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Carnelian Bead Production in Khambhat, India: An Ethnoarchaeological Study

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INTRODUCTION

The production and trade of various types of agate or carnelian beads has had an important role in local and regional economics of the prehistoric and historic periods in South Asia. At present the city of Khambhat (Cambay) is one of the largest stone bead working centres of the world, and it has been an important centre for over 3000 years of documented history (Arkell 1936; Trivedi 1964; Kenoyer *et al.* 1991) (Fig. 1). With the aid of archaeological research, the stone bead industry in Pakistan and western India can be traced back even earlier to the cities and villages of the Harappan phase of the Indus tradition, dated to around 2500 BC (Hegde *et al.* 1988; Kenoyer 1986; Rao 1973) (Fig. 2).

The ethnoarchaeological study of Khambhat bead making has been an attempt to record a wide set of data on this traditional specialized industry before it is completely transformed by technological change and the introduction of modern socioeconomic relationships (Kenoyer *et al.* 1991). The overall objective of this project has been to document and correlate the dynamic and complex socioeconomic relationships of the bead industry with specific archaeological patterns. In this paper we will focus only on the production of red-orange agate beads, more commonly referred to as carnelian.

It is not possible to go into detail on all aspects of the carnelian bead industry but in the following paper we will present an overview of the important new technological and organizational aspects of this industry that will be useful in developing interpretive models regarding the role of agate bead production in early urban societies.

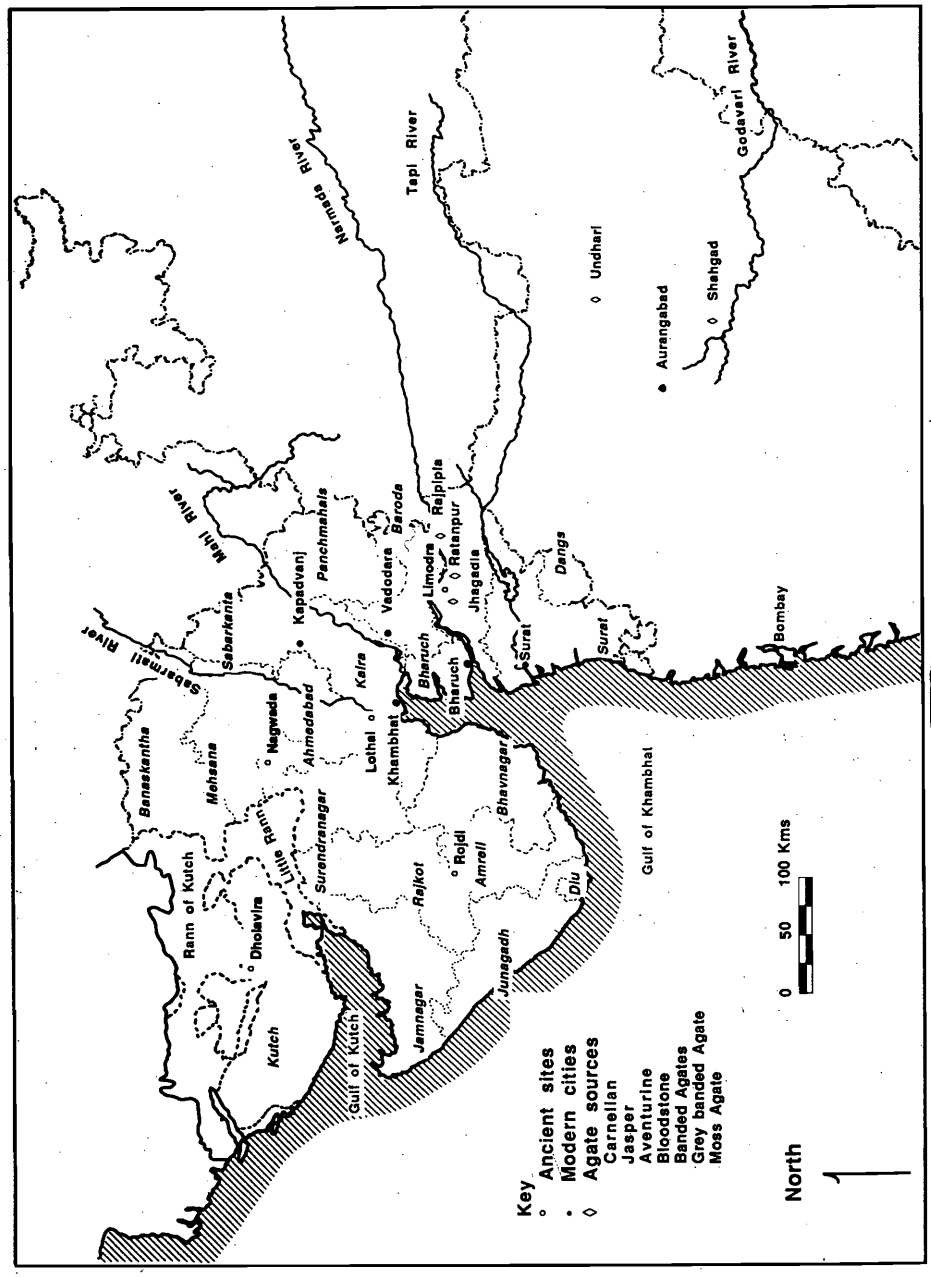

Fig. 1. Agate industry of western India.

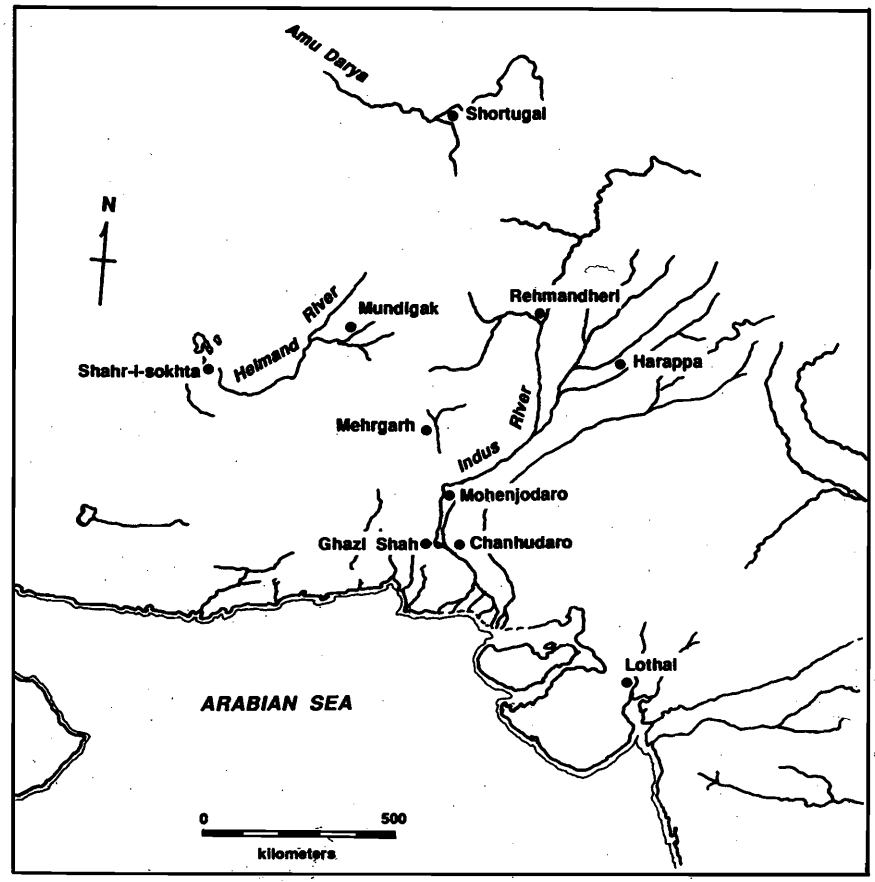

Fig. 2. Important agate working sites of the Indus tradition.

Archaeologically discernible patterns can be attributed to the different types of workshops and there are distinctive patterns of variation in finished goods resulting from small and large-scale production. By correlating the archaeological patterning of manufacturing waste and finished objects with other features such as architecture and settlement layout it is possible to identify levels of organization and control of production.

The initial results from this study indicate that a vast amount of archaeologically relevant information can be obtained through systematic ethnoarchaeological research of a traditional craft, such as bead making. On the basis of this information it is possible to propose new research strategies and interpretive models for the study of prehistoric bead making.

