PALEOLITHIC ARTIFACTS IN SIWALIK AND POST-SIWALIK DEPOSITS OF NORTHERN PAKISTAN

Daniel Stiles
Department of Anthropology
University of California
Berkeley, California 94720

A recent visit to the Potwar Plateau of northern Pakistan suggests a new interpretation of the nature and dating of Paleolithic industries in this area of Asia. This paper presents a history of past research in the area and reports on the results of an investigation carried out by the author during the winter of 1976 in collaboration with the Geological Survey of Pakistan-Yale University and University of Peshawar-Dartmouth College geological and paleontological research groups.

HISTORY OF RESEARCH

The Potwar Plateau has the distinction of containing all but one of the type sites of the well-known Siwalik formations. These deposits of Tertiary and Pleistocene age have supplied the abundant mammalian faunas upon which the Neogene biostratigraphy of a good part of Southern Asia is based. Paleontological and geological work was begun in the 19th century by Falconer and Cautley (1837), Lyddeker (1883), and Middlemiss (1891) and was continued into the 20th century by Pilgrim (1910, 1913), Matthew (1929), Colbert (1935), and Lewis (1937a). The area is of particular interest because of the variety of Miocene and Pliocene hominoid fossils contained in the deposits, notably the genus Ramapithecus which may prove to be an early hominid (Lewis 1934; Simons and Pilbeam 1965).

Isolated Paleolithic implements were known from the Potwar area in the 19th century (Swynnerton 1880; Theobald 1880) although it wasn't until 1928 that attention was called to the abundant stone artifacts found in the valley of the Soan River (Wadia 1928). After preliminary collecting (Hawkes and De Terra 1934), the first detailed archeological exploration of the Potwar area was carried out in 1935 under the direction of Hellmut De Terra, in association with T.T. Patterson and P. Teilhard de Chardin. This expedition was sponsored by the Carnegie Institution, Yale University, Cambridge University, and the American Philosophical Society. The objectives of the Yale-Cambridge Expedition were to work out the glacial-interglacial cycle in the Himalaya and sub-Himalaya mountains and to establish the culture history and chronology of the Pleistocene stone tool assemblages found in the alluvial and loessic deposits of the area.

The work of the Yale-Cambridge group resulted in the formulation of a four-fold glacial cycle in northwestern India and Pakistan as well as in the discovery of a new Early Paleolithic industry named the Soan

(De Terra 1937, 1938; De Terra et al. 1936; De Terra and Paterson 1939). The Soan Industry falls within the chopper/chopping tool complex as defined by Movius (1948), which is characterized by single-edged cutting implements.

A subsequent Italian expedition led by Graziosi (1964) made archeological collections similar to those of De Terra and Paterson. Essentially the results of the Italian expedition supplemented those of the Yale-Cambridge group but added little new information. More recently Elden Johnson (1972) of the University of Minnesota conducted a cooperative archeological site survey with the Pakistan Department of Archaeology and succeeded in locating later Pleistocene sites in the Soan River terraces and Potwar Loessic Silts.

GEOLOGY AND STRATIGRAPHY

The Potwar Plateau forms part of the western extension of the Himalayan foredeep, a downwarped trough fronting the rising mountain chain. Physiographically, the Potwar region may be defined as the elevated, dissected peneplain which lies between the Indus River in the west and the Jhelum River in the east, forming a platform between the Salt Range in the south and the outer ranges of the sub-Himalaya, the Kala Chitta and the Margala Hills in the north (Gill 1952). The structure of the Potwar region is complex and was first summarized by Pinfold (1918) in terms of the following structural belts from north to south:

1. The Kala Chitta anticlinorium
2. The isoclinal zone
3. The fault zone
4. The anticlinal zone
5. The Soan syncline
6. The Salt Range

The geosynclinal trough, into which the over 20,000 feet of deposits were laid, was formed during Miocene times when intense orogenic activity commenced along the Himalayan front. Most of the sediments which filled this trough were derived from the denudation of the newly risen mountains and from the erosion of localized anticlinal folds. The sediments are made up of sandstones, grits, conglomerates, silts and clays and were laid down under varying fluviatile conditions. They have been involved in the later phases of Himalayan orogeny and are found folded, faulted, and overthrust (Gill 1952). The overthrusting often results in an inversion of the normal order of superposition which makes stratigraphic work very difficult as many of the beds resemble one another. The great thickness of these deposits indicates that the basin was in continual subsidence.

The stratigraphy of the Siwalik Group has been studied and discussed by numerous workers (Pilgrim 1910, 1913, 1944; Wadia 1928, 1932; Gill 1952; De Terra and Paterson 1939; Johnson and Vondra 1972). Most of these

reports, however, were based only on preliminary field observations and, as a result, the only point commonly agreed upon is the order of superposition of the beds. It is apparent that the lithology, distribution, variability, and lateral facies relationships are very complex, and this complexity has resulted in differing interpretations for various segments of the stratigraphic record.

