CHAPTER 5

GRINDINGSTONE ACQUISITION NETWORKS

CHAPTER INTRODUCTION: THE IMPORTANCE OF GRINDINGSTONES

Groundstone implements are, in terms of total weight, by far the most abundant kind of stone artifact found at Harappa. Included in this category are querns, mortars, mullers, pestles, whetstones, burnishers and adzes. Examples have been recovered in abundance from every chronological phase and on every habitational mound at the site. The only lithic categories containing more individually tabulated artifacts are those for steatite, chert and agate, which is certainly due in large part to the fact that a great deal of debitage is generated in the process of turning those raw materials into finished products. In this chapter, I examine the networks through which residents of Harappa acquired the largest, heaviest and perhaps most important kinds of groundstone implements - the querns and mullers that are essential for both processing foods and for performing many craft activities.

Preparing cereals for human consumption is a multi-stage procedure that usually involves several different kinds of implements. Evidence for cereal processing at Harappa mainly exists in the form of stone querns and hand mullers. Other implements used may have been made of perishable materials that have not survived. The use of wooden mortars and pestles to de-husk cereals by pounding prior to further processing with stone querns is documented in Egypt during this period (Nesbit and Samuel 1996: 51-53). The prevalence of querns and mullers at the site might reflect the differential preservation of processing implements and/or that some processing stages took place away from of the city. These objects were, nevertheless, indispensable tools for preparing staple cereals (and many other foods) and so having a reliable supply of them would have been especially critical to the development and maintenance of an urbanized society supported by agricultural surplus.

The role of craft activities in the economic and political development of complex societies in general (Costin 1991; Helms 1993) and the Indus Civilization in particular (Kenoyer 1989, 1992a) cannot be underestimated. It is therefore important to note that querns and mullers were also necessary for modifying a range of non-consumables such as wood, shell, bone, hide and minerals (Dubreuil 2004). In a burgeoning center of craft production like Harappa a reliable supply of these implements would have been essential.

Querns and mullers (hereafter referred to together as "grindingstones") are the largest and heaviest utilitarian artifacts found at Harappa. Some of the few complete querns that have been recovered weigh in excess of 20 kg. Transporting these bulky items from distant sources to the site in the amounts necessary to fulfill the requirements of an urban population would have required some form of organized effort. As Harappa grew, it certainly would have demanded an increasing expenditure of energy over time. When that reality is considered together with the requisite need for grindingstones to process staple foods and in craft production (plus the fact that there are no local stone sources whatsoever), it makes this category of artifact an excellent one with which to investigate issues relating to economy, transportation capabilities and early urban lifeways at Harappa.

I begin by first examining the regions within and surrounding the upper Indus Basin that would have

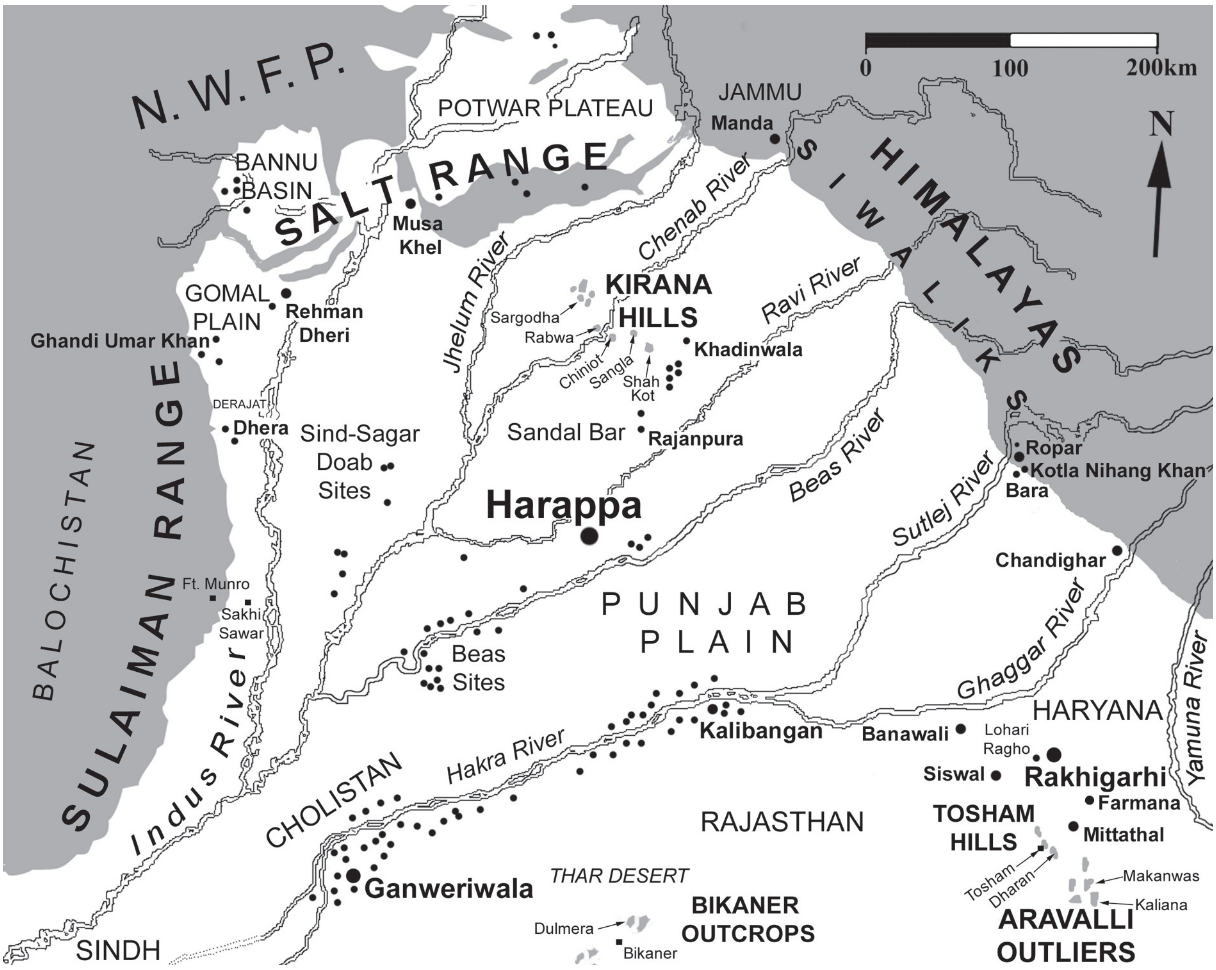


Figure 5.1 Sites and source areas discussed in this chapter.

been the most likely sources of the grindingstones used at Harappa. Then I provide the details and results of a large-scale study in which geologic materials from those sources were visually compared to grindingstones recovered during excavations and surveys at the site. Lastly, I examine the geologic provenience determinations made in that study in relation to Harappa's location, chronological sequence and spatial layout.

POTENTIAL GRINDINGSTONE SOURCES IN AND AROUND THE UPPER INDUS BASIN

Querns and mullers can be fashioned out of different varieties of geologic material. At Harappa grindingstones made from sandstone or quartzite were most common, but other sub-varieties of igneous and metamorphic rocks were also used. In this section, the potential grindingstone sources of the upper Indus Basin are reviewed in order of their proximity to the site. Multiple locations in each of the source areas discussed below were visited for this study. Samples representing the range of material sub-varieties present at those locations were collected and stored at Harappa for eventual comparative studies. All sources, regions and sites discussed in this chapter are identified on Figure 5.1.

The Kirana Hills

The Kirana Hills would have been nearest source of grindingstone (or of any variety of stone) for residents of Harappa. These Precambrian outcrops emerge from the alluvial plain near the center of the Ravi-Chenab doab, 120 km to the northeast

Figure 5.2 The southernmost Kirana Hills outcrop at Shah Kot - 120 km north-northeast of Harappa. For residents of Harappa, this would have been the closest source of stone of any kind. Note that the outcrop and the historic period site that abuts it are being destroyed by quarrying.

Figure 5.3 One of the northernmost Kirana Hills outcrops near Sargodha.

Figure 5.4 The Chiniot (foreground) and Rabwa-Chenab Nagar outcrops (background) at the point where the Chenab River passes between them.

Figure 5.5 Rock engravings at Rabwa-Chenab Nagar. Photo courtesy of Muzaffar Ahmad.

of Harappa at Shah Kot (Figure 5.2) and continue intermittently to around Sargodha (Figure 5.3), 150 km due north of Harappa in the Jhelum-Chenab doab. Some outcrops are composed mainly of metasedimentary rocks (quartzites, conglomerates and slates) while others are intrusive bodies of igneous materials such as andesite, dolerite, rhyolite and/or volcanic tuff (Alam *et al*. 1992). In the Gazetteer of the Jhang District (Punjab Government 1884: 15) it was reported that there were several quarries for "millstones, pestles and mortars" just north of Chiniot, near the point where the Chenab River passes between several Kirana outcrops at Rabwa (Figure 5.4). Rock engravings (Figure 5.5), reminiscent of those found across the Chilas and Hunza regions of Pakistan's Northern Areas (Jettmar 1991), have recently been documented in Rabwa area by Muzaffar Ahmad (personal communication 2010).

The Sulaiman Range

A nearly complete sequence of Jurassic to Pleistocene sedimentary rocks (Akhtar and Masood 1991: 1) can be found beginning 220 km due west of Harappa in the extensive, north-south oriented Sulaiman Range (Figure 5.6). Monsoonal hill torrents, "heavily laden with detritus" (Punjab Government 1898: 2-3), have resulted in the formation of massive alluvial fans and boulder beds (Figure 5.7) that extend along the base of these mountains.

The Salt Range

The Salt Range rises 225 km north of Harappa, abruptly marking the end of the Punjab Plain (Figure 5.8). Material for grindingstones could have been obtained from any number of the sandstone formations or boulder beds found here (Shah 1980). The pinkish-red to maroon colored sandstone of the Kherwa formation (Figure 5.9), which occurs along the southern base of the range is locally used as grindingstone today (Figure 5.10). I have observed artifacts composed of the very same material at the Early Harappan and Harappan period site of Musa Khel (Dani 1971: 32), located less than four kilometers to the southwest of the Salt Range.

Bikaner area occurrences

Approximately 250 km directly south of Harappa, low outcrops of sandstone, shale and limestone (Pareek 1984) intermittently rise above the dunes of the northern Thar Desert around the city of Bikaner in northwestern Rajasthan. The famous red sandstone of Bikaner Palace was quarried (and is still today) from one such outcrop at Dulmera (Figure 5.11).

The foothill zone of the Himalayas

The foothill zone of the outer Himalayas begins approximately 300 km northeast of Harappa at the Siwalik Hills (Figure 5.12). These hills extend continuously from the Potwar Plateau in northern Pakistan all the way to eastern India. Although the Siwaliks primarily consist of the sedimentary rocks, cobbles of igneous and metamorphic stone brought down from the Inner Himalayas can be found within the loosely consolidated conglomerates (Figure 5.13) and river beds of this zone (Kumar *et al*. 1991: 1-2).

Tosham Hills and Aravalli Outliers

Nearly 350 km southeast of Harappa, in southern Haryana, India, a series of igneous outcrops emerges from the plains in the vicinity of the town of Tosham. Most of the hillocks in the area are composed of grey granite (Figure 5.14) of Precambrian age (Grover and Kumar 1980). The outcrop at Tosham (Figure 5.15) itself is made up of rhyolite, granite and metasedimentary rock and contains a polymetallic ore deposit (Murao *et al*. 2008) that has been pointed as a possible source of tin for the Indus Civilization (Kochhar *et al*. 1999).

Around 30 km further southeast of the eastern-most Tosham area outcrop begins the western-most outliers of Delhi quartzite, which is a formation that makes up large parts of the northern Aravalli

Figure 5.6 The Sulaiman Range near Ft. Munro.

Figure 5.7 Massive boulder beds at the base of the Sulaiman Range near Sakhi Sawar.

Figure 5.8 The southern base of the Salt Range, Pakistan.

Figure 5.9 Khewra sandstone, Salt Range, Pakistan.

Figure 5.10 A man near Lille (central Salt Range) displaying a locally made Khewra sandstone muller.

