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40. The Harappa Project 1986-1989: New Investigation at an Ancient Indus City

with Contributions by
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I. EXCAVATION AND OVERVIEW

INTRODUCTION

HARAPPA has a special place in Indus studies. It was there, a century and a half ago, that Charles Masson made the first references to Harappa and the Indus Civilization (1842: 452). Subsequent random discoveries, mostly of inscribed seals, eventually attracted the attention of the Indian Government but it was not until 1920 that the Archaeological Survey of India officially protected the site and opened a systematic program of excavations, (for reports on the preliminary work see Annual Reports of the ASI for 1920-21, 1923-24, 1924-25 and Sahni 1922). The most extensive excavations were conducted by M.S. Vats between 1926 and 1934-1940. A major event accurred in 1937 when K.N. Shastri discovered Cemetery R. 37 (1965). R.E.M. Wheeler conducted important excavations in the cemetery and on the Citadel Mound AB in 1946 (1947) and Dr. Mhd. Rafique Mughal expanded excavations in the Harappan period cemetery in 1966-1968. (Fig. 40.1).

These investigations provided important clues to the research potentials at Harappa in spite of its one major drawback, namely, during the mid-19th century, the site was severely damaged by railroad contractors who mined bricks for construction of the Lahore-Multan tracks. This disturbance had always posed an obstacle to new excavations but archaeology as a science has advanced dramatically during the past twenty years and new techniques allow more sensitive recovery and recording of the remains than were possible in the earlier years.

Following negotiations in 1984 with the then Director-General of Archaeology, Mhd Ishtiaq Khan, a three-year license was issued for the years 1986-1988. This was renewed for a second three years to 1991 by the current Dirctor-General, Dr. Ahmed Nabi Khan who has been providing generous support and encouragement for this cooperative venture of the University of California at Berkeley and the Pakistan Department of Archaeology.

OVERALL RESEARCH OBJECTIVES

The long-term objectives of the research focus on developing a better understanding of the cultural, economic and social history of Harappa as a discrete urban phenomenon and also its role in the development and life of the Indus Civilization as a whole.

In the context of the mid-third millennium B.C., a site of this size was not born fully formed, but must have grown out of a smaller, pre-urban settlement. Wheeler's excavations in 1946 had, in fact, turned up Early Harappan (Kot Diji related) sherds beneath massive structures along the western edge of the Citadel Mound E (Wheeler 1947). A major objective of the Harappa project has been to locate

in Harappan Civilization: A Recent Perspective, 2d ed., Gregory L. Possehl, ed. New Delhi: Oxford & IBH Publishing Pvt. Ltd., 1993.

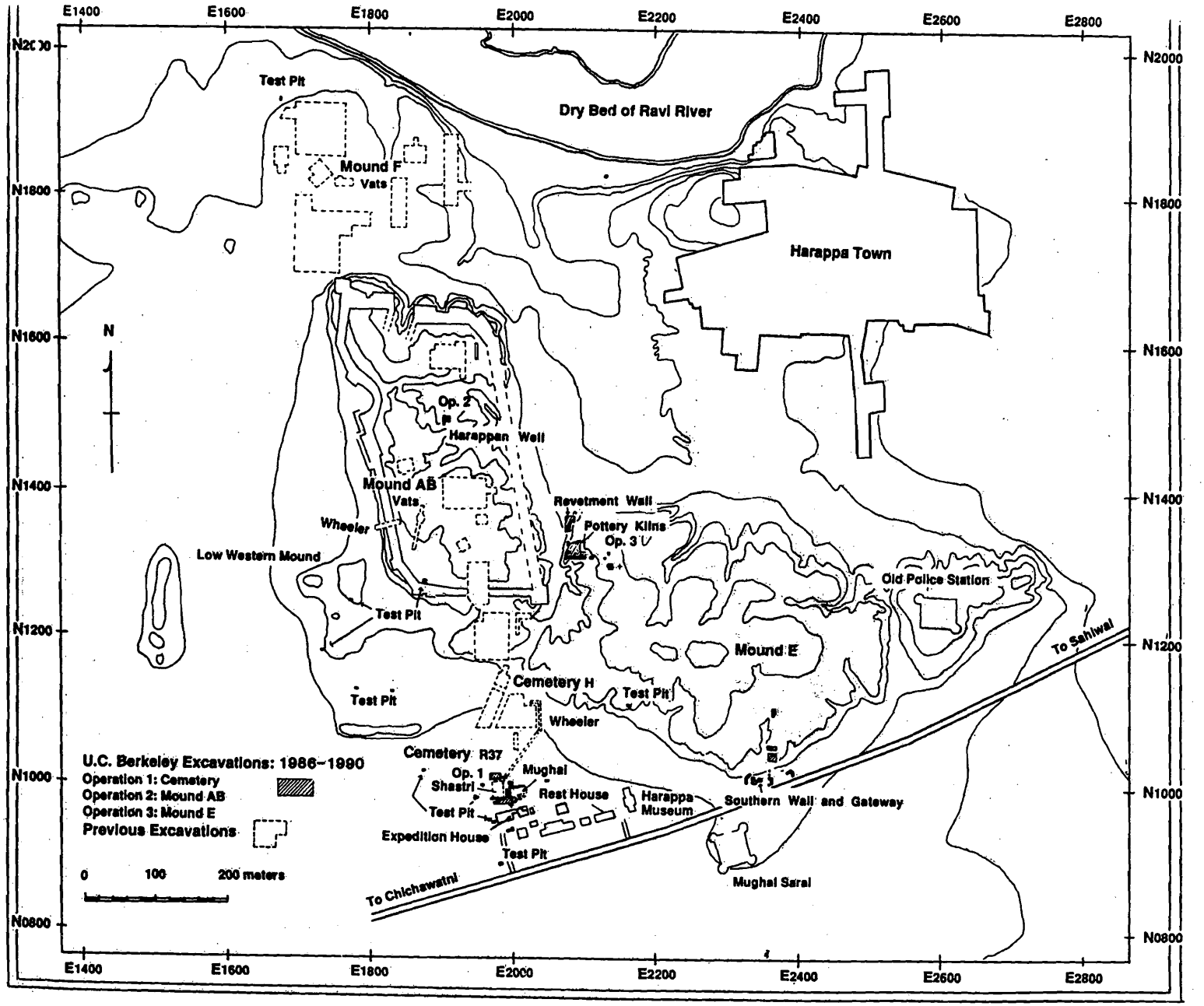


Fig. 40.1. Site plan of Harappa showing areas of excavations.

the Early settlement and to investigate as many factors as possible relating to the chronological, cultural and technological relationships between the Early and Mature Indus settlements.

The current research at Harappa includes the reconstruction of the prehistoric environment and the ecological setting through the study of the soils and sediments—both natural and anthropogenic—within and surrounding the site as well as through the study of the palaeobotanical and faunal remains.

Very little was published by the earlier excavators relating to the daily life of the Harappans, their subsistence patterns, settlement patterns, or socio-economic structures. The new project is addressing these types of issues with methodologies and scientific procedures not available to the earlier excavators.

Another aspect of Harappan life that is of special interest is ritual activity. At no site of the Indus culture has a temple or ritual structure been irrefutably identified. On the other hand, the largest sites such as Harappa and Mohenjodaro have yielded scores of figurines and other artifacts that suggest some sort of ritual or symbolic practices. Through the correlation of stylistic features and spatial distributions of figurines and other symbolic objects it may be possible to identify general aspects of cultic and religious practices that may or may not have been associated with specific architectural structures.

In addition to the habitation areas of the site, we have focused excavations on the Harappan cemetery dating to the Urban Phase. The new excavations have provided a wide range of information on Harappan burial practices as well as the physical characteristics of the urban population, new information regarding sex and age, disease, trauma, stress, diet, and causes of death.

Another interest relates to the enigmatic Indus script. After 70 years of decipherment efforts we are still unable to understand this ancient script, the language it represents, and its functions within Harappan society. Continuing excavations at the site may turn up longer texts or a bilingual inscription that would provide new insights into these questions.

Essential to the pursuit of the above goals is the establishment of a secure internal relative chronological framework, enhanced with "absolute" dates derived from radiocarbon analysis. No comprehensive internal chronology exists for Harappa, nor is its precise relative position within the Indus Civilization certain.

Many of the specific studies of artifacts, technology and site formation processes etc. are being supplemented with problem-oriented experimental and ethnographic research. The present town of Harappa and the surrounding settlements provide a unique opportunity to study the organization of occupational specialists, especially craftsmen, and how this organization is reflected in the archaeological record. We are also conducting experimental reconstructions of ancient technologies using locally available raw materials. The types of manufacturing waste and the finished artifacts themselves provide important comparative materials for more reliable interpretations of the archaeological data.

This report presents an overview of the current state of research at Harappa, with summaries of the major findings from the first four seasons (1986-89) and an addendum with a brief description of important discoveries and developments during the January-March 1990 season.

DEFINITION OF TERMS AND THE CULTURAL SEQUENCE

Over the past fifty years, different labels have been used for the stages of cultural development in the greater Indus Valley, such as pre-Harappan, Early Harappan, Early Indus, Mature Harappan, Late Harappan, Post Harappan, and Cemetery H. All have the common feature of implying a uniform linear development. Often the same label has been applied to what may in fact be regional variations, thereby resulting in a confusing overlap of what should be distinguishing cultural features.

In our own preliminary reports we have used some of these terms in a very general and undefined manner to communicate the general association of artifacts and structural units with one or the other cultural phase. However, from the rapidly accumulating new evidence at Harappa, it is clear that there are significant temporal and regional variations that have become obscured by the continued use of these terms. It is proving helpful to use more objective terms to distinguish the cultural, technological and socio-economic sequences of events at Harappa. In this and subsequent reports we will use

the designations of Period I, II, III, IV and V. These Periods have no innate reality but have considerable heuristic value for ordering the masses of new material and for focusing analyses on specific questions of continuity and/or discontinuity. They are described here in general terms and will be related to the more commonly used terms with necessary qualifications.

Period I

The earliest levels of the site contain ceramics related to Kot Dijian ceramics from Kot Diji (Khan 1965; Mughal 1970), Jalilpur II (Mughal 1974), Rehman Dheri I, II and III (Durrani 1989), Sarai Khola (Halim 1970-71, 1972), and sites in the Bannu region (Khan, Knox, and Thomas 1988). These ceramics are associated with what Dr. Mughal defined as the Early Harappan, or formative phase of the Indus Civilization (Mughal 1970) and with Possehl's (1977) Pre-urban Harappan (Fig. 40.2).

Period II

Period II levels are characterized by the construction of massive mud brick revetments or retaining walls at the periphery of the mound as revealed so far at the northwestern corner of Mound E. In certain areas there is evidence for the construction of massive platforms or foundations inside the peripheral walls. These structures are associated with numerous strata containing ceramics identical to those in Period I. However, in the later levels of Period II there are some stylistic and morphological changes in the ceramics that may reflect a continuous development or a synthesis of different cultural elements leading up to the ceramic styles of the Mature Harappan. (Figs. 40.3 and 40.4).

Period III

Period III comprises those cultural, stylistic and technological features that are commonly associated with the "mature" urban Indus period as known from other sites throughout the greater Indus Valley. It is distinguished at Harappa, at the northwestern edge of Mound E, by the construction of massive retaining walls of baked brick, directly above the earlier mud brick structures of Period II. On the upper slope there is evidence for massive mud brick platforms that consolidate the edge of the mound and provide foundations for other structures. On the top of Mound E, Period III is represented by streets and drains together with mud brick and baked brick structures oriented in the cardinal directions.

The associated pottery is related to that of the Mature Indus Civilization that has been documented at Harappa (Vats 1940) and Mohenjodaro (Marshall 1931, Mackay 1943, Dales and Kenoyer 1986). Also there are distinctive seals, tokens, chert weights, metal objects, figurines, terracotta artifacts of many types, and the so-far undeciphered Indus script.

Period IV

The Period IV designation refers to stratigraphic deposits on Mound E and possibly on Mound AB containing ceramics which are not readily identified as either Mature Harappan or Late Harappan/ Cemetery H. They appear to represent a transitional development between these two otherwise distinctive cultural occupations. On the basis of ceramic styles and morphology, some of the latest burials in our cemetery excavations, as well as some of the early burials in the Cemetery H excavation by Vats (1940), may be associated with Period IV.

The precise distinction and characterization of this period will be possible only after more extensive exposures of the pertinent levels are made and the ceramics and other artifacts have been fully studies.

Period V

The final occupation of the protohistoric period is characterized by Cemetery H or Late Harappan ceramics as first defined by Vats (1940) and later by Wheeler (1947). Most of the strata with these ceramics have been obliterated by brick robbing, but there are isolated units on Mound E where undisturbed levels have been identified.

Mound E

Most of the Period V occupation deposits had been obliterated by brick robbing and erosion, however in one small area a mud brick platform and drain was found associated with Period V pottery. The drain was made from baked bricks that were smaller than the earlier Period III bricks, however, the proportions are still the same (1:2:4). In addition to the distinctive pottery, there are other categories of artifacts such as faience objects and some distinctive figurines associated with the pottery that may also be related to this period.

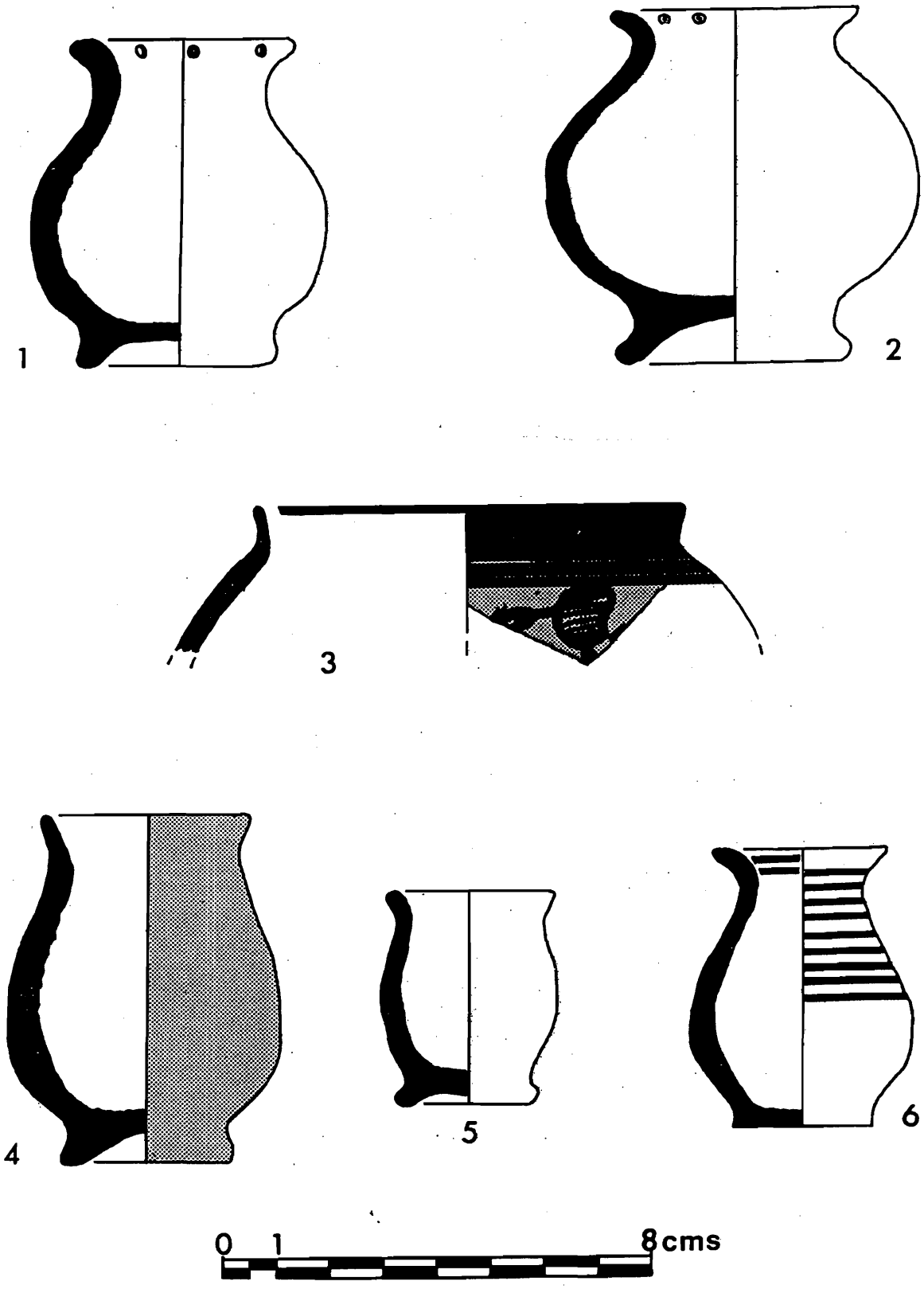


Fig. 40.2. Pottery: from Early (Period I).

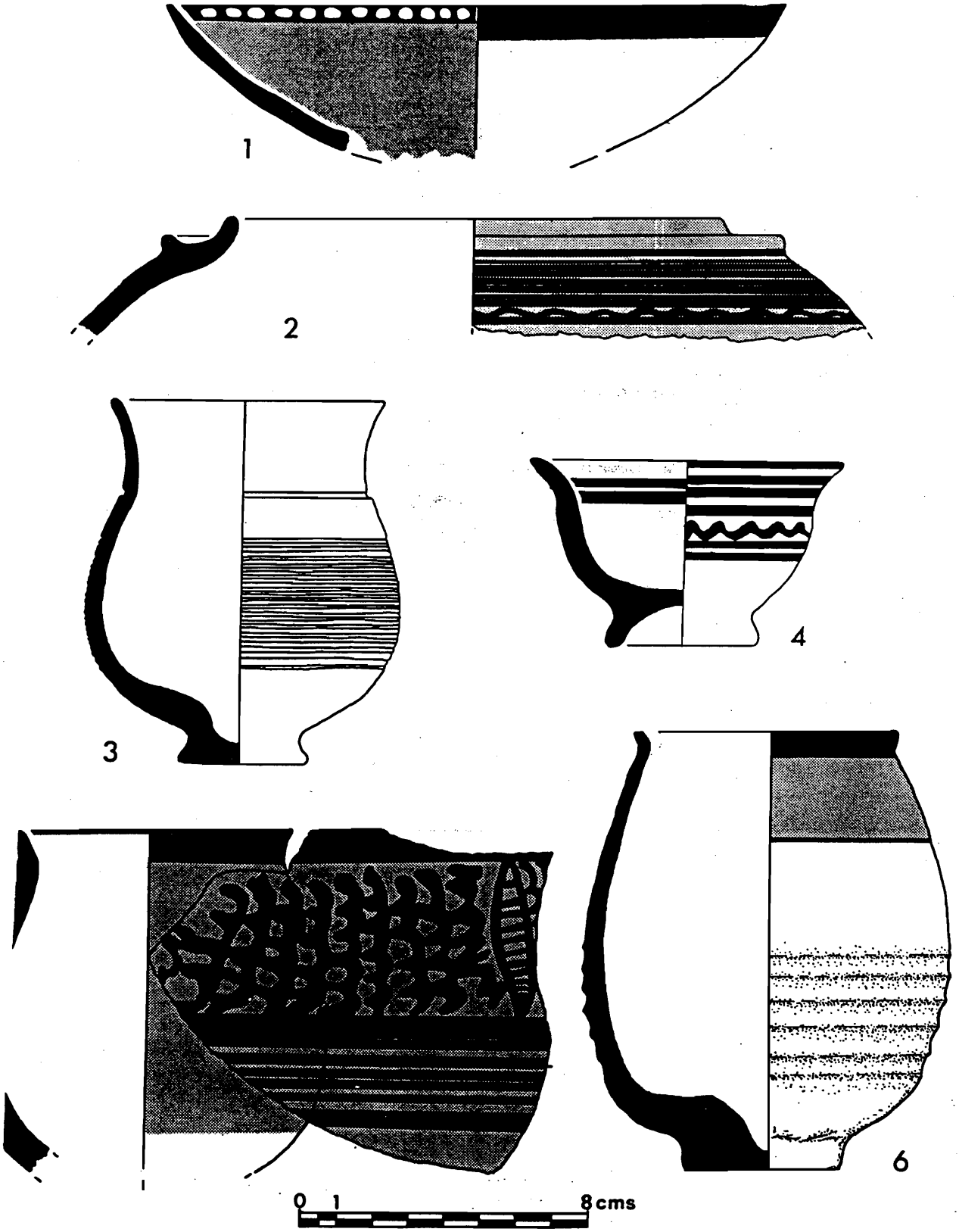


Fig. 40.3a. and 40.3b. Transitional (Period II) levels.