The Siwaliks are divided into three main subdivisions, ranging in age from Middle Miocene to Pleistocene. The various formations are named after localities in the Potwar and were originally based on lithology although the considerable amount of lateral variability made dependence on faunal zones necessary for correlation. These faunal, or biostratigraphic, zones took the same names as the lithologic units which has resulted in some subsequent terminological confusion.

Recently the Pakistan Stratigraphy Committee has revised the Siwalik nomenclature of past workers to conform to modern standards. The entire sequence is now known as the Siwalik Group and its subdivisions are as follows:

Upper Siwalik Subgroup	Boulder Conglomerate Formation
	Pinjor, Tatrot } Soan Formation
Middle Siwalik Subgroup	Dhok Pathan Formation
	Nagri Formation
Lower Siwalik Subgroup	Chinji Formation

All of these rock units are variable in thickness and facies and are more appropriately called "para-time-rock units," as they are all probably time-transgressive (D. Pilbeam, personal communication).

Lying above the Boulder Conglomerate, which is certainly a highly time-transgressive unit, De Terra and Paterson (1939) defined four Pleistocene alluvial terraces and one post-Pleistocene alluvial terrace (T 1-5). Found lying upon T-2 and T-3, sometimes in considerable thickness, is a distinctive eolian silt called by De Terra and Paterson (1939:271-276) the Potwar Loessic Silt. All of the archeological material known to date has been found in the Boulder Conglomerate and overlying terraces and silts. The existence of these terraces and the Boulder Conglomerate as regional stratigraphic markers is highly debatable and the nature of the widespread "loessic silts" is also open to question (W.W. Bishop, personal communication). Detailed geologic mapping will have to be carried out to settle the question. At the moment it seems best not to put too much emphasis on past geological work until further research either confirms or leads to a revision of the conclusions of these studies.

CHRONOLOGY

The chronology of the Upper Siwalik and post-Siwalik sediments has been much discussed in the early literature (Pilgrim 1910, 1913, 1944, 1952; Colbert 1935; Lewis 1937b; De Terra and Paterson 1939; Movius 1948; Gill 1952), with the evidence centering on climato-stratigraphic and faunal data. There is still no universal agreement as to what constitutes the base of the Pleistocene or its subdivisions. Research in Europe and Africa carried out after the Yale-Cambridge Expedition has considerably lessened the original value of the glacial chronology proposed in 1929 as a result of that expedition. Recent studies have lead to considerable doubt regarding the established four-fold glacial sequence (see discussion in Butzer 1974; Isaac 1974), and thus, dating based on intercontinental correlation with the European Alpine sequence should be considered invalid. With the advent of geophysical dating techniques, such as potassium-argon, fission track, and paleomagnetic stratigraphy, the meaning of the terms Early and Middle Pleistocene has altered dramatically. The beginning of the Pleistocene is now recognized to be three or four times earlier than it was thought to be in the 1930's and the beginning of the Middle Pleistocene has recently been suggested to date from the Brunhes Normal Epoch, dated by K-Ar at 0.7 m.y. B.P. (Isaac 1974).

An "absolute" chronology based on the calibration of biostratigraphic zones is possible if there is a dated biostratigraphic sequence available with which to make such a correlation. At present East Africa is the only area which offers faunal units calibrated in any detail by geophysical methods into an absolute chronology (Coppens 1972; Brown 1972; Maglio 1972; Bishop et al. 1971; Coppens et al. 1976), but the results of this ongoing research are as yet incompletely formulated into regional biostratigraphic zones. The faunas and paleoenvironments, as well as the paleomagnetic stratigraphy, of both areas will have to be studied in more detail in order to overcome the problems inherent in biostratigraphic correlations and to achieve a sound absolute chronology (see Maglio 1975:419-424).

In furthering this aim, a collaborative research program between Dartmouth College and the University of Peshawar is currently under way involving an investigation of the fossil fauna and paleomagnetic stratigraphy of the Siwalik Group. Thus far several sections with continuous paleomagnetic control from the lower Gauss up into the middle Brunhes Epoch (i.e., ca. 3.3 to 0.3 m.y. B.P.) have been identified. Presently, it is thought that the Matuyama/Brunhes boundary has been located in the Upper Soan Formation, with a fair amount of Soan Formation deposit remaining above it, which would indicate that the overlying conglomerates and silts are appreciably younger than 0.7 m.y. (G.D. Johnson, personal communication). A final report on this research is in preparation, and the results will have an important impact on the dating of the post-Gilbert events in the Siwalik Group.

