on the lower parts of slopes where the degree of terrain inclination is lower (219, 223, 254, 274, 286). Just like on plateaus, they were flanked by meandering lines (224, 253, 287) and spirals (252). The *reloj solar* or sun dial geoglyph (240) is a peculiar combination of both line types (fig. 46). Its construction date remains unknown, but evidence from other sites suggest that all spirals were constructed no later than in the Early Nasca period. Some of the lines on slopes seem to cut through trapezoids, but the evidence is not clear. The odd-shaped geoglyph 226, which seems to cut a series of lines and a trapezoid, was probably left unfinished. Its uncommon shape is in any case not due to the

[69] Each Harris matrix was generated using ArchED 1.4.1 which is available for free download at: www.ads.tuwien.ac.at/ArchEd/ (accessed August 18, 2004).

Fig. 46. View over geoglyphs on site PV67A-39 from the upper plateau of Cresta de Sacramento (cp. map 1).

modern reconstruction of geoglyphs mentioned above, since it is already visible in that shape in a 1944 SAN aerial photograph.

9.1.2 Geoglyph sites on plateaus

Site PV67A-35 (Cresta de Sacramento)

This site occupies the southwestern-most part of the main plateau of Cresta de Sacramento. It is composed of three major trapezoids, a series of lines, and the figure of a whale or shark (map 3). The central part of the site is crossed by a road leading from Río Grande to Palpa, and a radio transmitter has been built on the northeastern side of the road on the main plateau. Both modern features have destroyed parts of several geoglyphs. Furthermore, cars have left their tracks on many parts of the site, and modern trash has been dumped in several places. All in all, however, the geoglyphs are well enough preserved to study their stratigraphy in detail (fig. 47).

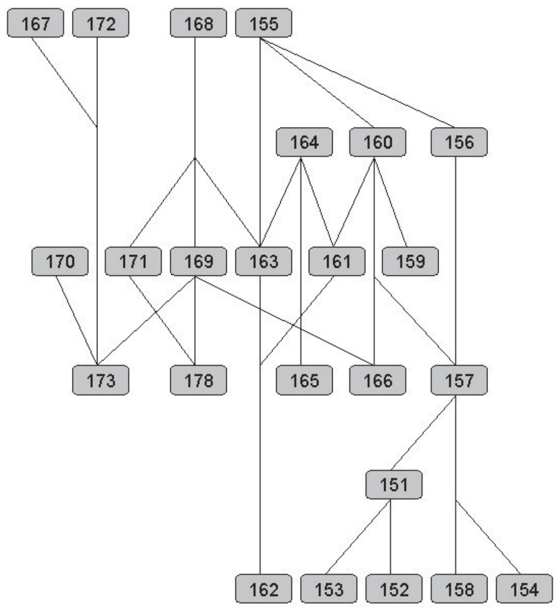


Fig. 47. Geoglyph stratigraphy on site PV67A-35 (cp. map 3).

The first geoglyphs to be constructed on the plateau were several narrow straight lines (152–154, 158, 162, 178), none of them very long, and some of them parallel to each other. Since no datable ceramics were found on either of them, it is unclear when this first activity occurred, but certainly no later than Nasca 2 when the first datable geoglyphs were constructed that partially covered the previously mentioned lines. The whale or shark figure (151) as well as the largest trapezoid dominating the site (161) were constructed next (fig. 48). Both had ceramics dating to Nasca 2, 3, and 5 on them that indicated a long period of use. This is confirmed by evi-

Fig. 48. Aerial view of western portion of geoglyph site PV67A-35 (cp. map. 3).

dence that both geoglyphs were remodeled at least once. Thus, Nasca 2 marked the beginning of large-scale geoglyph related activity on the site. In the northeastern part of the site, the second major trapezoid (169) was also constructed during that time, partly covering an already existing zigzag line (173). Though no ceramic evidence is available, several lineal geoglyphs must have been constructed in Early Nasca times as well which is indicated by their stratigraphic position. This includes lines flanking the major trapezoids (159, 163, 171) and possibly the star-like geoglyph 164 (in fact composed of six U-shaped lines).

These geoglyphs may have been constructed as well during the second major activity phase on the site which is marked by ceramics dating to Nasca 5. During this time, meandering lines flanking the major trapezoids were constructed (157, 170) and later partially covered by a series of areal geoglyphs, some of which were designed so as to connect existing cleared areas (167, 168) while others occupied hitherto unused parts of the plateau (156). Furthermore, the largest trapezoid (161) was converted into a rectangle (160) (though this remodeling was never finished) as was the close-by geoglyph 168 that dates from the same time. Some straight lines cutting earlier geoglyphs (156, 172) complete the group of geoglyphs dating to Nasca 5. By the end of that phase, geoglyph construction seems to have ceased, although other activities continued.

For epochs later than Middle Nasca the evidence is solely from datable fineware ceramics. These sherds are clustered around trapezoid 156 on the northern part of the western portion of the site. While the meandering line 157 had Late Nasca ceramics associated with it, ceramics from the Middle Horizon and the Late Intermediate Period were found on the trapezoid. However, there is no evidence of new geoglyphs being constructed later than Nasca 5.

Site PV67A-47 (Cresta de Sacramento)

This site occupies the central part of the main plateau of Cresta de Sacramento just above the famous *reloj solar* or sun dial geoglyphs on the southern slope of the ridge (map 5, fig. 49). Though situated far from drivable roads, the site is equally marked by recent car tracks. Its proximity to the tourist viewpoint that overlooks the *reloj solar* site has furthermore led to people walking over the main geoglyphs. The eastern end of the geoglyph complex was de-

Fig. 49. Aerial view of site PV67A-47 on Cresta de Sacramento (cp. map. 5).

stroyed in prehispanic times by a site from the Late Intermediate Period. But, the preserved evidence is suitable for a detailed study of the development of the geoglyph complex based on stratigraphic relationships and associated datable ceramics (fig. 50).

Site PV67A-47 is linked to site PV67A-35 by a long zigzag line (183) that crosses the open space between both sites and uses its full width. As evidenced by Nasca 2 ceramics associated with this zigzag line, it was one of the earliest geoglyphs to be constructed on the site and dominated it in the beginning. Just like site PV67A-35, several rather isolated straight lines (184, with Initial Nasca ceramics, and 205) were also among the earliest geoglyphs on site PV67A-47. The zigzag line 183 was accompanied by a second line of the same shape (203). Both were covered by a large trapezoid (189) on which the earliest ceramics date to Nasca 2. Two spirals (206, 208) on the northern edge of the site were constructed at about the same time as were several lineal geoglyphs (190, 193, 202) that flank the main trapezoid. The S-shaped spiral (206) was remodeled during Nasca 3 (207), when an areal geoglyph linking the main trapezoid with a viewpoint overlooking the valley

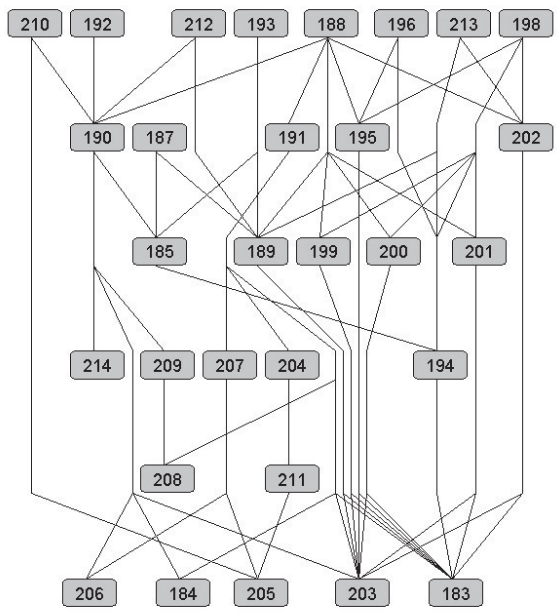


Fig. 50. Geoglyph stratigraphy on site PV67A-47 (cp. map. 5).

(196) was constructed, too. All in all, construction activity was substantial and varied during the Early Nasca period.

By the Middle Nasca period, Nasca 4 and 5 ceramics indicate that several lineal geoglyphs were added to the complex on the southern side of the main trapezoid (195, 199–201) and on its western end (187). The spirals on its northern side were partially cut or covered by several lines (191, 210) as well as by one of the smallest trapezoids documented in the Palpa region (209). The narrow eastern end of the central trapezoid (189) was converted into a large rectangle and continued in use.

In the Late Nasca period, the largest trapezoid found on Cresta de Sacramento (188) was built in such a way that it cut through most existing lines and also the central trapezoid in an oblique direction. Nasca 7 sherds were found on this geoglyph. Its orientation allowed optimal use of the remaining free space on either side of the central complex of geoglyphs. Near its narrow end, the trapezoid partially covered an unfinished areal geoglyph with Nasca 6 sherds on it. Some Nasca 7 and Loro sherds were found on areal geoglyphs close to the eastern end of the site. The presence of sherds from the Late Intermediate Period also found on that part of the site is most probably due to the construction of buildings during that period which obliterated some geoglyphs. All in all, the latest evidence of activity on site PV67A-47 dates to the Nasca 7/Loro transition. Contrary to site PV67A-35, this activity still included the construction of large geoglyphs.

Site PV67B-55 (Cerro Carapo)

This site occupies the westernmost foothills of the ridge between Río Palpa and Río Viscas (map 13, fig. 7). This is the only plateau on the Carapo ridge comparable to the larger plateaus on Cresta de Sacramento and Pampa de San Ignacio. Though closer to Río Viscas, the site is only accessible from Río Palpa via a slope also covered by geoglyphs, whereas a sharp escarpment separates it from the Viscas valley. Towering on small hills above this escarpment, a site from the Late Intermediate Period dominates the plateau. Structures built during that time, among them walled enclosures, graves, and a ditch, have damaged the site´s central trapezoid. Other than that, the geoglyphs are well preserved since no modern path or road crosses the site.

Just as on the Sacramento sites, the first geoglyphs constructed on Cerro Carapo were several narrow straight lines distributed over different parts of the site (595, 599, 603, 612, 613, 615, 620, 624 and probably others more,

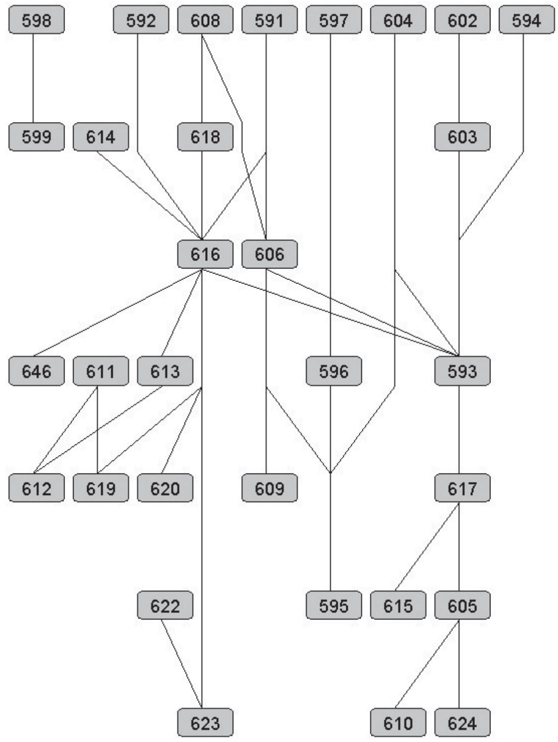


Fig. 51. Geoglyph stratigraphy on site PV67B-55 (cp. map. 13).

see fig. 51). Associated ceramics date the earliest of these lines to Nasca 2. Early Nasca furthermore saw the construction of an angular spiral (596) and a large meandering line (593). Probably at about the same time, the first large trapezoid of the site (605) was started but never finished. Though associated ceramics suggest a later date, the stratigraphic position of two large zigzag lines crossing the plateau shows that they also were constructed during the Early Nasca period, cutting several earlier geoglyphs. Thus, a wide array of geoglyphs dates to that period. On many of these, Nasca 5 ceramics indicate a continued use during Middle Nasca times when new geoglyphs were added to the complex. Among them were several amorphous geoglyphs (592, 597, 598, 602), and probably some of the lineal geoglyphs that lack datable finds. Most important of all, the large trapezoid 591 that dominates the southern half of the site was constructed during the Middle Nasca period, probably covering a series of earlier geoglyphs and thus changing the layout of the site. By then, a good part of the available space of the plateau had been covered by geoglyphs.

The dates of other trapezoids (590, 600) on the site are unknown. There is no evidence of Late Nasca activity. Late Intermediate Period sherds scattered on the surface are clearly associated with the stone structures of the site from that period which is situated south of the geoglyphs.

9.2 Excavation of stone structures on geoglyph sites

Several well preserved stone structures associated with geoglyphs were fully or partially excavated on Cresta de Sacramento and Cerro Carapo in order to determine their construction technique, age, function, and relationship with the geoglyphs. Two types of stone structures could be distinguished: elongated platforms on the edge of plateaus, and rectangular platforms on trapezoids.

9.2.1 Elongated platforms on the edge of plateaus

Site PV67A-47 (Cresta de Sacramento)

On the southern margin of the vast plateau on which site PV67A-47 is located (fig. 49, maps 1, 5), a low stone platform is situated on the edge of the flat terrain and overlooks the Palpa valley (Horkheimer 1947: figs. 21, 22; Reindel et al. 1999: fig. 16). Unlike the main part of the plateau, the surface is not covered by a continuous stone pavement around the platform[70]. To the north, a roughly rectangular cleared area (geoglyph 196) crossing a shallow *quebrada* connects the platform with the central trapezoid of the site (189) crosscutting several lines (183, 194, 195). To the south, the platform marks the starting or ending point of a straight line (256) running down or up the slope, ending or starting at a not clearly defined point at the foot of the slope.

The stone structure (figs. 52, 53) is oriented from southwest to northeast, thus following the general orientation of Cresta de Sacramento. It has an elongated, roughly rectangular shape, and is composed of six adjoining chambers of roughly equal size organized in a somewhat irregular row with one lateral chamber abutting the middle chambers on the southeastern side. The structure is approximately 11 m long and 1.00 – 1.20 m wide. The chambers are outlined by a single row of unworked boulders or slabs standing upright in the subsoil. There is no evidence of mortar or additional stone layers. The chambers are filled to an average height of 0.20 m with gravel composed of stones of different sizes, probably the same material that forms the desert pavement. No debris is visible around or upon the platform. Although some stones of the retaining wall are missing or seem to be out of their place, the overall state of preservation of the stone structure is good.

Two chambers were excavated in 1997: the northeastern and the lateral one. The results of the excavations were the same for both pits. The main part of the fill consisted of gravel as described above. Below it was a thin layer of beige soil, apparently the material excavated to place the stones of the retaining wall. Below this second layer of the construction fill, the natural desert surface appeared. Apart from one Nasca 3 sherd, the construction fill contained no other cultural remains. Contrary to Horkheimer's speculation (Horkheimer 1947: figs. 21, 22), there was no evidence that the structure may have contained a tomb.

Site P67A-35 (Cresta de Sacramento)

A similar elongated stone structure was partially excavated on the neighboring site PV67A-35 (map 3). It is situated on the southwestern edge of the main plateau of Cresta de Sacramento, not far from the whale figure (geoglyph 151), and is oriented from northwest to southeast following the edge of the plateau (fig. 48). Together with two gravel heaps, this structure marks the somewhat irregular wide base of the central trapezoid of the site (161). The stone structure is constructed in a similar fashion as its counterpart on site PV67A-47, with a row of stones that retain gravel fill. It consists of five chambers in a row and two lateral chambers attached to the central section on both sides (fig. 54). Unlike the structure on PV67A-47, however, the chambers vary greatly in size. The lateral chambers are the smallest, and the two easternmost chambers slightly bend towards the north. The overall length of the structure is 12 m, and its average width is 1 m. The structure is generally well preserved.

A small pit was excavated in 1997 in the central part of the stone structure. It cut through two lateral chambers and part of the chamber

[70] Similar areas without dense stone cover have been repeatedly noticed on the *pampas* around Palpa, always along the margins of plateaus. They seem to lack a stone cover due to natural reasons, whereas an anthropogenic origin can be ruled out since the transition to the dense stone cover is gradual and without clear limits. It is not clear whether the term *campo barrido* as used by Silverman and Browne to describe cleared areas without well defined boundaries refers to such areas (Silverman 1990b: 444; Silverman/Browne 1991: 211f).

Fig. 52. Stone platform at the end of geoglyph 196 on site PV67A-47 (cp. map. 1).

Fig. 53. Partially excavated stone platform on site PV67A-47 (cp. fig. 38).

in between them (fig. 55). The excavation results were exactly the same as described for the structure at PV67A-47, except that no ceramics were found in the construction fill.

Summary

Low, elongated platform or bench-like stone structures similar to those excavated on sites PV67A-47 and PV67A-47 are a common feature on geoglyph sites in the Palpa region. They generally occur in two contexts: at the wide end of large trapezoids or on the edge of plateaus where one or several straight lines run up or down the hillside. Often, albeit not always, both conditions coincide.

The structures were constructed in a simple manner using only materials available on the spot. The presence of individual chambers suggests that the platforms were constructed in several steps, though no clear building stratigraphy is usually evident. In some cases the central section of the structure is distinguished

Fig. 54. Stone platform at the end of geoglyph 161 on site PV67A-35 (cp. map. 3).

Fig. 55. Partially excavated stone platform on site PV67A-35 (cp. fig. 48).

by lateral chambers or by the incorporation of large boulders (*e. g.* on site PV67A-22). Stones used to construct the structure were probably gathered when a new geoglyph was constructed. It is clear, however, that only a small number of the removed stones ended up in the platforms, while the majority were used to form the heaped borders of the new geoglyph. The platforms do not have any surface finish. It is not clear whether the platforms were stood upon. There is furthermore no direct evidence that objects were placed on them, although broken vessels seem to occur in higher frequency around those platforms.