Figure 5.11 Red sandstone quarry at Dulmera, Bikaner District, Rajasthan.

Figure 5.12 The Siwaliks near Chandigarh, Punjab, India.

Figure 5.13 Sedimentary, igneous and metamorphic cobbles in the loosely consolidated conglomerate of the Siwaliks.

Figure 5.14 The gray granite of Dharan Hill, near Tosham, southern Haryana, India.

Figure 5.15 Tosham Hill, southern Haryana, India.

Figure 5.16 Sandy-textured Delhi Quartzite from Kaliana Hill, Haryana, India.

Figure 5.17 Grindingstone carver at Kaliana Village.

Figure 5.18 Quern, muller and mortar made from Kaliana Hills Delhi Quartzite.

Mountain Range from New Delhi down to Jaipur. The Delhi quartzite that occurs as outcrops within and to south of the city of New Delhi typically has a highly silicious or "glassy" texture and, for this reason, would have made poor grindingstone. However, the material found in theF Delhi quartzite outliers in the vicinity of Kaliana village in the Bhiwani District of southern Haryana has a sandy texture (Figure 5.16) and, in a few places, an unusual "flexible" quality that actually permits the stone to be significantly deformed before it breaks (Pande and Gupta 1969). Its suitability as grindingstone is attested to by the continued existence of a local industry (Figures 5.17) devoted to manufacturing querns, mullers (Figure 5.18) and mortars using stone from outcrops in the area.

DETERMINING THE GEOLOGIC PROVENIENCE OF HARAPPA'S GRINDINGSTONES

A large-scale geologic provenience investigation of querns and mullers was initiated following a preliminary study of grindingstone artifacts that took place during the HARP's 2000-2001 field season. That preliminary study had indicated that there were likely several distinct *types* of grindingstone present within the rock and mineral assemblage at Harappa. In this chapter, I use the word "type" rather than variety or sub-variety to refer to grindingstone material. A type is defined based on its visual appearance and/or the location/geologic formation where it occurs (so siliciclastic sedimentary rock is a variety, quartzite is a sub-variety and Delhi quartzite is a type). Examples of what appeared to be the different types of grindingstone from Harappa were included in the "traveling" set of archaeological samples (discussed in Chapter 3) that was taken around to institutions around Pakistan for comparative study. There they were evaluated by geologists with years of field experience in the potential source regions. Using their recommendations and identifications as a starting point, I undertook numerous field excursions in Pakistan and India over the next four years for the purpose of collecting comparative geologic samples. In addition to the six regions discussed in the preceding section, samples were collected from sources in Balochistan, Sindh, Gujarat, Jammu, the NWFP and Pakistan's Northern Areas as well as regions elsewhere in Rajasthan and Indian states in the western Himalayas. All samples collected in the field were brought to Harappa and, over time, a large set of geologic comparative materials was compiled.

By 2004, the geologic sample set was reasonably comprehensive and so a systematic comparison with grindingstone artifacts from Harappa could begin. While some form of quantitative analysis focusing on geochemical properties (isotopic compositions, elemental concentrations, etc) was undertaken on most varieties of stone and metal artifacts examined for this study, several factors made this unfeasible for grindingstones: no analytic instrumentation was available at Harappa; analyzing the entire assemblage using such techniques would have been prohibitively expensive; and physically removing material from each artifact for destructive analysis elsewhere was not possible. A series of petrographic thin sections from a selective sample of Harappan grindingstones representing each major material type were made at the Pakistan Museum of Natural History and will eventually be used to supplement this study. However, the provenience determinations made here were based solely on the qualitative comparison of the macroscopic characteristics of artifacts and source samples. Although visual analysis of stone artifacts, when used alone, does have limitations (Luedtke 1979: 745-46), it is rapid, cheap, non-destructive, can be done in the field on a large-scale and sometimes produces results that are as good or better than those obtained using more sophisticated methods (Moffat and Buttler 1986: 14).

Figure 5.19 Examining and recording grindingstones at Harappa.

All querns and mullers (whole and fragmentary) recovered from excavations and surveys at Harappa (Appendix 5.1) along with those from previous excavations stored in the site museum's reserve collection (Appendix 5.2) were individually examined and recorded (Figure 5.19). In total, 2586 grindingstone artifacts were compared with geologic source samples and assigned a provisional geologic provenience based on an assortment of qualitative physical criteria including rock sub-variety, color, texture, grain size, patterning, visible inclusions, degree of silicification and toughness. Those that could not be confidently assigned a provenience using these criteria were classified as source "unknown."

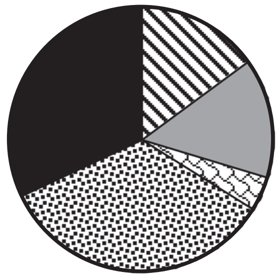
THE GEOLOGIC PROVENIENCE COMPOSITION OF HARAPPA'S GRINDINGSTONE ASSEMBLAGE

The overall composition, in terms of geologic provenience, of the grindingstone assemblage at Harappa is displayed, without reference to context or period, in Figure 5.20. Before proceeding, however, it is necessary to explain the manner in which the percentages found in the tables and charts used in this chapter were generated. Harappan grindingstones were tools that appear to have been used, broken, re-fashioned and re-used repeatedly. Thus, nearly all of the grindingstones recovered are in a fragmentary state. Some are almost complete – that is, they may only be chipped or slightly broken. However, even though multiple fragments that belong to the same implement have been refitted whenever possible, most of the assemblage consists of incomplete pieces what were clearly larger implements at one time. So this

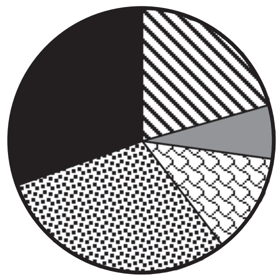
Figure 5.20: Overall composition of the grindingstone assemblage at Harappa (without reference to period or context)

Delhi quartzite; Gray Sandstone; Kirana Hills stone; Pab sandstone; Unknown provenience

Percentage calculated by weight	weight (kg)	portion of entire the grindingstone assemblage
Delhi quartzite	237.0	15.1%
Gray sandstone	231.9	14.7%
Kirana Hills stone	64.2	4.1%
Pab sandstone	539.0	34.3%
Unknown	501.2	31.9%
assemblage total	1573.3	100.0%



Percentage calculated by number of objects	number of objects	portion of entire the grindingstone assemblage
Delhi quartzite	534	20.6%
Gray sandstone	171	6.6%
Kirana Hills stone	314	12.1%
Pab sandstone	777	30.0%
Unknown	790	30.5%
assemblage total	2586	100.0%



raises the question – when calculating the amounts of different grindingstone types present at Harappa, is it more suitable to generate percentages based on the number of individually tabulated artifacts or the total weight of artifacts in a particular category? For some of the figures below both methods are presented and it is evident that, in most instances, the resulting percentages are not dramatically different. Ultimately, however, it was decided that generating percentages of material types present at the site based upon weight, rather than on the number of individual fragments, would more accurately reflect the degree to which material from a defined source was being utilized in a certain area of the site or during a particular period. Nevertheless, the total numbers of artifacts present in each category are listed in the tables that accompany the figures so that anyone wishing to evaluate the data by tabulated artifacts may do so. Nearly seventy percent (68.1% by weight and 69.5% by number) of all querns and pestles at Harappa could be confidently assigned to one of the following four material *types*, which I discuss next in order of decreasing abundance: Pab sandstone, Delhi quartzite, gray sandstone and Kirana Hills stone.

Pab sandstone

Sandstone from the Pab Formation (Figure 5.21 A) is, by weight (34.3%), the most common type of raw material in Harappa's grindingstone assemblage. This Cretaceous sandstone has a sugary texture and macroscopically grades from solid brown to a distinctive gray-white color with small (< 3mm) regularly spaced brown patches (Figure 5.21, B). The grindingstones at Harappa that have been categorized as Pab sandstone, two of which can be seen in Figure 5.21 C & D, are highly variable visually. The majority are grey-white with the distinctive brown spots or speckles. In other examples the characteristic spots are muted and there is a prominent brown, wavy, banded pattern. Some simply have a uniform brown color. In numerous cases two or more such visual patterns are present *in a single grindingstone* – sometimes as sharply defined components and at other times gradually grading into one another. After inspecting a range of this material in the field and examining (and re-examining) nearly 800 examples at Harappa, I felt confident in my ability to recognize these variations and correctly assign material type and provenience. Although this method of categorization is admittedly subjective, I would argue that the results it produces are sound given the large number of samples and the striking visual and tactile differences between materials in each type-provenience category.

The most extensive and well-developed sequence of Pab sandstone occurs beginning 220 km due west of Harappa in the Sulaiman Range (Kassi *et al*. 1991). After a break of nearly 300 km beginning near Balochistan's northern border with Sindh, the Pab Formation appears again over 600 km to the southwest of Harappa in the Las Bela and Khuzdar districts of southern Balochistan. The assumption made here is that the majority of Pab grindingstones identified at the site probably derived from the closer occurrence in the Sulaimans. Quarrying grindingstone directly from formations in the mountains themselves would have almost certainly been unnecessary during the proto-historic period as large cobbles suitable for querns and pestles could have easily been obtained from the alluvial fans or stream beds of the foothills that line the range. For this reason it is difficult to state precisely at what point or points along that approximately 300 km long north-south running mountain range that Pab sandstone used at Harappa was obtained. The site of Dhera, which has cultural affinities with Early Harappan cultures of the Punjab Plain and the adjacent Balochistan highlands, is located in this foothill region adjacent to a cobble-filled perennial hill torrent emanating from the central part of the Sulaiman Range (Siddique 1996). I observed Pab sandstone querns and mortars in a recent collection from the Harappan Period site of Ghandi Umar Khan (Khan *et al*. 2000), which lies near the foothills of the northern end of the Sulaiman Range.

The sugary texture and toughness of Pab sandstone makes it exceptionally well suited for grinding purposes. It is widely used for this purpose in modern Pakistan and "is also exported to Arabian countries" (Khan, M.A. *et al*. 1991: 223). During a visit to the city of Mardan in the NWFP, I visited a workshop where rotary millstones were being carved (Figure 5.22). Despite the fact that there are no lack of local stone formations in the NWFP from which millstone material could have been acquired, I was told that the stone they were using – Pab sandstone (Figure 5.23), was transported over 450 km (as the crow flies) from the Ft. Munro area of the Sulaiman Range to Mardan. The unmatched quality of this particular material made transporting the heavy stone long distances and in large quantities worth the effort and expense.

That same sentiment may have held true in Harappan times as well. I have noted Pab sandstone in collections made by Dr. Rita Wright from the Early Harappan (Kot Dijian) Period and Harappan Period sites found along the old bed of the Beas River (Wright *et al*. 2002; Schuldenrein *et al*. 2004). The majority of the grindingstones from Mohenjo-daro (Figure 5.21 E) that are stored in the collection of the Department of Archaeology and Museums,

Figure 5.21 The Pab Formation, details of the types of sandstone found in it and examples of Pab sandstone artifacts from Harappa and other sites.

A. Exposed section of Pab Sandstone in the Sulaiman Mountains near Ft. Munro, D,G. Khan District, Punjab.

B. Brown (left) and speckled (right) types of Pab sandstone in the Sulaiman Range.

C. Pab sandstone quern (#318) from M.S. Vats' excavations at Harappa.

D. Pab sandstone muller (H95/5802-8) from Harappa, Mound ET, Period 3C.

E. Pab sandstone hand muller from Mohenjo-daro. Department of Archaeology and Museums Excavation Branch Collection.

F. Pab sandstone quern fragment on the surface at the Harappan Period site of Ganweriwala, Cholistan. [10 cm scale]

Figure 5.22 Workmen carving millstones out of Pab sandstone.

Figure 5.23 Detail of Pab sandstone millstone at Mardan showing a mixture of both brown-speckled and homogenous brown material.