The chronology of the prehistoric industries of the Potwar region has been based to date on the glacial-interglacial scheme established

by Dainelli (1922) and De Terra and Paterson (1939). The Boulder Conglomerate was said to be of Second Glacial age, which marked the beginning of the Middle Pleistocene. The terraces were then assigned to aggradational and degradational phases marking glacial and interglacial periods of the Pleistocene. However, at least seven and possibly eight glacial-interglacial events have been recorded since the Matuyama/Brunhes boundary 700,000 years ago (Shackleton 1975; Kukla 1975), and thus the term "Second Glacial" is rather meaningless. Likewise the dating of the terraces to specific time-stratigraphic phases of the Pleistocene is hazardous, particularly in the light of recent studies which indicate that the system of terraces may be a result, in part, of tectonic activity (Misra 1972:116; Joshi et al. 1974). Porter (1970), in a recent study of the Himalayan glaciation in northern Pakistan, established only three major glacial stages and stated that the four-fold glacial succession is in serious need of re-evaluation.

In spite of the uncertainties involved, based on available evidence it seems likely that the Upper Siwalik Subgroup dates from late Pliocene to Middle Pleistocene and the post-Siwalik deposits from late Middle or early Upper Pleistocene to Holocene age.

ARCHEOLOGY

All of the artifacts described by Paterson (De Terra and Paterson 1939; Paterson and Drummond 1962) were obtained by extensive collections made along the Soan and Indus rivers. No excavations were conducted and, therefore, none of the assemblages can be considered as a wholly accurate representative of the industries subsequently defined.

Stratigraphically, the earliest stone artifacts found in the Potwar region are said to occur in the top of the Boulder Conglomerate. These artifacts consist of large, crude, water-rolled flakes, and it is believed that the degree of rolling indicates that they were manufactured while the conglomerate was still in the process of deposition. The flakes are massive and thick and display large, plain striking platforms that form a high angle (100^{o} to 125^{o}) with the long axis of the implement. This industry has been termed the Pre-Soan by Paterson and the Punjab Flake Industry by Movius (1944). The exact nature of the context and disposition of the implements is **undescribed** in the published reports, thus one must consider the possibility that these implements are of natural origin formed by high intensity contact of moving cobbles and boulders in the rivers during periods of flooding.

The Early Soan Industry, known from ten sites, is found in all cases in association with what was called T-1 or in the derived basal gravels of T-2. Three groups have been recognized on the basis of patination and typology and are said to progress from massive and crude core and flake forms to "Proto-Levallois" forms in the latest series. Acheulean type handaxes in small numbers were also said to be found in deposits of the same age, and sometimes in association with Early Soan type artifacts, which raises some interesting questions concerning cultural taxonomy.

The subsequent Late Soan Industry is divided into two phases. The Late Soan A occurs in the basal gravels of T-2 and includes a large variety of chopping and scraping types of artifacts made on pebbles. They are generally smaller and better made than those of the Early Soan, and many more flake implements are associated. The Levallois technique occurs at this time, in addition to a few parallel-sided blades. The Late Soan B, seen at 21 sites, is found in the basal portion of the Potwar Loessic Silt on T-2 and the artifacts are in fresh conditions. The assemblages are mainly composed of flake and blade implements although some pebble choppers are present. A more recent analysis of an assemblage from the Potwar Loessic Silt concluded that the Late Soan was a combination of an intrusive "Levallois-Mousterian" element and a pebble tool tradition (Krantz 1972), emphasizing the distinctive character of this industry.

INVESTIGATION RESULTS

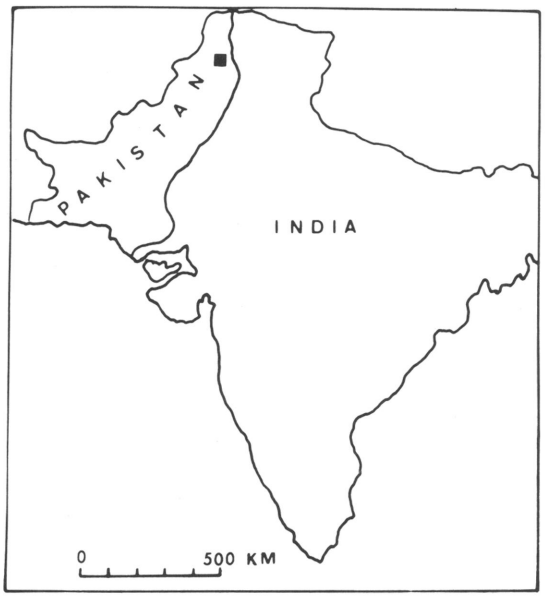
The research objectives of the Geological Survey of Pakistan-Yale University and University of Peshawar-Dartmouth College groups were principally those of mammal fossil collecting, geological investigations of the Siwalik Group formations, and paleomagnetic sampling. While participating in this research, it was possible to visit some of the archeological sites mentioned in De Terra and Paterson (1939) and also to make certain observations on situations where flaked stone was encountered. A short description of the localities visited is given below. Their location may be found in Figure 1.

Tatrot. Located in the southwest Potwar, exposures of Upper Siwalik (Tatrot and Pinjor faunal stages) deposits are found in a winding gorge, reminiscent of a small Olduvai Gorge. No flaked stone was observed during searches for fossil deposits.