PREVIOUS STUDIES OF THE KHAMBHAT BEAD INDUSTRY

In the last century there has been a proliferation of documentary accounts of the bead industry at Khambhat and the mining in nearby regions. One of the most comprehensive critical historical accounts of the bead industry in Gujarat has been provided by Peter Francis (1982), but there are numerous discrepancies in his description of the region, the prevalent techniques used in different localities, and other aspects of the industry that are crucial to archaeological interpretations. Many other scholars have reported on their visits to Khambhat or have referred to this industry in their studies of bead making at specific archaeological sites (Bannerjee 1959; Mackay 1937; Possehl 1981; Rao 1973, 1979, 1985). While all of these many accounts of the bead industry are important historical documents, the data on material culture aspects and details of technology are not recorded adequately for archaeological purposes. The present authors have recently published a general overview of the production processes and the types of archaeological indicators that can be observed (Kenoyer *et al.* 1991).

KHAMBHAT: A BRIEF HISTORICAL BACKGROUND

The city of Khambhat has a long history as a major port and its importance has fluctuated with the periodic silting and clearing of the tidal channels that allow ships access into the Gulf of Khambhat. From as early as the 10th century AD the channels were clear and the city functioned as an important port until the 17th century when the approaches became too silted for large ships to dock (Janaki 1980:5).

Carnelian beads were being produced and traded from various settlements in the regions surrounding the Gulf of Khambhat from as early as the mid-third millennium BC, but it is not clear when carnelian bead manufacture became an important industry at the city of Khambhat itself. Excavations at the town of Nagara, some 3 km north of Khambhat, have revealed that carnelian beads were being manufactured there during the 14th century (Mehta and Shah 1968). A single unfinished bead from Period III can be dated to the early centuries of the Christian Era and some of the beads from Periods I and II (6th and 5th centuries BC) may have been broken in manufacture. While these few examples do not indicate a large-scale production of carnelian beads, they do suggest that some manufacture was going on in a town close to Khambhat for many centuries.

The port of Baruch (Barygaza or Broach) was of major importance during the 1st to 3rd century and continued as a port until the Arab incursions around the 7th century. However, around the 10th century,

during the rise in power of the Solanki Dynasty, Khambhat became the most important international port, possibly due to silting of the channels leading to Baruch (Janaki 1980: 3–4).

While the trade may have shifted to Khambhat, the large-scale production of carnelian beads was probably still carried out in towns nearer to the mines. This is suggested by the oral traditions related to us by some of the older Muslim merchants in Khambhat and the various traditions regarding the Abyssinian mendicant, Bawa Ghor, who lived sometime prior to 1452 when the first historical reference to his tomb is recorded (see Francis 1982:22–27 for more discussion).

One of the more important oral histories collected during our fieldwork was obtained from Abdul Rasul of Pith Bazar, age 55. When he was a boy he heard older agate workers say that agate beads used to be processed in Jagadia, a village in the agate mining area near Bawa Ghori Hill (Fig. 1). Merchants would bring the finished beads to Khambhat where they would sell them to Arab traders. However, due to the political instability in the regions outside the city, bandits would often rob them of their profits and supplies as they travelled back to their homes. In order to avoid being robbed, most of the major workshops and merchants came across the gulf by boat from Baruch and shifted to the fortified city of Khambhat. He said that this event occurred hundreds of years ago, but he was not sure of the exact date. Ever since this shift in production centre, the unprocessed raw materials have been transported from the mining areas to Khambhat, initially by boat or oxcart and more recently by railway or trucks.

This historical background is important because it provides an important model for understanding the transport of raw materials from distant regions to market centres. On the basis of studies of stone tool manufacture and theoretical models relating to energy conservation, one would expect that the cortex and poor quality raw materials would be removed nearer the source and only the dressed blanks or half-finished pieces would be transported to the cities. During the Harappan Phase, this process was in fact practised with the trade of chert core blanks from the mines at Rohri (Kenoyer 1984), but it does not apply to the trade of agate nodules and bead making.

The Harappan site of Chanhudaro in southern Pakistan is covered with poor quality nodules and carnelian cortext flakes that are production waste. Similar patterns are seen at Lothal, Mohenjodaro, and to some extent at Harappa. The source for most of the carnelian used during the Harappan Phase is probably in the Rann of Kutch or the current mining areas of Rajpipla district. These mining areas are from 400 or 750 km to the southeast of the sites in Sindh and even further from Harappa which is located in the Punjab.

Why did the Harappans ship agate nodules to the Chanhudaro or, for that matter, Mohenjodaro and Harappa, which were even more distant? There is no physical reason why craftsmen working at the mines could not have conducted preliminary heating and removed the excess cortex and discarded poor quality nodules. Nevertheless, since there is no evidence for this practice, it appears that the merchants controlling the shipment of the nodules and the eventual production of the beads were concerned that all stages of manufacture were conducted in a controlled or protected environment.

The only way to determine if the Harappan merchants or elites were trying to control the production of carnelian bead manufacture is to define how this would look in the archaeological record. The major reason for studying the agate bead manufacture in Khambhat is that it provides an opportunity to study the archaeological patterning resulting from different types of workshops that produce carnelian beads with varying degrees of control. It is also possible to observe the archaeological patterns remaining from production carried out by a few artisans as opposed to production stages divided between numerous specialists.

CARNELIAN BEAD PRODUCTION

There are many different types of carnelian production carried out in the city of Khambhat, but in our study we focused on two major types comprising large-scale merchants and small-scale entrepreneurs. We define large-scale merchants as those who have been producing and marketing carnelian beads for several generations. Numerous craft specialists are employed by a large-scale merchant and the quantities of raw materials processed, the production of finished beads, and the size of the workshop is considerably greater than those of small-scale entrepreneurs. The large-scale merchants we studied were Thakore Keshari Singh and Sons and The Cambay Agate Stones and Jewelry Trading Company, Krishna Pole (hereafter referred to as KS and KP respectively) (Fig. 3).

Small-scale entrepreneurs were those who used to work for a large-scale merchant but had recently (in the past generation or two) broken off to establish their own businesses. We were able to study several small-scale entrepreneurs, but in this article we will only discuss one group of three brothers, Inayat Husain Lalbhai (IH), Hasambhai Lalbhai (M), and Husainbhai Lalbhai (HB). Their grandfather used to work as a bead chipper on a daily wage basis, but broke off and established his own workshop sometime in the early 1930s. Although the three brothers were trained by their father, they occasionally worked on a