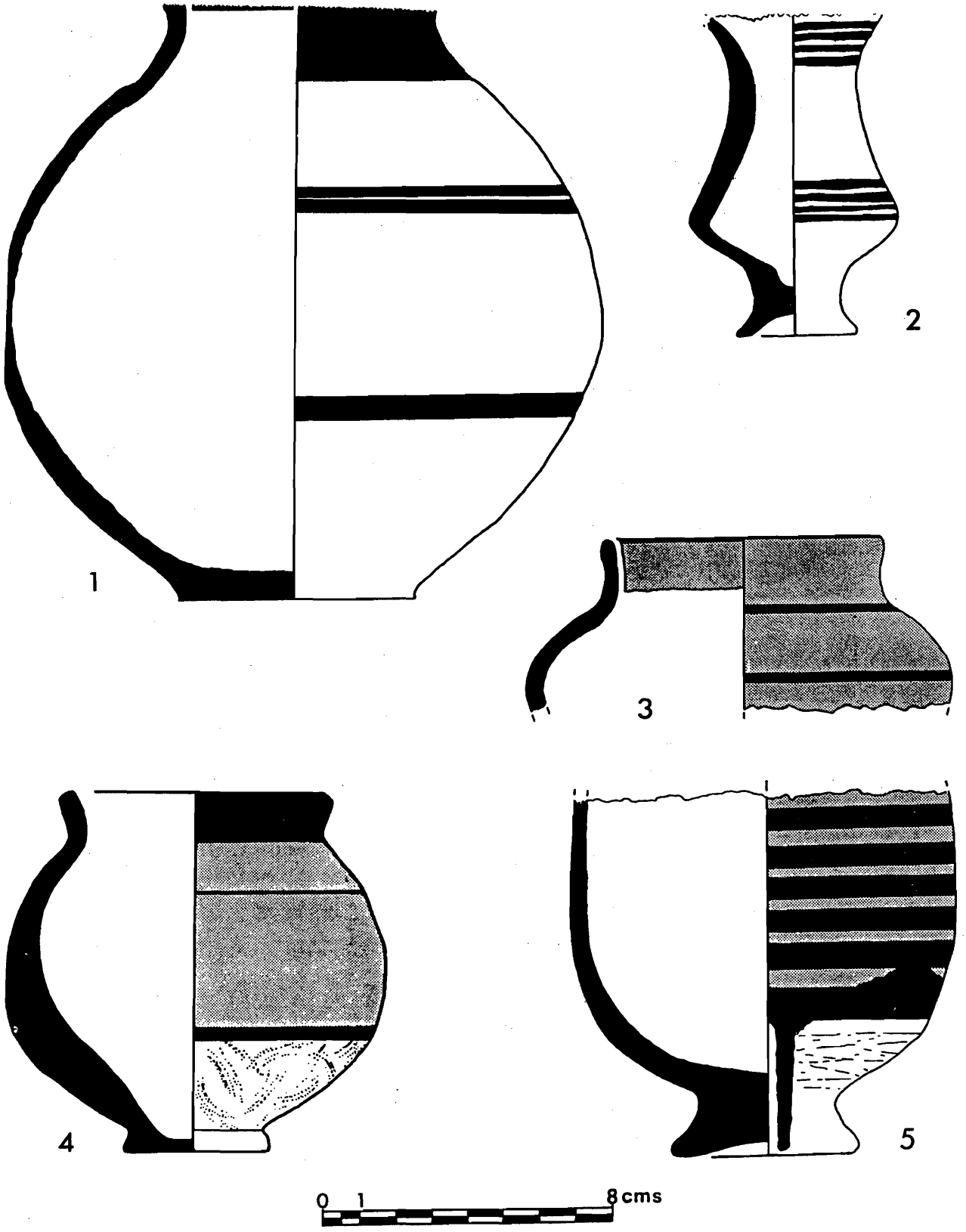


Fig. 40.3b.

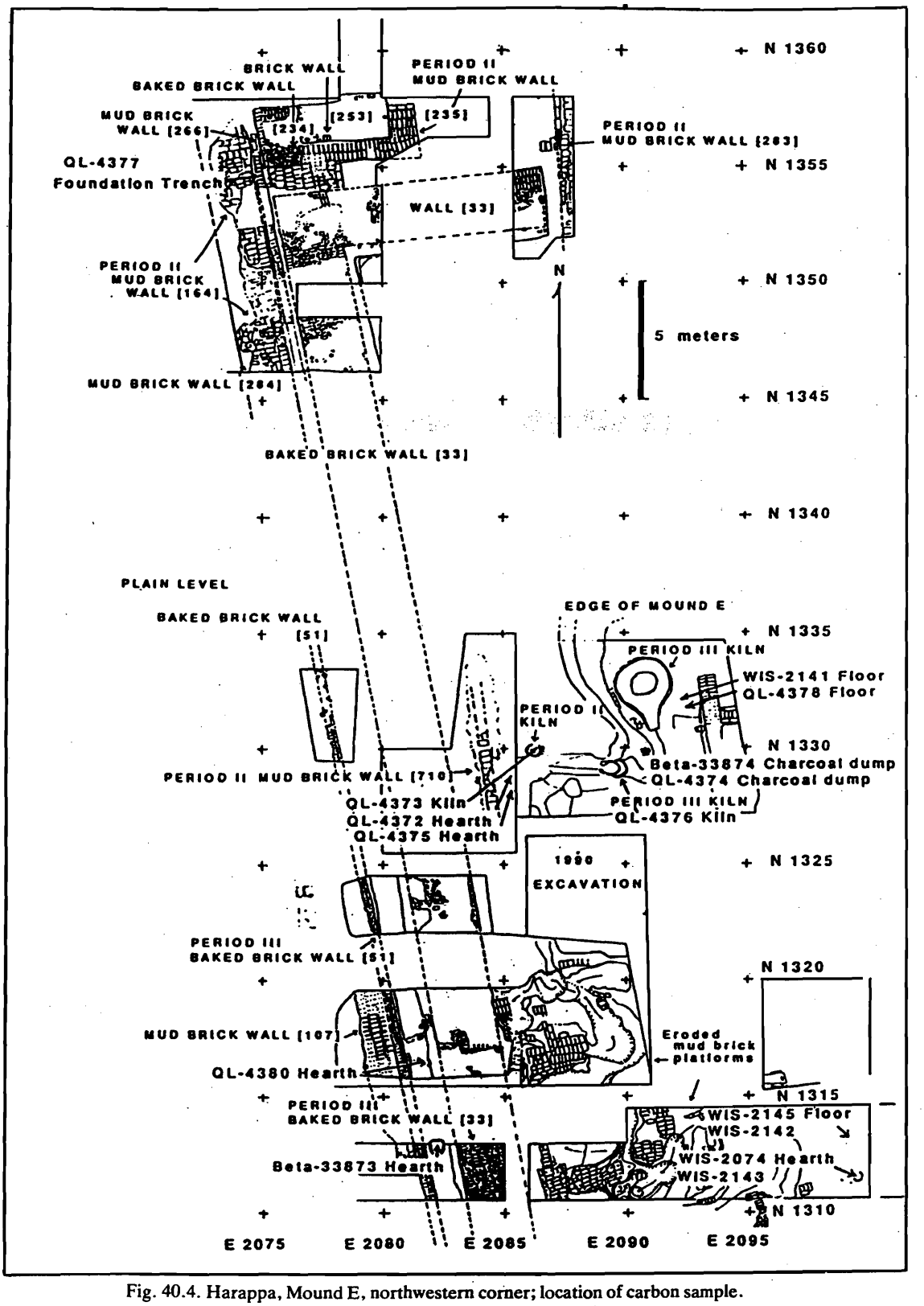


Fig. 40.4. Harappa, Mound E, northwestern corner; location of carbon sample.

Mound AB

Surface surveys in 1987 and 1988 revealed a considerable quantity of Period V (Cemetery H) pottery in the uppermost surface of the Mound. Both sides of the large gully we selected for deep excavations in 1987-88 were covered with these sherds. During the 1989 season a long north-south trench was excavated at the top of the western edge of the gully in hopes of finding *in situ* architectural or other habitational features. Unfortunately, the uppermost levels were found to be badly disturbed by brick robbing activities and modern burials that were not apparent on the surface. Because of the burials it was not possible to fully expose the area, but it appears from the vertical sections on the gully side of this area that the mud brick structures we had expected to belong to Period V actually date to Period III or IV.

The earlier excavators also found fragmentary evidence for several subsequent occupations that can be attributed to the Early Historic/Buddhist, Medieval, Islamic and British Periods. We have not yet encountered significant stratigraphic evidence for these occupations and they will not be discussed in this report.

SURFACE SURVEYS AND TEST PITS

During each season, systematic surface surveys have been made of the mounded area and the immediate environs in order to locate undisturbed areas and areas of specialized activities and to help in selecting locations for excavations. For a discussion of the survey methodology and sampling strategies see Dales and Kenoyer (1989) (Pakistan Archaeology 1990).

The physical limits of the site have not yet been defined by extensive excavations, but it is evident from the surface surveys, test pits, and systematic corings made during 1987-1988, that the site is much larger than previously supposed, possibly as large as 150 hectares instead of the 45 hectares which Vats refers to for the higher mounded area.

On the evidence derived from the surface surveys and subsequent test pits, several areas were selected for more extensive excavations. The results of these excavations are discussed below within the framework of the period designations that we have defined above (Fig. 40.1).

RADIOCARBON DATES

At the present time a total of 21 carbon samples from the recent excavations at Harappa have been dated (Table 40.1). Additional samples from the excavations are still being processed. Twenty of the dated samples were processed using the conventional radiocarbon method and one sample was dated with Accelerator Mass Spectrometer in Zurich (Beta-33873, ETH-5949).

These various samples come from two different mounds. Four of the dates are from Period III, Mature Harappan floor levels and fill below the floors on Mound AB, while the remaining samples come from the northwestern corner of Mound E (Figure 40.5). The samples from Mound E span the total occupation of this portion of the mound, beginning with the earliest hearth on natural soil (Period I) and ending with the uppermost undisturbed habitation levels of the Period III, Mature Harappan occupation.

In the table and graphs given, the dates have been arranged in their relative stratigraphic position on Mound AB and Mound E. The earliest date is obtained by using AMS technique and comes from a hearth of the Period I, Early Harappan occupation on Mound E. This hearth was situated just above the natural soil.

Period II, dates are from upper stratigraphic levels, between one and two meters higher than the hearth of Period I, Although these dates are very close to the dates of the following Period III, the dates from *in situ* hearths indicate a slightly earlier range (Figure 40.3a).

One sample of carbon (QL-4377) was obtained from a foundation trench between a large mudbrick wall of Period 2 and a smaller mudbrick wall of Period III. The objective of this sample was to determine the latest possible time frame for the construction of these structures. The piece of charcoal that was dated indicates that the latest structure could not have been built after 2198 B.C., 2151 B.C. or 2149 B.C. (based on CALIB program). This date falls quite well within the chronological framework of the Harappan Phase.

For Mound E, the Period III, dates show a wide range of variation and although every effort was made to take samples from what appeared to be undisturbed primary contexts, it is possible that

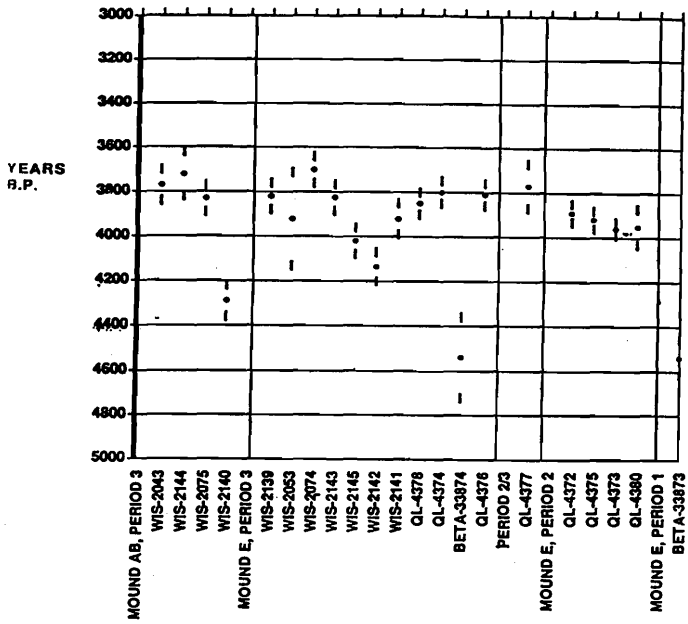


Fig. 40.5a. Harappa dates: 5568 B.P. Arranged stratigraphically.

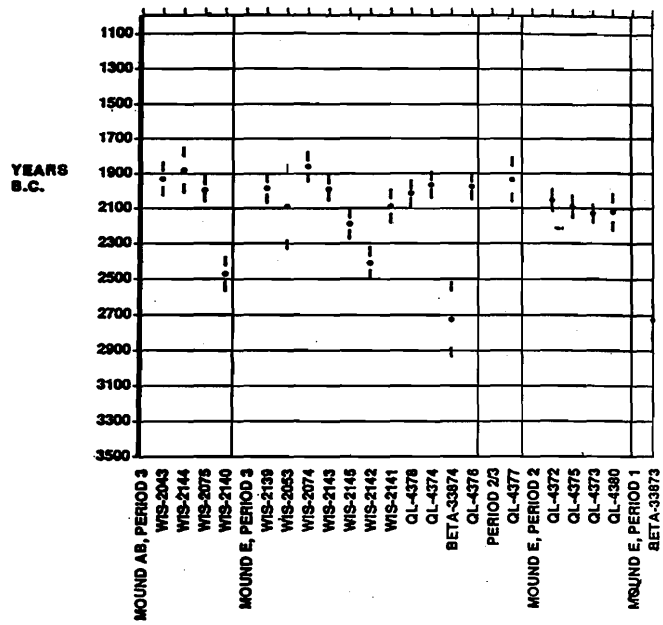


Fig. 40.5b. Harappa dates: 5730 B.C. Arranged stratigraphically.

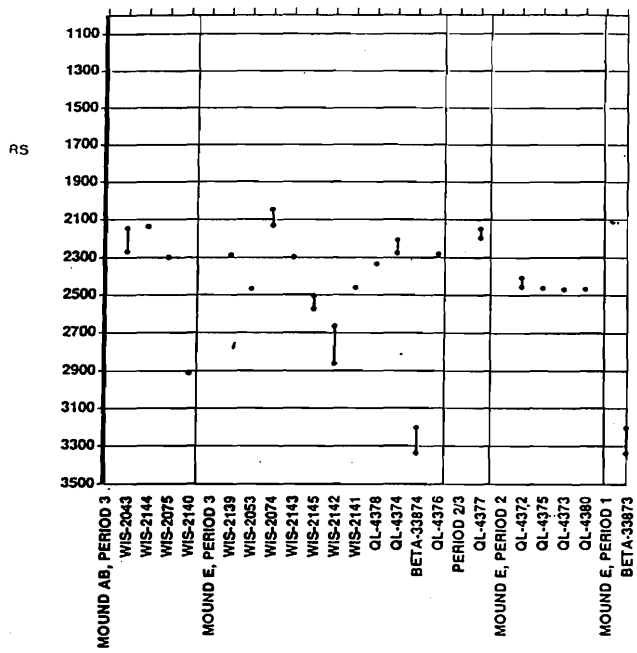


Fig. 40.5c. Harappa dates: Calibrated arranged stratigraphically.

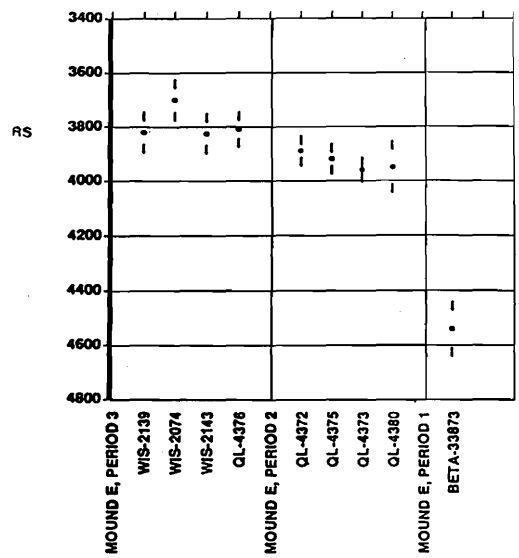


Fig. 40.6a. Harappa dates: 5568 B.P. Charcoal from inside hearths and kilns arranged stratigraphically.

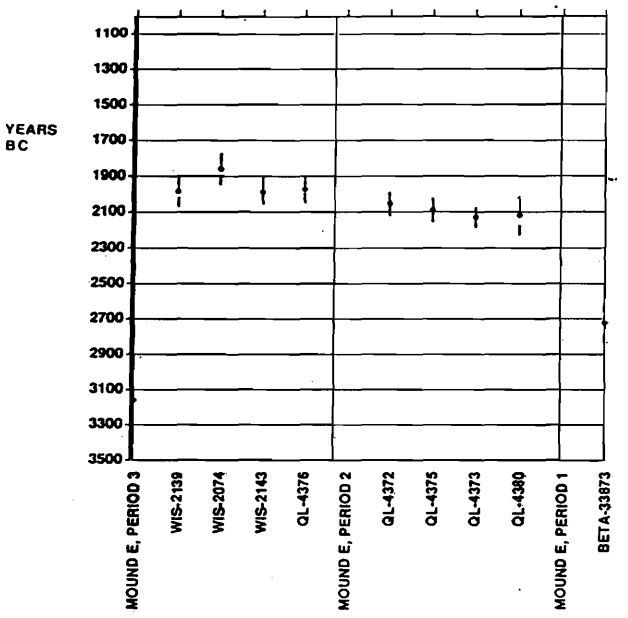


Fig. 40.6b. Harappa dates: calibrated charcoal from inside hearths and kilns arranged stratigraphically.

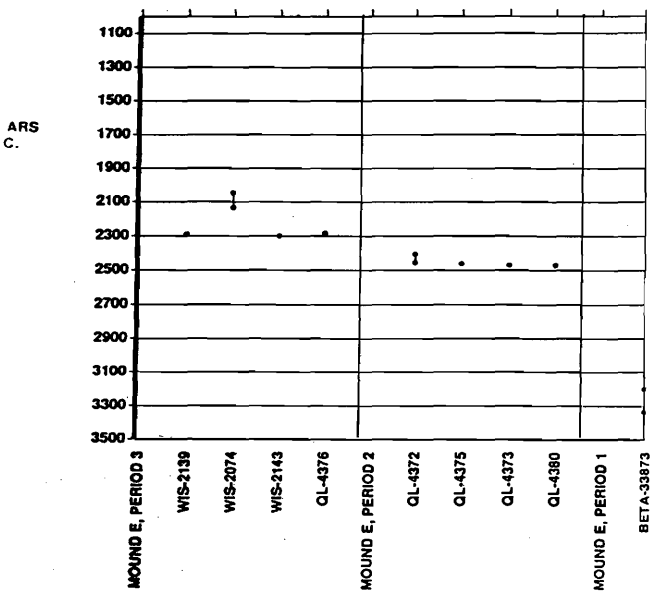


Fig. 40.6c. Harappa dates: calibrated charcoal from inside hearths and kilns arranged stratigraphically.

Table 40.1. Harappa dates arranged stratigraphically*

PROVENIENCE	5568 bp		5730 bc		CALIB bc
MOUND AB, PERIOD 3					
WIS-2043	3770	± 70	1930	± 70	2268, 2263, 2203, 2147, 2146
WIS-2144	3720	± 100	1880	± 105	2138
WIS-2075	3830	± 60	1995	± 60	2299
WIS-2140	4290	± 70	2470	± 70	2913
Mound E PERIOD 3					
WIS-2139**	3820	± 60	1985	± 60	2288
WIS-2053	3920	± 210	2090	± 215	2469
WIS-2074**	3700	± 60	1861	± 60	2133, 2067, 2047
WIS-2143**	3825	± 60	1990	± 60	2293
WIS-2145	4020	± 60	2190	± 60	2573, 2535, 2506
WIS-2142	4135	± 65	2410	± 65	2863, 2812, 2742, 2726, 2696, 2677, 2666
WIS-2141	3920	± 70	2090	± 70	2462
QL-4378	3850	± 50	2015	± 50	2334
QL-4374	3800	± 50	1965	± 50	2278, 2234, 2209
BETA-33874	4540	± 180	2725	± 185	3338, 3213, 3203
QL-4376*	3810	± 50	1975	± 50	2283
MOUND E	**PERIOD 2/3**				
QL-4377	3770	± 100	1935	± 105	2198, 2151, 2149
MOUND E PERIOD 2					
QL-4372**	3890	± 40	2055	± 40	2455, 2416, 2405
QL-4375**	3920	± 40	2090	± 40	2462
QL-4373**	3960	± 30	2130	± 30	2470
QL-4380**	3950	± 80	2120	± 80	2468
MOUND E PERIOD 1					
BETA-33873**	4530	± 85	2725	± 90	3338, 3213, 3203

* The dates Arranged According to the Specific Stratigraphy in each Area of the site. Mound AB dated can only correlated with Mound E dates on the basis of General Ceramic Comparisons, but they are approximately Equal to the period 3 dates from Mound E.

** These dates are from Charcoal Inside Hearths Or Kilns.

(Acknowledgement: Radiocarbon dates From the Radiocarbon Lab of the Center for Climatic Research, University of Wisconsin-Madison, were supported by the Climate Dynamics Program, National Science Foundation under grant ATM86-03295.)

some fragments of earlier carbon from platform fill may have contaminated these samples, producing anomolous dates. The most aberrant date is Beta 33874 and it is obtained from a small sample of charcoal from a pit filled with charcoal in front of the Mature Harappan Kiln [100]. A second sample from this pit (QL 4374) was dated by a different laboratory, and this date falls in the expected chronological and stratigraphic sequence. The difference between these two dates could be due to the sample size, since the BETA sample was quite small and has a large error factor. Another possible explanation is that the BETA sample was indeed a small fragment of earlier charcoal derived from the platform fill and not from the cleaning of the Mature Harappan kilns.

The remaining dates available for Period 3 come from stratigraphic units that begin with the earliest deposits containing Mature Harappan ceramics and continue to the latest undisturbed levels of the Mature Harappan phase. On both Mound AB and Mound E, there are between one and two meters of disturbed Mature Harappan occupation levels above the uppermost dated levels (WIS-2139 and WIS-2043). Consequently the latest dates can not be taken to represent the end of Period 3.

For Period III, (Mature Harappan) the dated samples range from 2913 B.C. to 2047 B.C. (based on CALIB program). Since 2900 B.C. is much earlier than dates reported at any other Harappan site, it is possible that the earliest dates (WIS-2140 and WIS-2142) are based on charcoal from the proceeding phase that has been mixed in with the fill on the floors of the Mature Harappan occupation.

By using only the dated from undisturbed hearths and kilns, which come from the middle of the stratigraphic sequence, the mid-range for Period 3 falls between 2293 B.C. and 2047 B.C. (based on CALIB program). It should be pointed out that even when he samples of carbon are taken from the same hearth (WIS-2074 and WIS-2143), there is possibility of a wide range in the counted date. However, given the ± 60 years for a one-sigma standard deviation, the two sigma deviation would be 120 years. For all practical purposes, these dates are identical.

EXCAVATIONS: General Descriptions of Areas

Mound AB

Mound AB dominates the western half of the mounded portions of the site and is generally referred to as the "citadel" mound (Fig. 40.1). The entire periphery of the mound is comprised of deep gullies that cut through eroding massive mud brick platforms, baked brick structures and thick accumulations of stratified occupation debris. The deep gullies appear to have been the result of excavation and tunneling for the removal of baked bricks, during the 19th century. Although parts of the mound are presently covered with vegetation (tamarisk and thorny underbrush) and are relatively stable, the brick robbing operations and continued tunneling by animals (rabbits, jackals and porcupines) contribute to major erosion during the annual monsoons. Mound AB stands some eight meters above the surrounding plain and has an absolute maximum elevation of 175 meters AMSL.

