CHAPTER 6

CHERT ACQUISITION NETWORKS

CHAPTER INTRODUCTION: THE THREE MAIN TYPES OF CHERT AT HARAPPA

Indus Civilization peoples, although heavy consumers of copper and skilled producers of copper-alloy implements, still chose to utilize chert to manufacture many of the tools (blades, drills, scrapers, awls, etc.) that they used in their daily lives. At Harappa, tools composed of this opaque variety of microcrystalline silicate (or, more commonly, the debris from the manufacture of them) make up more than one-third (37.21%) of the over 56,000 artifacts in the site's rock and mineral assemblage (recall Figure 4.2). Chert also seems to have been the preferred stone for making the distinctively Harappan style of cubical weights. Visual examinations of this material sub-assemblage at Harappa indicate that there are three main macroscopically distinct types of chert represented in it (to see a selection of these refer back to Figure 4.3 B). A *purplish-hued chert/chalcedony* and a *black-brown*-colored chert are the two most abundant types in levels dating to the site's earliest two occupational phases (Ravi and Kot Diji phases). Black-brown cherts occur throughout Balochistan (Aubry *et al.* 1988) and, prior to this study, material of this type found at Harappa was believed to have originated from that region (Meadow and Kenoyer 2001: 24). Artifacts made of a tan to gray-colored (*tan-gray*) chert that often has a distinctive banded pattern have been recovered from strata representing all periods at Harappa. This type appears to have been the only one used during the site's urban phase (Period 3). Tan-gray chert that is sometimes banded is also found at Indus Civilization settlements across the entire Greater Indus region (Ratnagar 2001b: 64) and is widely believed to have originated in the extensive Rohri Hills chert quarries of northern Sindh (Allchin and Allchin 1997: 172).

In this chapter, I present an account of my attempts to determine from which regional geologic sources each of the three main macroscopically distinct types of chert in Harappa's rock and mineral assemblage were most likely derived. For the purplish hued chert/chalcedony, this entailed only the evaluation of that type in relation to chert artifacts in other contemporaneous archaeological assemblages, information in the geologic literature and observations in the field. For the black-brown and tan-gray cherts, however, I was able to directly compare a small set of artifacts (Figure 6.1) from Harappa and the Harappan Period site of Nagwada in Gujarat to samples from potential sources using instrumental neutron activation analysis (INAA). I have provisionally concluded that the purplish hued chert/chalcedony probably comes from volcanic trap rock formations in regions to the north of Harappa. Black-brown chert artifacts from Harappa were almost certainly derived from sources of the site in the Salt Range. Although most of the tan-gray chert artifacts from Harappa and other Harappan sites like Nagwada are probably indeed from the Rohri Hills of Sindh, there are indications that other sources also may have sometimes been used.

Figure 6.4 shows the locations of the four trenches at Harappa from which 24 of the 25 chert fragments analyzed for this study came from. INAA-derived elemental data for these artifacts samples and the geologic to which they were compared are listed in appendices 6.1 through 6.6. Appendix 6.7 lists

Figure 6.1 Chert samples from Harappa (numbered) and Nagwada (NGW) analyzed for this study. Numbers = appendices 6.1 and 6.4 and below.

the standardized (canonical) discriminant function coefficients for each of the figures (6.18, 6.30 and 6.31) in this chapter that were generated using canonical discriminant analysis (CDA). All regions, sites and chert sources discussed below are noted on figures 6.2, 6.10 and 6.21. I begin with a few brief observations/ remarks on the ubiquity of chert in the Greater Indus region and at Harappa.

CHERT IN THE GREATER INDUS REGION

Geologically speaking, chert is a rather ubiquitous material. It may form anywhere that "silica, in solution at low temperatures, can precipitate" (Luedtke 1992: 17). This includes sedimentary, metamorphic and volcanic rock formations (Blatt 1992). I have encountered chert in one form or another within most of the regions that I have visited across northwestern South Asia. The ophiolite sequences of the Las Bela, Zhob and Waziristan regions literally contain small mountains composed entirely of massive mixed beds of radiolarian[1] chert and jasper (Figure 6.3). As their primary context host rocks erode, nodules and fragments of chert and other microcrystalline

1) *Radiolarian* cherts and jaspers contain the mineralized skeletons of microscopic protozoa. Such microcrystalline silicates are sometimes referred to as *radiolarite*.

Figure 6.2 Regions, sites and chert sources discussed in this chapter.

silicates may be transported and redeposited far from where they originally formed. I have collected bags of secondary context chert and jasper at places ranging from the Makran coast of Balochistan to the Baquka area of western Rajasthan. Still, although chert is widespread in the Greater Indus region, sources where good quality material (e.g. homogeneous unfractured stone for making long blades and other tools) may be acquired are relatively few in number.

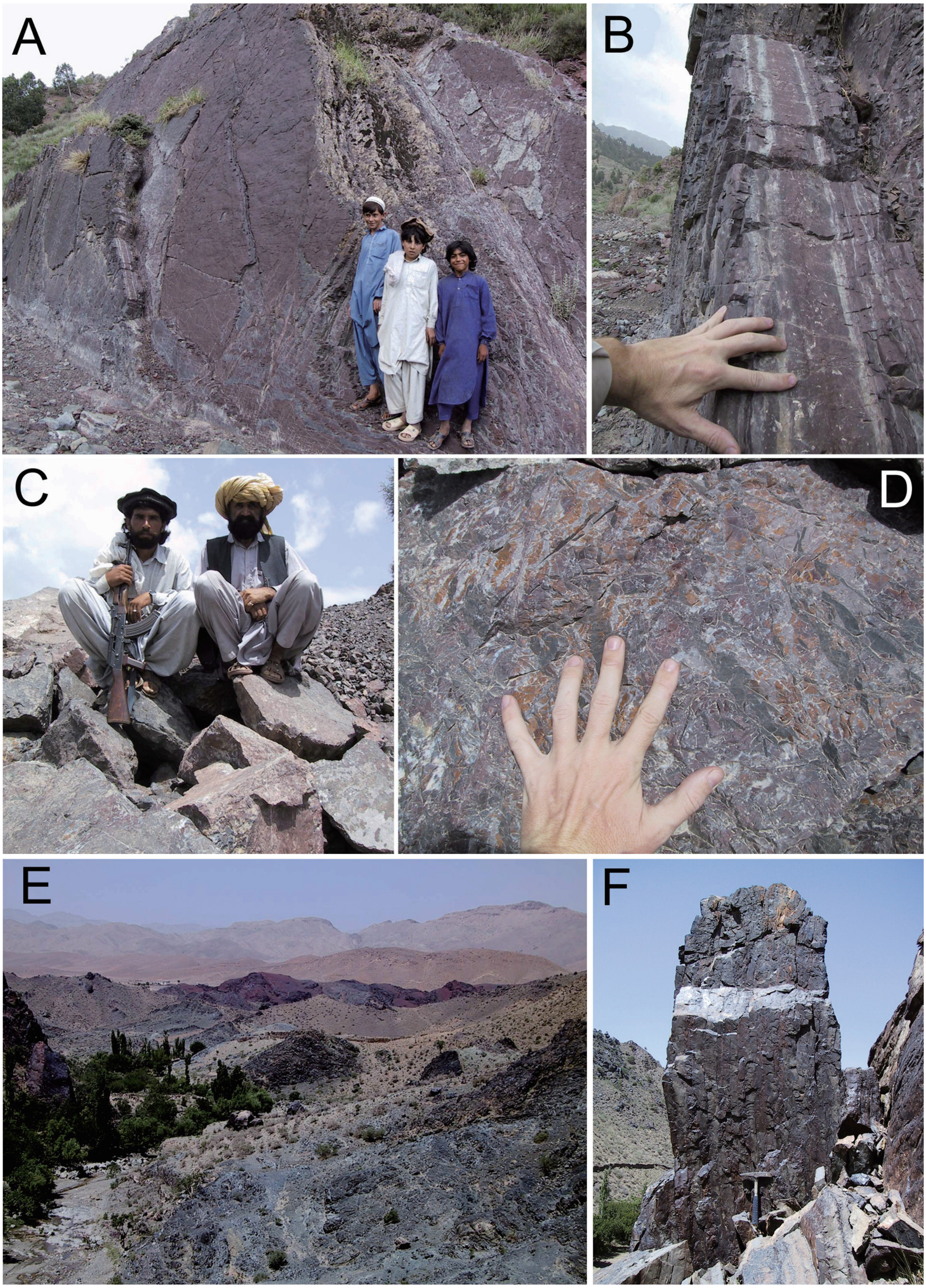


Figure 6.3 **[A & B]** Bedded, multi-colored ophiolitic chert/jasper formation at Barzai, North Waziristan. **[C]** Men from the Sadgai area, North Waziristan sitting atop blocks of brecciated jasper-chalcedony. **[D]** Detail of Sadgai jasper-chalcedony. **[E & F]** Bedded, multi-colored ophiolitic chert/jasper formation at Ashgar Tangi, northern Zhob District, Balochistan.

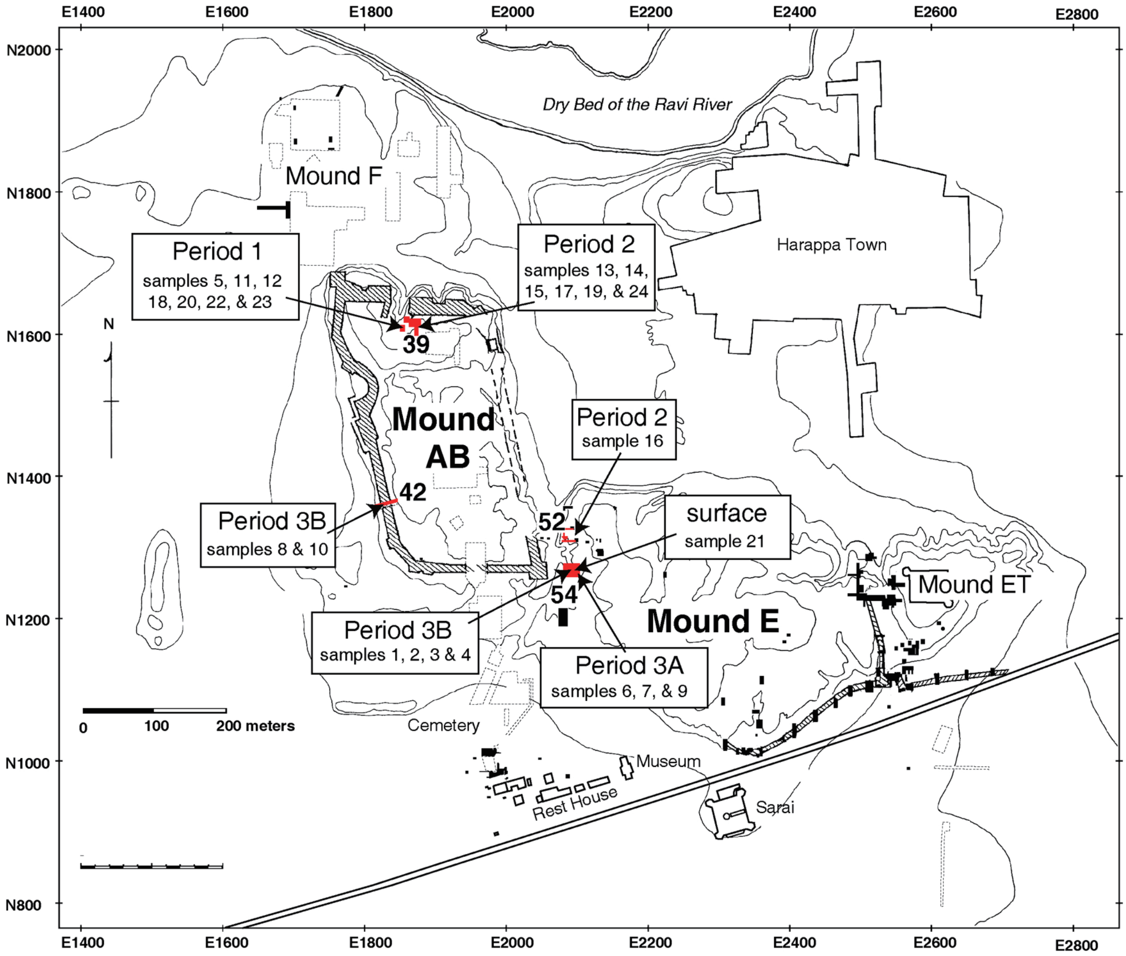


Figure 6.4 Harappa chert sample locations and contexts.

Figure 6.5 Temporal distribution of the 9,325 chert artifacts at Harappa from secure contexts.	
Period 1	n = 625 *or* 6.70%
Period 2	n = 105 *or* 1.13%
Period 3A	n = 161 *or* 1.73%
Period 3B	n = 932 *or* 9.99%
Period 3C	n = 7472 *or* 80.13%
Period 4/5	n = 30 *or* 0.32%

CHERT AT HARAPPA

Chert is also ubiquitous at Harappa. It is found in every part of the site and in every one of its chronological phases. Of the 20,967 chert artifacts tabulated by the HARP, 9,325 (44.5%) are from chronologically secure contexts. Figure 6.5 is a table showing how those are temporally distributed. All chert artifacts tabulated at Harappa were individually inspected by HARP team members and their technological attributes were painstakingly recorded. However, information on color, translucency and macroscopic patterning were not recorded in either the tabulation database or in the Harappa database. Time did not permit me to go back and record such attributes for every one of the chert artifacts from secure contexts but I was able to closely inspect most of the approximately 900 examples that date to periods 1 through 3A and Period 4/5. Only a cursory examination could be given to the remaining 8,400 or so chert artifacts from period 3B and 3C levels. Consequently, the relative abundances of the three main macroscopic types have not yet been calculated. The statements made in this chapter regarding their distributions are based solely upon my impressions from those examinations and my conversations with Prof. Mark Kenoyer, who has dealt with these artifacts for 24 years at the site and knows where and when the different types are and are not found. Although much more work on this major material variety clearly needs to take place, I am confident that my inferences are reasonably accurate and will be borne out when quantitative data eventually become available.