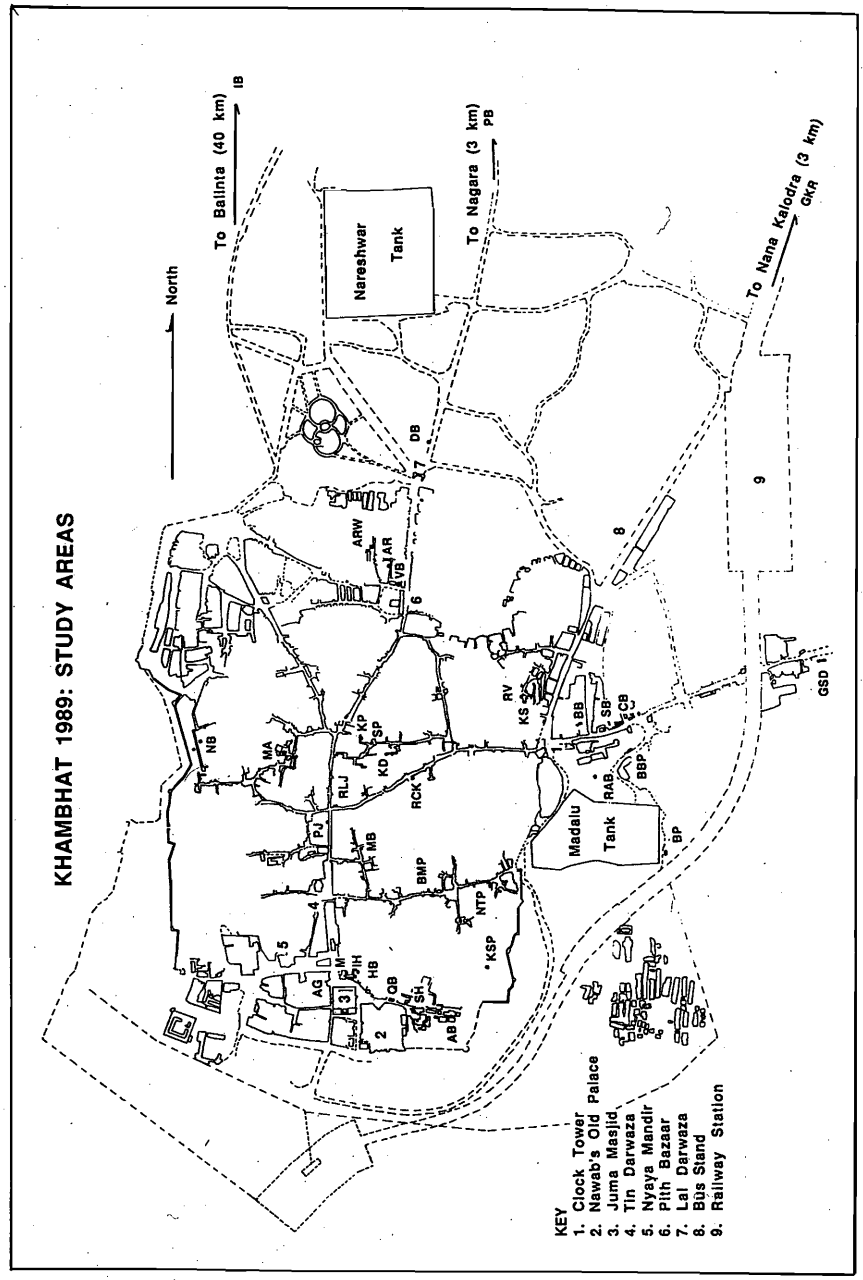

Fig. 3. Map of Khambhat and study areas.

daily wage basis in the KS workshop when they were younger. Even now, when each has his own separate business, they continue to produce beads on consignment for the KP workshop and other major merchants.

Although it is not possible to present all of the supporting data here, the differences between these two types of workshops is seen in most stages of production (Figs. 4 and 5). These differences are represented in archaeologically preserved patterning of activity areas and waste materials. A few of the important categories of evidence found in workshop layout, in raw material acquisition, in drying and heating, and in the chipping stages of production are presented below.

WORKSHOP LAYOUT

The workshops of most large-scale merchants are quite well organized and segregated into different activity areas. While each merchant has a slightly different layout, the KS complex provides a general example that is representative of the organization of production. Each of the major categories of production is segregated to specific activity areas some of which are in the same building, while others are located in separate structures or on different floor levels. The main chipping workshop and storage area is located on the lowest floor of the family's four-storey residence where the owner lives with his elder brother. His brother's workshop is located on the lowest floor of an adjacent building.

The KS showroom storeroom for finished beads is situated on the second floor next to the owner's private rooms. All sales are conducted in the showroom/storeroom as well as all transactions involving the giving or receiving of beads from the drillers, polishers, or grinders. Detailed account books and ledgers are maintained for all transactions. An old worker who is too blind to chip beads is employed in counting different containers filled with different beads and this is done on the verandah next to the store room.

No direct archaeological evidence of this second floor showroom/storeroom could be observed, but hypothetically, some of the records of stocks might become buried if the building were to collapse suddenly.

The lower floor is made up primarily of a stairwell with some space for storage and one large room that is divided into a chipping area and a storage area. The chipping area is itself subdivided into specific working areas where different craftsmen sit in a semi-circle facing the open doorway which provides light and fresh air. The storage area contains burlap sacks filled with unheated and heated nodules, broken nodules in process, bags of debitage, containers filled with

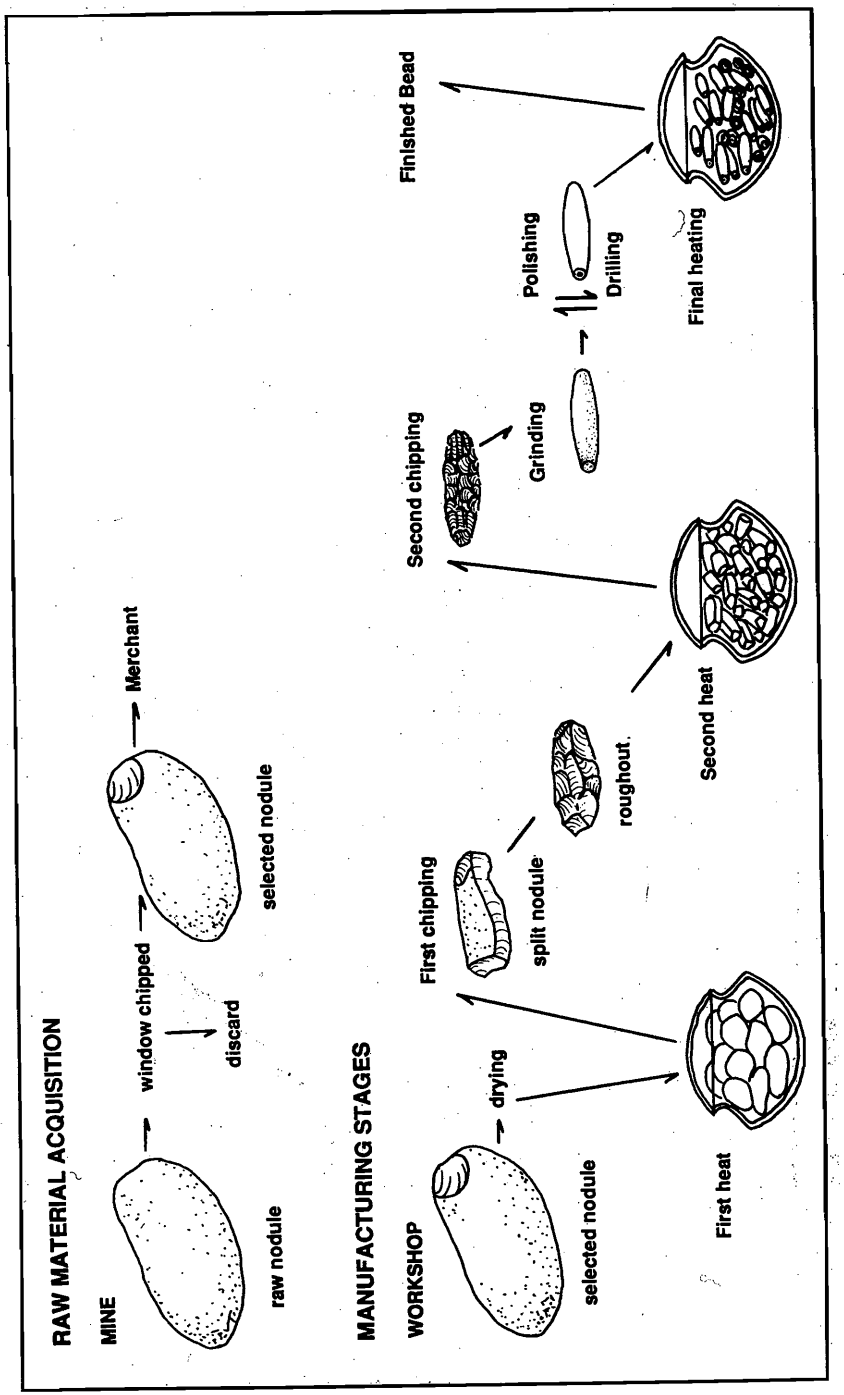

Fig. 4. Raw material acquisition and manufacturing stages.