What draws the most attention is the position of the structures in the landscape. They are usually found on edges of high plateaus marking the upper end of one or several straight lines on the slope. Both the valley and the geoglyph sites can often be viewed from these vantage points. Often, lines on slopes and trapezoids on plateaus meet at such a structure or they are

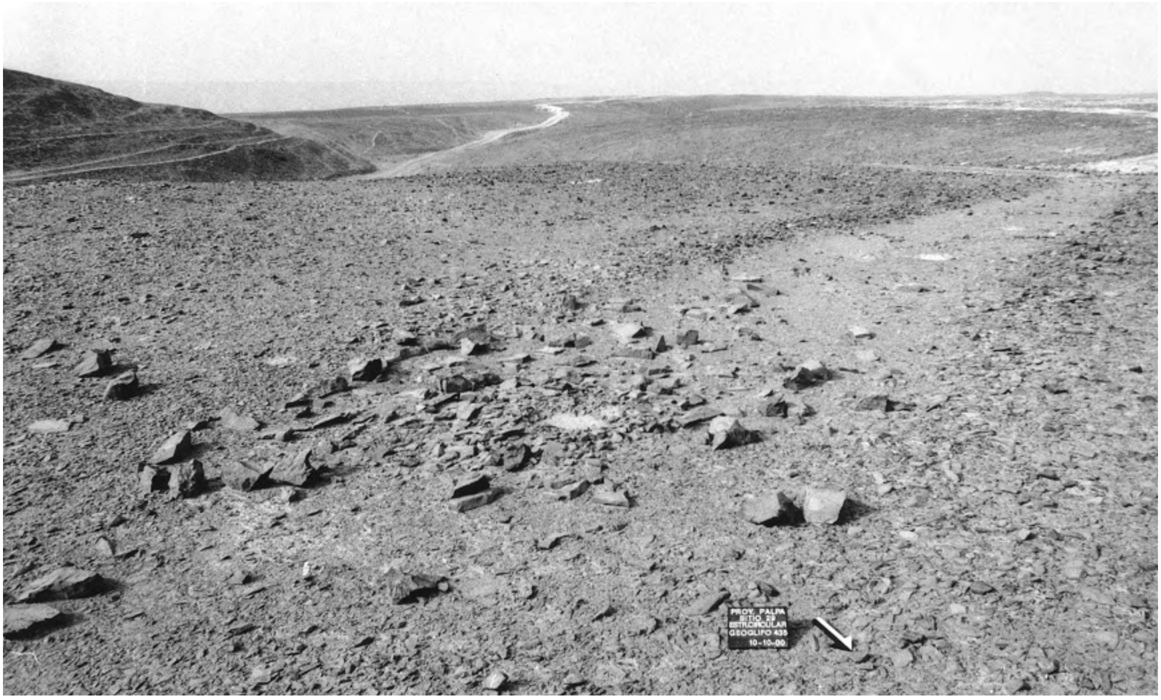


Fig. 56. Geoglyph 395 with stone structure on site PV67A-90 (cp. map 11).

Fig. 57. Stone structure on geoglyph 395 on site PV67A-90 with broken pottery.

connected by some kind of bridging geoglyph like the one on PV67A-47. Thus, the platforms together with the lines on the hill indicate where the trapezoids on the plateaus are located. Without the platforms they cannot be located visually from the valley floor.

9.2.2 Rectangular platforms on trapezoids

Site PV67A-90 (Cresta de Sacramento)

PV67A-90 is one of the biggest geoglyph sites on Cresta de Sacramento. It is situated on the eastern end of the main plateau close to the foothills of Cerro Pinchango (map 11). The main part of the badly preserved site is composed of an impressive series of lineal geoglyphs, but there are also some small trapezoids and rectangles, and a possible bird figure (geoglyph 389, now largely destroyed).

On the northeastern end of the site, one of the smallest trapezoids in the Palpa area is somewhat separated from the main geoglyph complex close to a shallow *quebrada*. This trapezoid (geoglyph 395) is only about 21 m long and up to 3.20 m wide (fig. 56). It is defined by two heaped borders framing a cleared interior. Between the stones of one of the borders, sherds of an Ocucaje 8 ceramic vessel were recovered. Close to the northeastern end (the wider one), a small stone cairn approximately 1.40 m in diameter is located in the cleared interior of the geoglyph. It has a sand-filled hole in its center, probably due to looting, which would also explain the presence of larger stones dispersed around the cairn. Sherds of a Nasca 7 painted vase were found on and between the small stones of which the cairn was built (fig. 57).

This was confirmed by the excavation in 2001 of a small trench dug through the center of the cairn down to the original desert surface. The whole cairn consisted of stones or small boulders piled up without any type of construction like a retaining wall. No worked stones were present, and no evidence of mortar was found. Between the stones, aeolian sand had accumulated over time. The cairn rested directly on the desert surface.

The whole trapezoid, and especially the small cairn, seems to mimic the well known larger geoglyphs of the same type. The chronological evidence is confusing. Two vessels were recovered that date to different times (Late Paracas and Late Nasca, respectively), and seem to indicate different construction dates for the geoglyph and the cairn. This would be in accordance with evidence from other trapezoids where stone buildings upon them seem to have been built long after the geoglyph itself. The Nasca 7 vase was intentionally broken when placed on the cairn.

Site PV67A-80 (Cresta de Sacramento)

Crossing the flat plateau on top the Sacramento ridge in a southwesterly direction from PV67A-90, the next big geoglyph site is PV67A-80 (map 8). The northeastern end of this site is heavily affected by a site from the Late Intermediate Period that partially covers several geoglyphs (fig. 58; cp. Clarkson 1990: fig. III.6).

PV67A-80 is dominated by a large trapezoid (geoglyph 333) about 535 m long, which is among the largest geoglyphs on Cresta de Sacramento. It is flanked by other areal geoglyphs, several lines, and a spiral. The northeastern narrow end of the trapezoid is somewhat irregular, possibly because it was left incomplete. It gets narrower where two stone structures were placed in a central position between its lateral borders. The situation is unclear because of disturbances by structures from the Late Intermediate Period and modern dirt roads. The partially looted stone structures, both approximately 3 m wide, 0.60 m high, and separated by 1.20 m, were excavated in 2001 (figs. 39, 60). They were found to be low rectangular platforms consisting of a retaining wall of a single row of large stones set without mortar on the leveled ground, and with a fill of gravel and some sand. The northern platform measured 1.45 m × 2.0 m, whereas the southern one was slightly larger (1.55 m × 2.40 m). No second row of stones and no surface finish was observed, although the platforms originally might have been higher judging from the amount of debris. On the debris, but not in the platform fill, two datable sherds were recovered (Nasca 5 and Nasca 7, respectively). No other finds or construction features were observed.

Sites PV67A-15 and -16 (Cresta de Sacramento)

The geoglyphs of site PV67A-15 and -16 are located on a flat natural terrace about half way between the bottom of the Palpa valley and the top of Cresta de Sacramento (map 9). Apart from a series of smaller geoglyphs, the site is dominated by a large trapezoid (geoglyph 52) approximately 390 m long. Its narrow end crosses obliquely the end of meandering line 55. Along with a connecting meandering line (56), this lineal geoglyph was converted into a huge cleared rectangle (57) after its initial construction. Another later alteration of the ensemble was the lateral enlargement of trapezoid 52 on its northwestern side. On this trapezoid, two stone structures were placed on the narrow end and a larger one was built on the central axis close to the wide base of the geoglyph. The former were excavated in 2000, the latter in 2001.

The two stone structures close to the narrow end of the trapezoid (fig. 59) are located in a place where several geoglyphs (52, 55/56, 57) converge, and which is disturbed by modern footpaths and the frequent presence of goat herds in the neighboring *quebrada*. It is therefore difficult to determine the relationship between stone structures and geoglyphs. The two structures are not placed on the central axis of

Fig. 58. Stone structures on geoglyph 333 on site PV67A-80 (cp. map 8). Note LIP buildings covering geoglyphs.

Fig. 59. Excavated stone structures on the narrow end of geoglyph 52 on site PV67A-16 (cp. map 9).

trapezoid 52, but shifted in a northwesterly direction, roughly in line with the border of the lateral enlargement of that trapezoid. It is therefore clear that the structures could not have been built on the original trapezoid. The stone structures are furthermore positioned such that part of meandering line 55 passes through them. But, since that line is almost completely obliterated by the later rectangle 57 on which the stone structures also rest, this relation remains ambig-

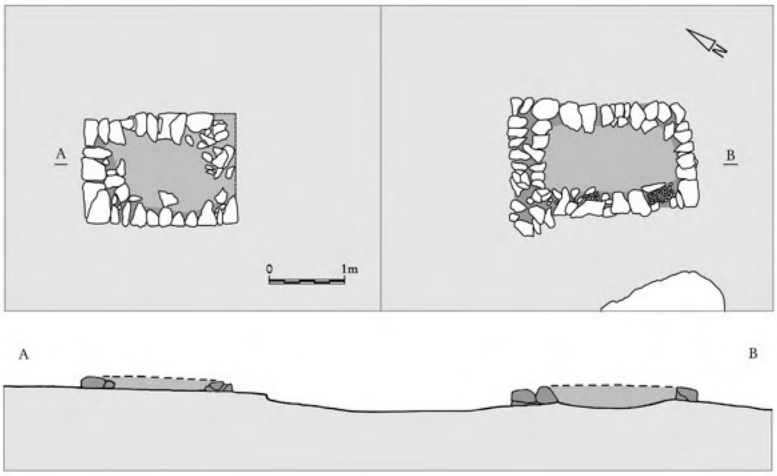


Fig. 60. Stone structures on geoglyph 333 on site PV67A-80 after excavation (cp. fig. 39).

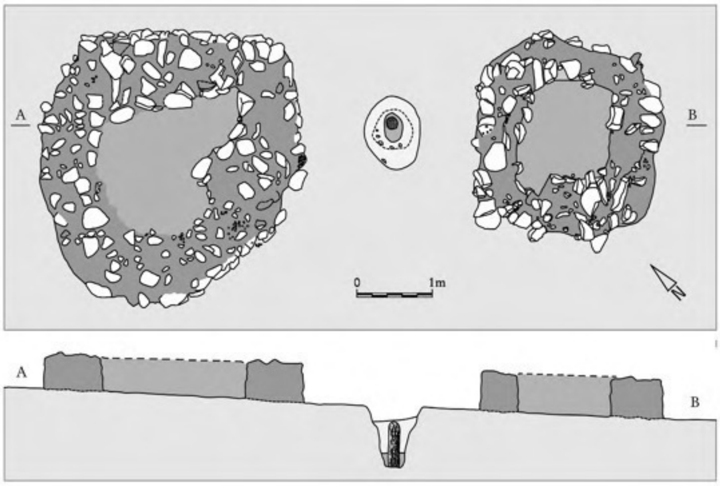


Fig. 61. Stone structures and wooden post on the northeastern end of geoglyph 52 on site PV67A-16 after excavation.

uous. In any case, the typical combination of two structures on the narrow end and one bigger structure on the wide base of a trapezoid indicates that the stone structures were built as part of trapezoid 52, but after other geoglyphs of the ensemble had been built.

The stone structures appeared to be simple stone heaps before excavation. They were both roughly 4.50 m in diameter and 1 m high, with holes in their centers indicating they had been looted. The excavation revealed two irregular, roughly rectangular, low structures with double-faced walls made of large unworked stones set with mud mortar on the natural ground (fig. 61). The southern structure had interior subdivisions of upright stones that retained the construction fill. In this first building phase, the interior of the structure had apparently been accessible. In its final phase, however, it was covered by gravel and sand that served as fill retained by the outer walls. In the debris that covered the preserved remains as well as in the construction fill, sherds

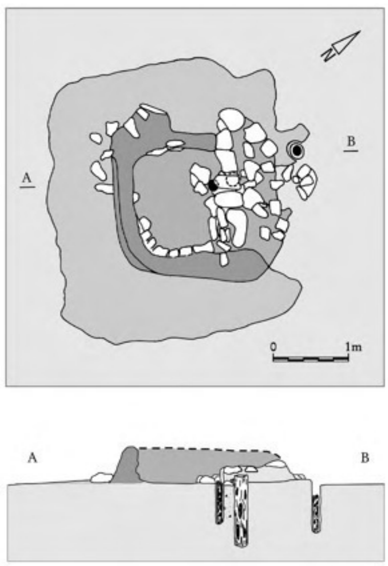


Fig. 62. Stone structure and wooden posts on the southwestern end of geoglyph 52 on site PV67A-15 after excavation (cp. map 9).

from Nasca ceramic vessels (Initial Nasca, Nasca 3 and 7), several fragments of *Spondylus* shells (one of them made into a pendant, fig. 40), and fragments of crawfish were found. Due to the looters' pits the original context could not be determined exactly, but some of the finds seem to have been placed as offerings, while others were part of the construction fill.

The northern structure was built in a similar way but it was a little smaller. The overall shape, construction technique, interior subdivision, and recovered materials closely resembled the southern platform, but a maize cob wrapped in textiles was also found in the fill.

Midway in between both platforms, the remains of a wooden post (*sauce*) were found in a hole in the ground. It had apparently been cut already in prehispanic times, and the hole filled with stones. As on the stone structures, found in the pit were sherds dating to Initial Nasca and Nasca 7.

Close to the wide base of the same trapezoid, and placed on its central axis, another partially looted stone structure was excavated in 2001 (fig. 62). It had a roughly oval form and measured 3.60 m × 4.50 m. The low height of only 0.60 m was mainly due to its having been torn down by looters which is why many large stones were scattered around the structure. The excavation revealed a badly preserved structure with two building phases corresponding to different uses.

In the first phase, a rectangular wall entirely formed of mud was set on the leveled ground, measuring about 2.20 m × 2.20 m, and with a height of 0.40 m. A compacted dirt floor inside the enclosure as well as around it indicated that the wall in the first phase enclosed an accessible room with an entrance on its northern side. However, due to later remodeling and the subsequent destruction of the structure, no traces were left of the alleged access. Four wooden posts, three of them arranged in a row leading out of the room in a northerly direction and a fourth one outside the structure, were part of the first building phase. Because of subsequent destructions it is not clear in which way the walls, the interior room and the posts were integrated into the original structure. All of the posts were poplar (*sauce*) logs, their diameter ranged from 0.07 m to 0.18 m, and their preserved height was from 0.20 m to 0.91 m. Furthermore, all of them were deeply embedded in the ground and affixed by a framework of stones that indicated that they once reached a considerable height above ground. In three of the post holes, well preserved guinea pigs were placed there as offering and could be recovered.

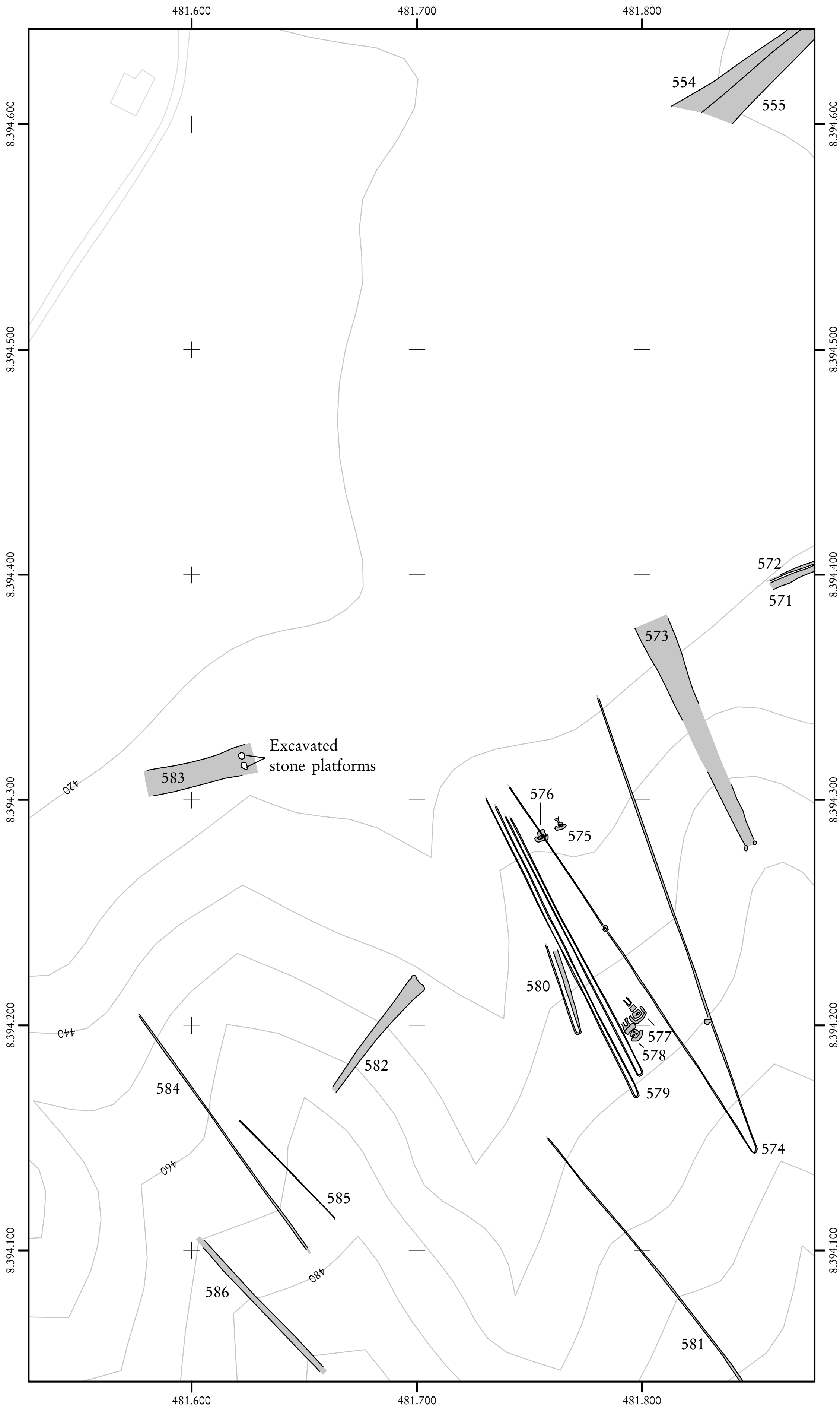
In a second building phase, the posts were cut and covered by adobe bricks, the interior room was filled with gravel, adobe bricks, straw, and mud, and the original walls were heightened using stones and mud mortar. Apparently, the fill was sealed with a mud layer, providing a plain surface. In the construction fill, fineware ceramic sherds dating to Initial Nasca and Nasca 7 were found. In the debris caused by the slow collapse of the structure further fineware sherds dating to Nasca 2, Nasca 3, Nasca 5, and Loro were recovered. Further finds included maize cobs, rodent bones, chrysocole fragments, and *Spondylus* shells. The disturbance caused by looting made it difficult to determine which layers the finds were related to, but in any case the recovered sherds indicated a long period of use of the structure. A radiocarbon sample of the single post outside the structure was dated to AD 603–644[71]. The date seems late since the post is associated with the first building phase before the structure was remodeled. Nevertheless, Nasca 7 and Loro sherds indicate that the structure was still in use during the transition from Late Nasca to the early Middle Horizon.