PURPLE CHERT/CHALCEDONY AND OTHER MINOR EARLY HARAPPAN MATERIAL SUB-VARIETIES

A wide range of microcrystalline silicates were used to make tools during the Early Harappan Period at Harappa (Figure 6.6 A, B & C). In Ravi Phase levels, all three main macroscopic types of chert are present along with a number of other material sub-varieties that include jaspers of different colors and even a few examples of *novaculite* – an opaque white microcrystalline silicate. My general impression is that tool material variety decreased slightly during the Kot Diji Phase. Only the three main chert types seem to be present in those levels. Jasper was still being used then but not to make tools.

Prominent in the lithic assemblages of the Early Harappan Period (especially during the Ravi Phase) is a type of *purple-hued chert/chalcedony*. This type tends to be quite variable in itself. Some examples are a completely opaque (Figure 6.6 B) while others have a semi-translucent (thus the use of the combined term *chert/chalcedony*) light purple appearance with a "smoky" interior banding (the Ravi Phase blade seen on the left hand side in Figure 6.6 C is a good example of the latter). It is very possible that there are actually two or more geologically distinct materials represented by this single macroscopic "type." It is also possible that the purple-hue is due to heat-treatment of the materials (Kenoyer 2001 *personal communication*). If that was the case then the original, unheated stone might have looked like the Ravi Phase blade fragment on the right hand side of Figure 6.6 C, which has same semi-translucent smoky appearance but is tan instead of purple.

I have not yet undertaken any geochemical comparative studies of the purple-hued chert/chalcedonies, the various jaspers or the less abundant types of microcrystalline silicates from Harappa's Ravi and/or Kot Diji phase levels. I have, however, examined lithic assemblages from numerous prehistoric sites around and adjacent to the upper Indus Basin region in an effort to get a sense of what types of microcrystalline silicates were being used by peoples living in the vicinity of the highland areas where the potential sources of those materials were located. Searches of the geologic literature and a number of pertinent observations in the field have also been made. Below, I present some provisional thoughts regarding the potential sources of these Early Harappan raw materials.

The lithic assemblages that I have examined from Early Harappan period sites in the Gomal Plain (Rehman Dheri, Jhandi Babar) and Bannu Basin (Lewan, Tarakai Qila) regions of the NWFP, as well as in the northern Zhob Valley of Balochistan (Periano Ghundai), are replete with radiolarian chert/jasper artifacts (see Figure 6.7 A, B & C for examples). That

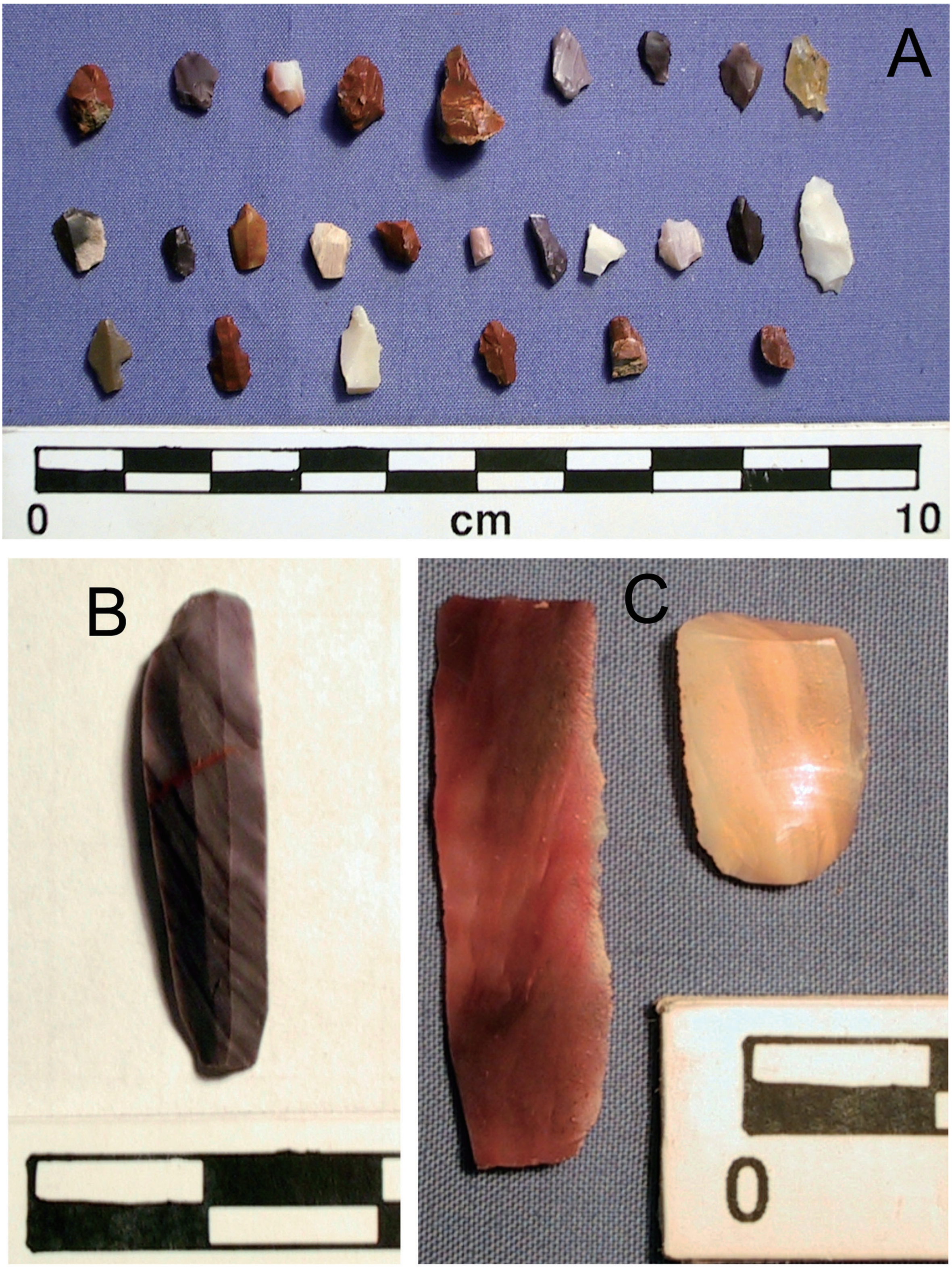


Figure 6.6 The highly varied Early Harappan Period cherts, chert/chalcedonies and other microcrystalline silicates.

material is found just west of those regions in the ophiolites of Waziristan and the northern part of the Zhob District, Balochistan (recall Figure 6.3). Notice the close similarity between the block of brecciated jasper-chalcedony in the top right hand corner of the Lewan lithics image (Figure 6.7 B) and the Sadgai brecciated jasper-chalcedony (Figure 6.3 C & D). *Some* of the chert/jasper tools from Ravi Phase levels

Figure 6.7 Radiolarian chert-jasper blades and fragments from the sites of **[A]** Rehman Dheri and **[B]** Lewan. Collections of the Sir Sahibzada Abdul Qayyum Museum of Archaeology and Ethnology, University of Peshawar. **[C]** Radiolarian chert-jasper hammerstones and flakes on the surface of Periano Ghundai.

at Harappa appear as if they could be from radiolarian sources such as these.

Jaspers and/or colorful types of chert can also be found in the Salt Range (Figure 6.8) and northern Rajasthan regions, although I have observed that those usually are of very poor quality (i.e., highly fractured and/or brittle). Still, such material can sometimes be used to make tools, as is evident by the worked chert and jasper debris (Figure 6.9) covering the dunes at Gidali (N27° 47' 25", E 76° 03' 37") in the Sikar District, northern Rajasthan. The people who left behind those remains were either content or compelled to make do with the locally available (Kishore Raghubans *personal communication* 2003) low quality stone. Despite being far removed from any chert sources the early residents of Harappa clearly had more and better options.

I have yet to encounter any stone that even remotely resembles the purple-hued chert/chalcedony from Harappa while doing geologic field studies in Pakistan and India. However, I have seen this exact same material in collections from two other Early Harappan Period sites in the upper Indus Basin region and I suspect it is present at many more. On display in the Kalibangan Museum and pictured in a full color plate in the recently the published report (Bala 2003: 223-228; Plate XXXVI) for that site in western Rajasthan are 25 purple-hued chert/chalcedony microliths that look almost as if they could have been excavated from Ravi Phase levels at Harappa. I have

Figure 6.8 The colorful but the fractured and brittle chert of the Amb Formation, Nilawahan Gorge, central Salt Range.

Figure 6.9 Left: The microlith-covered dunes near Gidali, Sikar District, Rajasthan.
Right: Examples of the chert and jasper artifacts found there.

also examined tools of identical form and appearance among the artifacts that Aasim Dogar recovered at in the Hakra Culture site of Tala Wala Ther in Cholistan (Dogar 2001). Some of the colorful lithics that Mughal described (1997: 68, Plate 43) as being associated with other Hakra sites in that region are likely more of the same. A "microlith of chalcedony" reported in Period 1 (Early Harappan) levels at Banawali (Bisht 1987: 136) is possibly this material as well. I strongly suspect that this distinctive type of chert/chalcedony will eventually be identified at many more sites of this period across the upper Indus Basin region.

No purple-hued chert/chalcedony artifacts were among the lithic assemblages I examined from sites in the NWFP and, therefore, I doubt this type of

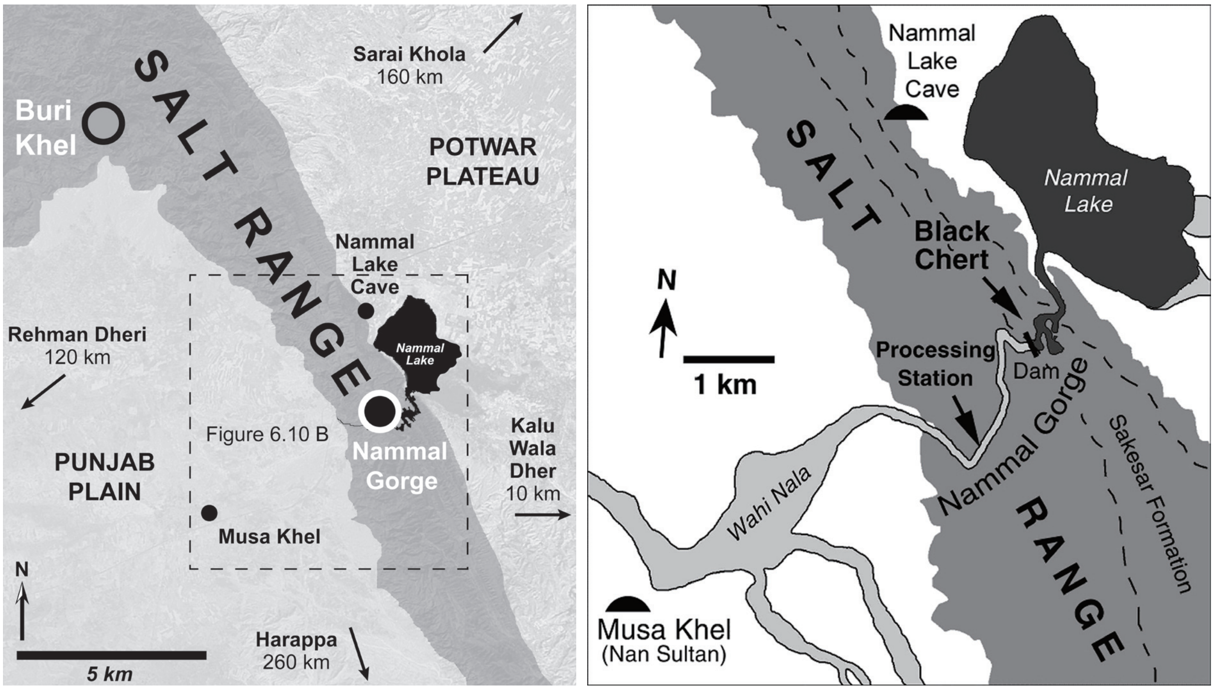


Figure 6.10 Central Salt Range. **[A]** Chert sources and prehistoric sites. **[B]** Nammal Gorge area.

material was derived from a source in that direction. In addition, although its translucency and visible internal patterning provides the material with a very agate-like appearance, it is quite unlike the agates that I have seen in Gujarat or from elsewhere in the Deccan Traps. There are, however, other agate/chalcedony-bearing volcanic "trap" formations in South Asia. Significantly, two of those are located directly north of the upper Indus Basin: the Khewra Trap in the eastern Salt Range (Jan and Faruqi 1995) and the Pir Panjal Trap of Kashmir (Wakhaloo 1979). Chalcedony geodes have been reported in both of those formations (Wadia 1928: 240; Wynne 1878; 75) and this is one reason why I believe them to be the most promising candidates for the source(s) of the Early Harappan purple-hued chert/chalcedonies. The other reason is that the earliest residents of Harappa clearly had connections to both regions where those formations are located. There are Kot Diji Phase sites throughout the Salt Range (Dar 2002) and excellent evidence (Saar 1992: 13-14) for Kot Dijian or "Late" Kot Dijian interaction with Northern Neolithic peoples living just to the east of the Pir Panjal Range in the Kashmir Valley. The black-brown chert brought to Harappa during the Early Harappan Period almost certainly comes from the Salt Range (I demonstrate this in the next section) and apparently so did some of the alabaster used at that time (demonstrated in Chapter 10). Also the earliest (Ravi Phase) lead artifact found Harappa is isotopically analogous to lead from sources in Jammu and Kashmir (see Chapter 12). Finally, it is worth mentioning that the only reported occurrences in South Asia of novaculite – the white microcrystalline silicate that is occasionally found in Early Harappan levels at Harappa and which I also saw examples of in the Tala Wala Ther collection, are located in Pir Panjal Traps of Kashmir (Dhall *et al.* 1977).