Dhok Pathan. Located about a kilometer south of Dhok Pathan village across the Soan River is the Dhok Pathan resthouse. About one kilometer further south on the road to Talagang one finds massive, fine-grained silts ("loessic silts") lying unconformably on Dhok Pathan Formation deposits. Two thin pebble conglomerate bands (ca. 10 cm thick) were found separated by approximately 1.5 meters of silt. There were wide surface exposures of pebbles and artifacts where the silts had eroded down to leave the remains of the two pebble conglomerates lying scattered on a sandstone (probably number 9) of the Dhok Pathan. No artifacts were found below the pebble conglomerates.

Located on the east side of the road, marked DP I in Figure 1, artifacts were seen on the pebble conglomerate surface scatter. The ratio of possible artifacts to pebbles and cobbles was extremely low. One fine bifacial chopper was seen and some rather large modified flakes and a well-flaked disk core were also found. The core was made of green mudstone and the other artifacts were of fine-grained quartzite.

The conglomerate was traced northwest across the road to the level in the silts where artifacts were found eroding from the lower pebble



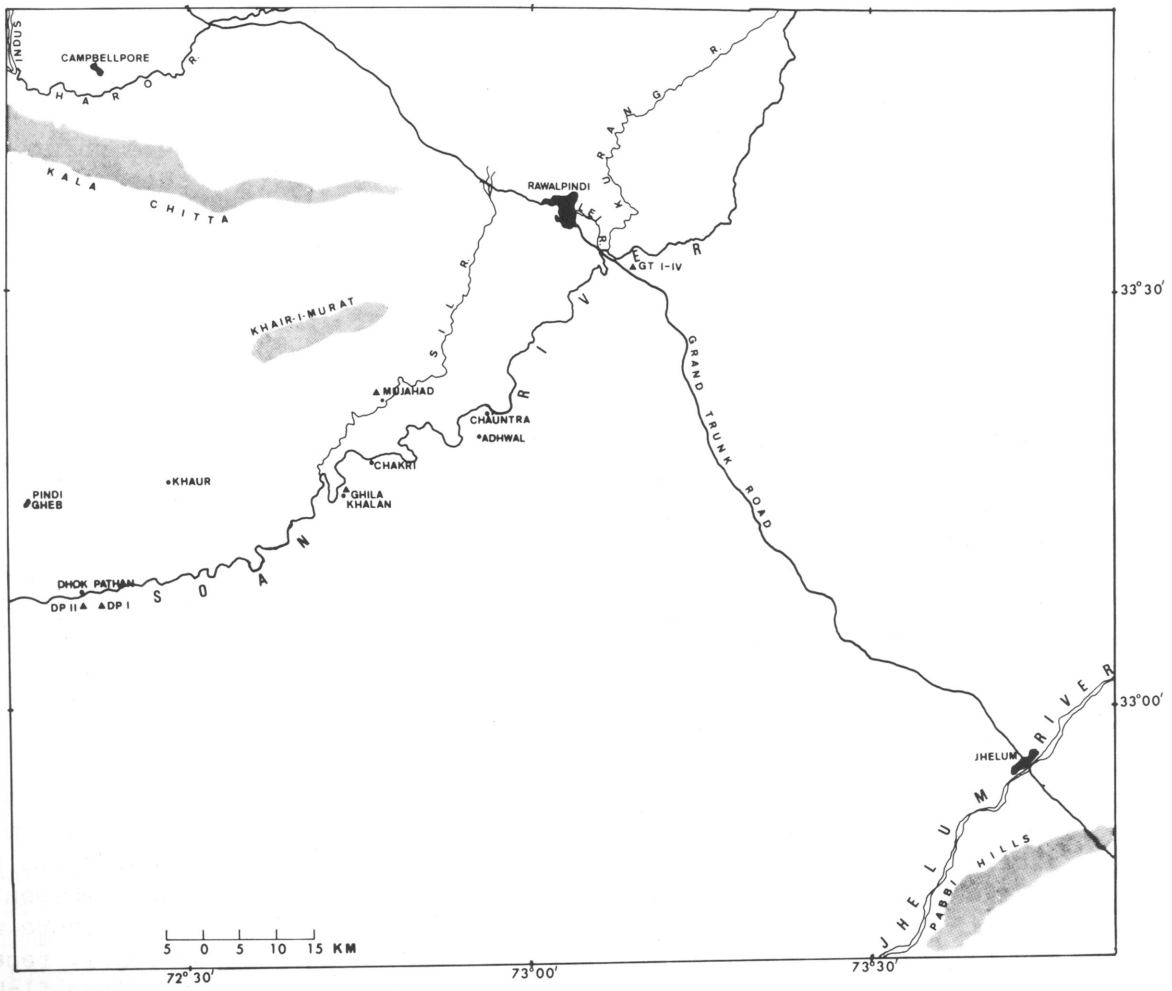


Fig. 1 Area of investigation. Triangles represent localities where flaked stone was observed.

conglomerate. Two artifacts were found in situ in the silts at this level. One notched piece, one side scraper, a flake and flake fragments were found as well as the fossilized distal tibia of an unidentifiable medium-sized bovid (H. Thomas, personal communication). One of the in situ artifacts was a large end chopper approximately 20 cm in length.

