LATE QUATERNARY CLIMATIC CHANGES IN INDIA: A GEOARCHAEOLOGICAL APPROACH

S.N. Rajaguru and S. Mishra

Deccan College, Pune 411006, India

ABSTRACT

One of the dominant environmental parameters that affects India’s political, cultural and economic development is monsoonal rainfall. Any variation in monsoonal rainfall has an impact on human cultures in India and the possibility of climatic change in the future due to global warming is of serious concern. Historical disciplines like history, archaeology, geology and palaeobotany can provide data for understanding the long term record of past climatic change, which is needed for building predictive models of how climate might change in the future. We can also study the impact of climatic change on human cultures of the past. In the last two decades considerable effort has been made to study palaeoenvironmental changes in parts of the peninsular and coastal regions of India. In this paper we summarise some of the important geoarchaeological and geomorphological research of the last decade related to the Late Quaternary period.

The Quaternary record of the Indian sub-continent is extremely diverse as so many different geotectonic and climatic settings are represented. A major motivation for Quaternary studies in India has been to understand the context of Palaeolithic archaeological material and to understand the palaeoclimatic record. Therefore, a great deal of work has been done in the peninsular region where Palaeolithic artifacts are common in Quaternary deposits. Most of Peninsular India is an erosional landscape and Quaternary deposits can provide valuable evidence for Quaternary climatic change and human cultures, although such deposits are a minor component of the landscape. Dating of these deposits is quite difficult as few absolute dates are available. Relative dating, using the degree of weathering of pebbles in gravels, calcrete and soil development, and fluorine phosphate ratios of fossils, has been used (Mishra, Kshirsagar and Rajaguru 1988). Archaeological material found in the Quaternary deposits is perhaps the most sensitive relative dating indicator. For the past 40 kya period C14 dates are available, although their reliability is untested for the period earlier than 25 ka. This means that it is difficult to make precise interpretations of the data for the earlier part of the Quaternary record. In this paper we look at the palaeoclimatic data in relation to Palaeolithic cultures since the last interglacial (125 kya).

LAST INTERGLACIAL AND EARLY LAST GLACIATION

Evidence for the early part of the Late Quaternary is difficult to identify in the peninsular region. At Ranjani, about 80 km north of Pune, on the Miza tributary of the Bhima river, a gravel containing a Middle Palaeolithic assemblage has been reported (Mishra and Ghate 1989). A few Middle Palaeolithic artifacts have also been found at Chandoli, on the Ghod river, just a few kilometres south of Ranjani (IAR 1961/62: 27, 1962/1963: 14). The Middle Palaeolithic context at both these sites is a poorly sorted local gravel, indicative of a period when the river was aggrading due to low discharge and high sediment load in a climate more arid than that of the present. Sali (1990) has also reported Middle Palaeolithic tools from similar gravels in the Tapti basin at Daibvel, Amoda and Badne, district Dhule, Maharashtra. The arid climate during the Middle Palaeolithic might belong to the early part of the last glaciation, around 80 ka. In general, however, Middle Palaeolithic tools are rarely found in Quaternary deposits in the peninsular region, although they are common on the surface or in rubble/weathered regolith away from the main streams. This indicates that most of the streams were in an erosive mode during Middle
Palaolithic times, as they are at present. This would conform with a Last Interglacial age for most of the Middle Palaolithic.

The association of the Middle Palaolithic with a relatively humid climate during the Late Quaternary is much better documented in the Thar desert. In a 20 metre deep trench excavated at Site 16R, Didwana, District Nagaur in the eastern margins of the Thar desert, a Middle Palaolithic horizon is associated with evidence of dune stability during a relatively humid climate. TL and Th/U dating of this level places it in the Last Interglacial time period (Misra, Rajaguru and Raghvan 1988; Misra and Rajaguru 1989; Raghvan, Rajaguru and Misra 1989). At Jankipura and Mangalpura, about 30-40 km NNE of Didwana, Middle Palaolithic artifacts were recovered by excavation (Misra et al. 1982). These artifacts occur in marly sediments of fluvo-lacustrine origin. Middle Palaolithic artifacts have also been found in gravel deposits in the Luni basin (Misra 1962) and have been recently dated to greater than 100 kya by the TL method (Singhvi, personal communication). In the Jaisalmer region, close to the arid core of the Thar desert, surface finds of stone tools are either of Middle Palaolithic type or Early Holocene microliths. Misra, Rajaguru and Ghate (1993) have suggested, therefore, that the region around Jaisalmer might have been exploited by human groups only during the relatively humid phases of the Late Quaternary.