BLACK-BROWN CHERT

The overwhelming majority of chert artifacts at Harappa are tan to gray colored in appearance. When tools or debris fragments composed of a macroscopically different type of chert are encountered, such as those discussed in the preceding section, they stand out dramatically. Occasionally

Figure 6.11 Nammal Gorge, central Salt Range.

these different types are found on the site's surface or in strata that have been disturbed. Usually, however, they are met with in trenches where excavations have reached levels *below* the site's Period 3 or Harappa Phase occupation. Most prominent among the distinctive Early Harappan period cherts is the type that will be referred to here as *black-brown* chert. Like the other two "main" types, black-brown chert is actually quite variable in appearance. Nine examples are pictured in Figure 6.1, numbers 16 through 24. The color of this chert type ranges from black (#24) to a medium-brown color (#17). Many examples exhibit the remains of a very light grayish cortex.

HARP excavators immediately recognized that black-brown chert was closely associated with the Early Harappan Period occupation at Harappa (Dales and Kenoyer 1990a: 248). Prof. Kenoyer has recently pointed out, however, that there *could* be sporadic occurrences of this material in the site's later occupational phases. Although I did not come across any examples the black-brown type among the 161 chert artifacts from Period 3A or the 30 from periods 4/5, as I have previously stated, time did not permit me to individually examine each of the 8,400 or so examples from periods 3B and 3C. For those, I made only a quick assessment by looking through the transparent plastic sample bags in which they are stored (grouped by excavation lot and artifact type). If any items among the tan-gray chert flakes, chunks and blades within in the bags had stood out, I would have removed it and inspected it closer. Nothing did, but clearly these assemblages deserve a much more detailed examination of than the cursory look I gave them. Still, if there are any tools or fragments composed of the black-brown type belonging to periods 3B and 3C, I suspect they constitute an extremely small percentage of those assemblages.

Nine black-brown chert artifacts (Figure 6.1: 16 through 24) were selected for a geologic provenience study using INAA. Full details (their HARP

Figure 6.12 Black-brown chert nodules within the Sakesar Limestone Formation, Nammal Gorge.

Figure 6.13 Black-brown Sakesar chert tool-preform found in Nammal Gorge.

Figure 6.14 Black-brown Sakesar chert cores and nodule fragments (red arrows) and a gray Sakesar chert blade (blue arrow) among the Kot Dijian and Harappan Period materials on the surface of Musa Khel.

numbers, contexts and trench information) for each one can be found in Appendix 6.1. Of the nine artifacts, four each are from periods 1 and 2 levels while one is from a disturbed context. The eight samples from secure contexts probably represent around a 5% to 10% sample of the total number of black-brown chert artifacts from their respective chronological sub-assemblages. The nine artifacts were compared to samples collected from three potential sources of black-brown chert located in northwestern South Asia.

Potential sources of black-brown chert

Prior to this study, the black-brown chert used to make tools during the Early Harappan Period at Harappa was thought to have probably come from sources to the west of the Indus Valley in Balochistan (Meadow and Kenoyer 2001: 24). This is not an unreasonable assumption as chert of this description is known to occur widely across that region (Aubry *et al*. 1988). Still, the assumption had never been tested and so, beginning in mid-2000, I started to seek out potential sources of that material and collect samples for comparative studies. There are, in fact, many geologic formations surrounding the Indus Valley Basin where dark colored cherts occur that, to varying degrees, resemble the black-brown type from Harappa. However, as I previously pointed out, sources of homogeneous unfractured material suitable for making long blades and other tools of the quality used by Harappans are few and far between. In the end, I located three sources or source formations where excellent to just mediocre quality black-brown chert existed.

Sakesar Limestone, Salt Range, Punjab

In November of 2000, I with undertook an extended period field research with Dr. Syed Baqri

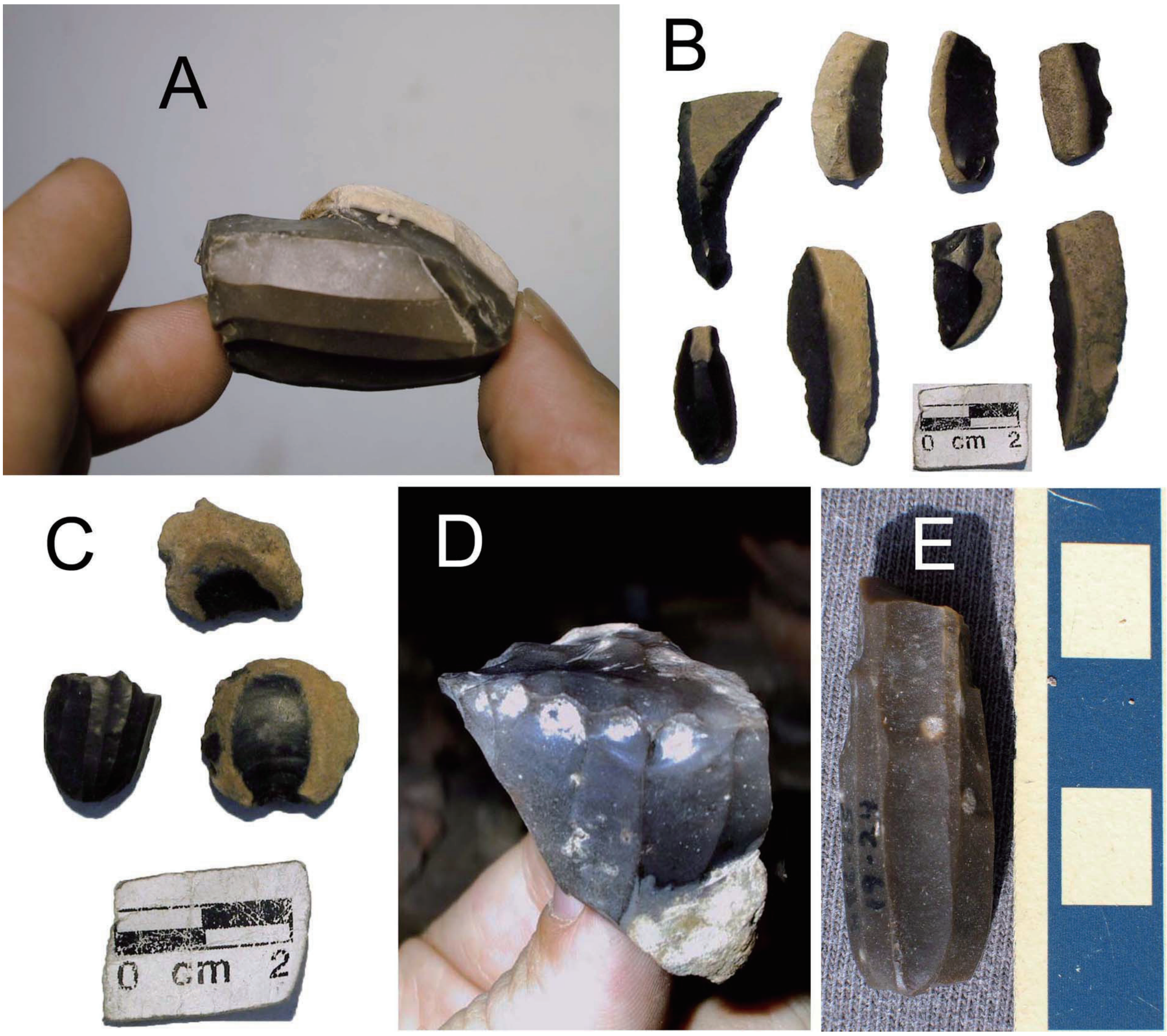


Figure 6.15 Black-brown Sakesar chert cores and flakes from **[A & B]** Rehman Dehri, **[C]** Lewan, **[D]** Hathial and **[E]** Harappa.

of the Pakistan Museum of Natural History for the purpose of identifying the potential sources of a wide range of rock and mineral varieties used by Indus Civilization peoples. The initial focus of our efforts was the Salt Range. Chert is abundant in these mountains, which mark the northern extent of the Punjab Plain in Pakistan. The materials that we encountered in eastern portion of the range were highly fractured (recall Figure 6.8 A) and would have been unsuitable for tool making purposes. In the central part of the Salt Range (Figure 6.10 A & B), however, nodules of unfractured chert occur in the *Sakesar* formation. This Eocene age limestone runs the entire length of the range but is thickest towards the west where chert is located in its upper portion (Shah 1977: 80). Based on observations in Nammal Gorge and nearby areas and sites, Dr. Baqri and I suggested that the Sakesar Formation was potentially an important source of chert for the Early Harappan peoples at many sites in the upper Indus Basin region (Law and Baqri 2003).

Nammal Gorge (Figure 6.11) is a short defile that transects the Salt Range near its narrowest point. At the head of the gorge there is a British Era dam and a small lake created by it (Punjab Government 1915: 197-198). In former times, this would have been an unobstructed passageway linking the Punjab Plain with the Potwar Plateau. It is quite conceivable

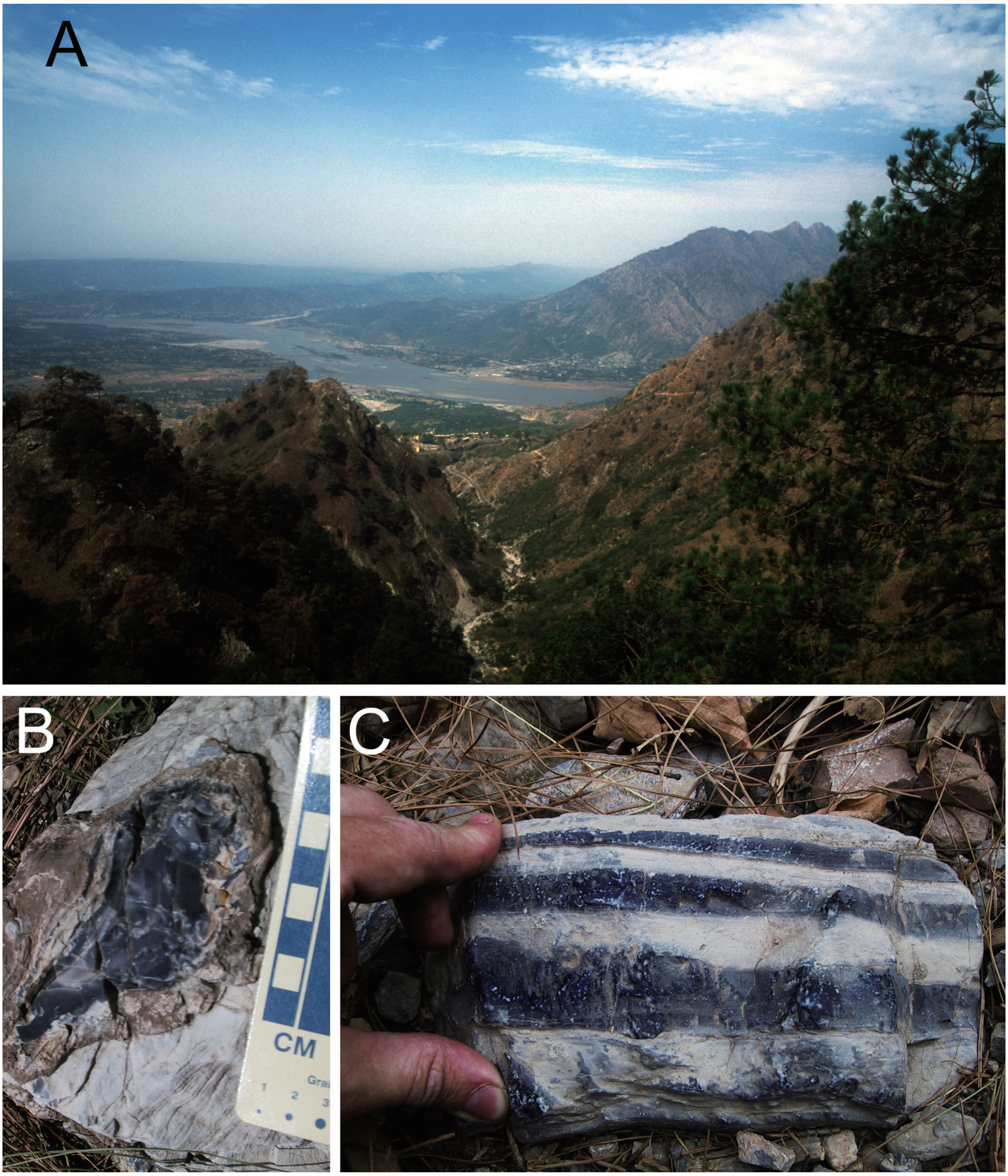


Figure 6.16 **[A]** The Great Limestone Formation near Riasi, Jammu above the point where the Chenab River emerges onto the Punjab Plain. **[B]** Black Great Limestone chert at Mari nala. **[C]** Black Great Limestone chert at Jangleghari.

that Kot Dijian Phase Early Harappans might have traveled via Nammal Gorge to and from sites in the northern Potwar Plateau region like Sarai Khola (Halim 1972) and Hathial (Khan 1983). Evidence that Kot Dijians dwelled in the immediate vicinity has been found on both sides of the gorge at the sites of Musa Khel (Dani 1971: 32), Nammal Lake Cave (Salim 1992: 44-45) and Kalu Wala Dher (Dar 2002).

