Sir AUREL STEIN

An Archaeological Tour Along the Ghaggar-Hakra River

Edited by
S. P. GUPTA

An Archaeological Tour Along The Ghaggar-Hakra River

By

MARC AUREL STEIN

Other Contributors

A. GHOSH
M. RAFIQUE MUGHAL
V.N. MISRA
YASH PAL
BALDEV SAHAI
R.K. SOOD
D.P. AGRAWAL

Editor

S. P. GUPTA

Kusumanjali Prakashan, Meerut

KUSUMANJALI INDIAN HISTORY MONOGRAPHS : NO. 1
Editor : S. P. Gupta, Allahabad

KUSUMANJALI PRAKASHAN
P. L. Sharma Road, Begum Bridge
Meerut-250 001 (India)

First Edition, 1989

Published by Shankar Goyal for Kusumanjali Prakashan, P. L. Sharma Road, Begum Bridge, Meerut-250 001 and printed by Ved Prakash Gupta at Dayal Printers, 224, Biru Kuan, Meerut-250 002. Printed in India.

PUBLISHERS' PREFACE

The Kusumanjali Prakashan, Meerut, proudly presents the report of the renowned explorer Sir Marc Aurel Stein on the archaeological tour undertaken by him in the winter of 1940–41 of the Sarasvati Valley in Bikaner region as well as of the adjoining Cholistan Desert of the former Bahawalpur State, now in Pakistan. Due to the untimely demise of Sir Stein, the report had so far remained untraced and unpublished. But as it was expected to be highly significant and informative for the prehistoric and historical archaeology of Rajasthan and adjoining regions of Pakistan, everybody was looking forward to its publication. Now, *the Kusumanjali Prakashan is publishing it for the first time.* In order to make it more useful four appendices have been added which describe and examine the work done by archaeologists of India and Pakistan in the same region in the post-Stein decades. The first one, 'the Rajputana Desert—its Archaeological Aspect' by Shri A. Ghosh is a report on the survey of the Ghaggar bed undertaken by him in 1952. The second by Mr. M. Rafique Mughal of Pakistan, discusses the recent archaeological researches in the desert region of the former Bahawalpur State, now in Pakistan. The third is by Prof. V. N. Misra. It is entitled 'Climate, a Factor in the Rise and Fall of the Indus Civilization—Evidence from Rajasthan and Beyond'. And the fourth one is by Yash Pal, Baldev Sahai, R. K. Sood and D. P. Agrawal on the 'Remote Sensing of the Sarasvati River'. The learned introduction by Dr. S. P. Gupta provides a summary of work done by other scholars in this region and brings the reader up-to-date on the state of archaeological researches in this part of the Indo-Pakistan sub-continent. Thus *the book not only brings to the scholarly world a so far unpublished work of the great archaeologist Sir Aurel Stein, it also provides at one place all the necessary material on the work done by other scholars on the track of Sir Stein.* We are sure that it will prove to be an indispensable work for all those who are interested in the history and archaeology of Rajasthan and the adjoining regions of Pakistan. It is also imperative for all those who are interested in the problems of the identification of the ancient Sarasvati river, the archaeology of its valley and that of the Indus civilization.

EDITOR'S NOTE

Like human beings, rivers also die because they are born. The most mighty and sacred river of the Vedas, the Saraswati, was born in the depths of time, possibly in the early Holocene period, and got lost in the wilderness of time, only just a few hundred years ago. However, the memory of the latter event is fortunately preserved not only in the annals of history but also in the living traditions of our people—the town of Prayag, modern Allahabad, is located traditionally on the confluence of three rivers or *triveṇī* : the Ganga, the Yamuna and the Saraswati. But while the first two are tangible realities, the third is now mythical.

That what is now 'mythical' was once a reality is, however, proved archaeologically and geographically. The present collection of articles, on the subject of the 'lost' Saraswati, is intended to give in historical perspective the results of the efforts which have been made in the recent past to unfold the mysteries of this mighty river and civilization which thrived on its banks.

The foremost archaeological and geomorphological exploration of the Saraswati was conducted by the late Sir Aurel Stein in the year 1940–41. It is a matter of common knowledge that he was the greatest archaeological explorer of his times. The second half of the 19th and first half of the 20th century is known in archaeological historiography as 'the age of great discoveries', and he was indeed the *avant garde* of this age. He traversed some of the world's most inhospitable lands of Chinese Central Asia, Afghanistan, Baluchistan and Iran as well as the deserts of Bikaner, Thar and Sind besides the valleys and plains of various rivers in the Indian subcontinent.

In 1942 Aurel Stein was pretty old. He was 80. He could barely see without using thick glasses. But his infatigable zeal took him to sun-parched deserts of the Bahawalpur region, now largely in Pakistan, as well as of Bikaner in India. Here he followed the old channels of Saraswati, now completely dry, except for the upper reaches, from the town of Suratgarh upwards, which get swelled annually when heavy rains bring excess water in the channels.

These channels are now called Ghaggar. Beyond the frontiers of India, a large portion of this river running across the deserts of old Bahawalpur state of Pakistan, known as Cholistan, is called Hakra. A little beyond, it is called Nara, a channel which runs almost parallel to the Indus. Meandering through the dry deserts of Sind, it once joined the Arabian Sea, near the Runn of Kutch.

On either bank of this long serpentine river, Aurel Stein located the deserted remains of a large number of settlements. From them he picked up a large variety of potteries, both plain and decorated, terracotta figurines, stone objects, metal implements, etc. A few trenches, dug here and there, provided him an insight into the nature of settlements in terms of locales of workshops, agricultural activities, forms of houses, etc.

Stein was a geographer *par excellence*. His observations in the field were rated 'excellent' by his contemporaries. He had earlier mapped the chain of cases which existed along the southern Silk Route that skirted the Taklamakan desert. Thus, when he decided to explore the Saraswati in India, he had already an experience of nearly half-a-century in stock. He may have made some mistakes in his judgement, both in the details of geographical formulations and archaeological observations, that too mainly because he was very old, but the directional changes which he broadly worked out in the sphere of environmental and cultural history of the land, through which the Saraswati once flowed, have been found correct even by those who subsequently explored this region with more years in life and more time at their disposal for this work.

Stein wrote the account of all this work done during the closing years of his life; he died at Kabul and was also buried there. His typed manuscript was micro-filmed. From the xerox copy of the text, made available to us by my friend Dr. Gregory L. Possehl of the university of Philadelphia, we have printed here this last writing of Aurel Stein for all those young and old archaeologists of the world who are deeply or marginally interested in the archaeology and history of ancient India. It is the faithful reproduction of the text, without any alteration or modification, or comments and observations. Hence, it is in the from of 'tribute' to the savant.

The greatness of a pioneering work lies in the fact that it generates an unending interest in the subject. That Stein's work did it

in fact, and did it in a very big way, is clear enough by the series of works which followed his own work on the Saraswati.

We, therefore, thought is proper to include in this book a few of those writings which emerged out of the works done on the same subject subsequently. It is a random selection. Absolutely random; to the extent that it does not include the results of the most recent work done in the field and that too by no less a person than V.S. Wakankar, an explorer of international repute. Unfortunately, his findings have as yet not been made available to the scholarly world in the form these ought to be; only some short popular accounts have been published which try to build up the theory that the Vedic Saraswati once discharged its waters in the Arabian Sea through the Runn of Kutch in Gujarat. A series of townships still flourish on the banks of this river. It emerges, at least today, as a small stream from the rocky boulders of the lower Himalayas in Haryana and soon cuts across the plains of its own system which included even Drishadvati, the modern Chitang. It was indeed a great act of re-exploration by a team of archaeologists, historians, geographers and others.

Similarly, we have also not included here the work done by some of our eminent scientists, like Ghose, working in the Central Arid Zone Research Institute, Jodhpur, although they did publish an article in *Man and Environment*. They maintain that the Vedic Saraswati once flowed through the Aravalli ranges. According to them, traversing through central Rajasthan, it got lost in the Thar. It is undoubtedly a very important work but perhaps not directly connected with the work of Sir Aurel Stein, confined as it has been to the Ghagghar-Hakra channel of the old Saraswati in north-western Rajasthan.

Concentrating ourselves in the same region (old Bahawalpur State in Pakistan and old Bikaner State in India through which the old channels flowed) we first picked up the publication made by the late A. Ghosh, former Director General, Archaeological Survey of India. When India was partitioned in 1947 almost all important archaeological sites on the Saraswati known till that day remained with Pakistan. It included the Harappan or the Indus Valley sites as well as the post-Indus settlements. However, the Indian side of the thread was picked up by the team headed by Ghosh in District Ganganagar. His field-work led to the discovery of a number of

Harappan and post-Harappan mounds on the banks of the old Saraswati. He marked them. Explored them. Mapped them. He then laid a few sondages or small exploratory trenches on some of them. He recorded the findings meticulously. Therefore, this work constitutes the next logical step in the direction of archaeological researches conducted on the Saraswati.

But what about the region explored by Stein in Pakistan? Was any further work done there? What have been its results? The answer to these questions is provided by Dr. Mohammad Rafique Mughal, one of the most leading field arehaeologists of Pakistan, who is known the world over for his most hard and meticulous work. He re-explored the Cholistan deserts, in and around the old Bahawalpur State, bordering India. When he came out with a list of more than 400 small and large ancient sites, some industrial, some habitational, some camps and some permanent settlements of different historical and protohistorical cultures (Harappan, Painted Grey Ware, etc.) on the Hakra (old Saraswati) as well as on the old channels of the Sutluj, the archaeological world was taken by surprise. At last, we found true what was recorded in oral traditions: here was a large bowl of golden wheat of the land which was also once most thickly populated It was anciently watered not only by the flow of the Ghaggar-Saraswati but also the Sutluj, which was then perhaps its tributary. It was the most fertile land which sustained not only a large agricultural population but also a large network of trade, commerce and industry—spread over both short-lived small workshop-sites as well as large townships with highly complex socio-economic systems. Obviously, in a sense the Saraswati played a role larger in dimension and greater in importance than the Indus, particularly in the third and second millennia B.C. I, therefore, once proposed that the Indus Valley Civilization be renamed as the Saraswati Civilization.

We decided to include the work done by Mughal since it infact proved a big step forward in the direction Stein had worked earlier.

The problems of research on the Saraswati concern not only archaeology and geography but also hydrology and climate since the Saraswati has not been a very 'stable' river; archaeology and tradition both uphold this fact. For example, it is held that in the mixed waters of the Ganga and the Yamuna at Prayag there is the water of the Saraswati. But where is that water? Did Saraswati change its course so drastically at any point of time that it emptied

all its water into the Yamuna? The Yamuna rises at a point different from that at which the Saraswati arose—though both are located in the Himalayas. However, at places like Indri the two rivers flowed very near each other. Thus, at such places some possibility did exist where the water of one river would start flowing into the other provided some land movement did the miracle of tilting the land changing the direction of the water channel. Where, how and how many times did such a phenomenon occur, if it occurred at all? Could modern scientific methods of investigation, say landsat imagery and satellite photography, help us in finding out the truth of 'old' and 'new' channels of the Saraswati and also the Yamuna, in which, the Saraswati seems to have merged itself, and got lost more than once, and now only the memory of these events is lingering in our written and oral traditions.

The first very significant work on this problem was done by the famous hydrologist, Robert Raikes while he was investigating a Harappan site on the Ghaggar. Gurdeep Singh, the most noted Indian Palaeobotanist, who worked on the history of some of the lakes of Rajasthan in the light of local and widespread climatic and cultural changes in the north-western regions of India, elaborated the work done by Raikes.

The team of scientists working under the guidance of the most noted Indian environmentalist and metallurgist, D.P. Agrawal, at Physical Research Laboratory, Ahmedabad, has also come out with very interesting results which go a long way to providing the necessary bone to the body of various speculations and calculations, and also scientific dates. The team has used all that goes under the term landsat imagery, the most modern scientific technique of land survey and land exploration from the air. We have here included the work done by this team primarily to provide solid scientific underpinning to an otherwise shaky edifice on various counts. That there were the 'old' channels of the Saraswati is now clear enough. That the present day Yamuna is comparatively a young river is also clear enough. That the Sutluj may have once joined the Saraswati-Ghaggar also appears to be correct. But how and when the Saraswati got dried up due to the fact that at some point of time some tectonic movement took place in the lower Himalayas and the Saraswati changed its course and joined the Yamuna, is a matter on which Agrawal's team has something vital to say—different from what Ghose said, different also what Raikes and Singh said, but still

within the same parameters which provided substance to their work.

And in fine, we have thought it prudent to present a complete overview of this jungle of a problem, both in terms of issues involved and great efforts which have been put in solving them for over a century now. But where to get a work of a such a magnitude except in the most comprehensive paper written by V. N. Misra, the most leading name in the annals of Indian prehistoric studies. It is a full survey. It is comprehensive. It takes into account all that Raikes, Singh and other had to say. Even what the older palaeontologists had to say. And yet it is fully original. It includes not only his comments on other works but also the results of his field work done for over three decades in Rajasthan—the land of the Saraswati.

To all these authors I am personally indebted since except for Aurel Stein, whom I never met, all are my friends and colleagues. And all are members of the Indian History and Culture Society, on whose behalf the book is being published. That another most esteemed friend of mine, Dr. S. R. Goyal, Professor and Head of the History Department, Jodhpur University, has taken keen interest in its publication as 'Kusumanjali Indian History Monographs' No. 1 is also a matter of great personal satisfaction for me.

My personal thanks are also due to ebulient Mr. Shankar Goyal of M/s Kusumanjali Prakashan, Meerut, for the excellent layout and production of the work.

The book is primarily intended to serve a cause—the cause of multi-disciplinary research in history since history is always multilinear.

Allahabad Museum Allahabad
15th August, 1988

S. P. GUPTA

CONTENTS

LIST OF MAPS

Chapter 1

ALONG THE GHAGGAR IN BIKANIR

Section 1. Introductory

A survey of ancient remains in the desert area of the Bikanir and Bahawalpur States to which this Report refers recommended itself to me on both archaeological and geographical grounds, for work on my return to India, after my recent exploration of the Roman *Limes* in Iraq and Transjordan had been completed.

Through that area passes that great dried-up river bed of the Ghaggar or Hakra which by the traditional belief in its identity with the sacred Saraswati River of the earliest Vedic literature presents a special interest to the student of the historical geography of India.

The fact that this ancient river bed, still well-known locally though abandoned for most of its course for long ages, lies in what our maps usually designate as the "Great Indian Desert", was bound to offer a special, quasi-personal, attraction to me. For my Central Asian expeditions had afforded me ample opportunities of observing how often it is just on desert-ground to which rivers have long ago ceased to carry their life-giving water, that remains of earlier human occupation preceding that great physical change can be traced, as it were on the surface, more easily than elsewhere.

I was well aware of the fact that in this great area climatic conditions—fortunately for those who inhabit it—are still far removed from such aridity of the "true desert" as has among the sandy wastes of Chinese Turkistan allowed manifold relics of ancient life to survive in remarkable preservation at sites which the want of water has closed to human occupation for many centuries past.

But all the same, there was reason to hope that by careful observation of physical features on long stretches of the dry river bed of the Ghggar or Hakra and by a rapid survey of whatever remains former settlements had left behind on adjacent ground,

it might become possible to throw some light on the periods and conditions when this ground knew settled occupation.

From this some indication might be gathered as to the time which saw the ancient river dry up and, perhaps, also as regards the cause or causes of this process. Any indication in the latter direction would have a direct bearing on that much discussed question as to "dessication" in Asia which has its wider interest for both the historical student and the geographer.

It was clear that with a view to this special aspect of the proposed investigation attention would have primarily to be directed to the determination of the latest period when any particular site or series of sites was abandoned. Equally certain it was that in order to arrive at safe conclusions the investigation would have to be extended over long stretches of the dry bed and would have to include an examination of all old sites traceable on or near them.

The great extent of the ground to be surveyed and the limitation of available time due to climatic conditions and personal circumstances might well have caused me to hesitate about the proposed tour, had not prolonged experience elsewhere shown me that on arid desert ground reliable evidence as to the approximate time of abandonment of a particular site can usually be gathered from objects and observations gathered on the surface.

This expectation has been fully borne out also by the tour here described. But trial excavations such as often help to confirm evidence of this kind and to make it chronologically more precise, could on this tour be carried out only at a few of the many old mounds traced and had to be restricted in extent. The limitations just indicated necessarily imposed upon the tour the character of a mere reconnaissance survey; but whatever useful archaeological evidence could be gathered by me at any of the sites visited has been fully noted in this Report.

An autumn tour in Kashmir intended to provide needful illustrations of ancient sites and remains for a new edition of my annotated translation of Kalhana's *Rajatarangini*, together with other obligations, did not allow me to set out until the middle of December, 1940, for the Bikanir State in Western Rajputana. Through it passes a long stretch of the Ghaggar bed which topographical and practical considerations combined had suggested as specially suited for examination at the start of my survey.

The recommendation which Sir A. C. Lothian, Resident for

Rajputana, had kindly made on my behalf with the approval of the Political Department of the Government of India, had secured the permission of His Highness, Maharaja Ganga Singhji of Bikanir, for my intended investigations.

Nothing could have exceeded the kind welcome which this remarkable ruler, an outstanding figure among all Indian Princes, extended to me, or the most effective assistance with which my work within his State was encouraged and furthered by His Highness.

I must feel particularly grateful for all the attention and support which was throughout given to me by the local authorities under the instructions issued through Kunwar Jasvant Singh, Political Secretary to His Highness's Government. The use of a motor car of the State generously granted enabled me to effect visits to widely scattered places of antiquarian interest with far less expenditure of time and effort than could have been hoped for otherwise.

Grateful appreciation of all the facilities granted, as well as the impressions received of a regime which combines the benefits of an administration on effective modern lines with respect for a cherished cultural heritage, will make my work in Bikanir rank among the happiest memories of all my years in the plains of India.

Here I may fitly record also my warm gratitude for the very valuable help which the spontaneous offer of a special grant kindly made by Rao Bahadur K. N. Dikshit, Director General of Archaeology in India, just before my start on this planned tour, has afforded me in connection with my labours.

The provision of a subsidy of Rs. 2,000 from the budgetted funds of the Archaeological Department proved particularly useful, because it made it possible to secure the very efficient assistance of Surveyor Muhammad Ayub Khan, late of the Survey of India and now retired. He had been deputed with me for survey work on my 4 archaeological expeditions in Iran (1932–36). He now once more proved a most willing and efficient helper for surveying old sites and for manifold practical tasks in the field. His experienced eye for ground-features, acquired during many years' training in topographical survey work, often guided me to useful observations. In addition, the kindly offered grant provided for the cost of such trial excavations at certain sites as could be use-

fully undertaken within the limited time available, and for transportation expenses.

Before leaving the Bikanir State at the close of January, I was joined by Mr. Krishna Deva, M.A., Archaeological Scholar attached to the Department, whom the Director General wished to acquire further experience in the course of our Survey. I found the young scholar well acquainted with methods of archaeological work and keen to avail himself of whatever opportunities were offered for gaining experience in the field and in the archaeological collections of the Museums visited at Bikanir and Jodhpur. He rendered throughout very useful assistance by collecting specimens of ancient ceramics, etc., at the sites surveyed and by supervising trial excavations.

Before I proceed to record the observations of archaeological interest made along the course of the Ghaggar, it will be useful first briefly to indicate the origin and upper course of the river the floods of which at one time created the great bed, now dry, passing through the area of sandy desert in the north of Bikanir territory. Next I may show succinctly why that river, known as the *Saraswati* to Indian literature and sacred tradition from the earliest Vedic texts, claims the special interest of students of the ancient geography of India.

The Saraswati, called *Sarsuti* in Hindi, is formed by the junction in the Ambala District of the Punjab of a number of smaller streams descending from the outer Himalayan range of the Siwaliks. The river bed is filled mainly by the drainage of the monsoon-rains which that hill-range receives in abundance. Its water is made by dams to irrigate much ground in Ambala District. Thence it passes along the western portion of the Karnal tract, the sacred Brahmatshi[1] of Hindu tradition, into the eastermost part of Patiala territory. There it ceases to carry a perennial flow of water.

The wide bed of the river next enters the Hissar District and continuing its southwestern course carries summer-floods of a volume varying in accordance with the intensity of the monsoon to the northeastern border of Bikanir. At a distance of some 12 miles before reaching that border, a weir constructed in 1897 now holds up the flood water to form the artificial lake of Otu. This

[1]It should be Brahmarshi-desa. Cf. *Manusamhita*.

feeds 2 canals intended to irrigate narrow belts of land on either side of the Ghaggar bed, as far as this runs, in a westward direction to near the small town of Hanumangarh with its great medieval fort of Bhatner.

The Ghaggar bed itself, known as Nali, still receives annually some portion of the summer-flood. But the volume of this varies greatly and with it also the area in the Ghaggar bed which can benefit from irrigation with the water of the Nali. Statistical tables with which I was kindly supplied by the Secretariat of the State and also by Kunwar Ganesh Singh, the obliging Tahsildar of Hanumangarh, show that since 1914 the flow of water in the Nali has but on a few occasions extended as far as 16 miles below Hanumangarh. In most years it has stopped at varying distances above this small town.

In order to realize fully the important bearing which the volume of water once carried in the bed of the Ghaggar must have had upon artificial irrigation and consequently upon settled occupation of the ground, account must be taken of the climatic conditions affecting cultivation in the area through which the Ghaggar passes. A striking feature of these conditions is the very irregular rainfall. This is principally determined by the southwest monsoon current and is, as the records kept at Bikanir City since 1879 show, subject to extreme variations. Thus, while during the first period of 35 years an average rainfall of 10.92 inches per annum was registered, this period included a minimum of only 1.14 inches in 1899. This was a year of very severe famine for Bikanir and adjacent parts of the Punjab.

In the absence of artificial irrigation the prevailing uncertainty about crops being raised is so serious as to make the agricultural population throughout the State dependent to a very large extent upon a supplementary pastoral livelihood. Yet even this is rendered precarious in years of indequate rainfall when wells and tanks over a great portion of the territory are liable to dry up. Maintenance would then become altogether impossible were it not that the cultivators in the parts most affected, just like the wholly pastoral tribes of the desert, are accustomed in such times to migrate with their flocks of sheep and goats and their cattle into the more favoured adjacent parts, whether in Rajputana, the Punjab and Sind, until more favourable conditions permit their return.

Consideration of the economic facts of the present, as just briefly sketched, necessarily leads up to the conclusion that conditions for settled life must have been very different at the period when there still flowed a river down the Ghaggar with a volume large enough, be it only in the monsoon season, to carry water to a portion at least of that wide bed and thus to permit irrigation and with this permanent cultivation along it. The question as to the great physical change observed here and its cause or causes, important as it is, cannot be discussed in this place. Obviously, it is just this question which invests with special interest whatever chronological or other evidence the archaeological examination of ancient remains found along the now dry bed of the Ghaggar may yield.

Before proceeding further it will be useful to note here a few main topographical facts concerning the Ghaggar bed as it now presents itself, in a bird's eye as it were, within Bikanir territory. From the border near the hamlet of Tibbi it stretches for about 25 miles in a roughly east-west direction to the small town of Hanumangarh, headquarters of a *Tahsil.* Thence it turns to the southwest and follows this line for approximately 30 miles of direct distance to Suratgarh, the chief place of a district. There a conspicuous mass of sand dunes rises like a promontory to a relative height of more than 100 feet above the ground occupied by the little town, and causes the Ghaggar to turn to the general direction of west-southwest. On this line it continues with numerous minor windings for an approximate distance of 60 miles, as measured along the branch line of the railway which follows the bed, as far as the *Tahsil* village of Anupgarh and thence to the hamlet of Binjor close to the Bahawalpur border.

Along the whole course thus indicated the bed of the Ghaggar appears as a band of fairly flat ground from 2-4 miles in width. Here and there it shows rudimentary dunes, also shallow Nullahs. At comparatively short intervals mounds of varying heights and sizes marking always sites of ancient occupation rise above the level ground. On small patches of this ground, showing a fairly hard loamy surface, precarious cultivation is carried on near scattered hamlets, mostly situated near the edges of the bed.

Elsewhere the whole bed is covered with ample scrub. This affords plentiful grazing for dear and blackbuck, thus providing as it were a huge hunting park for His Highness. A very notable feature of the Ghaggar bed is that almost throughout it is lined

on both sides by ridges of accumulated dunes. These form practically continuous bands and when seen from a distance or from the air might suggest bank of a river.

In reality those high sand-ridges nowhere show the marks of water-erosion, characteristic of true river banks. A frequent experience made on my surveys in the deserts of Chinese Turkistan supplies the right explanation of them. Wherever my explorations took me into the Taklamakan and Lop deserts, I found the beds of rivers which pass into that vast expanse of drift sand, whether dead or still carrying water, marked by continuous ridges of high dunes. These rise in some cases to heights of 300 feet or more. These ridges found along river beds, dry since long ago, are due to the wind-borne sand having been stopped by the vegetation once growing in the riverine belts which were or are still reached by seasonal inundation. The gradually rising accumulation of drift sand, if once sufficiently high, prevented the onward movement of fresh dunes and has thus protected the dry beds from being smothered altogether.