Site PV67A-62 (Cerro Carapo)

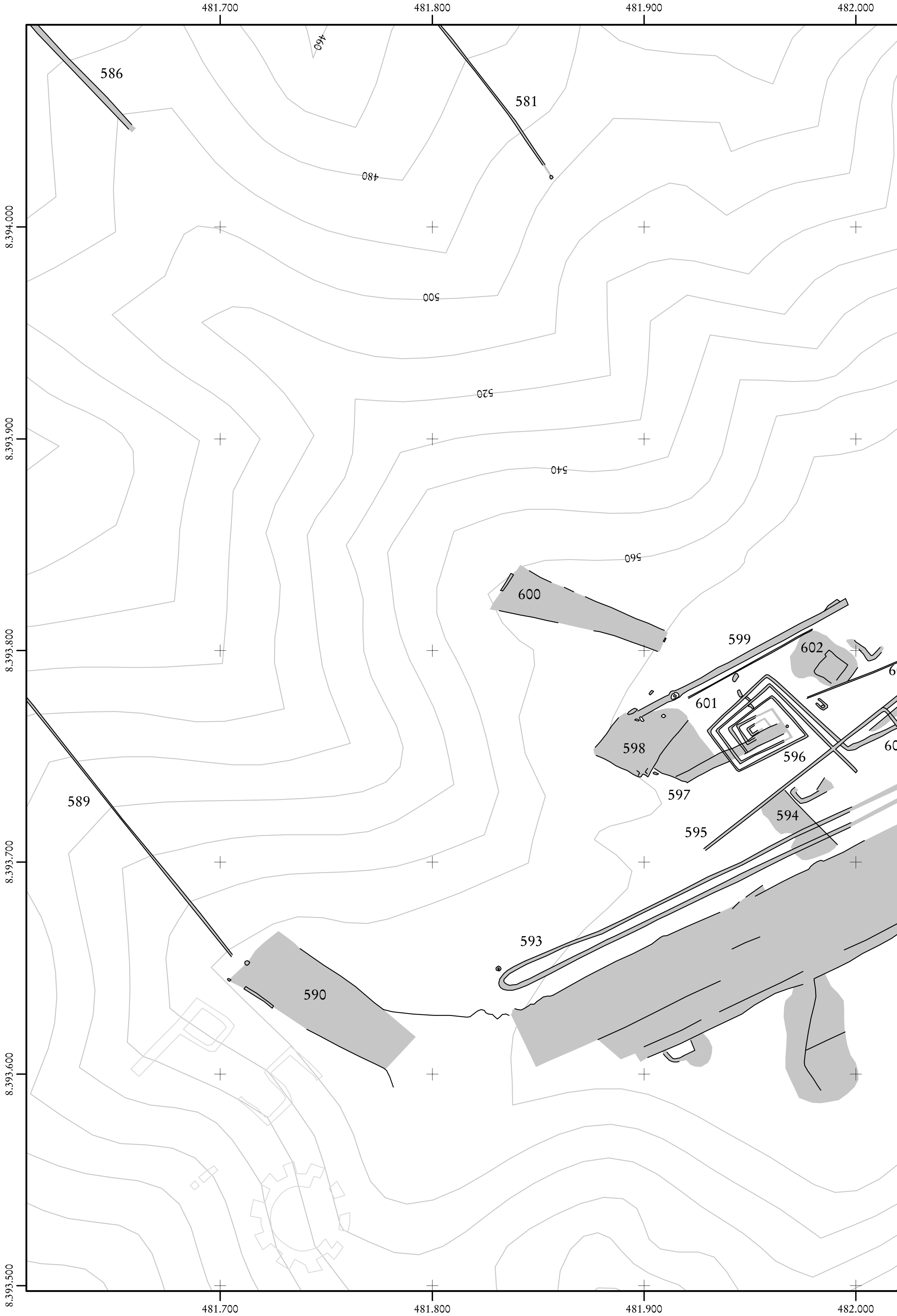
Site PV67A-62 is located on the base of the northern slope of Cerro Carapo, near the western end of the ridge (map 12). The slope is covered by several lines and figures. At the foot of the hill a rectangle (583) measuring approximately 50 m × 13 m is located on gently sloping terrain and partially destroyed by an irrigation channel and a field. In its cleared interior two relatively well preserved stone cairns were placed close to the narrow end of the geoglyph (fig. 63). Both had a diameter of approximately 3 m and a height of about 0.80 m, but were disturbed by looters' pits placed in their centers. Both stone structures were excavated in 2001.

The northern structure (the one closest to the valley floor) was a low, rectangular platform measuring approximately 2 m × 2 m, with a preserved height of 0.70 m. It consisted of one row of large, unworked stones set upright on the leveled ground without mortar that served as retaining wall for a fill composed of gravel and some sand. On its northern side a small annex built in the same way abutted the plat-

[71] Sample HD-24683, age given as calibrated 1 sigma range. Date courtesy of Ingmar Unkel, Heidelberg.



Map 12. Geoglyph site PV67A-62 at the foot of Cerro Carapo.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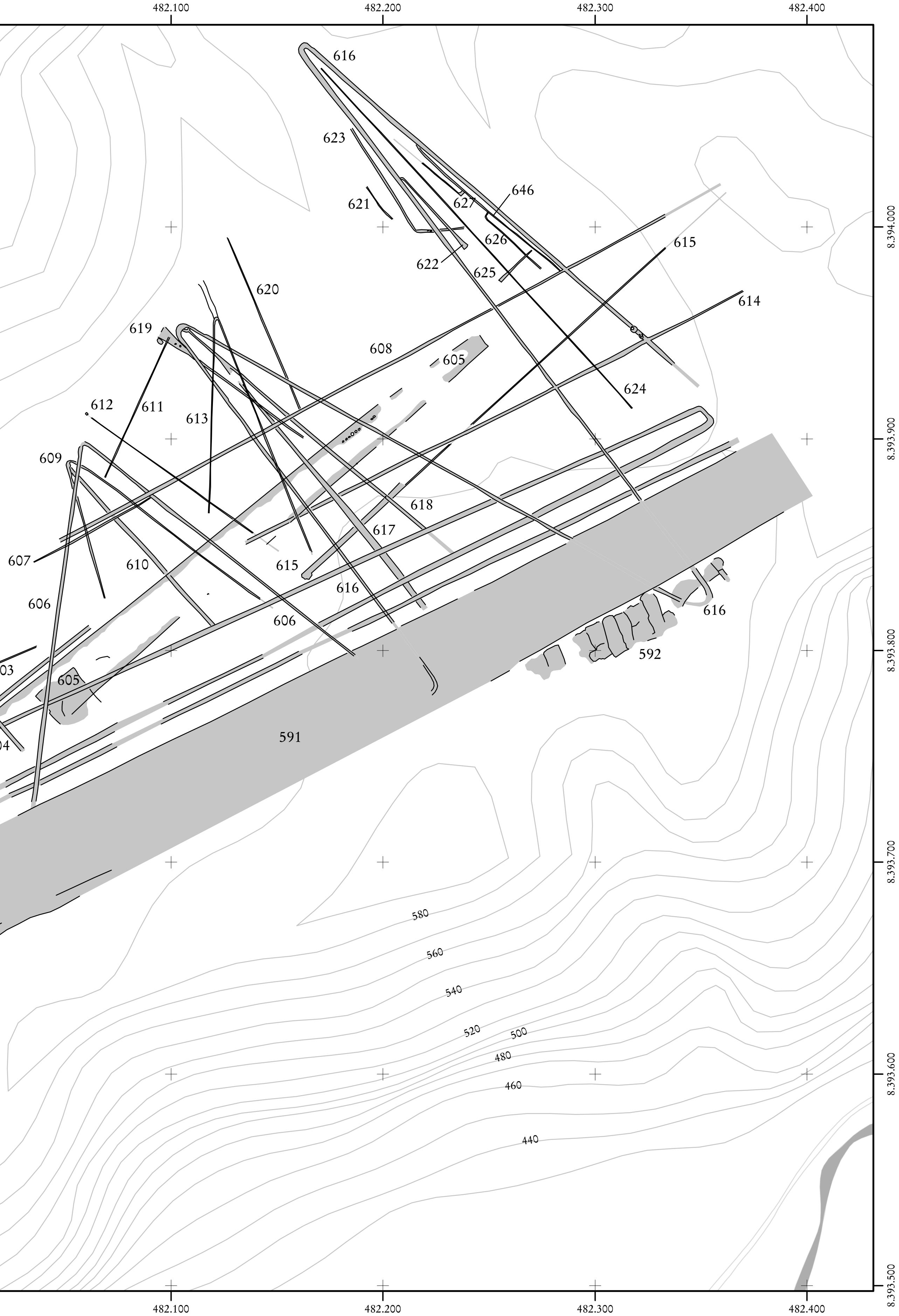

Map 13. Geoglyph site PV67B-55 on Cerro Carapo.

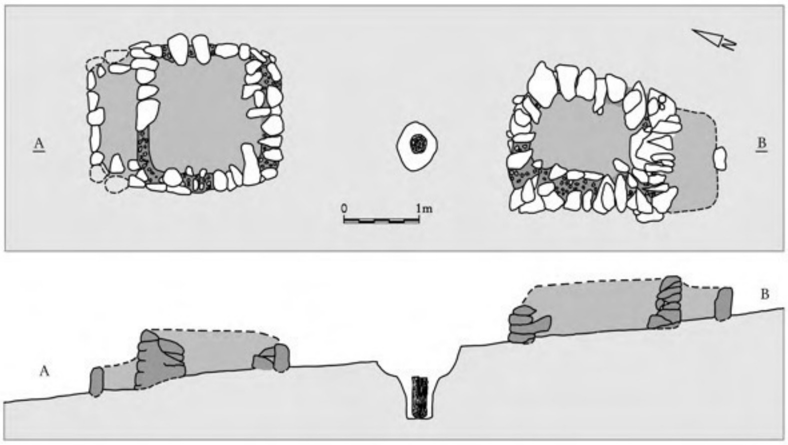

Fig. 63. Stone structures and wooden post on geoglyph 583 on site PV67A-62 after excavation (cp. map 12).

form, serving either as constructional support or as step leading up to the platform. The upper surface of the platform was not preserved. Fineware ceramics recovered from the construction fill of the main platform dated to Nasca 4 and 5, while sherds from the annex fill were from Nasca 7 vessels. The platform was covered by debris resulting from the deterioration of the platform after its abandonment, although some debris may also have been placed on it intentionally to cover the structure. Among the debris, maize cobs, obsidian and chrysocole fragments, seashells, rodent bones, and Nasca 4 sherds were found. These materials had probably once been placed on the platform.

The southern structure, built on slightly higher terrain, was constructed in much the same way, and included an annex that was built later. The platform measured 1.75 m × 2.25 m, again with a preserved height of 0.70 m. Due to a looters' pit it was less well preserved than the northern platform.

Midway between the two structures the remains of a wooden post were found set in a hole in the ground approximately 1.10 m deep. The post, a poplar (*sauce*) log with a diameter of 0.10 m, was preserved to a height of 0.47 m inside the hole. The fact that the post hole was more than 1 m deep and the post had been affixed with large stones indicates that it once had reached a considerable height above ground. Under the post, chrysocole fragments and a guinea pig were found. The latter was well preserved due to arid subsoil conditions. It had apparently been placed there as offering before the post was put in place in a similar fashion to that on PV67A-15.

Summary

While low, elongated platforms like those excavated on PV67A-35 and PV67A-47 apparently were built at the beginning or during the construction process of adjoining geoglyphs, only a few, if any, of the pairs of stone structures excavated on PV67A-15/16, PV67A-80, PV67A-90, and PV67A-62 were built at the same time as the geoglyphs they were placed on. Furthermore, several of them show clear indications of later alteration which means that the structures were used over a considerable time span. This is confirmed by associated finds, although it is often unclear which phase the datable finds are related to due to the bad state of preservation of most structures. All in all, the structures seem to have been part of the long-term process of construction, use, and alteration typical of complex geoglyph sites.

The stone structures were constructed in a simple manner, with most of their material picked up on the site. Mud mortar was used only in some cases, while other structures feature dry walls or in the case of the smallest excavated structure on PV67A-90 there were no walls.

The best identifiable activity related to the structures was the placing of maize cobs, ceramic vessels, seashells (among them *Spondylus*), fragments of chrysocole, and other materials on the top of the platforms. The platforms may also have been used to stand upon, but there is little evidence to support this idea. Only on PV67A-15/16 are there indications of the structures having served as rooms or enclosures, but both were later also converted into platforms. On PV67A-15/16 and PV67A-62 there are some indications that the debris covering the platforms did not result solely from the deterioration of the structures but that part of it may have been placed intentionally on them after their abandonment.

The function of the wooden posts associated with the stone structures is not entirely clear. In two cases (PV67A-15 and PV67A-62), a single post was placed in the middle of two stone structures near the narrow end of the trapezoid, a position where no post was found on PV67A-80. On PV67A-15 wooden posts were furthermore associated with the single structure placed in the center of the wide base of the trapezoid, whereas on PV67A-90 no such posts were found. All posts must have reached a considerable height above ground, as judged by the deep holes into which they were placed, and must therefore have been visible from a considerable distance. Their general association with the central axis of the trapezoids may indicate that they were needed in some way during the construction process of the trapezoids. The leveled and compacted ground around the structures indicates the frequent presence of people close to them. Compared to lineal geoglyphs, many of which are compacted along their whole course, the trapezoids are only compacted, presumably by human activity, around the platforms.

Resumen

En este resumen se ofrece una síntesis del texto principal en versión española. Debido a su carácter de síntesis, resulta evidente que hubo la necesidad de recurrir a modificaciones y omisiones, por lo que es preciso consultar el texto completo de la tesis, en idioma inglés, para los que deseen tener información más completa y detallada.

1. Introducción

Los geoglifos de las Pampas de Nasca en el desierto costeño surperuano, que se ubican en una meseta entre los valles del Río Ingenio y del Río Nasca, al pie de los Andes (fig. 1), gozan de fama mundial y atraen la visita de miles de turistas por año. Pese a su fama, sin embargo, se sabe poco acerca de su función y de su significado. Por mucho tiempo se pensó que estos geoglifos, también conocidos como las "Líneas de Nasca", servían como calendario astronómico. Desde la década de los ochenta, sin embargo, se recurre, en forma cada vez más intensiva, a investigaciones arqueológicas, etnográficas e históricas de otras regiones y otras épocas correspondientes al área andina, con el fin de explicar los geoglifos, basándose en tradiciones andinas referentes a la organización social, prácticas religiosas o conceptos culturales. Hoy en día se los entiende como espacios sagrados, creados y mantenidos por grupos sociales reunidos en estos lugares, donde éstos llevaban a cabo actos rituales relacionados con cultos a las montañas, al agua o a la fertilidad.

Subsiste, sin embargo, un problema mayor de la investigación de los geoglifos, que se centra en la ausencia del control de estas y otras hipótesis por medio de datos arqueológicos confiables ya que éstos no existen. Tampoco se dispone de su documentación apropiada, pese a investigaciones respectivas efectuadas en el lapso de varias décadas. Con el afán de subsanar estas deficiencias, se registraron más de 1,500 geoglifos en los alrededores de Palpa por medio de su levantamiento completo con la ayuda de la fotogrametría aérea y con control posterior en el terreno. De esta manera se logró armar un archivo digital de los geoglifos en esta región, los que, hasta ahora, habían escapado mayormente a la atención de los científicos. Este archivo nos permite contrastar los nuevos enfoques interpretativos valiéndonos de contextos arqueológicos concretos. La investigación respectiva se llevó a cabo en el marco del Proyecto Nasca-Palpa, entre 1999 y 2004, y formaba la base de la tesis doctoral del autor, presentada al Departamento de Pre- y Protohistoria de la Universidad de Zurich (Suiza). Este texto presenta una versión revisada de la disertación.

Los geoglifos de la región de Palpa son muy parecidos a los de las mejor conocidas Pampas de Nasca, pero ostentan algunas diferencias. En Palpa, por ejemplo, las figuras zoomorfas son menos frecuentes, mientras que existe mayor cantidad de figuras antropomorfas de dimensiones pequeñas. El área de estudio abarcaba 89 kilómetros cuadrados, en el entorno de las desembocaduras de los ríos Palpa y Viscas en el Río Grande. Las fotos aéreas condicionaron los límites de esta área; se las sacó especialmente con el fin de la documentación fotogramétrica para cubrir las laderas y mesetas que se ubican alrededor de la planicie fluvial. Luego del mapeo los geoglifos fueron documentados en el terreno. El conjunto de todos estos datos se almacenó en una base de datos integrada en un sistema de información geográfica (SIG). De esta forma los datos pudieron ser administrados y luego sometidos a un análisis espacial, a lo cual se agregó el análisis arqueológico.

La consistente aplicación de modernos métodos de la geomática, así como la síntesis y la evaluación crítica de las hipótesis más recientes que pretenden explicar los geoglifos, constituyen aspectos novedosos que forman la base de este trabajo. La presentación de los geoglifos de la región de Nasca es el tema del capítulo 2; el capítulo 3 ofrece una síntesis de los trabajos publicados en cuanto a la ocumentación e interpretación de los geoglifos. El capítulo 4 es un breve resumen de los trabajos del Proyecto Nasca-Palpa. El capítulo 5 y el capítulo 6 constituyen la parte principal de este trabajo ya que estos dos capítulos están dedicados a la documentación fotogramétrica y al análisis arqueológico de los geoglifos de Palpa, respectivamente. En el capítulo 7 se discuten los resultados y en el capítulo 8 se presenta un resumen y las conclusiones.

2. Los geoglifos de la región de Nasca

El término "Líneas de Nasca" se suele utilizar para designar los geoglifos de la cuenca del Río Grande, al pie de los Andes (fig. 2). El término "geoglifos" que se suele utilizar en el contexto arqueológico, significa literalmente "grabados en el suelo". A pesar de que este último término no es de todo correcto, su uso se ha generalizado. Geoglifos se encuentran en los desiertos pedregosos a lo largo de toda la costa occidental americana (Clarkson 1999). La mayor concentración se encuentra en la cuenca del Río Grande, entre la cordillera costeña y los Andes, una fosa geológica rellenada por sedimentos aluviales del Pleistoceno (Eitel et al. 2005). Estos sedimentos a su vez fueron cortados posteriormente por los ríos, de los cuales sólo el Río Grande tiene agua durante todo el año.