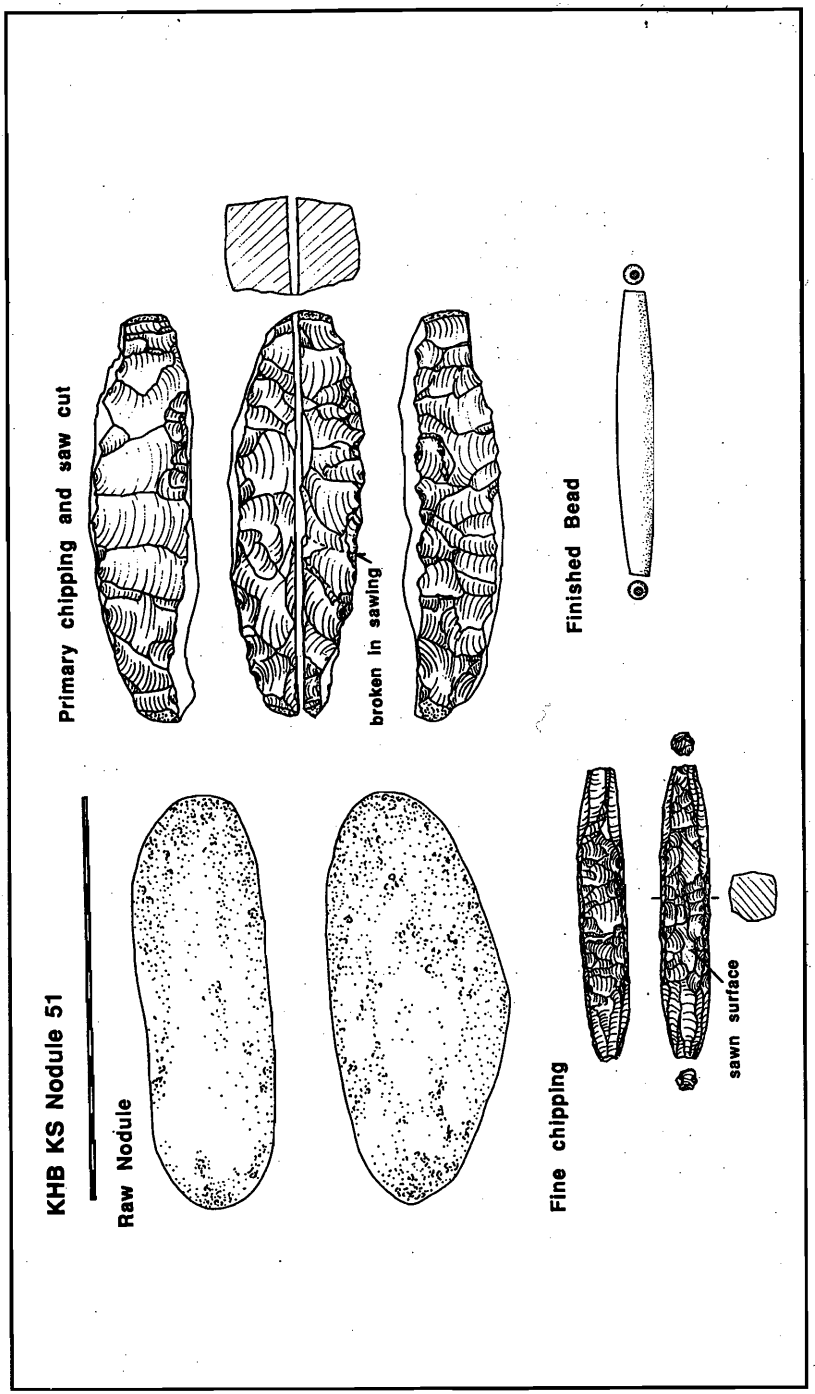

Fig. 5. KHB KS Nodule 51.

chipped bead rough-outs, ground bead blanks, water jars, and various complete or broken tools (Figs. 6 and 7).

Two other nearby buildings have rooms that are used as workshops for heating and for grinding the beads. The second floor of an old building just in front of the main house has been modified into a grinding area that has a roof, but is open on two sides so that air can blow away the silica dust. In a building not far from the main house is an enclosed kiln area that has storage facilities for agate nodules as well as fuel (Fig. 8).

The KS merchant also owns agricultural land and often conducts the heating of large quantities of agates in large trenches near the farm house. Some of the agate debitage and poor quality nodules that cannot be sold have been dumped at the farm. During harvest times or when the owner wishes to retire to the farm, he conducted some chipping in the country residence, but this is not done on a regular basis by his workmen.

The different workmen who are employed by the KS establishment include a workshop and kiln foreman, an assistant (apprentice) foreman, four to six chippers, two or three grinders, and a retired chipper who is also a bead counter. Drilling and polishing of the beads is carried out on a piece-by-piece basis by craftsmen who have a long-term hereditary relationship to this merchant.

Agate nodules are purchased from a mining contractor who has had a long-term hereditary contract with the workshop. Fuel is purchased on an ad hoc basis from pastoralists and charcoal merchants. The finished beads are marketed primarily to established middlemen who have a long-term hereditary relationship to the merchant.

Each of the actual working areas can be distinguished archaeologically by the accumulation of specific types of debitage that characterize the major activities being undertaken. The absence of drills or polishing apparatus, but the presence of broken beads resulting from drilling and polishing would indicate that these two stages were carried out elsewhere, but in a controlled or closely monitored manner.

Archaeologically, the KS complex would demonstrate a well-organized workshop with adjacent heating and grinding facilities. The relationship between the KS workshops in the city and those in the countryside would not be determinable without careful comparison of household pottery and utensils (some might be from matching sets) or from personal names on documents or seals. If stockpiles of finished beads were found in both workshops, it might be possible to determine the similarity in raw material, style, morphology, or production techniques.

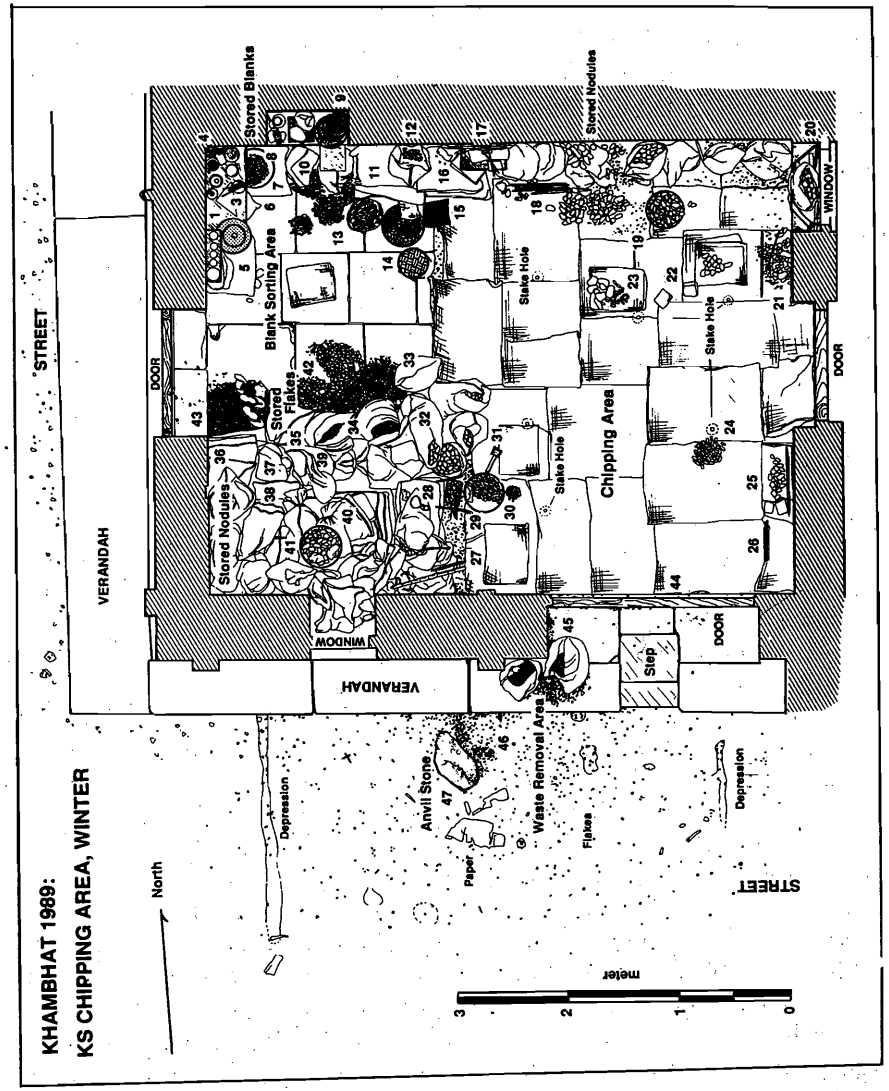

Fig. 6. KS workshop, ground floor chipping areas.