Nodules of black-brown chert (Figure 6.12) ranging in size from three to 75 cm occur in the Sakesar limestone near the dam site at the head of Nammal Gorge (N 32° 39' 45", E 71° 48' 1"). They are typically egg-shaped, have a light khaki cortex and can easily be extracted from the host rock at places where the Sakesar limestone is soft. No old quarries or blade workshops like those found in the Rohri Hills of Sindh (discussed below) were identified but a concentration of flakes and possible tool preforms (Figure 6.13) was observed a few kilometers downstream from the dam. Black-brown Sakesar chert blades, bullet cores, flakes and nodule fragments are found among the Kot Dijian and Harappan Period artifacts (Figure 6.14) on the surface of Musa Khel, which is situated 3 ½ km to the southwest at the gorge's mouth. I have recorded black-brown chert cores and flakes with the light khaki cortex characteristic of Sakesar chert nodules in collections from several Kot Dijian sites outside of the Salt Range region such as Rehman Dheri (Figure 6.15 A & B), Lewan (Figure 6.15 B), Hathial (Figure 6.15 C) and, of course, Harappa (Figure 6.15 D and Figure 6.1 # 17, 18, 20, 22 & 23).

Chert occurs throughout the Sakesar formation (Shah 1980: 26) and so there are probably many potential sources elsewhere in the Salt Range in addition Nammal Gorge. Black-brown as well as light-gray colored types can be found in Buri Khel *nala* (stream), 12 km to the northwest of the gorge. I have also collected samples of black-brown Sakesar chert in the Chichali nala and Saiduwali nala areas, which are located in the extensions of the Salt Range (called the Surghar and Khassor ranges) to the west of the Indus River. Still, chert from Nammal Gorge is the best quality material that I have yet located and is, for several reasons, the strongest candidate for the source of the black-brown chert artifacts from Early Harappan levels at Harappa: it is situated in the immediate vicinity of several Kot Dijian Phase sites; it is located along what would have likely been an important avenue of trade and communication within the Kot Dijian core area; and it is macroscopically *identical* to most black-brown chert artifacts from Harappa right down to its cortex. To best evaluate the degree to which Sakesar chert is or is not chemical analogous to those artifacts, however, samples from other potential sources are required for comparison.

Great Limestone, Jammu

Black chert occurs throughout the Neoproterozoic ***Great Limestone*** formation (Figure 6.16 A) of Jammu (Raha 1984). Samples representing this potential source were collected from two locations (Figure 6.16 B & C) around 20 km apart in the Riasi District: Mari nala (N 33° 6' 25", E 74°51' 3") and Jangleghari (N 32° 59' 58", E 75° 2' 32"). Great Limestone chert (at least that from the two locations I sampled) can, at best, be described as a mediocre material for making tools. Although it is not too terribly fractured, it does seem to only occur as thin (≈1 to 2 cm) uneven beds. Striking a long blade using this material would probably prove difficult. However, there are some smaller fragments of black-brown chert from Harappa that could conceivably be this material (such as Figure 6.1 # 16, 19 & 24). Importantly, both sampled locations are situated just 25 km north-northeast of Manda, where an Early Harappan Sothi-Siswal Phase occupation has been identified (Joshi and Bala 1982). Moreover, I later show that at least some of the steatite (Chapter 7) and lead (Chapter 12) artifacts at Harappa probably came from sources in the Great Limestone of Jammu, which are located nearby (≈ 5 km) the chert occurrences sampled for this study.

Moro Formation, Bolan Pass, Balochistan

Nodular pods of black-gray chert occur in limestone within the Upper Cretaceous *Moro* Formation of central Balochistan (Aubry *et al.* 1988: 105-106). Samples for this study were collected at a location near Dozan (N 29° 56' 43", E 67° 11' 15") in the Bolan Pass (Figure 6.17 A & B). The quality of Moro chert is mediocre overall. Nodules are firmly affixed in the host rock and are often rife with fractures. Large, fairly homogeneous pieces can occasionally be removed, however. The importance of this source has to do with its position along a

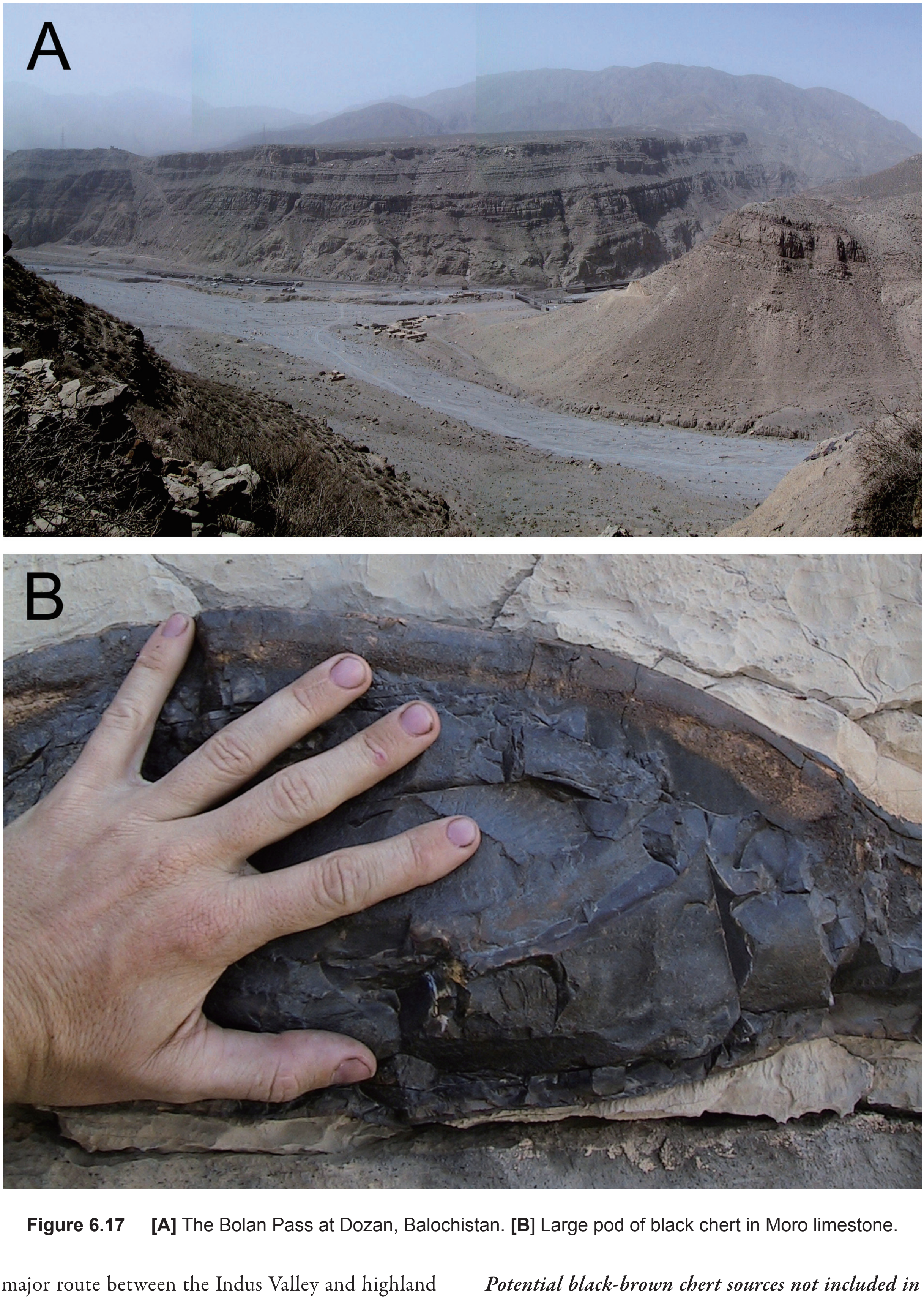


Figure 6.17 **[A]** The Bolan Pass at Dozan, Balochistan. **[B]** Large pod of black chert in Moro limestone.

major route between the Indus Valley and highland Balochistan as well as its proximity (≈ 75km) to the Early Harappans of Nausharo (I) (Jarrige 1993).

Potential black-brown chert sources not included in this study

There are many potential sources of black-brown chert that are not included in this study. Several more are known to exist in Balochistan (Aubry *et al.* 1988).

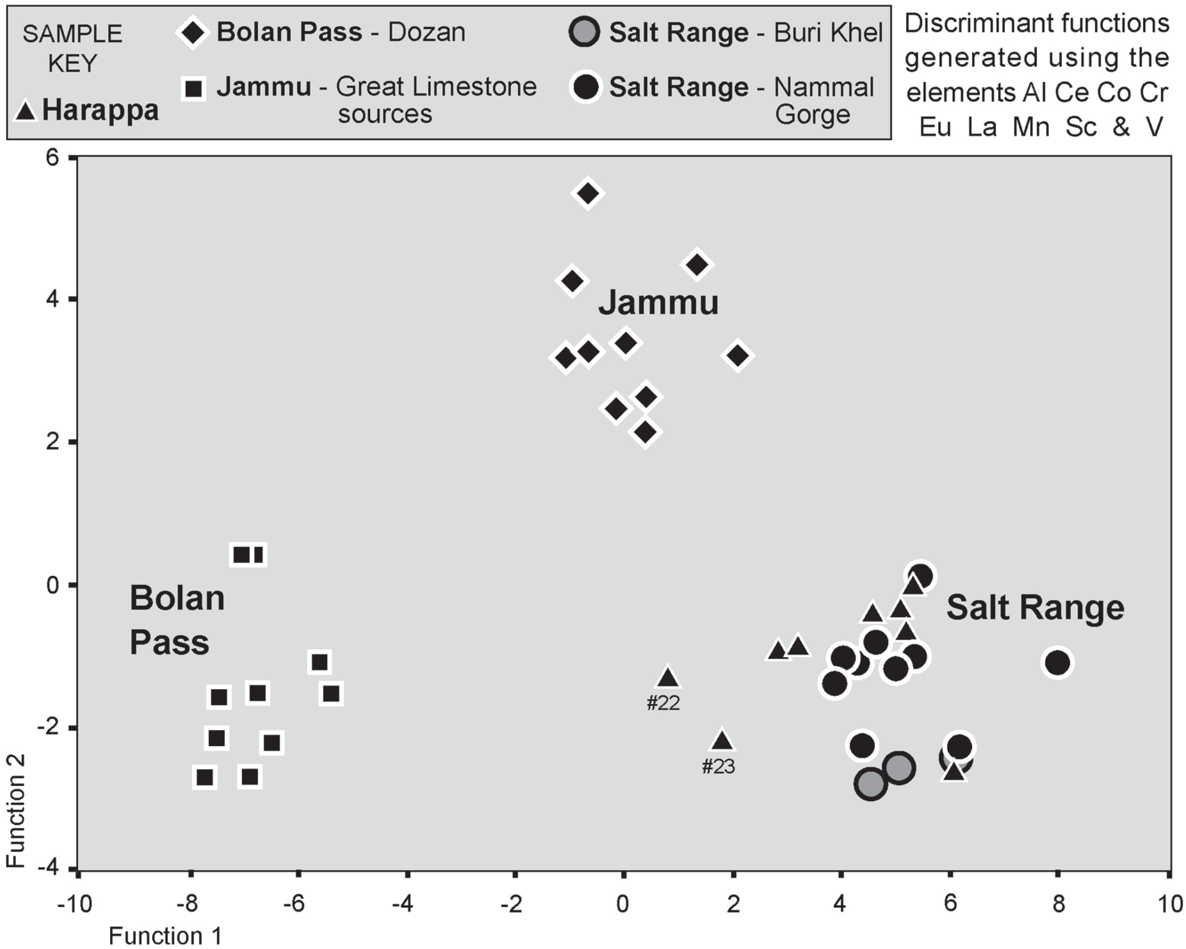


Figure 6.18 Black-brown chert artifacts from Harappa compared to black chert samples from three geologic sources.