Exactly the same phenomenon on a smaller scale was repeatedly observed by me in the Tarim basin along the edges of cultivated ground, whether still tilled or abandoned for ages, wherever such ground is exposed to the advance of wind-blown sand in its vicinity. In support of the same explanation applying to the Ghaggar in Bikanir territory, it may be noted that the sand-ridges[1] along what may be called the left or southern bank of the dried-up

[1]A special opportunity for commenting on the above noted sand-ridge formations along the Ghaggar was offered to me by the reference which Colonel O. Slater, then Director, Map Publication, Survey of India, made to me in the course of my tour. He pointed out that in the old survey sheets, like those on the 1/4 inch scale maps Nos. 44. G and K, the edges of the Ghaggar bed had been specially marked as banks by dotted lines. When a fresh survey had to be made in connection with the Sutlej Canal Project of that portion of Bahawalpur territory through which the Ghaggar bed passes further down, the Surveyors were specially instructed to pay attention to this feature of the ground. They uniformly reported that no "banks" could be found along the ancient river bed, and consequently no such indication of the Ghaggar is now found in the recent maps showing the Bahawalpur area.

It deserves, however, to be noted that while working in that area I found there, too, just as on the Bikanir side, the local people quite familiar with the traditional limits of the Ghaggar bed. As pointed out by them, they always agreed with the high sand-ridges which in the old survey sheets had been marked by dotted lines.

river show generally a greater height than those aligned on the opposite side. This difference is obviously due to the prevailing winds over the whole of Bikanir coming from the southwest and carrying the sand of the Rann of Cutch.

It is within the riverine belt clearly marked throughout by these high marginal ridges of sand that the river once carried its shifting course, but there is no reason to assume that it ever filled it completely. Throughout, the Ghaggar bed shows a firm, loamy soil due to alluvial deposit from the river and easily distinguished from the light sand of the ground on either side. Whenever it happens to receive adequate moisture this soil proves very fertile. This marked difference of the soil, of practical interest to the local people, added to the striking appearance of the marginal ridges of sand, no doubt helps to account for the general popular belief which recognizes in the Ghaggar the bed once totally filled by a mighty river that followed it down the ocean. In more than one place I found the traditional notion reflected in legends clinging to particular localities.

Above, a reference has already been made to the special interest which traditional belief that the Ghaggar or Hakra. as the bed is called on the Bahawalpur side, marks the terminal course of the Saraswati river of Vadic and later Sanskrit literature, presents to the student of the historical geography of India. The Saraswati is mentioned in numerous hymns of the Rigveda. In later Vedic texts, it certainly bears that character of a sacred river which attaches to the present Sarsuti in classical Sanskrit literature and Hindu religious tradition to the present day.

The question as to whether the same holy river passing to the west of Kuruksetra can be meant also in all hymns of the Rigveda which mention the Saraswati, has been much discussed since the critical study of the earliest Vedic texts was begun by European scholars. A careful synopsis has been presented by Professors Mecdonell and Keith of the different views held on the subject.[1] This makes it possible to restrict here my remarks on them to the essential points.

It is certain that in at least 3 passages of the Rigveda and in a large number of later texts the modern Saraswati or Sarsuti is referred to. It will suffice to mention among the former a verse of

[1]See *Vedic Index of Names and Subjects*, Vol. 2, pp. 434 *et seq.*

the hymn of the *Nadistuti* (R.V. X. 75) which with a precision unfortunately exceptional in Vedic literature enumerates all important rivers from the Ganges to the western limit of the Punjab in strict geographical order. In this passage the Saraswati is correctly named between the Yamuna or Jumna and Sutudri or Sutlej.[1]

But in a much larger number of passages of the Rigveda the Saraswati is referred to as "the foremost of rivers," as going to the ocean or otherwise in a way which seems difficult to reconcile with facts concerning the holy Sarsuti of Hindu worship; for by comparison with the great rivers of the Punjab fed by the ice and snow of Himalayan ranges this small stream, a tributary of the Ghaggar where it flows in the Ambala District, must well appear insignificant. Hence the late Professor Rudolf von Roth, that great master of Vedic studies, was induced to recognize the Sindhu or Indus as the river referred to in those passages. In this view he has been followed also by other western scholars.

This would not be the place to go into the question thus raised, even if I were at present in a position to examine the Rigveda passages on which my revered teacher's opinion was based, or go into the arguments which have been advanced against it. But a few brief observations may find room here. If we accept the clear geographical indication furnished by the *Nadistuti*'s list as evidence for the definite location of the Saraswati in the Madhyadesa of Hindu lore, wherever the Rigveda hymns mention the river, this location might well deserve consideration as an argument with regard to the important and still obscure question as to where those earliest records of Indian thought were composed. It would also help to explain why so much of the climatic conditions reflected in early Vedic mythology points far more to those plains of the Jamuna and Ganga than to the western Punjab.

On the other hand, it would be well to bear in mind also that river names are peculiarly liable to be shifted when migration of the people familiar with them takes place. The many Ganges to be found all over India may aptly illustrate such a transfer, especially in the case of a river the name of which is vested with sanctity. Nor ought the fact to be lost sight of that we find the very name of *Saraswati* in its due Iranian form as *Harahvati* attested for the Arghand-ab in ancient Arachosia, the modern

[1]See *JRAS*, pp. 91 *et seq.*, 1917.

Kandahar tract. This is an area of the Indo-Iranian borderland which there is good reason to believe to have lain on the main line of the Aryan advance into India.

It only remains to be added that the connection of the dry bed of the Ghaggar with the sacred *Saraswati* is known to the Brahmana literature; for two of these later Vedic texts mention the place (*Vinasana*) where the Saraswati is supposed to be lost in the desert.[1] But no indication is given as to the locality meant.

In the preceding pages I have endeavoured to explain the special object which had led me to plan and carry out the investigations described in the present Memoir. The account here rendered of them was prepared and completed in the summer of 1941 after my return from those surveys. In the course of them I had become aware, mainly through information received at the Bikanir Museum, that some ruined sites near the bed of the Ghaggar within Bikanir territory had been visited before by Dr. Tessatori and sculptural remains there recovered had been deposited by him at the Museum.

Dr. L. P. Tessatori, an Italian scholar of considerable Indological attainments, was known to have been engaged for a number of years in the collection and study of bardic and historical records of Rajputana. From a brief account published by him in the Annual Report of the Indian Archaeological Survey for 1917–18 on certain sculptures recovered by him at Suratgarh, it was seen that in addition to that task he had been entrusted by the Archaeological Survey of India with the collection of materials for the compilation of a list of ancient remains in Rajputana and had started these labours in the Bikanir State. Dr. Tessatori had died in 1919 before completing them, and no published account of the results he had obtained, apart from the above, could be traced by me.

It was only in February, 1942, long after the present Memoir was completed, that I learned through a kind communication of Dr. N. P. Chakravarti, Deputy Director General of Archaeology in India, that he had recently among the records of the Department come upon a voluminous manuscript report of Dr. Tessatori on tours he had made during the years 1916–17 and 1917–18 in search of archaeological remains in the Bikanir State. This manu-

[1]See Macdonell and Keith, *Vedic Index of Names and Subjects*, Vol. 2, p. 300.

script, comprising 228 closely written foolscap pages, was at my request very kindly transmitted to me. It proved to be accompanied by a collection of photographs representing antiquities and by a convolute of rough notes on 44 foolscap pages describing sites visited in 1918–19.

A perusal of these materials has shown that the bulk of the above mentioned report deals with structures, sculptural remains and inscriptions, mainly medieval or later, examined in different localities of the Bikanir State. Apart from these, an initial section describes earlier sculptures, assumed to be Buddhist, recovered from sites on the Ghaggar. A longer concluding section records observations on a series of what Dr. Tessatori calls "cinerary mounds" on the Ghaggar. To the latter relates almost the whole of the closely written rough notes, apparently jotted down on later visits paid to such mounds and after short trial excavations made at some of them.

An examination of all these materials, unrevised and very diffused as they are, has proved that Dr. Tessatori had devoted much painstaking labour to the task he had undertaken. It was carried out under conditions which, owing to the desert character of most of the ground visited, must often have been physically trying. But perusal of this record has also helped to explain the reasons which, together with the difficulty about needful revision and condensation after the writer's death, appear to account for the report having been unpublished by the Department.

Among such reasons it will suffice to mention the disregard of archaeological guidance afforded by the comparative study of ceramic types and similar indications; also, the preconceived attribution of a "sepulchral character" to all deposits found in mounds, even where the fact of their being due to prolonged occupation by the living is obvious.

I have considered it an obligation in the interest of research and also as due to the memory of a devoted scholar to indicate in supplementary notes whatever additional information of value I could gather from Dr. Tessatori's record concerning sites examined by me along the Ghaggar. This applies especially to the results of such short trial excavations as he was able to effect at a few of the mounds. All such information has been distinguished by placing it within brackets, with due acknowledgement made of its source.

Section 2. Remains at Rang-mahal

After reaching Bikanir City on December 17, 1940 at the start of my tour, I was accorded a most hospitable reception on behalf of His Highness the Maharaja. The next 3 days were busily spent over visits paid to the many interesting old structures in the traditional style of Rajputana which the capital of the State has fortunately preserved to the ancient pilgrimage site of Kolait near the Jaisalmer border, and to the numerous remarkable institutions and buildings with which the Ruler's care and taste has endowed Bikanir during his long and truly beneficent reign. It was a special satisfaction to find among these an imposing and excellently planned Museum building which would do credit to any large city of Asia.

It was following the advice, which His Highness himself was kind enough to give me in the course of very instructive and stimulating conversations, that I chose Suratgarh, the district headquarters on the Ghaggar, as a base for my first investigations. Although an attack of influenza, fortunately mild, interfered at first with my work, the fortnight following my arrival there on December 27 could profitably be used for a survey of a considerable number of ancient sites found along or within the Ghaggar bed. They extend over a total direct distance of more than 30 miles, marking approximately the extent of the Suratgarh *Tahsil* from northeast to southwest.

It may be noted that though the "Gazetteer of Western Rajputana" indicates 126 "villages" besides the small town of Suratgarh as comprised in the Tahsil, yet the total population in 1901 was just under 18,000 souls. This shows how small these present "villages" are and how thin the population is in general. Instructive, too, is the Gazetteer's statement that out of the total area of 5,072 square miles in the Suratgarh District, including the *Tahsils* of Suratgarh, Hanumangarh and Anupgarh, less than one-tenth had been annually under cultivation.[1]

The site of Rang-mahal within easy reach of Suratgarh had been mentioned to me first by His Highness as a well-known place of antiquity, as shown by its very name which indicates a "palace or mansion of note". It is situated about 3 miles to the

[1]See *Archaeological Survey of India*, pp. 22 *et seq.*, 1917–18.

northeast of the railway station of Suratgarh and of the Maharaja's tastefully furnished shooting lodge close by, which provided me with a very convenient base during my whole stay in this neighbourhood. The remains of Rang-mahal proved particularly instructive owing to finds which allow their date to be determined with approximate certainty. Hence, the chief features of the site be described first, even though the trial excavation which yielded those finds was made only after my return from Hanumangarh by the middle of January (1941).

Rang-mahal lies at the northern extremity of a high spur of sand hills which projects towards the flat bed of the Ghaggar near where the latter changes its direction from southwest to west. An outlier of that sandy spur is at its northeastern foot adjoined by a mound "A", thickly covered with pottery debris and rising to a maximum height of about 35 feet. Although much eroded and dug into largely, it seemed, for manuring earth, it still extends for close on 300 yards in length. It could clearly be recognized as marking an ancient settlement of some size.

All round it the flat ground also bears much broken pottery. To the east of the mound is found an ancient tank "F", described later. A short distance to the south of it there rise in small groups the huts of the present hamlet. From the flat ground which adjoins the northern foot of the sandy spur and is under cultivation in years of favourable rainfall, there rises a second and much smaller mound "B" bearing sherds of plain pottery differing in type from the painted or decorated ware which is found plentifully on mound "A".

Ascending the sandy spur southward to a height of about 140 feet, I found the flat top of a small knoll "C" strewn with scanty fragments of burnt bricks over an area about 30 feet in diameter. According to the villager's statement, they marked the spot where masses of burnt bricks from a massive but completely upheaved structure had been dug up some 40 years before and removed to serve for ballast on the railway line then under construction. The statement was confirmed by the plentiful small fragments of bricks which still cover the slope where the material thus quarried had been removed.

The structure thus dug up to its foundation might well have been a tower crowning the knoll which commands a distant view. The bricks, judging from the fragments traced, might have mea-

sured about 12–13 by 8–9 inches with a thickness of about 2 inches. On clearing the ground down to the natural sandy soil, the only object found, apart from brick fragments, was a terra-cotta ball (1 inch in diameter), which may have served for a sling. The absence of potsherds around made prolongued occupation of the spot appear improbable. Scattered small patches with similar brick fragments were also traced at 2 points on the sandy ridge to the south.

Dr. Tessatori (p. 92 of his M. S.), referring to this sandy spur, records the local tradition that on it stood once a stronghold of a chief called Wakho Phulani, whose capital is believed to have once stood at Phulara (Phulra near Marot in Bahawalpur territory). He also notes the local belief that a portion of the ancient structure is still buried under the sand.

The same popular belief is reflected in a notice of Colonel Tod quoted by Dr. Tessatori[1] which mentions Rang-mahal as possessing the vestiges of a "large town now buried in the sands." Dr. Tessatori rightly observes that Tod not having visited Rang-mahal wrote from hearsay and that possibly there is much exaggeration in his statement. Dr. Tessatori may have been helped to arrive at this correct conclusion by the trench he appears to have cut through the debris at the spot above described. The structure, whatever it was, stood on the sandy soil which forms the whole spur.

Descending the slope north of the knoll "C" to a level about 50 feet lower, I was shown a somewhat larger stretch of terrace-like ground which according to an old villager's statement had also been cleared of burnt bricks. Here 2 short lines of complete bricks (13 × 8 inches), laid side by side in a single course at right angles, could be seen exposed. They rested on sandy soil, and close to them were found ashes with numerous fragments of plain earthenware. These thin layers of bricks looked as if arranged later from the debris of some completely quarried structure.

Destructive digging for brick material declared to have been done earlier had been equally thorough also on the slope some 30 feet further down to the northeast. But here at "E" a small, carved brick fragment resembling a finial found on the surface attracted my attention. On having the slope cleared for a horizon-

[1]From *Annals of Rajasthan*, Routledge edition, Vol. 2, p. 166.

tal distance of some 50 feet there were found within a depth of 2 feet of sand from the surface a number of other fragments of carved bricks.

They included small relievo panels showing a chequer pattern and lotus petals, forming part of a string course. These evidently had belonged to the decoration of some shrine; another relief fragment represented a small, seated figure suggesting a goddess but too effaced to be definitely made out. As no other finds came to light on digging down in the sandy soil 6 feet, it became clear that these fragments must have slid down the slope from some structure higher up completely destroyed.

Insignificant as are the scanty relics here recovered from what obviously was a Hindu or a Buddhist shrine, they have made it possible to determine approximately the period from which this dated. On my return to Bikanir, we found large heaps of decorated brick fragments lying unarranged in the basement of the Museum. They were attributed to excavations made by the late Dr. Tessatori during 1917–18 in different localities of Bikanir. Among them a number could readily be recognized as closely resembling in style those picked up by us at the spot marked "E" of the Rang-mahal hill.

The pieces indiscriminately heaped up bore numbers, and these made it possible from fortunately preserved lists to separate those which had been brought by Dr. Tessatori from Rang-mahal. Both Kunwar Sagat Singh, the obliging Curator, and Mr. Krishna Deva worked hard during our brief stay to achieve the arrangements of all these *disjecta membra*. A selection of representative pieces was made at the same time with a view to placing photographs of these at my disposal on behalf of the State. For this favour my special thanks are due to Kunwar Jasvant Singh.

Dr. Tessatori for several years had carried on a very valuable survey of the bardic and historical records of Rajputana and in connection with the same had also undertaken work on behalf of the Archaeological Survey of India. He unfortunately died before he was able fully to record the result of his labours. But a short preliminary account contributed by him to the Archaeological Survey Report for the year 1917–18 throws light on other objects he recovered from Rang-mahal and on the vicissitudes the site had undergone before.

It is locally known that when the town of Suratgarh was

founded about 1800 by Maharaja Surat Singh, bricks brought from the ruins of Rang-mahal were used very largely for the construction of the fort now containing the headquarter offices of the district.[1] Some of the bricks thus removed bearing relievo decoration were walled into the outside face of the fort walls and are still to be seen there in different places, usually at some height. A number of others were apparently used to adorn the gate of the fort. These Dr. Tessatori succeeded in having taken down. In addition to these a number of complete brick panels showing figures and scenes in relievo known to have been brought from Rang-mahal were found by him lying in a small chamber of the Bikanir fort. Arranged like a frieze, these now form an interesting feature of the archaeological section of the Bikanir Museum.

There is no need here to attempt a description of the scenes which the relievo panels reproduced in the plates of Dr. Tessatori's above quoted account represent. The subjects and ornamental features are all those typical of Hindu temples, and the style in which they are treated is unmistakably derived from the Graeco-Buddist art of Gandhara. In all decorative details the agreement between the terracottas from the Suratgarh fort reproduced with Dr. Tessatori's article and the fragments found in the basement of the Museum is the closest. This is sufficiently shown by the specimens in the photographs which were taken in Pl. XX 1,2,3,6; XXI 4, 6.

The very stylized stiff treatment of such motifs as the palmette and the diaper of four-petalled clematis-like flowers, leaves no doubt about the debased character of this manifestation of Gandhara art. Since we find an application of the Sasanian pearl border as an ornament, it is safe to ascribe all these Rang-mahal fragments to the late Kushan period. With this agrees the somewhat coarse style of the figures in the complete panels at the Bikanir Museum. An exception to this is a youthful figure, seen touching the foot with his finger. This pose is found in *putti* of Gandhara relievos and in one of those shown by painted dados of the shrine of Miran.

Dr. Tessatori's detailed report now seen in MS. does not mention any relief-decorated bricks having been excavated or collected by him on the large sandy spur of Rang-mahal. But it refers to

[1]See *Annual Report of the Archaeological Survey of India*, p. 22 and pls. III, 1–3, 1917–18.

the many carved bricks which had served for architectural decorations and which, like the plain bricks brought from Rang-mahal, were found by him in the walls of the Suratgarh fort. These architectural carved bricks are stated to have been removed by him with the intention of placing them in the Bikanir Museum then under construction.

The identity of these decorated brick fragments from the Suratgarh fort with the Rang-mahal fragments found in the basement of the Museum is certain. Hence from what has been recorded above as to the pieces recovered at "E", it can safely be concluded that the ruined structure from which the materials for the Suratgarh fort were quarried, must have stood on the northern slope of the sandy spur in the close vicinity of this spot.

The repeated quarrying of the remains on the hill has been so complete that it was impossible to determine the exact position of the shrine which had yielded the decorated bricks. But the find at "E" of a complete brick ($12\frac{1}{2} \times 7\frac{1}{2} \times 2$ inches), makes it appear likely that all the destroyed structures on the hill were approximately of one age. It deserves to be noted that what potsherds could be picked up on the sandy slope of the hill to the north and northeast were either plain ware or else showed decoration only of simple, black painted bands or low and rather irregular ribbing. The painted pottery with elaborate floral designs, and the relief-decorated sherds so plentifully found on the large mound "A", were here conspicuously absent.

It was at this Rang-mahal mound that I first became acquainted with a type of painted pottery, which subsequently was found characteristic of numerous old sites along the Ghaggar bed within Bikanir territory. They are marked by mounds of varying size and height, all known by the term of *ther* or *theri*. Among the sherds which are thickly strewn over the whole of the mound known as Rang-mahal-theri, a considerable proportion is decorated with designs painted in black usually over a bright red slip. The decoration is always boldly applied with a free sweep of the brush. The designs are mostly geometrical, consisting of encircling bands, rows of circles and dartlike triangles, chevrons, pearl borders, scrolls of different kinds, and leaf shapes joined in a variety of ways. Combined with these are found also elaborate floral patterns, both solid and hachured. In a few pieces bird-like forms appear combined with foliage, while a fish is suggested in another. Incised

or stamped ornamentation is frequently found, especially along the rims of vessels, in the shape of scallops, vandykes, cables; zones of small bosses or cones; and impressed leaf shapes. A round plaque shows an incised lotus-leaf design, and imbrication is seen on the top of a small lid. Two pieces from a mould show how more elaborate relief decoration on the outside of a bowl was produced.

From the surface of the Rang-mahal-theri was collected also a small number of terracotta figurines. The most noteworthy among them is the head, about 2-3/4 inches in height, of a figure worked in high relief with an elaborate coiffure. The whole suggests influence of Gandhara style, particularly in the treatment of the hair. Two fragmentary bull figurines are of very poor workmanship and might be of any age. On the other hand the miniature figure of an elephant is well-modelled, and neatly worked also a miniature ram's head. A few copper coins brought to me as having been picked up on the mound are too poorly preserved to permit of identification.

A short trial excavation was made on January 17 on my return from Hanumangarh in a trench cut near the northern end of the mound from the top level down to a level of 15 feet above the ground. In the lowest section of the trench walls built with mud bricks ($13 \times 8 \times 2$ inches) were struck at about 2 feet from the surface, and an apartment $10\frac{1}{2}$ feet wide cleared down to its floor at a depth of 4 feet. Here were found a number of broken covers of pots, and beside them an interesting small earthern bowl. It shows on one side the applique relievo of a female figure with a bird's head rising above the vessel's rim and spreading its wings along it. Although roughly worked the whole suggests derivation from the composite figurines familiar to Graeco-Buddhist sculpture.

Some burnt bricks found at floor level showed a size almost identical with that from destroyed structures at "E" on the hillside. In the upper section of the trench masses of mud bricks were struck from the walls of a collapsed structure, not offering promise of any datable remains.

As regards the period down to which occupation of the mound had extended, sufficient evidence had been provided before by the type of the decorated pottery to be found in abundance both on its top and slopes. This ware, whether painted or bearing incised and stamped designs, shows very close resemblance to that with

which I had become familiar at the numerous old mounds examined in 1927 between Draband and Tank along the foot of the Takht-i-Sulaiman range.

Comparison with the specimens reproduced from these sites will amply demonstrate this resemblance.[1] Several reasons had led me to assign the protracted occupation of these sites to early historical times. This conclusion was fully confirmed by the observations which my examination of the remains at the site of Munda in the Hanumangarh area, preceding my renewed visit to Rang-mahal, had yielded.

These had definitely shown by the stratigraphic evidence that decorated ceramic ware exactly corresponding to that found at Rang-mahal-theri and at a number of adjacent sites to be mentioned further on was in use during the whole of the Kushan Period and probably for some time before it. Without prolonged excavations it would not be possible definitely to indicate a *terminus ad quem* for the period during which the Rang-mahal mound continued to be occupied beyond Kushan times. But that such occupation had ceased long before the Islamic invasion may be considered as certain from the total absence of any remains of glazed pottery, notwithstanding the comparative nearness of this ground to those parts of the Indus Valley where Iranian cultural influence through Muhammadan domination had established itself at an early time.

On the other hand, it may be noted at once that neither at Rang-mahal nor at any of the numerous ancient sites examined along the Ghaggar bed within Bikanir territory, where the same decorated pottery is to be found pointing to Prehistoric occupation. This negative fact deserves here specially to be noted since it strikingly contrasts with the clear evidence as to Prehistoric occupation which our survey of sites further down along the continuation of the Ghaggar-Hakra bed in Bahawalpur territory has yielded.

There still remains to be described the ancient tank "F" which lies in a slight hollow of the ground some 150 yards to the east of the Rang-mahal-theri. It was said to have been almost completely filled with alluvium before its clearing was carried out as a famine relief work in 1939. This clearing had disclosed on the southwest

[1] See *An Archaeological Tour in Waziristan and North Baluchistan*, pls. I-III with comments on pp. 8 *et seq.*

and southeast sides solid revetment walls of a tank, measuring 170 feet square; on the other 2 sides the walls for the most part had given way and could be traced only in places. The walls are faced with burnt bricks ($14 \times 8 \times 3$ inches), apparently laid in mortar. The thickness of the walls seemed nowhere less than 3 feet.

There are 2 buttress-like projections on each side and 3 recessed stairs leading down to the water, one 10 feet broad in the middle of each side and two 6 feet broad symmetrically placed nearer towards the corners. The steps of the stairs are formed of bricks ($10 \times 6 \times 2\frac{1}{2}$ inches), set on edge. The walls reach down to a depth of 14 feet below their edge, while the recent digging had been carried to a level 2 feet lower.