Government of Pakistan's Excavation Branch in Karachi are made of Pab sandstone. Similarly, most of the grindingstones that I encountered on the surface of the as yet unexcavated Harappan period city of Ganweriwala (Figure 5.21 F) in the Cholistan region were composed of Pab sandstone. Fully one-third of all grindingstones recovered at Harappa are Pab sandstone and I suspect the same may be true when the full assemblages at Mohenjo-daro and Ganweriwala are examined as well. I have even seen a handful examples of Pab sandstone grindingstones during my ongoing study of stone and metal artifacts from the site of Rakhigarhi, which lies approximately 550 km east of the Sulaiman Range.

Delhi quartzite

The second most common type of grindingstone at Harappa (15.1% by weight) appears to be the type of Delhi quartzite found only in the westernmost outliers of the Aravalli Mountains, located in southern Haryana (discussed above). Unlike the glassy, highly silicified gray-colored material that is typical of Delhi quartzite elsewhere in the Aravallis, the stone from these outcrops in the vicinity of Kaliana and Makanwas villages (Figure 5.24: A) in the Bhiwani district has a sugary texture, is red-pink to pinkish gray in color and is crisscrossed with thin hematite and quartz filled fractures (Figure 5.24: B). None of the other geologic formations immediately surrounding the upper Indus Basin contain material that even remotely resembles this distinctive type of quartzite. Grindingstones made of this stone at Harappa (Figure 5.24: C & D) are easily identifiable.

In certain places, the Delhi quartzite from these Aravalli outliers has an unusual "flexible" quality that may make it especially good stone for use as querns and mullers. Describing stone from the Kaliana outcrop, the geologists Pande and Gupta wrote:

> If one of the specimens which exhibits this peculiarity in any marked degree be examined, it will be found to yield with readiness to any external force applied, and it can be stretched, compressed or bent in any direction with the greatest ease up to a certain point beyond which the force is released along fractures (Pande and Gupta 1969: 589).

A grindingstone composed of Delhi quartzite with some degree of flexibility may be less likely to fracture under the stress of grinding and pounding than would a more ridged type of sandstone-quartzite. In future studies it would be very informative to conduct mechanical stress tests comparing this and the other types of grindingstones as a way to gage the "quality" of the different materials used at Harappa. Poor quality (a tendency to fracture under the stress of grinding and pounding) may perhaps be one of the reasons why (as we shall see below) certain types of grindingstone material become less represented in Harappa's assemblage over time.

The northernmost of these Delhi quartzite outliers is located 389 km southeast of Harappa but is only 29 km south of the site of Harappan period site of Mitathal (Bhan 1969). I have observed this type of quartzite in abundance on the surface and/or in collections from Mitathal and several other Early Harappan and Harappan period settlements that lay between the Delhi outliers and Harappa including Siswal (Figure 5.24: E), Kalibangan (Figure 5.24: F), Banawali, Farmana and Lohari Ragho. The Indus city of Rakhigarhi (Nath 1998) is located 75 km north of these outcrops. A large mortar and several querns recovered from that site on display at the National Museum in New Delhi are very clearly composed of the Kaliana area type of Delhi quartzite. In fact, while my study of the grindingstones from Rakhigarhi is presently incomplete, around 90% of the 650 examples I have documented thus far are also composed of this type of stone.

Figure 5.24 Delhi quartzite outliers in southern Haryana, detail of stone types found there and examples of Delhi quartzite artifacts from Harappa and other sites.

A. Delhi Quartzite outliers near Kaliana, Bhiwani District, Haryana.

B. Detail of Delhi quartzite at Kaliana.

C. Delhi quartzite saddle quern fragment (H96/7205-2) from Harappa, Mound AB, Period 3 or later.

D. Delhi quartzite flat quern (H95/5181-1) from Harappa, Mound E, Period 3C.

E. Delhi quartzite quern from the Early Harappan site of Siswal, Hissar District Haryana. This artifact was unearthed by and is in the possession of, the farmer whose fields now cover the surface of the site.

F. Delhi quartzite fragment on the surface of the Harappan site of Kalibangan, Hanumangarh District, Rajasthan.

Gray sandstone

The next most common type of grindingstone material at Harappa (14.7% by weight) is an extremely dense and tough gray sandstone (Figure 5.25 A & B). It is clear from an examination of complete artifacts and larger diagnostic fragments that most, if not all, querns and mullers composed of this material were made from water-rounded cobbles rather than stone that was quarried and then chiseled into shape. Cobbles of this description are found beginning 350 km east-northeast of Harappa, both within the formations of the Siwaliks foothills (Srikantia and Bhargava 1998: Chapter 5) and in the beds of Chenab, Beas, Sutlej and Ghaggar rivers (Figure 5.25 C & D) at the places where they meet the Punjab plain (*personal observation*). Importantly, several Harappan and/or Early Harappan settlements are located near these debouchures. The site of Manda is located in the Siwalik Foothills of Jammu at the northernmost navigitable point of the Chenab River (Joshi and Bala 1982). Harappan remains were also unearthed at Chandigarh, not far from where the Ghaggar River meets the plains (IAR 1985-86: 15). Ropar, Bara, Kotla Nihang Khan and Dher Majra are all proto-historic sites found within 10 km of the point at which the Sutlej River leaves the foothills (Prüfer 1956; Sharma 1982). Most of the grindingstones visible on the surface at Ropar (Figure 5.25 E) and on display in its site museum have clearly been made from river cobbles of this type of gray sandstone (*personal observation*). Cobbles of this material could have easily been transported downstream to Harappa and other plains settlements via the rivers of the upper Indus Basin. I have observed identical gray sandstone grindingstones on the surface of and/or in collections from Indus sites in Haryana including Banawali (Figure 5.25 F) (Bisht 1982), Lohari Ragho (Garge 2006) and Rakhigarhi (Nath 2001).

Kirana Hills stone

The final and least abundant overall by weight (4.1%) of the four major identifiable grindingstone material types at Harappa is from the Kirana Hills. Kirana Hills stone, in terms of grinding purposes, is of decidedly inferior quality when compared to the other three material types described above – e.g., it is much more friable and, thus, breaks easier and produces many fragments. This then is an instance where the choice to consider material usage by weight rather than by number of individual artifacts tabulated makes a significant difference in how the composition of the overall grindingstone assemblage appears. For example, gray sandstone is very compact and tough and many more complete or nearly complete artifacts made from that type of material have been recovered as compared to Kirana Hills stone artifacts, which are nearly always found as fragments. When judged by number of fragments present, Kirana Hills stone accounts for 12.1% of the grindingstone assemblage, making it, instead of gray sandstone, which by number only accounts for 6.6% of the assemblage, the third most common type in the assemblage. Conceivably, the exact same amounts of both material types could have been brought to the site and used. However, using the more friable stone from the Kirana Hills would have almost assuredly resulted in more pieces of debris. It is for this reason that, in most cases, I have chosen to evaluate grindingstone source usage by weight instead of number.

Within the Kirana Hills, the composition and characteristic of stone are variable from outcrop to outcrop (Alam *et al*. 1992). Two different sub-types seemed to have been in use at Harappa. At certain outcrops, such as those found at Shah Kot, Sangla Hill (Figure 5.26 A) and some locations around Chiniot and Sargodha, a fine grained grey-green mottled, hematite-stained meta-quartzite is the dominant material (Figure 5.26 B). The grindingstone artifacts recovered at Harappa that are made from this material (Figure 5.26 C) are invariably fragmentary. No complete examples of querns or mullers have been found. At several places in the Sargodha area

Figure 5.25 Gray sandstone artifacts at Harappa, rivers draining the Himalayas, cobbles found in their beds and gray sandstone artifacts at other sites.

A. Gray sandstone flat quern (#8841) from Vats' excavation at Harappa.

B. Gray sandstone muller (H94/5502-61) from Harappa. Mound ET, Period 3B.

C. Cobbles in the bed of the Ghaggar River at the point near Chandigarh where it leaves Himalayas.

D. Gray sandstone cobbles in the bed of the Sutlej River, 2km from the Harappan period site of Ropar.

E. Gray sandstone saddle quern on the surface of Harappan period site of Ropar, Ambala District, Punjab.

F. Gray sandstone muller on the surface of Harappan period site of Banawali, District Hissar, Haryana.

and again in the hills straddling the Chenab River near Rabwa (Figure 5.26 D), quartzite occurs that is gray-red to purplish-gray in color and has a coarse, conglomeritic texture with small clasts of cherty material (Figure 5.26 E). Grindingstones made from this conglomeritic quartzite (Figure 5.26 F) are found more frequently at Harappa than are examples of the fine grained sub-type. Also, several examples of complete mullers and nearly complete querns made from conglomeritic Kirana stone have been recovered, which suggests that they were more durable.

Although it would have taken a resident of Harappa several days to walk the 120 to 150 km distance to the Kirana Hills, there are a handful of Early Harappan and Harappan period settlements that are relatively close to that formation's southernmost outcrops. These include Khadin-wala (Dar 1983) and a cluster of eight other recently discovered proto-historic sites in the Ravi-Chenab doab or Sandal Bar (Qasim 2002), which are located 15 to 25 km south and west of the Shah Kot outcrop along what may have been the former watercourse or a tributary of the Ravi River. Harappan peoples making a journey to and from the site of Manda in the foothills of Jammu via the Chenab would have passed between the outcrops in the Rabwa-Chiniot area. Kirana Hills stone seems to have also been transported to settlements in regions beyond Harappa. I have observed a numerous fragments of what appears to that material in Beas Survey (Wright *et al.* 2002) collections from Early Harappan and Harappan Period sites along the old bed of the Beas River, some of which lie as far as 275 km away from the outcrops (Schuldenrein *et al.* 2004).

"Unknown" Provenience

Slightly more than thirty percent (31.9%) of the grindingstones in the assemblage could not be confidently assigned to any specific geologic formation based on macroscopic characteristics alone and so were categorized as having an "unknown" provenience. A great many of these were igneous and metamorphic rocks such as dense black basalt, gabbro, gneiss and diorite that are visually identical to other rocks of the same sub-varieties found in numerous regions surrounding the Indus Valley. Several gray or pink granite grindingstone fragments were recorded that could have been from the Tobra boulder beds of the Salt Range (Shah 1980: 12), the Nagar Parker outcrop of southern Sindh (Jafry and Ahmad 1991), outcrops in the Jhunjhunu district of northern Rajasthan (Basu 1982) or several other locations including the Tosham Hills outcrops. Likewise, the numerous highly silicified white quartzite cobbles encountered could have come from as near as the Dok Pattan Formation of the Siwaliks (Iqbal 1994) or one of several formations in the North Delhi Fold Belt of the Northern Aravallis (Sinha-Roy *et al* 1998: 129-140). Chemical composition, isometric dating of igneous rocks and/or petrographic analyses may, in the future help, to resolve the geologic proveniences of many of these "unknown" types.

DIACHRONIC AND SPATIAL VARIATIONS IN GRINDINGSTONE SOURCE UTILIZATION AT HARAPPA

Nearly 43% of the 2586 querns and mullers from Harappa evaluated in this study were recovered during surface surveys or came from disturbed or secondary contexts such as brick robber trenches or the sifting of back dirt piles from past excavations. However, 1475 of the grindingstones were excavated from secure, stratified contexts spanning Harappa's five main periods of occupation. This assemblage essentially represents a 100% sample of grindingstone artifacts in excavated areas. With such a substantial dataset it is possible to address questions relating to diachronic and spatial variation in grindingstone source utilization at Harappa with a reasonably high

Figure 5.26 Kirana Hills outcrops, details of two types of stone found there and examples from Harappa.

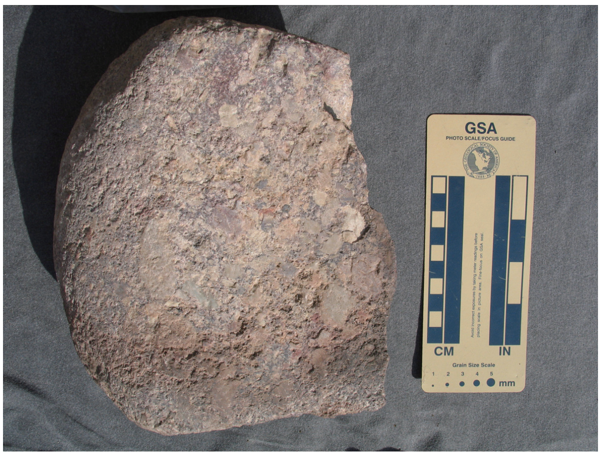
A. Kirana Hills outcrop at Sangla, District Sheikhupura, Punjab.