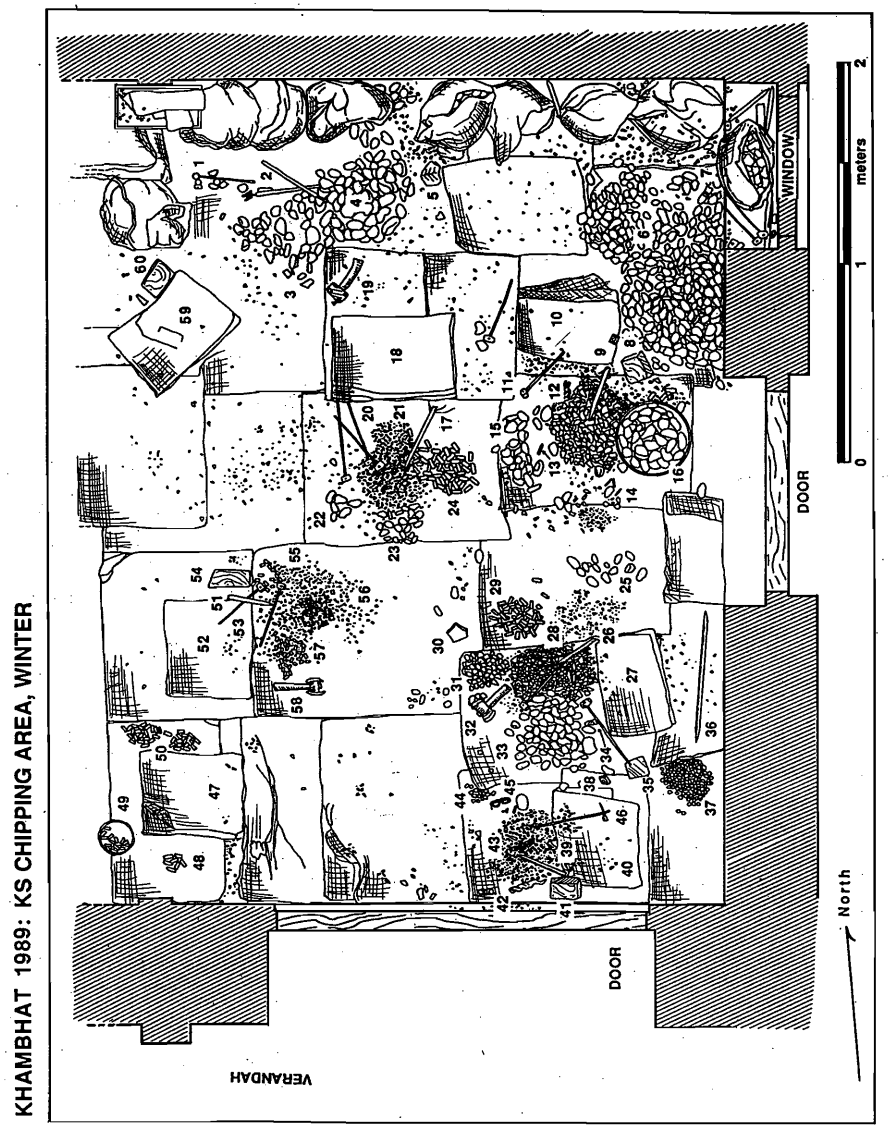

Fig. 7. Detail of KS workshop.

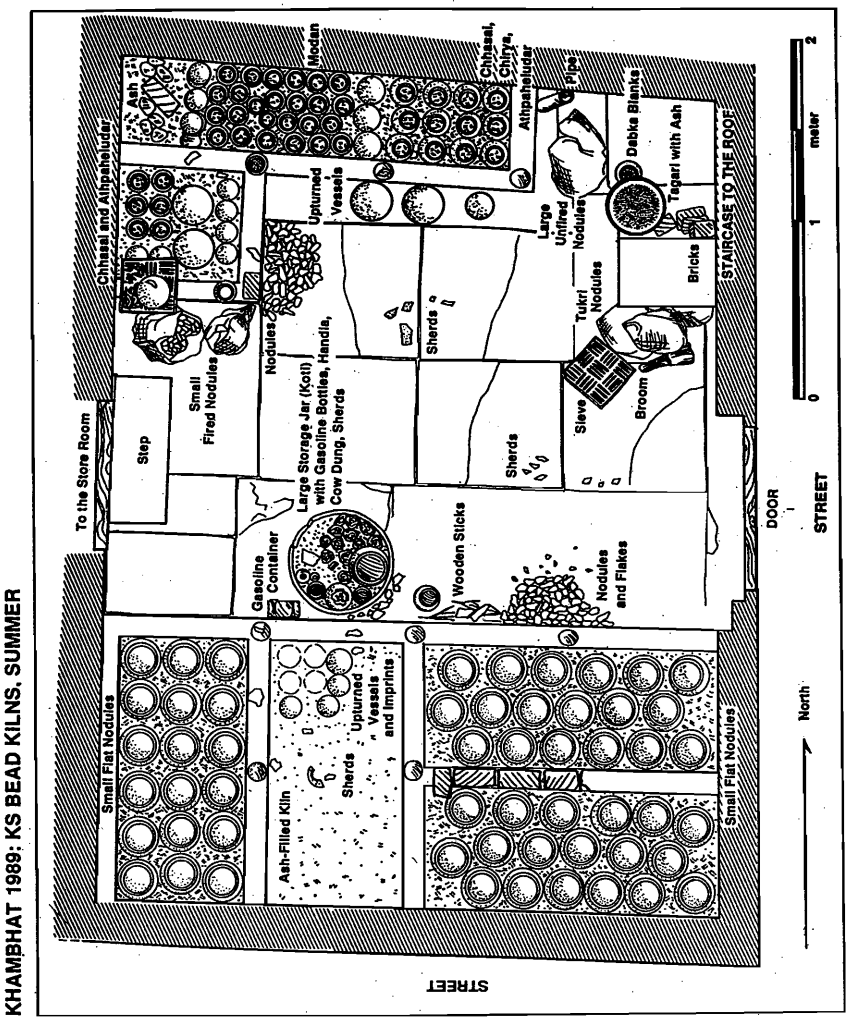

Fig. 8. KS kiln area, summer.

ENTREPRENEURS

The workshops of Inayat Husain (IH) and Hasam bhai (M) are adjacent to each other. The third brother, Husain bhai (HB) has a workshop next to his own house which is located further along the alleyway. All three brothers are involved in the production of carnelian beads, though they also have various other manufacturing activities and use a variety of raw materials.

The IH workshop is a partly covered and fenced area located at the edge of a larger building (Fig. 9). Many of the nodules and stockpiles of raw materials or debitage are found outside the fenced area, as are firing areas or kilns.

Most of the production activities are carried out inside the fenced area and these include drying of nodules, heating, chipping, grinding, and dumping or stockpiling of raw materials and fuel. Chipping is done in specific areas while seated on burlap sacks, but these areas are occasionally used for dumps, stockpiling, or even for grinding. The grinding machines are movable and can be shifted to different areas of the workshop depending on the production requirements.

The kilns are located at the edge of the enclosure, but they have been shifted to other areas when needed. Dumping of flake debitage is relegated to one side of the enclosure, but bags of debitage are located in all section of the workshop. During the working hours, chickens, goats, and children are found running through the workshop, scattering debitage and stockpiled beads. The goat and chicken droppings are supplemented in the evenings and mornings by children using the edges of the workshop as a latrine.

A large water jar for storing water used in grinding is located on one side of the workshop and a smaller water container for drinking is moved around to convenient locations. Other tools such as hammers, grinding discs, iron stakes, corrugated iron sheets, scale pans, and weights are scattered here and there around the workshop. One interesting aspect of the workshop is the small piles of semi-finished pieces or unique nodules that are being saved for some reason or other. These often become buried in the clutter and lost as other short-term priorities are met. The lack of a full-time workshop foreman results in considerable loss of half-finished and occasionally finished goods.

Merchants commissioning special orders or purchasing finished goods often come to the workshop and transactions are carried out there in the open. When more privacy is needed these transactions are carried out in the owner's domestic quarters, which are located on the second floor of a nearby building. Stocks of finished goods are kept in the private domestic quarters and not in a separate store or office.