After some rain during the night of January 2, and a heavier fall of 0.4 inch on the 16, the floor of the tank was for the most part covered with water. This suggested that the tank when intact might in the event of a favourable monsoon have been expected to hold some 400,000 cubic feet of water, amply sufficient for the needs of humans and beasts of a large village, even if no flood in the Ghaggar brought water within easy reach. In any case, the construction of so solid a tank proves that at the time of the occupation of the site, probably down to Kushan times, occasional failure of water supply from the Ghaggar might have had to be reckoned with.

On rising ground about 30 yards from the northern edge of the tank there were found near the foot of an old tree several large burnt bricks up to the size of $34 \times 22 \times 9$ inches. Judging from their great thickness, they suggested having formed part of a platform or base. But whether they were found *in situ* or had been collected from somewhere else was uncertain.

Section 3. From Suratgarh up the Ghaggar

From Suratgarh up the bed of the Ghaggar as it stretches toward Hanumangarh a large series of mounds (*thers*) was traced, most of them showing on their surface fragments of ancient pottery resembling the types of painted and decorated ware found at Rang-mahal-theri. I propose to note them briefly in topographical order.

At a little more than 2 miles to the northwest of Rang-mahal there rises the small Bamani-theri to a height of about 25 feet.

It measures some 175 yards in diameter at its foot. Apart from painted sherds with simple geometrical or floral designs, there may be noticed pieces with a neat raised pattern of rosettes and leaves, and the rim of a vase, showing an impressed narrow scroll.

About 1 mile to the west lies an extensive mound designated by my local guide as that of Kanisar after a small hamlet about 1 mile to the north of it. It measures half a mile in circumference at its foot and rises to 20 feet where highest. Among the sherds, which cover its surface, painted and relief-ornamented pieces are particularly abundant. Among the former may be noticed some specimens with roughly drawn animal figures. Relief ornament from moulds is frequent. Apart from some small copper coins, too much corroded to be identified, there was picked up one of unmistakable Kushan type. There were fragments of bangles of bluish celadon-like ware, such as were frequently seen also at sites of Prehistoric occupation. With this indication agrees the presence at Kaniser-ther of plain pottery, showing coarsely impressed patterns of hachures, characteristic of mounds dating from late Prehistoric times.

This mound appears to be the same which Dr. Tessatori (his MS. p. 227) mentions by the name of Dotheri. He assumed it to be of square shape on the strength of a "raised path" which on a rapid visit he believed to recognize as running around its foot and as being marked by "traces of large bricks". The presence of such a "peripateral path" suggested to him the idea of a Stupa. On two visits to the mound I failed to notice this feature. Nor did I notice among the abundant sherds any justification of the description of pottery on the mound as "the usual cinerary fragments".

At the mound of Bhavar-ther, which is situated about 6 miles to the northwest of Suratgarh and is about 300 yards long and rises to 40 feet, the abundant ware showed the same types as at Kanisar. Ornamentation with strings of pearls found on small fragments suggested Sasanian influence. Of interest is a neatly drawn figure of a scorpion, and a chequer design. The relief decoration on one fragment suggests imitation of basket work and neatly impressed rim of another deserves notice. For this mound Dr. Tessatori also assumes a "sepulchral nature", without indicating evidence. About 1 mile to the west a cutting for the railway had been made through a large mound about 15 feet high near the hamlet of Rampura. Most of the pottery debris on the surface had been removed for

ballast. But sherds taken from the sides of the cutting also showed here a close resemblance to the painted and relief-decorated ware of Rang-mahal and Kanisar.

The same was observed also at the small mound known as Bhaurian-Wali-theri about 1 mile to the north of Bhawar-theri; there the motif of pearl strings was found combined with a row of small cones.

Finally, there remains to be mentioned in connection with the group of mounds just described the site of Dokal, close to the east of the railway 3 miles to the northeast of Rampura. Two low mounds, flat on the top, the larger one measuring fully a quarter of a mile from north to south, lie here close together and are adjoined by patches of flat, pottery-strewn ground.

The surface of the mounds had largely been cleared of sherds for purposes of ballast, as shown by the heaps of such found at the foot of the mounds. Although few painted fragments were to be seen, they, like the more numerous specimens of relief-decorated ware, suffice to prove that occupation dated back here also, to the same period as at Rang-mahal.

Before proceeding further along the Ghaggar towards Hanumangarh, reference may be made to 2 localities with marks of ancient occupation which lie to the east-north-east of Rang-mahal in what looks like a large bay of the Ghaggar bed. Near the hamlet of Manik-theri, about 4 miles in a straight line from Rang-mahal, a mound about 28 feet in height and some 220 yards long at its foot, bears painted sherds of the Rang-mahal type, also some with impressed patterns. A damaged terracotta figurine represents a double-humped camel, such as are no longer found in these parts, with owner's marks scratched on the hind legs.

About 4 miles to the east, at the end of the Ghaggar bay, lies the small village of Badopal, and near it to the northwest a large mound, some 400 yards in diameter, rising with its flat top about 15 feet above adjacent tilled ground. Among the sherds covering this mound and a much smaller one north of it, some pieces with coarsely painted floral designs were picked up, also some fragments of small bowls with more careful relief ornamentation.

No information was obtained at the time about the spot where a number of terracotta relief panels and fragments subsequently seen at the Bikanir Museum had been obtained by Dr. Tessatori. These probably belonged to the wall decoration of a Hindu

shrine. Judging from the style of relief plaques and their typical Brahminical subjects, this shrine may be assumed to have been somewhat later than the one on the Rang-mahal hill, although here too some influence of Graeco-Buddhist style is still recognizable.

From Dr. Tessatori's report (MS. p. 95), it is learned that he discovered the panels walled inside the courtyard of the house of a local village headman, who declared that they had been brought there by his grandfather from some *theri* in the neighbourhood many years ago. Dr. Tessatori, who has fully described the 10 relief panels in his report, assumed that they were all brought from Rang-mahal. Several of them are reproduced in the preliminary account contained in *The Annual Report of the Archaeological Survey*, 1917-18, pp. 22 *et seq.* At the same time, he rightly indicated that the marked difference in style makes it very unlikely that they belonged to the same building as the terracottas carried from Rang-mahal to the Suratgarh fort.

Here may conveniently be mentioned a group of "Thers", mostly small and flat, within a radius of about 5 miles to the west and northwest of Suratgarh. At those of Panna Bishnoi, Lalujat and Bhagwansar, the last near the hamlet of the same name, only few incised and impressed sherds were found. A large hummocky area, covered with plentiful sherds of plain coarse ware and numerous Muhammadan graves, and lying less than a mile to the west of Suratgarh, probably marks the medieval site of the latter place; the same applies also to a large debris-strewn patch between Suratgarh and the hamlet of Manaksar near it.

Proceeding further to the west toward ground in the Ghaggar bed, to which a branch of the Ganganagar Canal fed by the Sutlej has in recent years brought water and with it cultivation, there are found in succession beyond the hamlet of Chopra (Sheopura) the "Theris" of Bhaironpura and Suwaiki. Both are flat patches of ground where decorated sherds show only poorly impressed hachures, herring-bone, and similar coarse, geometrical patterns. To which period of occupation this ware may be referred is uncertain. However, only a mile beyond Suwaiki-ther painted and relief-decorated sherds of the Rang-mahal type were to be found again on the mound of Jawaiya. It is only 10 feet high but a quarter of a mile in diameter, situated south of the village of Sirdargarh. The well-modelled terracotta head of a monster or boar may have served as a spout.

Some 3 miles further west, amidst canal-irrigated patches of the Ghaggar bed, and near the new village of Daulatabad, there rises the mound of Sohankot. It bears on its surface plentiful sherds of painted pottery and relief-decorated ware of the same kind as at Rang-mahal. It is about 15 feet high, and although much dug for manuring, the mound still measures some 250 yards in length.

Dr. Tessatori's special interest was attracted to the mound of Sohankot because a tradition was heard by him among the Johiya people at the neighbouring village of Sirdargarh which located the site of Sahivana, the "capital" of an early chief of this tribe, at Sohan-Kot, "the fort of Sohan" or Suhavana (Suhana, as Dr. Tessatori spells the name). The Johiyas themselves he believes to represent the Gandheyas, a people known to early Indian literature as being settled near the Sutlej.

This connection discussed at great length induced Dr. Tessatori to devote days to sinking pits into the larger of the two *theris* of Sohan-kot. Apart from a Muhammadan grave, a well lined with mud bricks and some broken pottery, assumed to be "cinerary", there were found remains of a double wall built with burned bricks, mostly of a size similar to that found at Rang-mahal. The character of this wall, traced for some little distance, was not determined.

The largest of the mounds along this stretch of the Ghaggar is the one close to the village of Sirdargarh, some 10 miles to the northwest of Suratgarh. It has a diameter of about 500 yards and rises to some 20 feet in height; its top is reduced to a cluster of narrow ridges by numerous ravines due to erosions. The painted sherds exposed show designs closely akin to those seen at Rang-mahal, and just as there, strings of pearls are a frequent motif on the relief-decorated ware, produced from moulds. Digging in one place on the slope has exposed a large collection of intact conical, earthen lids packed into a kind of nest, as if for disposal or transport. They are such as are still used nowadays for covering vessels to hold food or water, and are also found broken at other mounds.

Dr. Tessatori seems to refer to this collection of intact earthenware, where he describes a "conglomeration of cinerary vases mostly of a campanulate bell-shaped" which his digging had exposed close to the surface. He assumed it to have been placed over a tomb.

Summing up the observations recorded at sites around Surat-

garh, it seems safe to conclude that this portion of the Ghaggar bed must have been occupied down to Kushan times by a settled population greatly in excess of that now living in small scattered hamlets and a few villages. Only once within living memory, and that about 40 years ago, is a small volume of flood-water known to have reached down so far as the vicinity of Suratgarh. There it finally lost itself near Chopra.

On moving up the Ghaggar beyond the Bhaurianwalitheri, the northernmost of the mounds of the Suratgarh group, no sites were found for a distance of close on 8 miles. There, about two and a half miles southeast of the village of Pili-bangan, 2 narrow, parallel ridges rise conspicuously near the eastern belt of sand hills edging the Ghaggar. Separated by a narrow depression, together they form a mound about 600 yards from north to south and about 400 yards across. From their narrow crests reaching a maximum height of about 30 feet, deeply eroded ravines descend on either side.

The ridges are covered throughout with calcined slags and fragments of burnt bricks, giving the whole a curious dark appearance. Obviously the ridges mark the position of kilns in long continued use, which were gradually raised by the steady accumulation of their debris. Sherds were comparatively scanty on the surface, but the type of painted ones found among them left no doubt about the kilns having been worked at the time when the sites about Suratgarh were occupied. Their position was probably determined by the presence of suitable clay in the immediate vicinity. A large tank near the south foot of the mound is likely to mark the place where much of the clay had been dug and where the water needed for manufacture could conveniently be kept available. From the size of the "Awa", as such kiln mounds are known in the Punjab, it might be concluded that the produce was widely in demand.

Dr. Tessatori, who visited this site in April, 1917, and in December, 1918, dug some trial pits there. He described the results on pp. 99–103 of his MS. report and again on pp. 10 *et seq.* of his rough notes. He gives its name as Kala Vangu from the hamlet about 8 miles north of it, mentioned below as Kali-bangan. From the description given by him, it appears that according to information he received from Mr. Warren, an employee of the Bikanir State Railway, much had been removed from the mounds for

ballast in constructing that railway. Reference was made by Mr. Warren to small rectangular chambers enclosed by walls of large bricks and having no entrance. By these, probably small kilns were meant. Of special interest is the mention of small, circular lumps of baked clay having at that time been found in large numbers; these had a finger-hole on each side.

Such clay "implements", as Dr. Tessatori rightly calls them, were also picked up by him. Now these curious circular lumps or discs were found by us at most of the Prehistoric mounds lower down along the Hakra in Bahawalpur, but not elsewhere at mounds along the Ghaggar in the Bikanir area. This suggests that occupation of Pili-bangan site and its use for kilns goes back to a much earlier period than that marked by the painted pottery of the Rang-mahal type. These primitive clay implements may have been brought to the surface at Pili-bangan mounds by the excessive clearings and the cuttings made into lower strata for railway ballast.

About 2 miles to the north of this kiln-site is found a much smaller mound which from the hamlet close to the east of it was designated as the "theri" of Kali-bangan. Extensive digging for saltpeter for making soda—a staple industry in the Hanumangarh *Tahsil*—appears to have reduced the mound to its present size of about 170 yards in diameter. Here sherds with good painted designs of the Rang-mahal type were numerous.

Close to the village of Dulmena, about 2 miles to the north of this mound, is found another *Ther*, where operations for the extraction of soda are being carried on still more thoroughly. The mound, about 170 yards in diameter at its foot, still rises to a maximum height of about 35 feet. It appears to have been occupied until a comparatively recent period, and the rain preceding my visit on January 7 allowed lines of mud-brick walls from decayed dwellings emerging on the surface to be traced on the top. Painted sherds with boldly executed floral designs, also fragments with impressed geometrical patterns, were to be found on the slopes.

The same observations also apply to a conspicuous mound some 240 yards in diameter, to be seen near the village of Dabli, 5 miles further up on the edge of the Ghaggar and reached by the South Ghaggar canal. On following the line of this canal to the northeast there were passed 2 small mounds, appropriately

known as Dotheri, about 6 miles before reaching Hanumangarh. Here also pointed sherds of the same type as at Dabli were to be found on the ground dug up for saltpeter. At Fattehgarh, about 3 miles southeast of Dabli, the dwellings of a recently abandoned hamlet adjoin the foot of a mound. This has been so extensively exploited for *Shora* (saltpeter), that although its top still stands to a height of 47 feet only a very narrow crest is left for a length of some 80 yards.

On excavated ground lower down remains of walls with mud bricks (15×10 or $13 \times 8\frac{1}{2}$ inches) had become exposed. The fact that at deep levels exposed by these diggings painted sherds with floral designs of the Rang-mahal type could be found *in situ* is an indication of the long period during which this kind of decoration was in use. Also at Ekal-theri, a low mound about 100 yards in diameter, to the west of Hanumangarh, pieces of such painted ware were to be seen.

Arriving at Hanumangarh, the small town forming the headquarters of the *Tahsil*, which stretches along the Ghaggar to the Hissar border, I found a rapid survey of its remains much facilitated by the information which Kunwar Ganesh Singh, the very alert and well-educated *Tahsildar*, had collected in advance. A sketch map carefully prepared by him showed all mounds, large or small, to be found in each village area. From it also was clearly seen that "Thers" are with one notable exception, that of Munda, confined to the Ghaggar bed.

Tables kept available at his office made it possible for me to form an idea as to what proportion of cultivation was in each year due to irrigation from the 2 branches of the canal fed by the barrage at Otu or to inundation from the *Nali* of the Ghaggar or to rainfall only. This showed that inundation in favourable years still plays a part of some importance in the total cultivation of the *Tahsil*. This circumstance, perhaps, accounts for the fact that the number of "Thers" (mounds marking village sites which have been abandoned as no longer supporting an agricultural population), appeared smaller in proportion along the Hanumangarh portion of the Ghaggar bed than along that in the Suratgarh *Tahsil*.

Hanumangarh, although now only a small town, was a place of importance in mediaeval and Mughal times under the name of

Bhatner.[1] This name is still borne by the great fort, which sheltered the local population until recent times. It forms a large square protected by 12 round bastions on each side, and in its present state, maintained with laudable care, shows features of Mughal fortification. The central portion of the interior bearing a Jain temple rises fully 100 feet above the level of the inner gate, and this itself is reached by a steep ascent from the level ground outside. It is hence obvious that the fort stands on an ancient mound. But owing to the debris and rubbish covering the surface within the walls and the slopes below them, no early sherds were traced.

Beyond the fort there stretches eastward well-wooded ground receiving moisture from the *Nali.* Passing through it there is reached after 4 miles the large Ther of Bhadrakali named after the shrine of the goddess which occupies its eastern end. It measures close on 300 yards in length and shows a maximum height of 43 feet. The much-repaired, small temple raised on a massive platform is thickly covered with plaster and affords no clear indication of age. But judging from the quantity of painted and relief-decorated sherds, all of the Rang-mahal type, strewing the surface of the mound, continuity of local worship at the site may be assumed.

Passing thence along the South Ghaggar canal eastward, 3 flat "Theris" were visited as far as the village of Tibbi, a former *Tahsil* headquarters. But only the Theri of Masani, stretching in patches for some 700 yards from east to west, showed scanty pieces of painted and stamped pottery. It seems possible that in this area which flood water from the Ghaggar could more easily reach, alluvium has overlaid sites of earlier occupation.

When proceeding from Tibbi for about 1 mile to the north to where the Ghaggar bed was reached and seen very clearly defined, I had been shown a small mound about 15 feet high. It is known as Pir Sultan from a Muhammadan saint supposed to be buried there. From the quantity of fragments of burned bricks of different sizes it looked like an abandoned kiln.

From Dr. Tessatori's rough notes, detailed but rather difficult to follow, it is now seen that when first visiting the mound on January 16, 1919, he found on its surface several small fragments

[1]For references to Muhammadan historians see *Western Rajputana Gazatteer,* Vol. 3, p. 393.

of relief-ornamented bricks. He subsequently made a small excavation into the mound between January 20–24. This appears to have led to the discovery of a small room in a completely wrecked structure built with burnt bricks and of a small platform in the centre of this room. Here was found a small terracotta relief showing the well-modelled figure of a draped female. There were also numerous small fragments, mainly architectural, but also some of human animal figures.

Dr. Tessatori assumed these terracotta relics to have come from a "Stupa" he endeavoured to locate. But it appears likely that they all had adorned a small shrine the remains of which were dug *in situ*. Their style agrees with that of the terracottas carried away from Rang-mahal and now in the Bikanir Museum.

When proceeding on a later occasion along the North Ghaggar Canal, which follows what looked like a well-defined and perhaps more recent bed of the Ghaggar, there was found within 1 mile south of the village of Surewala a mound where painted sherds with floral designs were numerous. The mound, known as Khodan-wala Ther from a neighbouring hamlet, rises to a height of 33 feet and is about 260 yards long from north to south. Here the border of the Hissar District was closely approached.

Section 4. The Site of Munda

At Hanumangarh I first received information from *Tahsildar* Ganesh Singh of an ancient site at the village of Munda. It was declared to be the only one at a distance from the Ghaggar. It was first visited by me on January 10 and found to be situated about 11 miles in a straight line southwest of Hanumangarh. But in order to reach it by car a very devious route had to be followed, first leading to the east to Sherekan and then winding between a succession of sand ridges, typical of the *Dora* ground south of the Ghaggar.

This detour allowed me to receive some impressions of the way in which cultivation is carried on here near scattered hamlets. These obtain their water either from deep wells or else from tanks, both liable to dry up after bad seasons. But if at irregular intervals the rainfall of the summer proves adequate, very ample crops are gathered at suitable depressions between the sandy ridges tilled in an intermittent fashion. The extensive area belong-

ing to each small settlement facilitates rotation of the sown acreage.

The village of Munda is larger than most of them in this area and counts close to 100 households. But the majority of the dwellings stood empty at the time, their owners having moved away with their cattle for the time being after the poor rainfall of the preceding season. Yet I noted the fairly substantial structure of a number of such temporarily vacant dwellings. All the houses are built near the northern extremity of a sandy spur. This reaches its greatest height where its top knoll on a level of about 50 feet above the nearest flat ground is crowned by a shrine of Hanuman. The little cella is raised on a base of burnt bricks heavily covered with plaster and displays no marks of great age. But that it owes its position to continuity of local worship at this spot was at once demonstrated by the fragments of terracotta relievo and burnt bricks found nearby. These were picked up over a small plateau-like area, about 200 feet south-east of the shrine at an elevation of about 40 feet and on the slope below it.

Several shallow trenches overrun by drift sand, such as spreads all over the hill, were at once pointed out by villagers as the place where Dr. Tessatori, apparently about 1918–19, had carried out some trial excavations. I found subsequently a considerable number of terracota relief fragments from this excavation among the sculptural remains stored in the basement of the Bikanir Museum.

Dr. Tessatori (pp. 27–32 of the rough notes attached to his Report) has recorded lengthy notes regarding the excavation he effected at Munda for several days from January 26, 1919 onward. These notes, unrevised by the writer and evidently jotted down some time after the digging was done, are difficult to follow in detail, a rough sketch plan without scale or bearing not helping much to make them clearer. The following may serve as a brief summary of essential facts gleaned from them.

Dr. Tessatori found numerous fragments of relief-decorated bricks walled into the superstructure of different walls of the village and lying in the courtyard of houses. The villagers declared that for a long time it had been a common practice to dig at the site on the top of the sandy spur for building materials. In the course of digging the shallow trenches which are still visible, there were found at several places scanty remains of walls of both burnt and sun-dried bricks; the former showed sizes varying from

$13\frac{1}{2}$ to $14\frac{3}{4}$ inches in length and $8\frac{1}{4}$ inches to 9 inches in breadth with a width of $2\frac{1}{2}$ inches. Some burnt bricks were found also in patches of brick pavement disclosed. On digging some feet below a block of wall resting on a brick pavement, some broken vessels and ashes assumed to be of burnt bones were found. This evidence sufficed to induce Dr. Tessatori, always on the lookout for a Stupa, to recognize here the relic deposit of a Stupa. Some lines of "brick-bat packing" cleared at some distance from this spot were assumed, on equally inadequate evidence, to mark the foundation of the Stupa.

More useful as bearing on the true character and dating of the shrine which once stood at this place, is the reference made to numerous fragments of terracotta reliefs, including human and animal heads, found both in the course of the digging and on the eastern slope below the ruined area. As seen from the specimens examined at the Bikanir Museum and referred to below, they agree closely with the pieces which could still be picked up by us. The information contained in Dr. Tessatori's notes definitely establishes the provenance of those relief fragments and thus helps to confirm the conclusion previously arrived at as to the top of the sandy spur having been occupied by a shrine down to Kushan times.

The terracotta fragments collected at different spots, mainly on the eastern part of this area and on the slope just below it, are shown grouped in a photograph taken at Hanumangarh. They comprised pieces which at once could be recognized as having belonged to the relievo decoration of a temple dating from the Kushan period. Among them are found familiar motifs of Gandhara sculpture, such as the palmette, the four-petalled clematis-like flower, lattice-work, and part of a Corinthian capital and of a pilastered railing. Special mention deserves to be made of a small well-modelled head of a man about 5 inches high, with straight nose and eyes, moustache and curly hair. The little sculpture distinctly shows the influence of Graeco-Buddhist art. The base of a small relievo statue shows the feet of a figure and at the base characters of a very cursive Brahmi which Mr. Krishna Deva has read as Yaśodā Kṛti, interpreting it as referring to a representation of Kṛṣṇa's foster mother.

The series of terracotta fragments in the Bikanir Museum includes ornamental pieces showing such close resemblance to those

recovered by us on the surface of the Munda hillock that their having formed part of the decoration of the same shrine can be assumed for certain.

There are also found in it a number of well-executed heads both human and animal, which in size and style resemble closely the one described above. The style of the terracotta fragments recovered in the course of our preliminary search pointed to the destroyed shrine dating from the Kushan period.

This conclusion was definitely confirmed when on searching the slope below the position of the shrine as marked by those sculptural relics there were first picked up on a level of about 15 feet half a dozen copper coins lying close together on the surface, and then nearby under only a few inches of sand a small hoard of similar copper coins. Most of these, altogether 93 in number, were thickly encrusted with verdigris and thickly stuck together in lumps. But some of those from the surface appeared to me to be of late Kushan type.

This observation was confirmed when Pandit Bisheshwar Nath Reu, Superintendent of the Archaeological Department, Jodhpur, showed me the kindness of having these coins cleaned at his Museum and then recognized 2 of them as being of Kadphizes I and 3 more as of later Kushan issues. Since then the cleaning of the copper coins comprised in the hoard has been effected at the Taxila Museum through the kind help of Mr. N. Gupta, its Curator. It has shown that all of them are pieces of late Kushan type.

Sherds with painted designs, floral and geometrical, closely corresponding to the painted ware from Rang-mahal-theri and other mounds previously described, were to be found on the surface chiefly on eastward slopes below the site of the ruined shrine. There were to be also found pieces with relief and impressed decoration just like those associated with the painted ware from the same sites. In order to make quite certain of the statigraphic relation between this painted or ornamented ware and the structural remains on the top, I had a trial trench dug at "B" from the edge of the area "A" over which those remains had been traced. In the course of this digging carried on for 2 days (January 11–12) only plain sherds were found down to a depth of 4 feet, together with fragments of burnt bricks ($13 \times 8\frac{1}{2} \times 3$ inches and $11 \times 8 \times 3$ inches). But below this level painted fragments

turned up again down to a depth of 7 feet where a mass of burnt bricks was struck from a fallen wall. Among this were several intact bricks ($14 \times 8\frac{1}{2} \times 2\frac{1}{2}$ inches).