Bedded black cherts similar to those in Jammu occur throughout the Neoproterozoic Krol Formation of the western Himalayas (Gautam and Rai 1997; Shukla *et al*. 2005). Deformed beds of dark Proterozoic chert are found within the various formations of the Mawar supergroup in northwestern Rajasthan (Geological Survey of India 2001b: 21). At the Department of Archaeology and Museums' Excavation Branch in Karachi I have seen black to dark brown cherts in the collections from the sites of Allahdino and Ghazi Shah, which are probably coming from Sindh Kohistan and/or the Kirthar Range. Samples from these and other potential sources will eventually need to be obtained and incorporated into future studies

INAA/CDA comparison of black chert artifacts to potential sources

Nine black-brown chert artifacts from Early Harappan levels at Harappa (Appendix 6.1) were compared to samples of chert from three potential geologic source areas using INAA-derived elemental data and canonical discriminant analysis (CDA). Details relating to sample preparation, INAA and CDA have already been presented in Chapter 3. The geologic set includes ten samples of Moro chert from the Bolan Pass, Balochistan and ten samples of Great Limestone chert from two locations (five each from the Mari nala and Jangleghari areas) in the Riasi District of Jammu (Appendix 6.2). Thirteen samples of Sakesar chert from the Salt Range (Appendix 6.3) were analyzed: ten from Nammal Gorge and three from Buri Khel. All samples from each regional source formation were treated as a single group for CDA. Archaeological samples were evaluated as ungrouped cases.

In Figure 6.18, all analyzed black-brown chert samples (archaeological and geologic) are plotted by their first and second discriminant scores, which were generated using the log normalized concentrations of nine elements in those samples – Al, Ce, Co, Cr, Eu, La, Mn, Sc and V. Excellent visual separation between the datapoints representing the three grouped sets of geologic samples is evident. Application of the leave-one-out classification function resulted in a 97% grouped sample cross-validation success rate, which shows that the three groups are also highly distinct statistically. All of the ungrouped archaeological cases plot among or near the datapoints for the Salt Range samples. Based on their Mahalanobis distances to the centroids of the three geologic groups, all artifacts are predicted to belong to the Salt Range group.

In summary, the sets of black-brown chert samples from sources in the Salt Range, Bolan Pass and Jammu regions that were analyzed for this study are, chemically, very distinct from one another. Of those three sources, the nine black-brown chert artifacts from Harappa are, chemically, most analogous to the chert samples from the Sakesar limestone in the Salt Range. In fact, in the majority instances they appear to be quite closely related to them. A few artifacts (#22 & # 23 – refer to Figure 6.1 and Appendix 6.1), although still predicted to belong to the Salt Range group, do plot somewhat away from that source and from the other archaeological samples. I strongly suspect, however, that those are actual examples of Sakesar chert and not materials from some other unrepresented formation that just so happens to be more chemically analogous the Salt Range group than to the other groups. If the two samples in question looked somewhat out of the ordinary (like say #19) then I might be inclined to think otherwise. However, samples #22 and # 23 look *exactly* like Sakesar chert, right down to their cortex. The fact is that the Salt Range source area is represented by only thirteen geologic samples from two locations. Those samples almost assuredly do not represent the full range of chemical variability that Sakesar chert likely exhibits across the extensive formation in which it occurs or, for that matter, at any one location like Nammal Gorge. A larger, more representative sample set will eventually need to be assembled and analyzed. When it is, those outliers will likely be better defined.

In the end, this INAA study suggests that the black-brown chert acquired by Early Harappan period residents of Harappa came from the Sakesar Formation of the Salt Range.

Figure 6.19 Various tan-gray type chert artifacts from Harappa.
[left-to-right] blade tools, blade core, weight blank or celt roughout?, bead and cubical weight.

TAN-GRAY (ROHRI?) CHERT

As I stated in the introduction to the preceding section, the vast majority of chert artifacts at Harappa are composed of a material type that has a tan to gray appearance. Many of those objects also possess a highly distinctive banded pattern. Here, these macroscopic variations are collectively defined as the *tan-gray* chert type that is sometimes banded. Approximately one-third of the roughly 20,000 tabulated tan-gray chert artifacts at Harappa are flakes or other debris fragments like those seen in Figure 6.1 – #1 to 6 and 10 to 15. Although most of the remaining two-thirds are tools (blades, drills, awls), a small percentage includes blade cores, objects that may be weight blanks or celt roughouts, an occasional ornament and distinctively Harappan-style cubical stone weights (see Figure 6.19 for examples of these objects). Tan-gray chert is present in every one of Harappa's chronological phases. From Period 3A onwards it *appears* to have been the only type used at the site. In this section, I evaluate the widely held assumption that this type of chert came from sources in the Rohri Hills of Sindh.

The extensive chert deposits of the Rohri Hills – a series of Eocene limestone outcrops in northern Sindh, are assumed by many to have been one of the primary sources, possibly *the* primary source, for the high-quality tan and gray chert artifacts found at Indus Civilization sites from Gujarat to northern Afghanistan (Allchin and Allchin 1997: 118; Francfort 1989: 129; Gupta 1984: 420; Kenoyer 1998: 43, 91; Ratnagar 2001b: 64; Rao 1985: 555; Thapar 1993: 11; Vidale 2000: 36-37). Lending weight to those assumptions are the widespread finds of artifacts composed of the banded sub-type that is only known to occur in the Rohri Hills. Various studies (Allchin 1979b; Inizan and Lechevallier 1997; Kenoyer 1984a; Pelegrin 1994) have documented technological and morphological analogies between tan-gray chert blades from several Harappan sites and those produced at workshops in the Rohri Hills during that period (Biagi and Cremaschi 1991). These observations and studies can now be supplemented with direct artifact-to-source chemical comparisons. In this section, fifteen tan-gray chert artifacts from Harappa and one from the site of Harappan site of Nagwada in Gujarat are compared to geologic samples from potential sources in the Rohri Hills, the NWFP, Balochistan and the Punjab.

Figure 6.20 The Rohri Hills.

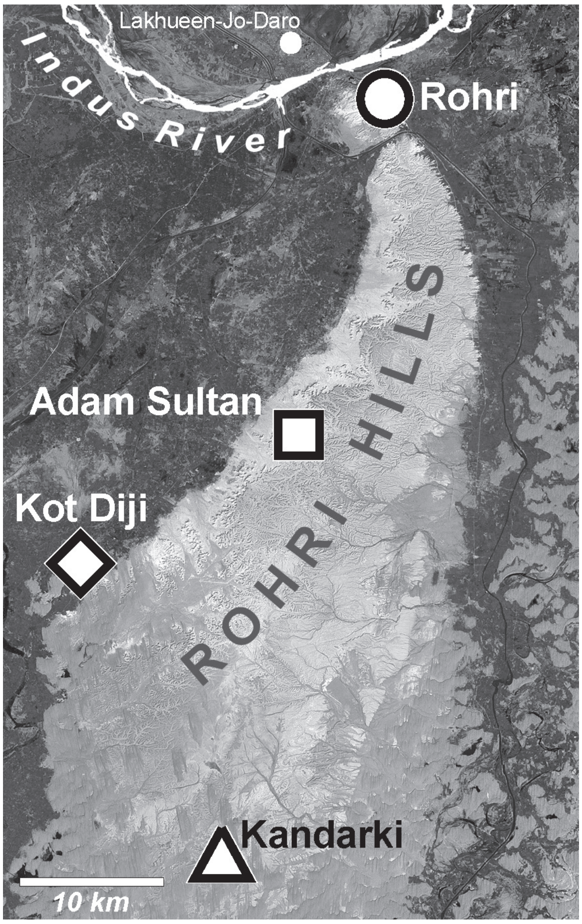


Figure 6.21 Map of the Rohri Hills showing the four locations sampled for this study.

Rohri Hills, Sindh

The significance of chert deposits in the Rohri Hills of Sindh (Figure 6.20) began to become apparent when, in the later half of the 19th century, the existence of large concentrations of cores and flakes was first reported there (Evans 1866; Tremlow 1867; Blanford 1875, 1879). Half a century later, de Terra and Paterson noted (1939: 334-35) that many artifacts found in that region were analogous in form to those that had recently been excavated at Indus Civilization site of Mohenjo-daro, 55 km to the west of the hills. Research in the 1970s by Bridget Allchin and others (Allchin 1976; Allchin *et al.* 1978) and, more recently, by members of the joint Pakistani and Italian project in the region (Biagi and Shaikh 1994), has subsequently produced a wealth of evidence that documents the intensive exploitation of chert resources in the Rohri Hills from the Lower Paleolithic through the Harappan Period.

In November of 2000, chert from four localities in the Rohri Hills (Figure 6.21) was sampled during field research in that area with G.M. Veesar of the Department of Archaeology, Shah Abdul Latif University, Khairpur.

Rohri

Nodules of tan-gray chert occur on the extreme northern tip of the Rohri Hills (Figure 6.22) adjacent to the modern town of Rohri and approximately five kilometers southeast of the Harappan Period site of Lakhueen-Jo-daro (Kazi 1989). The material at this location exhibits a pattern of parallel concentric bands (Figure 6.23) and is *identical* in appearance to the chert that seems to have been the preferred stone for making cubical weights used at Harappa (Vats 1940: 361; Figure 6.13 *bottom right*) and many other Indus Civilization settlements. With the exception of a recently reported occurrence near Kandarki along the southern fringes of the Rohri Hills (Nilofer Shaikh *personal communication* 2004), no other sources of tan-gray chert with this distinctive banded pattern are presently known to exists elsewhere in the Greater Indus region. Unfortunately, this source may not exist much longer as the outcrops around Rohri town are rapidly being destroyed by limestone mining operations (Biagi 2006).

Adam Sultan

The chert that occurs in the central portion of the Rohri Hills generally appears to be the most homogeneous (in terms of both color and texture) in the region. Nodules collected at a location near the tomb of Adam Sultan were mostly a uniform medium gray throughout, with the chert grading into a brown-gray within 1 to 2 cm of the cortex. Visually, this material is indistinguishable from that found at the Harappan Period quarries and workshops (Figure 6.24) documented slightly farther (≈ 5 km) to the north near the shrine of Shadee Shaheed (Shaikh and

Figure 6.22 Limestone mining at Rohri, on the northern tip of the Rohri Hills.

Figure 6.23 Banded tan-gray chert from Rohri.

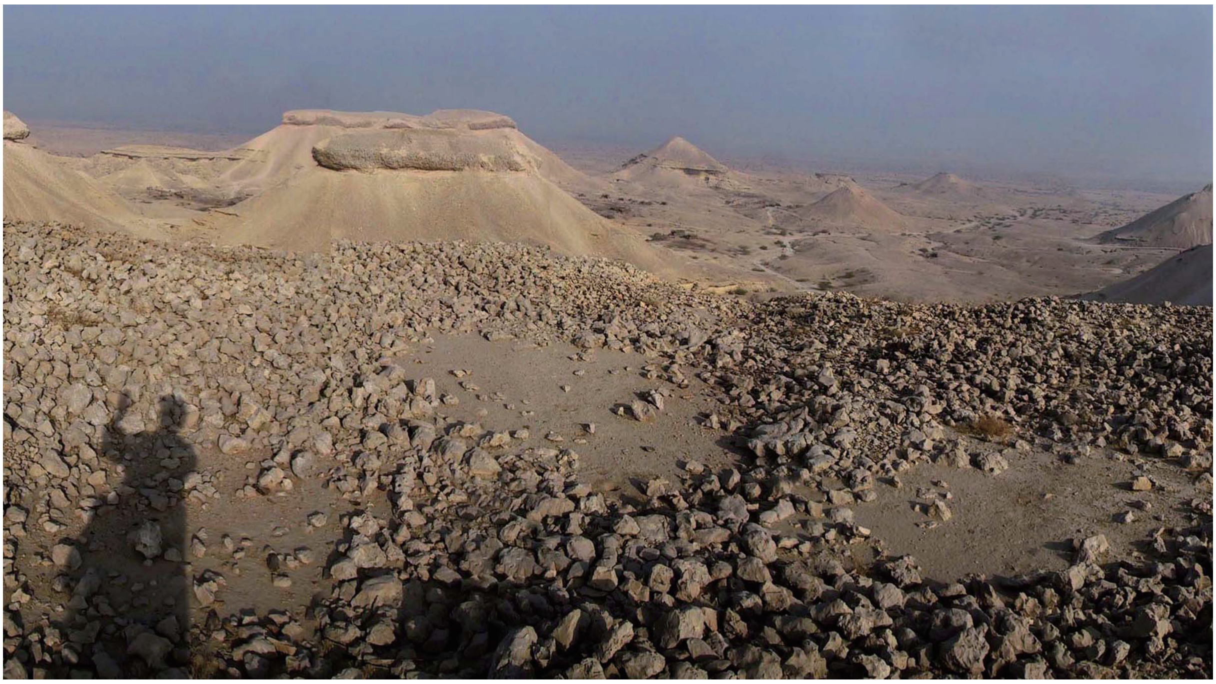


Figure 6.24 Harappan Period quarries and workshops near Adam Sultan at Shadee Shaheed.

Figure 6.25 Chert debris covering the ground surface at Shadee Shaheed.

Biagi 1999). The ground surface at that location is completely covered with debris (Figure 6.25) from the production of highly standardized chert blades.