The major objectives for excavation on Mound AB were to reach the lowest levels of the site in order to document the structural history of the mound and to locate the Early Harappan (Period I) settlement. The first location selected for excavations was in the southwestern corner, just south of Wheeler's main trench, where an erosional gully provided easy access to the lower levels of the site. In 1986 a test pit beginning with an area of three by five meters was excavated down to natural soil. With the exception of a single stratum, just beneath the eroded surface of the gully, with in situ features of Period III, the deposits were all debris and secondary in nature. Several small sherds of Early pottery were found in the lowest debris layer.

A second excavation area is in the east-central portion of the mound. Here again, a deep gully provided access to undisturbed occupation layers in the center of the ancient mound and also the possibility of reaching the earliest occupation levels. In 1987 and 1988, excavations were conducted along the slopes and in the lower portion of this gully (Fig. 40.1, Pl. 40.17), and in 1989 the uppermost levels of the gully slopes were investigated in hopes of locating undisturbed contexts of Period V (Cemetery H).

Mound E

Mound E is the large mound that dominates the southeastern quarter of the site. (Fig. 40.1). The maximum height of the mound, at the northwest corner, is 172.8 meters AMSL, slightly lower than Mound AB. The central and eastern parts of the

mound are heavily eroded along what appear to be either major streets or collapsed brick robbing tunnels.

The 1986-1987 surface surveys revealed that the eroding perimeter of the mound provides a wealth of information. For example, on the easternmost portion known as the Old Police Station, craft activities such as shell working and chert processing were identified. The southern perimeter of the mound revealed numerous traces of baked brick architecture and massive mud brick structures that appeared to be the remains of platforms (but see Notes on the 1991 Season).

In 1987 the northwestern corner of the mound was selected for excavation (Fig. 40.5). There were traces of massive mud brick platforms, brick walls, a ceramic production area, and pottery from both the Mature (Period III) and the late Harappan (Period V) occupations.

The initial excavations in 1987 were limited to test pits on the top of the mound to determine the degree of disturbance by brick robbers and to identify the cultural association of rectangular features observed on the surface. Rectangular shaped surface features are found scattered across the entire length of Mound E and they are oriented in many different directions. Some of these resemble eroded mud brick walls but excavations in 1987 revealed that at least one group of these features consists of shallow rectangular pits probably dug by brick robbers. The dirt and brick bats from the pits were piled along the edges giving the impression of walls.

Additional excavations in this area in 1988 confirmed that the uppermost layers of architecture had been robbed of bricks, and an East India Company two anna coin dated to 1843, Victoria Queen, provides dated evidence for the brick robbing activities. Fortunately, beneath the disturbed layer, Period III (Mature Harappan) architectural units are preserved in association with streets, drains and sump pits.

In 1988, more extensive excavations were begun on the northwestern slope of Mound E. These consisted of a five-meter wide step trench oriented east-west and extending from the crest to the base of the mound (Figs. 40.5, 40.6 and 40.7). Horizontal exposures were made in five by five meter areas. In 1989, additional areas were exposed to the north and south of the step trench to expose architectural features and special activity areas. The total excavated area on the slope at the end of the 1989 season was 181.5 square meters, with the depths of the excavations ranging from 50 centimeters to 6 meters. During the 1990 season the horizontally exposure uppermost Period I and Period II levels was expanded to an area of 225 square meters.

Also during the 1990 season extensive excavations were conducted along the southern periphery of the mound with unexpected results.

The Cemetery Area

The cemetery area—originally designated Cemetery R37—is located to the south of Mound AB and is known to extend from irrigated fields to the west of the mounded area to the Harappa Museum grounds in the east (Figs. 40.1 and 40.8, Pl. 40.1).

The modern topography of the cemetery area before excavations was an undulating surface comprised debris derived from the ancient mound. After 1946 much of the area was leveled and cleared of underbrush and several buildings were constructed over portions of the cemetery. Beginning in 1986, we excavated test pits to determine the extent of the cemetery, and in the course of subsequent seasons, 25 one by two meter pits were dug. Where there was evidence for burials, or concentrations of bones or pottery, the pits were expanded and the areas were excavated horizontally.

SUMMARY OF FINDINGS

Period I

Wheeler had reported early sherds from the lowest levels of his large trench on the western edge of the citadel mound (AB), but our discovery of similar sherds on the tops of his other dumps indicates that the early settlement might have extended virtually the entire north-south length of the Period III "citadel."

Our 1986 test pit within the southwestern corner of Mound AB confirmed the presence of early sherds in secondary deposits just above natural soil. The slope and direction of waterborne sediments in the lowest levels from east to west suggested that the earliest settlement itself was further east under Mound AB or even further under Mound E.

And, in fact, our excavations of the northwestern corner of Mound E have revealed the presence of the Period I (Early Harappan) mound. And during the 1990 season, more Early deposits were found along the southern slope of Mound E. Associated with the walls and occupational levels are distmetive early pottery (Figs. 40.9, 40.10, 40.11) and figurines (Figs. 40.13 to 40.17).

Period II

Period II is defined primarily by the construction of massive walls discovered along the northwestern periphery of Mound E (Fig. 40.5). The walls are made with large mudbricks that measure 10 × 20 × 40 centimeters. The orientation of these mud brick walls is approximately 10° west of true north. They, as well as the later baked brick walls of Period III have approximately the same orientation as the so called "defense walls" identified by Wheeler on Mound AB (12° west of magnetic North). It is possible that Wheeler's earliest walls actually belong to this period.

Five, possibly six, superimposed walls are made of the large mud bricks. The most complete wall [164] extends north-south for over 15 meters (Fig. 40.5). It is two meters wide and has a surviving height of approximately two meters. A possible northwestern corner of this wall has been identified but its eastern extension has been obliterated by later construction.

Wall [235] was built after wall [164]. It is 2.5 meters wide and has a well defined corner and eastern extension that continues for about four meters. The north-south portion of this wall has been obliterated by later Period III (Mature Harappan) construction.

The precise function of the walls is not clear, but since the exterior faces are invariably eroded and the interior faces are not eroded, they may have functioned as retaining or revetment walls.

Due to the disturbance by Period III structures, the precise stratigraphic relationship between the perimeter walls and the large section of early deposits exposed at the edge of Mound E is still not clear. In the section (Figs. 40.6 and 40.7) we can see that the Period I and II deposits make up a mound that is 2.5 to 3 meters high at its exposed western edge.

Specific types of artifacts found in the Period I deposits were found also in Period II. In addition, numerous stone beads, a stone celt, distinctive human and animal figurines, triangular terracotta cakes, terracotta toy tops, and red fired terracotta bangles were found. These categories of artifacts, along with certain ceramic types, continue into Period III (Mature Harappan). The detailed study of these artifacts will help clarify some of the questions about change and continuity between the Early and Mature Harappan periods.

One very important discovery in Period II is a small round kiln, 50 × 60 cm in diameter and approximately 40 cm high containing early pottery (Pl. 40.14). This kiln has a unique firing structure made by placing the upper half of a large pot in the center of the kiln. The fuel appears to have been placed on the outside of the broken pot as well as on the inside. The interior of the pot is vitrified and reduced while the exterior is oxidized. This suggests that the objects being fired may have been placed inside the pot for a high temperature reduction that would have resulted in dark gray or black color. Possibly this structure was for firing the thin grayish-black bangles that are common in Periods I and II, but no bangles were found inside the kiln. The presence of this technology in the Early Harappan levels at Harappa may have some relationship to the development of the stoneware bangle production of Period III that has been documented recently at Mohenjodaro by Halim and Vidale (1984).

Period III

New evidence relating to the transition from Period II to Period III has been documented so far only on Mound E. This transition is defined on the basis of architecture and changes in artifact types. Although there is an architectural continuity in terms of orientation and brick bonding, a major development is seen in the introduction of baked brick combined with mud brick, construction in Period III.

Many artifacts and ceramic forms demonstrate significant continuities between Periods I-II and III but the overall stylistic features of ceramics, figurines, stone tools, ornaments, etc. during Period III are distinctive.

Period III: Peripheral Walls and Platforms (Fig. 40.5)

At the northwest corner of Mound E the massive mud brick perimeter walls of Period II appear

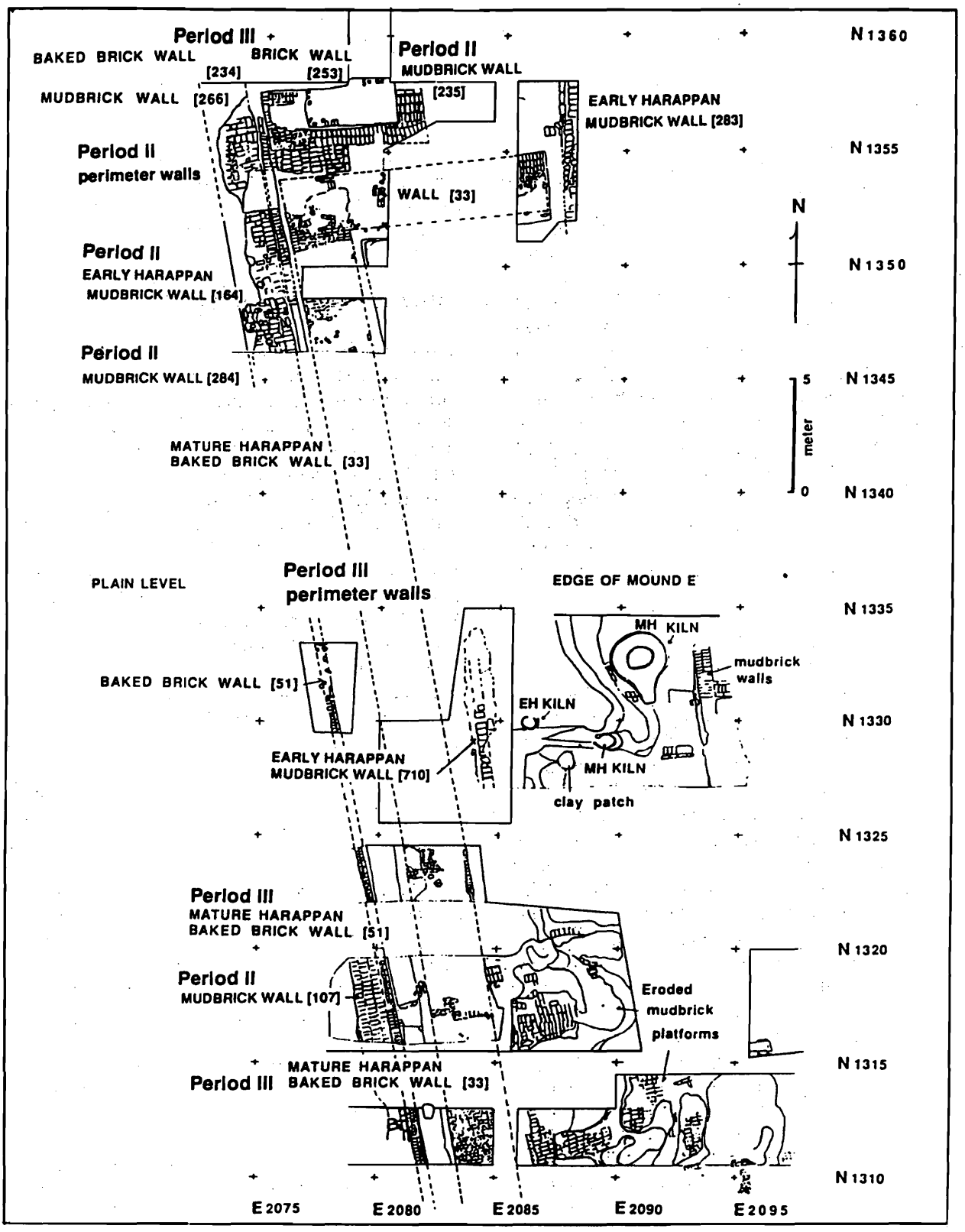


Fig. 40.7. Harappa 1989: Mound E, northwestern corner.

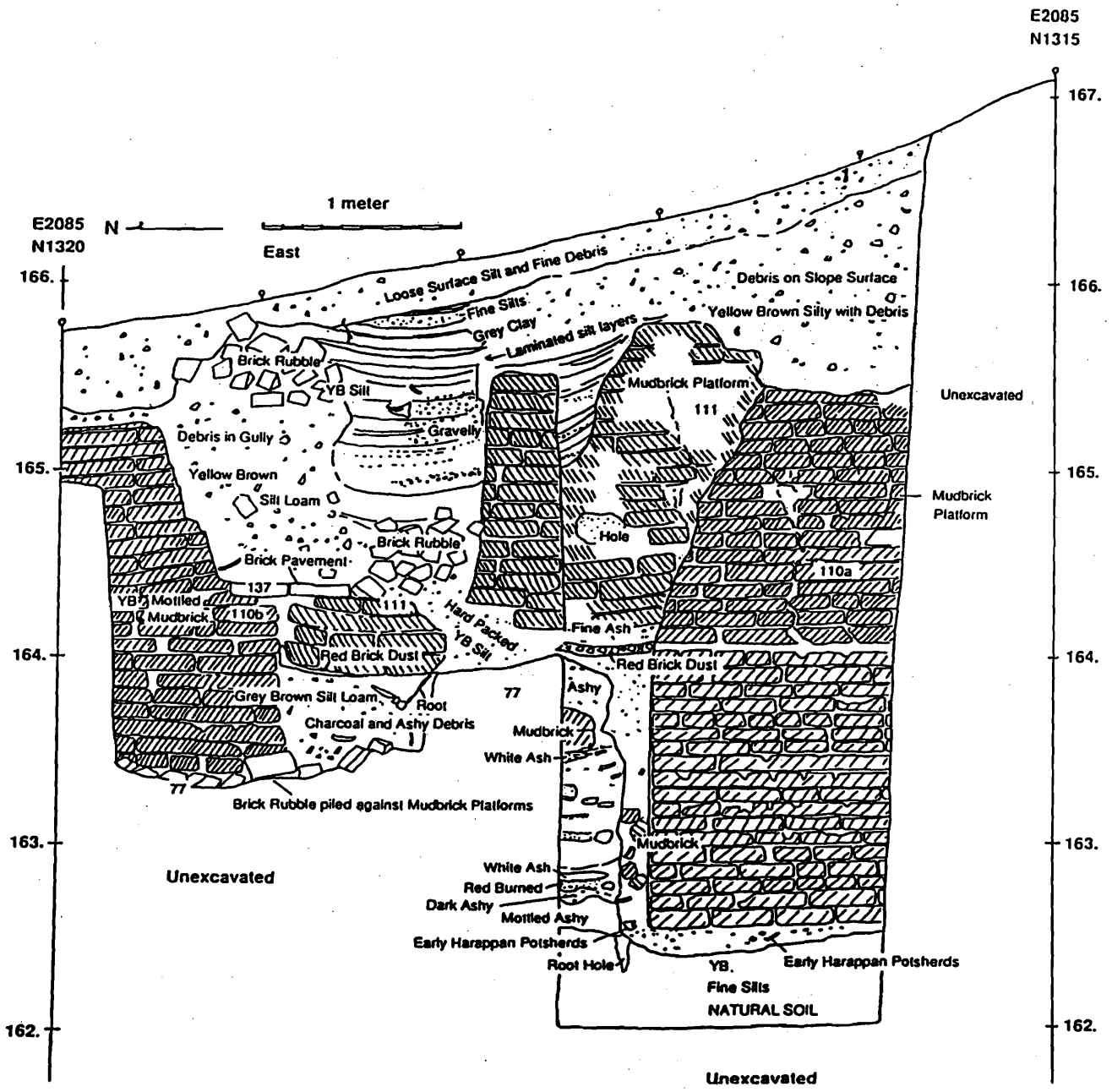


Fig. 40.8. Harappa 1988: Mound E, northerwestern slope and platforms. North-south section, facing east: E2085, N1315-1320.

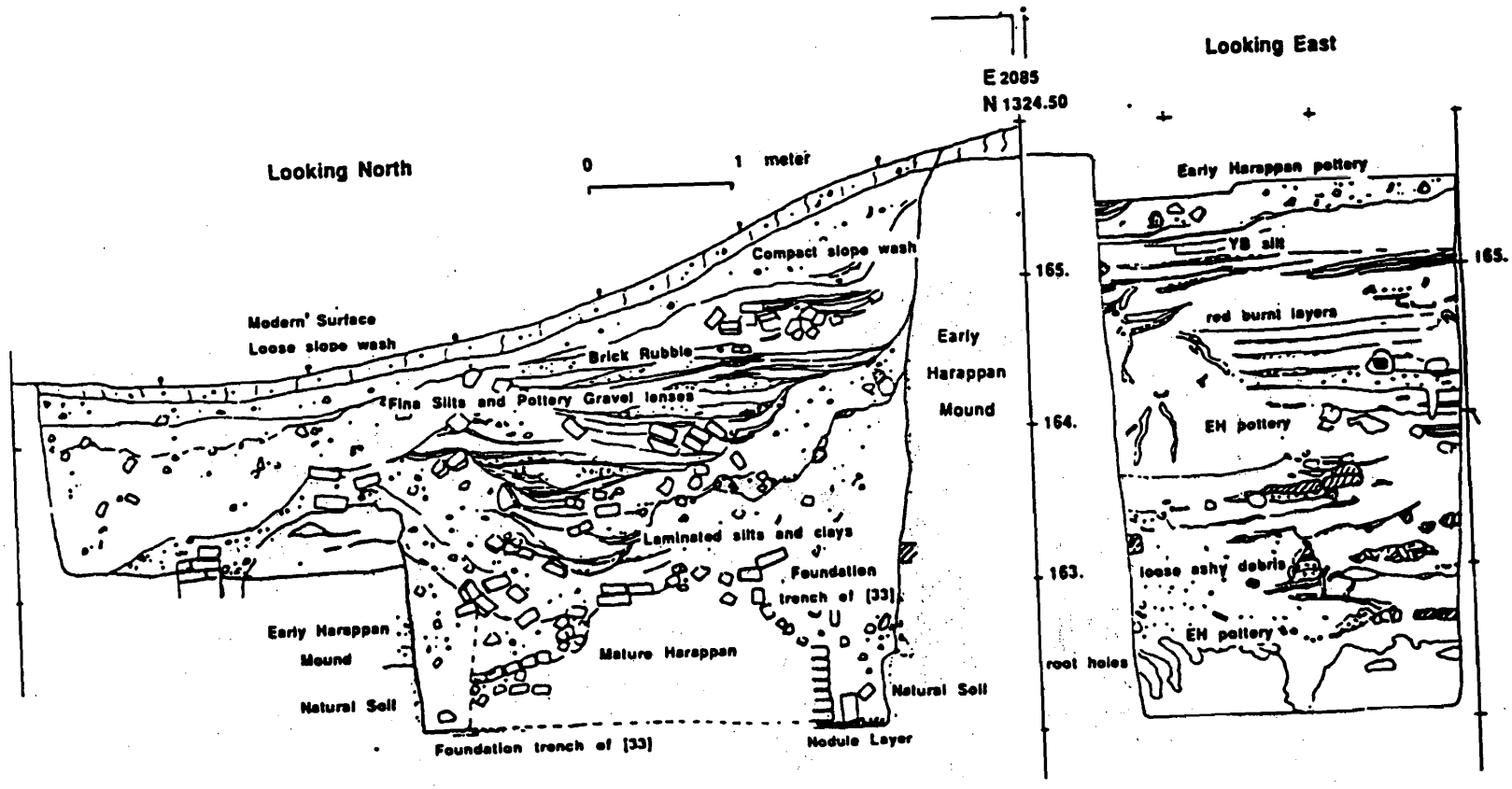


Fig. 40.9. Harappa 1989: Mound E, slope section of Early Harappan Mound.

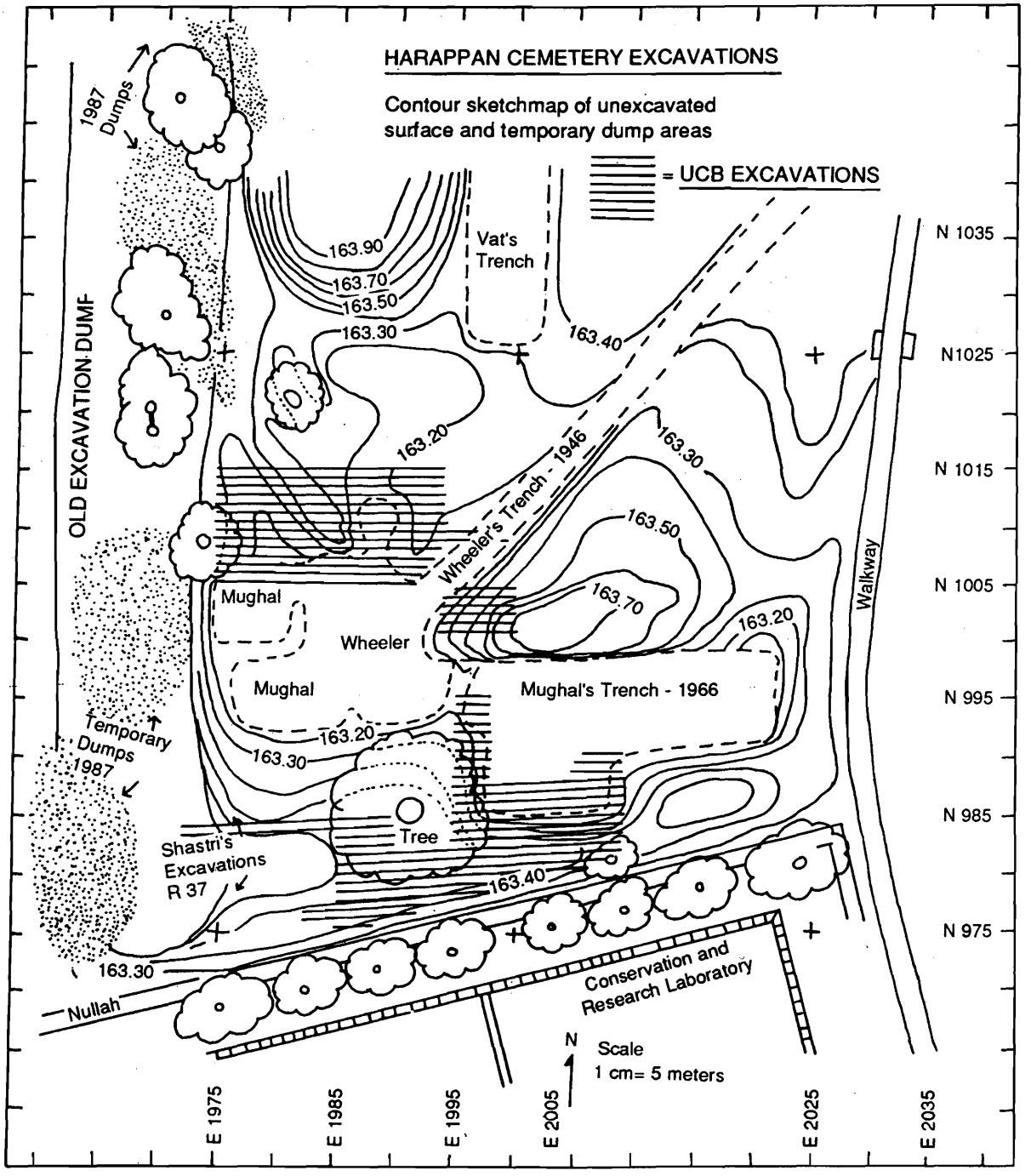


Fig. 40.10. Harappan cemetery excavations: Contour sketch map of unexcavated surface and temporary dump areas.