After this layer had been removed, more painted and decorated pieces were found down to a level of $9\frac{1}{2}$ feet. Among three slender handles found here, probably from small bowls or cups, 2 have a thumb rest; a third shows relief decoration, resembling a head, where it apparently rested against the side of a cup. At the same depth turned up numerous small fragments of black, burnished ware. A small bowl showing a pattern executed with neat perforations was also recovered at the same depth. At the same level there were found pieces of a large plain vessel and by its side numerous broken cover lids of conical shape meant for pots, such as those found at Sirdargarh and other mounds of the Suratgarh area.

The objects clearly showed that the ground below the shrine down to a level of about 30 feet had been occupied at a time when painted and decorated pottery was in use. The excavation below was continued for some 5 feet more, but disclosed only the same fine sandy soil as found all over the hill and along its foot.

On the ground stretching to the spur to the south, small patches between low dunes were seen to be covered with much broken sherds for a distance of some 500 yards from the Hanuman shrine on the top. Similar "Tati" patches of small extent were observed to the west also, but for a lesser distance on ground now overrun by drift sand. According to an old villager's statement cultivation, no doubt intermittent here as elsewhere, had at one time approached the foot of the hill, and trees growing here among rudimentary dunes seemed to support this statement.

Short as our trial excavation on the hilltop had been, it afforded definite evidence supporting the belief that the painted and decorated ware found here at Rang-mahal and other sites along the Ghaggar described above had continued in use down to the Kushan Period and is likely to have preceded it for some time.

Accepting this evidence and taking into account the size of these sites and their number, it seems safe to conclude that at that period physical conditions along this portion of the Ghaggar bed must have facilitated cultivation to an extent perceptibly greater than the one found at present. This permits only a very scanty population to maintain a precarious existence on that ground. The cause or causes for this change will best be considered further on, after

examining what observations made on similar lines along other portions of the Ghaggar bed and its continuation known as the Hakra may teach us.

Here it may conveniently be stated that general opinion repeatedly expressed to me in the Hanumangarh area alleges that the volume of water available for cultivation both from the Nali and the Ghaggar canals has considerably diminished for many years past. This reduction is uniformly attributed to the increased diversion of flood water from the upper course of the Ghaggar which takes place in the Punjab districts and Patiala, through numerous weirs there constructed to irrigate the land of villages along the banks.

The complaints repeatedly raised by the Bikanir Durbar about the loss of water due to this cause, are recorded in the Gazetteer as having led to the construction in 1897 of the Otu barrage and the Ghaggar canals. This recent diminution of the available supply of water for irrigation may not affect as yet the prevailing physical conditions of the Ghaggar bed to an appreciable extent. But this case of human interference with the flow of water in a terminal river course deserves to be kept in view as illustrating a question of wider geographical interest discussed by me elsewhere.

There is good reason to assume that the steady extension of the demand for irrigation which has caused weirs to be raised across the Ghaggar in its upper course within the districts referred to and has thus brought about diversion of its waters, is a direct result of that increase in population and in cultivation needed to feed it which has followed the establishment of peace and security since those districts came under British control early in the last century.

Section 5. Down the Ghaggar to Anupgarh

After my return to Suratgarh and the renewed examination of the Rang-mahal site, there still remained to be made a survey of that portion of the Ghaggar lower down which extends to the Bahawalpur border and lies within the Anupgarh *Tahsil.*

Here the old bed of the Ghaggar is now occupied all along by new colonies which receive irrigation from the southern terminal portion of the modern Ganga Canal fed by the Sutlej. I had reached the vicinity of this canal irrigation already before when

visiting the Sohan-kot Ther on December 29 from Suratgarh. Before starting on January 19 to complete the survey of the remaining portion of the Ghaggar within Bikanir territory, heavy rain during the preceding 2 days had rendered the ground within the irrigated area along the bed impassable for cars. It therefore became necessary to proceed first by rail to Ramsinghpur Station in the direction of the *Tahsil* headquarters at Anupgarh, whence transport facilities by camel or horse could conveniently be secured.

Using the canal Inspection Bungalow at Ramsinghpur as a base, there was visited the same day the reported *Ther* near the neighbouring village of Red. It proved to be a small, low mound bearing only plain sherds on its surface but no fragments or painted or otherwise decorated ware. On proceeding next to the "Ther" called after the old hamlet of Baror, some 4 miles below Ramsinghpur, I found there a mound measuring about 260 yards in diameter and rising to 25 feet at its highest point. Here also painted ware of the Rang-mahal type was conspicuous by its absence and only a few fragments with incised narrow ribbing could be found.

In view of what has been stated below about the evidence of late Prehistoric occupation at mounds in the Anupgarh *Tahsil* afforded by the type of incised pottery found there, it is of interest that Dr. Tessatori in his rough note on the Baror mound (spelt by him Varoravalitheri) mentions having found there a stone blade.

Dr. Tessatori mentions having picked up stone blades also at the mound called by him Mallavali-theri. Judging from the reference he makes to the lofty sand hill at the foot of which it is found and from an entry made by him in an "Atlas of India" sheet accompanying his Report, there is reason to believe that this mound is identical with the one for which the name of Mathula-theri was given to me. The designation of Mallavali (the "mound of the boatman"), suggests connection with the story about the ferry boats for which the Mathula ridge is supposed to have once served as a landing place.

On January 20 a camel ride of close on 40 miles mainly along the canal branch called Binjor Minor enabled us to examine 2 reported *Thers* westward. The one situated about 2 miles to the southeast of the hamlet of Binjor proved very flat and about 200

yards across. Here all broken pottery was plain with the exception of a few fragments painted with simple black bands or showing incised circular lines. But the worndown appearance of the surface, manifestly due to erosion of ages, suggested antiquity and the find of a small flint, apparently worked, seemed to confirm this.

The second mound about ½ mile further up the canal branch closely resembled the former in size and appearance. Here, too, apart from a few pieces with coarsely incised or impressed simple patterns, all the sherds were plain. It deserves to be noted that much of the ground passed during this tiring ride was uncultivated in spite of available irrigation. The salty nature of the soil was said to account for this. The thought suggested itself that possibly at a remote period terminating floods of the Ghaggar used to spread over this ground, and leaving their water to dry up here, impregnated the soil with its salt.

The next day's ride took us from Ramsinghpur for a distance of about 7 miles up the Ghaggar first where the left bank of the Bijainagar Minor Canal branch passes close to the mound called Kharuwala-ther [Chak 43]. This is called after a former owner of the cultivated ground at its foot. The mound is a fairly large one measuring about 400 yards in length along its 2 ridges and rises fully 20 feet where highest. Apart from plentiful plain potsherds, there were found here a few painted with single or double black bands.

Following the same canal branch for 4 miles further there was reached the Mathula-ther. It lies about 1 mile to the northwest of a conspicuous sand hill, which juts out like a promontory into the wide Ghaggar bed from the line of sand ridges on the south and is known by the name of Mathula

On the mound which measures roughly 300 yards in diameter and is some 25 feet in height, there were to be seen amidst abundant plain pottery debris only few sherds with very coarsely painted geometrical designs. Some fragments of bangles made of a blue celadon-like ware were picked up such as are frequently met with also at apparently Prehistoric sites further down on the Hakra in Bahawalpur territory.

A curious local legend takes the Mathula sand hill for the place where boats starting from the sandy ridge on the opposite northern edge of the Ghaggar bed, nearly 4 miles away in a straight

line, used to land. That ridge is now known as Juhanzwala ("the boatman's place"). Whether possibly some "popular etymology", connected with an early form of that name, or the appearance of the 2 projecting sand ridges gave rise to what obviously can only be a legend, I am unable to say. In any case it affords interesting proof how much alive in local belief is the notion of a large river having once flowed down the dry bed of the Ghaggar.

Crossing the main Anupgarh Canal there was reached to the northeast of Bijainagar Station an extensive debris area between the cultivated ground of the new colonies called Chak B.G. 21 and Chak B.G. 23 (no local designations have so far had time to grow up). Known as Jaurinwala-ther, it measures on flat ground nearly a quarter mile across, with a mound in its centre rising to some 25 feet. Here too no painted sherds were to be found and of decorated were only some pieces with narrow ribbing.

Proceeding next morning from the Inspection Bungalow at Bijainagar to the northwest there was passed first at Shivapuri a newly-built residence of Maharja Mandhata Singh, occupying the top of what was an old mound. Then, on following for 2 miles the northern edge of the Ghaggar bed well-marked by high dunes, we came to the residence of the Commander-in-Chief of Bikanir, a relative of the Ruler. It was interesting to note that about walls surrounding the place built some 10 years before drift sand had accumulated so much as to cover up the loopholes. I may mention here in passing that a similar advance of driftsand could be observed also outside the enclosing walls of His Highness' shooting lodge at Suratgarh.

Half a mile to the east of this fortified residence there stretches a "Tati" patch—to use the convenient designation supplied in Chinese Turkistan for such debris areas—close on 400 yards in length. This is known by the name of Juhanzwala, already referred to before. No painted fragments were to be found amid the plentiful plain sherds on it. But at 2 mounds, situated 4 and 6 miles respectively further to the northeast and known by the numbers of the new colonies near them as the Thers of G.B. 16 and 12, painted sherds first turned up again, although not in great numbers and only with coarse geometrical designs.

Then finally going a couple of miles further north there was found close to the foot of a conspicuous ridge of sand, marked with 627 feet on the quarter inch map, the mound known as

Jandewala. This is supposed to have been named after the boatman whom local belief assumes to have taken his boat across the Ghaggar river from Juhanzwala to Mathula. The mound, originally large, has been greatly reduced by digging for manuring earth and now rises only to 15 feet with a diameter of some 160 yards. Here painted sherds, with coarsely worked patterns, were to be seen again in great number. From the mound the railway station was well in view and also the mound of Sohankot, the nearest of the sites marked by pottery of Rang-mahal type less than 4 miles distant eastward.

Thus, it became evident that here we have reached the westernmost limit of the ground in the Ghaggar bed to which settled occupation can definitely be assumed to have extended in Kushan times. And here my survey of remains along the stretch of the Ghaggar lying in Bikanir territory was concluded.

Before completing this Survey, I had at the advice of the very helpful and experienced Nazim of Suratgarh, Pandit Bholanath, availed myself of the opportunity offered by the opportune rainfall to visit from Suratgarh the village of Pallu where old remains were reported. It is situated about 25 miles in a straight line east-southeast of Suratgarh amidst the sandy ridges of the "Dora".

Owing to unavoidable detours fully 41 miles had to be covered on the journey to it. If the visit there had had to be done with camels it would have cost me several days. Fortunately, the preceding rain had hardened the sandy soil sufficiently for it to be done by motor car in one day. But at every hamlet passed a fresh guide had to be successively picked up to show a practicable passage between the dunes. It was a very instructive experience, since it allowed me to gain some idea as to how semi-agricultural, semi-pastoral existence can be maintained here amidst very serious physical drawbacks.

Throughout, this "tame" desert supports a good deal of scrub and tree-growth, and a season with a fair rainfall provides an ample amount of grazing for cattle and camels. Then wells and shallow tanks also suffice for water. In recurrent seasons of draught, spasmodic "transhumance" to riverine belts or areas with a less arid climate serves as an expedient. But the losses in livestock then are often serious.

Pallu is a village now counting about 50 households held as a fief by the Raja of Mahajan. It occupies the top of a mound ris-

ing some 25 feet above the flat ground around. That the place is old and was once much larger can be safely concluded from the remains of a rectangular circumvallation, of which the mound lies in the southern position. The north and west faces of it are traceable in the shape of much decayed ramparts covered with debris of calcareous stone. The western face, partly occupied by houses, measures about 260 yards in length. On the top of the ramparts where clear of dwellings sherds are plentiful and among these were found some which by their painted and incised or impressed decoration recalled the Rang-mahal type. They are likely to have been carried up there with earth from once occupied ground within or outside the enceinte.

The north wall, near its eastern end, bears a modern shrine of Siva. Outside its base are placed 2 steles bearing relief carvings of mediaeval aspect representing apparently manifestations of Visnu. Outside the west wall stands a small ruined mosque. Within the village is a shrine of Devi heavily coated with Chunnam, and against the walls of an outer court are placed numerous carved slabs of different sizes and styles. All were declared to have been found along the circumvallation, several of them being manifestly Sati monuments. (Dr. Tessatori's Report of 1917–18 on pp. 61–69 contains a full account of Pallu, describing in detail the sculptural remains at the shrine and recording at great length legendary traditions about the place). In spite of its scanty remains, Pallu enjoys the reputation of being a place of great antiquity and former importance.

On completion of my work along the Ghaggar I returned to Bikanir City, where a busy stay over January 23–25 enabled me to take my leave from H.H. Maharaja Ganga Singhji and to thank that very remarkable Ruler personally for all the help and hospitable attention which had so greatly facilitated full use of the time spent over my labours in his State.

The renewed visit to the capital enabled me to study, as already stated, the antiquities from Rang-mahal, Munda, etc., which had previously been brought to the Museum and to have photographs taken of representative specimens for comparison with my finds. All sculptural relics among the latter were also photographed before being deposited by me at the Museum.

Chapter 2

FROM JODHPUR TO BAHAWALPUR

Section 1. Through Jodhpur and Jaisalmer to the Bahawalpur Border

After completing the examination of old sites along the Ghaggar bed as far as it lies in Bikanir, the next task was to continue this Survey into Bahawalpur territory through which leads the same dry bed, there known as the Hakra.

Arrangements for this part of my tour required to be made with the authorities at Bahawalpur City, the capital of the State. To the southeast Bahawalpur is adjoined by Jaisalmer territory containing a main portion of the "Great Indian Desert".

By approaching Bahawalpur from that side I could gain some preliminary acquaintance with the ground along which once passed the river marked by the dry bed of the Hakra. The quickest way to pass through Jaisalmer territory, still almost completely devoid of motorable roads, lay from the side of Jodhpur, and the fact of the Resident from Western Rajputana, Major N. S. Alington, being stationed at Jodhpur provided an additional reason for taking the route.

The very helpful and hospitable reception accorded to me at the Jodhpur capital by the State authorities, for which my very grateful thanks are due, especially, to the Prime Minister and Mr. S. G. Edgar, Minister of Public Works, Jodhpur, enabled me to pay visits to several localities of archaeological interest.

Much useful instruction was derived from the guidance which Mahamahopadhyaya Pandit Bisheshwar Nath Reu, Superintendent of Archaeology, Jodhpur, afforded both to the sculptural remains gathered in the State's excellently managed Museum, and to the temples of Mandor, the ancient capital.

Thanks to the information provided by Mr. F. F. Ferguson, Executive Engineer, I was able to make distinct excursions to separate areas near Phalsund, Pachbhadra and Pali in which the

presence of dry river beds suggested the possibility of sites of early occupation being found.

The ground traversed on each occasion, mostly desert with eroded rock outcrop and sand dunes, proved interesting from the geographical point of view, but it was only in the vicinity of Pachbhadra that remains of some antiquity could be traced. There to the southwest of the small town lies the site of Kher. Its extensive mounds stretching along an abandoned bed of the Luni River are believed to mark the old capital of the Mallani tract of Marwar.

A much-restored temple of Visnu Chaturbhuja, which is still a regular place of pilgrimage, contains in its cellar an image base with the Samvat date of 1237. The line of mounds stretching along the right bank of the dry bed bears at its western end a small temple. It stands on accumulated debris on which are found numerous fine sculptural remains of a larger and earlier temple. Some of their relievo ornament shows Gandharan motifs. Among the plentiful sherds, mostly of dark gray, which covered the mounds, impressed floral and geometrical designs are frequent as well as narrow close ribbing. Painted fragments with simple geometrical designs are rare.

Popular belief, as noted also in the "Preliminary List of Antiquarian Remains of Marwar," of which I was kindly enabled by the Resident to see a copy, ascribes to the ancient capital a circumference of 7 miles. In support for this local tradition, we were guided by an old villager to a small mound close on 4 miles distant lower down. This is cut into by an inundation bed of the Luni and rises steeply above it to a height of about 25 feet. Apart from pottery debris, closely agreeing in type with that of the Kher site, there were found on it numerous burnt bricks ($13 \times 9\frac{1}{2} \times 2$ inches).

Another visit was paid to the old town of Pali some 45 miles southeast of Jodhpur City. Mounds had been reported along several feeders of the Luni, which were crossed both on the way along the new canal now feeding the artificial lakes above the city, and then back by the main road, but they all proved to be natural.

Pali itself is an old place as proved by an inscription dating from A.D. 1143 in its earliest temple, that of Siva Somnatha. The town was once of importance owing to a great trade route, which

passed here from Sind toward Malwa and Central India. The contrast between the fertile irrigated tract down toward the Luni and the barren areas to the north and west of the town wholly dependent on the erratic rainfall of Marwar, was striking.

Arrangements were secured with Major Alington's kind help for my passage through Jaisalmer territory. On February 1 they allowed me to leave Jodhpur City by a newly-opened branch line of the railway for Pokuran near the State's eastern border. On the following day a motor journey of 71 miles brought us to the capital of Jaisalmer. It led partly over the northern portion of the much longer route from Barmer, which before had been the only one available for wheeled traffic in the territory.

The very hospitable attention shown to me under the orders of His Highness the Maharawal of Jaisalmer enabled me in the course of a 3 days' stay fully to appreciate the special interest presented by the town. Owing to its position it has long remained unaffected by Westernising influences and has thus been allowed to preserve many fine specimens of the traditional architecture of Rajputana.

The capital, with solidly built walls of the local yellow sandstone surrounding it for a distance of about 3 miles, and the citadel rising on a high rocky ridge within, present a very impressive appearance and contrast strikingly with the barren desert look of the State as a whole.

While the ground over which the town is approached from the south and that elsewhere in its vicinity consists of low rocky ridges, most of the country has well been described as a great sandy waste. That the area of some 16,000 square miles comprised in the Jaisalmer State supported in 1901 a population of only 4.5 per square mile, sufficiently illustrates the desert character of the territory.

The great proportion of the ground covered by continuous chains of high sand hills, the scanty and very irregular rainfall, and the almost complete absence of running water, fully explain this. To the close limitations thus imposed upon cultivation by the physical features is added that which affects pastoral occupation owing to the great depth at which subsoil water can be found and the consequent scarcity of wells.

It is obvious that with a population so widely scattered and so devoid of resources no old sites indicative of denser and economi-

cally more advanced occupation could be looked for, unless climatic conditions had undergone a material change since Prehistoric times or later. Of such a change no indication has so far revealed itself. It might hence well appear puzzling to find now in the midst of so poor a territory a place like the present Jaisalmer town.

According to the Census preceding the severe famine of 1899–1900 with its attending emigration, Jaisalmer counted some 10,500 people, and in many of its private buildings, in its large tanks, temples and funerary monuments, it still displays unmistakable evidence of considerable former affluence. Fortunately, knowledge derived from comparatively recent history and even from living memory helps to explain this observation more easily than would be possible for an antiquarian student with centuries of evidence.

Until the extension of the British Raj and the construction of railways radically changed conditions, Jaisalmer had been an important emporium for the caravan trade which passed from Sind and the side of Kandahar toward the Gangetic plain and Central India. The desert routes through Jaisalmer town afforded just the conditions best suited for camel transport on which caravan trade until then mainly depended in the northwest of India, as it had done all through the Middle East.

To the wealthy merchants, mostly Paliwal Brahmans, who had a principal share in this trade, in the old days, "Jaisalmer was a favourite retreat, being remote from the scenes of war and from exactions in the times of Mughals, Marathas and Pindaris." This record of the Gazetteer was confirmed and amplified by interesting information I was able to gather locally.

When conditions of traffic changed in the course of the last century, those enterprising trading and banking families gradually moved away from Jaisalmer and other old seats of theirs in Rajputana to secure new bases for more profitable and extensive operations in the great ports and other commercial centers of British India.

There known by the general designation of "Marwaris," many of them play nowadays an important part in the commerce of the Empire as bankers, brokers and the like. But it is still customary for those families to return to their old homes for the celebration of marriages and for other important occasions, to keep their heirlooms of special value, etc. This accounts for the good conser-

vation of a number of old residences in Jaisalmer, the facades of which display a lavish ornamentation with fine carvings in the local yellow marble. Elsewhere the large number of houses abandoned or decayed into ruins to be seen within the town walls clearly shows how the departure of the trade once passing through Jaisalmer has affected the population and general prosperity of the place.

Thus, Jaisalmer town offers a striking modern pendant to those ancient "caravan cities"—to use Professor Rostovtzeff's happily coined term—in the Near East, such as Palmyra, Petra, Hatra, which now lying in ruins still attest the importance of the trade routes once passing through its deserts.

Just as in the case of those "caravan cities", the transit dues levied on the trade passing through Jaisalmer territory and the payments made for its protection from raids which the caravans needed, are likely to have played at one time a large part in the resources of the chiefship. Otherwise it would be difficult to account for the massive fortifications which gird the ridge of the citadel and for the numerous old temples and places crowding its top. But, however this may have been, the most effective protection afforded to Jaisalmer town against attack was the barrenness and want of local resources in the surrounding territory, precluding aggression by any large body of enemies.

As a place of safety the isolated rocky ridge of the Jaisalmer fort must always have been specially inviting provided deep wells could assure water, yet it is certain that it did not become the capital of the Bhati Rajputs, after the Muhammadan invasion had ousted them from the Bahawalpur tract, until the rule of Rawal Jaisal from whom it received its name.

Without trusting the so-called "Bardic Annals" too far for exact chronology, the reign of this Jaisalmer ruler may be placed in the twelfth or thirteenth century. Lodorva is traditionally accepted as the side of the preceding capital. Its site, now occupied only by a small hamlet about 10 miles to the northwest of Jaisalmer town, was visited by me on a day's excursion from the latter. The ruins of the place lie mainly along a narrow stretch of ground between the western bank of the Kaknai stream and a series of shallow ravines running more or less parallel from north to south. The stream carries running water only during rain floods but holds water in places at no great depth.

Remains of stone-built walls much decayed could be traced along the b nk for a distance of about 500 yards from a small temple holding a four-faced Linga to the ruin of another small cella further on. From a short stretch of wall foundations near the latter, steps of a Ghat could be recognized leading down into the bed of the stream below. At a small rocky eminence further north the scanty remains of a circumvallation seemed to turn away from the bed for some 250 yards, and the debris of pottery marking former occupation here stopped.

Turning south from this point foundations of detached structures could be found lying in a line, but no recognizable wall until a short stretch of a bastioned ramp rt was reached. It forms part of the enclosure of a handsome and well-preserved Jain shrine still serving as a place of worship. It is dedicated to Parasnath and shows much fine carving both on its walls and on a Torana rising in front of the entrance. I could not secure any definite indication of the date of the construction of the temple, but it certainly looks early mediaeval.

Near the entrance to the enclosure of this temple a small Hindu shrine is found inside a massive rectangular colonnade, which looked early and is now half-filled by driftsand. The ruined rampart outside the Jain temple could be followed further for a short distance past later dwellings built with old materials to where a gate seems to have led through it into a small ravine. From here the rampart in a much decayed state was traceable for close on 400 yards running to the bank of the Kaknai bed and then along it to the Siva Temple before mentioned.

Information previously collected had indicated the desert route leading northwestward to Sadiqabad as the line which would conveniently take us to the southern extremity of Bahawalpur territory. It would also allow me to gain some acquaintance with the physical and economic conditions in the belt of high sands which confine Jaisalmer toward the Punjab plains on the Sutlej and Panjnad. The greatest part of the journey had to be made with camels, and I had reason to feel very glad for the prompt and very efficient arrangements as regards transport and guidance which under the instructions of the ruler, Dr. Sikund, the very obliging Dewan of Jaisalmer, had very kindly made for my progress. It was a special satisfaction to me to find that the proposed route would take me through Tanot, the place which

tradition indicated as the first seat of the Bhati chiefs preceding Lodorva.

Before my departure I had the pleasure and privilege of being received by His Highness, a fine figure of the true Rajput type. It was instructive at that interview to learn from that enlightened but wisely conservative ruler of the lines on which an endeavour is being made in the State to maintain local traditions of architecture and art, to promote material progress in keeping with the available resources, and to meet the difficulties which beset agricultural development owing to climatic drawbacks by means of conserving the rainfall.

Since the configuration of the ground practically precludes irrigation from any source, the only chance of this is offered by the increased construction of *kharins*. It is the traditional method by which suitable patches of ground between sand dunes are enclosed by low embankments and thus made to retain such moisture as may permit crops being sown after what modest amount of rain has favoured the arid land.