Mujahad. Located near the Sil River, three areas were observed. The first locality consisted of exposures of Upper Siwaliks (?) capped by a thick boulder conglomerate on the east side of the Sil River. No artifacts were seen below or in the conglomerate. An area of extensive Potwar silts and loess canyons (khuddera) was reconnoitered about 1.5 kilometers from Mujahad to the north of the road and again no stone implements were seen. Several egg shell (ostrich?) fragments were found in situ in the silts. The third locality was a gravel surface lying on a hill slope about two kilometers from Mujahad to the northwest. Several artifacts displaying varying degrees of patination were seen. The stratigraphic position is uncertain, but it appears to be below the silt exposures.

Ghila Kalan. The village is located approximately four kilometers southwest of Chakri on the south side of the Soan River and lies in a small valley with hills on either side. The Ghila Kalan site of De Terra and Paterson was located on Pir Abdul Hill to the southeast of the village while I searched an area to the north, probably very near the site of Ghila Kalan discussed in Johnson (1972:62). Artifacts were observed on the surface of the Boulder Conglomerate, which rests disconformably on the Dhok Pathan. No artifacts were observed in situ though some were at the base of silt outcrops and could easily have eroded from them onto the adjacent conglomerate.

There were scrapers, a burin, flakes and fragments, blades, and a prismatic core with flake and blade negatives, all made of quartzite.

Grand Trunk Area. While investigating the silt and conglomerate exposures in four dispersed localities in an area approximately 10 kilometers southeast of Rawalpindi and north of the Grand Trunk Road artifacts were encountered in several places, marked GT I-IV in Figure 1. GT I and GT III artifacts were seen on the surface of an exposed conglomerate defined as the basal or Potwar gravels by De Terra and Paterson (1939:273) and the artifacts of GT II were located in the overlying silts. It was difficult to distinguish whether there was one or more conglomerate horizons in the area and how the silts related to these horizons as the localities were separated by stream valleys.

GT I. This site is located between 200 and 500 meters north of the Grand Trunk Road at milestone 163. A conglomerate, which was up to 10 meters in thickness in places, is situated within the Potwar silts with sands and silts above and below. According to De Terra the sediments below this conglomerate belong to the Boulder Conglomerate. There were many flaked stones on the surface, many of which were obviously recently flaked. Core choppers, Levallois flakes, a blade, and modified flakes were seen.

GT II. This site is located approximately 200 meters north of the Grand Trunk Road between milestones 163 and 164. A scatter of grey quartzite artifacts was seen in a localized patch on a hill slope in an area where no other stone was found. One piece was found *in situ* in the silts above and most likely marks the level from which the surface artifacts originated. This assemblage contained thick, parallel-sided blades, a blade core, and flakes and flake fragments where the Levallois technique was not in evidence. One fossilized bone fragment was also seen.

GT III. This site is located about three quarters of a kilometer north of the Grand Trunk Road between milestones 163 and 164. Artifacts were observed in a small area where they were concentrated in a higher than normal density. This assemblage was characterized by thick flakes and blades and one casual core was present.

GT IV. Pieces were seen on the surface of a conglomerate in various dispersed places north of the Grand Trunk Road and also eroding out of silts at a higher level. A symmetrical, biconical core made of quartzite was found, along with a scraper, flakes, and a blade.

Other areas visited include:

Lei Kurang-Soan confluence. An area about 5 kilometers southeast of Rawalpindi where the Lei and Kurang tributaries flow into the Soan River just north of the Grand Trunk Road. Here there are large exposures of the massive Boulder Conglomerate overlain by silts (see Figure 162 in De Terra and Paterson 1939:281 for a general cross section). Middle and Upper Siwalik deposits lie beneath the conglomerate. The entire exposed section was searched closely and no definite artifacts were found, though flaked stone was seen in both fresh and rolled condition. It was from the surface of this boulder conglomerate that De Terra and Patterson (1939:282,303) reported the large Pre-Soan flakes and rolled crude Early Acheulean handaxes. The pieces I saw appeared to be "naturefacts," and more will be said about this below.

Hasal. A local basin of exposed post-Siwalik (?) silts and sands near the village of Hasal about 5 kilometers south of Khaur was explored. No conglomerate was present and no flaked stone was found.

Adhwal. Exposures of Potwar silt (khuddera) located about 3 kilometers south of Chauntra. De Terra and Paterson mentioned Acheulean handaxes being found on a low gravel and sandstone ridge in this area, but the site could not be found. No stone was found in the silts.

Pabbi Hills. Extensive Upper and post-Siwalik exposures located about 7 kilometers east of Jhelum, actually outside of the Potwar proper. No artifacts were found in the Upper Siwalik deposits, but a few scattered artifacts were seen in isolation on the surface of the overlying silts. The visit here was a cursory one. This area deserves a much more intensive examination.