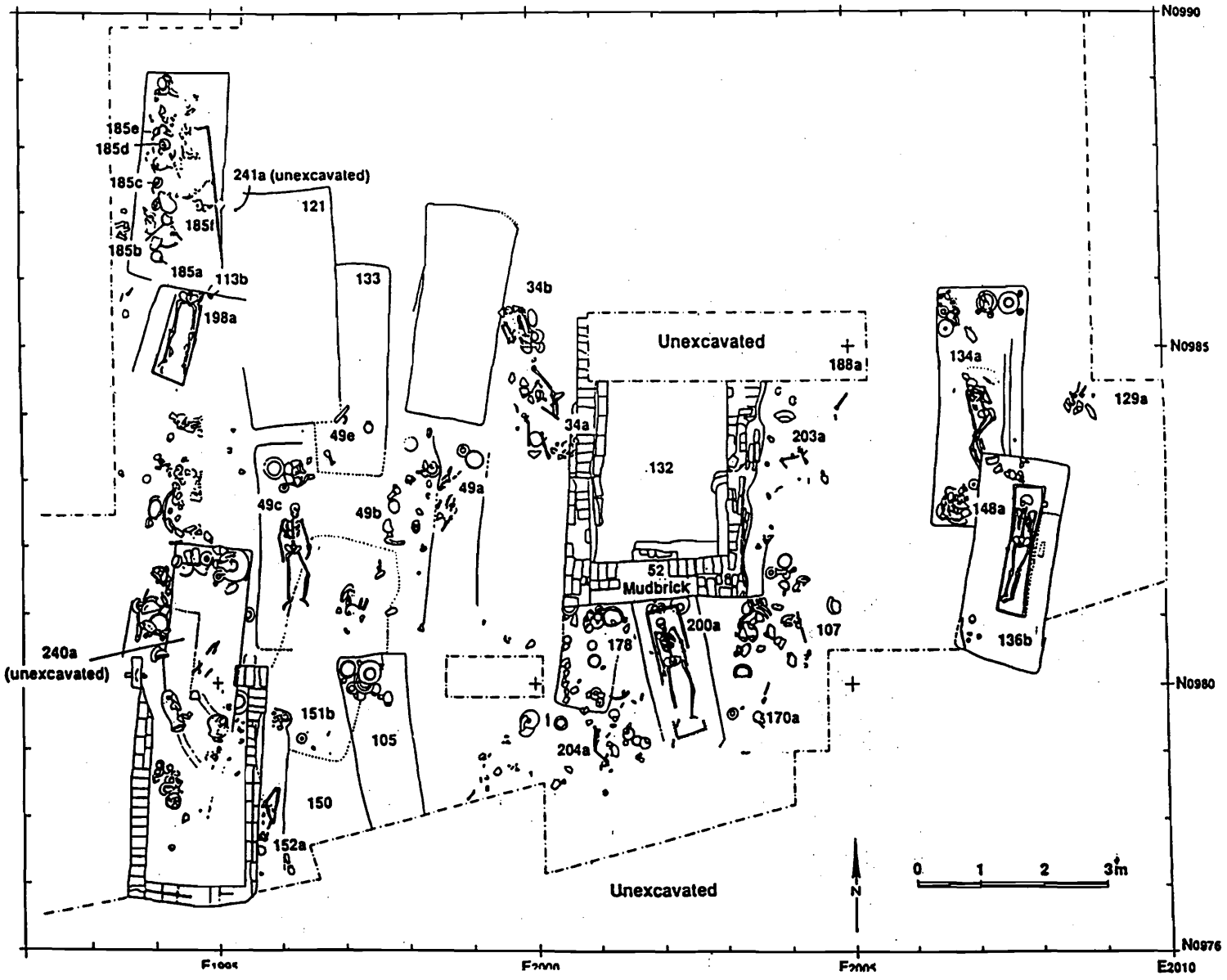


Fig. 40.11. Cemetery excavations upper levels with feature numbers.

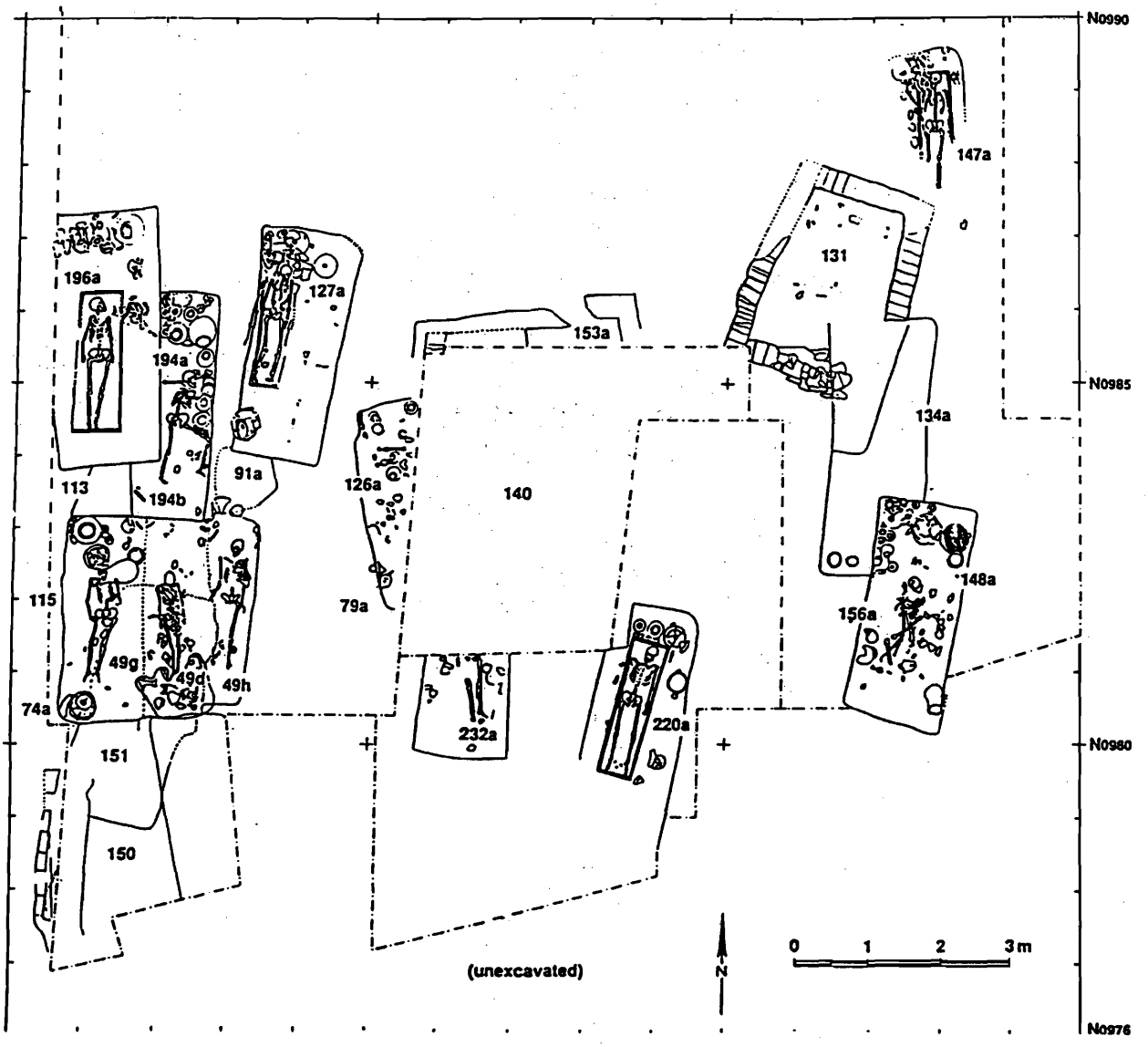


Fig. 40.12. Cemetery excavations lower levels with feature numbers.

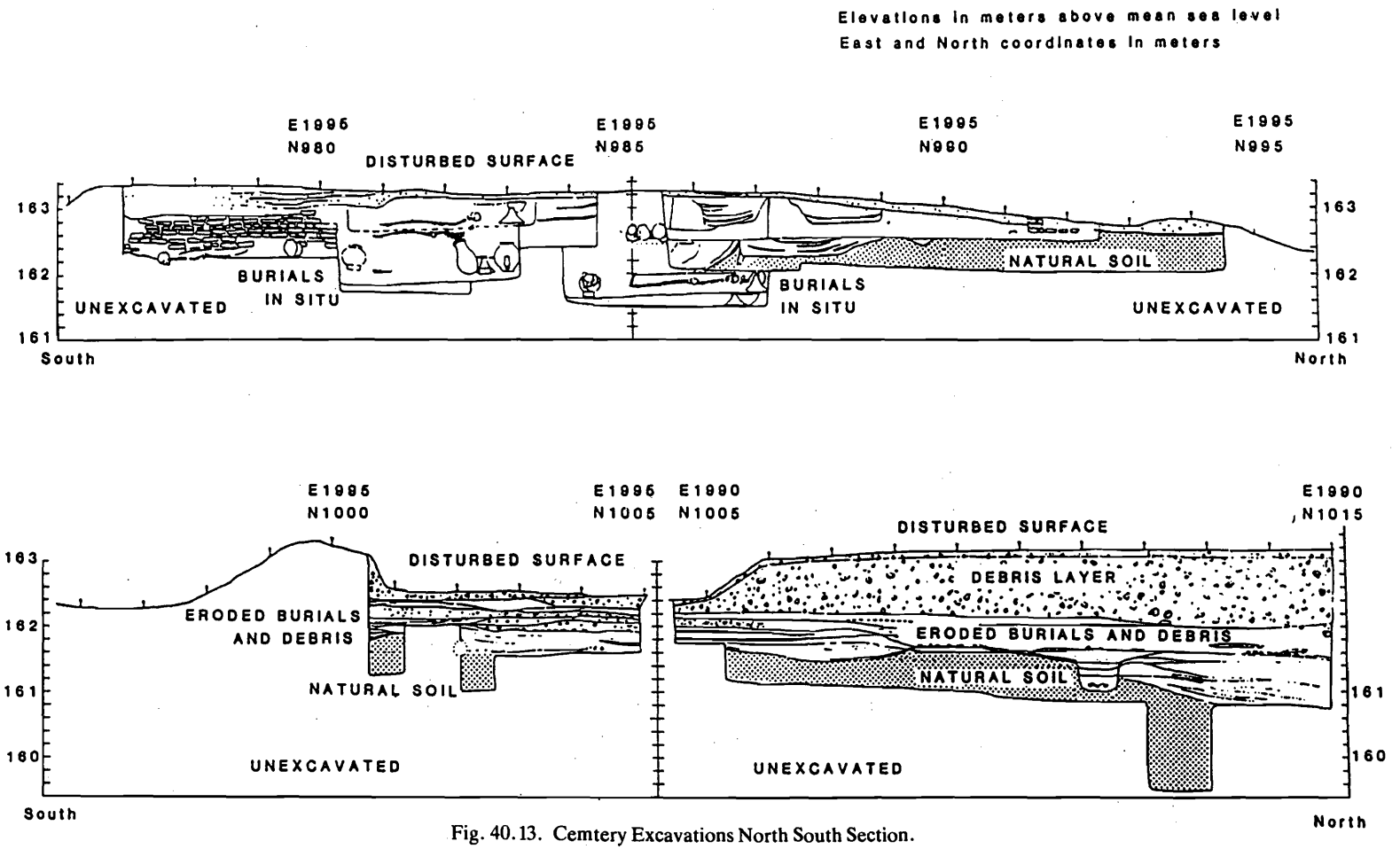


Fig. 40.13. Cemtery Excavations North South Section.

to have been repaired during Period III using both mudbrick and baked brick. The exact sequence of these repairs is not certain but they appear to precede the construction of long retaining walls of baked brick that are aligned in the same orientation as the earlier mud brick walls.

The earliest baked brick wall [51] is relatively thin, being only 45 to 50 centimeters wide. It had been rebuilt at least three times and the exterior edge is heavily eroded, while the interior face is still intact. This suggests that it functioned as a retaining rather than as a free standing wall. Later the Harappans built a larger and more massive structure, wall [33]. They did this by cutting through the thin wall and digging a large foundation trench down into natural soil that essentially shaved off the edge of the Period I and II mound to a height of 3.5 to 4 meters (Fig. 40.6). Before building the wall the architects laid a thin layer of overfired clay nodules along the entire length of the trench (Pl. 40.12). It is a tribute to their engineering skills that the level of the bottom of the wall has only a 2 centimeter variation along the 45 meters of its exposed length.

The baked brick sizes are generally 7.5 × 16 × 32 centimeters which is approximately the same size as the mud bricks used during Period III, but smaller than the mud bricks used in Period II. The brick size ratios remain constant at approximately 1:2:4.

This wall [33] is 2.5 meters wide, with brick bonding the same as in the earlier mud brick walls of Period II. It has the same orientation as the earlier walls (10° west of true north) and even has the same northwestern comer angle (83°). In eastern extension is nine meters long and ends abruptly with no evidence for a gateway or entrance. The exterior face is battered at an angle of 85° and rested against the face of the mound. It seems to have functioned as a revetment or retaining wall.

Such massive retaining walls baked brick represents a large-scale municipal construction effort along the entire northwestern periphery of the mound. The construction of such platforms and retaining walls is quite evident in eroding deposits from other parts of Mound E and AB and is reported in the excavation report by Wheeler who interpreted them as being part of a massive defense system.

The evidence for peripheral walls around Mound E appears to be quite different along the southern edge of Mound E. The 1990 excavations revealed the foundations of what appears to be a massive free-standing wall system including a formal gateway (see 1990 season below).

Inside the peripheral walls at the northwest corner of Mound E, higher up on the crest of the mound, other platforms and retaining walls were constructed. There we find many building phases for domestic structures. To help protect them from erosion and collapse, mudbrick platforms and revetment walls were constructed. These differ in scale from the massive peripheral structures found at the base of the mound. Their layout appears to be similar to the pattern seen in modern houses of Harappa town that are located on the edge of the city mound. The ancient platforms seem to represent construction in limited areas, possibly built on an individual basis by the people living in the precarious location on the crest of the mound.

Period III: Mound E Kilns

Just up the slope from the Period II kiln are two other kilns of Period III, one small and one subsequent larger structure. The small Harappan kiln (Pls. 40.13 and 40.15) is structurally different from the Early Harappan kiln in that it is teardrop shaped and has a well defined opening to the west for air and possibly fuel. This kiln was probably used as a pit-kiln that would have been plastered to form a domed covering, presumably with vent holes. After each firing the structure would have been broken open and then rebuilt.

One interesting feature in the mouth of the kiln is the concentration of numerous low fired triangular terracotta cakes and *mushtikas* (potato shaped clay lumps with finger impressions). They may have served to allow air into the kiln and at the same time effectively sealing in the heat.

Traditional potters in Pakistan today place old pots or stones at the mouth of similar kilns for this particular purpose.

Although no complete objects were found in this kiln, it is probable that because of its size the kiln was used for firing only small vessels or figurines.

Subsequently, a large kiln measuring almost two meters east-west and three meters north-south, was constructed just to the north of the smaller kiln (Fig. 40.5, Pl. 40.16). It is teardrop shaped with an extended opening to the south for air or fuel. The

construction, and operation, of this kiln is unusual and is under study.

In layers associated with this kiln we found a wide range of Mature Harappan pottery that represent the types of vessels being produced in the kiln. These include dish-on-stand, medium to large painted pots and jars, perforated vessels and medium to large plain wares. There is no evidence for the production of pointed base goblets or smaller plain wares. In addition a clay chuck mold used for making the base of large storge jars was found. Also associated are fragments of hematite used for making pigments, bone spatulas and worn stone blades for trimming the pottery before firing, and patches of fine clay that may represent the areas where the potters were mixing or wedging the clay.

Period III: Top of Mound E

The excavations on the top of the northwestern corner of Mound E revealed that underneath the thick layer of disturbance left by the brick robbers there are large, relatively undisturbed Harappan structures. In 1988, an area ten by eight meters was exposed down to the uppermost preserved structures of Period III. There are multiple levels of habitation units constructed of baked and mud bricks along an east-west street that was equipped with drains and sump pits. Many hearths and redeposited hearth materials were found within and around the structures.

The artifacts recovered from the architectural contexts reveal the presence of domestic activities such as food processing and cooking. In addition, remains of craft activities such as chert tool manufacture, steatite working, bone working, and possibly the manufacture and processing of agate and carnelian beads were found in the vicinity. At this stage of our analysis we cannot say if these craft activities are associated with the domestic activities, or if they represent workshops, or are secondary dumps from workshop areas.

Period III: Southwestern Slope of Mound E

A small excavation during the 1988 season (Fig. 40.1) revealed *in situ* baked brick architecture of Period III. A significant find from the debris covering the structure is a large steatite seal with a bull motif and Harappan script (Fig. 40.19.1a). Only six other seals with this animal motif have been found at Harappa.

During the 1990 season, extensive excavations were conducted at another location along the slope revealing the foundations of what appears to be a massive peripheral wall with a gateway, a north-south street, and houses with a wealth of associated artifacts (see 1990 season below).

Period III: Mound AB (Fig. 40.1)

One stratum of Period III remains—a brick drain, sump pit, and fired brick paving—was exposed in the upper part of the 1987 test pit at the southwestern corner of the mound. This habitation level was built on top of a deep accumulation of debris and wash deposits that extended down to natural soil.

More extensive excavations were conducted in 1987 and 1988 in a deep gully in the east-central portion of the mound (Pl. 40.17). The original excavation area was ten by ten meters, but this area was reduced when well preserved Period III structures were encountered along both edges of the gully—mainly fired brick drains and wash floors.

In 1988 a brick well was discovered in the center of the gully. The well is constructed of specially made wedge-shaped bricks and the interior diameter is 1.2 meters. The wedge-shaped bricks are marked with a double incised line on the exterior edge (Pl. 40.19). The markings do not correspond to any specific placement in the wall of the well and may have indicated to the builders that the bricks were made specifically for this well as opposed to any other well.

The interior of the well was excavated in 1989 to a depth of about six meters from the existing top layer of bricks. The removal of the debris from the interior of the well revealed ominous cracks in the lower portions of the structure. For safety reasons, clearing was suspended and the well top was sealed. A limited area against the outside of the well, on the northern side, was excavated to investigate the techniques of construction (Pl. 40.18). It appears that the well was constructed sometime late in Period III by excavating a large square pit in the center of the mound. The exact construction procedures are yet to be determined.

Plain between Mound E and Mound AB

Two test trenches (two by three meters each) were excavated on the plain level between Mound E and Mound AB. In both trenches the natural soil

was reached at a depth of 3.5 to 4 meters below plain level (161.10 AMSL). In the upper levels of these trenches is evidence of historical period structures made from reused Period III (Mature Harappan) bricks. Below these late structures the strata were primarily pits and debris dumps filled with Period V (Late Harappan) and then Period III (Mature Harappan) pottery. In one level associated with Period III there was a paving of crushed brick and pottery that could possibly represent a roadway. The lowest level of silty wash above the natural soil contained small fragments of Period I and II (Early Harappan) pottery and gray bangle fragments.

Period III Cemetery: The Excavations

The major objectives of the cemetery excavations were to document Harappan burial practices in more detail than had been done by earlier excavators, and to obtain new information on population variation, diet and disease during Period III. The general location of the Period III cemetery was discovered by K.N. Shastri and excavated by him from 1937-41. Subsequent excavations were carried out by Wheeler in 1946 (Wheeler 1947 and 1968) and Mughal in 1966 (1967).

In 1986 a systematic stratified random sampling strategy for determining the extent of the cemetery was implemented. A five-meter grid was laid out over the entire area selected for investigation and one by two meter random text pits were excavated in each five meter square to determine the nature of the stratigraphy and to locate human skeletal remains.

The results of the test pits and horizontal exposures in the cemetery area indicate quite clearly that the main concentration of *in situ* burials is along an east-west axis just north of the modern irrigation ditch at the northwestern corner of the Harappa Museum grounds, in other words, along east and westward extensions from the central area where the earlier excavations were conducted. To the south of the ditch, within the Museum Campus, we found disturbed and eroded burials consisting mainly of pottery (Pls. 40.6 and 40.7). To the east are eroded sediments with a thick overburden of Period III debris, while the northern limit of the primary context burials can be defined on the basis of our recent excavations and those of Wheeler (1946). To the west the cemetery extends for at least another 60 to 70 meters into modern cultivation. These fields have been irrigated for at least the last 60 years, but distinct north/south oblong patches of lighter colored vegetation suggested the presence of subsurface features. The uppermost levels of debris that protected the cemetery to the west have been removed by the farmers to get to the rich alluvium. This has exposed the uppermost burials to intensive plow zone disturbance and these burials have been almost totally obliterated. However, the lower burials are in quite good condition and indicated the intensive use of this part of the site for burial purposes. Due to limited time and the presence of standing crops, further excavations were not conducted in these fields.

Cemetery Stratigraphy

The ancient Harappan burials were dug into natural soil of what may be a Pleistocene terrace or ridge. The ancient land surface was heavily eroded during and following the Period III (Mature Harappan) occupation of the site, resulting in the displacement and erosion of large areas of the cemetery. An area forming an east-west ridge just north of the irrigation ditch is the uneroded "A" horizon of the Period III occupation. The ancient surface slopes away in all directions, but the major directions of erosion appears to have been south to north and west to east (Fig. 40.8). Eroded burials and debris form layers of variable thickness which lie unconformably on the natural soil. The eroding surfaces of the cemetery were covered by a massive layer of Period III debris (Pl. 40.2)—mostly ceramics (between 30 and 40 percent of which are the well known pointed base goblets).