Gujarat is an alluvial plain which has been undergoing subsidence during the Quaternary (Sant and Karanth 1993). Unlike the peninsular rivers, the Mahi, Narmada and Sabarmati flow through alluvium. In all three rivers a conspicuous soil horizon has been correlated with the last interglacial by Zeuner (1950), Wainwright and Hegde (1964) and Chamiyal and Merh (1992). Only a few Late Acheulian artifacts, mostly from the Pre-Last Interglacial deposits, have been recovered from these deposits.

In Saurashtra, miliolite, interpreted as a coastal beach-dune complex formation at 4 m above sea level has been dated by Bruckner (1987, 1989) to 125 kya at Porbandar. Acheulian artifacts have been recovered from gravel deposits by Neto (1987) at Umthi, Junaghar and Gopnath (Marathe 1981). Middle Palaolithic artifacts have been recovered from pebbly gravel at Jetpur in the Bhadra valley, Central Saurashtra, underlying a thin (2 metres) miliolite formation dated to around 56 kya by the Th/U method (Baskaran et al. 1986).
Table 1: Late Pleistocene radiocarbon dates from Peninsular India (converted from published half-life of 5570 years to 5730 years)

<table>
<thead>
<tr>
<th>SITE NAME</th>
<th>LAB. NO.</th>
<th>DATE</th>
<th>MATERIAL DATED</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhedaghat</td>
<td>A 6619</td>
<td>25,160±550</td>
<td>freshwater bivalve shell</td>
<td>Mishra &amp; Rajaguru 1993</td>
</tr>
<tr>
<td>Belan Valley,</td>
<td>TF 1245</td>
<td>19,175±340</td>
<td>freshwater shells</td>
<td>I.A.R.72-73</td>
</tr>
<tr>
<td>(Deoghat)</td>
<td>PRL 86</td>
<td>25,790±830/730</td>
<td>freshwater shells</td>
<td>Mandal 1983</td>
</tr>
<tr>
<td>Chandrasal</td>
<td>GRN 10638</td>
<td>36,550±600</td>
<td>ostrich eggshell</td>
<td>Kumar 1988</td>
</tr>
<tr>
<td>Chandrasal</td>
<td>GRN 10639</td>
<td>38,900±750</td>
<td>ostrich eggshell</td>
<td>Kumar 1988</td>
</tr>
<tr>
<td>Dharampur*</td>
<td>BS 286</td>
<td>25,890±850</td>
<td>freshwater bivalve shells</td>
<td>Mishra 1985</td>
</tr>
<tr>
<td>Gargaon</td>
<td>TF 1111</td>
<td>10,310±155</td>
<td>bone</td>
<td>Kale &amp; Rajaguru 1985</td>
</tr>
<tr>
<td>Inamgaon</td>
<td>TF 1003</td>
<td>21,110±615/570</td>
<td>freshwater bivalve shells</td>
<td>IAR 1969/70: 66</td>
</tr>
<tr>
<td>Inamgaon</td>
<td>TF 1177</td>
<td>19,290±360</td>
<td>freshwater bivalve shells</td>
<td>IAR 71/72: 84</td>
</tr>
<tr>
<td>Inamgaon*</td>
<td>BS 146</td>
<td>12,040±150</td>
<td>freshwater bivalve shells</td>
<td>Rajaguru et al. 1979</td>
</tr>
<tr>
<td>Kurnool caves</td>
<td>TL date</td>
<td>17,390±10%</td>
<td>burnt stones</td>
<td>Nambi &amp; Murthy 1983</td>
</tr>
<tr>
<td>Mahagara</td>
<td>PRL 603</td>
<td>14,140±410/390</td>
<td>freshwater shell</td>
<td>Mandal 1983</td>
</tr>
<tr>
<td>Mahagara</td>
<td>PRL 602</td>
<td>11,300±130</td>
<td>freshwater shell</td>
<td>Mandal 1983</td>
</tr>
<tr>
<td>Mahagara</td>
<td>SUA 1421</td>
<td>10,030±115</td>
<td>freshwater bivalve shells</td>
<td>Mandal 1983</td>
</tr>
<tr>
<td>Mehtakheri</td>
<td>A 6518</td>
<td>30,680±1040/920</td>
<td>freshwater bivalve shells</td>
<td>unpublished</td>
</tr>
<tr>
<td>Mehtakheri</td>
<td>AA 8463</td>
<td>&gt;41,900</td>
<td>ostrich eggshell</td>
<td>unpublished</td>
</tr>
<tr>
<td>Nagda</td>
<td>PRL 1196</td>
<td>&gt;3,100</td>
<td>ostrich eggshell</td>
<td>Kumar 1988</td>
</tr>
<tr>
<td>Nandepalle</td>
<td>PRL 293</td>
<td>25,360±660/710</td>
<td>freshwater gastropod shells</td>
<td>Reddy &amp; Sudarsen 1978</td>
</tr>
<tr>
<td>Nevasa*</td>
<td>BS 517</td>
<td>13,220±190</td>
<td>freshwater bivalve shells</td>
<td>Rajaguru &amp; Kale 1985</td>
</tr>
<tr>
<td>Nevasa*</td>
<td>BS 575</td>
<td>16,890±200</td>
<td>freshwater bivalve shells</td>
<td>Rajaguru &amp; Kale 1985</td>
</tr>
<tr>
<td>Patne</td>
<td>GRN 7200</td>
<td>25,000±200</td>
<td>ostrich eggshell</td>
<td>Sali 1989</td>
</tr>
<tr>
<td>Ramnagar</td>
<td>PRL 1196</td>
<td>&gt;31,000</td>
<td>ostrich eggshell</td>
<td>Kumar 1988</td>
</tr>
<tr>
<td>Rampur</td>
<td>Beta 4752</td>
<td>11,870±120</td>
<td>freshwater shells</td>
<td>Mandal 1983</td>
</tr>
<tr>
<td>Rampur</td>
<td>Beta 4793</td>
<td>26,250±420</td>
<td>freshwater shells</td>
<td>Mandal 1983</td>
</tr>
<tr>
<td>Sangamner*</td>
<td>PRL 470</td>
<td>12,890±350</td>
<td>freshwater shells</td>
<td>IAR 1978/79: 105</td>
</tr>
<tr>
<td>Sangamner</td>
<td>BS 78</td>
<td>25,390±710</td>
<td>freshwater shells</td>
<td>IAR 1978/79: 105</td>
</tr>
</tbody>
</table>