Las mesetas estériles, llamadas pampas, en el entorno de los oasis verdes de los valles, están cubiertas por una capa de piedras oscuras, el llamado pavimento desértico, que yace sobre una capa de arena clara. Para crear un geoglifo, sólo hubo que remover estas piedras oscuras, aunque, en las laderas, a veces se observan surcos cavados en la capa de arena debajo de la superficie. En su mayoría se trata de áreas limpiadas con el fin de formar trapecios o rectángulos. Estos suelen estar acompañados por líneas rectas (fig. 3), en zigzag o en meandros. Figuras biomorfas como aves, ballenas o representaciones antropomorfas son las más conocidas, aunque sólo representan una fracción reducida del corpus total de los geoglifos. Por lo general los geoglifos están ordenados en complejos mayores (fig. 4).

Gracias a las estables condiciones climáticas de la región de Nasca, los geoglifos se han conservado en áreas grandes. Las áreas libres del pavimento desértico también resisten la erosión eólica ya que la humedad del aire forma una costra sobre el sedimento limpiado, la que se destruye con facilidad al caminar encima de la misma. Por esta razón las actividades humanas en el desierto representan el mayor peligro para los geoglifos, a lo que se suma que la topografía agreste y la mala visibilidad de muchos de ellos en el terreno dificultan su conservación. Las Pampas de Nasca fueron declaradas zona intangible y luego patrimonio cultural de la humanidad y están bajo protección, pero numerosos geoglifos se encuentran en zonas de libre acceso fuera del área protegida. Ya que la conservación de ellos también es importante, el INC de Lima elaboró un plan maestro, en colaboración con la UNESCO, con el fin de garantizar la protección sostenida y el usufructo de los geoglifos (Lumbreras 2000). El presente trabajo sigue los planteamientos generales de este plan.

Por lo general se asume que los geoglifos se crearon durante el período Nasca (aproximadamente 200 a.C. hasta 600 d.C.), iniciándose en el período Paracas (aproximadamente 800 a.C. hasta 200 a.C.) (tabla 1). La cultura Nasca se basaba en una sociedad compleja cuyos logros se reflejan no solamente en la creación de los geoglifos, sino también en la producción de su cerámica fina polícroma, los tejidos de alta calidad y un sistema de irrigación altamente desarrollado (Rickenbach ed. 1999; Silverman/Proulx 2002). Más allá de la cuenca del Río Grande y del valle de Ica, esta cultura ejerció influencias sobre las regiones aledañas a lo largo de la costa y en la sierra (Moseley 2001: 197ss.). Durante largo tiempo padeció de conflictos, por regla interiores, que condujeron a cambios en su organización sociopolítica (Silverman 1993b), pero fue el impacto Wari de la sierra sobre la costa sur el que causó su ocaso (Isla 2001b).

Se ignora si este ocaso coincidió también con el de la tradición de los geoglifos, ya que hubo algunas propuestas que sugieren fechas más tardías para algunos geoglifos (Clarkson 1990), pero éstas se basan en datos inseguros. Por lo tanto, los geoglifos pueden considerarse principalmente como un fenómeno de la época de Nasca.

3. La investigación sobre los geoglifos de Nasca

3.1. Documentación de los geoglifos

Pese a la presencia de descripciones de los geoglifos en numerosas publicaciones, no existe aún una documentación que satisfaga los estándares arqueológicos. Los mapas disponibles se caracterizan por calidades muy desiguales. Por lo general se limitan a la representación de áreas parciales como el margen septentrional de las Pampas de Nasca, a lo largo del Río Ingenio[72].

Estas deficiencias se deben, entre otros factores, a los métodos de levantamiento topográfico que se emplearon en los diferentes proyectos. Mediciones terrestres con cinta, brújula, teodolito o plantillas consumen mucho tiempo y tienen su utilidad para áreas reducidas o mapas de carácter general. Las fotos aéreas del Servicio Aerofotográfico Nacional (SAN, Lima) que se emplean con frecuencia en la arqueología de Nasca suelen servir para la ubicación y la elaboración de cróquis de los geoglifos mismos. También se han aplicado mediciones más precisas por medio de métodos fotogramétricos, sin haber alcanzado mayores resultados (Hawkins 1974; IGN 1993). Por un lado, la escala de las imágenes usadas no permitía detectar las líneas más delgadas, por otro lado al parecer, no hubo participación de arqueólogos en la elaboración de los planos.

Por el hecho de que los métodos aplicados no habían conducido a resultados aceptables, el Proyecto Nasca-Palpa tuvo que buscar otras soluciones para la documentación de los geoglifos de Palpa. La teledetección, cuyos métodos suelen aplicarse en la cartografía actual, ofrece los medios apropiados del caso. En estos métodos las informaciones no se obtienen directamente del objeto, sino de la irradiación electromagnética emitida por o reflejada del objeto. Satélites o aviones son las plataformas potenciales para sensores de teledetección.

Imágenes de satélites aún no se han utilizado para mapear los geoglifos, lo que se debe a la resolución espacial de las imágenes comercialmente disponibles que ha mejorado notablemente en los últimos años (tabla 2), pero aún no permite registrar las líneas más delgadas. A modo de ejemplo, la mejor opción en imágenes digitales en la actualidad es el sensor QUICKBIRD 2 que tiene una resolución de 61 centímetros en el suelo (Lillesand et al. 2004). Las líneas más delgadas, sin embargo, tienen anchuras entre 10 y 15 centímetros, por lo que no se dejan reconocer en estas imágenes. Imágenes de alta resolución, v.g. de los satélites IKONOS, QUICKBIRD 2 o ORBVIEW 3 ya sirven para mapear geoglifos mayores, en el caso de tomas en estereo, también en forma tridimensional. Este tipo de documentación hubiera sido útil en muchos casos y podría servir de punto de partida para trabajos en el futuro.

Si la tarea por realizar consiste en mapear la totalidad de los geoglifos, como en el caso de Palpa, las fotos aéreas ofrecen la mejor solución debido a su escala potencialmente mayor. Un análisis fotogramétrico requiere la presencia de imágenes seguidas y solapadas (el llamado recubrimiento en estereo) lo que se logra fácilmente por medio de vuelos en los que se sacan tomas convencionales.

> "La *Fotogrametría*, según la [...] Sociedad Americana de Fotogrametría y Teledetección (ASPRS), se define como: '*...arte, ciencia y tecnología de obtener información fiel acerca de objetos físicos y su entorno a través de procesos de grabación, medición e interpretación de imágenes fotográficas y patrones de energía electromagnética radiante y otros fenómenos.*'" (Lerma 2002: 31, cursiva del original).

La fotogrametría, como parte de la teledetección, permite modelar objetos en forma tridimensional sobre la base de mediciones realizadas en imágenes del objeto, mas no en el objeto mismo. La fotogrametría sirve para medir objetos de las escalas y formas más diversas, desde partículas microscópicas hasta planetas enteros[73]. En el caso de sitios declarados como patrimonio cultural la fotogrametría ofrece la gran ventaja de afectar el sitio en menor grado que los levantamientos tradicionales. Reconstrucciones basadas en imágenes son factibles aún en el caso de que los objetos respectivos se encuentren dañados o destruidos.

Para poder realizar una medición fotogramétrica se requiere de las imágenes, los datos de la cámara y los datos de control. Dos imágenes que presentan recubrimiento, tomadas de lugares ligeramente desplazados a semejanza del funcionamiento del ojo humano, permiten la visualización del objeto en forma tridimensional. En estas pares de imágenes, los llamados modelos estereoscópicos, también se puede medir en forma tridimensional. El modo de la producción de imágenes de una cámara depende de los parámetros técnicos como del objetivo, de la distancia focal, etc. Si estos parámetros son conocidos, se puede calibrar la cámara, es decir se pueden hacer inferencias sobre el objeto a base de imágenes del mismo. Con el fin de garantizar el posicionamiento correcto y el escalamiento del modelo es preciso definir algunos

[72] Véase diversos mapas en Kern/Reiche 1974; Hawkins 1974; Aveni et al. 1990; Reinhard 1996; Lumbreras 2000; así como los mapas publicados por Nikitzki (1993) y el Instituto Geográfico Nacional (1993).

[73] Mikhail et al. 2001; Lerma 2002; Luhmann 2003; Kraus 2004.

puntos de control del objeto por medio de mediciones independientes.

En el caso de los geoglifos se pueden tomar series de fotos aéreas verticales y solapadas sobre un terreno sin vegetación, mientras que las mediciones de GPS (*global positioning system*) permiten la definición de puntos de control en el terreno. En el laboratorio las imágenes son analizadas y la cámara es calibrada. Sobre la base de los datos obtenidos se miden los geoglifos en forma tridimensional con alta precisión, se los modela y se los georeferencia. La textura de la imagen permite una visualización fotorealista, que sirve también para la confección de mapas o planos.

Los trabajos fotogramétricos deben estar acompañados por una prospección en el terreno ya que muchos detalles no se captan en forma completa en las imágenes o no se los puede interpretar correctamente. Además de ello es preciso disponer de un registro de los hallazgos en el terreno, sobre todo en el caso de la cerámica.

Los datos geométricos de la medición fotogramétrica y los datos de atributos que provienen del trabajo arqueológico se reunen luego en una base de datos y se los analiza en un sistema de información geográfica (SIG) (Baena et al. 1997; Wheatley/Gillings 2002). Un análisis de los geoglifos basado en el SIG constituye una meta buscada desde hace cierto tiempo, sin haberla alcanzado por la insuficiencia de los datos disponibles. El SIG permite la realización de un análisis sistemático de las relaciones espaciales entre contextos arqueológicos y su entorno y, de esta manera, ayuda en detectar principios de ordenamiento que pueden haber jugado un papel en el proceso de elaboración de los geoglifos.

La combinación entre la fotogrametría moderna con fotos aéreas, el trabajo de campo arqueológico y el manejo y análisis de datos basados en el SIG parecía, por lo tanto, constituir el enfoque metodológico más prometedor en la investigación de los geoglifos de Palpa.

3.2. Interpretación de los geoglifos

Por mucho tiempo, los geoglifos de la región de Nasca fueron interpretados dentro de un contexto astronómico. Paul Kosok los llamó "el libro de astronomía más grande del mundo" (Kosok 1965: 49), y Maria Reiche buscó, por décadas, relaciones astronómicas y calendáricas (Kosok/Reiche 1947, 1949; Reiche 1993). La hipótesis astronómica fue sometida a varias pruebas que llevaron a resultados negativos[74], por lo que no se la considera como punto de partida de este trabajo. En cambio en este estudio se presentan resúmenes de los enfoques interpretativos más recientes y se los analiza. Estos enfoques son frutos de investigaciones arqueológicas, etnográficas e históricas, realizadas desde la década de los ochenta. Se caracterizan por el afán de recontextualizar los geoglifos en la prehistoria andina, tal como ya lo habían hecho los primeros expertos a partir de la década de los veinte[75].

Las tradiciones andinas de conceptos religiosos, del orden social y del ordenamiento espacial constituyen importantes puntos de partida. En primer lugar, provienen de las fuentes históricas de la Colonia temprana con referencias a eventos poco después o antes de la conquista española. Relaciones con estadios culturales más tempranos, establecidos por medio de la arqueología, se especifican por medio de conceptos basados en enfoques iconográficos, patrones de asentamiento, etc. En la medida en que estas analogías se remontan más hacia el pasado, su aplicación se torna cada vez más especulativa. Ya que la investigación arqueológica de la región de Nasca fue escasa durante mucho tiempo, la interpretación de los pocos contextos conocidos por medio de los mencionados conceptos de tiempos posteriores fue a menudo la única posibilidad para llegar a conocimientos acerca de las relaciones sociales, políticas, económicas y religiosas de la época de Nasca. Estas interpretaciones se complementan y se resumen a continuación.

Basándose en las tradiciones orales e informes históricos se sabe que había la creencia que la disponibilidad de agua en los oasis fluviales de la costa tenía relación con divinidades definidas. Una de ellas era Kón que habría sido el dios más importante del panteón costeño peruano antes del ascenso de Pachacamac (Rostworowski 1993). Las montañas, en las que nacen los ríos, fueron considerados como sedes de otras divinidades (Reinhard 1996). Algunos geoglifos lineales apuntan hacia cumbres de cerros (Reinhard 1996) o se orientan hacia cursos de agua (Aveni 1990b). Geoglifos figurativos que representan animales y plantas marinos o de la tropical región amazónica amplían la conexión con el agua y la fertilidad (Reinhard 1996). De esta manera los geoglifos se interpretan como lugares de reunión de feligreses o como señales

[74] Hawkins 1974; Aveni 1990b; Ruggles 1990.

[75] Mejía 1942, 2002; Kroeber/Collier 1998; Horkheimer 1947.

espaciales hacia divinidades de cerros, así como caminos de comunicación entre lugares de importancia religiosa. Vasijas fracturadas intencionalmente y halladas sobre las líneas apuntan hacia la realización de rituales religiosos llevados a cabo en el lugar (Clarkson 1990; Browne 1992). Fuentes históricas sugieren que hubo carreras en los trapecios y sobre las líneas, mientras que los geoglifos figurativos servían para bailes y otras líneas para viajes de peregrinos o procesiones (Rodríguez 1999).

La interpretación religiosa de los geoglifos se enriquece con la de las relaciones sociales. Se supone, basándose en investigaciones etnohistóricas y etnográficas, que las sociedades andinas se subdividían en mitades complementarias en diferentes niveles siguiendo el principio de la dualidad. El grupo social más importante en el tiempo incaico fue el *ayllu* que consistía de personas que se afiliaban con ancestros comunes que les conferían derechos comunales de utilización de tierras (Moseley 2001). Según Urton (1990), Silverman (1990b, 1993) y Aveni (1990b), grupos sociales parecidos formaban la base de la organización social durante la época de Nasca y fueron responsables para la instalación y la manutención de geoglifos particulares, donde también llevaban a cabo sus ceremonias. Según este modelo las pampas subdividían la cuenca de Nasca en una mitad septentrional y otra meridional y servían de punto de encuentro para los grupos de ambas mitades. Actividades relacionadas con los geoglifos servían también para definir el status de grupos sociales en un contexto social más amplio (Silverman 1990b). La propia construcción de los geoglifos, fuera de su uso posterior, fue de una relevancia particular (Clarkson 1990). Las expresiones formales de los geoglifos constituyen conceptos culturales comprensibles a sus constructores (Aveni 1990b; Silverman 1990b). Algunos geoglifos servían también de caminos de peregrinaje y de tráfico a través de las pampas[76].

Las interpretaciones e hipótesis de los investigadores citados se complementan y, por ende, se prestan para resumirlas en un “Modelo Andino” para fines de la presente investigación (fig. 5). Este modelo representa el estado actual de la investigación de los geoglifos al inicio del Proyecto Nasca-Palpa y sirvió de punto de partida para el estudio de los geoglifos de Palpa. Su meta consistió en la verificación o falsificación de aspectos de este modelo por medio del contexto arqueológico de Palpa. Antes de entrar en este tema, es preciso señalar algunas críticas de este Modelo Andino.

- Como se ha visto arriba, determinados conceptos culturales sirven para la interpretación de los geoglifos, documentados para regiones distintas y tiempos posteriores. Estos se adaptan a la época de Nasca, a veces de un modo bastante acrítico, sin considerar la distancia temporal considerable ni las rupturas históricas intermedias ni las diferentes condiciones ambientales. De esta manera los geoglifos se interpretan, por último, de acuerdo a un concepto incaico, pese a que su tradición se había truncado mucho antes.
- El Modelo Andino se desarrolló, en primer lugar, en las Pampas de Nasca y trata de explicar la situación local. Los geoglifos, sin embargo, también se extienden en gran cantidad a lo largo de los afluentes del Río Grande, a menudo en cercanía directa de los asentamientos y en situaciones topográficas claramente diferenciadas. No se pretende explicar estos contextos menos conocidos por medio de este modelo.
- Varios aspectos del Modelo Andino no se pueden analizar con métodos arqueológicos. Ahí entra el problema de divinidades determinadas que se habrían venerado o el carácter específico de ceremonias particulares, celebradas sobre los geoglifos. En general, los autores respectivos no toman en cuenta contextos arqueológicos concretos y tampoco describen qué tipo de contexto debería esperarse, en caso de que sus hipótesis fueran correctas.

A pesar de estas dificultades, el Modelo Andino, como una interpretación actual de los geoglifos, tiene que ser analizado sobre la base del conjunto de los contextos respectivos de Palpa. En los capítulos siguientes se describirá primero el Proyecto Nasca-Palpa, luego la documentación de los geoglifos y, por último, el análisis de los contextos.

4. El Proyecto Nasca-Palpa

La Fundación Suiza-Liechtenstein para Investigaciones Arqueológicas en el Exterior (SLSA, Zurich) inició el estudio de la cultura Nasca en Palpa, en el año 1997, dentro del marco del Proyecto Nasca-Palpa, y lo financió mayormente en los años siguientes. Markus Reindel, de la Comisión para Arqueología de Culturas Extraeuropeas (KAAK, Bonn) del Instituto Ar-

[76] Urton 1990; Clarkson 1990; Silverman 1994.

queológico Alemán (DAI, Berlín) se encargó de la dirección del proyecto, junto con Armin Grün, del Instituto de Geodesia y Fotogrametría del Instituto Federal Técnico de Suiza (ETH, Zurich), ambos apoyados por el director local Johny Isla, del Instituto Andino de Estudios Arqueológicos (INDEA, Lima).

La primera fase del proyecto (hasta 2002) abarcó tres áreas de trabajo[77]:

- Un estudio regional de los asentamientos en el que se documentaron más de 700 sitios prehispánicos (Reindel et al. 1999, 2003a),
- Excavaciones en los Los Molinos y La Muña, ambos asentamientos de la época Nasca, en el valle del Río Grande (Reindel/Isla 2001; Reindel et al. 2002), así como
- Un registro completo y el análisis de los geoglifos de Palpa[78].

En la segunda fase del proyecto, cofinanciado por el Ministerio Federal de Educación e Investigación (BMBF, Bonn), así como por otras instituciones, las investigaciones se ampliaron tanto en el sentido temporal como también en un sentido metodológico (para una síntesis véase Reindel/Wagner eds. 2004). En el presente trabajo los primeros resultados de esta segunda fase sólo se tocan de modo tangencial.

La región alrededor de Palpa que fue investigada en forma sistemática ofrece condiciones favorables para los estudios arqueológicos. Los geoglifos se ubican en la cercanía del valle (figs. 6, 7), a veces en conexión directa con los asentamientos lo que favorece un análisis integral. Por otro lado no se encontraban bajo protección legal, lo que hizo más urgente su documentación. Pese a estos factores favorables, la investigación previa había descuidado esta región. Si bien Kosok, Reiche y Horkheimer, entre otros, trabajaron en Palpa, en la década de los cuarenta (Kosok/Reiche 1947; Horkheimer 1947), luego su interés casi exclusivo se trasladó a las Pampas de Nasca y sus valles aledaños. Sólo una prospección parcial por Browne (Browne/Baraybar 1998; Browne 1992) mostró el potencial de los estudios arqueológicos de los geoglifos en esta región.