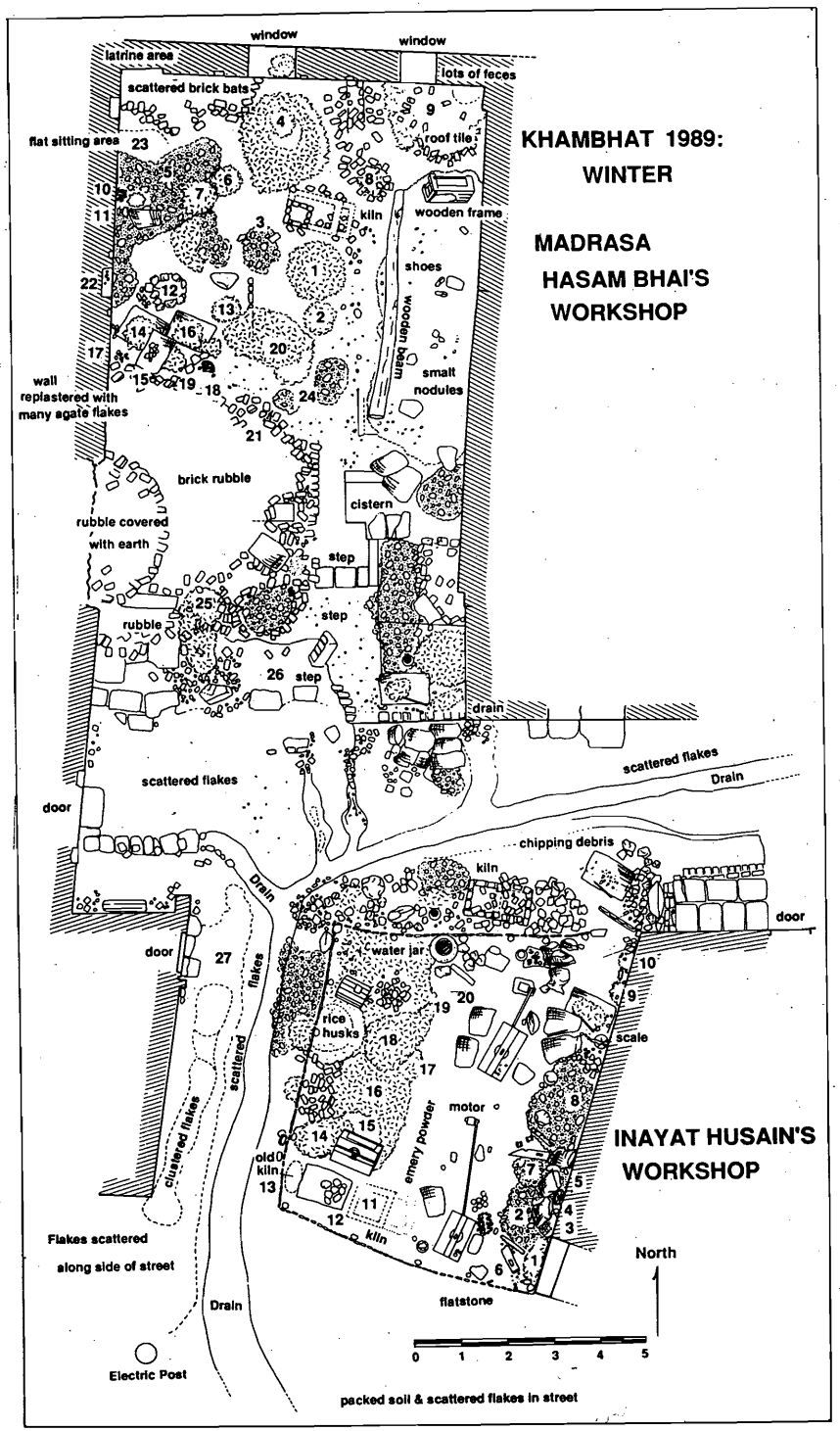

Fig. 9. Madrasa and Inayat Husain's workshop.

In terms of accumulations, the workshop debris is not systematically removed or swept aside and a rapid accumulation occurs. When the piles of debris become too large to allow effective work, a massive cleaning effort is undertaken and various areas of the workshop are cleaned out in order to allow more accumulation. The debris that is removed is often given to the laborers who then resort it to obtain recyclable materials, and the remaining debitage is dumped outside the city.

Drilling and polishing is done by other specialists though on one occasion IH tried to do his own polishing and bought a polishing drum. The drum, now falling apart, is moved from one area of the workshop to another as is gets in the way of different activities.

Depending on the short-term production demands, IH employs additional workers to chip and grind. These craftsmen are positioned wherever there is space inside or outside the workshop, even in areas across the road. Occasionally craftsmen take raw materials to their own home nearby and then return the chipped bead blanks and debitage. The number of finished bead blanks per kilogram of original raw material is variable, but there is a market understanding that if less beads than expected are returned, the chipper is fired and often his pay is cut or withheld. Disputes are avoided by keeping the craftsmen in sight rather than letting them leave the area with raw materials. This pattern would be reflected in the location of activities within a small area that could be easily observed by the workshop supervisor.

Inayat Husain does have another workshop area that is more formal. This workshop is rented for a small fee and is part of a series of shops that were built facing the main mosque. He had not used this workshop for several years.

Hasam bhai's workshop is actually an old abandoned house lot that is slated for becoming the neighbourhood madrasa or parochial school (Fig. 9). Until construction begins, it is being used as his primary workshop, with flaking areas and kiln structures as well as areas to stockpile fuel, raw materials, and debitage. The grinding machine used by Hasam bhai is located in a separate area at the edge of his house which is adjacent to the IH workshop. Its location is easily noted by layers of grinding powder and partly ground or broken bead blanks. The roof above the grinding area is used for storage of special nodules, bead blanks, pottery, and broken tools. Hasam bhai also employs additional workers to chip and grind when he has to process large orders. They generally work in the open workshop area, along the side streets, or in the shade of nearby buildings.

Husain bhai's workshop is adjacent to his rented house and is basically an old dilapidated building with three walls removed to

provide air and light (Fig. 10). The roof is falling apart but still covers most of the working area. Most of the chipping and grinding is done is specific areas, while the heating of raw materials is carried out in a separate area of the workshop. Husain bhai only processes a small amount of carnelian and his main occupation is polishing items by hand for other merchants or in the production of special objects such as crystal lingams, fine buttons, or imitation crystals for the export market. As he is usually working for someone else he rarely employs more than one other person to help him in grinding and polishing. Two persons can sit at a single lap wheel that is being run by electric power. This arrangement optimizes the use of electricity.

Archaeological accumulations in the three workshops would reflect all aspects of chipping, heating, and grinding in overlapping or contiguous areas. However, unlike in the KS workshop, there is no long-term segregation of activities and there is a very low maintenance of the work areas. There is a high variability of both the quality and the nature of the raw materials being processed. Overall, these workshops clearly reflect the fluctuating nature of the organization in the workshop and the fluctuating scales of production.

RAW MATERIAL ACQUISITION

The KS workshop purchases raw materials in large quantities, up to 15 truckloads at one time. Hundreds of burlap sacks filled with agate nodules are stockpiled at the countryside farm, in the workshop itself, in the kiln area, and in living areas. This material is used throughout the year, but the initial purchase requires a major investment of cash or credit. In contrast, the small-scale entrepreneurs purchase raw materials in smaller quantities, up to 15 burlap sacks at a time. These bags are stored in the open air workshops where they can be watched by the craftsmen or his relatives. The neighbourhood children keep track of all movements into and out of the area.

DRYING OF RAW MATERIALS

The KS raw materials are sorted and dried both at the country farm and no roof tops in town. Good quality nodules are dried for longer periods ranging from two to three months. In the process of drying the nodules are sorted and poor quality nodules are removed and kept aside to be sold to other workshops. The entrepreneur workshops do not spend as much time drying the nodules and often skip this stage and begin immediately with the kiln heating.