To meet on my subsequent marches with such *kharins* in apparently hopeless wastes was just as refreshing for the eyes as it was to find shall plantations of fruit trees at a few places near the capital where rocky ravines had allowed former rulers to create reservoirs for the storage of rain water by the construction of regular dams.

How precious these plantations are was curiously illustrated by the inscribed slabs below particular mango trees of great age recording the grant of their fruit to certain families by former rulers.

On February 6, I started from Jaisalmer with feelings of grateful remembrance for all the kind and hospitable attention received there. The first stage of the journey lay to the village of Ramgarh at a distance of some 40 miles and could be covered by lorry, although not without some difficulty where the track led first over stony plateaus and across what looked like wide flood beds. Ramgarh proved a fairly large village said to count about 300 homesteads. But half the dwellings, mainly huts built with brushwood, stood empty, the owners being away with their cattle and camels at different grazing grounds. Ramgarh is favoured with a number of wells of no great depth in a wide sandy drainage bed. The ample supply of water thus assured for most of the year accounts

for its serving as a convenient base for the relatively large number of families leading an essentially pastoral life.

It was of interest to note here a type of quasi-seminomadic existence which is characteristic of these arid parts and helps to throw light on their earlier economic history.

At Ramgarh we were joined by Jamadar Baribakhsh Khan, a wiry and active petty foudatory of the Darbar from Tanot. His effective arrangements for camel transport and mounts greatly facilitated progress over what otherwise might have proved a rather troublesome journey.

The belt of low sandy ground showing plentiful scrub, and supporting tree growth in places, came to an end after some 12 miles from Ramgarh. Beyond this a zone of well-defined ridges of high sands was entered. Curiously enough these long-stretched ridges, rendered stationary by patches of scrub, chiefly tamarisks, seemed to run in a direction, approximately north to south; yet the individual dunes as observed from the back crossing the saddles between them showed a "Barkhan" shape indicative of prevailing winds from the southeast.

After another 12 miles of march the well of Girdau was reached on a narrow patch of clayey ground between 2 of those high sand ridges. To this well (90 feet) large herds of camels were being brought for watering from different directions during our halt for the night.

The next day's march which brought us to Tanot showed the difficulty about water experienced by the grazing people who spend most of the year away from their homes. A number of families from Tanot we found living in round huts built with brush-wood among dunes at a point known as Akli, depended for water on the well of Girdau more than 5 miles away to the south.

Near Akli the north-south direction of the high sand ridges was observed for the last time. From there onward the dunes crossed grew broader and showed a "Barkhan" shape, facing for the most part northward. Before passing the trough of Ghatyal with a well some 150 feet deep and apparently out of use at the time, trees made their appearance sparsely. They were encountered at intervals on approaching Tanot after another 15 miles of march.

Tanot, traditionally believed to mark the Bhatis' first "capital"

after they had been obliged to abandon their seat at Derawar, now in Bahawalpur territory, to the invading Baluchis, is a poor-looking hamlet of some 150 homesteads. But most of the dwellings built with and bricks or lumps of clay stood empty at the time, the owners with their families were away to graze their camels and what livestock was left after 3 preceding years of inadequate rainfall. The 3 inches of rain of the last summer reported in Jaisalmer had, however, resulted already in some recovery by reviving vegetation in the desert.

The hamlet occupies the top of a low mound bearing the remains of a square circumvallation; of this 2 much decayed towers are still standing on the north side. They show walls built with mud bricks and faced with small burnt bricks of square shape. Many of the dwellings inside are rough circular huts covered with a roofing of mere scrub. The only more substantial dwelling is the *Tahsildar*'s house. It is built with burnt bricks taken from the ruined circumvallation; its outside wall bears an inscribed slab which records its construction in Samvat 1780 (A.D. 1725).

Inside the once-walled area is a well 90 feet deep; outside it to the east 2 shallow tanks were found dry. Plenty of debris of mud bricks, rough sherds and ashes covers the slopes of the mound, but there is nothing to suggest early occupation of the site. All the same, the tradition about Tanot having served as the first stronghold of the Bhati Rajputs after their having lost their hold on Derawar, is of some interest. It shows that Baluch occupation of the land east of the Sutlej in the present Bahawalpur territory had stopped short near the edge of the unproductive sandy desert, and thus it remains to this day.

On my visit to H.H. the Maharawal, it was mentioned to me that on enquiry made on my behalf about any old remains within reach of Tanot, 3 places with pottery debris had been reported. Their names were given as Ratriak Dehri, Jhumki Dehri and Tulewali Dehri. From enquiry made at Tanot it was learnt that none of these was nearer than about 12 miles, all 3 being situated in different directions. In order to avoid waste of time, I had to be content with having different couples of Tanot men sent out on the day of my arrival to search each of them for fragments of pottery or other old objects. A day's halt had to be made to await their return. In each case the report received was that no mound was to be found at the place named, but flat ground amidst dunes

bearing pottery debris.

The specimens brought from the latter were either coarse plain ware or else showed simple impressed designs on the rims of vessels or rough flat ribbing. Since no useful indication as to the time of occupation at these spots was likely to be secured from such finds, the journey towards Sadiqabad was resumed on February 10.

That day's march was to take us across the Bahawalpur border to a grazing ground known as Kandera near the edge of the flat, alluvial plain stretching along the Panjnad in which gather the united waters of the rivers of the Punjab before joining the Indus. Our track led northwestward across low dunes past a succession of high ones, having the shape of "Barkhans", with their apex turned to the northeast.

When approaching after 8 miles a flat patch of bare ground known as Ahmad Khan Dehri on the lee side of a "Barkhan" (40–50 feet), we came upon a low ridge of sand showing plenty of sherds on its surface.

The pottery was scattered over an area about 250 yards in length and about 100 yards wide where not covered by drift sand. Among the pottery fragments there were a number painted with black bands and simple cross-hatchings over a red slip; there were also perforated pieces and others showing impressions from basket work on a burnished surface. Antiquity of occupation at this spot was proved by numerous finds of small worked flints, among these a dozen or so could with certainty be recognized as used blades, scrapers or borers, one of these measuring 3 inches. With these were found some chipped flint cores. There were picked up also 2 small balls of black stone which probably served as sling-stones, and part of a terracotta bangle. One or two pieces of stone evidently contained ore.

Only 2 furlongs further the patch of bare flat ground properly, known as Ahmed Khan's dehri, was found to be covered with plenty of similar remains. It measures about 460 yards from north to south and only little less across where widest. On the south and west it is adjoined by the steep slope of a "Barkhan", while on the north lower dunes encircle it. The ground thus surrounded is quite clear of sand except where small cones bearing dead scrub have allowed drift sand to accumulate at their foot. These cones exactly corresponding to the "tamarisk cones", so familiar to me

from the Taklamakan and other Central Asian deserts, show at their foot unmistakable signs of the wind erosion to which this open ground has been exposed for a long time. It is important to note this fact; for it explains how pottery fragments dating probably from a prolonged period of occupation have come to lie uniformly on the surface and in such abundance.

Apart from plentiful plain sherds varying in their fabric, there were found quite a number of sherds showing simple hatchings painted in black; 2 very small scraps of copper work were also picked up. Side by side with these were found pieces of plain burnished ware and plenty of small worked flints (or cherts), among them several showing unmistakable marks of use. No cores were seen here. This might suggest that those who produced such articles did not live here but perhaps on the previously mentioned low ridge to the southeast. Apart from the ring base of a cup and the portion of a lid no fragments from readily recognizable vessels were recovered. This fact seems to point to a more advanced disintegration of ceramic remains, whether due to longer exposure or to wind erosion. In any case the finds of worked flints afford clear evidence that occupation at this spot goes back to a Prehistoric period.

The abundance of broken pottery and the extent of the ground it covers—a good deal more of it may now be overrun by dunes—might suggest that conditions for settled life were more favourable and hence occupation, perhaps, denser than they are at such graziers' settlements as Tanot. But without the discovery and close examination of other sites of this type in the great belt of sand dunes it would be hazardous to conclude that the occupation of Ahmad Khan-dehri necessarily goes back to a period when a larger annual rainfall permitted extensive cultivation on this ground. It still remains to be noted that according to Jamadar Baribakhsh's statement the site owes its name to his grandfather who had a well sunk at the site with a view to its occupation. But though water was struck, it proved too brackish and the attempt at renewed occupation was abandoned.

Beyond this site the dunes still continued fairly high and the tamarisk scrub scanty for some 5 miles until the demarcated boundary of Bahawalpur was passed. Then at a distance a group of trees, known as *kanda*, was sighted. They marked the approach to the grazing ground of Kandera near the edge of the alluvial

plain of the Indus. There we halted after a total march of close on 20 miles. At Kandera were found several water holes, some of them brackish. A number of Baluch graziers with large herds of camels camping near them showed that an ethnic as well as a physical line of division had been crossed on our way to the Indus Valley.

Close to the water holes of Kandera there rises on a low mound a ruined fort of the same type as found at Tanot and about 50 yards square. It was said to have been built by the Mirs of Sind, and the construction of its mud-brick walls faced with small burnt bricks indicated its late date.

Jamadar Baribakhsh Khan declared the fort to have been occupied for some time by his great-grandfather, Umar Khan. It was an indication how this uninviting ground on the edge of the sandy desert had been even down to modern times a bone of contention between Rajputs and Muslim invaders. Among the sherds strewing the ground near the mound there were many painted with black bands and hatchings resembling those found at Ahmad Khandehri and suggesting early occupation; but no worked stones could be found here.

Proceeding to the northwest across a wide stretch of bare, clayey ground suggesting an inundation bed or lagoon, there were seen in quick succession at distances of 1-1.5 miles from Kandera 2 low mounds known as Tikrat-dehri and Lundi-dehri, respectively. At the former some painted sherds of the same type as just mentioned turned up among the abundant plain fragments, as well as 2 unworked flints. On the second and smaller mound such decorated sherds as could be found showed only incised and impressed designs with circlets and shell-shapes. It is likely that on ground like this which may have been liable to inundation from the Indus at different periods, cultivation whether intermittent or regular has led to renewed occupation of the same site after intervals.

The extent to which the flat, alluvial plain northward is subject to changing conditions affecting cultivation was brought home to me when only a mile or so further on we came upon a large modern brick kiln. It had been constructed and for a short time used to provide building material along the "Kandera Distributary", a branch of the new Panjnad Canal which since the last 10 years irrigates most of Bahawalpur territory in the south.

Owing to the volume of water available at the head of the canal having failed to reach the expected measure, the terminal portion of the distributary had to be abandoned. In consequence of this failure to provide needful irrigation, the track toward Sadiqabad led for 6 miles more across a desolate waste of flat mud-encrusted ground covered with small scrub and overrun in places by low rudimentary dunes. It was a typical picture of the alluvial desert plain, which the rivers of the Punjab with their ever-changing courses have deposited for long ages over vast portions of their valleys. Then on passing the small village of Maijuwaidi-mer where scrub-covered huts occupying a low mound mark an old settlement of graziers such as seen on the Jaisalmer side, there was noted a marked change in the picture. Channels cut by new colonists had brought canal water to small patches of ground seen already under cultivation and laborious clearing of the scrubby jungle around was proceeding.

It was the same on the march thence to Sadiqabad, the way lying partly along miner canal branches in full flow and partly over straight roads made to connect the new colonies with the *Tahsil* headquarters and railway station at Sadiqabad. It was interesting and pleasant at the end of a long and tiring march to see there how the rapid development of this area, for the most part, fit only for grazing before the new canals came, reflected by a flourishing little town with cotton mills, some factories and bustling trade. Still more pleasant, perhaps, it was to be assured by the welcome I received there that through the kind help of Mr. H. Trevelyan, Deputy Commissioner and Colonization Officer, Bahawalpur, all arrangements to facilitate my planned survey of old sites along the Hakra bed had been made by the authorities of the State.

Section 2. From Sadiqabad to Bahawalpur

On the morning of February 12 following my arrival at Sadiqabad Mr. Trevelyan had the kindness to come in person to meet me. The information received from him made it clear that in order to settle the programme for my proposed survey along the Hakra bed and to make the needful preparations a preceding visit to Bahawalpur City, the capital of the State, would be needed. For the first part of the journey there I was fortunately able to avail

myself on the same day of Mr. Trevelyan's instructive company and his car as far as Khanpur. This permitted a rapid visit to be paid on the way to the ruined site of Pattan-Munara which he wished to show me. The site lies about 14 miles to the east of Sadiqabad and 7 miles south-southeast of Rahimyar Khan, the administrative headquarters of the new colonies in the south of the State. It takes its name from a high ruined structure (*munara*) overlooking a wide bed, which tradition as noted in the Bahawalpur Gazetteer takes for an old branch of the Indus. As the first part of the name (*pattan*) shows, the site is supposed to mark an ancient river crossing.

As Mr. Trevelyan was called by urgent official work the same afternoon to Khanpur on the way to Bahawalpur, no close examination of the ruin was possible. It is a square structure faced with carved bricks showing ornamentation with Indian architectural motifs. On the top storey a relievo figure could be made out, and also, on the three sides that still partially retain their facing, niches which evidently once held images. The badly decayed ruin stands on a small mound which in recent times has been dressed into a conical shape and faced with sherds. In general appearance it curiously recalled ruined Buddhist shrines or Chaityas found in Chinese Turkistan, such as the Sirkip-tura and others in the Turfan Oasis. Whether it served Buddhist or Brahminical worship, I was unable to decide on an unavoidably cursory inspection.

To the north of the ruins extends a large area of mounds furrowed by ravines and covered with abundant pottery debris. Among these ruins fragments of painted and relief-decorated or impressed ware were observed in plenty. It deserves to be noted that among the painted ware collected, the bold floral designs of the Rangmahal type appear but rarely. On the other hand, in a number of pieces a bichrome treatment is produced by the insertion of a dark crimson colour in geometrical pattern, a treatment never found at Rang-mahal and other Ghaggar sites. In the relief-decorated or impressed ware more elaborate patterns are frequent.

There is every reason to assume that the site was long occupied during Hindu times and to some extent probably continued to be so at a later date. To this points a ruined mosque built on a prominent mound with burnt bricks of different sizes obviously quarried from earlier structures. That the ruined shrines conti-

nued to be visited as a Tirtha appears from a notice of the Gazetteer which refers to a pilgrimage made there by Hindu Rajas early in the eighteenth century and also to an inscription of a date corresponding to A.D. 1539 seen by Colonel Minchin. This long continued occupation of the site is fully accounted for by the fact that old inundation canals from the Indus, such as the Mubarik Wah, brought irrigation close to it, just as do now several Distributaries from the modern Panjnad Canal.

After reaching Bahawalpur by rail on the morning of February 14, a 3 days' busy stay at the capital of the State served profitably for collecting the information essentially needed for preparing the programme of the proposed survey along the Hakra bed. Thanks to the effective help kindly offered by Mr. F. Anderson, Minister of Public Works and Irrigation, Bahawalpur, and by Mr. Trevelyan, I was able to secure from local officials familiar with the ground definite indications as to numerous old mounds to be found along the dry river bed, and at the same time to make the practical arrangements which would best enable me to effect my purpose within the available time.

I had reason to feel particularly grateful for this most readily afforded assistance when I realized to what extent the timely and profitable execution of my programme would depend upon transport facilities and local guidance. The portion of the Hakra bed which presented special interest for the purpose of an archaeological survey, was obviously the one forming the immediate continuation of the Ghaggar beyond the Bikanir border. This lay entirely through that area of Bahawalpur which bears the old and very significant designation of *Cholistan* or the "Desert".

It was a consideration of practical importance for me to find that the "Hakra Branch" of the great canal system known as the Sutlej Valley Project lies actually for most of its length within the Hakra bed and that the roads leading along that Branch and its Distributaries, etc., would permit of motor transport being used for my movements.

The consequent saving of time was an advantage which I could well appreciate after the preceding travel with camels in Jaisalmer territory and also in view of the trouble likely to be experienced on such ground from the heat of the approaching spring. Full use of that advantage was facilitated by my being kindly allowed to hire a lorry from the Public Works Department of the State with

a driver fully acquainted with the area. His ability to negotiate difficult ground between dunes, across drainage beds, etc., was amply attested by the many sites which were visited without any serious breakdown, far away from any roads or even tracks.

There was a special reason for starting my investigation along that portion of the Hakra which could be safely assumed not to have seen cultivation and settled occupation since water had ceased to flow in the Hakra bed. A considerable portion of the riverine plain within Bahawalpur territory, stretching along the eastern banks of the Sutlej, Panjnad and Indus for a total distance of close on 190 miles in a straight line, has received irrigation probably from an early historical period through inundation channels, these whether natural or artificial, carrying water from the spring floods of the rivers over low-lying ground. Irrigation of this kind, although dependent on the annually varying volume of the river floods and hence irregular in extent, had permitted cultivation over certain areas adjoining the lower course of the Hakra.

This is clearly seen in map which shows these inundation channels (*wahs*), as they existed until the beginning of the present century. Since then the construction of a modern system of perennial canals based on 3 large weirs across the Sutlej and Panjnad has completely replaced them and greatly extended the cultivated area in the State with a corresponding vast increase of the produce.

It is obvious that remains found at sites which might have received water from such channels could not without such evidence as only excavation might furnish be expected to furnish indication as to the time when a river flowed in the Hakra bed. For the purpose of this investigation it was best to turn first to that eastern portion of the Hakra which, lying between the Cholistan in the north and the high sand ridges to the south on the Bikanir and Jaisalmer side, had never been approached by any inundation channels from the Sutlej.

This portion could be defined roughly as marked on the east by the Bikanir border below Anupgarh and in the west by the line of the Bahawalpur-Bahawalnagar branch of the North-West Railway where it runs due south of Bahawalpur. Several practical considerations induced me to start by examination from the western end of this section of the Hakra. There on February 14 a

preliminary visit paid from Bahawalpur had shown me the large mound of Lurewala Ther.

It will be convenient to describe all the sites in their topographical order as visited on my tour and subsequently to sum up the conclusion derived from their examination. But before describing those sites mention may be made of what I was able to observe on a visit paid on February 15 to the ruined Stupa of Sui Vihar.

The village of that name has become well-known to archaeologists from a copper plate inscription in Kharosthi found thereabout and published by Sir Alexander Cunningham. It is situated about 17 miles to the southwest of Bahawalpur within old cultivated ground. The inscription records the construction of a shrine during the Emperor Kanishka's reign and may safely be dated from the second century A.D., even though the exact commencement of the era is still a subject of learned discussion.

The ruin, which does not appear ever to have been described, is that of a Stupa build solidly with sun-dried bricks and once cased all over with burnt bricks. This outer casing has been completely stripped off, many of the bricks having apparently found their way into tombs of the adjacent Muhammadan burial ground. Bricks found lying at the door of the Stupa measure 16–10 inches and are $2\frac{1}{2}$ inches thick. The Stupa base is partially burried in a debris mound about 20 feet high, above which rises the drum with the remnant of the dome to a total height of about 30 feet more. The top of the structure shows a cutting on the north side indicating where a relic deposit with the inscription mentioned is likely to have been rifled.

About 180 yards to the south of the Stupa is seen a mound about 12–15 feet high. It apparently marks the site of a completely decayed structure, probably a Vihara, correctly orientated and about 120 feet square. There is evidence of cuttings made into it and excavation along its sides. All around the mound and Stupa are found sherds with relief decoration of the same type as noted among the ware of the Rang-mahal and Munda sites, thus confirming the dating from Kushan times. Continuity of local worship is attested by the burial ground near the Stupa.

Chapter 3

SURVEY OF OLD SITES ALONG THE HAKRA BED IN BAHAWALPUR

Section 1. From Kudwala-Ther to Marot

On the morning of February 17 we left Bahawalpur for the tour which was to take us up the Hakra from where the "Desert Branch" of the new canal system which the Sutlej feeds from the Sulemanki weir strikes near Guzman a wide belt of flat desert ground traditionally believed to have been once watered by the ancient dried-up river.

About the old mounds to be found on the proposed tour much useful information had been collected by me while at Bahawalpur from several local officials acquainted with the ground which the new canals in that direction were intended to bring under cultivation. Still more helpful was the experienced local guide kindly provided in the person of *Zaildar* Jusain Jahaniya, headman of all the graziers in the area to be visited from Yazman up to Marot. His familiarity with the desert and its resources also made camping arrangements easy where we found terminal canals abandoned and the Inspection Bungalow, elsewhere providing very comfortable bases, dismantled.

While proceeding first on a road running south parallel to the railway towards Yazman, there was reached on ground overrun by low dunes the site of Kaliyar about 15 miles from Kut-al-Amara (Bahawalpur East) station. There an almost flat stretch of ground, about 300 yards in diameter, was found to be covered with plenty of plain sherds and fragments of an unpainted ware of a type with which we were to become very familiar elsewhere. Its surface shows a peculiar relief decoration, produced from moulds, and showing a variety of reticulated patterns with rows of dots, nodules, bosses, etc. Incised scrolls and scallops are often associated with this type.

Following the "I.R." Minor channel which passes close to this site, there was reached eastwards the "Desert Branch" canal and

along it after another 11 miles irrigated land at the Inspection Bungalow of Kudwala. A little more than 1 mile to the south there rises the large and conspicuous mound known as Kudwala-Ther. It has a height of 53 feet and stretches fully 1000 yards from north to south. Including several lower ridges curving eastwards, it measures quite as much or more in width.

The mound is thickly covered with pottery debris and in places with kiln remains in the shape of slags and brick fragments. This site yielded on the surface painted sherds both of the Harappa type and of the Cemetery "H" type of Harappa. Very rarely a dark red slip applied in a band between black lines gives a bichrome appearance. A creamy slip was found on one fragment. Decorated ware with the finger tip patterns of the type found at Cemetery of "H" of Harappa is very abundant, while very flat ribbing is rare. Puzzling findings were numerous: roughly moulded semi-baked cakes of clay usually 2 to 3 inches in diameter, probably intended as votive offerings. At other Hakra sites they often show finger holds on both sides. Conical cup-like lids of different sizes meant to cover the mouths of pots or bowls are common. Fragments of faience bangles were picked up in numbers, also pieces of shell bangles. A little vase almost complete, by its bulging side and very small base is of interest, for its shape recalls Prehistoric vases from Baluchistan sites. A miniature flat bottomed article may have served as a thimble.

From the top of the Kudwala mound there could be sighted to the south a wide belt of flat ground suggesting an old river bed. Proceeding under the *Zaildar*'s guidance toward the Ahmadwala-Ther there reported, we followed first the bank of the canal which the map marks as "2 L Distributary". Like other terminal channels of the "Desert Branch" and "Hakra Branch" with which we were to meet further on, it had to be abandoned since about 1935 because the volume of water at the head of these canals had proved by experience insufficient to provide the supply of water expected and needed for perennial irrigation at their tails.

When after 3 miles we had turned off eastward from the canal bank and arrived at a wide bed clear of the dunes, the *Zaildar* took us to a place he called *Karman*, where the bank of the old Hakra bed was well recognizable. It showed clearly the effects of water erosion and was furrowed by small ravines from the sandy hillock rising above it on the north to a height of close on 30 feet

from the flat bed below. The line of the bank was seen to continue from this point both to the southeast along the foot of the lows and hills which the sheet No. $39\frac{O}{I\,6}$ of the Survey of India on scale of 1 inch to a mile indicates.

On crossing the flat and fairly hard ground of the old river bed (250 yards) to the south a chain of sand hillocks was struck marking the opposite bank. After negotiating with difficulty a passage through them and crossing the railway and a couple of narrower beds, we were brought by our capable guide to the *Ahmadwala-Ther.* It is a low mound rising only some 10 feet above the ground, measuring some 300 yards from north to south and but little more across where widest.

Among the plentiful sherds a few could be definitely recognized as Harappa wares. A miniature vase corresponds with its small base and bulging side exactly to such little vases from Prehistoric sites in Baluchistan and Makran. The fragment from a large pot with wide perforations evidently formed part of a brazier like the high vessel found at the Kulli site of Makran. A round flat base must have carried an "offering dish" on a high stand like one found in a funerary deposit at Mehi in Makran. There were found here also a number of those curious roughly-shaped, pottery cakes of coarse make having usually finger holds in the centre and varying in shape from round to oval.

The view from Ahmadwala-Ther to the south showed that the flat belt within which the Hakra may be supposed to have meandered at different times is fully 2 miles across in most places. Sinuous ridges of sand mark its edges on both sides, those to the south being higher. Ahmadwala-Ther lies approximately half-way between them. The map calls the belt the "Jaidiwali Dahar" (a term used also elsewhere for such flat parts of the Hakra bed) and shows that the now abandoned "Hakra Right Distributary" had been intended to irrigate it.