Kot Diji

The famous Early Harappan and Harappan Period site of Kot Diji (Figure 6.26 A) is situated on the southwestern margin of the Rohri Hills (Khan

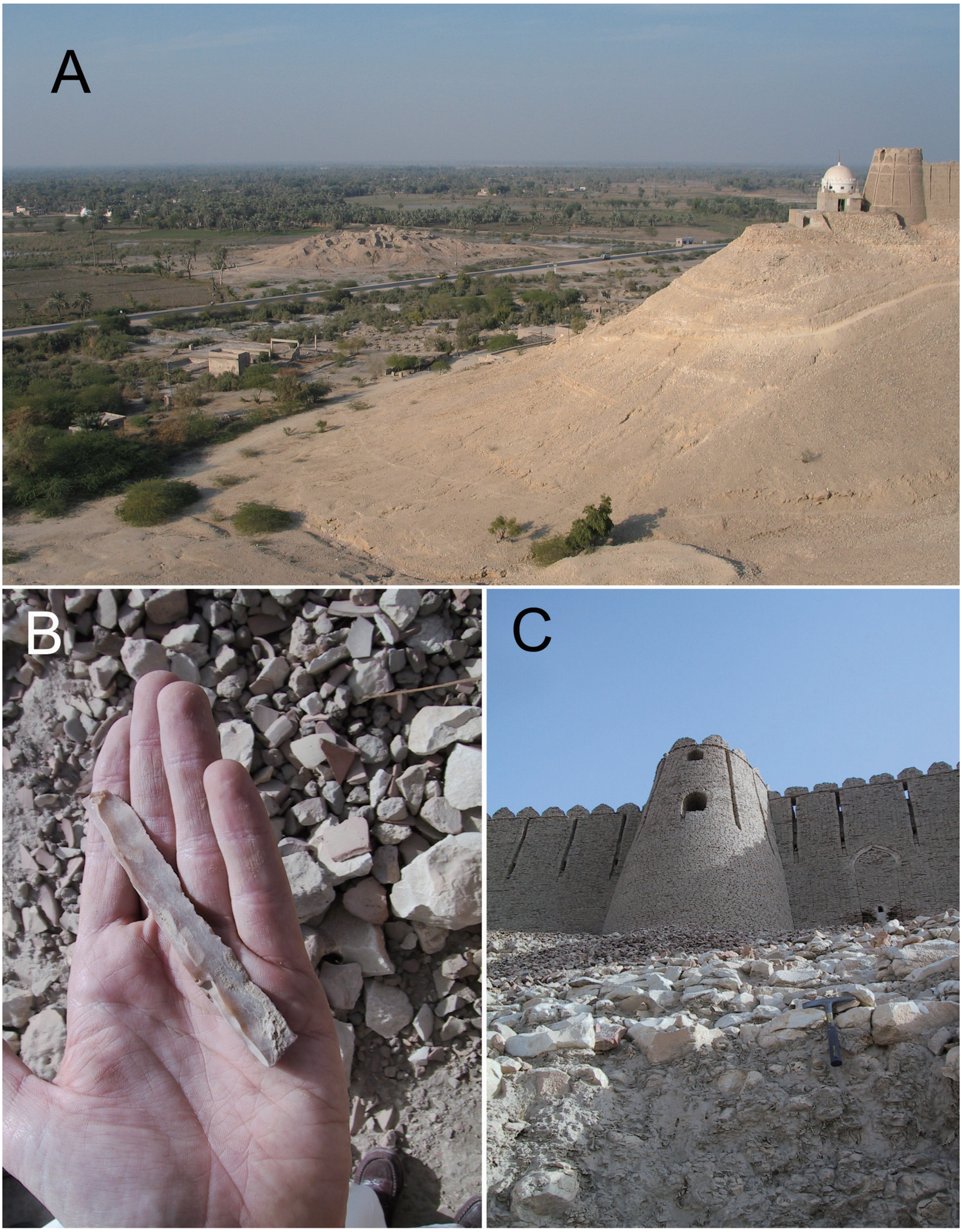


Figure 6.26 **[A]** The prehistoric site of Kot Diji adjacent to the fort of the same name. **[B]** A tan chert blade at Kot Diji. **[C]** Chert nodules eroding from the limestone bedrock below the Kot Diji fortifications.

1965). The chert artifacts on the surface of the site (Figure 6.26 B) and the chert nodules eroding from the hill slope 200 m to the east (Figure 6.26 C) tend to have a brown and gray mottled appearance.

Kandarki

The southern extremities of the Rohri Hills consist of intermittent low-lying limestone mesas surrounded by sand dunes called the Kandarki Hills

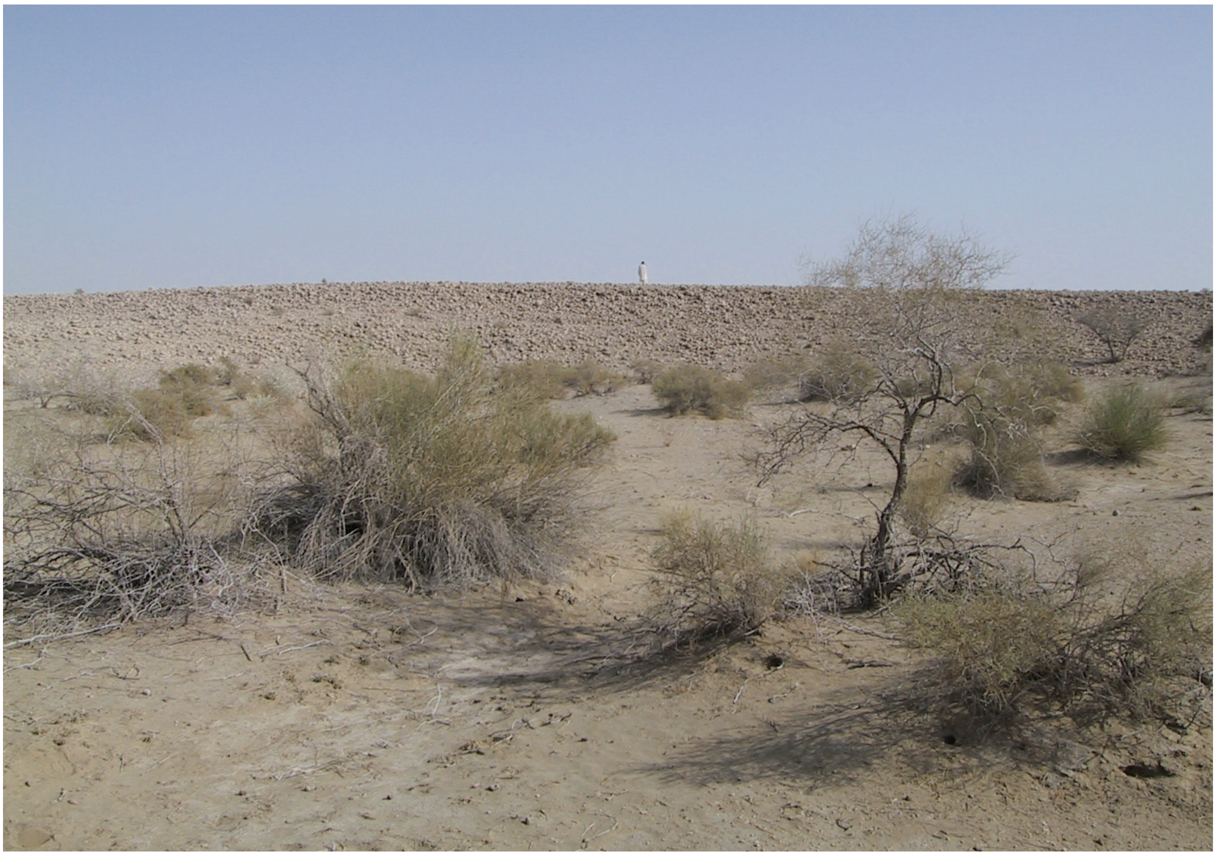


Figure 6.27 The low-lying limestone mesas called the Kandarki Hills.

Figure 6.28 Chert blade production debris at Kandarki.

Figure 6.29 **[A]** Tan chert sample from the Mohmand Agency, NWFP. **[B]** Gray Chilton Limestone chert samples from the Kalat District, Balochistan. **[C]** Gray Sakesar chert samples from Buri Khel nala - Salt Range, Punjab.

(Figure 6.27). The light brown and gray cherts found here tend to contain more inclusions and have a coarser texture than materials found farther to the north. The material is, nonetheless, of excellent quality, as is evidenced by the numerous workshops discovered in the area (Figure 6.28).

Other potential sources of tan-gray chert

Although the rich, high-quality chert deposits of the Rohri Hills were optimally located with regard to supplying material to settlements across the Harappan realm (i.e., situated in the central Indus Basin along the principal north to south running waterway/ trade route), they together constitute only one of many potential source areas around the Greater Indus region from which Harappan consumers could have acquired this resource. For comparative purposes, samples of brown or gray chert were collected from potential sources three additional regions located outside of the northern Sindh area – the NWFP, Balochistan and the Punjab.

Mohmand Agency, NWFP

Little published information exists regarding chert occurrences in the northern part of the NWFP. However, geologic samples from that region in the collections at the Department of Geology, University of Peshawar bear a strong resemblance to the darker types of tan-colored chert found in the Rohri Hills as do many of the chert artifacts from prehistoric sites in the Swat Valley on display in the Swat Museum at Saidu Sharif (*personal observations*). For this study, dark tan chert (Figure 6.29 A) was obtained from a limestone crushing plant at Dand, in the Mohmand Agency. The limestone and the chert at the plant reportedly came from formations near the border of the Mohmand and Malakand agencies (Irshad Ahmad, Centre of Excellence in Geology, University of Peshawar – *personal communication* 2001). Clearly this was not the best way to obtain samples but I felt that inclusion of material from this region in the dataset was essential.

Kalat, Balochistan

Cherts that occur in Balochistan are highly variable, which is not surprising given the large area and diverse geology that the province encompasses. Thierry Aubry and others (1988) made a sizeable collection of samples from across that region, which are now stored at the Department of Geology, University of Balochistan-Quetta. Access to these samples was graciously provided by Drs. Khalid Mahmood and Mehrab Khan of the Center of Excellence in Mineralogy, University of Balochistan-Quetta. In the Kalat District, nodules of yellowish-gray to gray-colored chert are found in Chilton limestone (Figure 6.29 B). For this study, five examples of gray Chilton chert were selected from a set of materials collected near the village of Gajan (ibid.: 103).

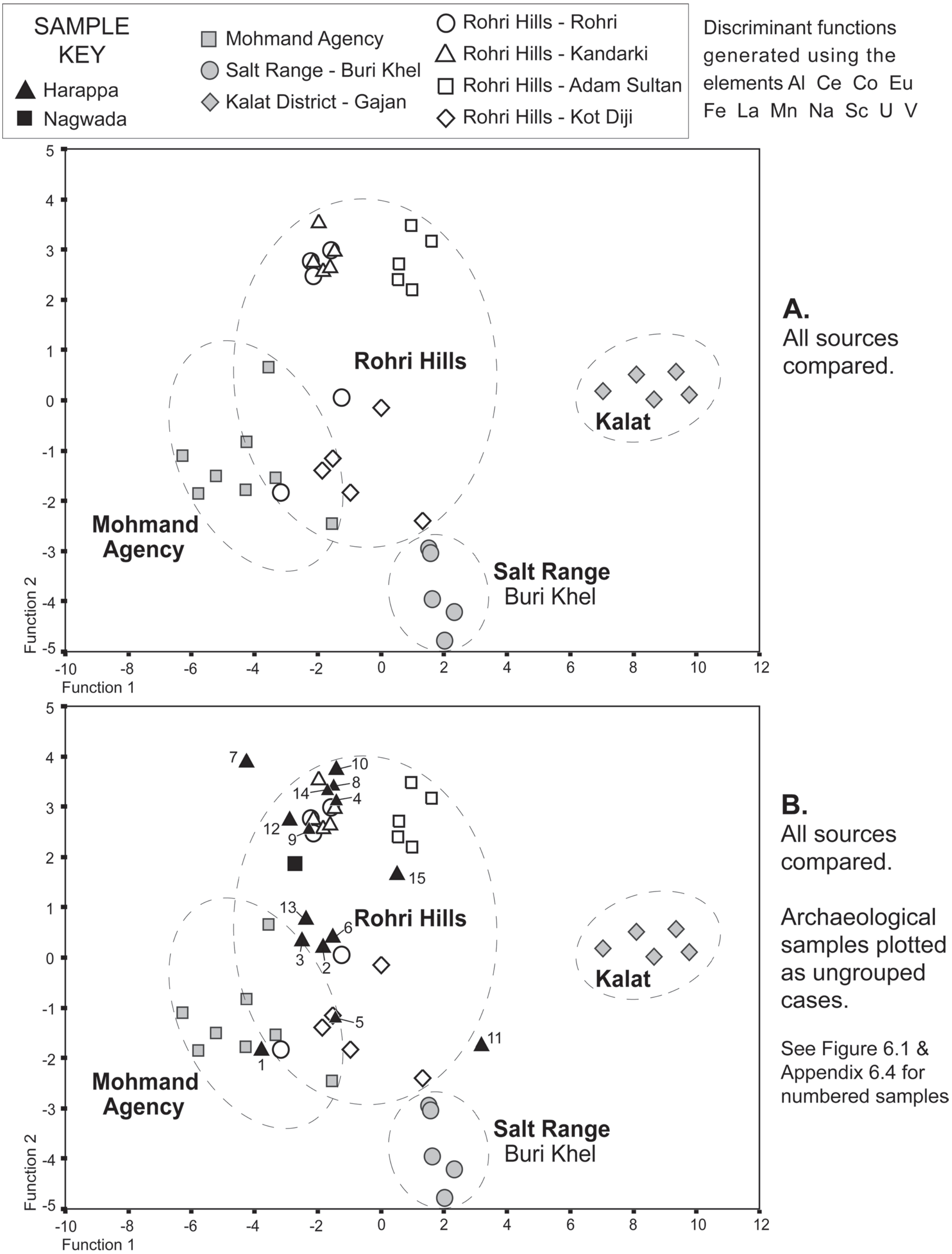


Figure 6.30 INAA results: Tan-gray chert artifacts from Harappa and Nagwada compared to geologic samples from sources in four regions.