sent. During the early Holocene there was continuing transgression of the sea and by 6 kya the level was more less as it is today (Ghate 1988).

The eastern part of the peninsula also shows the imprint of late Pleistocene aridity. Recently, Basak et al. (in press) have observed well developed nodular calcite of pedogenic origin in alluvial deposits in the Tarapheni valley, District Midnapur. The presence of calcite in this region, which receives 1600-2000 mm annual rainfall, is indicative of a climate much more arid than the present. Animal fossils like Axis axis, Antilope cervicapra and Bos taurus, which indicate open, grassy sa-
vanne conditions, are associated with microliths in the upper part of the calcrite. Similar evidence has recently been observed further south in coastal Andhra Pradesh near Vishakhapatnam. At Agharam, about 10 km north of Visakhapatnam, microliths were found associated with calcrite below the “Red Sand” of early Holocene age (K.T. Reddy, pers. comm.).

In the northeastern region of Manipur and the Garo Hills, colluvial cone deposits have been extensively developed over alluvial and lacustral deposits tentatively dated to the early Late Pleistocene. In the Imphal valley these deposits, dating between 25-11 ka, disconformably cap fluviolacustrine formations. The sudden influx of colluvial material in the valley suggests a change in the relationships between soils, rainfall and vegetation cover, leading to erosion of hillslopes (Thokchom 1987). In the Garo hills, Meghalaya, Medhi (1981) has also observed colluvial silts of Terminal Pleistocene age in mountain streams. These silts disconformably cap channel gravel beds of Late Pleistocene age. Deposition of these colluvial silts in the presently humid parts of Meghalaya occurred in response to the glacial arid climate of the Terminal Pleistocene.

The former extensive developments of calcrite in alluvial deposits in Tripura (Ramesh 1989), in the Tarapheni valley in West Bengal (Baska et al., in press) and in fluviol-acolian deposits near Visakhapatnam in Andhra Pradesh (Reddy 1994), are all suggestive of relatively high degrees of aridity in these presently humid to sub-humid (900-2000 mm annual rainfall) regions of eastern India. The optimum development of pedogenic calcrite occurs in areas with rainfall between 500-700 mm.

In the Thar desert, artifacts occur on the stabilized surfaces of fossil dunes, within buried calcisols, in fossil playa deposits and in the cemented pebbly conglomerates laid down by ancient streams. A good number of TL dates on dune sands and a few carbon 14 dates on pedogenic carbonates developed within aeolian sands and fluviatil silts have helped reconstruction of the interrelationship between Stone Age sites and paleoclimate in these presently semi-arid to arid regions. The Upper Palaeolithic industry existed around 35 kya at Didwana, probably in response to somewhat better climatic conditions prevailing between 40 kya and 25 kya. Playas (as at Kavas) were carrying more water during this period and aeolian activity was interrupted by fluvial and pedogenic activity in a hillslope context at Shergarh, near Jodhpur.