B. Detail of the medium to fine-grained quartzite found at Sangla Hill.

C. Fragment (H98/8590-3) of Kirana stone from Period 1 at Harappa similar in appearance to the Sangla sub-type.

D. Kirana Hills outcrops astride the Chenab River at Chiniot, Punjab.

E. Detail of the coarse-grained, conglomeritic quartzite found at the Rabwa area outcrops.



F. Broken quern (H96/7466-12) from Period 2 at Harappa that looks similar to the Kirana Hills Rabwa sub-type.

level of confidence. In the following sections I use this dataset to investigate how acquisition patterns for this important utilitarian goods shifted as the site was transformed over time from a small village into a large urban center. I also investigate if variations in source utilization existed between the different habitation areas at Harappa during those periods (2 through 3C) from which grindingstones have been recovered from two or more of the site's mounds.

Site-wise diachronic trends in grindingstone source utilization

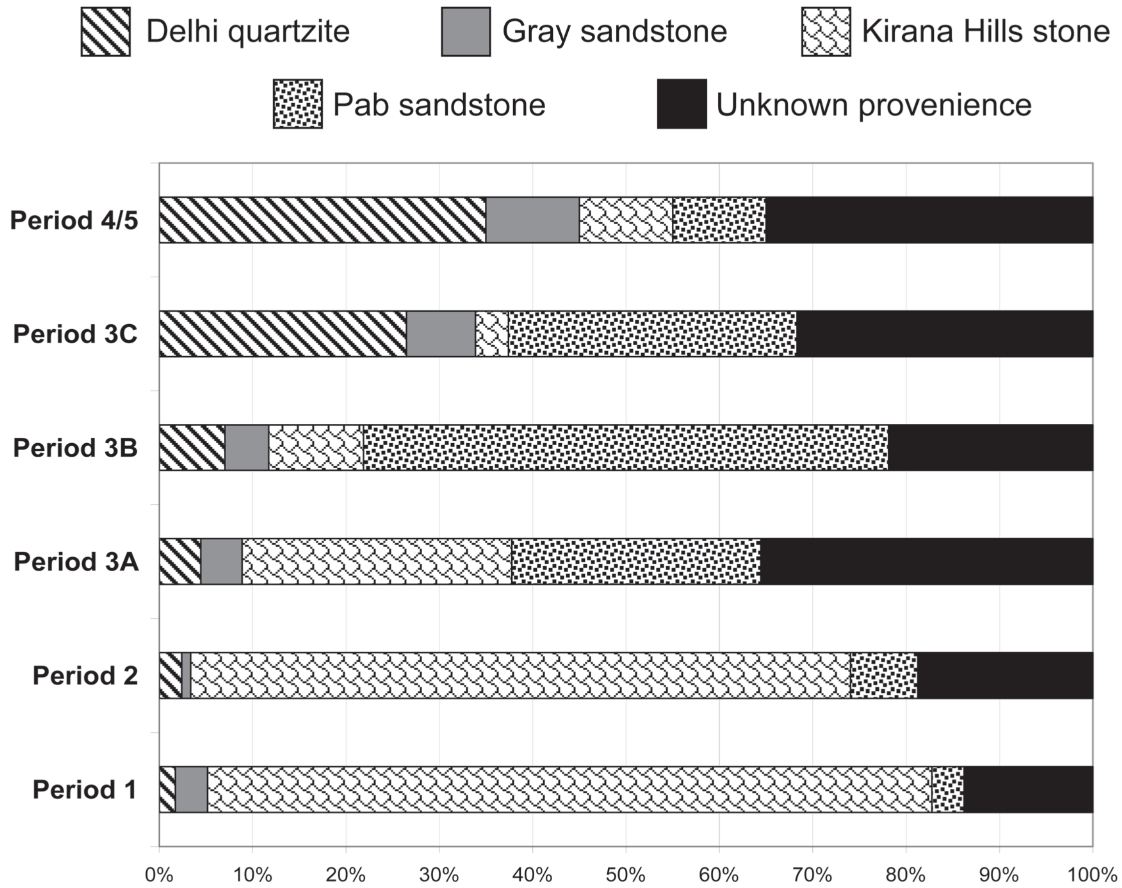
I begin with a presentation of the general diachronic trends in grindingstone source use for the site of Harappa as a whole (without reference to temporal trends on individual mounds). These trends have been calculated in two ways: by number of artifacts by period (Figure 5.27) and by total weight of all artifacts in each category by period (Figure 5.28). I present both methods here because, although they have produced some notably different compositional patterns during certain periods, the basic large-scale diachronic trends appear to be more or less the same using either weight or number for calculating use percentages. We see that the sources in the Kirana Hills are by far the most heavily utilized during the early pre and early urban periods (Ravi and Kot Diji Phases) but then appear to rapidly fall out of use starting in the fully urban period (Harappa Phase). Conversely, Pab sandstone utilization is sparse early on but increases significantly after the beginning of the urban phase. Very little Delhi quartzite is used as grindingstone at first but its overall proportion in the assemblage slowly and steadily increases over time. Gray sandstone seems to have always remained a relatively minor component of the grindingstone assemblage, never reaching 10% of the total during any period at Harappa.

I now examine these trends in detail; phase by phase and mound by mound. I refer to the percentages calculated by total weight listed in Figure 5.27 when discussing site-wise geologic source or material type (source-type) grindingstone use patterns. When looking at differences in material use between habitation areas, I exclude grindingstone artifacts recovered from features of the site outside of the main mounded areas (such as the cemetery area or various Harappan period dumps) from consideration, even though they may be from secure and dateable contexts. All of the remaining percentages that I discuss in this section have been calculated by total weight of each material type and are listed in the accompanying figures.

Ravi Phase – Period 1 (ca. 3300 BC to 2800 BC)

Although there is evidence of a Ravi Phase occupation in the northwest corner of Mound E (Kenoyer and Meadow 2000), at present, all of the grindingstones from the that period at Harappa (Figure 5.29) come from excavation units in Trench 39 on the northern end of Mound AB. During this initial phase the residents of the then village-size settlement (ibid.) acquired the vast majority (84.5%) of their stone for grinding purposes from the nearest sources in the Kirana Hills. Most of the remaining material (10.7%) recovered from this period is of unknown provenience. Some of these "unknowns" are mafic (dark colored due high magnesium and iron content) rocks like dolerite that could themselves come from the intrusive igneous bodies that also occur at places in the Kirana Hills. A few of examples of Pab sandstone, Delhi quartzite and gray sandstone are present in these early levels also. This indicates that, even at this initial stage, some degree of interaction was taking place with the distant regions to the west and east of Harappa where those material sources are found. By and large, however, it is clear that during Ravi Phase Harappans were very much focused on utilizing the closest and, presumably, most accessible grindingstone sources.

Figure 5.27: Grindingstone source utilization through time
(percentage calculated by ***number of individual objects***)

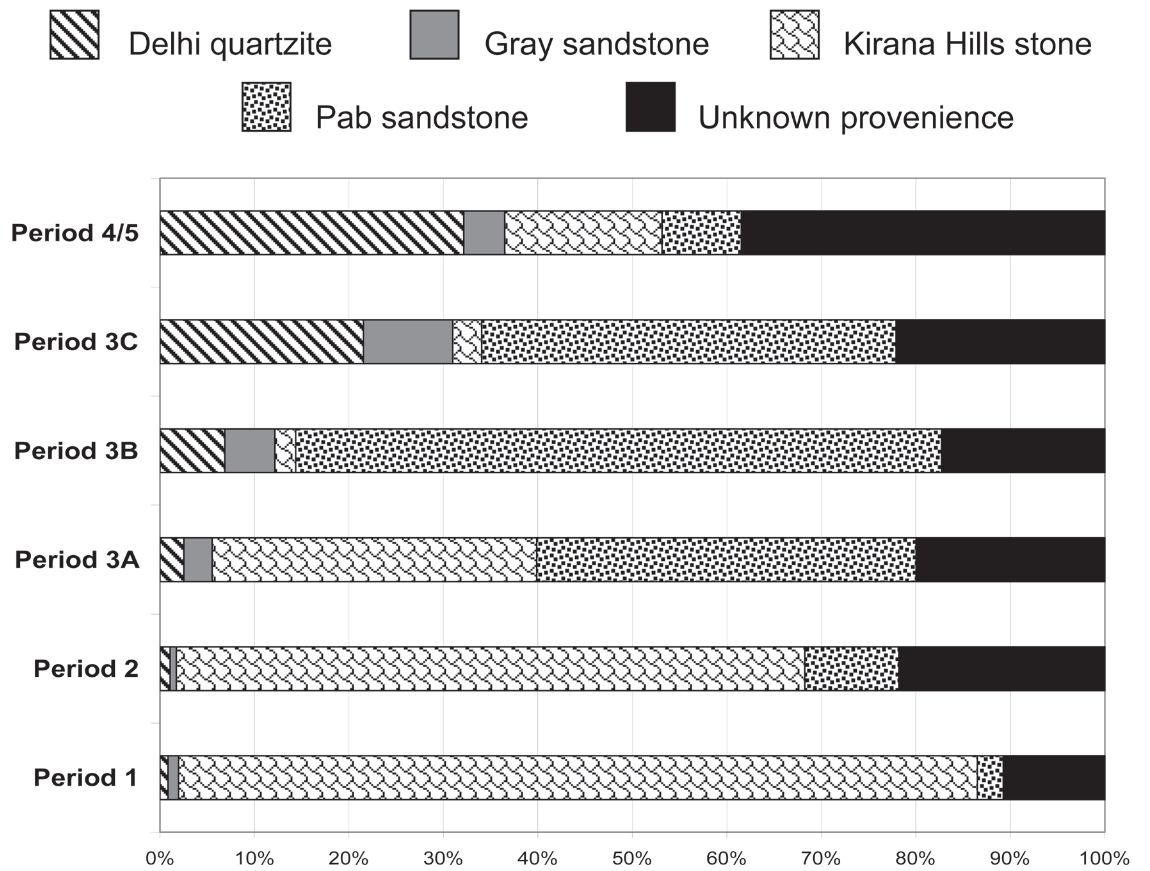


	Period 1	*n* =	Period 2	*n* =	Period 3A	*n* =	Period 3B	*n* =	Period 3C	*n* =	Period 4/5	*n* =
Delhi quartzite	1.72%	*1*	2.40%	*5*	4.44%	*2*	7.03%	*9*	26.48%	*269*	35.00%	*7*
Gray SS	3.45%	*2*	0.96%	*2*	4.44%	*2*	4.69%	*6*	7.38%	*75*	10.00%	*2*
Kirana Hills stone	77.59%	*45*	70.67%	*147*	28.89%	*13*	10.16%	*13*	3.54%	*36*	10.00%	*2*
Pab SS	3.45%	*2*	7.21%	*15*	26.67%	*12*	56.25%	*72*	30.91%	*314*	10.00%	*2*
unknown	13.79%	*8*	18.75%	*39*	35.56%	*16*	21.88%	*28*	31.69%	*322*	35.00%	*7*
total	100%	*58*	100%	208	100%	*45*	100%	*128*	100%	*1016*	100%	*20*

Kot Diji Phase – Period 2 (2800 to 2600 BC)

By the subsequent Kot Diji Phase, the site of Harappa and Harappan society were well on their way to becoming fully urban. The area of settlement grew to encompass all or most of. Mound AB, Mound E and parts Mound ET (Meadow and Kenoyer 2001: 24). In total, 208 grindingstones have been recovered from trenches penetrating Period 2 levels in mounds AB and E (Figure 5.30). Residents of the young

Figure 5.28: Grindingstone source utilization through time (percentage calculated by ***total weight*** of each type)