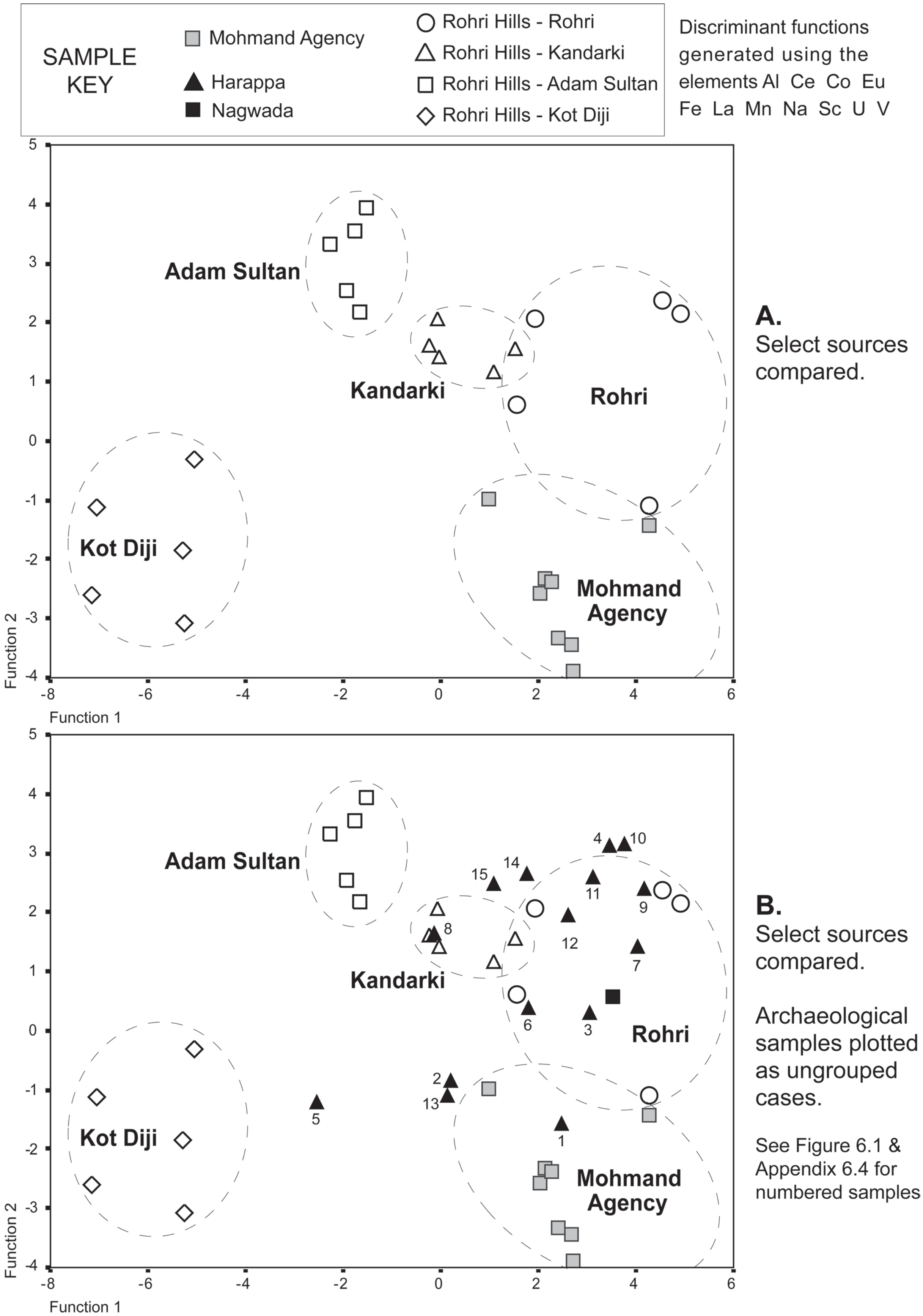


Figure 6.31 INAA results - Tan-gray chert artifacts from Harappa and Nagwada compared to geologic samples from sources in select regions.

Figure 6.32 Percentage of chert artifacts at Harappa sampled by context.

Period	*total chert artifacts*	*number analyzed*	*percent sample*
1	625	7	1.12%
2	105	7	6.67%
3A	161	3	1.86%
3B	932	6	0.64%
3C	7,472	0	0%
4/5	30	0	0%
Surface & disturbed	11,642	1	0.009%
All from secure contexts	9,324	23	0.25%
Total	20,967	24	0.11%

Buri Khel, Salt Range, Punjab

In the central portion of the Salt Range, Punjab Province, nodules and fragments of a light gray-colored chert (Figure 6.29 C) are found in the bed of Buri Khel nala. Although I did not locate in situ deposits of this material, it most probably derives from the nearby Eocene limestone of the Sakesar Formation as it was found in association with black-brown Sakesar chert fragments. Fifteen kilometers south of this location, I observed blades made of a light gray chert identical in appearance to the Buri Khel material on the surface of the Early Harappan and Harappan period site of Musa Khel (Dani 1971: 32).

Tan-gray chert sources not included in this study

It is important to point out that there a number of potential tan-gray chert sources that are not included in this study. Southern Sindh is one area that will need to be intensively sampled in the future. Bridgett Allchin and others (1978) reported chert quarries and working floors on a limestone ridge adjacent to Milestone 101 near the modern city of Hyderabad. In that same area, chert beds continue in the Eocene limestone hills to the west of Kotri town (Blanford 1879: 142). Paolo Biagi's recent (2005) surveys there revealed only Paleolithic workshops, which suggest that the exploitation of material from the region probably ceased well before the Harappan Period. The material reported was light brownish gray in color (Biagi 2005: 1). Another occurrence lay south of Kotri at Tharro Hill, where N.G. Majumdar observed (1934: 20-21) "innumerable" chert flakes and cores and suggested that the location was a "centre of flint-knapping industry." To the northwest of Kotri, not far from the site of Ghazi Shah, Majumdar noted (ibid.: 122) a heavy concentration of worked and unworked chert at Bandhni Nai.

Balochistan is also a region where much more exploration for potential chert sources needs to take place. Dr. Syed Baqri recently observed an extensive chert working area while doing palaeontological fieldwork in the Dera Bugti region of east-central Balochistan. Although his examination was cursory, the archaeological remains and the tan-gray chert found there were considered to be very reminiscent of that at similar activity areas in the Rohri Hills (S.R.H. Baqri *personal communication* 2004).

INAA/CDA comparison of tan-gray chert artifacts to potential sources

The fifteen tan-gray chert artifacts from Harappa (Figure 6.1 # 1 through #15; Appendix 6.4) selected for INAA/CDA comparison to the geologic sources described above were excavated from secure contexts ranging from Period 1 through Period 3B on Mound AB and Mound E (Figure 6.4). The samples were judiciously chosen to represent the range of variability evident among artifacts defined as being composed of this material type. A few examples (# 1, 6 & 11) were specifically selected because, although they are tan-gray in appearance, they have a somewhat "un-Rohri Hills-like" texture or cortex.

Dr. Kuldeep Bhan of the Department of Archaeology, Maharaja Sayajirao University, Baroda provided the single tan-gray chert blade fragment (Figure 6.1 NGW; Appendix 6.4 bottom row) recovered in Harappa Period levels at the Indus Civilization settlement of Nagwada in northern Gujarat (Figure 6.2). Chert artifacts of this type were found throughout that site's stratigraphic sequence (they are described in Hegde *et al.* 1988 publication as being "ivory" colored). The excavators wrote that "ivory colored chert is not reported from anywhere near Nagwada" and that "it would be interesting to know if they came all the way from the Rohri Hills" (Hegde *et al.* 1988: 62-64).

The geologic dataset includes 20 tan-gray chert samples from the Rohri Hills – five samples each from the four locations visited in that region (Appendix 6.5). Eight samples from sources in the Mohmand Agency, NWFP and five each from Buri Khel, Punjab and the Kalat District, Balochistan round out the dataset (Appendix 6.6). Details relating to sample preparation, INAA and CDA were presented in Chapter 3. Data for eleven elements (Al, Ce, Co, Eu, Fe, La, Mn, Na, Sc, U and V) are reported in the appendices.

All sampled tan-gray chert sources are included in the initial CDA of the geologic and archaeological datasets (Figure 6.30 A). Although the four Rohri Hills locations are treated as separate groups for the analysis, I have placed dashed ellipse around all samples from that region, as well as ellipses for each of the other three groups, in order to demarcate the approximate areas where the regional sources plot. These ellipses are hand drawn visual guides and do *not* represent statistical confidence intervals. Good visual separation, overall, between the different sources is evident. There is a degree of overlap between samples from Rohri Hills deposits and those from the Mohmand Agency source. The Kalat and Buri Khel sources both group separately, however. Exactly 73.7% of leave-one-out cross-validated grouped geologic cases were classified correctly. The misclassifications that resulted in that percentage were among the Rohri Hills sources (not unexpected as they are from the same broad geologic formation) as well as between samples from two of the Rohri Hills locations (Rohri and Kot Diji) and the Mohmand samples.

When the chert artifacts from Harappa (solid black triangles) and Nagwada (solid black square) are considered as ungrouped cases (Figure 6.30 B), the majority including the Nagwada artifact plot among the geologic samples from the Rohri Hills. The CDA-predicted group memberships for <u>all</u> samples is one of the Rohri Hills sources (Rohri = 12 artifacts including the Nagwada sample, Kot Diji = 2, Kandarki and Adam Sultan = 1 each). Several artifacts, however, fall in or near the area where samples from the Rohri Hills and Mohmand sources overlap. Since this is an area where misclassification of some cross-validated geologic samples occurred there is the possibility that some artifacts in this area, although predicted by CDA to belong to a Rohri Hills source, could actually be an outlier of the Mohmand source. Sample number 1 (H2001/2939-27) plots especially close to that group and, in fact, was one of the samples that was chosen because it had a somewhat "un-Rohri Hills-like" appearance to it. Similarly, sample number 11 (H96/7500-30) plots away from the main group of artifacts toward the Salt Range samples from Buri Khel. Upon closer examination, this artifact *could* be grayish-colored Sakesar chert and it does come from a context (Period 1) when material of that kind was being used at Harappa.

For the second CDA (Figure 6.31 A), only the Mohmand Agency cherts and samples from the four locations in the Rohri Hills are compared. The Buri Khel and Salt Range groups were removed from the geologic dataset because none of the artifacts from Harappa were predicted to belong to them and they did not overlap with the other sources. Where as the Kot Diji and Adam Sultan groups are distinct, varying degrees of overlap exists between the Kandarki and

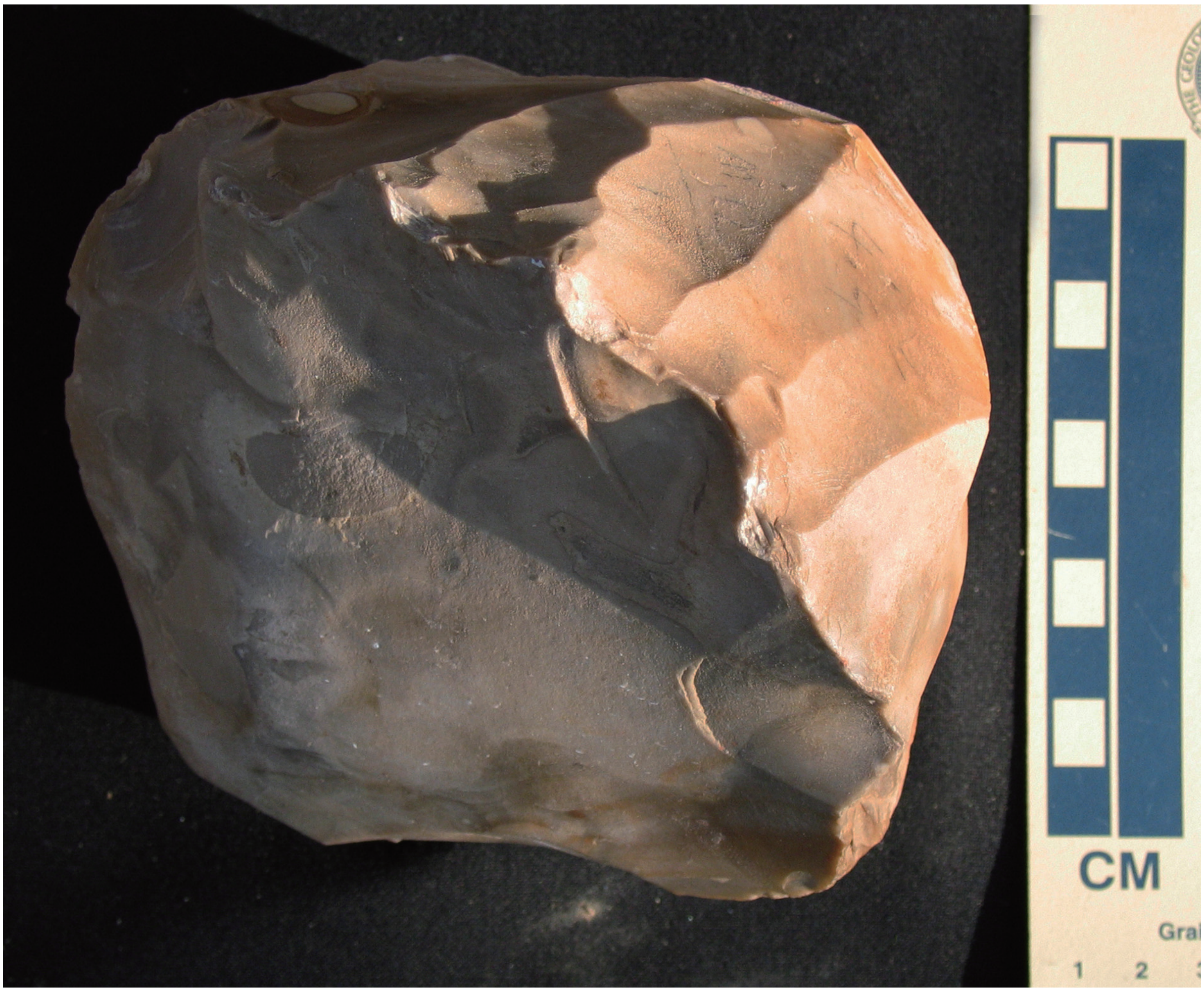


Figure 6.33 A large tan-gray chert nodule with its cortex removed. From the Harappa Museum Reserve Collection.