Returning westward to the abandoned Distributary of the Desert Branch, the *Zaildar* showed us another mound called Chabbuwala-Ther a short distance south of the railway and close to the right bank of the abandoned channel. About 250 yards in diameter and marked on the map with a height of 12 feet, it showed ceramic remains of the Harappa type as found at the adjoining site of Ahmadwala-Ther. It was sad to note near the mound signs of the short-lived cultivation which water from the

canal had brought here.

Similar sights met us repeatedly when proceeding on February 18 toward the area to which terminal channels from the "Hakra Right Distributary" had for some years brought irrigation. Insufficiency of the volume of water received at the canal head on the Sutlej had necessitated the abandonment of that Distributary from some distance below Marot. Irrigated ground soon ceased after leaving the Kudwala Canal Bungalow; thence the newly-made "link road" took us into a long-stretched belt of flat ground flanked on either side by dunes. It clearly represented another main branch of the Hakra. While moving along it to the south-east there was reached after a drive of 6 miles the small mound of Kaliwaryal. Amidst its debris of pottery there were noticed a few sherds showing red paint between black bands, but none of the decorated ware with that finger tip pattern of the Cemetery "H" of Harappa which was so plentiful about Kudwala-Ther. However, this appeared again in abundance on the mound of Khetwal-Ther, which was reached some 3 miles further to the southeast not far from the tail end of the channel marked as "2 R Minor" on the map and now closed. The mound, larger than the last named, stands to a height of 20 feet and measures some 300 yards in diameter.

Far more interesting in several respects than the mounds last mentioned was the "Ther of Kalapar", also called Kalepar, to which we were guided by the *Zaildar* after covering about 3 miles along the abandoned channel and then moving across low sands another $1\frac{1}{2}$ miles to the northeast. The mound takes its name from a well about 1 mile away to the east and readily sighted owing to a group of trees around it. The well appears to have served as a regular halting place for caravans moving from Multan and Bahawalpur toward Delhi. What attracted attention at once was the abundance of painted sherds with varied designs found on the surface. The mound which the map No. 44-C/SW marks with the height of 19 feet measures about 500 yards north-south and about 420 yards east-west. To the north the view lay over a wide flat stretch marking an old river bed and this had been for some years brought under cultivation while canal water had been available.

The great variety of colours in the body of the sherds, whether plain or painted, was noticeable from the first. Whereas at the

mounds visited before the pottery showed uniformly a reddish fabric, the colour of the wares found at Kalepar ranges from dark crimson and nearly black through various shades of brown and gray to buff and light cream. Where a slip is applied to the surface it varies in colour, although more frequently it is dark red.

The designs on painted ware are executed mostly in blacks or browns of different strength. In a few cases a bichrome effect is produced by the use of a dark red ground between black circular bands. The greatly varied designs, all geometrical, comprise rows of triangles, hachured lozenges, circles and other shapes; concentric squares and lozenges, hour-glass shapes, feathered forms, zigzag scrolls, etc.

Comparison of these specimens with the designs found on the painted pottery from certain Chalcolithic sites in Baluchistan and Makran shows how close the resemblance is between these painted wares. It suffices to prove that the occupation of the Kalepar site dates back to a Prehistoric period which can scarcely be much later than the third millenium B.C.

With this conclusion agrees the find of several worked flints, of a fragment of a tablet-like object of a stone resembling alabaster, of fragments of bangles of terracotta and shell, of a neatly worked clay whorl, and a bead of blue paste. It deserves to be noted that many sherds with low narrow ribbing were also to be found here. I fully realized the opportunity which this site offered for fruitful trial excavation; but the difficulty of collecting an adequate labour from the scattered camps of graziers without great loss of time was obvious, and equally also the urgency of first carrying my survey right up the Hakra to where that on the Ghaggar had ended. By the time I was able to visit Kalepar again on my return in March, the work done at the equally important site of Sandhanawala-Ther had not left adequate time for any systematic digging before the increasing heat of the season would stop field work. So I felt reluctantly obliged to leave this tempting task for some future investigator of this ground. Since the abandonment of the canal tail, it has elapsed again into desert conditions.

From there drive of 7 miles to the southeast took us first along the abandoned channel and then past the Kazmain Station of the railway, also now abandoned and in ruin, to the small graziers' hamlet of Januwala. It is situated amidst a belt of dunes, but

having a well of fairly fresh water it offered a convenient camping place from which to examine several small sites known to the *Zaildar*, our guide, to lie along neighbouring old river branches.

After pitching camp at the hamlet, practically empty at the time, and then winding our way westward between dunes for 5 miles we reached the eroded bank of an unmistakable river bed. A line of sand ridges along its right bank marked its course curving to southwest. Having crossed the bed diagonally for about a mile, we came upon a long-stretched flat patch of ground, a typical "tati" strewn with sherds, all plain or coarsely incised.

The dry channel of the "Hakra Right Distributary" runs here along an old bed known as Januwali Dahar, and unmistakable by its hard surface clear of sand. Moving along it, we reached 3 miles eastward the ruin of the Januwala Inspection Bungalow. Abandoned about 1935 and dismantled, it presented a sad sight, in its far advanced decay. Close to the south of it there was seen a "tati" about 300 yards in diameter, with scanty sherds.

Apart from plain ware of good fabric and a few painted fragments with simple black rules there were picked up here also a number of pieces with narrow ribbing such as those at Kalepar-Ther. As there were found also 2 worked flints and a bead of blue paste similar to that found at the latter mound, occupation at the same early period may, perhaps, be assumed.

Proceeding some 2 miles to the northeast over the Januwali Dahar, we were shown near the northern edge of the old river bed a group of small debris-covered patches close together, the largest measuring about 320 yards in length. An interesting find among plenty of plain ware of good reddish fabric was a piece showing a neatly painted geometrical pattern in dark gray over creamy ground. This certainly shows close resemblance to designs found on Chalcolithic pottery of Makran sites.

Other fragments painted with black or dark brown bands over a red slip were such as were found at Kalepar. But as we found also sherds, unpainted, with relief or incised decoration similar to such as noted before at the sites of Kudwala, it seems possible that the locality was occupied also at a later period.

Our search on the morning of February 19 led first back to the abandoned channel, "2 R Minor". As before, it proved to lie along an old branch of the Hakra. There 3 low mounds were found in succession at distances of from 2–3 miles called Dinewali-Theri,

Malhala-Ther and Babul-Beha, respectively. At all 3 the sherds, whether plain or painted, showed the good reddish body and mostly a fine bright red slip. Another feature common to all 3 sites was the presence of well-made pottery with neat narrow ribbing on a similar body.

The painted ware throughout shows simple but carefully executed geometrical patterns of a Kalepar type. Among the designs, always painted in black, are found rows of lozenges, solid or hachured, bands with hanging tassel-like lines, concentric circles, festoons. At Dinewali-Theri, which is small, only 1 worked flint was found; at Malhala-Ther, which is somewhat larger, several more turned up as well as numerous fragments of neat terracotta bangles, also one of faience. Both here and at Babul-Beha, which is the largest of these low mounds, measuring some 400 yards in length, there was found a small pottery cup of coarse make, only about $1\frac{1}{4}$ inch in height. It is so narrow at its flat bottom that it might well have been intended for use as a thimble. As a few fragments from worked flints were to be found also at Babul-Beha, the conclusion seems justified that at all 3 sites occpation dated back to the same period as at Kalepar.

From the dry canal we turned to the southeast in order to pitch our camp at the well of Chapu. From there a drive of 8 miles to the northwest took us across the canal and the railway to a wide stretch of flat bare ground, marking an old river bed, and beyond it to the large site of Chambrawala-Ther.

In places overrun by low dunes it stretched for about 900 yards from east to west and about half that across. Apart from a single sherd with black band no painted sherds were found here, nor any of the plain ware of good reddish fabric with red slip which had been met with since Kalepar. Of decorated unpainted ware only pieces with roughly incised or impressed scallops, circles, scrolls and the like were seen.

But after we had returned to the Hakra Right Distributary and beyond it had moved 2 miles south along "5 L Minor" sherds of reddish ware painted with simple geometrical patterns and red slip, also fragments of finely ribbed pottery, turned up again on the low Bannewala-Ther, which is narrow and stretches for some 600 yards.

Proceeding thence for some 4 miles to the south-west along the same channel, now dry, we came to an open stretch of ground

where abandoned fields and decayed dwellings marked the position of recent small colonies (Chaks 347–349 on the map). Over a low mound left between them and known as Chapliwala-Theri, which extends over an area of about 500 × 400 yards, sherds of both reddish and dark grey ware lay in plenty. Among the former a number showed geometrical patterns, painted in black but much effaced, of the type previously described. Plain pieces with fine narrow ribbing and a piece of worked gray stone similar to alabaster suggested occupation contemporary with that of the mounds seen since Kalepar.

After a night in camp at the Chapu well had brought a violent storm with driving sand and light rain, we moved back to the Hakra Right Distributary. About a mile above the point where the dry "5 L Minor" takes off from it, we were glad to meet again ground irrigated from that Distributary. Within the terminal cultivation of Chak 341, I was shown the almost flat debris-strewn mound of Kirarwali-Theri, measuring about 320 yards in diameter. Among plentiful sherds of good reddish body were found several showing simple geometrical designs painted in black over a dark red slip, also fragments with fine narrow ribbing. Two small worked stones and numeroug fragments of thin terracotta bangles support attribution of the site to the same period as that of Kalepar. The find of the bottom portion of a miniature cup like those found at Malhala and Babul-Beha is of interest because its diameter of less than half an inch inside suggests use as a thimble. To this point also numerous small identations on the outside bottom.

From here onward we followed up the Distributary carrying water for 8 miles to the Inspection Bungalow of Marot, which with its surrounding garden and trees provided a pleasant base for this and the following day. Here we were awaited by Mr. Abdul Qadir, *Naib Tahsildar* of Fort Abbas. For the remainder of our stay in this neighbourhood he proved very helpful by assuring local guidance, etc. From Marot Bungalow I was able to visit on the same day a succession of sites, all aligned along the flat stretch of open ground, obviously an old river bed, which the channel of "4 L Minor" follows.

The first of them, reached after 6 miles from Marot Bungalow, is the small mound of Ladolai, about 10 feet high and less than 200 yards in diameter. There the painted sherds agreed in their

body, geometrical patterns and frequent slip with those found at sites from Kalepar onward. A small worked stone blade, numerous dark terracotta bangles and pieces of ribbed ware were also in keeping. The same was the case at the mound of Gujaranwali-Theri situated 3 miles further south. It measures about 420 yards from east to west where its diameter is greater. Here painted reddish ware, often with a dark red slip, was seen in plenty, its geometrical patterns are of the type as described before, and a dark red slip black painting are found combined with ribbing. In addition to fragmentary bangles of terracotta, 4 small worked stones and the bottom of a miniature cup, as described above, were picked up. A smaller mound, surrounded by dunes and found about 1 mile further south, is likely to have formed part of the same site. The type of the painted pottery remains and 3 worked flints found there indicate this.

From near this pointed onward the "4 L Minor" Channel no longer receives water. Following its line for about 5 miles further south over a long stretch of absolutely bare ground we reached the ruined tomb known as the Ziarat Bahram Shahi. It is a late structure built with small burnt bricks, and the well of Kandai a short distance off to the west of it is a regular camping place for graziers. An area extending for about 400 yards to the east of the tomb and except for small fragments of reddish pottery with black bands were to be seen there and a small worked stone was picked up.

On the forenoon of February 21 while the baggage was left at the Marot Canal Bungalow, I was able to visit on horseback the small but interesting old town of Marot about 4 miles off in a straight line to the south-southeast. It is reached after passing first across cultivated ground and then through a belt of low dunes which run along at the edge of bare flat *pad* marking an ancient branch of the Hakra. The little town of Marot occupies a mound rising about 100 feet above the flat bed to the north. (Sheet No. 44-C/SW of Survey indicates a relative height of 102 feet for the highest point).

From the sherds, bricks, etc., exposed in the eroded ravines running down the slopes, it is seen that the mound is formed wholly by the accumulation of debris. The walls enclosing Marot have fallen in most places. But where a section of them is best preserved, as near the Police Station, it is seen that their masonry

was of sun-dried bricks faced with burnt bricks of smaller size. Many of the houses within the walls are decayed and a larger number of the rest were found empty, for Marot serves nowadays mainly as a local centre for a pastoral population which lives away for the greater part of the year, grazing camels and cattle in the jungles of the Cholistan.

But it was different in the days still remembered when Marot served as a trading stage on an important caravan route leading from Multan to Delhi. The traffic passing through it provided profitable employment for the herds of camels kept by its people. Since the trade route has been displaced by the railways, the community of well-to-do traders, chiefly Jain Oswals, has moved away, just as from Jaisalmer, and left their houses to fall slowly into ruins. So Kot Marot has come to present now a typical picture of a decayed "caravan city" on a small scale.

However, the trading families who have moved away to Bikanir territory and elsewhere still keep up the connection with their old home. Thus, in the house of Amar Chand, the last remaining Jain trader of the place, the wedding of a relative of his with a young Jain from Rattanpur was being celebrated at the time of my visit.

Accompanied by Amar Chand, who acted as a very intelligent guide, I first visited the Khangah of Shah Mardan, a place venerated by Muhammadans and Hindus alike. An inscribed stone within the tomb records its construction in Akbar's reign A.H. 976 (A.D. 1568–69). An engraved slab taken from some Hindu temple marks the saint's praying place. Continuity of local worship at this spot is proved by a Jain shrine close by. It was inaccessible at the time owing to a religious gathering connected with the wedding. But the Samvat dates of 1236, 1515 and 1534 in Hindi inscriptions of which Amar Chand brought me copies prove the antiquity of the much restored little temple.

The small community of "Mahesvaris," all petty local traders, has also a temple of its own close to Amar Chand's house. This, with the elaborate carving of its wooden doors and galleries, recalled the old residences of Marwari families seen at Jaisalmer. A well-preserved pillar of yellowish marble or fine lime-stone brought from some mediaeval Hindu temple serves now as a part of the enclosure of a well at the highest point of the circumvallation. Another pillar richly ornamented in the same style lies flat

on the ground outside the northeast face of the circumvallation. A large tank at the northern foot of the mound which the town walls crown is also old, as shown by the great age of the trees which grow around it.

It still remains to be mentioned that Kot Marot is one of a series of old forts which stretches roughly parallel along the border of Bahawalpur toward Bikanir and Jaisalmer. It was obviously intended to keep off inroads from the side of those territories. On desert ground fit only for grazing such as extends here along both sides of the border, raids for livestock were until comparatively recent history frequent incidents. In fact, they formed more or less a kind of subsidiary livelihood for the semi-nomadic people of these territories.

In that chain of old border posts Kot Marot was flanked eastward by the fort of Phulra close to the local centre of the new canal colonies, named Fort Abbas, and westward by the half ruined fort of Mojgarh south of Januwala.

Further to the southwest it was Derawar, once a seat of the Bhati Rajputs, which played the part of a main stronghold in this chain of border defences.

Section 2. The Hakra from Marot to the Ghaggar

Returning from Kot Marot, the small Baghanwali-Theri was examined about 1 mile south of Marot Bungalow. There a few painted sherds found all showed the type observed since Kalepar in febric, slip and design. Strikingly different in type was the broken pottery observed on visiting on the same day the low mound known as Loharki-Theri across the canal and railway. It is situated on cultivated ground about 5 miles to the northwest of Marot Bungalow and measures about 200 yards in diameter.

Here not a single painted fragment or piece of good reddish fabric was to be seen, only sherds of coarse body, incised or impressed, often on the inside surface, with very rough geometrical designs. They closely resembled inferior ware of this type found at certain sites on the Lower Ghaggar. There were picked up here also a few broken shell bangles, an indeterminate piece of blue paste and a small flint which looked like a worked core.

After returning to the Hakra Distributary we followed its left bank up to where near Chak[1] 319 a stretch of low-lying ground

[1]This is designation for a new village.

was reached which had for the last few years been inundated with spill water from the canal in order to improve it with silt. Thick growth of tamarisks and other scrub covered it, and close to its southern edge we were guided to the mound of Qadarwali-Theri. The mound, partly overrun by light dunes, measures about 320 yards from east to west and some 200 yards across. The height is close on 20 feet. Among the pottery debris there were found painted pieces of the Kalepar type, also ribbed ware; several perforated frangments such as are common at Prehistoric sites, and the bottom part of what may be taken for a thimble.

The mound is used by Marot graziers who own the ground as a place for watching their camels while grazing in thick scrub. This explains why we found on its top some fragments of manifestly modern ware, one of a *chilam*, the bowl of a decorated water pipe, and others which evidently belonged to a relief-decorated *surahi* or water jug. These "intruded" pieces might well be puzzling to an archaeologist, say 2,000 years hence.

Part of a flint "blade" and some broken terracotta bangles, also found on the surface of this mound, date, of course, from antiquity and conform to similar finds at other mounds with Kalepar type of pottery.

On February 22 our Survey was continued to reported sites up the Hakra bed. Proceeding from the small colony of Shah Suwar to a low mound measuring about 200 yards from east to west and situated about half a mile north of Risafa Railway Station, there was found plenty of sherds with raised rope and scallop ornamentation produced from moulds. The absence of painted ware and the frequency of simple scroll and rope ornamentation from moulds was observed also at the small Chamkalyar-Theri situated in an angle between the canal and railway some 3 miles to the southeast.

When moving up the canal for 5 miles from Risafa Station there was found close to the right bank a narrow stretch of flat ground, closely covered with sherds and known as Ghaziwala-Ther. It was significant that while painted pottery was here conspicuously absent, ware of coarse fabric bearing impressed decoration with geometrical pattern, including leaf shapes, was abundant. The same decoration had been frequently met with at sites lower down on the Ghaggar bed.

It became evident that above Marot we had reached a portion

of the Hakra bed which showed remains of a period of prolonged occupation different from, and probably later than, the one attested by the mounds lower down. This impression was confirmed when examining first a small site half a mile to the east of the Quraish Canal Bungalow where we had halted, and then another close to the west of the Quraish Railway Station. For the former the name of Saiyid Muhammad Dhab was given; the latter, which is larger and stretches quite flat for more than 300 yards from east to west, appears to be unnamed. At both, sherds with impressed patterns such as cross-hatching, leaf shapes, spirals, and imbrication were found in abundance, whereas not a single painted fragment was to be seen. The resemblance of this ware to the pottery of sites on the Lower Ghaggar was here as close as before.

Since leaving the neighbourhood of Marot the sand ridges edging the flat Hakra bed were seen to increase in height and the continuity of their lines both on the north and the south sides to become distinctly more marked. From a scrub-covered sand ridge some 30 feet high which Surveyor Muhammad Ayub and myself ascended northeast of Quraish Station we could clearly recognize the northern "bank" of the Hakra bed as it winds away with well-marked bends to the east and the west. The opposite (left) "bank" was also discernible running more or less parallel, at a distance of about 2–3 miles.

The whole of the Hakra bed from here upward to Fort Abbas and beyond showed a practically continuous sheet of cultivated ground. It was impressive proof of the beneficent change which the Sutlej water brought by the Hakra Branch had carried into the waste of the Cholistan.

On February 23 we left Quraish for Fort Abbas, as the market-place newly-created for the irrigation colonies nearing the bend of the Hakra Canal has been named. It lies in the vicinity of the old border post of Phulra. After moving along the canal road for close on 5 miles a group of flat "tati" patches was met amidst cultivated ground. The first and largest, measuring about 300 yards in length and known by the name of Satkui-Ther, showed apart from inferior plain ware only sherds with impressed geometrical patterns as found at sites about Risafa. At 2 smaller sites to the south, half a mile from each other, pieces of similar decorated ware were seen as well as some fragments showing painted bands

but indeterminate in type.

It was of interest to learn from the old *Zaildar* of this area that before irrigation was brought to it, grazing people used to do some cultivation on this ground in years of good rainfall when some flood water reached it in a shallow channel of the Hakra.

As we moved up along the canal, the continuous chain of dunes along the northern edge of the Hakra bed kept within near view. Close to where a kind of sandy promontory from this chain projects southward into the cultivated belt along the canal, a detached mound thickly strewn with pottery debris came conspicuously into view. It is known as Sandhanawala-Ther. It lies 3 miles to the northeast of Fort Abbas and rises to 28 feet above the level ground by the right bank of the canal. It measures about 320 yards from north to south and some 200 yards across where widest. Its foot is adjoined by a wide stretch of flat ground strewn with sherds. A first inspection showed plenty of reddish ware painted with geometrical or floral designs, often on a dark red slip for specimens closely resembling in type the sherds found on the Harappa sites and at Kalepar. What few incised fragments were picked up. differed distinctly from the decorated unpainted ware found at mounds beyond Marot. More than a dozen worked flints or cherts, including several blades and borers, were quickly picked up on the surface, also pieces of bangles of terracotta and shell as well as a piece from the rim of a small alabaster cup.

These remains left no doubt the mound marking a site of prehistoric occupation; its height raised the hope that some stratigraphic evidence might be secured here throwing light on the relation between the ceramic type on its surface and that observed elsewhere on the Hakra and Ghaggar. The mound recommended itself all the more for a trial excavation because the vicinity of Fort Abbas and of colonies close by would allow the requisite labour to be raised without loss of time.

But before undertaking this task it appeared to me very desirable to follow up the Hakra bed to where, as the latest Survey maps on the half-inch scale (Nos. 44-C/SE and 44-C/SW) clearly show, it has its continuation in the portion of the Ghaggar bed we had traced before down to Anupgarh and the Bikanir border.

It is just there that the Hakra Branch Canal after running from northeast to southeast makes a very marked bend in its line. It takes up a new direction from east to west and it follows this

thence right through toward its termination. A close study of the maps, together with certain observations made while moving up the Hakra bed to Fort Abbas, had suggested to me that the alignment of the Hakra Branch Canal from its head on the Sutlej might well mark the line of an ancient bed of the Sutlej, which at a period, in all probability Prehistoric, had joined that of the Ghaggar. In order to test this suggestion to which I shall refer further on, I decided to move up the Hakra Branch Canal to where it approaches the tail end of the Ghaggar between the old hamlets of Binjor and Wallar.

Starting on February 24 for the Inspection Bungalow named after the latter place, I first examined the mound reported to the south of the Canal in Chak 265, about 6 miles from Fort Abbas. Its old name was Khansar Theri, but to the new settlers from the Punjab it is known as Ratti-Theri ("The Red Mound"), from the abundant debris of pottery which covers the mound. It measures about 250 yards in diameter and rises in its centre to 10 feet. No painted sherd was found here, but plenty of decorated ware with impressed patterns of leaf-shapes, spirals, circles, rope scrolls, scallops, etc. such as had been found at sites above Marot.

From Fort Abbas I had taken along as guide an experienced old local grazier living at the ruined border post of Phulra south of Fort Abbas. Apart from the Ratti-Theri, he could show us within the Bahawalpur border only the large mound of Raowali-Theri situated about 1 mile to the south of the Wallar Inspection Bungalow, which served for our next halt. It is an extensive mound stretching for more than 500 yards from north to south and somewhat more across, rising to some 20 feet in the middle. Here, too, amongst the plentiful pottery debris covering the surface, only pieces of decorated ware could be found showing coarse impressed or incised designs of the type seen at Ratti-Theri and elsewhere. The flat ground both to the south and north of Raowali-Theri distinctly suggested a river bed, and our guide spontaneously referred to it as 2 branches of the Hakra enclosing an island-like stretch of higher ground.

Here we crossed the demarcated border of Bikanir which skirts the mound, and passing over perfectly flat open ground which but for the line dividing the 2 States could easily be brought under irrigation from the Hakra Branch Canal, reached the hamlet of Binjor. Close to the south of it we were shown a flat pottery-

strewn patch of ground about 300 yards in diameter. Here, too, the only ornamented sherds to be found displayed impressed geometrical patterns as described before. We had reached at Binjor the ground irrigated by the tail end of the Ganga Singh Canal of Bikanir.

Neither our Phulra guide nor 2 local men whom the obliging *Tahsildar* of Anupgarh had at my request sent to meet me at Wallar, could indicate any other "Thers" on the Binjor side besides those 2 which I had already visited on January 20.

When we attempted to proceed from the cultivated ground about Binjor northward to look for any level open ground that might possibly mark the bed of an old branch of the Ghaggar or Hakra, we were stopped after only 2 miles by a chain of close-set sand ridges. These, as the map clearly showed, are rising further north to relative heights of from 39–60 feet. It thus became evident that no bed either of the Ghaggar or Hakra could lie here.

Neither at Wallar nor before at Fort Abbas had my enquiries led to information about any old sites to be seen further up near the Hakra Branch Canal. But it seemed useful to obtain some general impression of the character of the ground over which it passes, at least on that stretch of its course which lies near to the bend that takes it to the bed of the Ghaggar.

On my move from Fort Abbas towards Wallar, it had become quite clear that the continuous line of high sands stretching along the northern edge of the Hakra bed which we had observed very distinctly all the way from Marot, came to an end on approaching Wallar. Between that line and the closely-packed dunes running in an west-east line north of Binjor, a distinct gap marked the ground where the Hakra Branch Canal coming from northeast made its bend to the west.