	Period 1 percentage (weight)	**Period 2** percentage (weight)	**Period 3A** percentage (weight)	**Period 3B** percentage (weight)	**Period 3C** percentage (weight)	**Period 4/5** percentage (weight)
Delhi quartzite	0.86% (80.2 g)	1.06% (397.0 g)	2.5% (313.4 g)	6.87% (4060 g)	21.54% (73902 g)	32.16% (988.5 g)
Gray SS	1.12% (104.3 g)	0.68% (253.4 g)	3.0% (374 g)	5.28% (3122.2 g)	9.45% (32413.7 g)	4.33% (133.2 g)
Kirana Hills stone	84.53% (7890.7 g)	66.51% (24819 g)	34.3% (4275.2 g)	2.22% (1311.6 g)	3.05% (10471.9 g)	16.66% (512 g)
Pab SS	2.74% (256 g)	9.95% (3714 g)	40.1% (4997.1 g)	68.34% (40378.1 g)	43.86% (150479.2 g)	8.37% (257.1 g)
unknown	10.75% (1003.7 g)	21.80% (8133.9 g)	20.0% (2486.8 g)	17.29% (10213.4 g)	22.10% (75817.57 g)	38.48% (1182.6 g)
total	100% (9334.9 g)	100% (37317.6 g)	100% (12446.5 g)	100% (59085.3 g)	100% (343084.4 g)	100% (3073.4 g)

city were now part of the Early Harappan cultural entity termed "Kot Dijian", which extended from central Sindh in the south to the Potwar Plateau in the north (Mughal 1990a). Despite their increasing social complexity and enlarged cultural horizons the majority of the grindingstone Harappans used (66.5%) was still obtained from the closest sources in the Kirana Hills. However, percentages of the other grindingstone types do begin to increase somewhat (Pab sandstone in particular grows to comprise nearly

Figure 5.29: Grindingstone source utilization on Mound AB – **Period 1**
(percentage calculated by *total weight* of each type)

Delhi quartzite | Gray Sandstone | Kirana Hills stone | Pab sandstone | Unknown provenience

Mound AB	amount	weight (g)	percentage
Delhi quartzite	1	80.2	0.86%
Gray sandstone	2	104.3	1.12%
Kirana Hills stone	45	7890.7	84.53%
Pab sandstone	2	256	2.74%
Unknown	8	1003.7	10.75%
total	58	9335	100%

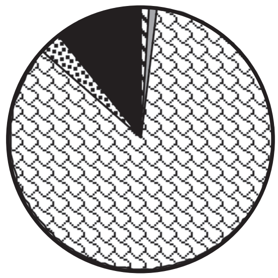
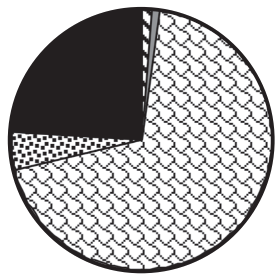


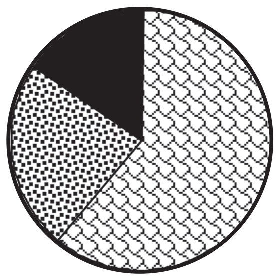
Figure 5.30: Grindingstone source utilization by mound – **Period 2**
(percentage calculated by *total weight* of each type)

Delhi quartzite | Gray Sandstone | Kirana Hills stone | Pab sandstone | Unknown provenience

Mound AB	amount	weight (g)	percentage
Delhi quartzite	4	354.2	1.33%
Gray sandstone	2	253.4	0.95%
Kirana Hills stone	82	18290	68.89%
Pab sandstone	7	1204.9	4.54%
Unknown	26	6447.2	24.28%
total	121	26550	100.00%



Mound E	amount	weight (g)	percentage
Delhi quartzite	1	43.1	0.40%
Gray sandstone	0	0	0.00%
Kirana Hills stone	65	6529	60.63%
Pab sandstone	8	2509.1	23.30%
Unknown	13	1686.7	15.66%
total	87	10768	100%



10% of the Period 2 assemblage) suggesting that some people living at or visiting the site were beginning to expend energy and/or wealth acquiring greater quantities of material from those higher quality but more distant grindingstone sources. Such increases may represent another aspect of the socio-economic development that is evident during this incipient-urban phase (Kenoyer and Meadow 1999).

The percentage of Kirana Hills stone used by Harappans occupying the two main mounds during this period does not seem to have not differed greatly (68.9% for AB vs. 60.6 % for E). Residents of Mound E seem to have used much more Pab sandstone their counterparts on AB (23.3% for E vs. only 4.4 % for AB). People living on AB made up part of that difference by utilizing more Delhi quartzite and gray sandstone (2.2% combined) than their counterparts on Mound E (only a single small fragment of Delhi quartzite and no gray sandstone at all that been recovered thus far from Period 2 level on Mound E).

Overall, it seems that although all residents of Harappa still relied on the closest sources for the majority of their grindingstone requirements during Period 2, they were beginning to acquire a markedly larger portion (nearly one-quarter of the overall total in the case of Mound E) of material from more distant sources. The fact that people residing on Mound E used over 80% more Pab sandstone than people on AB could perhaps indicate that the former group had stronger economic and/or social ties to the region west of Harappa at this time.

Harappa Phase – Period 3A (2600 to 2450 BC)

Fully urban lifeways at Harappa had emerged by Period 3A, the first of three sub-periods of the Harappa Phase. Unlike other some other Indus sites where there are reported to be sharp demarcations between the Early Harappan and Harappan occupations – such as at Kot Diji (a site-wide episode of burning – Khan 1965) or Ghandi Umar Khan (a 50 cm sterile layer – Ihsan Ali 2004 *personal communication*), the transition between the two periods at Harappa itself is one of "gradual transformation" (Meadow and Kenoyer 2001: 25). Approximately 20 grindingstones came from levels deposited right around the late Period 2 to early 3A transition. The context of each of those artifacts was judged individually and, for analytical purposes, was assigned to either Period 2 or 3A. Even though the majority were placed into the Period 3A group, the number of querns and mullers from this period totals only 45 artifacts, which are more or less even split between excavated 3A levels on Mounds AB and E (Figure 5.31). With the exception of the combined assemblage for periods of 4 and 5, this represents the smallest sample we have for any of the periods under consideration. Even a handful of samples added to any one of the material categories could significantly alter the percentages presented here. I have raised the issue at this point because although the Period 1 grindingstone assemblage was nearly as small (n=58) as this one, the site at that time is thought to have been only been seven to ten hectares in size (Kenoyer and Meadow 2000: 56). By Period 3A, however, Harappa was substantially larger. Thus, for this phase we are dealing with both a smaller sample and a bigger area. For these reasons, the data below for this period should be treated with due caution.

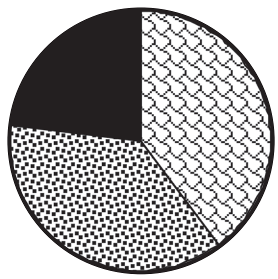
In Period 3A, the use of Kirana Hills stone appears fall to around half of what it was during the Kot Diji Phase. This material still, however, makes up fully one-third (34.3%) of the material used as grindingstone by Harappans at that time. Conversely, the utilization of Pab sandstone sees a four-fold increase over the preceding period (rising to 40.1%) making it, for the first time, the most common type of grindingstone used at Harappa. The portion of Delhi quartzite in the assemblage rises slightly (to 2.5%) while gray sandstone use drops a bit (to 3.0%).

To date, grindingstones have been recovered only from Period 3A levels on mounds AB and E. When

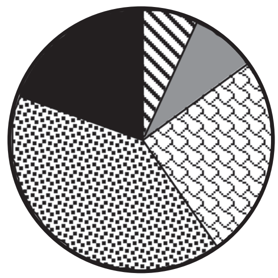
Figure 5.31: Grindingstone source utilization by mound – **Period 3A** (percentage calculated by *total weight* of each type)

Delhi quartzite | Gray Sandstone | Kirana Hills stone | Pab sandstone | Unknown provenience

Mound AB	amount	weight (g)	percentage
Delhi quartzite	0	0	0.0%
Gray sandstone	0	0	0.0%
Kirana Hills stone	6	3123.2	39.7%
Pab sandstone	6	2928	37.2%
Unknown	9	1823.4	23.2%
total	21	7875	100%



Mound E	amount	weight (g)	percentage
Delhi quartzite	2	313.4	6.9%
Gray sandstone	2	374	8.2%
Kirana Hills stone	7	1152	25.2%
Pab sandstone	6	1840.3	40.3%
Unknown	7	892.2	19.5%
total	24	4572	100%



assemblage compositions on those two habitation areas are compared it is evident that for Pab sandstone there is hardly any disparity in material use between them (40.3% for E vs. only 37.2% for AB). It does appear that Harappans residing on Mound AB tended to use somewhat more (39.7%) Kirana Hills stone than did those dwelling on Mound E (25.2%). People on Mound E, however, made up the difference by utilizing Delhi quartzite and gray sandstone (15.1% combined) while neither of those materials have been recovered thus far from Period 3A level on Mound AB.

In summary, despite the fact that during this initial period of the fully urban phase the percentage of querns and mullers made from Kirana Hills stone falls considerably, these closest rock outcrops to Harappa remained significant sources for grindingstone material. The emphasis, however, had evidently begun to shift toward the acquisition-consumption of higher quality Pab sandstone from more distant sources in the Sulaiman Range. Differences in source utilization between habitational areas at Harappa do not seem to be pronounced during this period. Once again, because of the small sample of grindingstones from Period 3A in combination with the larger size of Harappa at that time levels, these conclusions should be considered tentative.

Harappa Phase – Period 3B (2450 to 2200 BC)

Approximately three times as many grindingstone samples (n=128) have been recovered from stratified contexts in Period 3B (Figure 5.32) than from the preceding phase. However, with the addition of querns and mullers recovered from Period 3B levels on mounds F and ET, a greater spatial area is now under consideration. Therefore a degree of caution is once again advised, especially for data from mounds AB and F where only 11 and 7 (respectively) grindingstone artifacts have been recovered for this time period.

Period 3B, which was a time of urban renewal for some Harappans (most notably for those residing on Mound E – Kenoyer 1992a: 6), sees some rather significant shifts in grindingstone source-type utilization at the site. Kirana Hills stone, the dominant material type for the first two periods at Harappa, now accounts for only 2.2% of the overall grindingstone assemblage. It appears instead that Harappans are acquiring nearly 70% of their querns and mullers in the form of Pab sandstone from the Sulaiman Range. Small increases in the use of Delhi quartzite and gray sandstone are once again seen during this period. When assemblage compositions between mounds E and ET (the two habitation areas from which the most samples were recovered) are compared we see that the differences between them are generally slight. Pab sandstone was by far the most-used material for grindingstone on both mounds (76.2% for E vs. only 71.0% for ET) and the three remaining identifiable types collectively account for approximately 10 to 15 percent of the assemblages in both areas. Such similar patterns suggest close ties between the two areas. Although evidence of occupation east of Mound E in the area now defined as Mound ET extends back to the Kot Diji Phase (Meadow and Kenoyer 1997: 140), grindingstones have only been recovered in 3B and later levels on that mound. By that time, Mound ET was encompassed by a perimeter wall (built in late Period 3A or early Period 3B), which extended directly from the city walls of Mound E (ibid.: 143-144) and joined the two habitation areas in a manner suggesting that an expansion of, or annexation by, the larger mound had taken place. If during Period 3B the residents of Mound E exerted a degree of control regarding what raw materials were used by people living and working on Mound ET or if the residents of both mounds were members of the same social-political group, then the closely related source-type use patterns seen for the two areas are understandable.

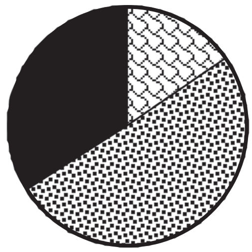
On mounds AB and F the assemblage compositions appear quite different than those of mounds E and ET. When compared to the overall percentage, Kirana Hills stone accounts for a minor but still significant portion of the grindingstones on both mounds (15.3% for F and 17.3% for AB). Delhi quartzite is the most (45.6%) utilized grindingstone on AB during Period 3B while Pab sandstone use falls far below site-wise average at only 7.88%. On Mound F only two of the identifiable types of querns and mullers appear to have been used. Pab sandstone makes up just over half of the assemblage while Kirana Hills stone (mentioned above) accounts for a smaller portion.