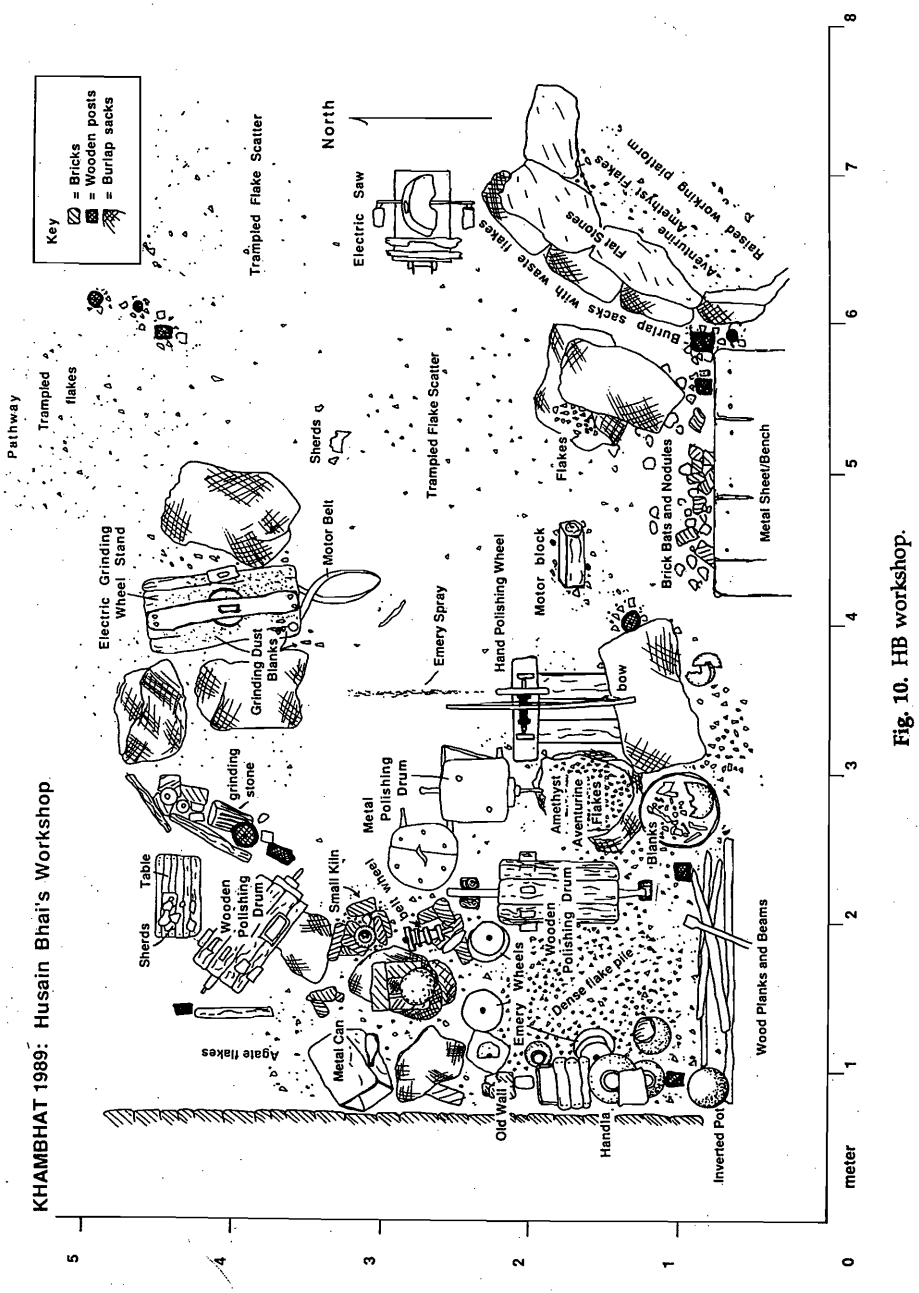

Fig. 10. HB workshop.

HEATING OF RAW MATERIALS

In the KS workshop and other large-scale workshops, the kilns are permanent structures and often are segregated from the chipping and grinding areas (Fig. 8). The initial heating is done inside pottery vessels called *handla*, using sawdust as the fuel. The heating process takes as long as three days, with additional fuel being added on the second and third day. There is relatively little breakage during the heating because of the even burning of the sawdust and the fact that the kilns are enclosed and not affected by changing wind.

In contrast, the entrepreneur kilns are usually located at the edges or corners of the workshop. They are made from broken bricks and are easily modified depending on the quantity of nodules being heated (Fig. 11). The heating is done with rice husks, which is a cheaper fuel than sawdust. The kilns are fired for one day instead of three, and there is relatively more breakage during the heating process. This is the result of several factors, including poor quality raw materials, the fact that the nodules were not well dried before firing, the outdoor location, and the irregular burning of rice husks.

CHIPPING AND SELECTION OF USABLE PIECES

In the KS workshop, once the nodules have been heated, they are taken to the main workshop to be chipped into rough-outs. One craftsman is delegated the task of breaking the nodules into blocklets. In the process, he sorts out the poor quality nodules and throws these into a pile that will eventually be removed from the workshop and resold to other producers. During the subsequent stages of flaking, the blocklets are shaped into bead rough-outs by different craftsmen in distinct working areas (Fig. 7). All of the debitage is collected and placed in large sacks for recycling or resale.

The entrepreneur workshops tend to make more low quality beads in order to optimize the use of the raw materials. Furthermore, due to the low volume of material being processed, they do not usually collect the poor quality materials for resale. Instead, the nodules and discarded blocklets are scattered throughout the workshop or in the street.

In order to provide some quantitative control of the patterns discussed above, samples of debitage were collected from chipping areas in both types of workshops. We also conducted small-scale excavations in each workshop to document site formation processes and long-term patterns of debitage accumulation. The comparison of samples from the excavations in the KS and IH workshops reveal distinctly different patterns of raw material and flake variation.

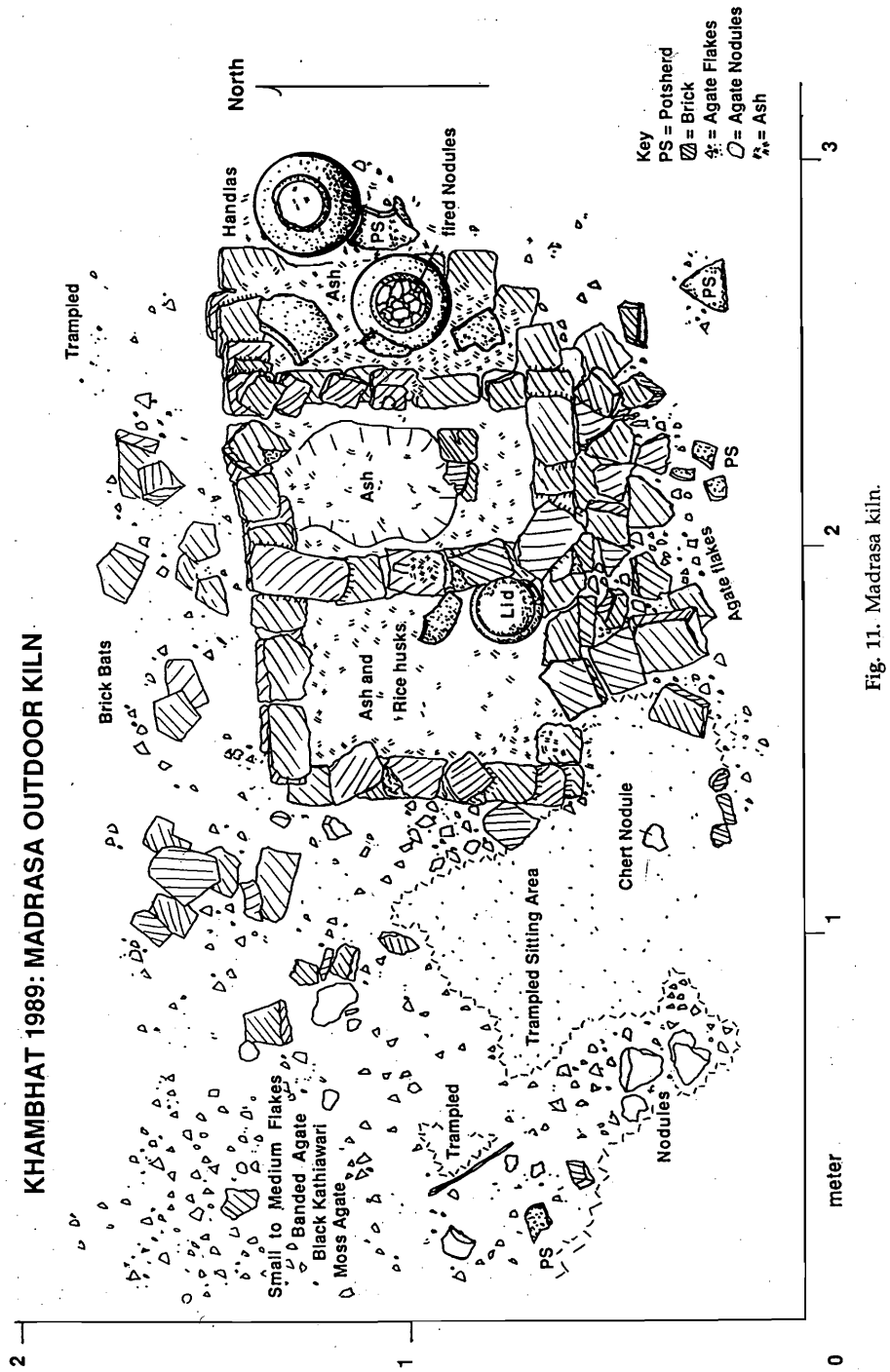

Fig. 11. Madrasa kiln.

Comparing samples of raw materials from the KS and the M workshop reveals a very different pattern of raw material use (Figs 12 and 13). The carnelian flakes are coded with 3,000 numbers and all other numbers relate to non-carnelian flakes. The flake size variation from the same sample demonstrates the presence of workshop maintenance, as there are no flakes of the greater than 20 mm scale in the KS workshop (Fig. 14).

Other comparisons can be made with the types of flakes and bead blanks accumulated in the workshops. These artifact types reflect the general types of finished beads being produced in the workshop. In the larger workshops there is considerable evidence for the long-term standardization of specific types of beads, while the smaller workshops do not reveal the same degree of standardization.