Campbellpore. There are extensive exposures of post-Siwalik and possible Siwalik deposits in a large area cut by gullies and ravines located between the northern flanks of the Kala Chitta ridge and Campbellpore. It was not possible to explore this area in 1976. Any future archeological survey should include it.

DISCUSSION

The results of the 1976 investigation were:

1) No stone artifacts were observed in the Upper Siwalik Plio-Pleistocene deposits.

2) Stone artifacts were observed on exposed conglomerate surfaces.

3) Stone artifacts were observed in situ and on the surface of the Potwar silts.

These results conform to the results of all previous archeological reports from the area. There are, however, some important questions to discuss, including the following:

1) What can be said about the typology and other morphological characteristics of the conglomerate and silt artifacts observed?

2) How do these artifacts compare to the artifact collections of previous workers in the area?

3) What is the Boulder Conglomerate?

4) To what age range can the observed artifacts be assigned?

5) Why have no in situ sites been found which pre-date the Potwar silts and terraces?

In the section which follows, each of the above questions will be dealt with in order.

With regard to the first question, many of the artifact groups observed were obviously mixed, having accumulated in the conglomerates from many sites due to erosion and fluvial processes. However, Paleolithic industrial stages are extremely broad time-wise and these artifacts can be discussed in broad terms. In only one area were artifacts seen on the surface of the Boulder Conglomerate, and that was at Ghila Kalan. These pieces were characterized by medium-to large-sized flakes (3-10 cm in maximum length), a variety of blade types from fine to robust, small- to medium-sized choppers and cores (less than 8 cm in maximum length), and unstandardized scraper forms made on flakes and flake fragments. The retouch on the scrapers generally followed the form of the piece on which it was made, was not intensive, and thus did not seem to attempt to shape the piece into any preconceived form. GT I and GT III were from the basal or Potwar gravels, which immediately overlie disconformably the Boulder Conglomerate. GT I collections were the only ones which contained indisputable Levallois flakes, and these were rare. In terms of technology these artifacts would compare most closely to the later Acheulean or Middle Stone Age industries of Africa. The pieces were generally more robust than those of this period in Western Europe, but this factor can be explained by differences in raw material. Most of the pieces were of quartzite, with some of quartz. No bifaces were seen,

but their absence does not necessarily preclude a general later Acheulean stage of development for these artifacts. Since no detailed study was made of these artifacts, beyond field observations, it is difficult to make any statements on typology, but the relatively high incidence of generalized flake and blade tools and the apparent lack of standardized types would suggest a late Early or Middle Stone Age industry. The presence of choppers, regardless of how crudely made, is now widely recognized as being a poor indicator of relative antiquity. The occurrence of blades before the later stages of the Paleolithic is also not as rare as is generally believed.

The three artifact areas seen in the Potwar silts are DP I and II and GT II. There were few pieces found at Dhok Pathan, but the chopper and disk core seen were very well made with purposive directional flaking. As with the Boulder Conglomerate artifacts, large flakes ("Clactonian") and a scraper were also present. The GT II area contained a blade core and blades, manufactured by hard hammer technique, and crude flakes. Retouch was rare and did not seem to differ in nature from that seen at Ghila Kalan. Except for the chopper at DP I, there were no well-shaped tools.

Based on such a small sample of artifacts and with no systematic survey conducted, any conclusions are necessarily tentative, but no technological or typological features were observed which might distinguish the artifacts of the Boulder Conglomerate from those of the basal gravel or Potwar silt. They must differ in time, but either the time separating them was relatively short or cultural change was not significant. The combination of large "Clactonian" flakes and Levallois flakes (seen in the De Terra and Paterson, Graziosi, and Johnson collections) with blades and small choppers would appear to be qualitatively distinctive enough to substantiate the Late Soan as an individual industry. It should be pointed out, however, that to call on "Clactonian" invasions (Paterson and Drummond 1962) or "Levallois-Mousterian" intrusions (Johnson 1972) to explain the occurrence of particular modes of flake manufacture is totally unwarranted at this time.

Regarding the second question posed above, the artifacts observed here compare closely with those of De Terra and Paterson (1939) and Johnson (1972) and in some respects with Graziosi (1964). Only a blade core is unique to the 1976 investigation, while handaxes, cleavers, and Pre-Soan flakes are missing. Pieces resembling those shown in Plate XXXI of De Terra and Paterson (1939) were seen, but it was my impression that they were of natural or recent origin. On the surface of the conglomerate at Ghila Kalan, four pieces were found in a four-square meter area which could be assembled to form a complete cobble. It could be seen that one hard blow had shattered the cobble. Also at Ghila Kalan a modern "factory site" was found lying fresh in a small patch on the surface of the silt. It appeared as though someone had just flaked a cobble apart for amusement. After making inquiries, I found out that shepherds, who are found in abundance in the Potwar, do indeed flake stones out of boredom. They also throw stones at other stones on the ground in various games and sharpen their small wood-cutting axes, which they often carry with them, by pounding the blade on a pebble or cobble with a hammerstone, which sometimes produces flakes.