In summarizing this period it is worth again emphasizing that the grindingstone assemblages from Period 3B levels on Mounds AB and F are extremely small. Even so, the differences in assemblage source-type composition between mound group E-ET and AB (and to a lesser degree Mound F) may actually have some basis in the reality of grindingstone acquisition behavior during this sub-phase. As mentioned above, Period 3B was a time of rebuilding and renewal on Mound E and perhaps ET. It is conceivable then that at this time residents in these areas of the site were generally more affluent than their fellow Harappans residing on mounds AB and F and so could afford to expend more wealth obtaining high quality Pab sandstone. On the other hand, it may indicate that the people of mounds E and ET had stronger social-economic times with the groups in the Sulaiman region than did those dwelling on the other mounds – a situation similar to the one that perhaps also existed for Mound E during the Kot Diji Phase.

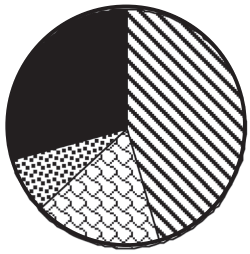
Figure 5.32: Grindingstone source utilization by mound – **Period 3B**
(percentage calculated by *total weight* of each type)

Delhi quartzite | Gray Sandstone | Kirana Hills stone | Pab sandstone | Unknown provenience

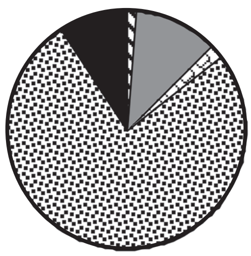
Mound F	amount	weight (g)	percentage
Delhi quartzite	0	0	0.00%
Gray sandstone	0	0	0.00%
Kirana Hills stone	1	211.5	15.31%
Pab sandstone	3	703.1	50.88%
Unknown	3	467.3	33.82%
total	7	1382	100%



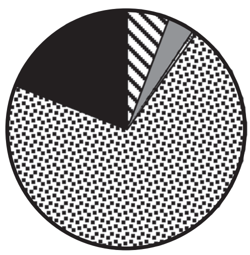
Mound AB	amount	weight (g)	percentage
Delhi quartzite	2	1652.3	45.65%
Gray sandstone	0	0	0.00%
Kirana Hills stone	4	628.9	17.38%
Pab sandstone	1	285.3	7.88%
Unknown	4	1052.8	29.09%
total	11	3619	100%



Mound E	amount	weight (g)	percentage
Delhi quartzite	2	201.1	1.29%
Gray sandstone	3	1740.3	11.16%
Kirana Hills stone	5	330.3	2.12%
Pab sandstone	29	11891.8	76.25%
Unknown	13	1431.6	9.18%
total	52	15595	100%



Mound ET	amount	weight (g)	percentage
Delhi quartzite	5	2206.6	5.86%
Gray sandstone	3	1381.9	3.67%
Kirana Hills stone	3	140.9	0.37%
Pab sandstone	37	26757.6	71.02%
Unknown	7	7189.7	19.08%
total	55	37677	100%



Or (quite possibly) the very small sample sizes for mounds AB and F may have resulted in an inaccurate representation of the true source-type composition for those areas. Whatever the case may be, overall this period does see the continuation of trends that had been developing since the early phases – namely, increasingly steeper declines in the use of Kirana Hills stone over time, progressively greater use Pab sandstone and a slow but steady increase overall of Delhi quartzite utilization.

Harappa Phase – Period 3C (2200 to 1900 BC) and surface/disturbed context finds

Harappa's grindingstone assemblage from Period 3C is the most robust of the entire sequence, consisting of over 1000 artifacts. Examples have been recovered in nearly every trench across the site in which Period 3C deposits have been exposed, which is to say nearly every trench across the site. Thus, appraisals of grindingstone source-type usage between habitation areas made for Period 3C are the most statistically secure and spatially representative of any chronological phase.

Looking at the overall source-type use pattern for Period 3C, we see that Pab sandstone is again the most utilized material for grindingstone at Harappa, although its percentage in the assemblage decreases to around 44% from its high of nearly 70% during the preceding period. Some of that decrease may be due to concurrent increases in the utilization of Delhi quartzite, which jumps markedly to 21.5% of the total, and gray sandstone, which sees its highest percentage (9.5%) in the entire chronological sequence. Apparently, Kirana Hills stone was infrequently used for grinding purposes during Period 3C, accounting for just 3% of the recovered assemblage.

Turning now to source-type usage between Harappa's mounds during Period 3C (Figure 5.33), we once again observe that the grindingstone use patterns for mounds E and ET are remarkably similar. Pab sandstone was the most utilized material for querns and mullers on E and ET– ranging from 52% to 57% of the assemblages. Delhi quartzite was used approximately 20% of the time, gray sandstone 8% and Kirana Hills stone less than 3% on both mounds. The continuation from Period 3B of roughly parallel assemblage compositions provides additional evidence that may indicate that factors determining grindingstone usage (be they economic or social-political) were the same for residents on both mounds E and ET.

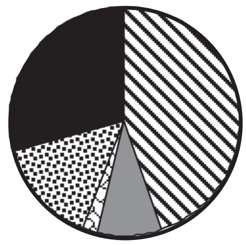
Over on mounds AB and F, we again see in this period that the patterns of use in those areas were quite different that those on E-ET. On Mound F, Delhi quartzite made up around half (44.7%) of the grindingstones used (twice as much as in any other area), Pab sandstone use was approximately one-third (15%) of the site average of 43.8% and the utilization of gray sandstone and Kirana Hills stone was roughly same as the site averages for those materials. On Mound AB, Pab sandstone made up one-third (33.1%) of the assemblage while another one-third were more or less evenly divided between the other three identifiable grindingstone types. Also in contrast to mounds E-ET, the assemblage compositions on both mounds AB and F for Period 3C differ greatly from than the ones for those same areas during the preceding period. This perhaps indicates that the factors (local and/or external to Harappa) influencing resource acquisition for residents of those mounds were somehow in flux between periods 3B and 3C. However, I would point out yet again that the perceived diachronic differences could be misleading due to the small sample sizes for Periods 3B assemblages on AB and F.

It useful at this point to examine the mound by mound grindingstone assemblage composition data for artifacts recovered during surface surveys and from disturbed contexts such as brick robber trenches (Figure 5.34). A comparison of the pie-charts in figures 5.13 and 5.14 shows that the patterns of the surface-disturbed assemblages closely mirror, in most cases, those of Period 3C assemblages from their respective mounds. I suggest here that those patterns help substantiate the grindingstone usage patterns that have been defined for Harappa's individual mounds during Period 3C. It is of course true that querns and mullers found in such non-secure contexts could be from any chronological phase (even historic or modern). However, the brick robbing of the mid-19th century effectively removed nearly all of the upper levels of the site resulting in the exposure of mostly Period 3C deposits across Harappa's surface. It

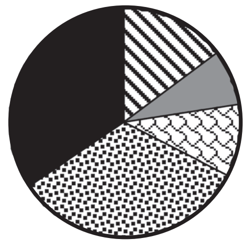
Figure 5.33: Grindingstone source utilization by mound – **Period 3C**
(percentage calculated by *total weight* of each type)

Delhi quartzite | Gray Sandstone | Kirana Hills stone | Pab sandstone | Unknown provenience

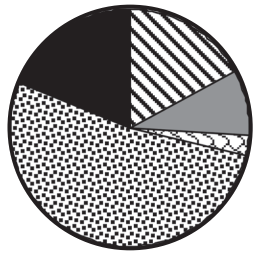
Mound F	amount	weight (g)	percentage
Delhi quartzite	49	21120	44.7%
Gray sandstone	10	4347	9.2%
Kirana Hills stone	6	946	2.0%
Pab sandstone	17	7090	15.0%
Unknown	54	13742	29.1%
total	136	47245	100%



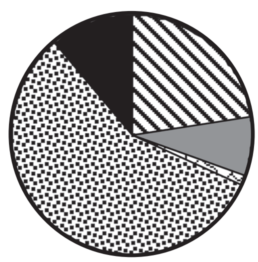
Mound AB	amount	weight (g)	percentage
Delhi quartzite	21	6357	14.78%
Gray sandstone	10	3383	7.86%
Kirana Hills stone	8	4272	9.93%
Pab sandstone	24	14261	33.14%
Unknown	34	14932	34.71%
total	97	43205	100%



Mound E	amount	weight (g)	percentage
Delhi quartzite	96	25180	17.35%
Gray sandstone	22	12853	8.86%
Kirana Hills stone	10	3911	2.69%
Pab sandstone	159	75906	52.31%
Unknown	117	27268	18.79%
total	404	145117	100%



Mound ET	amount	weight (g)	percentage
Delhi quartzite	73	16202	22.55%
Gray sandstone	20	5824	8.10%
Kirana Hills stone	11	947	1.32%
Pab sandstone	85	40976	57.02%
Unknown	51	7914	11.01%
total	240	71862	100%

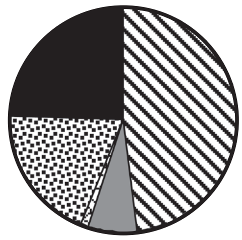


is probable that many (perhaps even a large majority) of querns and mullers recovered from the present-day surface of the site (or in brick robber trench fill that derived from the surface or higher levels) come from that occupational phase. In addition, every meter of the site's surface has been surveyed by the HARP at one time or another resulting in a substantial collection of grindingstones representing each of the major mounds (n = 917 total). Although it's true that unstratified or redeposited artifacts such as these

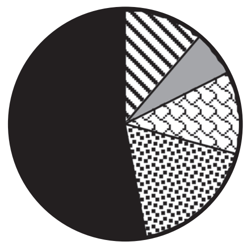
Figure 5.34: Grindingstone source utilization by mound –
Surface and disturbed contexts
(percentage calculated by *total weight* of each type)

Delhi quartzite | Gray Sandstone | Kirana Hills stone | Pab sandstone | Unknown provenience

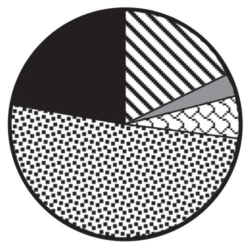
Mound F	amount	weight (g)	percentage
Delhi quartzite	25	23319	48.12%
Gray sandstone	6	3387	6.99%
Kirana Hills stone	4	485	1.00%
Pab sandstone	17	9464	19.53%
Unknown	34	11807	24.36%
total	86	48462	100%



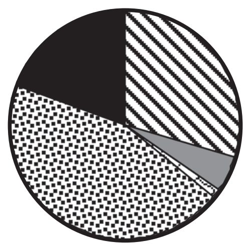
Mound AB	amount	weight (g)	percentage
Delhi quartzite	26	5532	10.99%
Gray sandstone	9	3300	6.55%
Kirana Hills stone	31	5913	11.74%
Pab sandstone	31	9026	17.92%
Unknown	90	26589	52.80%
total	187	50360	100%



Mound E	amount	weight (g)	percentage
Delhi quartzite	116	24177	17.88%
Gray sandstone	14	4218	3.12%
Kirana Hills stone	21	7975	5.90%
Pab sandstone	197	68947	51.00%
Unknown	133	29883	22.10%
total	481	135201	100%



Mound ET	amount	weight (g)	percentage
Delhi quartzite	47	12840	29.84%
Gray sandstone	12	2089	4.85%
Kirana Hills stone	2	508	1.18%
Pab sandstone	61	19248	44.73%
Unknown	41	8347	19.40%
total	163	43032	100%

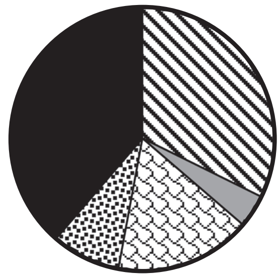


may have been moved far from their original points of deposition, it is highly unlikely that a substantial number of them (if any) came from a mound other than the one on which they were found. In other words, a quern recovered from the surface of Mound AB was almost certainly used by the former residents of Mound AB. For these reasons I would argue that, as long as its potential limitations are recognized, the similar source-type composition of the surface-disturbed assemblage provides a good line of

Figure 5.35: Grindingstone source utilization on Mound AB – **Periods 4/5**
(percentage calculated by *total weight* of each type)

Delhi quartzite — Gray Sandstone — Kirana Hills stone — Pab sandstone — Unknown provenience

Mound AB	amount	weight (g)	percentage
Delhi quartzite	7	988.5	32.16%
Gray sandstone	2	133.2	4.33%
Kirana Hills stone	2	512	16.66%
Pab sandstone	2	257.1	8.37%
Unknown	7	1182.6	38.48%
total	20	3073	100%



supporting evidence for the patterns of grindingstone use at Harappa during Period 3C and later phases.