As we moved up along the chain this gap proved about a mile wide for a distance of some 3 miles above the Wallar Bungalow. There was practically no cultivation on either side until Chak 239 was passed. Thence the canal was seen to run in a curving alignment to the north. Between continuous sand ridges receding to a distance on either side there stretched onward ground looking distinctly like a wide river bed. Only here and there small patches of sandy soil rose a few feet above the flat "pat", as such hard ground within or along old drainage beds is known in the Punjab.

Regard for the time which had to be kept available for my

remaining programme did not allow me to continue this move along the Hakra Branch further than Kamrani, a distance of 12 miles. There the "4 L Minor" takes off to irrigate a broad area of flat ground toward the Bikanir Border. But evidence far more reliable and instructive than a mere rapid passage along the Hakra Branch further up could have supplied became available, since the kindness of Mr. F. Anderson, Minister of Public Works and Irrigation, Bahawalpur, has enabled me to study the 56 sheets of the "Sutlej Valley Project Levelling Charts", which show the ground traversed by the Hakra Branch, on the large scale of 4 inches to 1 mile, from a detailed survey made in 1923–24. It has shown me that the whole course of the Hakra Branch Canal from the Sulemanki Headworks on the Sutlej, down to Wallar, a total distance of roughly 104 miles, lies over a succession of stretches of perfectly flat ground varying in width from about 2 miles to half a mile, similar to those seen between Chak 239 and Kamrani.

Low ridges separating these level stretches, with heights from 2–7 feet are shown by the Charts only between the Bungalows of Wallar and Ghulamali. Apparently it has been possible to avoid those ridges by making the canal curve round them. Nowhere does any cutting appear to have been necessary along the main Canal.

The topographical features here briefly sketched justify the conclusion already suggested above that a branch of the Sutlej at an early period once joined the Ghaggar bed above Fort Abbas. The added volume of its water could reasonably be held to account for the much increased width in the continuation of that bed further down and for the increasingly wide spread below Marot of the "Dahars" representing branching terminal beds. The same explanation applies in particular to the great width up to 3 miles, which the Ghaggar bed assumes onward Fort Abbas just below Wallar.

This is the point where we may place its junction with that old bed of the Sutlej, whic his now followed by the course of the Hakra Branch Canal. In the concluding Section of this Chapter, I shall have occasion to offer some remarks on the connection which may be traced to the junction here hypothetically assumed of the Ghaggar-Hakra bed and an ancient branch of the Sutlej with certain archaeological observations made on our survey along that bed.

Section 3. Trial Excavation at Sandhanawala-Ther

The increasing heat of the last days made it advisable to avoid delay over starting the intended trial excavation at the mound of Sandhanawala-Ther. So on returning on the evening of February 25 to Fort Abbas from Kamrani on the Hakra Branch Canal, arrangements were made for securing adequate labour, and a suitable camping place within easy reach of the site. Our tents were moved there early on the following morning and excavation started with 60 labourers. A trench 7 feet wide was opened from the top of the mound in the centre, at a level of 25 feet down the eastern slope; the last of its 13 sections was opened at a level of 10 feet above the flat ground at the foot of the mound. The total length of the trench opened measured 91 feet on the surface of the slope. For describing the finds made in each section and indicating their level, I am gratefully availing myself of the notes kept by Mr. Krishna Deva while he gave his very useful assistance in supervising the digging.

Excavation in the top section brought to light under 1 foot remains of walls built with mud bricks ($11\frac{1}{2} \times 5 \times 3$ inches). They formed part of the eastern and northern sides of a small room which a narrow door opened into another apartment on the north side.

The walls had a thickness of close on 2 feet and could be traced in several courses down to a depth of 5 feet where the floor lay. Remains of 2 small ovens, probably serving as kilns, were traced, one near the door in the northern wall, the other adjoining the western wall. That the two rooms had been occupied by a potter could be concluded from the walls near the kilns showing signs of exposure to fire; also from a large broken pot, having a diameter of 20 inches, in which lay dozens of coarsely baked cakes roughly circular from $2\frac{1}{2}$–$4\frac{1}{2}$ inches in diameter. They were such as had been found before at Kudwala-Ther, each with a finger-hold on the 2 flat sides. Part of another large vessel filled with similar cakes was found in the small room to the north.

Other finds in this same section, down to a depth of 5 feet, were the fragments of a massive base evidently intended for a stand, and an abundance of sherds of good reddish fabric, showing a dark red slip and often painted with black horizontal bands. Pieces of perforated pottery, such as might have belonged to

braziers, turned up here in plenty; also fragments of terracotta bangles. Of 2 lids 1 was flat with a knob in the centre.

In the second section (II) at a depth of about 3 feet were found packed close together 3 smaller vessels of the Harappa type by the side of a broken large jar; one of them was a long tumbler with a hole at its bottom. Placed against a mud brick wall by the side of Section II was found at a depth of 3 feet a small oven similar to those in Section I. A large quantity of ashes and charcoal lay close below it. From varying depths were recovered a number of small cups with shapes which have their exact counterparts in pottery of Chalcolithic sites in Baluchistan and the Indus Valley.

The very small bases deserve to be specially noted, also the shapes of the flat-bottomed, small bowls. On numerous painted sherds a deep red slip is sometimes used between black bands. Of special interest is the fragment of a large painted jar found at a level of 6 feet showing a well-known Harappa design consisting of a row of lozenges in one register and small flowers within circles in another. The painted pattern show vertical rows of hachured oval shapes with arm-like branches and parallel wavy lines suggesting tree branches and other familiar Harrapa motifs.

At a depth of 6 feet was found a plain sherd bearing an incised letter which appears frequently on seals of the Harappa culture. With it agrees the find of a flint knife (3 inches long) at 6 feet in this section. A small sheet of copper or bronze found at a depth of 2 feet is the only metallic remain recovered at the site. In Section III painted sherds with geometrical designs, of the type shown in specimens, were found in numbers from 5–7 feet of depth; also pieces from conical pot covers, with flat ring tops. A small stone cube, which may have served as a weight, came from a depth of 7–9 feet, as well as the fragment of a terracotta figurine showing the head of a ram.

Section IV at only 1 foot below the surface yielded a fragment from the painted rim portion of a large vessel showing on a red slip the elaborate Harappa design of a tree with leaves branching like those of a palm, also the fragment of a terracotta bull figurine. At 4 feet was found a cubical stone weight, like one slightly smaller from the depth of 5–7 feet.

In the same stratum were found: (a) small jar, with the incised figure X which might be meant for a sign manual; (b) another of miniature size; (c) 2 complete clay bangles; and (d) part of an

open jar with recessed rim. A small fragment shows an imbricated and dotted design on a dark red, burnished surface. A perforated piece shows the effect of fire such as would attend the use of such a vessel as a brazier.

At a depth of 8–9 feet 2 dozens of very smell shell beads, evidently belonging to a string, were recovered; also part of a well-made flat plate, and a fragment from the shoulder of a large pot showing broad ribbing on the inside. Finally, mention may be made of the massive stand (12 inches high) meant to carry a dish, perhaps for an offering, a pendant to such stands having been found at other Chalcolithic sites.

The finds in Sections V and VI did not vary in essentials from those already noted above. Worked flints came to light in both Sections at the depth of 7 and 4 feet, respectively. In both Sections there turned up at varying depths bottom portions of heavy earthenware with a plain surface outside and coarse ribbing on the inside. Fragments of similar ware had been found before elsewhere on the slope.

In Section VII the quantity of sherds painted with a slip of dark red between black rules was noticeable at a depth of 7–8 feet, and similarly, fragments of thick plain ware showing incised ribbing inside. A little jar, with a disproportionately small base has a shape familiar from the Harappa and Baluchistan sites. The same applies also to the incised decoration with concentric bands of crescents or scallops seen inside of a dish fragment. It is known from sites of the Harappa culture and Makran sites.

In Section VIII, where excavation was carried to a depth of 11 feet, almost level with the flat ground at the foot of the mound, decoration with flat impressed wavy lines was found at 6 feet, a deeply incised herring-bone design is seen in another sherd. A bichrome effect is seen in another, where the black rule over a dark-red band is adjoined by a zigzag festoon of balls known from Mohenjodaro. A bowl of elegant shape and very small base, found at 3 feet, shows close-set black lines over a dark red slip, contrasting with the light pink of the unpainted surface. On a plain sherd, there is found incised the figure which occurs as a letter at Harappa. A miniature cup shows its use as a thimble by minute indentations on the outside of the flat bottom.

A layer of 10–11 feet depth contained dark soil with ashes and what looked like decayed matter. In this there was found a quan-

tity of thin sherds of a light buff or cream fabric painted with various simple geometrical designs in shades of brown closely resembling the Amri ware. No ware of this kind was met within any of the higher strata passed by the trench, the pottery there being throughout of a thick red fabric showing the Harappa designs. From the depth of 11 feet came a flint "blade" with marks of use. At 12 feet virgin soil, composed of river silt and fairly solid, was struck.

In Sections IX–XIII, where excavation was carried to about 4 feet below the almost flat surface, only the Amri ware was found. From IX came the lower portion of a bowl painted with a row of narrow black bands, raised on a narrow high base. Finds to be noted in Section XI are an elegant bowl, showing very fine ribbing of parts of the shoulder, the mouth and upper portion of a flask, and a pottery whistle, with a shape well-known from Chalcolithic sites of the Indus Valley and Baluchistan. From Section XII may be mentioned the base of a vessel decorated with a neatly incised spiral and a piece of perforated ware from the side of large vessel.

In order to test the ground approximately down to the depth which the digging in Section VIII had reached, a fresh trench was opened about 50 feet to the south of Section XVIII. Its top Section XIV started from the same surface level of 10 feet, where Section XIII had stopped on the surface. In Section XIV there were found in a stratum of sandy soil extending down to a depth of 1–2½ feet plenty of sherds of thick reddish plain ware of the Harappa type. Beneath this in a layer of 3½–4½ feet depth, we came upon a quantity of thin sherds of cream colour of the Amri type which lay in dark gray, almost black, solid composed of ashes and decomposed matter, just as pieces of the same ware had been found on about this level at the bottom of Section VIII.

The simple geometrical patterns executed in shades of brown comprising bands and parallel zigzags also closely agreed. Between the upper left with thick reddish ware and the underlying one with thin cream ware intervened a thin stratum of fairly hard gray soil without any sherds. This corroborated in a striking manner the evidence of Amri where the Harappa Culture was found to be definitely later than the Amri Culture. Below the stratum holding the cream pottery there was seen a thin layer of sterile sand. Then, from a 5 feet downward, the virgin ground

showed as a solid deposit of pure river silt just as the excavation had struck at and below 12 feet depth in Section VIII.

During our stay in camp at Sandhanawala-Ther fierce heat had made itself increasingly felt. Regard for the advancing season and the remaining portion of my programme made me close our trial excavation by February 28. Yet as the details recorded above may show, its result was by then ample enough to establish a negative fact of some importance. Nowhere at this site did we find a single sherd showing those geometrical patterns coarsely impressed from moulds, scrolls, rope ornaments, leaf-shapes, etc. which were found in such numbers at all the low mounds or flat debris-strewn patches between Marot to above Quraish and again between Fort Abbas and Binjor.

On the other hand, at none of these sites was any painted ware found. Since at Sandhanawala-Ther the trial excavation had been carried down to virgin soil, it seems safe to assert that this type of decoration with impressed patterns must be later than the painted ware of reddish fabric so amply present there.

With this agrees the observation that the same ware with impressed patterns had been found at the end of the Ghaggar bed at a number of mounds directly continuing the line of the mounds with remains of painted pottery for which the Kushan Period is the *terminus ad quem*. Taking both observations into account, the conclusion suggests itself that the time when that unpainted ware with impressed decoration was in use lay between the Chalcolithic Period marked by the finds of Sandhanawala-Ther and Kalepar, and the historical period ending with Kushan times.

If we take into consideration the difference between the periods from which those 2 types of ceramic ware date and the corresponding difference in location between the mounds at which they are found, we must look for some explanation of the change of the ceramic types in a change of the physical conditions. Such a change in topographical observations noted above lead us to assume as having affected this portion of the Hakra bed since Prehistoric times.

We have seen above that at one time the line of the Ghaggar bed as far as followed within Bikanir territory was on its direct continuation above Fort Abbas joined by what was clearly the bed of a former branch of the Sutlej.

If we assume that this bed had carried water in a portion of the

Prehistoric Period approximately corresponding to the times when the Indus Valley sites of Mohanjodaro and Harappa were still occupied, but subsequently ceased to receive it at some time preceding the beginning of the historical period, we can explain why certain sites marked by high mounds on which only painted ware of the earlier type is found, became abandoned and were left unoccupied in later times, whether Prehistoric or historical.

The water carried by the Ghaggar still continued to flow into its old bed below the former confluence, but was no longer sufficient to assure cultivation to the same extent as before. Such agricultural settlements as might continue to use that inundation water, much reduced in volume, would naturally prefer to keep on low ground near it instead of occupying high mounds at some distance from the still available flow of water.

A closely corresponding change in the position of modern hamlets, as compared with mounds marking earlier occupation in the historical period, could be observed also where such came within the range of our survey higher up along the Ghaggar bed. In that area there are also definite indications of a reduction in the available flow of water having taken place, whatever its cause may be.

The explanation here offered must necessarily remain conjectural, for the present, partly because it is based on negative evidence, namely, the absence of any later impressed ware at the mounds of Kalepar and Sandhanawala, both of which can be definitely recognized as marking Chalcolithic occupation, and partly in view of no Chalcolithic sites having so far been traced up the assumed old bed of the Sutlej above Fort Abbas or higher up on the Ghaggar.

The proposed explanation would fully explain why that later type of decorated pottery is to be found only on more or less flat patches of ground, i.e. on a low level within the Ghaggar and Hakra bed, where even the gradually shrinking flow of water available from the Ghaggar alone could have sufficed to permit of cultivation. In the case of the Ghaggar higher up, continued occupation in historical times may well have covered up all Prehistoric remains within the bed higher up.

Before leaving Fort Abbas a visit was paid to Phulra, about 2 miles off to the south, where the pastoral population grazing near this portion of the Hakra lives during a part of the year in dwellings around a much decayed fort. This belongs to the same line of

border posts as the forts of Marot and Mojgarh previously mentioned. The village was said thus to form the local centre for about 2,000 people. It lies on what was an old trade route and is hence rightly described by Masson along with Marot and Mojgarh as a "bazar town". The walls of the fort are built as at Marot with mud bricks and a facing of small burnt bricks. From a statement based upon an inscription which is found in a high structure at the northeastern corner of the fort, it appears that the fort in its present state dates from repairs effected in A.D. 1752. The fort stands on the edge of an old river bed and occupies the top of what apparently was a mound. This accounts for the great depth (113 feet) to which the well inside the fort descends.

Section 4. The Hakra from Lurewala-Ther to Derawar

After our excavations at Sandhanawala-Ther,t here still remained available a short time for extending our survey of old sites down the Hakra from where we had first struck it near Kudwala. Near the latter point ends that portion of the Hakra bed to which the Hakra Branch Canal was meant to carry water from the Sulemanki Head on the Sutlej. To the west of Kudwala it is the Desert Branch of the same main canal which brings water of the Sutlej for irrigation to a distance of about 40 miles as far as Shahiwala. To the southwest of the line followed by the Desert Branch there stretches a wide belt of level ground which looks like an ancient delta of the Hakra. Canals taking off from the Desert Branch were intended to bring it under irrigation as far as the old fort of Derawar and for some 10 miles westwards beyond it. Very numerous mounds, many of them of considerable size, were traced over this wide belt, and of them this section is to present a summary account.

Our move down from Fort Abbas into this area was started on March 3, but the easternmost of the mounds just referred to had been inspected by me already before on February 14 when Mr. Trevelyan took me to see this well-known landmark. The large Lurewala-Ther, as it is locally known, is situated at a distance of about 10 miles to the west of the Yazman Railway Station, which the Desert Branch passes, and a mile to the south of this canal. It rises to 30 feet above the sandy flat at its foot and measures some 1,400 yards from north to south and nearly half that across. It is abundantly covered with sherds of well-made reddish pottery,

both plain and painted, which are analogous with the pottery from Cemetery "H" at Harappa in fabric type and decoration.

The painted ware shows both geometrical and floral patterns painted in black on a wet red slip and includes the characteristic designs of the Cemetery "H" at Harappa such as peacocks, goats, oxen, stars, etc. The floral patterns comprise mostly leaf shapes and forms suggesting branching trees. The painted mouth of a jar is of interest as having a perforated flanged rim which is as typical of Cemetery "H" at Harappa as the ware decorated on the outer surface with reticulated or finger-impressed patterns, which was found here in abundance.

At Lurewala-Ther there was found the first fragmentary specimen of a broad bangle of whitish paste; such bangle fragments were frequent at other mounds of the Derawar area. The fragment of a small bowl, with incised decoration, was collected. That only a single figurine, that of a humped bull, was found, and no worked stones, may be due to the limited time which was available for search on this large mound under the circumstances of the visit.

On march 4 when the long drive, close on 120 miles, from Fort Abbas to Shahiwala on the Dera Nawab Distributary had to be done under rather trying conditions, time could not be spared to turn off for a renewed visit of Lurewala-Ther. However, 10 miles before reaching the Shahiwala Inspection Bungalow in the evening, it became possible to inspect another large mound known as Ratta-Ther from the red colour of the pottery debris which abundantly covers it.

This mound, situated within 2 furlongs of the Dera Nawab Distributary, rises to 40 feet and measures about 750 yards from northeast to southwest. Its width measured across its greatest elevation is almost the same.

The sherds found in profusion on the surface, whether plain or painted, show the closest resemblance in fabric, type and ornamentation to those of the Lurewala-Ther which belongs, as has been shown above, to the Cemetery "H" culture at Harappa. On the painted pieces a dark red slip is frequent and the designs executed in black are either geometrical or floral. Among the latter, simple leaf and tree shapes prevail. Here some pieces of dark gray ware, also painted, appeared. It was of interest to pick up here a worked stone borer and fragments of decorated faience bangles. The peculiar relief-decorated ware which is so characteri-

stic of Cemetery "H" at Harappa was also represented here.

In the direction of Derawar, a large number of old mounds had been reported. So I was particularly glad for the arrangement which assured us the help of the experienced *Zaildar* of the grazing area of Derawar for guidance. I had reason to feel gratful also for the fact that the intelligent driver of our lorry proved equal to the task of conveying us in the end to most of the reported "Thers" in spite of the great difficulties presented by dunes. The area in which the mounds were situated, comprising about 180 square miles, was to have been irrigated from the Derawar Branch and the Dahri Distributary with water from the great Sutlej Canal.

But the available volume of water had in the end proved insufficient to feed these terminal channels. They were abandoned in due course, and the great level area of "Dahars" intersected by old river beds which they would have converted into fertile agricultural land, has relapsed into its former state of a sandy waste covered with patches of low scrub. Dunes which the vegetation of fields would have stopped were again free to move across it, while the beds of abandoned canals still remained to serve as obstacles to movement on wheels. If our survey of all those mounds had to be effected on camels, it might have cost a couple of weeks or more, and the heat of this desert ground was already becoming very trying.

Derawar, a place of some antiquity about 25 miles to the southeast, on the southern edge of a bed of the Hakra, offered itself as a convenient base, and there we proceeded on the morning of March 5. A good road connects Dera Nawab, the seat of the Bahawalpur Rulers, with Derawar, their traditional burial place. After leaving cultivation behind at Dahri village and crossing the Sahranwala Dahar, unmistakably an old river bed, there was reached the Daiwala Ther. There a debris-strewn stretch of ground, about 500 yards in diameter, surrounds a mound which the map marks with the height of 26 feet.

Sherds of good reddish ware, some burnished, were found in plenty. The painted pieces among them show the Cemetery "H" patterns closely corresponding to those seen at Lurewala and Ratta-Ther. The portion of a bowl has a typical Cemetery "H" shape. A few sherds of dark gray ware also were found, as well as some bearing geometrical designs painted in buff over a creamy ground. Relief-decorated ware of the Cemetery "H" type was plentiful.

This site also yielded half-a-dozen small stone "blades" and "borers". Fragments of faience bangles with impressed or incised decoration were found also, and there is a specimen of such rough baked "cakes" with finger holes as were found at the sites of Kalepar and Sandhana and elsewhere. A terracotta piece, with a series of holes is perhaps part of a "hanger" for securing small belongings or used in wearing. Here, too, gray-bodied ware, painted with geometrical designs, was represented.

Leaving the road and following the abandoned Mithra Distributary, there was reached after 3 miles the site known as Trekoe. Overrun in places by low drift sand, there are seen stretches of ground strewn with broken pottery for a distance of some 1,250 yards from east to west, with a width of about 400 yards. At its western end there rises a small mound to a height of 20 feet.

Among the prevailing ware of reddish fabric the painted pieces show designs in black of the type familiar from Harappa. There were found also fragments of gray ware painted with black bands. Incised patterns are seen both on the outside and inside of sherds. Among numerous perforated pieces, one in particular, is of some interest, for judging from its shape it seems to have belonged to a cylindrical brazier. A number of small stone "blades" were also picked up here. On both sides of Trekoe-Ther wide stretches of flat ground suggested old river beds, while on the way to Derawar several low ridges were crossed which looked like banks separating channels in a former deltaic area.

Fort Derawar, reached 2 miles further to the south, occupies a site of great antiquity. It was sufficiently indicated by the high mound passed on our way to the small structure which was to have served as a *Tahsil* Office for the new colonies it was expected to establish on the canals since abandoned. Now standing empty, it provided a convenient base for the next few days. As a closer examination of the mound and the ancient burial ground traced near it was not made until the end of that stay, an account of its results will conveniently be left for the concluding portion of this section. But a few notes on the history of the place and its extant structures may conveniently find room here.

Reference has been made already to the Jaisalmer record, which indicates Derawar as the earliest seat of the Bhati rulers before they established themselves in Jaisalmer. It is hence of interest that local Hindu tradition claims the Derawar Fort to have been

built by a Bhati chief called Deva Rawal and to have remained in possession of his descendants until Nawab Sadiq Muhammad Khan took possession of it in 1733. No reliance can be placed on the statement from the same Hindu source which assigns the building of Derawar Fort to the middle of the ninth century A.D. But the structural features of the walls and bastions of the existing fort make it appear probable that, like that of Bhatner which it resembles, it dates back to late mediaeval times. It is used now as a State prison and the interior was not accessible.

Evidence of the traditional importance still attaching to Derawar is afforded by the fact that a site to the east of the fort marked by a number of funeral domes had continued to serve as the burial place for members of the ruling family of Bahawalpur, apparently since the time of Nawab Muhammad Bahawal Khan, whose accession in A.H. 1186 (A.D. 1772) the inscription on his tomb records. From references made to Derawar during his reign, it is seen that it served then as a principal stronghold of the State.

A fine mosque of imposing dimensions and a modern residence of the Nawab built outside the fort attest to the continued attachment felt by the Bahawalpur Rulers to this place, unattractive as its position is, far away from any cultivation and close to the high ridges of sand which mark here the southern edge of the Hakra bed. As the map shows, they rise at numerous points to heights above 50 feet.

Neither the number of scattered homesteads to be seen on 3 sides of the fort nor the position itself of Derawar offers a ready explanation of the importance which the place has certainly claimed since mediaeval times. That this local importance dates back to a far more ancient period we shall see when dealing with the large mound which rises close to the west of the fort and village. Before this, however, I shall record what an extensive survey effected in the course of 2 days has shown as to the many early settlements traceable over the wide deltaic bed of the Hakra to the west and north of Derawar. I shall describe them in the order in which they were visited.

About 4 miles northwest of Derawar Fort and 2 miles from Trekoe-Ther there is found the Charaiwala-Ther about 10 feet high, rising within a debris-strewn area measuring about 420 yards in diameter. Sherds of reddish fabric show simple geometrical patterns painted over either a dark or light red slip, some of which are definitely attributable to the Harappa Culture.

It was of interest to observe on the inside of plain sherds incised patterns, including concentric rows of crescents, which also occur at Harappa. A considerable number of worked flint blades were picked up, among them a complete one nearly 4 inches long. Terracotta and shell bangles and small shell beads were found, also a small piece of copper ore. A miniature round cup may have been used as a thimble.

At Parharewala-Ther, situated about 6 miles to the west, a mound (41 feet) rises within a debris-strewn area about 440 yards in diameter. This site yielded a fair number of plain and painted sherds of that Harappa type which included the fragment showing a neatly drawn tree. A terracotta human head of Harappa type, fragments of flint blades, clay faience bangles, and a flat tablet of gray soapstone (?) were also picked up.