Burial Types

The Period III burial customs as reflected in this cemetery appears to have been relatively standardized. All of the primary burials are in distinct rectangular pits oriented north-south (Figs. 40.9 and 40.10). Also there are numerous examples of bone having been collected and dumped or buried in the fill of a grave shaft or on the sloping surface next to a grave shaft in ancient times. These collections of bone are invariably mixed with broken burial pottery and possibly represent the clearing of earlier burials to make room for subsequent inhumations. These groups of disarticulated bones and

broken pottery that do not belong to primary burials, are referred to as secondary context/fill to distinguish them from actual secondary burials.

Another context for the presence of human bone is the eroded surface of the cemetery that was subsequently covered by the thick debris deposits (Pl. 40.8). These eroded burials that are no longer *in situ* are referred to as being in secondary context/wash or secondary context/debris. Secondary context/debris means that the human bones were found in the debris layer itself, but because all of the bone in the debris layer occurs at the interface between the debris and the eroding cemetery surface, this bone is assumed to have come from the cemetery itself rather from debris brought from the habitation areas for disposal.

It appears that there were several methods of burial with a wide variation of burial goods. The most common form of primary burial was extended and supine, with the head to the north and the feet to the south. The orientation of undisturbed burials ranges from 9° East of true North to 2° West of true North.

Several burials had traces of wooden coffins that were approximately half meter wide and 1.7 to 1.9 meters long with walls 2 to 3 centimeters thick. The outlines of the coffins were indicated as dark stained soil and unfortunately no samples of the actual wood are preserved. Two coffin burials had what appear to have been wooden lids. Samples from these are under study.

The burial goods included varying quantities of pottery vessels usually arranged at the head and foot of the grave shaft (Pls. 40.20 and 40.21). In some burials the pottery was placed in the grave first and then partially covered with soil. The body was placed level with the top of the pottery, after which the grave was completely filled with soil. The subsequent weight of the soil often crushed the coffin and underlying pottery, resulting in a disturbed burial. Some of the later burials that cut into and disturbed the earlier burials were furnished with only a few vessels or no burial pottery at all.

Preliminary analysis of the ceramics suggests that there may be different relative proportions of painted to undecorated pottery from the lower burials and the upper burials. It is difficult at this early stage of the ceramic analysis to be certain of this. One complicating factor is that of differential preservation. This has been recorded in the skeletal samples as well as in the pottery. Pottery with excellently preserved surface can be found associated with pottery whose surface are severely disintegrated. This phenomenon is under study. It is crucial to the final understanding of stylistic development in the pottery industry.

An impressive range of ornamentation is seen in these burials, including shell bangles, a copper ring, steatite/serpentine disc beads, carnelian and lapis lazuli beads, short cylindrical gold beads, black stone amulets and a unique head ornament made of three shell rings, a jasper bead and numerous strands of thousands of steatite microbeads. At this stage it is difficult to discuss the presence or absence of significant status indicators, but the overall impression is that persons buried in this cemetery were not from greatly diverse socio-economic segments of society. However, there were some individuals with relatively simple burials, containing modest numbers of pottery and no ornaments, while others had more pottery, and quite striking ornaments. There does not appear at present to be a direct correlation between the use of wooden coffins and the amounts of pottery or ornamentations accompanying the burials.

An example of a simple burial (Lot 220, Feature 220a) is a man buried in a coffin with no ornaments and only nine pottery vessels arranged at the head of the pit. Another burial (Lot 198, Feature 200a) was of a woman, also in a coffin, with two shell bangles on the left arm and five carnelian beads lying on the right side of the pelvis. Beneath her was a collection of nine pottery vessels.

In contrast to these relatively simple burials, is a burial of a man (Pl. 40.3; Lot 136, Feature 147a) in a coffin with over a dozen vessels arranged at the head of the pit and additional vessels along the side of the pit. On his left wrist was a shell bangle and near the right hand a carnelian bead. The most striking ornament, mentioned above, was found lying to the right of his head, namely the complex of two or three shell rings, a jasper bead and thousands of tiny microbeads twisted together in circlets or bunches (Pl. 40.22). This collection was taken to the Smithsonian's Conservation Analytical Laboratory in Washington for cleaning and consolidating by our project Conservator Donna Strahan. A special case was constructed for it and the headdress is now on display in the Harappa Museum.

Another example of a more elaborate burial is

of a woman who had apparently died during or soon after child birth (Pl. 40.5; Lot 197, Feature 194 a and b). The infant skeleton was found immediately beneath the lower right leg. There was no trace of a coffin, but the skeleton looked as if it had been disturbed after interment. This burial had 33 pottery vessels arranged at the head and alongside the body. Many of the vessels were painted with elaborate black designs on a red background. A lead/orpiment rod (orange to yellow mineral) was found near her head, possibly used as a pigment for personal decoration.

Yet another coffin burial was of an older man (Pl. 40.4; Lot 194, Feature 196a). The constricted attitude of the body suggests that he might have been bound in some type of tightly wrapped shroud. Most striking was the fact that he had a magnificent necklace of 340 steatite disc beads and three beautiful stone beads, of jasper, onyx and serpentine, with gold caps on the ends. The pottery with this burial was all of plain or red slipped wares, but two crudely formed unfired vessels were found crushed beneath one of the larger vessels.

PRELIMINARY NOTES ON THE 1990 SEASON

The fifth season of research was completed just shortly before the deadline for this manuscript. The following notes have been abstracted from the end of season report prepared in the field by J.M. Kenoyer.

There were three main research objectives for the fifth season: (1) expansion of the excavations in the northwest corner of Mound E to obtain a larger exposure of the Early and Early/Mature transitional levels; (2) to investigate the nature of the Period III remains along the southern edge of Mound E and to search for indicators of Early Period I-II remains in that area; and (3) to continue the surface surveys of Mound E in search of intact Period III remains and traces of the easternmost extension of the Period I-II occupations.

Objective 2 received the most attention and produced the most significant new discoveries. The major north-south gully on the southern slope of Mound E was selected for investigation. As suspected, the present-day gully reflects an important detail of the Period III settlement, namely, it follows a well-defined street that appears to run north-south through the entire mound. Impressions of cart tracks were visible in upper levels of Period III and in the lowest level association with Early sherds.

The southern end of this street leads to an impressive east-west mud brick wall system belonging to Period III. Two superimposed stages of this wall were revealed. The later stage ranges from 5.4 to 6.5 meters wide and has been traced so far for more than 73 meters. Piercing the wall system is what appears to be a major gateway with an opening of some 2.8 meters. The associated wall in the later phase is 9 meters wide at the gateway. Traces of an original fired brick facing have been found bounded to the mud brick wall on the eastern edge of the gateway. Just how the north-south street articulates with the wall and gateway requires further excavations. Nonetheless, the discovery of this apparently free standing wall system provides an unexpected contrast to the massive facing walls, revetments and platforms seen at the northwestern corner of Mound E and around Mound AB.

House structures of Period III were discovered along the eastern edge of the street. The original fired brick walls were robbed, probably in the last century, but the floors and interior features are preserved virtually intact. One of these houses was constructed on a small mud brick platform. The platform has three distinct post holes that may have been for roof supports. A small kiln or oven and several pits filled with domestic debris were also found on the surface of the platform.

Most important, a total of eleven objects with Harappan script were found in the fill of the pits and in the floor deposits within this house. These include two steatite intaglio seals (one complete, one broken), with the common unicorn motif and short inscription; three identical rectangular molded faience tokens with script on both faces; one molded rectangular token with script only on one face; one triangular token and one lunate token with script on both faces. In addition, two inscribed and fired steatite tokens and one terracotta cone with a crudely inscribed inscription were found. The discovery of these objects in closely associated strata represent the use of at least four different types of objects with writing by the occupants of the house during a relatively short period of time. Additional seals, tokens and sealings were discovered in the street levels in front of the house and in other houses excavated to the north along the

eastern edge of the street.

Because of the importance of the discoveries along the southern edge, less time than originally planned was available for expanding the excavations at the northwestern corner of Mound E. However, a total of 15 by 15 meters of occupational levels from the Early Period I-II to the Mature Harappan Period III were exposed. In the Early levels several mud brick walls aligned east-west and north-south were found. Above these is a series of strata representing the transitional phase from the Early to the Mature period. In these transitional levels were found hearths and working floors containing debris related to ceramic production, as well as large quantities of carbonized grains and other plant remains.

The flotation process used for retrieving the palaeobotanical samples yield in addition to large quantities of animal bone, particularly very small bones which are seldom recovered even by the fine dry screening of excavated sediments. A preliminary scan of the materials revealed much fish bone, bones of small animals, birds, rodents, reptiles, and even crab claws. These minute finds when combined with the analysis of the larger bones recovered from the excavations, will provide the first comprehensive picture of animal exploitation in the Harappa region.

CONCLUDING REMARKS

The Harappa Project has only scratched the surface of the massive urban center of Harappa. And as we have scratched, systematically to be sure, we have become aware of how much larger the ancient settlement was than earlier reports had indicated and how much more complex is the understanding of it. Many professional lifetimes of excavation and analysis will be required to extract from the battered body of Harappa the secrets of its origins, its mature life, and its demise.

Nevertheless, these five years have been extremely successful. We now know the precise location of the pre-urban settlement at Harappa and we have a large body of data for addressing questions regarding urban development and chronology. The excavations in the cemetery area and the various domestic contexts of the site have also provided a vast amount of new information relating to the customs and daily life of the Harappans. The studies of the ancient soils, plants and fauna are adding a crucial dimension to our understanding of the interactions between the inhabitants and the natural environment.

Thanks to the cooperation of the Department of Archaeology, we have had the opportunity to apply modern excavation procedures at one of the earliest and largest urban centers of the ancient world. The excavations have provided specialists with new materials for study and upon which to apply new analytical and interpretative approaches. Furthermore it has provided field training opportunities for students and specialists from both Pakistan and the United States who will be able to continue to develop new research on the origins and character of the ancient cultures of South Asia.

II. BIOLOGICAL ANTHROPOLOGY

The study of the skeletal remains from the cemetery is being conducted by four physical anthropologists who participated in the 1987-88 excavations. These investigators are specialists in four areas of human skeletal biology: morphometric analysis—Dr. Kenneth A.R. Kennedy (Cornell University), dental anthropology—Dr. John R. Lukacs (University of Oregon), palaeopathology/palaeonutrition—Dr. Nancy C. Lovell (University of Alberta) and discrete trait analysis—Mr. Brian Hemphill (University of Oregon). In addition to their long experience with South Asian materials, they were selected because of their diverse methodological and analytical approaches. The Harappa project would provide a unique opportunity to apply and test a variety of methodologies on freshly excavated samples. Some preliminary results from these studies are published in *Pakistan Archaeology 1989*. An updated summary is presented below but the tentative nature of some of the interpretations must be kept in mind until the final reports are published. This will require integration of the skeletal and dental data with all the rest of the archaeological data from the cemetery excavations.

PALAEODEMOGRAPHY

Kenneth A.R. Kennedy and Nancy C. Lovell

The analysis to date of the skeletal remains excavated during the 1987-1988 seasons has identified twenty-five complete, or nearly complete, discrete individuals, from primary contexts. Nine additional crania, six mandibles, and hundreds of complete and fragmentary disarticulated skeletal elements were also recovered. (Dental remains are described separately by John Lukacs, below.) The age and sex distribution of the 25 discrete individuals is as follows:

Age:		
Subadult	(< 16 yrs)	2
Young adult	(16-34 yrs)	13
Middle-aged adult	(35-55 yrs)	6
Older adult	(> 55 yrs)	1
Adults of uncertain age		3
		N = 25
Sex:		
Males		11
Females		10
Uncertain		10
		N = 25

Preservation is a problem with the cemetery skeletal materials. The alkaline soil has destroyed much of the cancellous bone and has altered the structure of cortical bone in skeletons buried close to the present day ground surface. The ratio of relatively complete to fragmentary skeletons has been estimated by Kennedy to be about 1:2. The diagenetic problems have prevented the chemical analyses from providing the information anticipated (discussed later in this report).

MORPHOMETRIC ANALYSIS

Kenneth A.R. Kennedy

Every skeletal fragment, complete bone, and individual skeletal specimen has been described by the two procedures of morphometric analysis: measurement of size and shape variables using precision instruments, and morphological assessment using anthroposcopic analysis. Tabulations of measurements using the metric system include absolute length/breadth dimensions, angles and indices. A photographic record accompanies the written word, and certain specimens are represented by radiographic plates. Preliminary study of the Harappa data indicates that the predominant biological features of this population are long and narrow cranial vaults with cranial elevation low relative to maximum cranial length. Faces are generally broad and straight in profile, but there is some forward protrusion of the tooth-bearing regions. Noses are generally narrow, but there is a low incidence of crania with medium to broad noses. The shape of the eye sockets is rectangular. Palates are usually narrow and shallow, and all lower jaws are long and narrow. Bones of the postcranial skeleton reveal a population of medium stature height, relatively low skeletal robusticity and trunk/limb bone ratios that indicate a linear body build with relatively short trunks and moderately long arms and legs.

Analysis of the data is now underway at Cornell University's Human Biology Laboratory. Dr. Kennedy is working on the following specific problems:

1. Stature estimates based upon statistical regression formulae using limb bone lenths.
2. Identification of markers of occupational stress. These are marks on bone that are recognized as relating to habitual activities during life which produce variations of development in size, shape and location of ligament attachments on bone. Kennedy is a specialist in the interpretation of such markers.
3. Comparison of the 1987 and 1988 data with previously excavated skeletal series from Harappa, and with other skeletal series associated with the Harappan Civilization (Mohenjodaro, Chanhudaro, Lothal, Rupar, Kalibangan, etc.)

Morphometric analysis of the Harappa series,

when completed, will provide new information about the biological adaptations and diversity of the ancient people whose cultural achievement was the Harappan Civilization. These data are not obtainable from the archaeological record alone, although the biological anthropology of a population, living or ancient, requires a sensitivity to the role culture plays in behavior and the expression of physical variables.

PALAEOPATHOLOGY

Nancy C. Lovell

Identification of pathological conditions of the skeletal remains was made in the field through macroscopic and radiographic examination. Inflammatory lesions are exhibited by only seven individuals; six of these display periostitis on their long bone shafts, a condition that cannot be attributed to any particular infectious agent periostitis is usually, however, believed to be the result of a chronic, systemic infection. One of these individuals also exhibits a lesion suggestive of a localized infection, perhaps secondary to trauma, on a toe bone (Pl. 40.9).

Only four skeletons display evidence of traumatic injury. One individual displays a healed fracture of the left scapula, immediately below the shoulder joint. Another has a healed fracture of the distal right radius, plus a healed rib fracture. A third also has a healed rib fracture (Pl. 40.10). A fourth individual shows a compression fracture in the spine. In addition, one middle-adult female exhibits a compression fracture of a vertebra in the thoracic region of the spine, which appears to be secondary to osteoporosis.

Three individuals exhibit benign neoplastic growths, in the form of small "button osteomas" on the cranial vault. A fourth person has a similar, small, elongated growth on the shaft of the fourth metatarsal of the right foot (Pl. 40.11).

Congenital or developmental anomalies, exhibited by three individuals, include spina bifida, scaphocephaly, and partial sacralization of the fifth lumbar vertebra.

No cases of nutritional inadequacy, such as rickets, scurvy, or anemia were identified, however, there are two cases of arrested growth lines (Harris lines) appearing on long bones (visible on x-rays), which suggest that growth during childhood was halted temporarily in these individuals. Growth arrest may be caused by malnutrition and/or other physiological stress such as an acute illness. However, growth arrest lines may be remodeled with age. If the Harappa sample contained more younger age individuals it is probable that a greater number of growth arrest events would be recognized.

Arthritis is the most common pathological condition and appears in the joints of the knee, hands, feet and spine. Arthritic lesions in these locations are common among almost all people of the world and are usually associated with advancing age. Cervical and lumbar vertebrae exhibit similar frequencies and severities of arthritis although the joints that are principally affected differ: the lower back region has more severe arthritis due to disk problems while the neck region has more severe involvement associated with the interlocking apophyseal joints that are not cushioned by disks. The most severe cases of arthritis, two cases of bony fusion of adjacent vertebrae, are found in the neck region. The high frequency and severity of arthritis in the cervical spine is unusual and may reflect the stress of habitually carrying loads on the head, a common practice in South Asia today.

These frequencies of pathological conditions should be considered minimum estimates due to the poor preservation of some of the skeletal material. However, the overall impression is that the health of those Harappans interred in Cemetery R37 was very good.

PALAEODIETARY RECONSTRUCTION

Nancy C. Lovell

This aspect of the project was designed to reconstruct subsistence at Harappa using stable carbon and nitrogen isotope analysis of the organic portion of human bone. The results of isotope analysis in 1987-88 were spurious, and biochemical assays indicated that collagen preservation was very poor, at least in skeletons recovered from the upper levels of the cemetery. The possibility of differential preservation as a factor in the stable isotope results will be examined by comparing the histomorphology of

bone from burials at different locations and depths within the cemetery. New procedures for sample purification are also being investigated.

The suitability of the trace element analysis of the inorganic part of human bone for dietary reconstruction is also under study. Radosevich (1989, 1990) suggests that no useful dietary information can be obtained from stronium/calcium ratios in Harappan bone, due to contamination from the burial matrix. Additional trace element profiles of human and animal bones and soil samples from the cemetery have been evaluated by one of Lovell's graduate students, D. Link, (1990). Results of his analysis tend to support Radosevich's claim. Observed values for all elements analyzed (Aluminum, barium, calcium, manganese, sodium, strontium, and zinc) are much larger than the expected physiological levels, in some cases by a factor of ten. The diet-indicating elements, barium, strontium and zinc, are present in the burial soil in substantial amounts, suggesting that the observed levels of these elements in the bones represent both simple contamination and ionic adsorption and substitution from the soil. However, severe diagenesis did not preclude detection of gender-based dietary differences (Radosevich 1989, 1990) using trace element analytical methods.

DENTAL ANTHROPOLOGY

John Lukacs

The Sample

While human skeletal remains have been recovered from Harappan contexts for several decades, analysis of the dental remains have been sorely neglected and valuable information regarding Harappan dental health conditions and dental morphology were routinely omitted from these earlier investigations. This report summarizes the major pathologies and odontometric features of the Harappan dentition as represented in the sample recovered from the recent excavations. While the comparative and interpretive analysis of these data are still in progress, new insights into Harappan oral health, dietary patterns and tooth size are forthcoming.

The dental sample on which this study is based was recovered from two different burial contexts—primary and secondary. Primary contexts include undisturbed, or minimally disturbed, burials which contain a complete skeleton in its original burial position. Sixteen primary burials provided dental evidence for inclusion in this investigation. Loose teeth from secondary contexts not found in association with other skeletal parts are referred to as "isolated" dental remains. Excluded from this tabulation of dental remains are the numerous fragments of individual teeth, including chips of enamel, dentine and incomplete root fragments.

Dental remains from primary burials comprise 48.1 percent of the dental sample, secondary dental remains constitute 36.9 percent of the sample, and isolated dental elements make up only 15.0 percent. When the dental sample is broken down by sex, males (37.4 percent) and females (38.3 percent) are equally represented, but nearly one-quarter (24.2 percent) of the sample comes from skeletal elements of unknown sex.

DENTAL PATHOLOGY

The preliminary assessment of dental pathology at Harappa is divided into two parts. Part one reports the prevalence of dental disease at Harappa on the basis of the number of individuals affected by each disorder (individual count method). The second part provides a more detailed investigation of the prevalence and distribution of dental caries in the Harappan skeletal series (tooth count method).

The prevalence of dental diseases at Harappa are presented by sex and for the total skeletal series (Fig. 40.12). The sample on which these frequencies are calculated includes all "primary" context burials ($n=16$) and many of the more complete "secondary" context burials ($\bar{n}=26$). Of the dental disorders documented in this study gross linear enamel hypoplasia was the most frequent, affecting 72.2 percent of 36 individuals for which observations were possible. The least frequent condition in the series was hypercementosis (4.9 percent). Dental afflictions of low prevalence in the total sample include abscesses (18.4 percent) and exposure of the pulp chamber (17.1 percent). One individual (H87/137/148a) was afflicted by an exceptionally high incidence of dental abscesses, six in the maxilla and five in the mandible (Fig. 40.27). But if this unique individual is excluded, the inci-

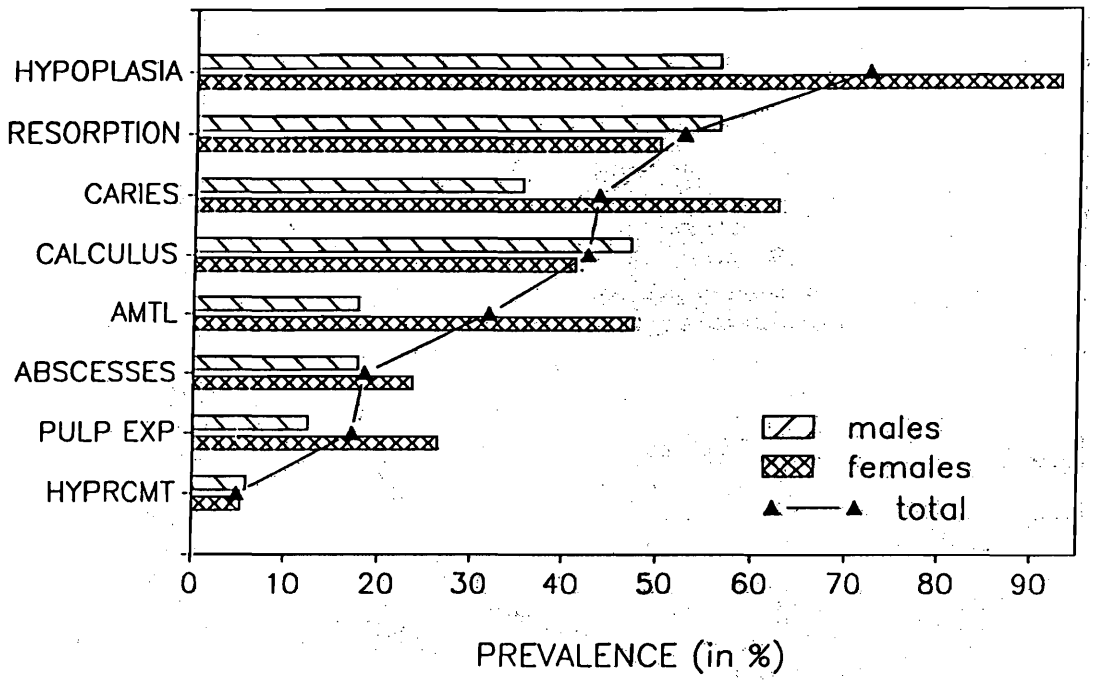


Fig. 40.14a. Prevalence of dental diseases at Harappa (individual count).