5. La documentación de los geoglifos de Palpa

La documentación de los geoglifos de Palpa demandaba una colaboración estrecha entre los ingenieros geomáticos y los arqueólogos. Los diferentes pasos del trabajo de ambas disciplinas que se especifican a continuación por separado, en realidad estaban estrechamente interconectados (figs. 8, 19).

Para el mapeo fotogramétrico de los geoglifos de Palpa se necesitaban fotos aéreas apropiadas. Ya que las tomas disponibles del SAN no cumplían con los requerimientos debido a su escala o la cobertura incompleta del terreno (tabla 3), se sobrevoló el área de nuevo para sacar las tomas requeridas. Estos vuelos cubrían los cerros y las mesetas alrededor de Palpa incluyendo la Cresta de Sacramento en el norte, el Cerro Carapo en el este y las Pampas de San Ignacio y Llipata en el sur. De acuerdo al terreno, los vuelos fueron separados en un bloque septentrional y otro meridional (fig. 9).

El primer vuelo de 1997 no logró la calidad requerida de imágenes. Por esta razón se llevó a cabo un segundo vuelo en 1998, durante el cual se tomaron 384 imágenes en blanco y negro, desde una altura de unos 750 metros sobre la superficie, en escala 1 sobre 7,000, con un grado de recubrimiento longitudinal y lateral de 60 % (fig. 10)[79]. En el mismo vuelo se tomó una secuencia completa de imágenes de las Pampas de Nasca, en escala 1 sobre 10,000, cuyo análisis se inició después de los trabajos de Palpa por lo que no se incluye en este trabajo. Para estas tomas se usó una cámara calibrada para fotos aéreas (Zeiss RMKA15/23) con una distancia focal de 152.9994 milímetros. Estas imágenes cubren un área de unos 89 kilómetros cuadrados alrededor de Palpa. Como ambos bloques de imágenes, que estaban orientados en la topografía de los cerros se solapan ligeramente, se los pudo analizar en conjunto.

Mediciones diferenciales de GPS en el terreno sirvieron para la orientación de las imágenes. Se midieron marcas señalizadas o puntos naturales reconocibles en las imágenes, con lo que se llegó a un total de 17 puntos de apoyo (fig. 9).

Un primer paso del análisis consistió en la triangulación de las imágenes, i.e. en su orientación interrelacionada. Para esta triangulación se usó un restituidor analítico para medir puntos homólogos que se pudieron identificar claramente en las imágenes vecinas. Luego se midieron los puntos de apoyo definidos por el GPS

[77] Véase también las páginas web del proyecto bajo www.dainst.org, www.photogrammetry.ethz.ch y www.slsa.ch.

[78] Reindel et al. 2003; Grün/Lambers 2003; Sauerbier/Lambers 2003.

[79] Grün/Brossard 1998; Grün 1999; Reindel et al. 1999; Grün/Lambers 2003.

(Grün et al. 2000a, Grün/Beutner 2001). Sobre la base del bloque de imágenes entrelazadas que resultó de este procedimiento se pudo calcular una compensación de haces. Como resultado todas las imágenes fueron orientadas en el espacio tanto en su relación mutua como en forma absoluta. Cada pareja de imágenes vecinas con recubrimiento de este bloque de imágenes (modelos estereoscópicos) luego sirvió de base para los trabajos propios de mapeo en el restituidor analítico.

Ya que no existió un mapa del área investigada con la precisión requerida, era preciso registrar la topografía respectiva. Para este fin se midió un modelo digital del terreno que refleja la superficie terrestre con alta precisión. En los modelos estereoscópicos se midieron los puntos de superficie a lo largo de perfiles ubicados en distancias de 20 metros sobre el terreno. Además de ello se midieron líneas de rotura a lo largo de cambios pronunciados en la topografía del terreno, v.g. de quebradas. Luego se integraron los puntos medidos en el mapeo de los geoglifos (véase abajo). La densidad media de los puntos era de 1.6 puntos por cada cien metros cuadrados. Con la ayuda de la triángulación por el método de Delauney que no pasa por las líneas de rotura, los puntos fueron conectados para formar una superficie. Sobre esta base se calculó una malla regular de anchuras de 2 metros. El modelo digital del terreno que resulta de este procedimiento (fig. 11) describe el área de investigación en forma muy detallada (Sauerbier/Lambers 2003).

Paralelo a las mediciones las fotos aéreas fueron escaneadas en scanners calibrados con un tamaño de pixel de 21 µm, lo que corresponde a una resolución de unos 15 centímetros en el suelo. Sobre la base de este modelo del terreno las imágenes escaneadas se combinaron en un ortomosaico, en el cual cada punto de la imagen está provisto de coordenadas (suplemento 3, 4). Para las diversas aplicaciones, las ortofotos fueron calculadas con resoluciones entre 2 metros y 25 centímetros.

Para el mapeo de los geoglifos los bordes de los geoglifos fueron marcados como vectores tridimensionales y se los registró en forma digital. Ya que la mayoría de los bordes de los geoglifos se encontraban interrumpidos (por superposiciones, erosión u otro tipo de destrucción) los vectores mapeados representaban, en un primer paso, sólo los segmentos no conectados de los bordes de los geoglifos.

Los mapas resultantes del mapeo en las fotos aéreas fueron controlados y corregidos en el terreno durante los trabajos arqueológicos (fig. 12). Estas modificaciones luego fueron integradas en el mapeo con el restituidor analítico, con lo que la calidad del mapeo mejoró notablemente. En un paso separado se mapearon también todos los objetos antropogénicos modernos como caminos y casas. Si bien éstos no formaban parte de la investigación, sirvieron luego para facilitar la orientación en los mapas.

La revisión del mapeo de los geoglifos ocupó una gran parte de los trabajos de campo. Iniciándose en 2000, se ubicaron y documentaron todos los geoglifos de la Cresta de Sacramento y del Cerro Carapo en el terreno, durante tres temporadas de campo de un total de ocho meses (mapas 1 a 13, suplemento 1). Por falta de tiempo sólo se realizó un estudio parcial de los geoglifos de las Pampas de San Ignacio y de Llipata (suplemento 2). Algunos de sus conjuntos de geoglifos fueron documentados de manera completa y para otros se corrigió el mapeo en el terreno, pero otros lugares con geoglifos sólo fueron mapeados por medio de la fotogrametría. Esta limitación se compensa por el hecho de que los geoglifos de esta región se encuentran relativamente bien conservados y sólo fueron mapeados en una fase tardía de los trabajos, cuando ya se contó con buena experiencia. Pese a que este mapeo resulta ser relativamente confiable, en el presente trabajo el análisis se limitó a los 639 geoglifos de la Cresta de Sacramento y del Cerro Carapo, ya que sólo esta zona contó con una documentación completa.

En el curso de las trabajos de campo, todos los geoglifos fueron ubicados en el terreno con la ayuda de mapas adecuados (formato A3 y escala de 1 sobre 1,000 a 1 sobre 100). Luego se definió cuáles de los vectores formaban un geoglifo. Cada geoglifo recibió un número corriente y fue descrito en una ficha estandarizada. Las características registradas abarcaron tamaño, forma, ubicación, orientación y estado de conservación. Además de ello se registraron las relaciones estratigráficas entre los diferentes geoglifos y se clasificó el material asociado (v.g. cerámica). Lamentablemente no se pudo recoger material en forma sistemática debido al tiempo limitado. Gracias a los trabajos previos de fotogrametría no era necesario realizar mediciones en el terreno o sacar fotos. En vez de ello se pudo aprovechar del tiempo disponible para concentrarse en la documentación detallada de los geoglifos. Esta documentación se llevó a cabo de la manera más estandarizada posible, con el fin de trasladar la información a una base de datos. Una parte de esta base de datos, con datos geométricos agregados, se encuentra adjuntada a este trabajo en DVD.

Con las informaciones del trabajo de campo se corrigieron y se complementaron los vectores tridimensionales. Estos, sin embargo, inicialmente formaban sólo secciones inconexas de los bordes de los geoglifos. Con el fin de obtener objetos tridimensionales significativos, se conectaron los vectores de la manera tal como los geoglifos supuestamente se vieron en su estado original y se definió la superficie intermedia como polígono (fig. 13; Sauerbier/Lambers 2004). De esta manera se obtuvieron objetos virtuales, tridimensionales y geométricamente correctos que se conectaron con los datos de atributos arqueológicos de la base de datos.

Para lograr esto, se necesitaba una apropiada base de datos. El modelo de datos fue desarrollado con la ayuda de un lenguaje modelar apropiado (UML, *unified modeling language*), que proporciona un medio gráfico simple que permite modelar estructuras de datos complejas (fig. 15; Lambers/Sauerbier 2003). Estas se implementan directamente en una base de datos de acuerdo al programa respectivo. El UML permite la interconexión de diferentes tipos de datos, como textos e imágenes. Además de ello ofrece la posibilidad de conexiones jerárquicas y, por consiguiente, se presta para la modelación de una tipología jerárquica de los geoglifos (véase abajo). El modelo concepcional de los datos se convirtió en una base de datos Oracle 9i. El software ArcGIS/ArcINFO se conecta con Oracle a través de su módulo ArcSDE.

El análisis de los datos de los geoglifos abarcaba diferentes enfoques que se describirán, en forma detallada, en el siguiente capítulo. Desde la perspectiva técnica, la combinación de la base de datos con el SIG abrió múltiples posibilidades para el análisis de los datos. De esta manera se pudieron plantear problemas específicos para el análisis de determinados grupos de geoglifos. Se obtuvieron informaciones adicionales por cálculos de los datos disponibles, v.g. el área o la orientación de los geoglifos. Finalmente, las funciones analíticas espaciales permitieron relacionar los datos de los geoglifos con el modelo digital del terreno, así como analizar su patrón.

Diferentes programas de software comerciales sirvieron para la combinación de las diferentes capas de datos en un modelo virtual tridimensional. El modelo digital del terreno como imagen de la topografía constituyó la base geométrica, sobre la cual se proyectó la textura fotorealista de la ortofoto (fig. 14). Las capas de vectores y polígonos para la representación de los geoglifos pueden insertarse en el modelo si esto fuera necesario (Sauerbier/Lambers 2003). Para poder visualizar el modelo tridimensional y los resultados de los análisis, se procede de diferentes maneras. Se pueden producir vistas estáticas relativamente simples del modelo virtual tridimensional, v.g. en ERDAS Imagine (figs. 16, 17). La cantidad de datos, producida por la fototextura de alta resolución, causa problemas en las visualizaciones de tiempo real, v.g. en sobrevuelos virtuales. Software con capacidad de LoD (*Level of Detail*) es capaz de generar pirámides de imágenes de los datos disponibles en resoluciones diferentes y muestra en la animación sólo el primer plano de la imagen con la resolución máxima, lo que reduce las cantidades de datos por procesar. El software Terra Explorer de Skylinesoft (fig. 18) permite, de esta manera, sobrevuelos virtuales sobre los geoglifos de Palpa (Sauerbier/Lambers 2003). Un ejemplo de este trabajo se adjunta en DVD. La calidad de la imagen es inferior a la de las imágenes originales y la determinación de las rutas de vuelo es problemática. No obstante, el modelo virtual ofrece grandes ventajas. No sólo sirve para la presentación de los trabajos de Palpa, sino está disponible para toda el área investigada durante los análisis en la computadora.

De este modelo virtual tridimensional se derivan mapas (v.g. en ArcGIS) que visualizan diferentes conjuntos de datos como los geoglifos y las curvas de nivel de acuerdo a lo requerido (mapas 1 a 13). Para la visualización de los resultados de análisis se pueden seleccionar también geoglifos basados en material almacenado en la base de datos que se insertan en los mapas (suplemento 5a a 10b). Los detalles, la escala y la combinación de capas pueden seleccionarse a voluntad. Los mapas bidimensionales no alcanzan el potencial de los datos tridimensionales, pero la posibilidad de producir mapas de los geoglifos sin mayor esfuerzo constituye un gran avance para la arqueología de Nasca.

Además, se produjo un modelo tridimensional físico de la Cresta de Sacramento para la exposición en el museo de Palpa, inaugurado en 2004. Una nueva técnica permitió la colocación de una textura de la ortofoto de alta resolución sobre el modelo de plástico, lo que produce un efecto muy realista.

Una combinación de métodos fotogramétricos y arqueológicos, así como de la tecnología SIG permitió la documentación de los geoglifos de Palpa en una precisión, una totalidad y un grado de detalle nunca antes alcanzados. Se armó un archivo digital que no sólo sirve de base para el análisis y la interpretación, presentados en los capítulos siguientes, sino significa un aporte importante para la conservación de los geoglifos de Palpa.

6. El análisis arqueológico de los geoglifos de Palpa

Sólo los 639 geoglifos completamente documentados que corresponden a los de la Cresta de Sacramento, Cerro Carapo y la región en torno de La Muña fueron incluidos en el análisis arqueológico. El primer paso de este análisis consistió en la clasificación tipológica de los geoglifos. Luego se juntó toda la información disponible sobre la cronología de los geoglifos. En un siguiente paso se analizaron los contextos arqueológicos con el fin de determinar actividades relacionadas con los geoglifos. Finalmente, se tomó en cuenta la distribución espacial de los geoglifos dependientes de componentes naturales y culturales del paisaje. Los resultados de estos trabajos se discuten en los capítulos 7 y 8.

6.1. La tipología

La tipología aplicada a los geoglifos sirve, en primer lugar, para su clasificación en unidades morfológicamente similares (Adams/Adams 1991). Los tipos resultantes se entienden como categorías analíticas sin que necesariamente tengan significados culturales o cronológicos (Eggert 2001: 142ss.). La técnica de construcción de los geoglifos y su morfología son los criterios básicos de su ordenamiento. Ambos son criterios formales y, además, los únicos que cuentan con información respectiva para el total de los 639 geoglifos documentados. Esta tipología se ordena de un modo jerárquico, lo que permite incluir también geoglifos mal conservados o excepcionales (fig. 20).

Existen dos técnicas constructivas: la positiva y la combinada. La primera se llama así por consistir en la remoción del pavimento desértico lo que produjo la coloración clara del geoglifo. Con esta técnica se acumularon las piedras a lo largo de los bordes o el pavimento en sí formaba estos bordes. El atributo dominante es el área interior limpia. Por otro lado, la segunda técnica constructiva combinada se percibe en la presencia de amontonamientos de piedras o zonas intactas de pavimento en el interior del área, las que definen su forma. Esto lleva, en algunos casos, a tales extremos, que la forma básica del geoglifo consiste en áreas pedregosas intactas y sólo los contornos fueron limpiados. Por medio de estas observaciones se logra un primer ordenamiento de los geoglifos en aquellos creados por el empleo de la técnica positiva y otros en la técnica combinada.

Esta clasificación general se confirma al agregar el criterio morfológico. Se distinguen dos clases de geoglifos, la geométrica, ejecutada en la técnica positiva y la descriptiva, hecha en la técnica combinada. Los geoglifos de la primera clase se llamarán formas geométricas, mientras que la segunda representa seres u objetos reconocibles.

Gracias a su gran diversidad, el atributo "forma" permite un ordenamiento más detallado de ambas clases en grupos, tipos y variantes. La clase geométrica se segrega en geoglifos en área y otros lineales. Pese a que ambos grupos se caracterizan por un área interior limpiada, el segundo se define más por su forma alargada que por la del área en sí. En la clase descriptiva la forma está definida por motivos en su gran mayoría. En ésta se deja separar un grupo de geoglifos biomorfos y otro que representa objetos.

Los geoglifos lineales (fig. 21) se dejan subdividir en varios tipos de acuerdo a la forma adoptada por la línea. Al lado de líneas rectas hay otras en forma de U, en meandros, líneas de zigzag o espirales (fig. 22). En estas espirales se distinguen simples o dobles de acuerdo a la terminación de la línea en el centro o su continuación hacia afuera. Los geoglifos en área se subdividen en trapecios (fig. 23), rectangulares, triangulares o amorfos. El grupo de los geoglifos biomorfos abarca representaciones de animales u hombres, la última se subdivide en una variante con cuerpo entero y otra reducida a la cabeza (fig. 24). El grupo de los geoglifos de objetos (fig. 25) no se subdivide más, ya que sólo cuenta con pocos ejemplos.

Esta tipología se elaboró exclusivamente para los geoglifos de la Cresta de Sacramento, Cerro Carapo y la región de La Muña. No incluye v.g. el tipo fitomorfo ya que tales geoglifos, conocidos de las Pampas de Nasca, no aparecen en el corpus estudiado. Por otro lado la tipología es tan flexible que se deja ampliar y, de esta manera, sirve también como punto de partida para otros estudios.

Si se contempla la distribución numérica de los diferentes tipos, se reconocen preferencias destacadas (fig. 26). El tipo más frecuente es la línea recta, que aparece en 298 casos lo que corresponde a casi la mitad del corpus. El tipo que le sigue en frecuencia está representado por 133 trapecios o una quinta parte del inventario total de los geoglifos estudiados. En frecuencias decrecientes siguen líneas en forma de U, figuras antropomorfas, rectángulos, líneas en meandros, áreas amorfas y espirales, que, en su conjunto, representan casi un tercio de los geoglifos. Otros tipos están presentes en el corpus con menos de diez casos cada uno, entre ellos sólo dos figuras zoomorfas. Esta clasificación demuestra que líneas y trapecios constituyen los tipos dominantes, mientras que las figuras zoomorfas, preferidas en las investigaciones previas, sólo aparecen raras veces.

6.2. La cronología y el contexto cultural

La datación de los geoglifos constituye una precondición ineludible, si se quiere insertarlos en su contexto cultural e interpretarlos (Clarkson 1996). Hasta ahora los geoglifos no pudieron fecharse en forma directa. Intentos respectivos con dataciones de la "laca desértica" se abandonaron por problemas metodológicos (Dorn 1998 contra Beck et al. 1998). El método de la luminescencia por estímulos ópticos (OSL) que fecha el momento en el que la piedra usada en la instalación del geoglifo fue tapada, se encuentra aún en su etapa experimental (Wagner 1998: 262ss.; Greilich et al. 2005). Dataciones de ^{14}C de hallazgos de madera son muy escasas y de valor dudoso ya que estas maderas no pudieron asociarse en forma clara con los geoglifos[80]. En el marco del Proyecto Nasca-Palpa se fecharon muestras cuidadosamente seleccionadas, procedentes de contextos asegurados, tanto por el método de la OSL como de la de ^{14}C, pero, para este trabajo, sólo se dispone de un fechado ^{14}C. La siguiente discusión, por lo tanto, se basa en fechados indirectos y relativos de los geoglifos, basados en:

- Relaciones estratigráficas entre geoglifos y entre geoglifos y otros contextos,
- La clasificación cronológica de cerámica asociada y
- Los paralelos iconográficos con otras categorías de hallazgos clasificables.