ARCHAEOLOGICAL IMPLICATIONS

The ethnoarchaeological study of carnelian bead manufacture in Khambhat has provided an entirely new perspective on the study of

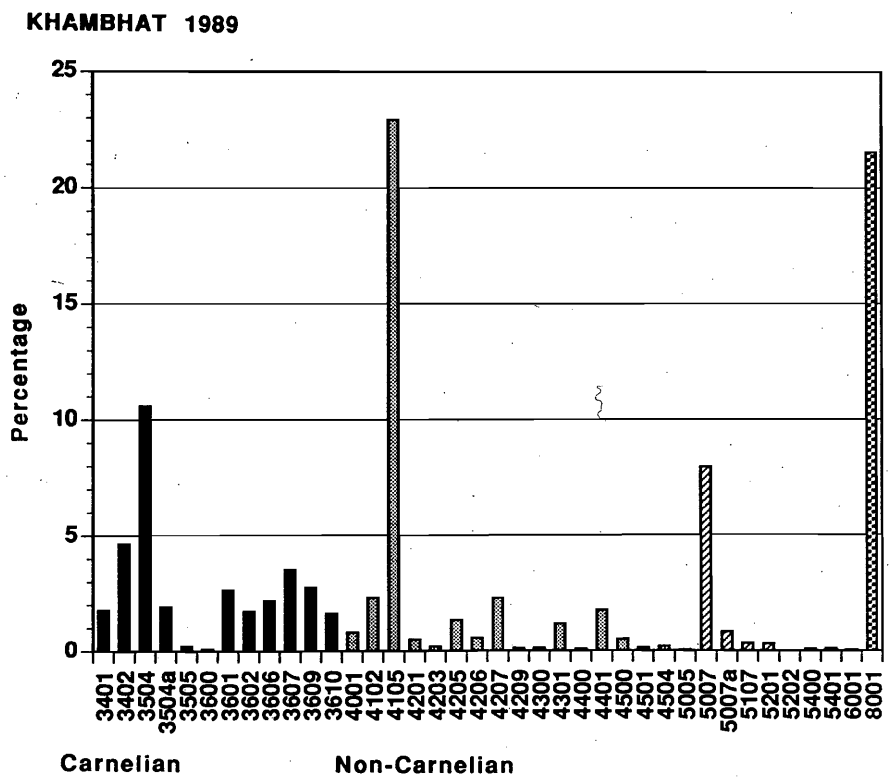

Fig. 12. Sample M13[3] Raw material percentages by weight.

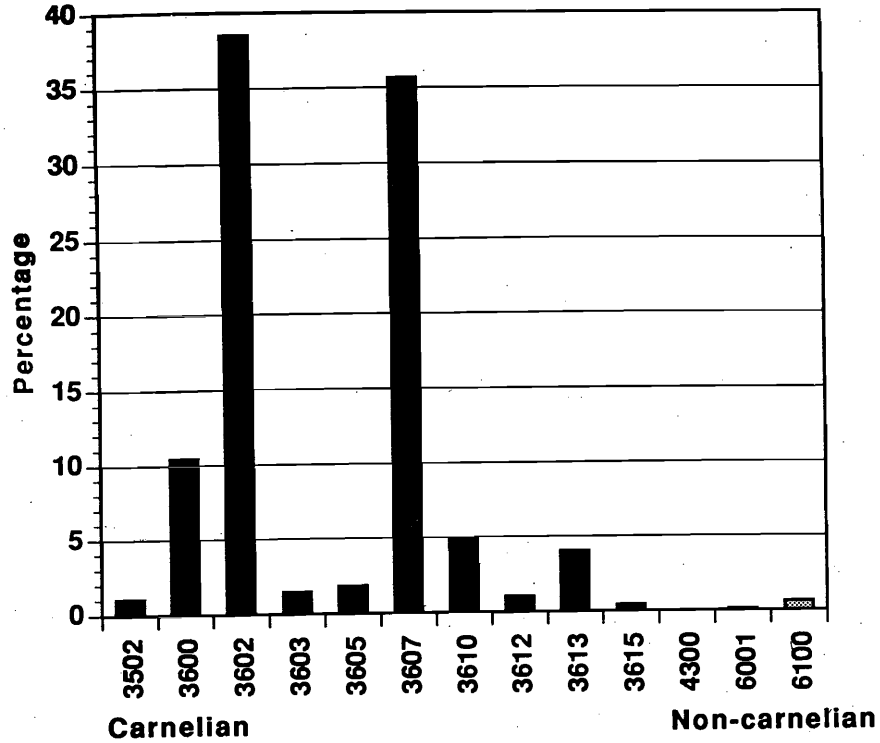

Fig. 13. Sample KS/Tr 1. Raw material percentages by weight.

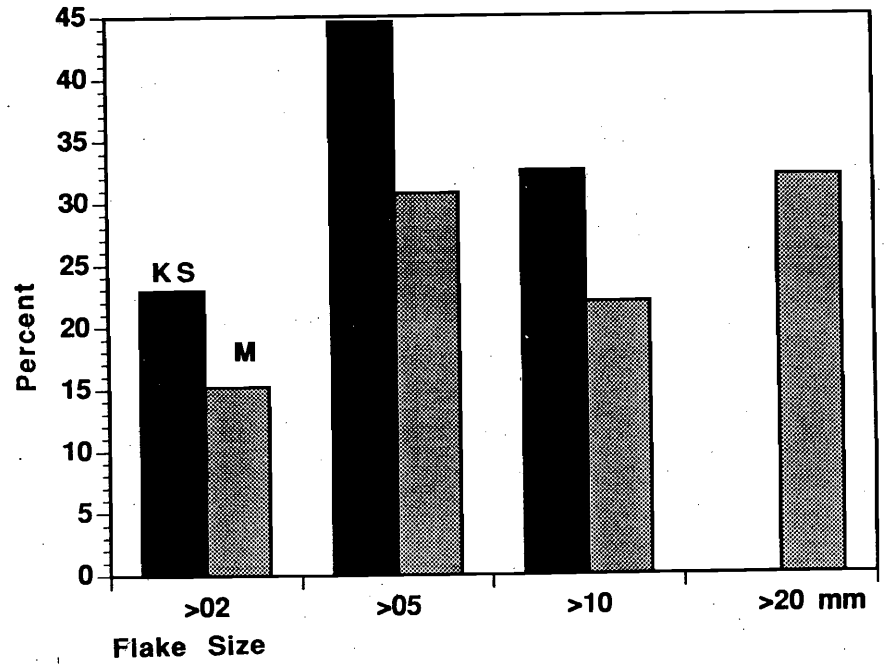

Fig. 14. Flake size comparison between KS and M samples.

specialized crafts in the prehistoric period. On the basis of this research it is possible to develop more precise methods of excavation and analysis. Furthermore, we can propose more reliable interpretive models for the production of agate beads in the cities of the Indus civilization. On the basis of the published data, it would appear that the bead production at the sites of Chanhudaro (Mackay 1943; Vidale 1989) and Mohenjodaro, Moneer Area (Vidale 1987; Vidale and Balista 1988; Vidale and Bondioli 1986), demonstrate two different types of production. Chanhudaro bead production appears to be highly controlled and centralized. Preliminary examination of the workshop debitage at the Boston Museum of Fine Arts indicates that the types of raw material being processed were predominantly carnelian and generally good quality materials. The range of finished bead types being produced was highly standardized and it is not unlikely that the Chanhudaro workshop was maintained by wealthy merchants who had strong connections with the elites of Mohenjodaro and Harappa. Many of the finished beads that were produced at Chanhudaro appear to have been traded throughout the Indus region and even as far as Mesopotamia.

The agate bead manufacturer in the Moneer Area appears to be a short-term production by entrepreneurs. The deposits are characterized by a wide variety of raw materials and different qualities of nodules. There is no evidence for maintenance of the area and a wide variety of flake types are found scattered across the surface. Overall this reflects a short-term production area and one that was taking place in abandoned buildings, in much the same way as the entrepreneurs in Khambhat are using older buildings as workshops. In the past the presence of craft activities in abandoned buildings was often interpreted as a lack of civic control or the abandonment of the cities. In Khambhat the use of abandoned buildings only reflects a shift in the centre of power in the city and does not reflect a period of decline. The presence of entrepreneurs at Mohenjodaro may actually represent a flourishing and dynamic economy.

In conclusion it is necessary to point out that the Khambhat bead project is only in its initial stages and that many new forms of information are expected as we continue in the analysis and interpretation of the vast amount of data that has been collected.

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