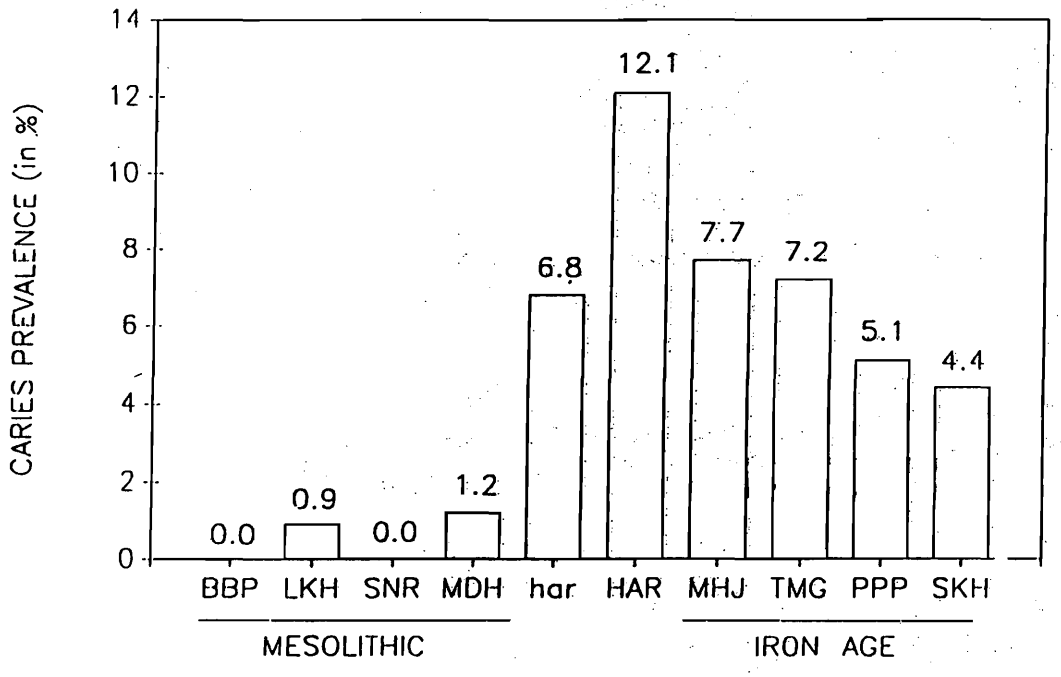


Fig. 40.14b. Caries prevalence among prehistoric South Asians (tooth count).

dence of dental abscesses in the remaining sample is rare. Ante-mortem tooth loss (31.7 percent), calculus (42.5 percent), dental caries (43.6 percent), and alveolar resorption (52.6 percent) exhibit intermediate frequencies at Harappa.

Sex dimorphism in dental health at Harappa was investigated using the chi-square test of independence. Dental disorders for which statistically significant differences between the sexes exist include AMTL and hypoplasia. The difference in prevalence of caries and pulp exposure between the sexes, while not statistically significant ($p > 0.05$), was large and probably of biological significance for the Harappans. Dental abscesses, calculus and alveolar resorption are disorders for which males and females display similar rates. Further comparative and statistical analysis of the dental pathology pattern at Harappa is in progress and will be presented elsewhere.

The dental pathology profile at Harappa is in agreement with an agricultural mode of subsistence. (Fig. 40.12). Analysis of dental caries by tooth count method found 51 carries teeth in a sample of 751 teeth, yielding a 6.8 percent caries rate. When corrected for bias caused by anti-mortem tooth loss, the tooth count caries rate increases to 12.1 percent, a more accurate estimate of the true caries rate for this sample of Harappans.

Odontometric Analysis

Odontometric analysis of Harappan teeth reveals an overall tooth size that falls in the high microdont range. The total summed crown area for Harappa is 1194 sq. milimeters and the tooth material index is 182 milimeters. Tooth specific indices indicate: (1) moderate reduction of maxillary lateral incisor teeth, (2) slight reduction of upper molars two and three (in contrast to the first upper molar), and (3) a high degree of reduction of mandibular molars two and three (in contrast to the first lower molar).

Several additional areas of dental analysis are currently in progress: (1) macroscopic and scanning electron microscopic study of dental wear patterns for evidence regarding diet and possible occupational uses of the dentition (see Lukacs and Pastor 1988), (2) frequencies of many discrete morphological variations (shovel-shaped incisors, extra cuspules of molars etc.,) in order to estimate the degree of biological relationship between the Harappans, their predecessors and their successors; and (3) interpretation of unique individual evidence of traumatic injury (Lukacs and Hemphill 1990).

DISCRETE TRAITS ANALYSIS

Brian Hemphill

The analysis of discrete morphological non-metric trait variation has been utilized by many workers in recent years to assess both population affinities and microevolutionary trends within and between human populations. This method of analysis, which looks at the frequency of occurrence of specific features of the cranial and post-cranial skeleton, is based upon the pioneering studies of Berry and Berry (1967). This study represents the first comprehensive application of this type of analysis on prehistoric South Asians.

Twenty-seven non-metric traits of the cranium were scored on all adult individuals excavated during 1987-1988. The details of the methodology will be given in the final report of the physical anthropologists that is scheduled to be completed by the end of 1992.

The frequency of cranial non-metric traits among the Harappans are placed in temporal and regional perspective by contrasting these results with ten other South Asian and Near Eastern samples. Only those samples scored by other workers in accordance with the criteria of Berry and Berry (1967) were used in the comparisons. Cluster analysis indicates that the specimens from the Harappan cemetery represent a population which has a very different set of phenetic relationships than those possessed, for example, by the populations at Sarai Khola, Mahadaha (Mesolithic Gangetic site), or modern Punjab. The Harappans appear to be most closely affiliated with ancient and modern samples from Palestine, and secondarily associated with other prehistoric samples from Lebanon and southern Turkey.

Another significant conclusion from these tests is that biological discontinuity was introduced into the South Asian gene pool prior to the rise of the Harappan civilization and following the neolithic period as defined at Mehrgarh. A second discontinuity occurred sometime before the Late-Bronze/ Early Iron Age settlements at Sarai Khola. The

historical, cultural and demographic implications of these conclusions are immense involving among other major questions those relating to the origins and decline of the Indus civilization. As stressed above, the conclusions must be regarded as highly tentative, due to the small sample sizes, and the fact that the results have not yet been integrated with the data from the other physical anthropological studies or the archaeological data.

III ARTIFACTS: TYPES AND TYPOLOGY

POTTERY: CLASSIFICATION AND DESCRIPTION

George F. Dales and Chris Jenkins

The classification and analyses (technological, stylistic, functional) of pottery is an especially important aspect of the research at Harappa. These studies all address the broader issues of continuity and change through time. Because of the enormous quantities of ceramic materials (almost one million sherds from the five seasons) and the variety of information preserved in them, they are the single-most important category of remains for these studies. Very little, for example, is certain about the relationship between the earliest settlers and the population responsible for the fully developed urban period. Superficially we refer to the early ceramics as being related to the Kot Diji-Jalilpur-Sarai Khola tradition which does provide some temporal and geographical framework. The ceramics can provide essential other information relating to technological and stylistic continuities.

The only comprehensive attempt to date to provide an analytical classification system for Indus pottery is the work by Dales and Kenoyer on the Mohenjodaro pottery (1986). The basic classificatory system was used as the starting point for the ceramics at Harappa. As we anticipated, differences immediately became apparent between the pottery of the two sites and new vessel types and variations have been identified. The differences may be the product of functional, aesthetic, temporal or other factors which are all part of our broader study of the relationships between the two sites. The important point is that the classification system developed with the Mohenjodaro pottery has been flexible enough to adapt easily to the new and different forms found at Harappa.

With the assistance of Chris Jenkins (U.C. Berkeley), a thorough study is being made of the classification procedures for all the vessels and sherds from the excavations. Just as with the Mohenjodaro pottery, the proportional ratios of the vessels (measurements and profiles of the body of the vessels, devoid of rims and bases) provide the starting point for the classification procedure. Because of the large quantities of complete or restorable vessels, it is possible to better define the basic form categories (jar, pot, bowl, or dish) than it was using the more fragmentary Mohenjodaro material.

We are also making more use of secondary attributes, such as rim and base forms, surface modifications (slips, paint, incising, scraping, etc.), unusual firing, and any other features that may be diagnostic.

The classification system applies fundamentally to complete or restorable vessels. More often, however, one is confronted in the excavations with just sherds. Rim and base sherds, being more distinctive in form than body sherds, assume a special importance. The original Mohenjodaro classification system for rims and bases has been improved at Harappa thanks to having a much larger sample of complete vessels for analysis. It is now possible to assign most individual sherds to specific vessel categories, or at least to a small cluster of categories, with greater assurance than before.

The technological aspects of the Harappa pottery industry—raw materials, forming and firing techniques, and specialized surface treatments—are being studied by Dr. Rita Wright.

Special attention is devoted as well to developing comparable classification and descriptive system to the Early and to the Late (Cemetery H) pottery.

FIGURINES

George F. Dales

Terracotta figurines of anthropoid and non-anthropoid creatures are abundant at Harappa. But without written documents of religious/mythological nature, and without the presence of recognizable religious or cultic structures, the original functions and significance of the figurines remain obscure. At the initial stage in the our study of the figurines we are developing systematic criteria for the classification and description of the various types and styles of representations. From this, with the addition of contextual and distributional information, some functional understandings may be forthcoming.

Non-Anthropoid Figurines

Some 550 complete or partial non-human figurines, and identifiable fragments of, were recorded during the first four season's. The basic problem is that of identifying the species of the quadrapeds (Figs. 40.13, 40.14, 40.15). With the exception of the rhinoceros, the humped bull, and the dog, each of which has unique body characteristics, it is impossible to identity species from the body alone. It is the horns, snout, and facial details that are the species indicators. Richard Meadow, the expedition's zooarchaeologist, is working with Dales to develop a coding system for recording distinct attributes of the figurines. The correlation studies are not yet complete but tentatively the study suggests the following breakdown:

Animal Types	Quantity	% of Total
Quadraped mammals	133	24.5%
Unidentified		
Horned quadrapeds	88	16.2%
Unidentified		
Cattle	164	30.3%
Buffalo	58	10.7%
Rhinoceros	34	6.3%
Sheep/Goat	15	2.8%
Other (Dog, Cat, Primate, Bird)	50	9.2%
(Turtle, Elephant, Unicorn)		

These figures, as yet tentative, suggest that cattle outnumber sheep/goat by 10 to 1; cattle outnumber water buffalo by 3 to 1; and cattle outnumber rhinos by 5 to 1. Of the 164 identifiable cattle, Bos indicus outnumber other types of cattle by 2 to 1. The further identification of examples within the large unidentified categories will no doubt modify these percentages.

Anthropoid Figurines

The anthropoid figurines present quite a different problem. Usually, identification of sex is no problem. Body configurations are different as are facial features, ornamentations and head-dresses. Standing male figures do have applied breasts but they are flat discs rather than the conical forms seen on the female figures (Fig. 40.16). There are two examples of what appear to be hermaphrodite figures but they require further study.

During the first four seasons, 497 anthropoid figurines, or parts were recorded. Of these, 393 (79.1 percent) are females, 73 (14.7 percent) are males, and 31 (6.2 percent) are too fragmentary to determine the sex. Female representations are thus about five times more plentiful than males.

Their distribution is also of interest. Most of the figurines came from the cemetery area during the second and third seasons but not a single figurine was found in primary context in a burial. All the objects were found in the thick debris layer covering the cemetary. Of these figurines, 76.7 percent are female and 17 percent are male. The situation is quite different, however, with the fourth season when the excavations concentrated on the western slope of Mound E. Only 58 figurines were found, 86.2 percent of which were female, 3.5 percent were male, and 10.3 percent are as yet unidentified.

Attention is focusing on the manufacturing procedures used for the figurines as well as on their types and styles. A peculiar manufacturing detail has been recognized for most of the female, and some of the male figures. They were made in vertical halves which were stuck together before the jewelry ornamentation and hip bands were applied and the figurines fired (Fig. 40.17). This join is quite evident on many of the figurines. Several examples where the join is not visible on the surface were x-rayed and the join shows clearly. The reason for employing this peculiar manufacturing procedure is not clear.

And there is a second fascinating aspect to the

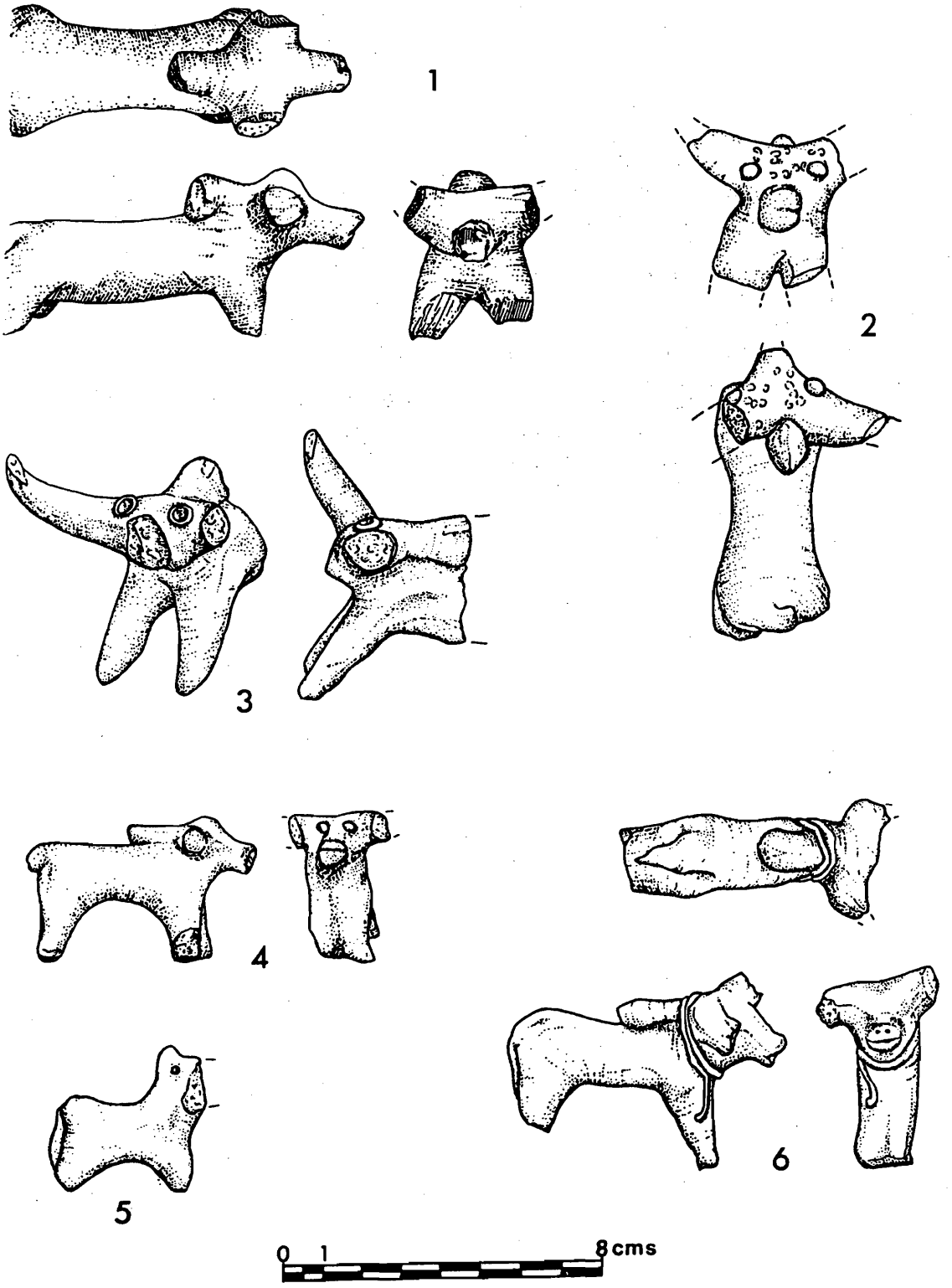


Fig. 40:15. Terracotta animal figurines zebu.

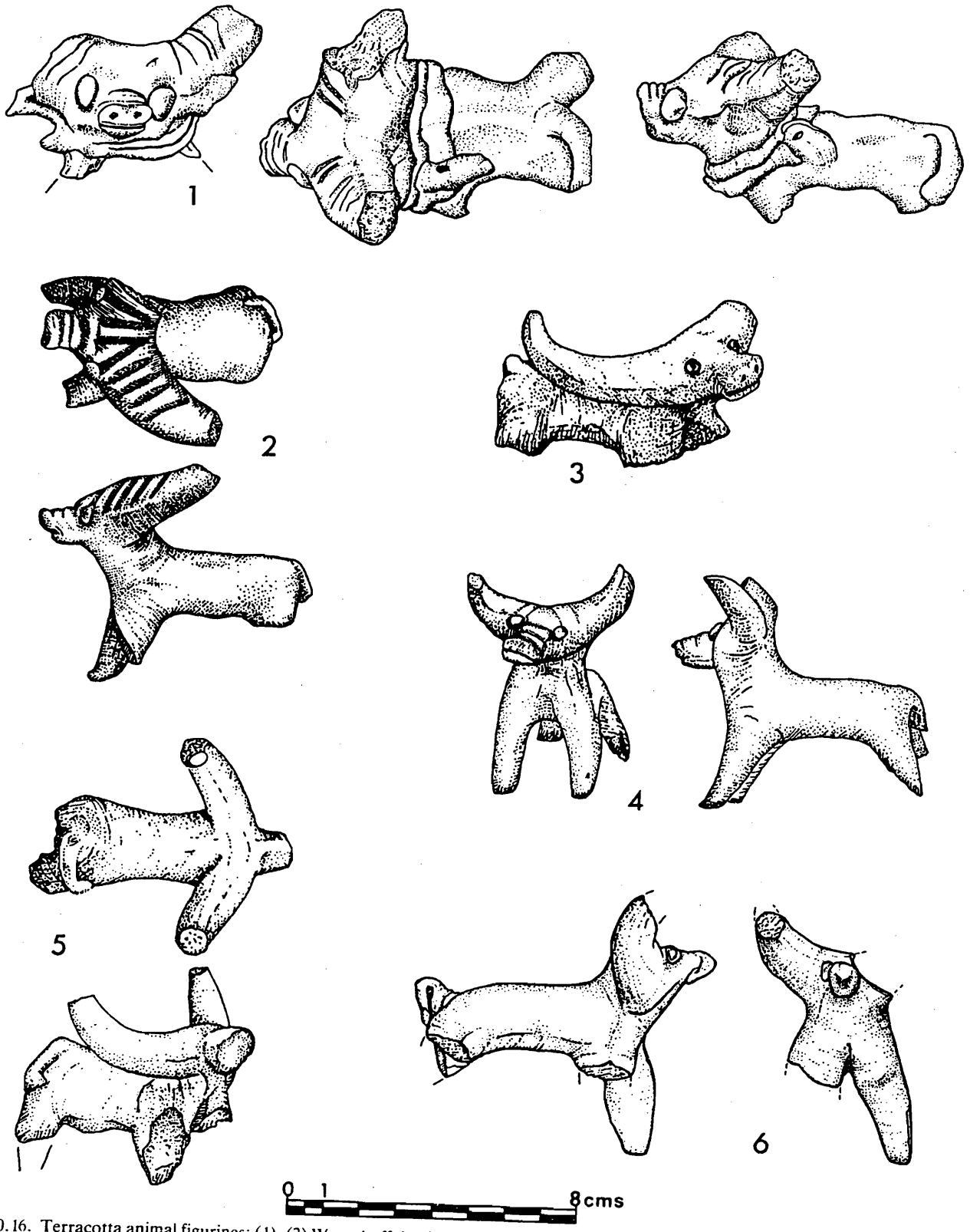


Fig. 40.16. Terracotta animal figurines: (1), (2) Water buffalo. (3-6) Bovine of uncertain identification uncertain indentification.

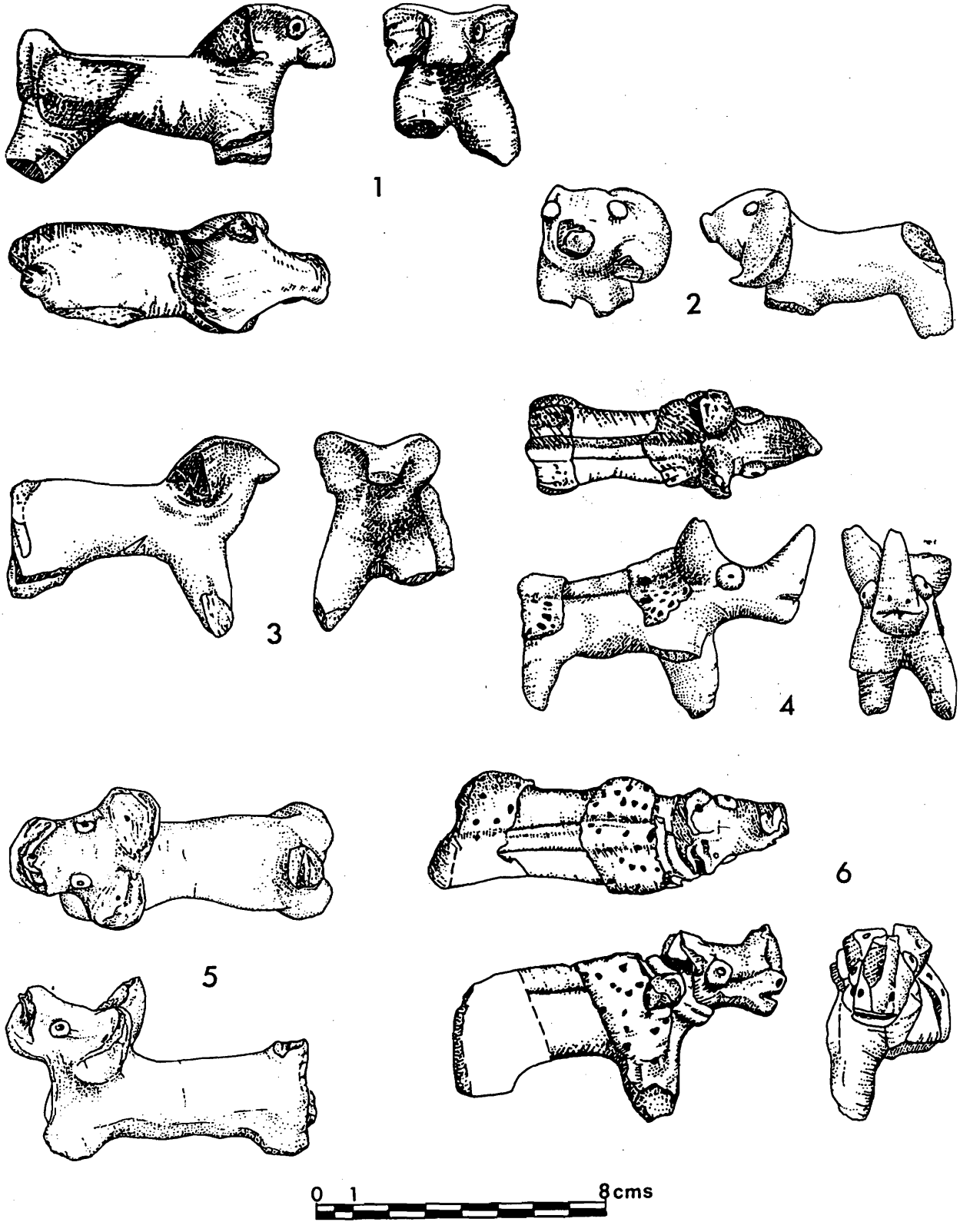


Fig. 40.17. Terracotta animal figurines: (1-3) Sheep. (4), (6) Rhincoeros. (5) Hyena.