El primer paso consistió en la definición del marco cronológico (fechados del inicio y del final de los geoglifos). Luego se determina en otro paso si los tipos definidos son relevantes desde el criterio cronológico.

6.2.1 El marco cronológico

Del total de hallazgos sobre los geoglifos sólo la cerámica fina pintada se deja fechar por medio de las fases estilísticas de las épocas de Paracas y Nasca, así como de fases posteriores, que cuentan con dataciones generales. Es preciso tomar en cuenta que la datación de hallazgos sobre los geoglifos sólo constituye un *terminus ante quem* para la datación de los geoglifos, pero si el mismo patrón de asociación se observa en numerosos geoglifos se torna probable asumir que los hallazgos están relacionados con los geoglifos[81]. Por otro lado sólo se registraron tiestos datables (figs. 27, 31) sobre 264 de los 639 geoglifos, de modo que esta información sólo vale para un 41 % del corpus. En caso de haberse hallado tiestos de varias fases cronológicas, para fines de este trabajo sólo se tomaron en cuenta los más tempranos ya que éstos deberían relacionarse más con la construcción de los geoglifos (fig. 28).

Ocho geoglifos arrojaron material del Horizonte Temprano, y 19 corresponden a Nasca Inicial. Estas cifras aumentan en el Nasca Temprano. En 44 geoglifos se registraron tiestos de Nasca 2, en 80 hubo material de Nasca 3. En Nasca Medio la cantidad se reduce: 22 geoglifos tenían cerámica de Nasca 4, como hallazgos más tempranos, y en 32 geoglifos se encontró cerámica Nasca 5. Las cifras correspondientes para el Nasca Tardío se reducen más aún. Seis geoglifos tenían material de Nasca 6 y cuatro tiestos de Nasca 7. De todo el Horizonte Medio, que no se subdividió en este trabajo, se conocen sólo cuatro geoglifos con la cerámica respectiva como la más temprana. En otros 24 geoglifos se encontraron tiestos del Período Intermedio Tardío como evidencias más tempranas.

A partir de los hallazgos de cerámica, por tanto, se puede constatar que la construcción de los geoglifos se inició en un momento durante el Horizonte Temprano, que es difícil de precisar, con un aumento considerable en el Nasca Temprano. Luego sigue un ocaso paulatino que perdura hasta el Horizonte Medio. La presencia de cerámica más tardía en los geoglifos se debe a otras causas, como se mostrará en lo que sigue.

Relaciones estratigráficas entre geoglifos y otros contextos, sobre todo estructuras, sólo se dejan precisar en pocos lugares. Entre éstos, sin embargo, hay una serie de casos comparables con relevancia cronológica. Estos casos se refieren a las construcciones de piedras del Período

[80] Strong 1957: 46; Morrison 1987: 56; Aveni 1990a: 21.
[81] Hawkins 1974; Clarkson 1990; Silverman/Browne 1991.

Intermedio Tardío. Los asentamientos del Período Intermedio Tardío ocupan una posición especial en el contexto arqueológico de Palpa. A menudo se trata de complejos grandes y relativamente bien conservados que se ubican en las laderas y en las mesetas y, por tanto, alejados de los ríos, a diferencia de los sitios más tempranos. En estos lugares destaca también la gran cantidad de cerámica en la superficie. Esta no solamente se encuentra entre las construcciones sino también a lo largo de senderos a través del terreno, algunos de los cuales pasan por los geoglifos. Algunos de estos asentamientos tardíos se habían construido encima de los geoglifos, por lo que los borraron parcialmente o los destruyeron por completo (fig. 58). Por lo tanto, el contexto general de Palpa indica que, en este tiempo, los geoglifos ya no estaban en vigencia (Horkheimer 1947: 53, 56), pese a que éstos y la cerámica del Período Intermedio Tardío parecen estar asociados a primera vista (Clarkson 1990: 167ss; Silverman/Proulx 2002: 175). Por consiguiente, se debe partir del hecho de que la tradición de los geoglifos ya había desaparecido en el Horizonte Medio. Si bien la datación concreta de esta tradición resulta difícil, el marco cronológico más probable debería corresponder a una duración total de unos 1,200 años, más concretamente entre 400 a.C. y 800 d.C.

6.2.2 La cronología tipológica

Para poder comprobar si los tipos formales revisten relevancia cronológica se vuelve a tomar la cerámica como indicador (fig. 32).

La cerámica del Horizonte Temprano hasta Nasca Tardío fue encontrada sobre líneas rectas, en una distribución que corresponde en grandes rasgos a la distribución general de todos los hallazgos cerámicos. Esto significa que las líneas rectas fueron hechas desde el inicio hasta el fin de la tradición de geoglifos y, por tanto, no se les puede fijar cronológicamente sólo por su forma. Una distribución parecida vale para los trapecios. Por consiguiente, tampoco el tipo que sigue en frecuencia tiene relevancia cronológica.

La gama cronológica de los hallazgos cerámicos más tempranos, en el caso de las líneas en U, va desde el Horizonte Temprano hasta Nasca Medio, en las líneas en zigzag desde Nasca Temprano hasta Nasca Medio, en las líneas en meandros desde Nasca Inicial hasta Nasca Tardío y en los rectángulos desde Nasca Temprano hasta el Horizonte Medio. En los casos de las áreas amorfas, así como en las figuras antropomorfas y zoomorfas, la cantidad de hallazgos se limita a menos de cinco especímenes por tipo. Mientras que las líneas rectas, las espirales y las áreas amorfas fueron construidas hasta el final de Nasca Temprano, las líneas en zigzag y en U siguen aún en Nasca Medio. En Nasca Tardío quedó sólo la línea en meandros, al lado del trapecio y de la línea recta. Sólo en algunos de los grandes geoglifos en área se encuentra cerámica del Horizonte Medio como indicador cronológico.

La iconografía también puede aportar al ordenamiento cronológico, aunque en forma más limitada. Motivos comparables en otros medios datables pueden dar pautas hacia la ubicación cronológica de geoglifos definidos. Esto, sin embargo, sólo vale para las figuras biomorfas que también aparecen en tejidos y cerámica. Las representaciones de tipos geométricos, o sea la mayoría de los geoglifos, no aparecen en otros medios o no fueron reconocidas como tales. Los geoglifos antropomorfos de Palpa se parecen en motivos, elementos y modo de representación de las figuras antropomorfas a las de tejidos de la tradición Paracas Necrópolis (v.g. Paul 1998: figs. 56, 58; Schindler 2000: 38, 43, 45). Las figuras en los tejidos están realizadas de manera más detallada y permiten la interpretación de algunos elementos de los geoglifos. De esta manera el geoglifo registrado como 235 y clasificado como cabeza, se debe entender como cabeza trofeo que el geoglifo 234 lleva colgada del cinturón a la altura del tronco (fig. 33).

Sólo una figura zoomorfa en la Cresta de Sacramento se conserva lo suficientemente bien para servir de información estilística y fue interpretada como ballena o tiburón (Aveni 2000a: 199). A diferencia de las figuras más conocidas de las Pampas de Nasca, no consiste de una sola línea, sino fue compuesta de varias líneas en el curso de algún lapso de tiempo (fig. 34). El motivo, como también su representación, corresponden a ceramios que muestran la Orca Mítica, sea en pintura o en forma plástica sobre el cuerpo de las vasijas[82]. El geoglifo de la Cresta de Sacramento no tiene brazo por debajo de la cabeza que podría llevar una cabeza trofeo. Debido a ello se parece más a las representaciones tempranas en vasijas de cerámica.

Las comparaciones iconográficas, por ende, favorecen una datación temprana de los geoglifos biomorfos. Los geoglifos antropomorfos tienen paralelos en el Horizonte Temprano,

[82] Eisleb 1977: Tafel 72; Aveni 2000a: fig. 50b; Wieczorek/Tellenbach eds. 2002: 122.

mientras que los geoglifos zoomorfos corresponden al Nasca Temprano.

Relaciones estratigráficas entre tipos diferentes ofrecen otros aspectos de una subdivisión cronológica, fuera de la cerámica y de la iconografía. Pese a que los geoglifos suelen sobreponerse (fig. 35), a menudo queda incierta la secuencia precisa debido a su técnica de construcción. A esto se suma el hecho de que muchos de los trapecios son resultados de ampliaciones diferentes. Pese a ello se pudo establecer la secuencia de la construcción de los geoglifos en algunos de los complejos grandes de un modo bastante detallado. De ahí resultan algunas tendencias claras acerca de la secuencia de diversos tipos de geoglifos.

Así las líneas en las faldas de los cerros se sobreponen a figuras antropomorfas del mismo lugar, mientras que se desconoce un orden inverso (mapas 2, 6, 12). En las mesetas, líneas en zigzag están superpuestas por trapecios (mapas 5, 13), lo que no sucede al revés. Algunas líneas rectas y trapecios suelen pertenecer a los geoglifos más recientes en su orden estratigráfico en los complejos grandes, pese a que corresponden a todas las fases.

La estratigrafía, por lo tanto, confirma, junto con la iconografía, los resultados ya obtenidos por los hallazgos cerámicos asociados. De acuerdo a estos resultados algunos de los tipos de geoglifos sólo fueron construidos en momentos específicos. Toda la tradición de geoglifos, sin duda, se inició durante el Horizonte Temprano y alcanzó su auge máximo, en calidad y cantidad, en el Nasca Temprano. Los dos tipos más frecuentes, las líneas rectas y los trapecios, fueron construidos durante toda la tradición de geoglifos, pero también pertenecen a los contextos más tardíos. Junto con las líneas en meandros y los pocos rectángulos, corresponden a una especie de standard en el Nasca Tardío, al que se redujo el repertorio amplio del Nasca Temprano.

Pese a estos primeros avances en la subdivisión cronológica de los geoglifos de Palpa, esta síntesis muestra que se necesitan métodos de datación directos para poder llegar a subdivisiones más finas y, sobre todo, poder fijar mejor el inicio de la tradición de geoglifos.

6.3. Las actividades relacionadas con los geoglifos

El contexto arqueológico, hasta cierto punto, permite reconstruir las actividades humanas que llevaron a su realización. En lo que sigue se estudiará qué tipo de actividades se pueden comprobar en los geoglifos, para poder contrastarlas con las hipótesis del Modelo Andino.

6.3.1 La construcción y las modificaciones de los geoglifos

El proceso de la construcción de geoglifos se puede seguir en detalle en varios geoglifos en área que parecen haberse quedado incompletos (fig. 36). Se dejan reconocer los siguientes pasos:

- Después de haber escogido el lugar, el tamaño y la forma del futuro geoglifo, se marcaron los contornos con piedras paradas que se clavaron en el suelo a distancias de varios metros.
- Luego se limpió una franja delgada a lo largo de las líneas señaladas en el interior del área destinada para su limpieza. Con cuidado las piedras removidas fueron colocadas en línea recta.
- Aún durante este proceso comenzó la limpieza del espacio interior. Sentados en cuclillas los obreros eliminaron las piedras de la superficie y las recolectaron en pequeños montones.
- Estos montones de piedras fueron retirados para amontonarlos a lo largo de los bordes del geoglifo. Estos, al inicio, eran muy precisos y rectos pero solían tornarse irregulares debido a este proceso, lo que sugiere que se botaron las piedras sobre los bordes desde recipientes.

Si el primer paso del trabajo requería una comprensión conceptual de la tradición de geoglifos que posibilitó la decisión sobre la construcción de un geoglifo y determinar su realización, los tres pasos restantes requerían sólo trabajo físico sencillo sin medios complejos que se podían coordinar en grupos. Esto sugiere la presencia de diferentes grupos sociales, tanto especialistas de geoglifos como obreros organizados pero no especializados.

Otras observaciones en los grandes complejos de geoglifos sugieren que no existía un fin claramente definido del proceso de su construcción. Por un lado numerosos geoglifos fueron modificados o ampliados posteriormente (mapas 3, 9), por otro lado se perciben rasgos de utilización en los geoglifos que dan el aspecto de no haberse completado. En varios lugares, geoglifos en área más recientes se sobreponen a líneas más tempranas. A estas líneas se las mantenía accesibles durante la construcción de las áreas, i.e. no fueron tapadas ni en sus bordes ni en su interior (mapas 3, 7).

Estos y otros contextos sugieren que los geoglifos no fueron construidos en un proceso rápido y efectivo como se había calculado en modelos anteriores (Hawkins 1974: 120; Aveni 1990a: 25). La construcción fue interrumpida constantemente por otras actividades (v.g. procesiones sobre las líneas) y continuada durante las modificaciones de los geoglifos. Interrupciones en el proceso de construcción llevaron también al abandono de los geoglifos para iniciar el trabajo en otros nuevos. Se pueden observar estas evidencias en geoglifos en proceso de construcción superpuestos por otros (mapa 5) que no marcan el fin súbito de la tradición de geoglifos como fue sugerido hasta ahora (Silverman/Browne 1991: 218; Silverman/Proulx 2002: 282).

En resumen, por lo tanto, no tiene mucho sentido diferenciar entre la construcción y la utilización de un geoglifo. Más bien la construcción y la modificación de geoglifos correspondían a elementos dentro de un complejo de actividades llevadas a cabo en las laderas o en las mesetas.

6.3.2 Procesiones sobre los geoglifos

Sobre todo en los geoglifos lineales, pero también en los bordes y las bases anchas de los trapecios, así como en el entorno de las estructuras de piedra, la capa del sedimento limpiado muestra una fuerte compactación. En las líneas se habían formado hasta surcos en la arena dura. Esto demuestra que se había caminado en estas áreas en forma repetida, lo que aparentemente constituyó su fin primario. En las áreas libres en el interior de los trapecios la situación está menos definida. En estos lugares no se percibe un sendero como en las líneas, sino los movimientos se distribuían sobre una zona mayor, por lo que la compactación de la capa de sedimento está menos definida.

En las laderas la situación es diferente, donde los geoglifos lineales o en área, así como los geoglifos figurativos no servían para caminatas debido al terreno muy inclinado, arenoso o pedregoso. A esto se suma el hecho de haber encontrado poca cerámica en las laderas, lo que indica que los geoglifos situados allí servían menos para poder caminar sobre ellos que sobre aquellos en las mesetas.

6.3.3 La colocación de vasijas de cerámica

La categoría de hallazgos que con amplio margen es la más frecuente sobre y cerca de los geoglifos, son los tiestos de cerámica. Si bien se trata de hallazgos de superficie, y como tales no tiene que haber una relación forzosa con ellos, la consistencia de la asociación entre geoglifos y cerámica sugiere una conexión directa.

Sobre los geoglifos de Sacramento, Carapo y La Muña sólo se encontraron tiestos, nunca se observaron recipientes enteros. A menudo, sin embargo, se observaron concentraciones de fragmentos que permitían una reconstrucción casi completa de las vasijas originales (figs. 27, 37). Este hecho sugiere que las vasijas se rompieron en forma intencional en el mismo lugar. Estas vasijas quebradas se encontraban sobre y entre los geoglifos, pero en forma concentrada ahí donde hubo señales claras de caminatas regulares, i.e. a lo largo de los bordes amontonados de líneas y trapecios, así como en el área de la base de trapecios y rectángulos, en este caso a menudo relacionadas con plataformas de piedras. Esta relación indica que existía una relación entre las caminatas y la colocación de las vasijas.

No se pudieron detectar residuos del posible contenido de estas vasijas quebradas. Esto puede deberse al hecho de que no contenían comida o bebida o a su estado fragmentado. De acuerdo a su forma, la cerámica fina, hallada sobre los geoglifos, sugiere la función de servicio y consumo de comida y bebida, mientras que la cerámica burda sirve más para la preparación de las mismas y el transporte. De esta manera tenemos un indicio indirecto del consumo de comida y bebida sobre los geoglifos.

Fuera de las frecuentes concentraciones de tiestos hubo una cobertura de diferentes densidades de tiestos aisladas que no se dejan armar. El origen de estos tiestos no se explica, pero su presencia no parece corresponder a una colocación intencional.

6.3.4 La construcción y el uso de plataformas de piedra sobre los geoglifos

Otro aspecto de actividades humanas se percibe en la construcción y el uso de plataformas de piedra sobre los geoglifos. En ellas se reconocen dos tipos.

Uno consiste en plataformas alargadas, angostas y bajas a lo largo de las bases anchas de los trapecios, en el punto final de las líneas en las laderas o, en forma general, en el entorno de los geoglifos (fig. 38). Su construcción es sencilla ya que suele consistir de una hilera de piedras relativamente grandes y sin trabajar clavadas en el suelo en posición vertical. Este contorno fue rellenado con piedras pequeñas. La forma básica de estas plataformas fue ovalada o rectangular, pero su ejecución a veces ha sido irregular y consistía de varias cámaras, agregadas en diferentes momentos. Aparentemente se usó una cantidad menor de las piedras retiradas durante la instalación de un geoglifo para la construcción de la plataforma. En sondeos no se recuperaron muchos hallazgos ni sobre las plataformas ni en su relleno, pero la concentración de cerámica alrededor de ellas tiende a ser más alta que en otros lugares. El atributo más evidente de muchas de estas plataformas es su ubicación destacada en el terreno. Se ubican con frecuencia en el borde de la meseta donde se tiene una vista amplia sobre el valle y sobre el geoglifo adjunto con el cual existe, por lo tanto, una conexión visual.

El segundo tipo de plataformas de piedra se distingue del primero por su construcción, forma y ubicación. Por lo general, se encuentra en el interior de grandes trapecios, donde hay varios casos de una plataforma más grande cerca del centro de la base ancha que corresponde con otras dos más reducidas en la angosta parte final (fig. 39). A menudo sólo hay una plataforma en una de las partes finales. En los casos excavados hay varios indicios que sugieren que su construcción original data después de la instalación del geoglifo. Las plataformas del segundo tipo muestran menor uniformidad en su construcción. En la mayoría de los casos se trata de plataformas rectangulares con lados exteriores bien definidos y relleno en su interior. Su material de construcción consiste de piedras sin trabajar, de tamaños diversos, en algunos casos también de adobes. Pese a contar con un cuarto interior accesible en algunos casos, todas estas construcciones adoptaron la forma de una plataforma en su última fase constructiva. Los hallazgos en o cerca de las plataformas sugieren una utilización prolongada, en cuya fase final algunas de ellas podrían haber recibido una cobertura. Aparte de vasijas de cerámica también se encontraron mazorcas de maíz, tejidos, fragmentos de crisocola, así como conchas *Spondylus* en diferentes formas (completas, en fragmentos o como colgante) (fig. 40).