In summary, although Pab sandstone remained the most commonly used material for querns and mullers at the Harappa during Period 3C, Delhi quartzite was being brought to the site in much higher quantities than before, suggesting that long-distance trade to regions east of the site was intensifying during this period. Residents of Mound F appear to be the ones most actively involved in these eastern grindingstone acquisition networks as they consumed twice as much as the site-wise average for Delhi quartzite. Gray sandstone and, in particular, Kirana Hills stone, were used in only small amounts overall. However, even though the assemblage composition on Mound AB is fairly mixed, people living there did use three times the site-wise average for Kirana Hills stone. In fact, residents of AB had been the highest users of Kirana Hills stone for every phase going back to Period 2. Those who lived on mounds E and ET continued to exhibit patterns of grindingstone source-type usage similar to each other. Although still relying mostly on Pab sandstone, they too were using an increasingly greater amount of Delhi quartzite.

Transitional and Late Harappa Phase – Periods 4 & 5 (ca. 1900 to <1300 BC)

Due to the fact that intact post-Period 3C deposits are rare at Harappa, the total number of querns and mullers recovered from the Harappa to Late Harappa Transitional Phase (Period 4) and Late Harappa Phase (Period 5) is small (n=20). Artifacts from these periods are therefore considered as a single assemblage. Also, although there is evidence that Late Harappa occupations existed on Mounds F and E-ET, all of the grindingstones from those phases come from a single trench (Tr. 38) on the north side of Mound AB. It should be kept in mind, then, that the usage pattern for this small part of Mound AB may not be at all representative of what was occurring elsewhere on the site, especially since this was often the case in other periods (notably 3B and 3C).

Despite the apparent cessation of important long-distance interaction networks with Sindh and Gujarat during the later periods at Harappa, several lines of evidence (demographic, paleoethnobotanical, technological) suggests that activity and innovation continued at Harappa itself (Kenoyer 2005b). Interesting new patterns also appear to have been taking place during these late occupational phases in terms of grindingstone acquisition (Figure 5.35). Both Delhi quartzite (32.2%) and "unknown" grindingstone types (38.5.7%) reach their highest percentages for any chronological phase. Delhi quartzite was, for the first time, more frequently used than Pab sandstone, which now accounts for fewer than 10% of the artifacts in the assemblage. In addition, Kirana Hills stone was used twice as often as Pab sandstone while utilization of gray sandstone dropped by half over Period 3C.

The changes in material source-type usage seen on Mound AB may reflect the general demographic shift of Harappan peoples toward the eastern Punjab and the western Gangetic region that occurred during the Late Harappan Periods (Possehl 1997c). As the emphasis on trade and interaction shifted eastward, Delhi quartzite source would have been even more accessible through interaction with the Late Harappans of Haryana. Access to new sources of grindingstone from around the Gangetic region could account for the increase in "unknown" types. The dramatic drop in Pab sandstone use may indicate that contacts with areas to the west of Harappa had decreased in intensity or at least that the nature of the interaction networks shifted away from the supply of bulk goods. A slightly greater reliance on closer sources for utilization materials during this period is suggested by the small increase in the presence of Kirana Hills stone in the assemblage.

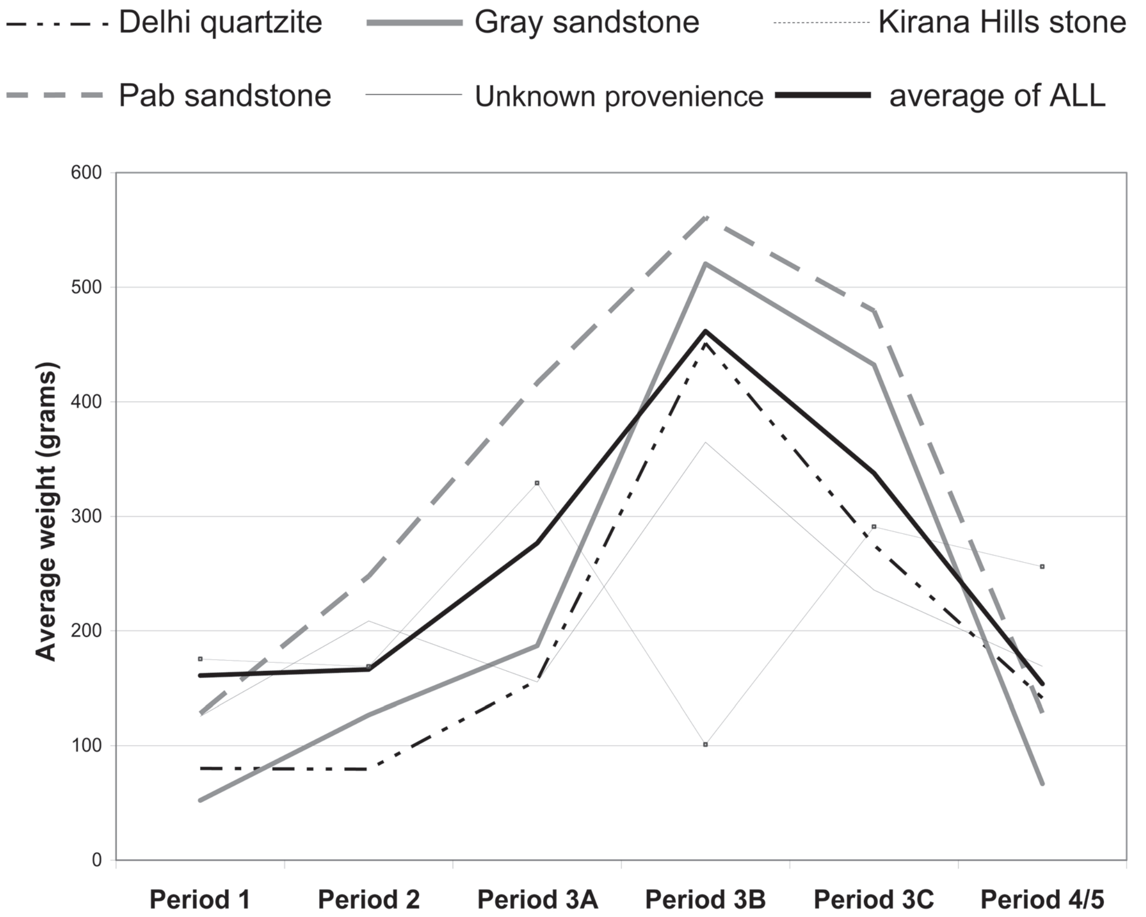
DISCUSSION: PATTERNS OF GRINDINGSTONE ACQUISITION AND DISCARD AT HARAPPA

Residents of Harappa acquired the majority of the stone that they used for processing cereals and other grinding purposes from one of four regions. From the Sulaiman Mountains they acquired Pab sandstone. The type of Delhi quartzite Harappans used seems to have been brought from a fairly restricted area (Kaliana Hills) of southern Haryana. The gray sandstone querns and mullers found at the site probably were acquired as water-worn cobbles from the Lower Himalayas or Siwaliks foothills. Finally, it appears that two different types of stone from the (relatively) nearby Kirana Hills were used. The presence of each of these types of stone at Harappa provides unambiguous evidence that some form of interaction (either direct or indirect) existed between the site and the regions from which they originated. In forthcoming chapters, I demonstrate that numerous varieties of stone and metal found at Harappa came from the Salt Range or regions beyond it. Somewhat conspicuous in its absence, then, is stone from those mountains such as Khewra sandstone. It would almost certainly be identifiable in the site's grindingstone assemblage if it were present. In any case, this geologic provenience study of querns and mullers demonstrates that residents of Harappa of all phases participated in exchange networks for utilitarian goods that extended across an area of no less than 600 km from west to east.

Examples of all four of the identifiable grindingstone types are present in each phase at Harappa. The proportions of those types that make up each chronological sub-assemblage, however, vary significantly from phase to phase. The most striking change in grindingstone source-type usage is the shift in emphasis over time toward the acquisition of stone from sources between 225 and 400 km away from the site. For approximately 1000 years following the initial settlement of Harappa, the large majority (≈ 85%) of mullers and querns were brought to the site from the closest possible sources in the Kirana Hills, which were only 120 km away. A trend toward the acquisition of stone from the more distant sources begins in the proto-urban phase (Period 2) and culminates in the middle of the urban phase (Period 3B) when only 2% of grindingstones used there came from the Kirana Hills region.

Why, over time, would residents of Harappa

Figure 5.36: Average weights of grindingstones (whole and fragmentary) by period.



	Period 1	n =	Period 2	n =	Period 3A	n =	Period 3B	n =	Period 3C	n =	Period 4/5	n =
Delhi quartzite	80.2g	*1*	79.5 g	*5*	156.7g	*2*	451.1g	*9*	274.7g	*269*	141.2g	*7*
Gray SS	52.15g	*2*	126.7g	*2*	187g	*2*	520.4g	*6*	432.2g	*75*	66.6g	*2*
Kirana Hills stone	175.3g	*45*	168.8g	*147*	328.9g	*13*	100.9g	*13*	290.9g	*36*	256g	*2*
Pab SS	128g	*2*	247.6g	*15*	416.4g	*12*	560.8g	*72*	479.2g	*314*	128.5g	*2*
Unknown	125.4g	*8*	208.6g	*39*	155.4g	*16*	364.8g	*28*	235.5g	*322*	168.9g	*7*
Average of all types	160.9g	*58*	166.2g	*208*	276.6g	*45*	461.6g	*128*	337.7g	*1016*	153.6g	*20*

increasingly acquire their grindingstones from comparatively distant sources when much closer ones were at hand? Doing so would surely have required them to expend a greater amount of energy and/or wealth. The loss or establishment of interaction networks to source regions does not provide a satisfactory answer to the question. As discussed above, Early Harappan period sites are found in the areas where the more distant grindingstone sources are located (at the base of the Sulaiman Range and in southern Haryana) and Harappan period settlements are found in the vicinity of the Kirana Hills. I would argue that the answer probably has to do with factors relating to qualities of material from different sources in combination with innovations that accompanied the emergence of urban lifeways in the greater Indus region.

Because of their homogeneity, grain size and toughness, Pab Sandstone, Kaliana-type Delhi quartzite and fine gray sandstone are, as compared to the stone available in the Kirana Hills, superior materials for grinding purposes. As just noted, impediments to acquiring those higher quality material types during the Ravi and Kot Diji phases at Harappa probably did not stem from a lack of access to the regions in which they occurred. It is more likely that transportation technologies and infrastructure in the upper Indus Basin during the Early Harappan Phase had not yet developed to the point where moving heavy stone implements overland in large quantities was cost-effective. Transporting heavy loads of stone from the Kirana Hills to Harappa and other sites in the central Punjab could have been easily accomplished by moving them a large portion of the way via watercraft downstream on the southeasterly flowing rivers of the region. The most direct routes from grindingstone sources in the Sulaiman Range and southern Haryana, on the other hand, run mostly perpendicular to those waterways. The transportation of Pab sandstone or Kaliana-type Delhi quartzite to Harappa would have, therefore, had to have taken place mainly via overland routes and on watercraft traveling upstream. As a result, the best quality querns and mullers would have been comparatively more costly to acquire in terms of wealth and/or energy expended.

Transporting heavy loads of stone by land would have been most effectively undertaken using a bullock-pulled two-wheeled cart – an innovation the origins of which are documented at Harappa and other Indus Civilization sites during the fourth and third millennia BC (Kenoyer 2004). Although there is limited evidence of its existence during the Ravi Phase at Harappa, use of the bullock cart increases during the Kot Diji Phase, which incidentally is also the time we see the initial small increase in Pab sandstone in the grindingstone assemblage. Evidence for widespread use of carts across the Greater Indus region and beyond is seen during the Harappa Phase (ibid.). It is during that time, of course, that grindingstones transported from relatively distant sources are the most utilized at Harappa.