Flaked and "retouched" or "utilized" pieces are also produced by the plowing of fields. These pieces are thrown out onto adjacent conglomerate exposures and down the hill slopes of Potwar silts periodically by the farmers. Flakes and other stone objects also receive edge damage by grazing animals, especially when the animals trample by on the conglomerate and gravel surfaces.

Flaking takes place as well in the present day khas beds (seasonal streams or wadis). From a careful inspection of several different khas conglomerates I observed that most of the flaking occurs to stones which protrude from the near vertical khas walls and to those stones which fall down the walls or steep hill slopes made up of conglomerates. Little flaking seems to take place in the floor of the conglomerates.

I would strongly suggest that many of the stone objects collected by previous investigators are in reality "naturefacts" or eoliths. The fact that many have been found with differing states of abrasion and rolling only points out that the principle of uniformitarianism has been in action. It is problematic to distinguish natural from humanly flaked stone, but some simple excavation could provide information on at least the relative time of flaking of the stone found in the conglomerates. At Ghila Kalan and in the Grand Trunk Area there exists a situation where an approximately 50 cm-thick layer of silt overlies a conglomerate surface which is also exposed adjacent to the silt. Using a random sampling technique, squares could be selected from a gridded area on the exposed conglomerate surface and the total amount of stone from these selected squares could then be collected and categorized as unflaked, flaked, retouched, etc. A similar collection could be excavated from the conglomerate in squares below the silt. This conglomerate has obviously remained undisturbed since the deposition of the silt, and the results of the categorization of this stone when compared to the exposed conglomerate set could reveal several things. For example, if the percentages of categories were statistically different, one could conclude that some recent flaking was taking place. With further detailed analysis more could be discovered about the nature of the flaking and explanations for the differences could be suggested.

Acheulean type handaxes and cleavers do occur in the Potwar, as evidenced by the Morgah site of Graziosi (1964:21-30 and plates 72-78) and by the later Acheulean material collected by Teilhard de Chardin and De Terra (De Terra and Paterson 1939:304, 310). These types appear to be extremely rare in this area, however, as I visited many different potential sites without encountering any.

I would suggest here that the Pre-Soan and Early Acheulean industries recognized in the Potwar, those coming from the Boulder Conglomerate or surface (T_D of De Terra and Paterson), are of natural origin, similar in origin to the former Kafuan industry of East and South Africa. Some of the pieces assigned to the Early Soan appear to be definite artifacts of human manufacture, but were most probably made by the same groups who fashioned the later Acheulean handaxes and cleavers, as all of the types associated with the Early Soan are found associated with the known Acheulean assemblages. It is also known from research elsewhere

that the Acheulean assemblages are extremely variable (Isaac 1972; Bar-Yosef 1975; de Lumley 1969) and handaxes are not always present: thus, the Early Soan assemblages could simply be a facies of the Acheulean. Recent research in Europe also suggests that there is nothing to differentiate late Early from Middle Paleolithic flake tools (Stiles 1974). It should be stressed that this is only a hypothesis and much more research will be needed to support or to refute it. The Acheulean is well represented in the Indian sub-continent to the south and east. Arguments presenting the opposite point of view have recently been proposed by Mohapatra (1975, 1976) and Sen (1976).

With regard to the third question, the Boulder Conglomerate is interpreted by De Terra as being the result of a combination of tectonic and climatic factors. According to De Terra, during the Second Glacial there was a period of uplift of the sub-Himalaya and Himalaya mountain ranges accompanied by increased precipitation and glaciation down to 1500 meters. Glacial melting released enormous amounts of water and morainic debris which resulted in the formation of boulder conglomerate fans hundreds of meters thick on the bottom slopes of the Himalayas (Sind and Liddar valleys), on the northern and southern slopes of the Pir Panjal Mountains and in the Kashmir Valley. Increased precipitation and uplift of the lower ridge systems in the Potwar (Kala Chitta, Khair-I-Murat, etc.) at the same time resulted in the formation of a Boulder Conglomerate zone made up of three facies contemporaneous with the Boulder Conglomerate of the higher elevations. These three facies are called the Fan Gravel, the Ridge Gravels, and the Plains gravel and sand. Due to the lithologic variability of the Boulder Conglomerate facies and their general similarity to later sediments in the Potwar silts, criteria for recognizing the Boulder Conglomerate had to be established. These criteria were (De Terra and Patterson 1939:265): (1) relation to overlying Potwar silts, (2) tilted status and general unconformity above older Siwalik beds, and (3) presence of Pre-Soan flakes.