Algunas plataformas de piedra del segundo tipo estaban relacionadas con postes de madera. Restos de palos grandes y altos se levantaban entre las plataformas en la parte final angosta de trapecios, otros postes más delgados estaban distribuidos en y alrededor de la plataforma y podrían haber sostenido un techo. Los palos grandes probablemente deben haber sido visibles desde mayores distancias.

6.3.5 Resumen de las actividades humanas en y cerca de los geoglifos

En el contexto arqueológico de Palpa se encontraron evidencias de las siguientes actividades:

- Construcción y modificación de los geoglifos y plataformas de piedra,
- Procesiones sobre los geoglifos lineales y áreas parciales de los geoglifos en área,
- Colocación de vasijas de cerámica quebradas en o a lo largo de los bordes de líneas y trapecios,
- Colocación de recipientes de cerámica, frutos agrícolas, conchas *Spondylus* y otros objetos en las plataformas de piedra,
- Erección de postes de madera sobre geoglifos en área en la cercanía de las plataformas de piedra.

Evidencias indirectas o poco claras existen para las siguientes actividades:

- Consumo y colocación de comida y bebida,
- Cobertura de las estructuras de piedra al final de su uso.

Estas actividades estaban estrechamente interconectadas y formaban parte de un complejo mayor de actividades. No se llevaron a cabo sólo por especialistas sino deben haber involucrado gran parte de la población en formas diferentes. Se presume que las actividades sobre los geoglifos eran constantes y definidas.

6.4 Ubicación y disposición de los geoglifos

6.4.1 La disposición en un sitio

Debido a la presencia de tipos definidos en forma regular y común de los geoglifos en los grandes complejos de las mesetas de Sacramento y Carapo, se pueden deducir ciertas reglas que tenían un papel importante en la construcción de los geoglifos. Las siguientes combinaciones se parecen en varios sitios tanto en la composición de los tipos como en su secuencia temporal:

- Una línea en zigzag, cortada en un lado por una línea en meandros, ambas superpuestas por un trapecio (mapas 6, 7),
- Un trapecio flanqueado por líneas paralelas, tanto rectas como en meandros (mapas 1 a 3, 5, 13),
- Un trapecio acompañado por una espiral, esta última enmarcada en algunos casos por una línea en U amplia (mapa 8),
- Combinaciones de líneas rectas que se cruzan o donde líneas laterales divergen de una línea original (mapas 1, 4).

Estas combinaciones típicas muestran que hubo reglas definidas para la construcción de los geoglifos seguidas durante un tiempo prolongado, si bien aún no es posible explicarlas.

También se perciben ciertos principios en relación con la topografía. Figuras antropomorfas sólo aparecen en las faldas de los cerros, mientras que las pocas figuras zoomorfas de Palpa sólo se observan en terreno plano. La mayoría de las líneas en las faldas se orientan de acuerdo a la pendiente del terreno, aunque un grupo diverge de esta dirección. En los trapecios, la parte final más angosta suele ubicarse más alto que la base ancha, aunque existen excepciones. Por lo general, la regla más importante en los geoglifos grandes en área parece haber sido su aprovechamiento óptimo del terreno disponible.

6.4.2 La disposición en una región regional

El patrón de distribución de los geoglifos

Pese a que las laderas de los cerros y las mesetas en torno de Palpa parecen estar cubiertas de geoglifos en forma regular, se pueden detectar preferencias cambiantes por medio de un análisis diacrónico de los patrones de distribución. Este análisis espacial fue realizado con la ayuda del SIG. En ArcGIS 8.3 se contrastaron tres conjuntos de datos:

- Geoglifos con información cronológica ordenados por fases,
- Otros sitios en los que se encontraron materiales culturales apto para su datación (sobre todo asentamientos y cementerios) ordenados por fases, así como
- Posibles caminos de acceso entre los asentamientos y los geoglifos contemporáneos, calculados por medio de criterios económicos en ArcGIS (compárese Wheatley/Gillings 2002: 151ss.).

Los suplementos 5a a 10b muestran estos conjuntos de datos ordenados por fases. Ya que los tres conjuntos de datos son incompletos por diferentes razones y contienen errores potenciales, es preciso evaluarlos con cuidado. Pese a ello se dejan reconocer algunas tendencias definidas.

En la fase tardía del Horizonte Temprano (400 a 200 a.C.; suplemento 6a), la mayoría de los sitios se encuentran al pie del Cerro Pinchango, mientras que unos pocos geoglifos del mismo tiempo se ubican en la parte baja de la Cresta de Sacramento. Entre geoglifos y otros sitios se deben recorrer caminos relativamente largos ya que sus patrones de distribución no se corresponden.

En Nasca Inicial (200 a 1 a.C.; suplemento 6b), la densidad de la población aumenta. Los sitios se ubican en parte a lo largo de la parte baja de la Cresta de Sacramento. Los geoglifos también se concentran en esta zona, pero se los construye por vez primera también en las zonas poco accesibles al pie del Cerro Pinchango y en el Cerro Carapo, mientras que las mesetas grandes siguen sin ocupación. En general, tampoco se deja reconocer una convergencia en los patrones de distribución de geoglifos y otros sitios.

Durante la fase Nasca 2 (1 a 100 d.C.; suplemento 7a), la densidad de sitios es menor que en la fase anterior, sobre todo al sur del Cerro Pinchango. Algunas zonas a lo largo del Río Grande se ocupan por vez primera. La mayoría de los geoglifos se ubican en la parte baja de la Cresta de Sacramento, en cuyas mesetas se instalan algunos de los geoglifos más grandes. Por primera vez la mayoría de los geoglifos de esta fase se ubican en la cercanía de otros sitios.

En la fase Nasca 3 (100 a 250 d.C.; suplemento 7b) se inicia la ocupación de algunas zonas a lo largo del Río Grande, mientras que otras (v.g. Cerro Carapo) ostentan menos sitios que antes. En general, sin embargo, se alcanza la máxima densidad de ocupación. Esta observación vale también para los geoglifos, debido a la construcción de nuevos geoglifos. Todas las grandes mesetas muestran huellas de actividades relacionadas con los geoglifos. La concentración de sitios al pie del Cerro Carapo - la zona más estable en cuanto a asentamientos en el área investigada - también está acompañada, por vez primera, de un gran complejo de geoglifos. El asentamiento más importante durante la fase Nasca 3, Los Molinos, en la ribera izquierda del Río Grande, sin embargo, se ubica hacia la periferia de los complejos de geoglifos en las mesetas, de modo que hay que recorrer un buen trecho para llegar al sitio.

Se conocen mucho menos sitios de la fase Nasca 4 (250 a 300 d.C.; suplemento 8a) lo que puede deberse a su breve duración. Sobre todo la zona central de la Cresta de Sacramento parece estar casi abandonada, aunque se siguen usando los complejos de geoglifos existentes, lo cual incluye la construcción de algunos geoglifos nuevos. Estos suelen encontrarse a distancias considerables de los asentamientos. Por lo tanto, los patrones de distribución de geoglifos y otros sitios vuelven a divergir claramente.

En la fase Nasca 5 (300 a 450 d.C.; suplemento 8b) se percibe otro incremento en la densidad de sitios, sobre todo en la parte alta del Río Palpa y en la parte baja del Río Grande. La zona central de la Cresta de Sacramento, sin embargo, queda básicamente sin evidencias de ocupación, y la densidad de sitios es menor que en la fase Nasca 3. Los complejos de geoglifos instalados en las fases anteriores siguen en uso y se amplían. Su distribución, nuevamente, no coincide con la de los sitios contemporáneos, y los caminos de acceso (v.g. de La Muña, el asentamiento más importante de esta fase) a veces son muy largos.

En la fase Nasca 6 (450 a 525 d.C.; suplemento 9a), la densidad de sitios a lo largo de la ribera izquierda del Río Grande y en la parte central de la Cresta de Sacramento disminuye. En el Cerro Carapo se abandonan la mayoría de los sitios y el gran complejo de geoglifos en la meseta. En las mesetas y en las laderas de los cerros de la Cresta de Sacramento se instalan geoglifos y los utilizan aunque en escala menor que antes.

En la fase Nasca 7 (525 a 600 d.C.; suplemento 9b), la mayoría de los sitios se concentran en la parte alta del Río Palpa y en la punta meridional de la Cresta de Sacramento. A lo largo de todo el Río Grande ya no existen sitios, con muy pocas excepciones. En esta fase las actividades relacionadas con los geoglifos se limitan a algunos complejos en las partes media y baja de la Cresta de Sacramento. El trapecio más grande del área investigada se instala en una zona de geoglifos que se encuentra a una distancia mayor de los centros de ocupación.

Sólo pocos sitios y geoglifos datan del Horizonte Medio (600-1000 d.C.; suplemento 10a), ubicándose en aquellas zonas ya ocupadas en la fase Nasca 7. Los pocos hallazgos de cerámica en los geoglifos consisten de vasijas rotas en los bordes de los geoglifos. Estas observaciones sugieren que los complejos de geoglifos continúan en uso en la cercanía de los asentamientos, al parecer sin que se hayan construido nuevos geoglifos.

Durante el Período Intermedio Tardío (1000 a 1400 d.C.; suplemento 10b) se nota otro incremento de sitios, sobre todo en el Cerro Carapo y en la parte alta de la Cresta de Sacramento. Pese a la presencia de mucha cerámica sobre los geoglifos, ya se demostró que ésta se relaciona con los asentamientos y los senderos en las mesetas, mas no con la utilización de los geoglifos.

Una síntesis de los patrones de distribución de los geoglifos y otros sitios a través del tiempo de la ocupación prehispánica muestra que ambos se desarrollaron en forma independiente. Los sitios de geoglifos más tempranos se encuentran distantes de los asentamientos contemporáneos. Sólo en las fases de Nasca Temprano se reconoce una conexión espacial entre ambas categorías, condicionada por su alta densidad. Al bajar la densidad de los sitios más tardíos, muchos complejos de geoglifos seguían en uso, pero nuevamente a distancias mayores de los sitios contemporáneos. En general, los geoglifos fueron utilizados durante más tiempo que los asentamientos cuya ubicación se debía a la accesibilidad de los recursos naturales.

La visibilidad de los geoglifos

Los geoglifos debían haber sido visibles si tenían que cumplir su función como símbolo cultural o lugar de actividades rituales. Mientras que los geoglifos en las laderas parecen tener buena visibilidad, la de los geoglifos en las mesetas es más problemática. Estos problemas se han estudiado en este trabajo, en forma preliminar, por medio del SIG. Se calcularon áreas de visibilidad para cuatro puntos valiéndose de la función *Viewshed* en ArcMap 8.3. Se trata del geoglifo antropomorfo 60 del sitio PV67A-16, del poste de madera en el trapecio 52 del mismo sitio, del trapecio 109 en el sitio PV67A-29 y un punto señalado por dos líneas convergentes por encima del sitio PV67A-90. Todos estos puntos se ubican en las laderas sur o en la meseta de la Cresta de Sacramento. Para el cálculo de las áreas de visibilidad se tomaron en cuenta los parámetros superficie del terreno, altura del observador, ángulo de vista y radio máximo (compárese Wheatley/Gillings 2002: 201ss.).

Las áreas de visibilidad que resultan de estos cálculos coinciden en forma clara con la ubicación de otros geoglifos (figs. 41 a 44). Este resultado vale, en particular, para los geoglifos que ocupan las laderas. Pero, desde puestos elevados, había buena visibilidad también en el terreno de los geoglifos en las mesetas. Tanto en las laderas como en las mesetas, las áreas de visibilidad incluyen geoglifos bastante distantes, donde quizá ya no se divisaba bien la forma respectiva del geoglifo, pero sí a hombres parados en el mismo. Desde el valle no se veían bien todos los geoglifos mismos, pero sí los postes erigidos sobre ellos. Estos estudios preliminares apuntan, por lo tanto, hacia el papel importante de las reflexiones acerca de la visibilidad en cuanto a la construcción y el uso de los geoglifos.

La orientación de los geoglifos

El SIG sirvió, además, para un primer paso en el estudio de las orientaciones de los geoglifos.

La orientación fue uno de los rasgos más discutidos por mucho tiempo, por su relación con cuerpos celestes o elementos particulares del paisaje. Para muchos de los geoglifos que, por su forma, contienen elementos predominantemente rectos, se calcularon los ejes, los que fueron georeferenciados y mapeados. 337 geoglifos cumplían con estas condiciones, lo que resultó en un total de 674 orientaciones (fig. 45).

Su mapeo señala que las orientaciones cubren un círculo casi completo. Si bien se dejan reconocer ciertas concentraciones, no se evitó ningún punto cardinal. Estas concentraciones se explican por la topografía ya que corresponden a la orientación de la Cresta de Sacramento, en el caso de los geoglifos en las mesetas, o de sus laderas (geoglifos en la falda de los cerros). De este modo queda evidente que la orientación de los geoglifos dependía en primer lugar de la topografía, aunque este punto requiere más estudio.

En resumen, se constata que existían factores a nivel local o regional que influenciaban la construcción de los geoglifos. Estos factores se deben en primer lugar a la topografía, luego a su visibilidad, así como las actividades sobre los geoglifos. La accesibilidad y la cercanía de asentamientos, en cambio, sólo parecen haber jugado un papel marginal. El resultado más importante del análisis espacial es el desarrollo independiente de los patrones de distribución entre sitios y geoglifos, así como la imposibilidad de relacionar complejos de geoglifos particulares con asentamientos determinados en base de conexiones espaciales.

7. Discusión: El Modelo Andino y los geoglifos de Palpa

Una revisión del Modelo Andino, definido en el capítulo 3 (fig. 5), resulta en que no se comprueban todos sus elementos por medio de los contextos arqueológicos. De este modo la ubicación y la forma de los geoglifos hacen improbables una función relacionada con caminos de tráfico. Tampoco se confirma una relación espacial sistemática con cursos de agua. Otros aspectos, sobre todo la veneración de determinadas divinidades de cerros, en principio, no se dejan comprobar por medio de la arqueología. Además, se dispone de evidencias para actividades determinadas en los geoglifos, como se pudo demostrar, pero no se sabe si éstas tuvieron carácter de reuniones o de bailes. Debido a su carácter repetitivo y sus relaciones con los geoglifos, estas actividades podrían llamarse "rituales", en el sentido del Modelo Andino. Esta caracterización, sin embargo, no equivale a una explicación (compárese Brück 1999).

Pese a estas limitaciones los aspectos centrales del Modelo Andino fueron confirmados. Procesiones y colocaciones de ofrendas sobre los geoglifos cuentan con evidencias claras. Se las llevó a cabo durante largo tiempo, y grandes porciones de las poblaciones parecen haber participado en estas y otras actividades. Si bien no se pueden reconstruir en detalle los conceptos que las motivaron, las ofrendas sobre las plataformas de piedra apuntan hacia una cierta dirección. Frutos agrícolas de campos irrigados de cultivo, camarones de los ríos que sólo llevan agua en épocas definidas y, por fin, conchas *Spondylus* de aguas tropicales (Marcos 1986, 2002) demuestran que el agua y la fertilidad figuraban como conceptos centrales en estos rituales. En vista de las tradiciones andinas respectivas no se puede comprobar si ciertas divinidades asociadas a las montañas jugaban un papel relacionado, pero esta hipótesis es plausible ya que las montañas fueron consideradas como fuentes de agua (Reinhard 1996).

Al lado de esta dimensión ceremonial, el contexto arqueológico de Palpa sugiere que el significado social de los geoglifos tenía un papel por lo menos tan importante que el de los rituales. Complejos de geoglifos contemporáneos, pero diferenciados parecen haber sido utilizados por diferentes grupos sociales, en forma paralela. Sus miembros se reunían en forma regular para la realización de actividades codificadas, que eran visibles para otros grupos, posiblemente con intencionalidad. Se puede asumir que el status social fue influenciado y quizá definido por estos rituales. Estos grupos no correspondían a los habitantes de los asentamientos cercanos, como está demostrado por los patrones divergentes de geoglifos y sitios, sino deben definirse de otra manera. Es posible que se trataba de grupos parecidos a los *ayllus* que definían sus derechos de tierra por medio de ancestros comunes (Moseley 2001: 53ss.) tal como está propuesto por el Modelo Andino en base de paralelos incaicos. Las excavaciones en La Muña demostraron que se colocaron ofrendas delante de entierros lo que puede haberse hecho como parte del culto a los ancestros (Reindel/Isla 2001). En este sentido los geoglifos probablemente eran relevantes para la organización social de la cultura Nasca, aunque se desconocen los mecanismos precisos en detalle.

Sólo a partir de los geoglifos no se puede reconstruir la organización social de la época Nasca. Los análisis de asentamientos, cementerios, patrones de asentamientos y otros, dentro del marco del Proyecto Nasca-Palpa, ofrecerán pautas nuevas.

Las actividades sobre los geoglifos se realizaron dentro de un marco cultural común que se expresó en un lenguaje formal uniforme en los geoglifos de toda la región de Nasca. Este marco se mostró estable durante muchos siglos y sobrevivió numerosos cambios políticos y económicos que se manifiestan en los diferentes patrones de asentamientos (Reindel et al. 1999: 372; Silverman 2002a: 167). De esta manera se debe entender a los geoglifos como un elemento constitutivo de las culturas de Paracas y Nasca (Silverman 2002b: 122). A través de sus marcas del paisaje desértico en grandes áreas, únicas en sus dimensiones y con visibilidad amplia, este fenómeno cultural se ha conservado hasta nuestros días.

8. Resultados y conclusiones

Los estudios presentados en este trabajo resultan en una imagen bastante detallada del origen, del desarrollo y de la función de los geoglifos de Palpa.

El origen de los geoglifos debe remontarse a la tradición de petroglifos de la época de Paracas. Motivos comunes, conocidos de otros medios (tejidos, rocas), fueron trasladados, durante el Horizonte Temprano, pero en un tiempo aún difícil de precisar, a las laderas pedregosas alrededor de Palpa. Estos geoglifos tempranos (sobre todo las figuras antropomorfas) se parecían aún mucho a los petroglifos en cuanto a motivos, función y ubicación en el terreno. Luego se construyeron las primeras formas nuevas (líneas y trapecios) en las laderas. Cuando éstos fueron trasladados a las mesetas, se desarrolló un complejo diversificado de geoglifos y actividades que tuvieron su auge en Nasca Temprano. Con algunas limitaciones, el Modelo Andino se presta bien para explicar y ubicar los geoglifos en su contexto cultural, en la expresión de este tiempo como en tiempos posteriores.