Wheeled vehicles traveling across the plains of the Indus Basin would have required some kind of infrastructure in the form of roads or, at the very least, a clear trail. Although no such roadways from this period have yet been discovered, the well-planned streets and broad avenues of Indus towns and cities allow us to reasonably assume that some form of maintained route probably existed in the countryside between Indus settlements. So, with the development of new transportation technologies (documented) and infrastructure (inferred) it became easier to supply Harappa with grindingstones from multiple sources around the upper Indus Basin. As a wider range of materials for querns and mullers became easier to get, many residents of the site chose to utilize the stone of better quality.

The shift toward more distant grindingstone sources could also reflect the general economic prosperity of urban phase Harappans. Residents of an increasingly urbanized settlement, in contrast to their village-dwelling ancestors, might have had comparatively more accumulated wealth to expend on the acquisition and transport of higher quality utilitarian necessities. Without the benefit of readable texts it is difficult to know precisely what value Harappans may have placed on any material. However, it may be instructive to consider changes in the average weight of the grindingstone artifacts during different periods. Less than 5% of the querns and mullers from Harappa have been found in a complete or nearly complete state. It appears that Harappans used these implements until they broke and then continued to re-use the pieces until at some point they were judged to be too small to be effective. By looking at the average weights for grindingstone artifacts it is possible to get an idea of how small that point was from period to period and from that, a relative sense of how willing Harappan were to discard grindingstone material at different points in time.

Figure 5.36 is a line graph plotting the average weights of individual material types through time at Harappa. Although average weights vary from type to type, most follow a similar trend. This trend is clearly evident when the average weights of all types in a single chronological assemblage are calculated and plotted period by period (bold black line). The general trend is as follows: During both periods 1 and 2 the average weight of discarded grindingstones hovered around 160 g. In the early part of the urban phase (Period 3A) the fragments thrown away were over 100 grams heavier on average than in the previous phases. By Period 3B the average quern or muller discarded by a resident of Harappa was nearly half a kilogram in weight. In the later part of the Harappa Phase (Period 3C) fragments of grindingstones deemed unusable were somewhat smaller (average 365 g) than before. Finally, it appears that Late Harappans (Period 4/5) tended to discard used grindingstones of a weight (153.6 g) that was slightly lower on average than in periods 1 and 2.

How valid are these trends base on average weight? It could be argued that there were factors affecting the average weights of grindingstone artifact assemblages other than, or in addition to, the point at which Harappans of different phases were choosing to throw their querns and mullers away. Any number of post-depositional processes may have acted upon these implements. Also the properties of the different material types themselves may have affected their weights. I have argued that one of the reasons that Kirana Hills stone. was of poorer quality and therefore less preferred over other types is because it is more friable and, thus, more apt to break during use. Should we expect to find many more small pieces of this type as compared to the others? Perhaps not, because it is only in Period 3B that Kirana Hills stone has the smallest average weight of all types. Nor does it appear that varying assemblage sizes from phase to phase is a factor. That is, the trend evident in Figure 5.36 appears to be independent of total number of samples considered in each phase. I would argue these average weights are reasonably good indicators of how the point at which Harappans decided it was worth discarding (and presumably replacing) grindingstone changed from phase to phase. Pab sandstone and Kirana Hills stone both would have been discarded when they more or less reached the same weights. Higher quality Pab sandstone, however, would have lasted longer before reaching that point.

The overall trend evident in Figure 5.36 would make it appear that Early Harappans (periods 1 and 2) were more inclined than their urbanized counterparts in Period 3 to use and re-use broken grindingstone fragments until they were very small. This suggests that such stone was dearer to them than it was to urban phase Harappans. That is, it was probably less readily available and/or more costly to acquire. During Period 3 it seems Harappans were more apt to discard larger pieces of grindingstones despite the fact that the majority used at that time tended to be composed of higher quality materials from distant sources. This suggests that grindingstone during Period 3 generally was not as valuable as it was during Periods 1 and 2 and/or that a reliable supply of comparatively inexpensive material was available to replace broken implements. Interestingly, it is in Period 3B that both the highest proportions of stone from sources over 200 km distant are found in Harappa's grindingstone assemblage and that the heaviest fragments are being discarded. It could be said that during Period 3B, more than in any other period, high quality querns and mullers were plentiful (there were a higher proportion of them) and cheap (they were more readily discarded). The slight drop in the average weight of grindingstones discarded by Period 3C Harappans may reflect a situation where the amounts of new grindingstone being brought to Harappa through regional trade networks was declining. A deterioration of architectural quality and the maintenance of public thoroughfares suggest that civic authority at Harappa was beginning to wane during that period (Kenoyer 1992a: 6). The steep decline in the average weight of discarded grindingstones that is evident in the Late Harappa Period (4/5) may then indicate that some of those networks had further or failed entirely.

Turning now to intra-site variation in grindingstone source usage, the only phases for which it is possible to compare patterns between two or more habitation areas at Harappa are periods 2 through 3C. In several instances the assemblages recovered from particular mounds are very small (n < 25). This may have resulted in unrepresentative or biased source-type usage patterns. However, even when the possible shortcomings of certain aspects of the dataset are taken into account, there appears to have been some genuine synchronic variation among the habitation areas at Harappa.

Looking first at intra-site similarities we see that all four of the identifiable grindingstones types were used to some degree or another by residents of each of Harappa's habitation areas. Occasionally grindingstone types are missing from some mound assemblages during certain periods but that is probably due, in large part, to problems related to small sample size rather than absence of a material type. It would seem safe to say that all Harappans, regardless of what part of the city they lived in, would have had access to any of the four material types if they wished to acquire them.

Residents of Mounds E and ET left behind more or less parallel patterns of grindingstone source-type usage during both Period 3B and Period 3C. The surface and disturbed context assemblages from the two mounds were also alike in composition. This indicates that people living in both areas had very similar needs, preferences and/or opportunities when it came to choosing grindingstone material. Mound ET has been described as a "suburb" of Mound E (Kenoyer 1998: 55) that was eventually incorporated into it around Period 3B (Meadow and Kenoyer 1997: 140). These findings provide evidence that could be used to support an argument suggesting that residents of the two habitation areas were probably part of the same socio-political entity.

When looking at differences among habitation areas at Harappa we see that residents of Mound E (and eventually E-ET) always seemed to have been the heaviest consumers of Pab sandstone. Only in Period 2 did people of Mound AB use roughly the same amount of that material type. There are several possible explanations for this emphasis on Pab sandstone on mounds E-ET. One is that the peoples living there had the strongest economic and/or social ties to the trans-Indus regions adjacent to the Sulaiman Mountains such as Derajat and the Gomal Plain. It might also be the case that, of all the groups at Harappa, those on E-ET could best afford to expend wealth or energy acquiring high quality Pab sandstone. Or, perhaps, residents of the two joined mounds were engaging (at least more so than Harappans in other parts of the city) in types of craft production or other activities where Pab sandstone was required or particularly well-suited.

Overall, Harappans living and working on the other mounds used significantly less Pab sandstone – approximately one-third on Mound AB and two-thirds less on Mound F in Period 3C. Residents of Mound AB always seemed to have used an above average amount of Kirana Hills stone, even during periods 3B and 3C when that type was least utilized overall in the city. This may indicate that Harappans dwelling in that particular area, which was one of the oldest parts of the city, had the closest "local ties," as it were, to peoples in the northern part of the Punjab Plain. On the other hand, they might have had slightly less wealth than their contemporaries on other mounds to expend on higher quality types of grindingstone. Or maybe they simply did not engage heavily in activities that required grindingstones with the unique qualities of Pab sandstone.

On Mound F during Period 3C, which is the one phase in that part of the site for which there is a reasonably large grindingstone assemblage to consider, we see that residents there used twice as much Delhi quartzite as anyone else in the city (Mound F's assemblage from surface and disturbed contexts more or less parallels this pattern). This may indicate that, of all Harappa's residents, those in this part of the site had the strongest trade relationships with peoples to the east of Harappa. I later present results from a provenience study of steatite artifacts (Chapter 7) that seem to support this interpretation.

BRIEF REMARKS ON GRINDINGSTONE ACQUISITION PATTERNS AT OTHER INDUS CITIES

I am currently conducting formal examinations of the grindingstone assemblages from the Indus cities of Dholavira in Gujarat and Rakhigarhi in Haryana. I have also had the opportunity to briefly study collections and/or make surface observations of grindingstones from the sites of Mohenjo-Daro in Sindh and Ganweriwala in Cholistan. Here I would like to make a few short remarks on the acquisition patterns that I see emerging at those cities and how they compare to and, in some cases, fit into the overall pattern seen at Harappa.

Some 90% of the querns and mullers that I have recorded thus far from the Indus city of Rakhigarhi appear to be composed of Delhi quartzite coming from the Kiliana Hills area outcrops, some 75 km to the south. Most of the remain grindingstone from that site is gray sandstone that is likely from the foothill formations or riverbeds of the Lower Himalayas. A handful of Pab sandstone querns and few fragments of what appears to be spotted red Mathura sandstone from the southwestern Gangetic Basin region were also found in the assemblage. The basic acquisition pattern for Rakhigarhi, however, seems to be one that is overwhelmingly focused on the closest regional grindingstone source. When my study of the assemblage is complete, I expect that this pattern will be more or less the same for all periods at the city. It probably will hold true in the larger surrounding region as well. Kiliana Hills Delhi quartzite was by far the most encountered stone at all of the smaller Early Harappan and Harappan sites I visited in Haryana. The difference between the acquisition patterns in this region and those seen at Harappa in the Punjab probably has a lot to due with the quality of material from the closest sources. Excellent quality grindingstone was available from the Kiliana Hills and so there was little need/incentive for regional consumers to seek material from more distant source. On the other hand, stone from the Kirana Hills in the Punjab was of comparatively poor quality. Residents of Harappa largely stopped using that material when it became cost effective to import high-quality grindingstones from distant sources, including the ones 450 km to the east that were preferred by the Indus peoples of Haryana.

The acquisition of grindingstone material from regionally available sources is even more pronounced at Dholavira in Gujarat. No examples Pab sandstone or Kaliana Hills Delhi quartzite have been recorded at that site. All of the querns and mullers that I have examined thus far appear to have come from local rock formations in eastern Kutch or slightly further afield (≈ 150 km) in northern Saurashtra (Dhrangadhra stone).

Like Harappa, the grindingstone assemblages of Mohenjo-Daro and Ganweriwala are much more diverse. Also like Harappa, the most common quern and muller material overall appears to be Pab sandstone, which would have come from either the Sulaiman Range or, perhaps more likely in the case of Mohenjo-Daro, the Pab sandstone formations of southern Balochistan. I have not yet seen any examples of Kaliana Hills Delhi quartzite at either site. Instead, I encountered many more grindingstones composed of raw material types that were unknown to me. This probably indicates that residents of these cities were accessing stone in areas that I have not yet fully documented, such as the Kirthar Range of Sindh or the Dera Bugti area of Balochistan.

CHAPTER CONCLUSION

The heavy and unwieldy nature of grindingstones makes examining artifacts in this category especially useful for detecting changes in the ability of ancient peoples to acquire stone resources that were difficult to transport. The large-scale study presented in this chapter revealed that residents of Harappa shifted away from the use of poorer quality grindingstone from the closest available sources during the pre and early urban phases towards the acquisition of higher quality stone from distant sources during the urban phase. I infer that this shift was, in part, due to a marked increase in the capability of Indus Civilization peoples to transport bulk stone goods over long-distances. It may also indicate that high-quality grindingstones had become less expensive during Period 3 and/or that site residents had comparatively more wealth to expend on their acquisition.

In Chapter 13, the results of the grindingstone analysis and their implications are considered again in relation to the other geologic provenience data produced for this study. In the next chapter, I examine the acquisition and use of chert at Harappa and other Indus Civilization settlements. Chert, like grindingstone, was a vital utilitarian material that was acquired by residents of Harappa in large quantities.