Using these criteria, therefore, any conglomerate with Potwar silt over it, with what was considered to be Siwalik deposits below it, or which contained large, crude flakes was called the Boulder Conglomerate. The assertion by De Terra and Paterson that no conglomerate in the silts or terraces contained Pre-Soan flakes is a circular argument, as any conglomerate in which such flakes were seen was automatically called the Boulder Conglomerate. Since some of the sediments of the Upper Soan Formation ("Pinjor beds") resemble those of the Boulder Conglomerate Plains facies, as well as some of the post-Siwalik sediments, and conglomerates are reported to occur by various authors throughout, it seems to me that the criteria established by De Terra and Paterson for recognizing the Boulder Conglomerate are tenuous. It is quite conceivable that the Boulder Conglomerate seen capping the Dhok Pathan Formation near Ghila Kalan is of a different age and quite distinct from the one southeast of Rawalpindi. Only detailed mapping of the conglomerates and other sedimentary units across the Potwar will produce a final answer.

The question of the age of these artifacts is an open one. From the paleomagnetic evidence it is clear that all of the artifacts known

thus far are considerably younger than 0.7 m.y. B.P. It is unwise to date these artifacts by typology since there are no dates anywhere in Asia for implements of this age range. Compared to radiometrically-dated assemblages in Africa, they could range anywhere from 500,000 B.P. (e.g., Morgah, which appears to be pre-Late Acheulean) to 50,000 B.P. or later for the Late Soan. Given the contextual situation of the archeological sites, it will be difficult to achieve any further resolution.

With regard to the final question, there are three possible explanations for the fact that no in situ Upper Siwalik sites have been located: one possibility is that they haven't been found by searchers. A second possibility is that none have been preserved, and a third is that man did not inhabit the area at that time and, therefore, sites don't exist.

The first possible explanation would be the least likely, as many research groups have surveyed the area. It is still possible, however, that the next rain storm may expose an Early Pleistocene living floor (but would anyone be there to recognize it?). The Potwar Plateau is large, over 20,000 square kilometers, with many exposures of Upper Siwalik deposits in ravines and on hill slopes that have never been explored. If hominid population density was very low during this period, then site density would be expected to be commensurately low, thus lowering the probability of a site being exposed and recognized.

The possibility that no sites of this age have been preserved is a real one since it was during the earlier phases of the Pleistocene that much of the orogenesis of the Himalaya and related mountain systems occurred. This resulted in the formation of large river systems draining these recently uplifted mountains and which carried huge amounts of eroded sediments down to the plains to create the massive beds of conglomerates, sands, and silts observed today. Any early man sites located on the banks of these huge rivers or in the flood plains would be washed away during flood periods. It is always possible, however, that early sites, if they exist, can be found in small, localized sedimentary basins or in exposed deposits that were laid down in low energy areas at the edge of former flood plains.

The fact that no sites have been found in the Upper Siwaliks because they don't exist would be the simplest explanation. Why there are no sites would be less easy to explain, however, since hominids are known from Southeast Asia at possibly earlier than 1.5 m.y. (Jacob 1972; Day and Molleson 1973). Another explanation might be that man had not, by Early Pleistocene times, adapted himself successfully to non-tropical climates. This is argued against, however, by the South African Transvaal cave sites, where winters can be quite cool (the winter monthly average low today is 4°C), and the Lantian site in east central China, all at least 1 m.y. B.P. (Pilbeam 1975). Movement by early man from Africa to Southeast Asia would probably have taken a southerly route, due to climatic factors and high mountains in Afghanistan. Unknown ecological or environmental barriers may have prevented northerly movement of hominids at this period. There was some faunal exchange between

northern Pakistan and Africa and Europe during the Plio-Pleistocene (Maglio 1975) and the Tatrot and Pinjor faunas contain many savanna forms. Since savanna was the preferred habitat of early hominids, their absence seems odd.

A much more intensive and systematic field survey coupled with an interdisciplinary research program is needed to answer the above questions.

CONCLUSIONS

The archeological observations made while conducting paleontological and geological research and discussions with many of the participants of the Yale and Dartmouth teams have suggested many new questions about the Soan Industry and early man in general in northern Pakistan. Some of the conclusions of this study are the following:

1) The old four-fold glacial chronology of De Terra and Paterson should be dropped in favor of one based on biostratigraphy, correlated paleomagnetic columns, and, if suitable material is available, radiometric dating.

2) The Pre-Soan and presence of Early Acheulean industries in the Potwar is called into question and the suggestion is made that artifacts attributed to these industries are in fact of natural origin.

3) The Early Soan Industry may possibly be a facies of the Acheulean or a product of sampling bias of Acheulean surface scatters.

4) The Late Soan Industry is probably equivalent to the Late Acheulean and/or Middle Stone Age of Africa in terms of typological and technological aspects.

5) If the Pre-Soan is an invalid industry and if the Early Soan is indeed part of the Acheulean complex, then the Late Soan should be named simply the Soan Industry with a status similar to the Mousterian of Europe, including usage in a broad geographical sense where appropriate.

6) The Boulder Conglomerate is not only time-transgressive, but it may be made up of several distinct conglomerates of different ages located in various parts of the Potwar.

7) The earliest manifestations of man in the Potwar seem to be well after the beginning of the Middle Pleistocene.

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