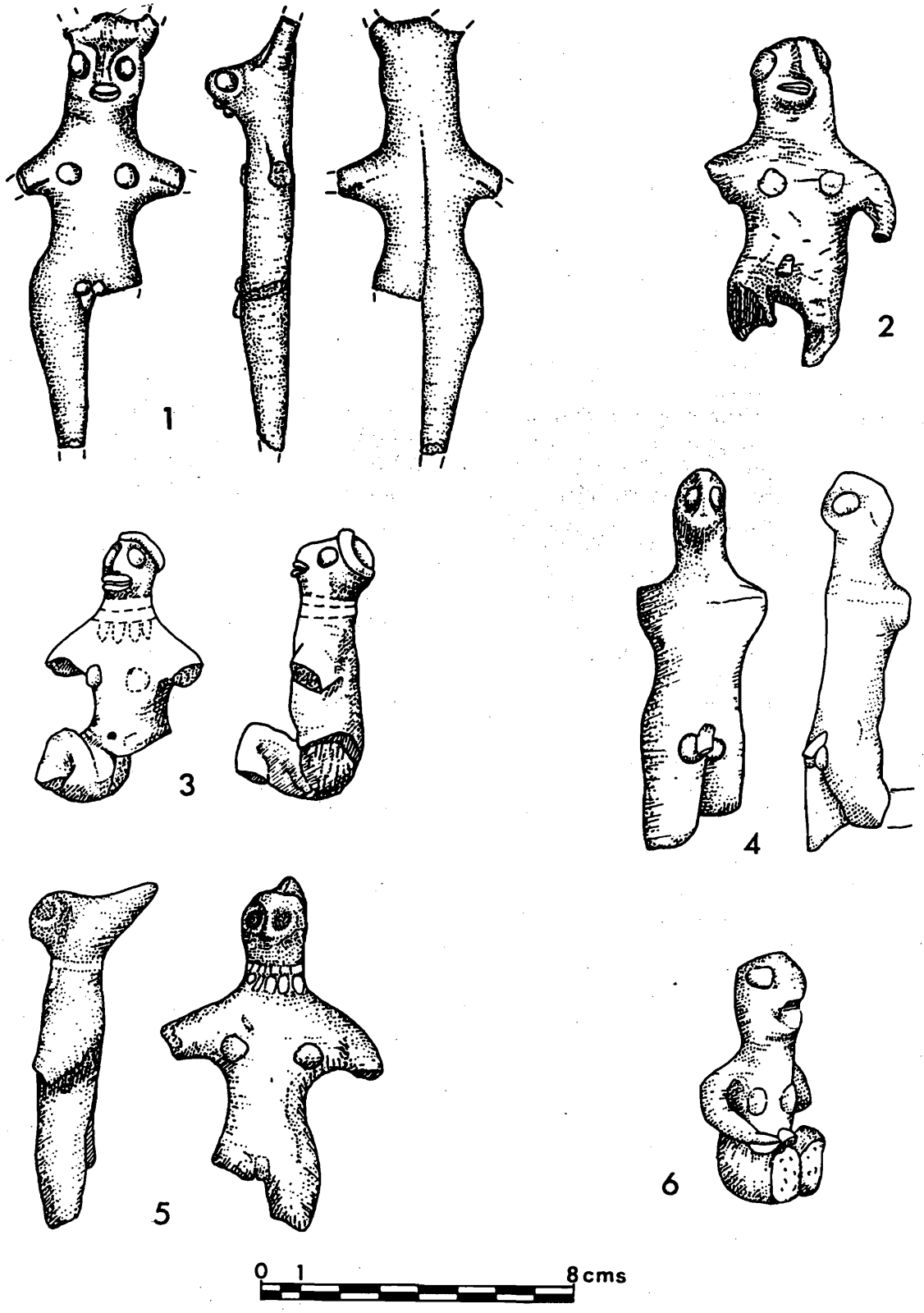


Fig. 40.18. Terracotta anthropoid figurines: Early (Periods I-II).

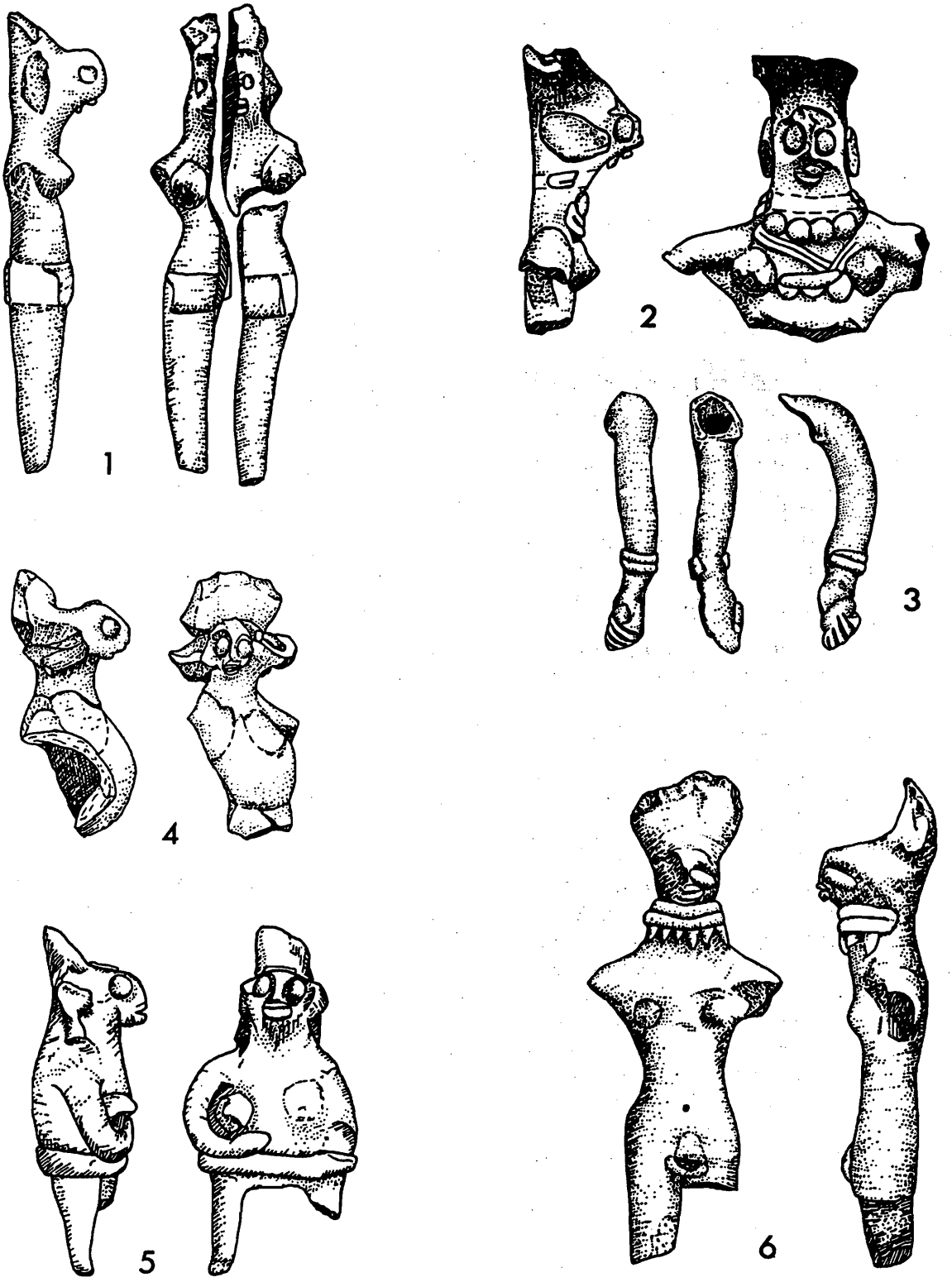


Fig. 40.19. Terracotta anthropoid figurines: Male.

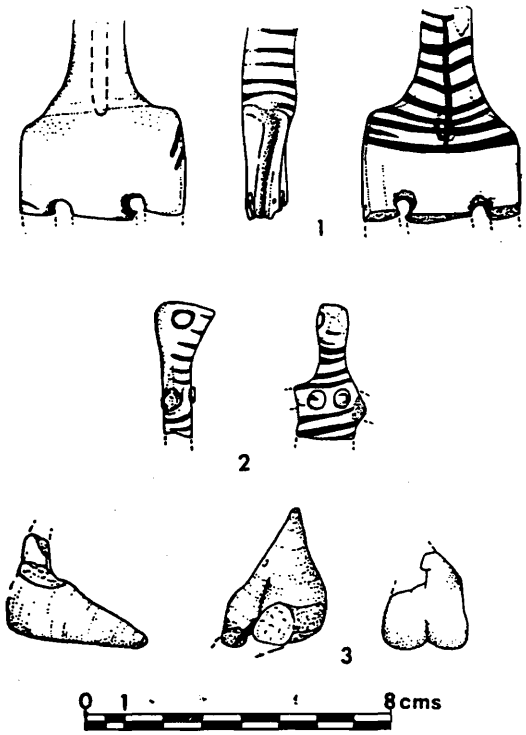


Fig. 40.20. Terracotta anthropoid figurines: female, showing manufacturing detals.

manufacturing of female figurines. The basic torso is almost flat on the front side with a pinched waist and short pointed stubs projecting horizontally from the shoulders. This same basic female representation can be traced back in time and sapce to the Neolithic, and even earlier, figurines in the Near East and the Mediterranean region (Dales, 1960, 1963, 1974). What is different, and new is that in the Indus region, during the Mature Harappan period, this basic stylized female figurine is added on to and embellished. Thick strips of clay were attached to the top of the arm stubs to produce prominent shoulders and the arms—made separately—were stuck on to the end of the stubs creating what resembles a ball joint (Fig. 40.17). Again, the explanation for this manufacturing procedure eludes us.

In addition to the Mature Harappan figurines, the 1989 excavations on Mound E yielded several fragmentary examples of earlier period figurines (Fig. 40.18) closely related in form and style to figurines from Sheri Khan Tarakai in Bannu District (Khan, Knox and Thomas 1988), and Gumla (Dani 1971). These examples are extremely important for our identification of the Pre-urban deposits at Harappa and for questions relating to contacts and interactions with other early sites.

INSCRIPTIONS

George F. Dales

The number of new seals, tokens, and inscriptions found during the first four seasons was surprisingly small considering the richness of the inscribed materials published in Vats's report on the initial excavations at Harappa. This can most probably be explained by the fact that our excavations had concentrated in areas quite different functionally than those exposed by Vats. The situation changed drastically during the 1990 season when a rich collection of contextually related seals, tokens and other inscriptions was discovered in and near a house along the southern edge of Mound E (see Addendum).

All the new inscriptions from the first four seasons are included in the pictorial corpus of Indus inscriptions prepared by Dr. Asko Parpola (1991).

Important to note is the variety of uses of the script. In addition to the well-known square steatite seals with animal representations (Fig. 40.19), there are rectangular steatite seals with only script; steatite "tokens" with script on both sides; molded faience "tokens" with script on one side and an animal on the reverse (Figs. 40.19 and 40.20); inscriptions on bone, terracotta, metal objects, and on stoneware bangles, and inscriptions on pottery.

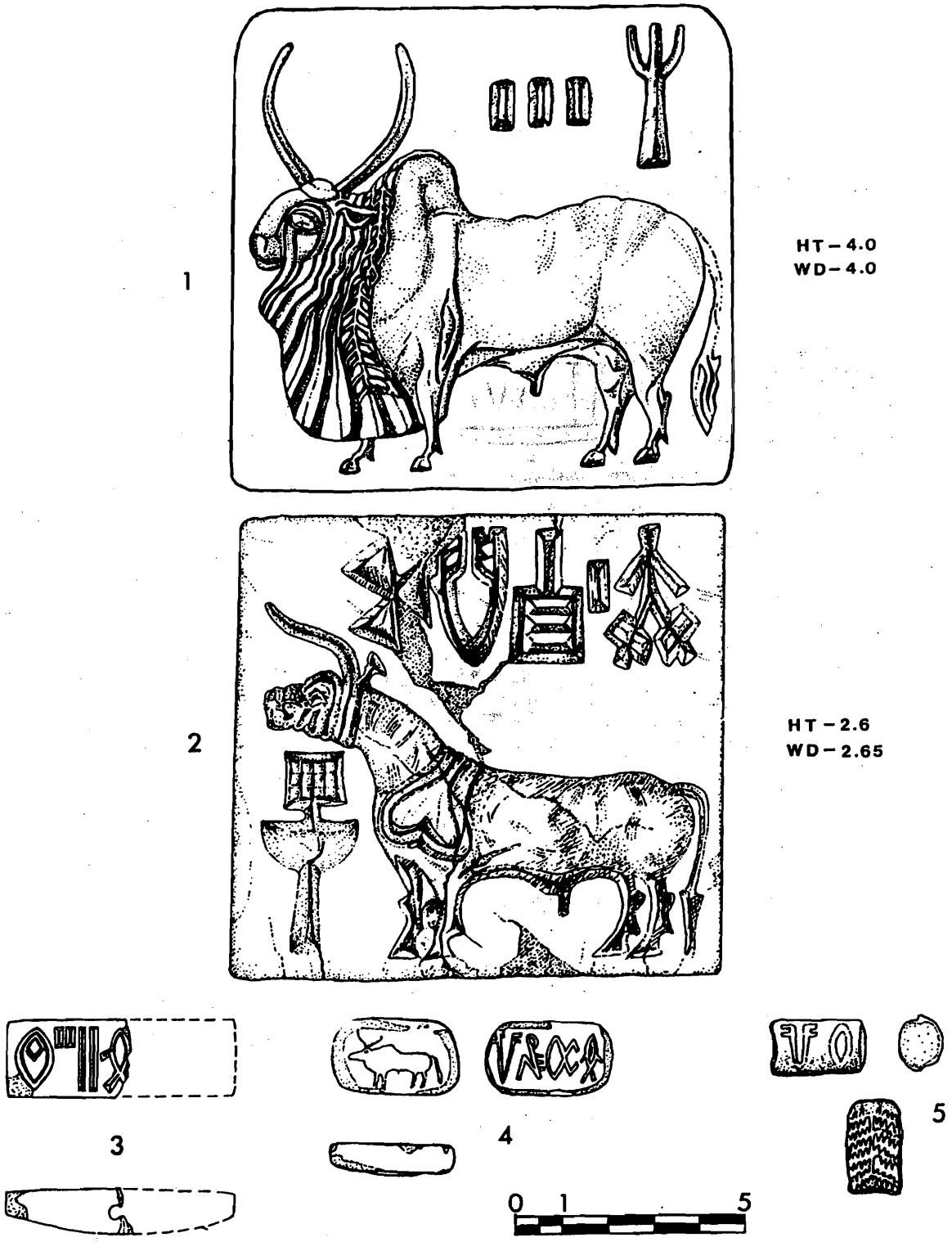


Fig. 40.21. Inscribed Objects: (1), (2), (3) are steatitie seals. (4) and (5) are faience "tokens".

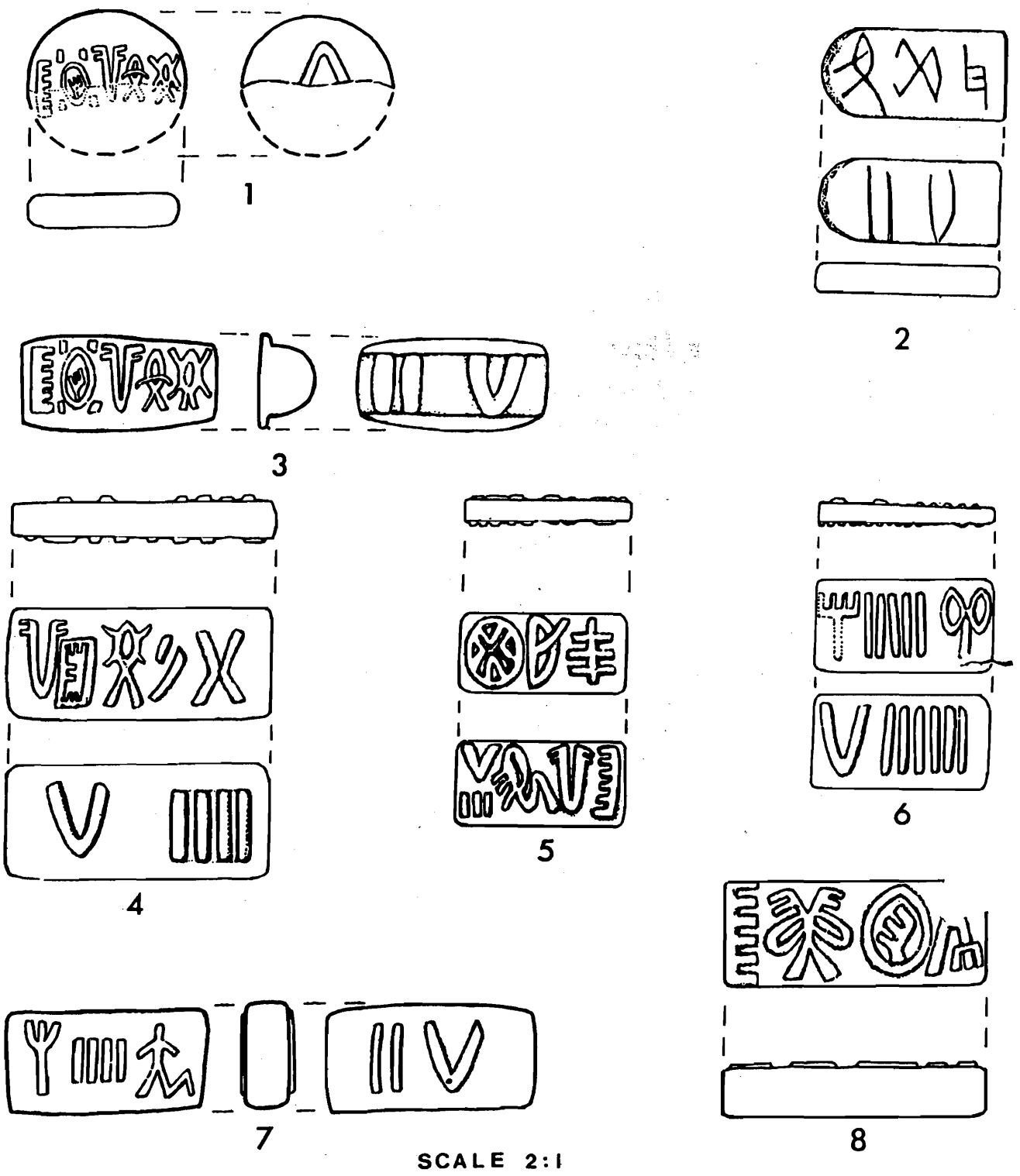


Fig. 40.22. Inscribed objects: (1), (3-8) are faience "tokens". (2) is steatite "Token".

IV TECHNICAL STUDIES AND CONSERVATION

CERAMIC ANALYSIS

Rita P. Wright

Archaeometric analysis of the pottery is being conducted to understand the continuities and discontinuities in ceramic technology between Periods I, II and III. The ceramic technology at Harappa is being compared with other contemporaneous sites. The analysis involves characterization of the raw materials used in the clays, the slip and paints, the manufacturing techniques, and the temperatures used to fire the ceramics.

Sherds from Harappa are being analyzed petrographically using both qualitative and quantitative techniques. Initial petrographic analysis conducted by Sherman Banker of the University of Wisconsin indicate that there is a substantial amount of qualitative and quantitative variation in the sherds studied. This variation could be due to temporal, functional, technological or other unknown factors. The continued petrographic analysis of these ceramics will help in understanding the development of specialized ceramic production and exchange, as well as chronological questions relating to the early chalcolithic and urban periods (Harappan) in Pakistan.

Stoneware Bangle Analysis

Thirty specimens of terracotta and stoneware bangles from surface and excavation contexts have been studied by M.J. Blackman (Smithsonian Institution) and Massimo Vidale (Is.M.E.O., Rome). This set of samples was studied together with a larger group of bangles and other ceramic artifacts from Mohenjodaro.

The goals of the research are:

1) To reconstruct the very sophisticated technology of Harappan stoneware bangles.

2) To determine if Harappa was a manufacturing center for this unique ceramic product.

3) To study the pattern of distribution and exchange of stoneware bangles between Mohenjodaro and Harappa.

4) To see if it is possible to understand the type of social structures involved in their production and consumption.