Rohri sources as well as between the Rohri and Mohmand Agency groups. This time, only 60.7% of cross-validated grouped cases were correctly classified. The lower cross-validation success rate is partially due to the removal the two most geochemically distinct groups (Buri Khel and Kalat) from the dataset and partially due to the misclassification between Kandarki, Rohri and Mohmand samples.

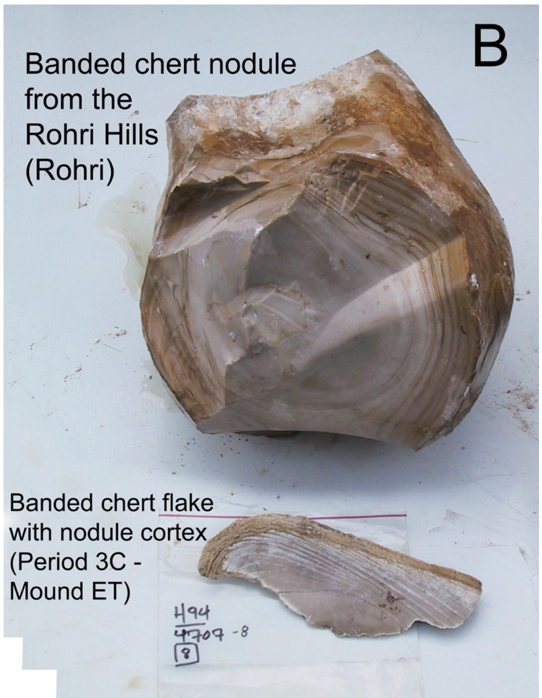
Most of the chert artifacts still plot among the Rohri Hills sources (Figure 6.31 B). Ten were predicted by CDA to belong to the Rohri group while three others (numbers 5, 8 and 15) were assigned to the Adam Sultan group. The latter prediction might seem unusual as none of the artifacts appear to fall near the Adam Sultan group on the plot. Recall, however, that group membership predictions are based upon proximity to a group centroid in multi-dimensional space, whereas only two dimensions can be represented on the plot. Interestingly, two chert fragments from Harappa (numbers 2 and 13) are now predicted to belong to the Mohmand group. Although those artifacts may indeed have come from that source, it is possible they are Rohri Hills outliers that just happen to fall closer to the Mohmand group centroid. It is worth pointing out again that the overlap between samples from the Rohri and Mohmand groups contributes, in part, to the misclassification of nearly 40% of the geologic cases. Chert artifacts derived from either of those source regions would be subject to the same risk of misclassification. Significantly increasing the number of geologic samples analyzed may eventually

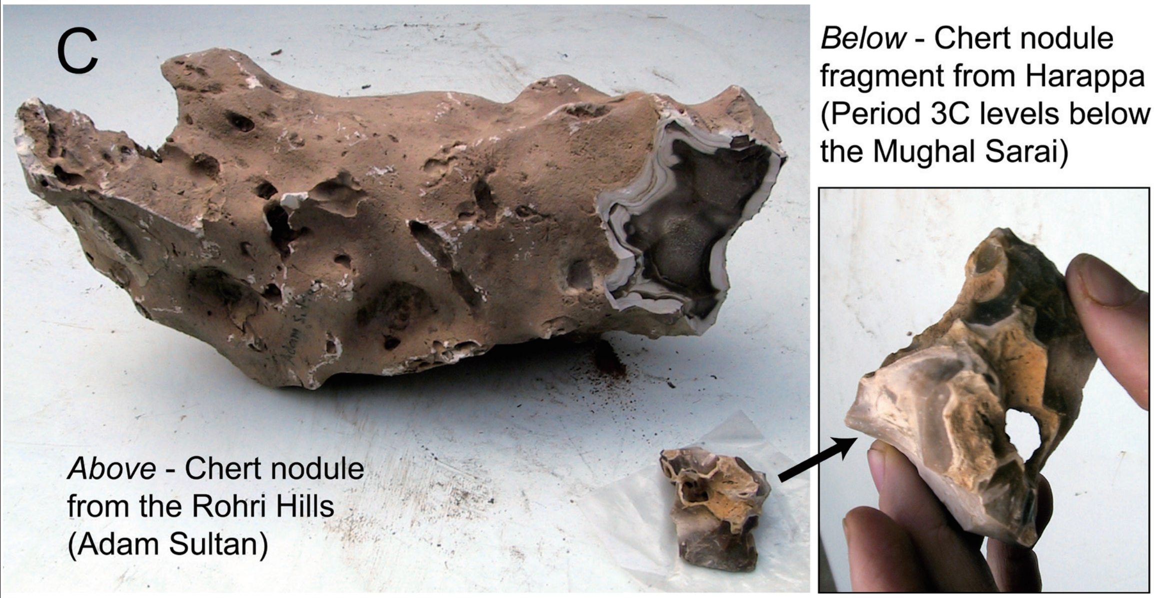
Figure 6.34 Chert artifacts with cortex and nodules fragments at Harappa.

A

Percentage of artifacts with cortex in Harappa's chert assemblage through time.

Period	*total chert artifacts*	*number w/ cortex*	*percent w/ cortex*
1	625	24	3.84%
2	105	8	7.62%
3A	161	10	6.21%
3B	932	35	3.76%
3C	7,472	368	4.93%
4/5	30	6	20.0%
Surface & disturbed	11,642	828	7.11%
ALL	20,967	1,279	6.10%





help mitigate this problem by providing a clearer understanding of the geochemical variation in chert deposits both within and between the regions being compared. Nevertheless, it is still possible to state that when artifacts from Harappa are compared to all of the chert deposits examined for this study, they are, on the whole, much more analogous to material from the Rohri Hills (especially the deposit near Rohri town), than they are to any of the other sources. There is limited evidence that the chert used to make a few of the artifacts might have been derived from a source outside of the northern Sindh region, perhaps one in the Mohmand Agency, NWFP. The "ivory" colored chert blade from Nagwada appears to have come from the Rohri Hills.

CHAPTER CONCLUSION

Geologic provenience studies of chert at Harappa are still at a very early stage. The sample size (Figure 6.32) represented by the 24 artifacts thus far analyzed from the site is miniscule (0.11%) in relation to the total number of chert artifacts recovered (and this is not taking into account the fact that the amount recovered assuredly represents the barest fraction of what actually exists at the site). Sample size is slightly better (0.25%) when considered as a percentage of chert artifacts just from secure contexts and even quite good for certain chronological sub-assemblages (Period 2 at 6.67% is the best sampled). Hundreds more artifacts will need to be analyzed, however, in order to obtain a sample that is reasonably representative both temporally and spatially (75 analyses are needed for just a one percent sample of the recovered Period 3C sub-assemblage). At this point it is simply not possible to say much about site-wise synchronic variations in chert source usage. Discussions of diachronic source usage are possible with the understanding that supporting INAA data is limited. That being said, the INAA results along with general observations about the composition and distribution of the chert assemblage at Harappa have provided important new insights into Early Harappan and Harappan Period chert acquisition networks. Some past assumptions about where certain types of material were obtained clearly need to be revised while others can now be supported for the first time with direct artifact-to-source comparative data. The major findings and evident trends, in summary, are as follows:

The founders and early residents of Harappa acquired three main types of chert. Based on field observations, a review of the geologic literature and studies of lithic assemblages at other Early Harappan sites, I have concluded that the most probable source or sources of the purplish-hued type of chert/chalcedony used during Periods 1 and 2 are the Khewra and/or Pir Panjal volcanic trap rock formations located approximately 225 km and 400 km to the north of the site respectively. Field reconnaissance in the eastern Salt Range and Kashmir, along with the eventual analysis of chert/chalcedony samples from those regions, will be required to confirm this, however. The black-brown chert used during the same Early Harappan periods was almost certainly derived from sources beginning around 250 km to the northwest of the site in the Sakesar limestone of the central and western Salt Range, rather than from sources in Balochistan as previously thought. Artifacts of this type at Harappa are identical in appearance to Sakesar chert and the INAA results indicate that, of the three regional sources compared, they are most geochemically analogous to samples of black-brown chert collected from the Nammal Gorge / Buri Khel area of the central Salt Range. Furthermore, this exact same macroscopic type of chert was being exploited by peoples living at several Early Harappan Kot Dijian Phase sites in the immediate vicinity of the Salt Range. INAA results suggest that tan-gray chert from the Rohri Hills of northern Sindh was being transported 500 km to Harappa as early as the Ravi Phase (Period 1) and continued to be acquired by the site's residents through at least the mid-urban phase (Period 3B). There is also some indication that examples of another type of tan-gray chert, which chemically resembles that occurring in the Mohmand Agency of northern Pakistan, *could* be present in Harappa's lithic assemblage. However, many more analyses of comparative source samples from the NWFP and northern Sindh are needed in order to determine if those indeed represent a different source or are just variants of Rohri Hills chert. The INAA results indicate that the single analyzed tan-gray chert blade fragment from Harappan Period levels at Nagwada in Gujarat was probably also derived from the Rohri Hills. This small but important piece of evidence, together with that results provided by the samples from Harappa, lends support to assertions that tan-gray chert from that specific part in northern

Sindh was being widely distributed across the Greater Indus region and beyond during the Harappan Phase of the Indus Tradition. Shortly before this book was being finalized, data were returned from the analysis of chert artifacts from Dholavira in Gujarat and Rakhigarhi in Haryana that confirmed the presence of Rohri Hills chert at those Indus cities. However, at Dholavira, just as at Harappa, it appears that alternate sources of tan-gray chert were used to a limited degree. Unlike at Harappa, however, residents of Dholavira also used a great deal (perhaps up to 50% of the lithic assemblage) of locally available microcrystalline silicates (mostly clear or milky semi-translucent chalcedony that occur at many places across Kutch) to produce blades and other tools.

Much of the tan-gray chert found at Indus Civilization settlements was probably transported to those sites in the form of finished, standardized long blades (Inizan and Lechevallier 1997). These were clearly produced on an enormous scale at Rohri Hills quarry/workshops dated to the Harappan Phase (Biagi and Cremaschi 1991; Biagi 1995). At Harappa, however, at least some chert evidently was acquired in unfinished form, probably as unworked, or perhaps marginally reduced (Figure 6.33), nodules. On average around six percent of the chert artifacts recovered at the site are wholly or partially composed of the cortex that forms on the exterior of such nodules (Figure 6.34 A). Over 80% of artifacts with cortex are flakes, which would indicate that nodules were being reduced at the site, as opposed to just blades with cortex, which could still have arrived at the site in finished form. When large-sized chert chunks and flakes with cortex from Harappa are directly compared with the Rohri Hills nodules collected for this study (Figure 6.34 B & C), the archaeological fragments are so similar visually that they appear as if they could have been struck directly from the geologic samples. Whole, unworked nodules, especially those from the northern tip of the Rohri Hills, would have been desired by makers of cubical stone weights as the most prominent banding occurs nearer the cortex. Nodules weighing 30 kg or more are not uncommon in that geologic formation (*personal observations* 2001). Transporting stones of that size over 500 km to Harappa easily could have been accomplished by means of bullock cart or river-craft. In Chapter 11, I show that limestone ringstones weighing more that 100 kg were likely being transported 800 km to the city from the northern Gujarat region during the latter part of Period 3.

What, ultimately, is most revealing about chert usage at Harappa is the way in which the variety of types decreased over time – from three main types plus several minor types during the Ravi Phase to the exclusive (or very nearly so) use of Rohri Hills chert during the Harappa Phase. This change cannot be explained by a diminishment of material acquisition networks stretching toward the Salt Range and beyond, as steatite (Chapter 7), vesuvianite-grossular (Chapter 9), alabaster (Chapter 10) and lead (Chapter 12) continued to be acquired from regions far to the north of Harappa during Period 3. That the shift to the use of one chert source/type occurred at the transition to Harappa's urban phase and appears to have been an extra-regional phenomenon is, no doubt, highly significant. Ratnagar concludes (2001a: 354) "that the distribution of [Rohri] chert blades reveals not trade according to variable regional demand but a regional distribution process handled by the rulers" of Indus society. That is certainly a possible explanation and one which I explore further in the discussion section of Chapter 13.

In the next chapter, I examine steatite – the single most abundant material variety in Harappa's rock and mineral assemblage.