So far, no sites in the core of the Thar desert have been dated to 18 kya, thereby suggesting that the aridity during the peak of the last glaciation led to the abandonment of this region. The period between 13 kya and 7 kya was environmentally dynamic. The southwest monsoon was gradually getting stronger, as indicated by intense sand dune development between 14-11 ka, by alternating layers of evaporites and organic-rich clays in the playa of Didwana, and by the development of calcisols on dunes and sand sheets. Mesolithic communities occupied almost the entire desert during this period.

The Early Holocene

The Pleistocene-Holocene transition was a period of unstable climate until about 7 ka. The Early Holocene was also a period of maximum monsoonal rainfall. The Thar between 6-4 kya enjoyed one of the best climatic phases in the entire Quaternary when the summer as well as the winter monsoons were strong and brought considerable moisture into the core of the present arid desert. Playas carried fresh water, dunes stabilized and fluvial activity was strong in the northwestern part of the Thar. Mesolithic cultures continued in the major part of the Thar and Harappan settlements occurred on the banks of braided streams. The peninsular rivers were in an erosional mode (Rajaguru and Kale 1985) and soils developed on older alluvial deposits.

The Middle Holocene

An increasing trend towards aridity returned during the middle Holocene. In Maharashtra, farming was adopted by some groups around 3.5 ka. These early farming villages occupied alluvial strips close to the rivers. However, a conspicuous “gap” in the archaeological record is seen between 3000 to 2500 years ago (Dhavalikar 1973, 1992). Dhavalkar has suggested that the abandonment of sedentary lifestyle during this period was due to severe aridity, although geological evidence for aridity during this period is so far scanty. Post-Chalcolithic alluvial fills have been taken as one indicator of renewed aridity during the Middle Holocene (Kajale, Badam and Rajaguru 1976), but dating of these fills has been minimal so far.

In Rajasthan and Gujarat, the sand dunes which had accumulated during the period of Late Pleistocene aridity were stabilized and most developed soils during the early Holocene. Some show evidence of later episodes of reactivation during the middle to late Holocene. At Langnaj, the late Mesolithic levels are associated with a land surface buried under about 80 cm of reactivated sand (Sankalia 1965). Similarly, the middle Holocene Harappan site of Kanewal, located on the stabilized surface of a sand dune, was covered by re-activated sand after the Harappan period ended (JAR 1977/78: 20-21).
CONCLUSIONS

During the last interglacial, around 125 ka, the sea level was higher than now by a couple of metres and the monsoons were comparatively strong, as indicated by milolite limestone and palaeosols in Saurashtra and the Thar desert respectively. During this relatively humid phase, Middle Palaeolithic cultures flourished in the present arid parts of the Thar desert. The early part of the last glacial (80-40 ka) is difficult to date as it is beyond the range of radiocarbon dating. During this period, global climate became arid as glacial conditions became established. A few Middle Palaeolithic sites in gravels from Peninsular India most probably belong to this period. Quite a few of these dated gravels belong to around 25 ka, which may represent a separate phase of aridity. All the gravels dated to this period contain blade tools, most of them microlithic.

The last glacial period is well documented in various parts of India. Between 18 and 12 kya most of the rivers were aggrading, playas in the Thar desert were hypersaline, and sea level dropped by over a hundred meters in the Arabian Sea and the Bay of Bengal. In the present humid parts of northeastern India, colluvial activity replaced earlier freshwater lacustral and alluvial regimes. These geomorphological changes were in response to weak monsoons in the Indian sub-continent. Though Upper Palaeolithic cultures survived in parts of Peninsular India, they were almost absent in most of the Thar desert.

The early Holocene (9-6 ka) was a period of good monsoons in India due to global climatic and geophysical factors. Dune activity, which was intense around 13-14 ka, became weak in the Thar, lakes expanded and carried fresh water, springs and waterfalls had higher discharge rates and streams became rejuvenated under conditions of less sediment load and more water. Sea level rose rapidly and reached its present level around 6 ka. Black soil developed over the aggraded alluvial plains in the northern Deccan and reddish-brown soil formed over stable dune surfaces in the Thar and also in the coastal parts of Tamil Nadu. Mesolithic cultures flourished across most of the Indian subcontinent during the early Holocene.

The summer monsoon became weak between 3.5-3 ka. Lakes in the Thar started drying and there was a decrease in forest density in the coastal strip of western India. Early farming activity in the present semi-arid parts of western India was badly affected during this period. The Indian monsoon at this time seems to have been responding to global climatic and geophysical factors. Broadly, its strength has an inverse relationship with the degree of cold at higher latitudes, being reduced during glaciations. A better understanding of peak monsoonal activity around 6 kya may help to anticipate the effects of greenhouse warming in India during the next century.

REFERENCES


IAR Indian Archaeology - A Review. New Delhi.


RAJAGURU AND MISHRA, LATE QUATERNARY CLIMATIC CHANGES IN INDIA