Tests include the use of instrumental neutron activation analysis at the reactor facilities of the National Institute of Technology and Standards, Gaithersburg, MD. This analysis revealed that the clays used at Mohenjodaro are easily distinguishable from those used at Harappa, primarily on the basis of their higher calcium content. The samples from Mohenjodaro appear to be fairly homogeneous, while the Harappa samples show a range of clay types that fall into two major categories: bangles made from clay that is chemically similar to clays found in the region today, and bangles that are chemically identical to the bangles produced at Mohenjodaro. This suggests that some of the stoneware bangles were probably made in Mohenjodaro and carried to Harappa, either by traders or through the movement of people wearing the bangles. The chemical and spatial analyses of additional samples from Harappa will help us to understand more clearly the significance of these remarkable bangles in Harappan society.

Faience Analysis

Research on the faience production at Harappa is being done by Pamela Vandiver and her student Blythe McCarthy at the Smithsonian's Conservation Analytical Laboratory. Various archaeometric techniques are being used to understand the composition, firing temperatures, colorants and forming processes of the different types of faience objects. Experimental faience produced by J.M. Kenoyer and also by B. McCarthy is being compared with archaeological materials from Harappa. Preliminary results of the analyses show clearly that the Harappan faience is more refined and of superior quality to that known from Egypt and the eastern Mediterranean (McCarthy 1990).

Metallurgical Analysis

Vincent C. Pigott

Many examples of copper/bronze objects have been recovered in the excavations of the domestic areas on Mound E and Mound AB. The complete tools include Period III (Mature Harappan) arrow points, chisels, a spear and several blades. Much of the copper was probably recycled to make new tools and in one case several small pieces of broken

tools were found wrapped together with fiber possibly collected for reprocessing or remelting. Small circular mirrors were also found associated with the Period III burials.

The analysis of the copper/bronze artifacts from Harappa is being conducted at MASCA (University Museum, Philadelphia) by Vincent C. Pigott and Stuart J. Fleming. At the present time eleven artifacts have been studied to determine the elemental composition of the metals, the microstructural features of the metal and the technology involved in the production of each specific object. Preliminary findings indicate the presence of relatively pure copper artifacts, objects made from arsenical copper and one object made from tin-bronze (see Fig. 40.21) for the elemental (PIXE) analyses of four samples). The techniques of manufacture and metal processing include casting, cold hammering, annealing and possibly drawing.

Precious metal (gold, silver) is also found. Preliminary analysis of samples is being done by J.M. Kenoyer and Jim Burton using the Electron Microprobe at the Department of Geology, University of Wisconsin-Madison.

LITHIC STUDIES

J. Mark Kenoyer

Another area of archaeometric analysis is the study of raw materials used to manufacture pecked and ground stone implements and chipped stone tools. A large sample of raw materials has been collected from Harappa for characterization and comparative analysis with rock samples from known source areas. These samples are being studied by J. Mark Kenoyer and Jim Burton at the University of Wisconsin—Madison using x-ray defraction and electron microprobe.

Also, Kenoyer has been conducting experiments with modern replicas of some of the tools, specifically the drills. These experiments are necessarily to develop a comparative collection of wear and use surfaces.

STONE BEAD MANUFACTURE

J. Mark Kenoyer

Harappa has produced a wide variety of stone beads made from a range of different raw materials. None of these materials are available in the alluvial plains and therefore all of the stone beads represent trade contacts with distant source regions. Some of the raw materials, for example carnelian, banded agate and amazonite appear to derive from the region of modern Gujarat, India. Lapis lazuli was probably obtained from the Chagai Hills region of Baluchistan or the mines near Badakshan in Afghanistan. Various colors of steatite could have been brought from Baluchistan to the west or from the Rajasthan ranges to the east. Variegated jaspers and limestones could have been acquired in the Kohistan or Baluchistan region as well as from Rajasthan, Kutch or Saurashtra. The identification of specific source areas is being done through the collection of modern examples of raw materials for comparative studies using petrographic characterization and trace element analysis.

Studies of bead manufacturing techniques are also under way. Some of the raw materials are microcrystalline silicates and can be easily flaked, while other crystalline materials were fashioned by grooving and splitting, sawing, or simply grinding. Each type of raw material requires a different manufacturing process. Special attention is focused on the technique used in the manufacturing of micro-beads (Pl. 40.22).

Every bead from the current excavations at Harappa is being studied to determine the type of drilling technique used. Silicone impressions of the drill holes are made and these casts are then studied under the scanning electron microscope at the Department of Geology, U.W. Madison. No evidence for the use of abrasive has been found in the hard stone beads studied so far. The softer stone beads, made from steatite, sandstone, lapis lazuli etc. appear to have been drilled with a rough drill, probably made from chert or chipped jasper (pthanite). Some of the short biconical beads made from rock crystal and carnelian were drilled using a

unique technique that has not yet been replicated. The interior hole is very rough and chipped, suggesting a pecking technique.

An exquisite example of the jewellers skills is seen in the teardrop shaped carnelian gem set in gold (Pl. 40.23).

FAUNAL STUDIES

Richard H. Meadow

Richard Meadow, assisted by James Knight in 1989 and Tonya Largy in 1990, continued his work on the faunal remains from Harappa as part of a larger study of animal exploitation during the Harappan Period in Pakistan funded in part by the National Science Foundation and in part by the Harappa Project.

The purpose of carrying out the analysis of animal bones from archaeological sites is to learn about the relationships between humans and animals in the past. Such study is particularly important at an urban site like Harappa where the population probably depended upon domestic animals for traction (plowing, pulling carts, carrying people and goods) and other secondary products (such as wool, hair, and milk), as well as for meat and hide. In addition, it was clear after the analysis of a small collection excavated from AB-mound during the 1986 season at Harappa that wild animals including deer, blackbuck and gazelle, fish, turtles, and birds were important to at least part of the population during the period of the Indus Civilization. This unexpected finding required confirmation from other parts of the site since the use of different animals for food could have varied through the ancient city according to what sections of the population had access to different kinds of animal resources. Furthermore, with the discovery of the extensive Early Harappan deposits in the area of E Mound, the question arose as to whether the nature of the exploitation of animals changed during the period that saw the development of the Harappan urban complex.

Study of the animal bones from different parts of Harappa site has begun to provide insights into these areas of enquiry. During the 1989 season, all previously excavated faunal materials were cleaned as a necessary preliminary to analysis. In addition, a number of lots from E Mound were examined and documented, and other materials from that area were selected for future study. During the 1990 season, vast amounts of faunal materials were excavated from the southern side of E Mound in street, occupational, and trash deposits. A large proportion of the remains from a north-south street was analyzed in the field and material from complementary loci was selected for future analysis. Even without final tabulations, it is already clear that the nature of the faunal remains varied considerably depending upon the intensity of occupation in the area. During periods of apparent abandonment or diminished use, the remains of whole animals or large parts thereof were dumped in the area while during periods of intensive use, material was highly fragmented and dominated by both smaller bones and the bones of smaller animals. Furthermore, the high proportion of bones from wild ungulate taxa noted in the 1986 sample was not duplicated, but large numbers of fish bones were recovered both through dry screening and water sieving. These findings have important implications for the interpretation of animal exploitation practices at Harappa in particular and at urban sites in general. They once again underline the need to carefully collect large samples from a wide variety of deposits.

In addition to the questions noted above, the analysis by George Dales of the figurines from Harappa has posed interesting problems. Water buffalo and non-humped cattle figurines are very common, yet there is little evidence so far for these forms in the animal bones. A problem faces the person who analyzes animal bones, however, and that is the difficulty of distinguishing between many of the skeletal parts of water buffalo and cattle and of humped cattle and non-humped cattle. With this in mind, a major effort was made during both seasons to make a collection of bones of modern animals and especially cattle and water buffalo from the "bonepits" outside of Harappa town. Specimens from nearly 75 animals were collected and prepared by simmering in laundry detergent, including the bones of water buffalo, zebu cattle, horse, donkey, mule, dog, and fish. Comparative osteological analyses are currently underway to define osteological differences between morphologically similar taxa. A complete collection of these modern specimens is stored at Harappa in order to

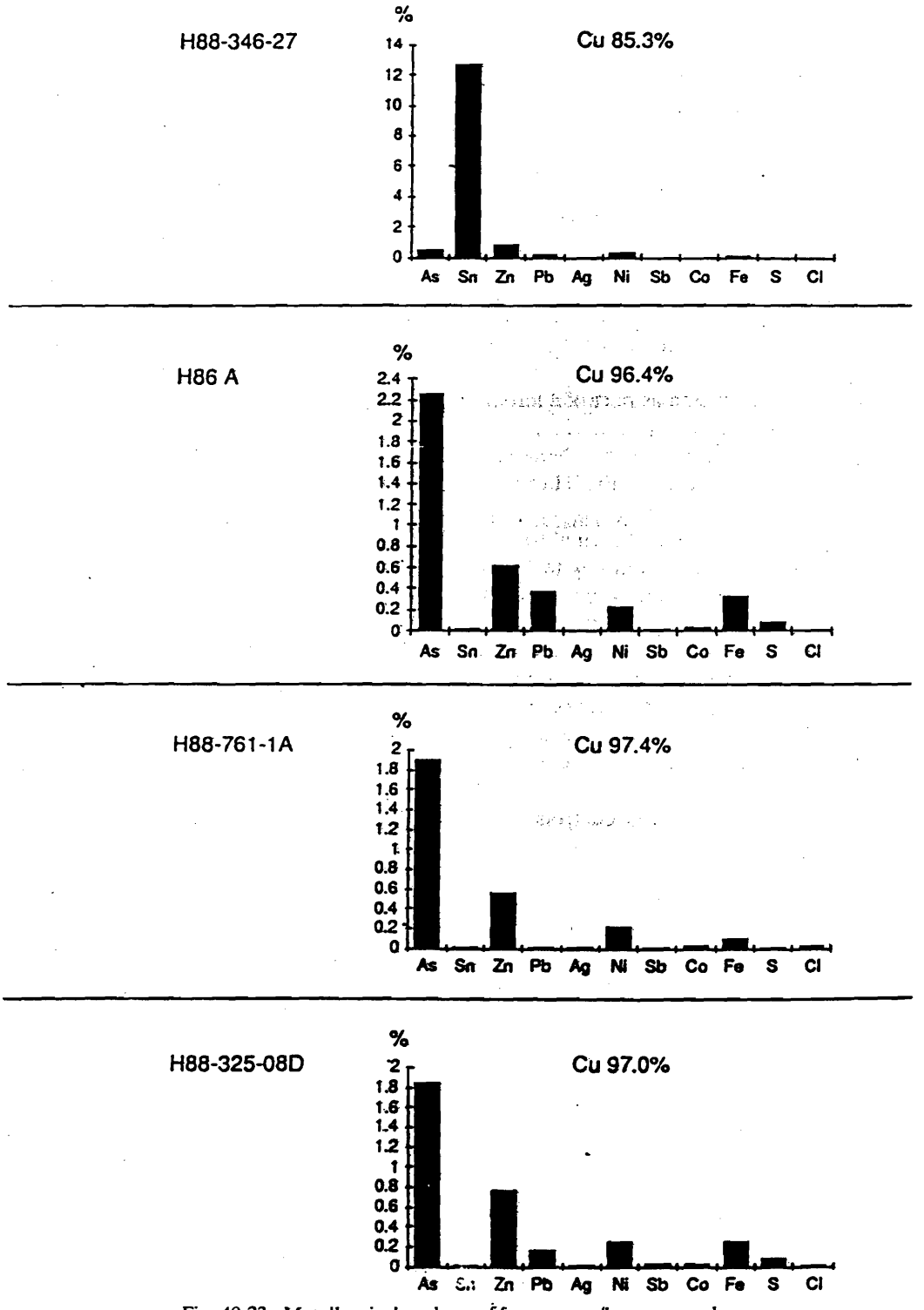


Fig. 40.23. Metallurgical analyses of four copper/bronze samples.

assist future researchers who wish to study the animal bones from archaeological sites in Pakistan.

Palaeobotanical Studies

The palaeobotanical samples collected from the 1989 excavations on Mound E contain a large percentage of carbonized seeds. These samples were collected in the field using flotation and then taken to Madison for cleaning and analysis. The remains are currently under analysis by Heather Miller and Seetha Reddy of University of Wisconsin. Dr. Steven Weber, University of Pennsylvania, has assisted with the identification of specific seeds. To date they have identified a wide range of plants spanning the Early Harappan and the Harappan periods.

The preliminary analysis of the 1989 samples identifies primarily winter grain crops of wheat and barley, together with a fine collection of legumes (Lens and a variety of the Lathyrus/Pisum/Cicer types). In addition, the samples contain a good array of wild seeds, including many "weedy" types. There are the seeds of various small wild grasses, Amaranthus/Chenopodium types, *Trianthema triguetra* and *Digera muricata,* as well as some *Zizyphus* sp. and *Albizia procesa/lebbeck.*

SOIL SURVEY

Elise Pendall and Ronald Amundson

INTRODUCTION

During the 1987 and 1988 field seasons, Dr. Ronald Amundson and Ms. Elise Pendall of the University of California, Berkeley conducted soil studies to assess the pre-settlement environmental setting and to investigate the fluvial history of the Ravi River around the archaeological site (Pendall and Amundson 1990). Samples of natural as well as archaeological sediments were collected for chemical analysis. Laboratory analyses were conducted to determine particle size, organic and inorganic carbon, major anions and cations, phosphorus, ph, alkalinity, and electrical conductivity. Further analyses were performed on the stable isotope chemistry and the morphology of calcium carbonate nodules found in the natural soil in the cemetery area (Pendall and Amundson 1990).

A soil survey of an eight square kilometer area around the mound of Harappa was conducted by augering 1.5 to 3 meter deep soil cores on north-south and east-west transects (Fig. 40.22). These borings, placed at internals of 150 to 200 meters, were described in the field and samples were collected for further analyses. Series names were given to the soils, but it should be noted that while some series names correspond to established soil series used by the Pakistan Soil Survey (e.g. Qadirabad), in other cases, new series names were given on the basis of local geomorphic features. A soil map was prepared using a topographic map of 1:50,000 scale as a base (Fig. 40.22).

At Harappa, most sediments associated with human occupation are silt loam to very fine sandy loam in texture. Within cultural strata, debris layers have sometimes been sorted by running water, and contain coarse (sand and gravel sized) particles of broken pottery and bricks. Cultural layers are dominated by silt loam textures, although silty clay loam textures can be found in some mud bricks.

At a distance of 0.5 to 1 kilometer outward from the edge of the mound, debris from Period III cover the natural soil surface to varying depths. This material may be associated with or buried by subrecent alluvium or may have gypsum accumulation within the profile. The surface is extremely salty and has sparse halophytic vegetation growing on it except where the surface debris have been scraped and the land reclaimed for agriculture. The presence of coarse rubble and other Period III debris at depths to three meters, as far as half kilometer from the site, may indicate locations of infilled borrow pits or rapid accretion of alluvium.

Recent Soils

The survey of the natural soil surrounding Harappa shows a dynamic and youthful environment because the meandering of the Ravi River has caused aggradation of the floodplain. The youngest geomorphic surface in the area is the lowest channel north of Harappa city and mound. Flooding, possibly as recent as 20 years ago, has cut into banks creating terraces around the recent stream channel. Soils of the recent channel are composed of silty clay loam to sandy loam to sand, and may have a slight accumulation of organized matter in a surfacial plowed horizon. This soil represents time

equals zero in the chronosequence since it is minimally developed.

Subrecent Soils

The next oldest geomorphic unit is loosely termed "Subrecent". The age of subrecent soils is difficult to establish since no datable materials were recovered. However, judging from relative soil development we place this unit between 500 and less than 7000 years in age. It is found mainly north and east of the mound, as well as in a band to the south. This unit consists of floodplain and channel deposits and levee remnants. The soils exhibit varying degrees of development, depending on age and facies. In most soils, incipient calcite or gypsum accumulation is evident, and agricultural soils have surfacial darkening from organic matter accumulation.

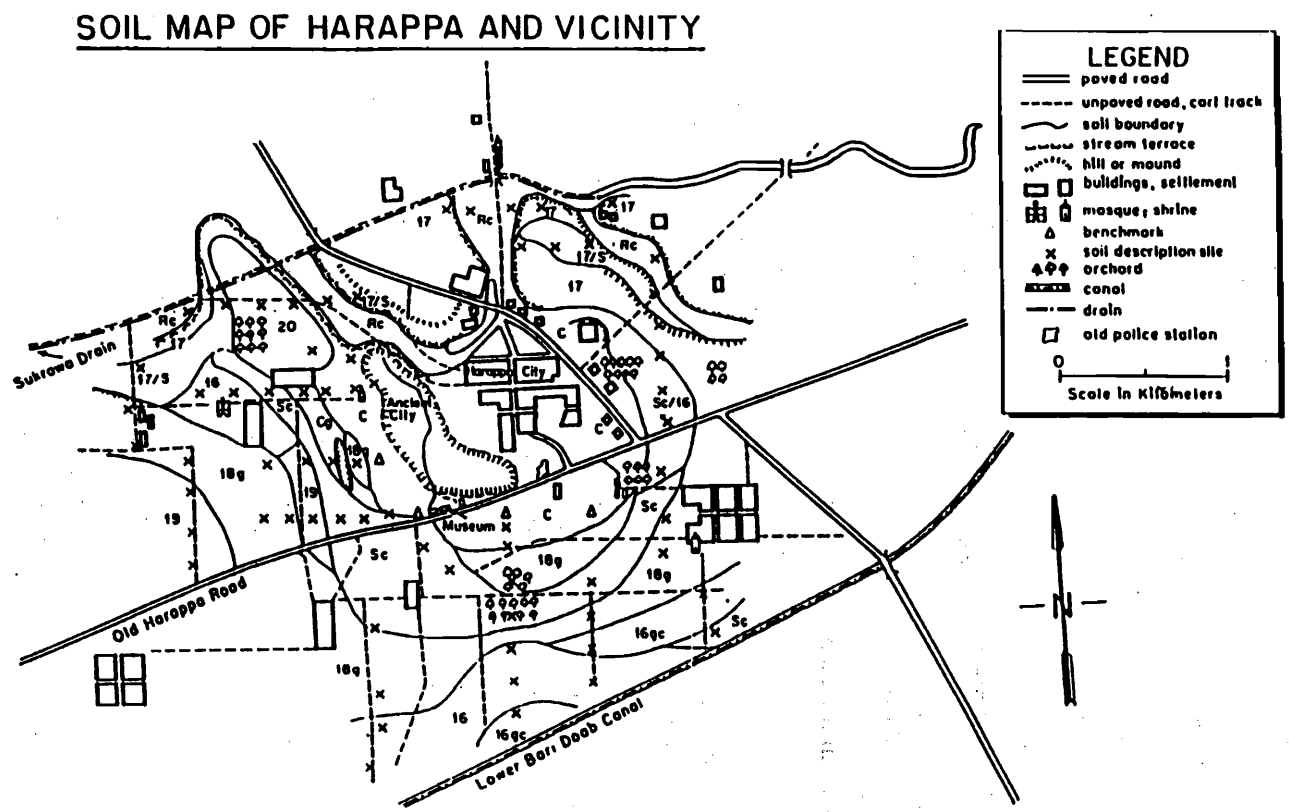
Late Pleistocene Soils

The oldest surface is late Pleistocene in age (Dr. Alim Mian, pers. comm., 1987), and was deposited by the Ravi River when rapid glacial melting and erosion of foothill soils was taking place. Soil formed in this deposit is relatively well developed. Its most noticeable feature is the presence of large and dense calcite nodules (kankar), which have formed over time by the downward movement of carbonates. The radiocarbon age of the single sample so far tested, of inner portions of these calcite nodules (5969 cal. B.C.) indicates that the soil reflects environmental conditions which existed prior to Period III occupation. A zone of clay accumulation may be present, but organic matter accumulation and intensive bioturbation are evident in the surface. This soil is found south and west of the mound area, and as remnant "islands" near the recent channel to the north and on the edge of the mound in the cemetery area.

CONSERVATION

The conservation laboratory at Harappa has proven to be of major importance in the treatment and preservation of artifacts as they come from the excavations. The laboratory was initially set up by Donna Strahan of the Smithsonian's Conservation Analytical Laboratory (CAL). She was assisted during the second season by Margaret Leveque of the Museum of Fine Art, Boston. Currently the laboratory is supervised by Harriet F. Beaubien of CAL. Additional assistance has been provided by Mr. Toseef-ul Hasan of the Department of Archaeology's laboratory, Lahore Fort; Mr. Wassem Ahmed, Senior Chemist at the Lahore Museum; Mrs. Barbara Dales and Ms. Dawn Morton, and during the 1990 season by Julie Lauffenburger of CAL.

Due to the high salinity in the soil, the rapid crystallization of salts and the fragile nature of many artifacts, it has proven essential to have full-time conservators at the site. Bone objects, metal objects, fabric impressions, seals, and pottery vessels and specific sherds with important painted motifs or surface treatments are either treated while still in the ground or are taken directly to the conservation laboratory for treatment. All the conclusion of treatment and consolidation, the objects can be safely handled or stored for further study, or prepared for museum display.



Soil map of the region around Harappa. Mapping units are described in text. Abbreviations for mapping units are: C Cg: Cultural material; Cultural material with gypsum. Rc: Recent Channel. Sc: Subrecent Channel. 16; 16gc: Sultanpur; Sultanpur, gypsum plus calcite phase. 17; 17/S: Sultanpur Levee Remnant Complex; Sultanpur Levee Remnant Complex, shallow over sand. 18g: Gamber. 19: Lyallpur. 20: Qadirabad.

Fig. 40.24. Soils map of Harappa area.

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We appreciate the opportunity to have had Mr. Tofeef ul-Hasan of the Department of Archaeology Conservation Laboratory (Lahore) work for three seasons in our field laboratory, to assist in the daily work and to acquire training in some of the new conservation techniques. And equally we appreciate the valuable assistance of Miss Rifa'at Saif Dar and Shokat Ali Shad, students at Punjab University, who filled in at a crucial time in the 1990 season to do the drawings of the artifacts and pottery.

And we wish to thank the twenty-five students from Karachi University, Shah Abdul Latif University (Khairpur), and Punjab University who participated in our field training sessions. We learned a great deal from them about university life in Pakistan and they in turn were exposed to wide variety of archaeological experiences. Appreciation is extended also to the Smithsonian Institution conservation Analytical Laboratory for providing the services of Ms. Donna Strahan during the 1986, 1987 and 1988 seasons; Harriett Beaubien for the 1988, 1989 and 1990 seasons; and Julie Lauffenburger for the 1990 season.

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