En Nasca Medio y Tardío se mantuvo la tradición de los geoglifos, pero ésta sufrió un paulatino ocaso. Por un lado se siguió con la construcción de geoglifos, entre ellos los más grandes que se conocen de Palpa, pero su diversidad formal y su cantidad disminuyeron. La tradición de geoglifos sobrevivió mayores cambios sociales, sin sufrir modificaciones esenciales por lo que se la puede considerar como constante cultural de las culturas de Paracas y Nasca. Durante el Horizonte Medio temprano, en cambio, ocurrieron cambios fundamentales. Tanto un proseso de aridización como la influencia de Wari contribuyeron al final de la tradición de los geoglifos. Algunas vasijas del estilo nuevo fueron colocadas aún sobre los bordes de los geoglifos, pero, al parecer, ya no se construyeron nuevos geoglifos, antes de que cesara todo tipo de actividad en los geoglifos.

En la actualidad el impresionante resultado final de muchos siglos de actividades que continua en el desierto de la cuenca de Nasca se suele observar desde el aire. Esta perspectiva negada a los constructores y los usuarios de los geoglifos resulta ser un obstáculo para la interpretación de ellos. A diferencia de hoy, en el tiempo de su uso, los geoglifos fueron un elemento de un paisaje dinámico, activo y sujeto a cambios constantes en relación estrecha con los valles habitados. En ellos se llevó a cabo una actividad casi constante y diversificada. Las plataformas de piedra, los postes de madera y, sobre todo, los hombres que hoy en día están ausentes, deben haber estado en el centro de la percepción en su tiempo. Estas reflexiones deben considerarse en todas las interpretaciones de los geoglifos.

Un registro fotogramétrico de los geoglifos en combinación con una documentación detallada en el terreno ha producido numerosos datos nuevos que permiten, por vez primera, crear un archivo digital de un grupo geográficamente delimitado de geoglifos. La metodología aplicada, sin embargo, tiene sus límites. De esta manera, el tiempo disponible no alcanzó para una documentación total de todos los geoglifos de Palpa ni para un registro sistemático de los hallazgos de cerámica. Las fotos aéreas no permitían una documentación buena de las figuras antropomorfas tempranas, ubicadas en las laderas.

Pese a estas limitaciones se percibe el potencial de la metodología aplicada. Sobre la base de los datos registrados se pudo probar, por vez primera, un modelo explicativo actual, contrastándolo con los contextos arqueológicos. Esta aplicación demuestra que aún se llega a conocimientos nuevos, pese a todo lo que se ha publicado sobre el tema, si se combina razonablemente la investigación arqueológica básica con los métodos de las disciplinas afines. En este sentido el presente trabajo pretende animar la realización de trabajos futuros en Palpa y Nasca.

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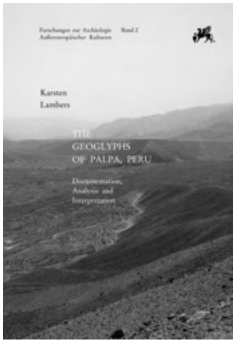
Hrsg. v. Kommission für Archäologie Außereuropäischer Kulturen, Bonn, des Deutschen Archäologischen Instituts, Berlin



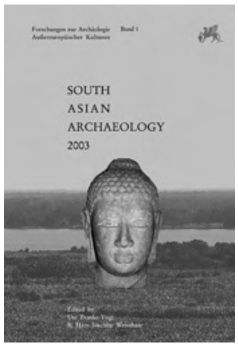
Forschungen zur Archäologie Außereuropäischer Kulturen (FAAK), Band 2 (2006)

Karsten Lambers, THE GEOGLYPHS OF PALPA, PERU – Documentation, Analysis, and Interpretation

The Geoglyphs of Palpa, Peru is a revision of the author´s Ph.D. thesis. In this study, the famed geoglyphs of the Paracas and Nasca cultures on the south coast of Peru are investigated in order to better understand their function and meaning. Combining aerial photogrammetry, archaeological fieldwork, and GIS-based analysis, more than 600 geoglyphs in the vicinity of the modern town of Palpa were recorded and analyzed. This interdisciplinary approach enabled the establishment of the first digital archive of these prehispanic monuments. It also led to important new insights into the origin, development, and spatial context of the geoglyphs. The Palpa dataset was furthermore used to test a recent model that explains the function and meaning of the Nasca geoglyphs in terms of Andean social, cultural, and religious traditions. The results of this study indicate that the ancient activities which took place on the geoglyphs revolved around concepts of water and fertility, and were a means of expressing social status and cultural concepts. The geoglyphs integrated the desert into the cultural landscape of the valley-based Paracas and Nasca societies, and were thus a valuable cultural resource that can still be appreciated today.

184 pages, soft binding, 82 illustrations (tables, figures, and maps; colour/b&w), 10 folded supplements, 1 DVD, hard cover box, 19 × 29 cm

ISBN 3-929290-32-4 www.lindensoft.de/Palpa



Forschungen zur Archäologie Außereuropäischer Kulturen (FAAK), Band 1 (2005)

SOUTH ASIAN ARCHAEOLOGY 2003
– Proceedings of the 17th International Conference of the European Association of South Asian Archaeologists (7–11 July 2003, Bonn), edited by Ute Franke-Vogt & Hans-Joachim Weisshaar

The Seventeenth International Conference on South Asian Archaeology was held in Bonn from 7th–11th July 2003. The conference was jointly hosted and organized by the *Kommission für Archäologie Außereuropäischer Kulturen* (previously the *Kommission für Allgemeine und Vergleichende Archäologie*) and the *Eurasien-Abteilung* of the German Archaeological Institute.

Nearly 200 scholars and students from Asia, Europe, America, and Australia participated in the conference. More than 100 lectures were given and poster-sessions were presented by those researchers, who could not be incorporated into the lecture programme.

Finally 66 papers on South Asian Archaeology found their way into the proceedings – covering topics from Upper Palaeolithic Rock Art in Balochistan to life and times of Sir Mortimer Wheeler in India in the Late 40s.

600 pages, 66 articles, c. 700 line drawings and b&w photographs; 19 × 29 cm, hard cover

ISBN 3-929290-31-6 www.lindensoft.de/SAA

Forthcoming/In Vorbereitung:

Forschungen zur Archäologie Außereuropäischer Kulturen (FAAK), Band 3 (2006)

IN KAISERLICHEM AUFTRAG
– Die Deutsche Aksum-Expedition 1906 unter Enno Littmann, Band I: Die Akteure und die wissenschaftlichen Unternehmungen der DAE in Eritrea, herausgegeben von Steffen Wenig & Burkhard Vogt

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Forschungen zur Archäologie Außereuropäischer Kulturen (FAAK), Band 4 (2006)

TRADITION UND WANDEL
– Untersuchungen zu Gräberfeldern der Westlichen Han-Zeit (206 v.Chr. – 9 n.Chr.).
Margarete Prüch, *Das Gräberfeld von Fenghuangshan, Jiangling, Provinz Hubei*; Annette Kieser, *Das Gräberfeld von Linyi, Provinz Shandong*

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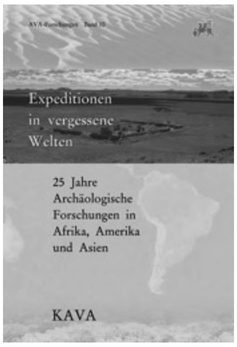
Forschungen zur Allgemeinen und Vergleichenden Archäologie*



AVA-Forschungen Band 10 (2005)

Kommission für Allgemeine und Vergleichende Archäologie, EXPEDITIONEN IN VERGESSENE WELTEN – 25 Jahre Archäologische Forschungen in Afrika, Amerika und Asien.

Im Jahre 1979 wurde anläßlich des 150jährigen Bestehens des Deutschen Archäologischen Instituts die *Kommission für Allgemeine und Vergleichende Archäologie* gegründet. Der zum 25jährigen Bestehen der *KAVA* herausgegebene Band gewährt anschaulich und allgemeinverständlich einen Einblick in die aktuellen Forschungsprojekte der Kommission in Amerika, Afrika und Asien. In dem reich bebilderten Band wird die Arbeit der Kommission durch Ausgrabungen in den Küstenregionen Südasiens, zum Mittelalter im nepalesischen Hochgebirge und in der äußeren Mongolei, zum Paläolithikum in Nordafrika, zum antiken Wasserbau im Yemen und zu den präkolumbischen Kulturen Südamerikas vorgestellt.

272 Seiten, 220 farbige Abbildungen, 19 × 29 cm, broschiert

ISBN 3-929290-30-8 www.lindensoft.de/Buecher

AVA-Forschungen Band 9 (2005)

Jörg Linstädter, ZUM FRÜHNEOLITHIKUM DES WESTLICHEN MITTELMEERRAUMS – Die Keramik der Fundstelle Hassi Ouenzga

Der Autor stellt eine der derzeit wichtigsten frühneolithischen Fundstellen Nordwest-Afrikas vor. Im Mittelpunkt seiner Untersuchung steht die Keramik, deren Analyse eine chronologische und räumliche Differenzierung des mediterranen Neolithikums in Nordwest-Afrika erlaubt.

Parallel wird mit Hilfe italienischer, französischer, spanischer und portugiesischer Fundstellen ein Überblick zum gesamten westmediterranen Frühneolithikum gegeben, sowie aktuelle Modelle zu dessen Entstehung diskutiert. Als Ergebnis wird ein unabhängiges Modell zur Neolithisierung des mediterranen Nordwest-Afrika entworfen.

211 Seiten, 74 z. T. farbige Abbildungen, 36 Tabellen, 20 Tafeln, 1 CD-ROM, 19 × 29 cm, broschiert

ISBN 3-929290-29-4 www.lindensoft.de/Buecher

AVA-Forschungen Band 8 (2002/2003)

Johannes Moser, LA GROTTE D'IFRI N'AMMAR, TOME I: L'Ibéromaurusien

Die jüngeren Schichten von Ifri n'Ammar, einer jüngst entdeckten und ausgegrabenen Fundstelle im östlichen Rifgebirge Marokkos, bilden die Grundlage zu der hier vorgelegten umfassenden Studie. Der Autor gelangt über die Stratigraphie und den Datierungsrahmen (16 000 – 10 000 B.P.) zu einer weitreichenden Neugliederung der reichen lithischen Industrien des Ibéromaurusien. Ein umfangreicher Abbildungsteil begleitet diese erste monographische Bearbeitung eines für den gesamten Maghreb bedeutsamen Schlüsselfundplatzes.

Französisch, 196 Seiten, 68 Abbildungen. z.T. farbig, 20 Tabellen, 32 Tafeln, z.T. farbig 19 × 29 cm, broschiert,

ISBN 3-929290-28-6 www.lindensoft.de/Buecher

AVA-Forschungen Band 7 (2002)

Andreas Reinecke, Nguyễn Chiều & Lâm Thị Mỹ Dung, NEUE ENTDECKUNGEN ZUR SA-HUỲNH-KULTUR – Das Gräberfeld Gò Mả Vôi und das kulturelle Umfeld in Mittelvietnam

Im Mittelpunkt dieses zweisprachig in Deutsch und Vietnamesisch verfaßten Bandes stehen die über 2000 Jahre alten Gräber mit ihren zahlreichen Beigaben von Gò Mả Vôi in der Provinz Quảng Nam in Mittelvietnam. Es handelt sich um eine der größten und kulturgeschichtlich interessantesten Fundkollektionen der in Mittel- und Südvietnam weit verbreiteten Sa-Huỳnh-Kultur (etwa 5. Jh. v. Chr. – 1. Jh. n. Chr.). Alle Funde wurden bei Sondagen und Ausgrabungen von 1998 bis 2000 geborgen, wobei die Ausgra-

* Herausgegeben von der *Kommission für Allgemeine und Vergleichende Archäologie*, jetzt *Kommission für Archäologie Außereuropäischer Kulturen*, Bonn, des Deutschen Archäologischen Instituts, Berlin. Erschienen bis Band 10, 2005. Fortgesetzt mit neuer Zählung als *Forschungen zur Archäologie Außereuropäischer Kulturen*, FAAK.

bungen im Jahr 2000 in ein langfristiges deutsch-vietnamesisches Forschungsprojekt des Deutschen Archäologischen Instituts und der Hochschule für Gesellschafts- und Humanwissenschaften der Staatlichen Universität Hanoi mündeten. Niemals zuvor in der 100-jährigen Geschichte archäologischer Forschung in Vietnam gelang es, unter den extrem schwierigen Arbeitsbedingungen die Hinterlassenschaften einer Fundstelle so umfassend in einem Katalog zu beschreiben und auf über 100 meist farbigen Abbildungen zu dokumentieren. Darüber hinaus gibt diese Publikation einen ersten Einblick in die Kulturgeschichte Mittelvietnams anhand von Verbreitungskarten und bisher unveröffentlichten Bildmaterialien.

Deutsch/Vietnamesisch, 233 Seiten, 122 farbige Abbildungen und 2 Faltkarten, 15 × 23 cm, broschiert

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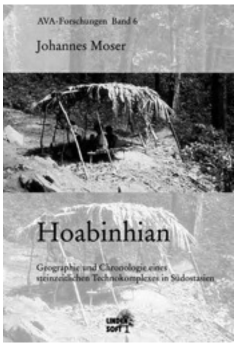

AVA-Forschungen Band 6 (2001)

Johannes Moser, HOABINHIAN – Geographie und Chronologie eines steinzeitlichen Technokomplexes in Südostasien

In einer Synthese zu dieser zwischen Laos, Kambodscha, Vietnam und dem südostasiatischen Archipel verbreiteten steinzeitlichen Kulturgruppe stellt der Autor erstmals übergreifend ihre Definition und Entwicklung dar. Die Daten des Hoabinhian reichen von 16000 bis 6000 B.P., möglicherweise bis in keramikführende Horizonte. Verwandte Industrien finden sich von Nepal bis in den Norden des australischen Kontinents. Der Synthese an die Seite gestellt ist ein geographisch gegliederter und kommentierter Katalog aller einschlägigen Fundorte.

256 Seiten, 52 Abbildungen, 25 Tabellen, 60 Tafeln und 1 Faltkarte, 15 × 23 cm, broschiert

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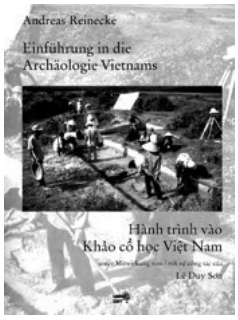


AVA-Forschungen Band 5 (1998)

Andreas Reinecke, EINFÜHRUNG IN DIE ARCHÄOLOGIE VIETNAMS / Hành trình vào Khảo cổ học Việt Nam

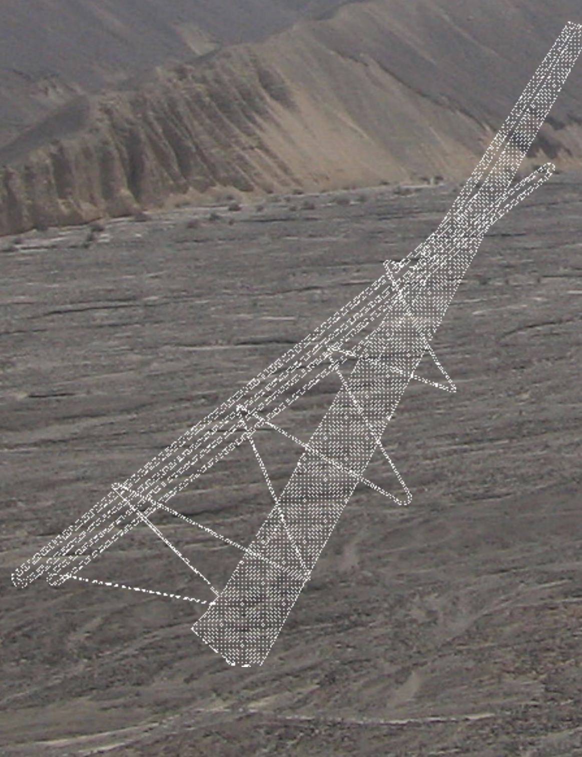
Dieser zweisprachig in Deutsch und Vietnamesisch verfaßte Überblick über die Besonderheiten und die Geschichte archäologischer Forschung und die vorgeschichtlichen Kulturen in Vietnam entstand aus einer Lehrveranstaltung an der Universität Hue. Durch die vielen neuen Fakten über die Archäologie Vietnams ist dieses Buch sowohl für vietnamesische Studenten und Fachleute als auch für alle anderen Leser im In- und Ausland informativ, die sich für Vietnam besonders interessieren.

Deutsch/Vietnamesisch, 220 Seiten, 87 Abbildungen und 1 Faltkarte, 15 × 21 cm, broschiert

ISBN 3-929290-04-9 www.lindensoft.de/Buecher

The Geoglyphs of Palpa, Peru is a revision of the author´s Ph.D. thesis. In this study, the famed geoglyphs of the Paracas and Nasca cultures on the south coast of Peru are investigated in order to better understand their function and meaning. Combining aerial photogrammetry, archaeological fieldwork, and GIS-based analysis, more than 600 geoglyphs in the vicinity of the modern town of Palpa were recorded and analyzed. This interdisciplinary approach enabled the establishment of the first digital archive of these prehispanic monuments. It also led to important new insights into the origin, development, and spatial context of the geoglyphs. The Palpa dataset was furthermore used to test a recent model that explains the function and meaning of the Nasca geoglyphs in terms of Andean social, cultural, and religious traditions. The results of this study indicate that the ancient activities which took place on the geoglyphs revolved around concepts of water and fertility, and were a means of expressing social status and cultural concepts. The geoglyphs integrated the desert into the cultural landscape of the valley-based Paracas and Nasca societies, and were thus a valuable cultural resource that can still be appreciated today.

Karsten Lambers is an archaeologist with the Commission for Archaeology of Non-European Cultures (KAAK, Bonn) of the German Archaeological Institute (DAI, Berlin). He obtained his MA in American Anthropology from the University of Bonn in 1998, and his Ph.D. in Pre- and Protohistory from the University of Zurich in 2004. During his university studies he conducted archaeological fieldwork in Germany, Mexico, and Bolivia. Since 1999 he has been engaged in the Nasca-Palpa Project in southern Peru where he is investigating the geoglyphs of the Paracas and Nasca cultures in Palpa and Nasca in close cooperation with the Swiss Federal Institute of Technology (ETH Zurich). Currently his main research interests cover the use of geomatic technologies (photogrammetry, remote sensing, GIS) in archaeology, landscape studies, and the archaeology of the prehispanic cultures of Mesoamerica and the Andes.



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