Some mounds to the north and northwest, marked on the map within distances from 2-8 miles, proved inaccessible by car owing to close-set dunes. This proved to be the case also with 2 "Thers" to the southwest shown by the map, near sand hills rising to great heights.

Well-guided, however, with many twists between dunes, we managed to reach the Jalharwala-Ther, near the abandoned Derawar Distributary. It rises to some 18 feet and with the debris area at its foot measures about 250 yards across. This yielded sherds of thick reddish ware, painted with the Harappa patterns. An unpainted bowl with a ring base seems to have had a buff slip, now mostly effaced by erosion. Fragments of small worked stones and of terracotta bangles were also found in plenty. A terracotta figurine may be meant for a dog.

Finally, with much difficulty access was gained southwestward to 2 mounds marked by the half-inch map on the Karowala Dahar. They lie near the end of the flat belt to which the terminal channels of the Derawar Branch now abandoned were expected to carry water. On the low Shikhri-Ther there were found sherds of the Harappa ware painted with patterns on dark red slip. including several from large pots. In addition to perforated pottery, there were numerous worked stone "blades" and "borers", also round "cakes" with finger holds of the kind found at Sandhanawala-Ther and elsewhere on the Hakra. A small triangular clay lamp is of very rough make.

The second mound, about 2 miles off in the same direction and

known as Dewaliana-Ther, is much larger. It rises to 15 feet, measuring some 600 yards from north to south and about 430 yards across. The whole of it is covered with plentiful kiln remains. Here, as also at Shikhri-Ther, a complete burnt brick was found (11×5×2 inches). The painted sherds with mostly geometrical designs on dark red slip agreed closely with those found at the last-named sites. Apart from this ware, fragments of gray or buff fabric with dark ruling over creamy slip occurred more frequently; also, perforated sherds. Small pieces of worked "blades", bangles of terracotta and shell, and beads of shell were abundant. Fragments of bronze (or copper) needles were also picked up, as well as part of a terracotta "hanger" and a humped bull figurine. Two flint cores indicated manufacture of stone implements on the spot.

There still remains to be noted close on 3 miles southwest of Derawar the Khanpuri-Ther. It stretches as a continuous ridge some 20 feet high for about 600 yards from north to south with a width of nearly 600 yards. This site yielded black on red sherds of the Harappa ware showing scales and pipal leaf patterns. In some sherds of buff fabric the application of a dark red slip in broad bands produces a bichrome effect. Some painted fragments of reddish ware display a greenish-gray slip. An open bowl with ring base and a little cup, with a very small base, are familiar examples of the Harappa shape. Impressed geometrical patterns make their appearance on the inside surface of sherds. Like relief decoration on the outside, produced from moulds, they suggest the introduction of a different and probably later type of pottery. So does also the "keeling". There is a good specimen of a flint knife with thumb hold.

On March 7 a group of mounds was inspected which lies in the vicinity of the graziers' hamlet of Mirana, situated some 12 miles to the north of Derawar and on the now abandoned tail portion of the Dehri Distributary. The two score of "Maldar" or pastoral families of Mirana graze their camels and sheep during the cold weather in the Hakra bed and move in the spring to the Sutlej or Panjnad until rain comes during the summer. They had seen water come and cease in the canal without changing their livelihood.

At the small mound of Lomriwala, about 3 miles northwest of Mirana, measuring some 180 yards in diameter, sherds of reddish

ware painted with geometrical patterns on dark red slip were plentiful. Of buff ware one piece had a creamy slip with graffito rules showing the underlying surface. Relief-decorated sherds typical of the Cemetery "H" Culture at Harappa, such as had been seen first at Lurawala-Ther, reappeared here in plenty. Of small worked flints there were many, and still more numerous were the fragments of faience bangles. The same surface was found on the fragment of a small cup decorated with incised hachuring.

Only a mile to the south, another low mound was visited for which our guides from Mirana gave the name of Khanpuri. Here it was of interest to note that by the side of the usual reddish ware with painted geometrical patterns in black there were found pieces with incised decoration. A later development was indicated here by the appearance of flat relief decoration from moulds on the outside surface of sherds.

About 4 miles to the southwest of Mirana hamlet are found 2 low mounds, both of small size and designated as Garakwali-Theris from the "Dahar" which they adjoin. On the northern one, here called Garakwali I, worked flints including several large "blades," were numerous. Incised decoration is shown by the inside of some painted pieces. The lower portion of a bowl has a ring base. The southern mound, here called Garakwali II, is largely covered with kiln remains. This yielded some pottery cakes, flints and painted sherds of the Harappa type. Buff ware showed a creamy slip with graffito ruling. Impressed decoration occurred on the inside of unpainted sherds. An ovoid bead of onyx-like stone may be mentioned.

Siddhuwala-Ther, situated about one mile to the north of Garakwali I, is larger, measuring about 350 yards in diameter with a height of 27 feet. It is largely covered by drift sand, caught by scrubby hummocks. Apart from fragments of relief-decorated ware which is typical of Cemetery "H" culture at Harappa, there were found sherds decorated on the rims with incised patterns of scallops or dots. The large quantity of green faience bangles of different sizes and often neatly decorated with incised hachuring, deserves mention. Numerous small pieces of copper ore suggest that this was used for the manufacture of the green colour of the faience bangles. Several fragments of bored bracelets of a whitish paste were also picked up. The place may have served for the

production of such ornaments. Also found was part of a large clay "hanger", perhaps used in weaving.

The most distant of the sites visited in the northern portion of what may be called the Hakra delta were 2 mounds, both known as Mubarakwali-Thers, to the southwest of Mirana. They are situated near the area which a terminal portion of the Abbasia Canal taking off from the Panjnad and now abandoned was expected to irrigate.

The eastern of the 2 Thers is a low mound emerging among dunes and bearing plentiful remains from kilns. Apart from some sherds with relief-decoration of the Cemetery "H" type of Harappa, there was found here a miniature pot of rough make, shell beads and small worked flints.

The western Mubarak-Ther, about $1\frac{1}{2}$ miles distant, rises to 34 feet admidst dunes. It may mark a settlement much larger than its diameter of some 250 yards would indicate, since small patches of debris-strewn ground emerge among the sand-hillocks around. In addition to some reddish ware with painted geometrical patterns over a dark red slip, there were found here pieces of thinner buff fabric, also worked flints and fragments of faience bangles.

The survey recorded above comprised nearly one half of the very numerous mounds in what may be called the Hakra delta. Rapid as it was, it justifies the conclusion that the remains traced over this extensive area date from prolonged and fairly uniform occupation in a Prehistoric, and probably Chalcolithic, Period. The acquaintance gained with the general type of civilization attested by these remains will make it easier to form an opinion as to the character of the great mound which rises in close vicinity of Derawar Fort and has, no doubt, played its part in the history of the site.

The Derawar mound lies about a third of a mile to the west of the Fort from which it is separated by the line of the now abandoned Derawar Distributary. It reaches its greatest height of 52 feet above the adjacent flat ground on its western side. It thence throws out 3 spurs of which the eastern one is the longest. The lower portion of this eastern spur is occupied by a Muhammadan cemetery, while on a small saddle below its top stands a half ruined modern structure declared to mark a Hindu burning place.

From the top of this spur, reaching a height of 51 feet, a broad

cutting has been made in recent years down to a level of some 20 feet when H.H. the Nawab ordered an excavation in search of hidden treasure. A similar but less wide cutting on the western slope of the mound was said to be due to the same order. These cuttings have throughout laid bare debris layers, and in these from the bottom upwards painted sherds of red fabric of the Harappa type could be observed. The larger cutting shows also two distinct layers of ashes and charred remains at an interval of about 6 feet. On a level approximately corresponding to the bottom of the broad cutting but a short distance to the west of it, burnt bricks have become exposed below courses of mud bricks. The size of these burnt bricks ($11 \times 5 \times 2$ inches), agrees closely with that of the Harappa sites including Parharewala and Dewalianwala.

From the observations which these "treasure-seeking" operations have facilitated, it may safely be concluded that a great, if not the main portion of the debris deposits which constitute the lower part of the mound belongs to the Harappa Culture. Only a systematic excavation could disclose full stratigraphic evidence as regards the rise of the Derawar mound.

But that this rise continued into later times is proved by the fact that, while away from the layers exposed by the aforementioned cuttings, painted sherds of buff fabric showing coarsely painted geometrical patterns of a manifestly later type were found in plenty on their surface. The fabric of such sherds is always of a light buff colour, and the slip usually applied is pink of various shades. A bichrome effect is made to appear by the use of a narrow band between black lines or by applying creamy streaks and dots over the slip.

Owing to inferior technique or firing, the very poorly executed patterns have faded or become abraded. It may be noted that even on the reddish ware the painting of designs in some pieces shows careless execution, probably a sign of later production.

It is significant that only 4 worked flints, all fragments of "blades" and 1 flint core were picked up on the large mound. Obviously the accumulation of debris and refuse from later occupation was bound progressively to cover the slopes on the surface and to hide most of the early remains. There can be little doubt that occupation of the mound continued into historical times, although no structural remains of this were traced in the course

of a necessarily cursory examination. From the fact that no glazed sherds were noticed on the mound with the exception of a piece of fine stoneware apparently Chinese and of uncertain date, I am inclined to conjecture that occupation on the mound itself had ceased before Muhammadan times.

Here my description of Derawar and its remains might have ended but for a lucky discovery. It was due at the start to Surveyor Muhammad Ayub's intelligent observation and keen eyes. On going with me on the morning of March 6 over a low plateau-like stretch of ground, he noticed what looked like broken rims of several pottery vessels sticking out close together slightly above the surface. Their appearance and the position of the place reminded him of burial deposits excavated by us in the autumn of 1936 at the Prehistoric burial ground on a similar plateau near the foot of the great mound of Hasanly in the Solduz tract of western Iran. This surmise was quickly confirmed when the clearing at a point near the middle of that ground disclosed a miscellaneous collection of pottery grouped round a large broken vessel. It was an unmistakable burial deposit covered by only 6–8 inches of loose earth and occupying a space of about $4\frac{1}{2} \times 2$ feet.

All the vessels, of which altogether 21 were counted, were plain unpainted ware of coarse fabric. Whether owing to imperfect firing, exposure through erosion, or the effect of salts, they were liable to break easily on removal. As the contents of 4 more burial deposits subsequently cleared agreed in the type of vessels represented though the numbers varied, it may be sufficient to record the description given of those comprised in this first deposit from Mr. Krishna Deva's notes. To this are added references to specimens which were removed from this and another deposit, together with brief notes on special observations.

Deposit "A" consisted of a large jar, broken, of 14 inches diameter; a dish-on-stand, turned down and in pieces a bell-shaped vase with ring-bottom and flared mouth, (height 12 inches), which a small lota-shaped vase covered; two high narrow vases with ring bottom, height 9 inches; a vase (7 inches high), with bulging body and ring base, a bell-shaped narrow vase (5 inches high); and 12 complete or broken plates of diameters varying from 7-12 inches, some placed in 2 nests.

The second burial deposit ("B") was found situated some 50 feet to the southwest of "A" and within an enclosure, about 5 feet

square, formed by mud-bricks put on edge. It comprised 24 pieces of pottery. Among these were the following: an amphora shaped vase (20 inches high); a vase (7 inches high), with wide bulging body tapering into a ring base; a beaker-like vase (7 inches high) with a small base; and a small vase shaped like a "tear-bottle". Near one of the 3 plates the earth was mixed with minute bone fragments.

In deposit "C" situated some 20 feet south of "B", almost all the 22 vessels were found much decayed. Among them was a dish-on-stand and 2 vases each with a narrow mouth and bulging body. The large jar around which in "A" and "B" the other vessels were grouped, was here missing. Fragments of 2 well-finished shell bangles suggested that the burial deposit was that of a woman.

The burial deposit "D" found between "B" and "C" comprised 32 pieces; among them were 2 dish-on-stands and 18 plates, most of these stacked in sets. The find of a small piece of bone among the debris deserves specially to be noted. There were several narrow-shaped small vases (5 inches high) and a small lid which might have belonged to one of them. Finally, mention may be made of a small deposit traced near the southern edge of the low plateau used as a burial place. Apart from one jar (12 inches in diameter) it contained only remains of 4 vases of shapes already described. Considering the small amount of this burial furniture it might have been meant for a child.

From the similarity of the types of these vessels to those of Cemetery R. 37 at Harappa, it appears certain that the burial deposits belong to the Harappa Culture. The uniformity of the objects found and their generally poor preservation made me feel less regret that a variety of practical considerations would not leave time for clearing the dozen or two other burial deposits traceable by surface indications before our return to Bahawalpur became necessary on the evening of March 8. Like the systematic exploration of the great mound of Derawar, that task had to be left for some future investigator; but care was taken by instructions given locally to prevent, if possible, any disturbance meanwhile of the small cemetery.

Section 5. General Conclusions Regarding the Ancient Saraswati Bed

Rapid as had been our survey of the many sites of Prehistoric

occupation to be traced in the wide area about Derawar, it sufficed to make it quite certain that this ground had for a prolonged Prehistoric period witnessed such cultivation and settled life as only an abundant flow of water in the Hakra bed could have yielded.

There seems good reason to assume that Derawar, near enough to that great expanse of once fertile ground and yet by its position protected from risks of inundation, had played the part of a local centre. Continuity of such local importance as is accounted for by the topographical features may help to explain what we know, as stated above, about Derawar's history in mediaeval times.

The rapidly increasing heat of the last weeks had made field work trying on this desert ground, and the hope of "prospecting" for future tasks of archaeological and geographical interest was drawing me back to cherished old haunts on the Northwest Frontier. So I left the Bahawalpur capital on March 11 full of grateful recollections of all the kind attention and help which had so much facilitated my reconnaissance labours in the State.

The account of the observations made during the remainder of my tour from Dera Ismail Khan to Swat must be left for another place. But here it will be convenient in conclusion to sum up succinctly what observations in Bikanir and Bahawalpur territory I had been able to gather bearing on the main object of my tour : the question of ancient geography presented by the dry bed of the Ghaggar or Hakra.

We have seen that this bed, as far as it was observed within Bikanir territory, is throughout so wide and so well-defined as to make it quite evident that the river the floods of which once found their way down it, probably changing their courses from time to time after the nature of rivers on flat ground and never quite filling it, must have carried a much larger volume then the present one. This allows only in exceptional years a certain amount of inundation water to pass for a short distance below Hanumangarh; it often fails to provide even that amount of irrigation which the modest villages within the Ghaggar bed above Hanumangarh need for their cultivation.

Yet the very numerous mounds, some of large size, to be found within the Ghaggar bed below Hanumangarh right down to the vicinity of Suratgarh, attest close settlement along this bed in historical times, for the type of their painted pottery is proved by

definite archaeological evidence to have remained in use for a long period down to the early Christian centuries.

A comparatively short distance below Suratgarh the sites of former traceable occupation cease to show this datable ceramic type. Instead of it there is found from here onward as far as the Bikanir border and beyond it to the vicinity of Marot an inferior type of decorated pottery, unpainted and showing only impressed patterns of a very simple kind.

Close to that border on the Bahawalpur side, the Ghaggar bed is joined by another dry river bed from the northeast. This is followed now by the Hakra Branch of the great canal system taking off from the Sutlej at the Deir of Sulemantic. This dry bed marks an ancient branch of the Sutlej, and to this the name of *Hakra* may conveniently be applied in distinction. Below its junction with the Ghaggar above Fort Abbas, the bed of the latter, while continuing its east to west direction as from Suratgarh downward, significantly enough shows a much enlarged width.

Here, close to this junction, mounds marking Prehistoric settlements make their first appearance, with a type of painted ware, worked flints and other objects distinctly characteristic of Chalcolithic times. We have seen that these sites of Prehistoric occupation thence stretch in a continuous line right down to Derawar. But for a distance of about 30 miles below that junction there intervene also on low ground small sites at which Chalcolithic remains are absent and of decorated pottery only the previously mentioned unpainted ware with rough impressed patterns. Of this the trial excavation at Sandhanawala-Ther has definitely shown that it is later than the Chalcolithic painted pottery.

So the explanation suggests itself that Chalcolithic occupation had been abandoned when the Sutlej branch which carried abundant water from the great snow-fed river down to the joint Ghaggar-Hakra bed had ceased to flow, and that the small sites with the later type of pottery dated from a time when subsequently that bed received water solely from the Ghaggar.

We have seen before that in the bed of the Ghaggar the same impressed pottery is found from below Suratgarh down to the Bahawalpur border, i.e. just above its junction with the old bed from the Sutlej. Now in the case of the Ghaggar which is fed entirely by the monsoon rainfall on the Siwalik range, a gradual diminution in the volume of water reaching its bed lower down is

definitely proved by the previously noted archaeological evidence. The same is asserted also for modern times by popular belief. So it may well be assumed that when after a time water from the Ghaggar alone also failed to reach that ground on the Hakra where those Chalcolithic sites had been occupied before, the same fate of abandonment overtook in turn the settlements of a later time.

We have no definite indication at present for dating these settlements, but that they preceded the historical period with its painted pottery attested down to Kushan times may be considered as certain.

From the above it appears safe to conclue that all the Chalcolithic sites traced from Fort Abbas down to Derawar mark a period when the river bed running in continuation of the Ghaggar and now known as the Hakra carried a volume of water sufficient to irrigate an area of cultivation much larger than any traceable along the Ghaggar on the Bikanir side.

The additional volume of water could only have come from the Sutlej, just as the latter feeds nowadays the modern canal system that has turned the greater part of Bahawalpur territory from scrub-covered sandy wastes into fertile agricultural land. But only further investigation could now show whether the ancient Sutlej branch which has been assumed above to have once lain along the line of the present Hakra Branch Canal was the only branch to have carried Sutlej water down to the wide once cultivated deltaic area about Derawar.

Much of what has been set forth above about the extent of ancient settled occupation along the Ghaggar-Hakra must necessarily remain hypothetical. In the absence of definite, clearly chronological indications, it would seem hazardous at present to use the archaeological observations concerning the ancient river course for any attempt to date the references made to the Saraswati in early Vedic texts. But the evidence now available shows that down to historical times the Ghaggar is likely to have carried such a volume of water as is necessary under existing conditions of climate for cultivation and settled life much further down than it does now.

We have also seen that even at present its bed allows in years of good monsoon rainfall inundations to reach points far beyond the limits which scholarly opinion, lacking adequate local know-

ledge, has so far been prepared to assume. This will help to make it more intelligible how the Saraswati, in itself an insignificant little stream among the headwaters of the Ghaggar, but by Indian tradition held to be sacred, has come in hymns of the Rigveda to be praised as a great river, worthy to rank with those which are fed by the eternal snows of the Himalaya.

What has caused the Saraswati to figure in early Hindu belief as sacred is a question shrouded in the obscurities of Indian mythological speculation. This belief in its sanctity may well be pre-Aryan in origin. But we can better understand the greatness which certain passages of the Rigveda attribute to the river fed by the Saraswati if attention is paid to 2 points.

In the first place, the chronological interval between the time that notion found its expression in Vedic poetry and the time when a branch of the Sutlej still joined the Ghaggar may not have been so great as to efface all traditional knowledge of the latter having once been large enough to make its way as far as the Panjnad and the Indus.

How extensive such knowledge on the part of those who composed hymns of the Rigveda was in respect of certain hydrographical facts, is proved by Hymn X. 75 of the Rigveda, the famous *Nadistuti* of "Praise of the Rivers". When discussing long ago the list of river names, contained in verse 5 of this text, I have had occasion to emphasize the fact that the exact order from east to west in which those river names are enumerated, as well as the mention made in it of a little-known river like the Marudvrdha, far away in the mountains adjacent to Kashmir, prove a far more detailed knowledge of the hydrography of that great region extending from Kuruksetra to the Indus than might have been supposed on the part of Vedic poets.

It was no doubt empiric knowledge acquired through people acquainted with the ground and not from quasi-literary sources, and this involves that list as an early geographical record with special value for the critical student of antiquity. It is in that very list that we find the Saraswati quite correctly placed between the Yamuna (Jumna) and the Sutudri (Sutlej).

Hence it may be reasonably assumed that even if at the time water from the Saraswati may not have passed further than archaeological evidence shows it to have flowed in early historical times, yet the composer of that hymn was aware of the river's

importance as proved by its unmistakably great and far-extended bed.

In the second place, note deserves to be taken of the fact that local tradition even at the present day is still fully alive to the Ghaggar-Hakra being the bed of a large river. As evidence how deeply rooted is this popular notion, and how it has left its mark for a long time past in local nomenclature, it will suffice to refer to 2 instances recorded above.

At the point called Jandewala on the right bank of the Ghaggar in Bikanir territory, popular tradition recognizes the place where a ferry service is supposed to have crossed the river to Mathula on the opposite bank, a distance of more than 3 miles.

Still more striking, perhaps, is the name of Pattan-munara, the "Minar of the ferry", borne by an old site in Bahawalpur territory which is similarly believed to mark a ferrying place across the Hakra, the bed of which is here, if anything, still wider.

However, a word of critical caution may suitably find a place here. I have repeatedly had occasion to point out above how striking is the effect created for the spectator passing along the Ghaggar or Hakra by the continuous lines of sand ridges marking the edge on both sides of the riverine flat. They might by themselves, even if all traditional recollection had disappeared for some reason, suffice to suggest to the popular mind that a mighty river had once cut its course here through the desert wastes.

In a similar way, the defiles below Baramula by which the Jhelum River leaves Kashmir carrying the whole drainage of the great valley, are by traditional belief embodied in a legend of great antiquity and are attributed to the gods, who caused the ring of mountains encircling the Kashmir Valley to be pierced there and the lake once covering to be drained. This tradition has often been assumed by early European travellers to corroborate the conclusion they drew from observed features as to Kashmir having once been occupied by a great lake. It reality there can be no doubt that the legend itself originated from the physical features which those travellers noted and imperfectly interpreted.

The observations recorded in these pages have shown sufficient ground for believing that the great change which has affected the Saraswati River as known to the earliest Vedic texts may be attributed to 2 distinct physical causes. As regards the upper or

Ghaggar portion of the ancient river course, archaeological evidence attests a process of drying up which has taken place partly during historical times and is likely also to have been at work before in a late Prehistoric period.

In modern times this process might have been hastened to some extent by human activity through increased diversion higher up of flood water for irrigation of land near the bed, the increased need for such water being due to more settled conditions and the pressure of population resulting from it. As regards the lower or Hakra portion the old river course, the main change was due to the Sutlej, a branch of which before joined the Ghaggar in the vicinity of Fort Abbas, having abandoned that bed in a late Prehistoric Period and this having greatly reduced the available volume of water lower down.

In the latter change, we can recognize the result of a hydrographical law which forces all rivers where the flow over plains or peneplains to shift their terminal beds after a time unless human activity restrains them. The question as to the cause or causes from which the process of drying up arises is one of great geographical and to some extent historical interest, but it falls beyond the scope of this Report. It could profitably be approached only by extending the investigation over a much wider field, that connected with the much discussed problem of "desication," in particular as far as it affects the rainfall recorded by northern India.

Even for an enquiry limited to the Saraswati, there still remains the need of extending the survey of ancient sites traceable along its bed both above and below that portion which my tour has allowed me to examine over a total distance of close on 260 miles. For such further investigations the facts already secured and recorded in this Report may, I hope, provide useful guidance.

Appendix 1

THE RAJPUTANA DESERT— ITS ARCHAEOLOGICAL ASPECT

By
A. GHOSH

Rajputana abounds in forts and palaces built by the Rajput princes and chiefs during medieval times. But though they form a significant part of the cultural heritage of India, they are of no consequence in the present context, as they were built at a time when the region had already acquired its present desert features.

Some data are available in early literature to indicate that the Rajputana desert is not of very recent origin, though it may have spread beyond its initial limits, as it is reported to be spreading even now.

Sanskrit inscriptions of the thirteenth to sixteenth centuries invariably refer to the Jodhpur-Udaipur-Bikaner region as the desert—*Maru*, *Maru-deśa* or *Maru-sthalī*. Earlier, the historians of Maḥmūd of Ghazna, who invaded India several times in the first quarter of the eleventh century, say that the Sulṭān, while going from Multān in West Punjab to Somnāth in Gujarat, had to cross the desert and to make elaborate arrangements for water-supply (Nazim, 1931).

The existence of the desert in still older times is attested to by the *Mahābhārata*. When the Pāṇḍavas went into exile, they travelled westwards from Hastināpura on the Ganges till they reached the Kāmyaka forest, said to be on the bank of the river Sarasvatī, by a *level and arid desert*. The epic also speaks of the Sarasvatī as disappearing in the midst of the desert. We shall speak below about the Sarasvatī, which flowed through the northern part of Bikaner. We may only note here that by the time of the composition of the *Mahābhārata*, *i.e.* roughly the early centuries A.D., the desert was already existing as far north as Bikaner.

In a long article published in 1892, H. G. Raverty, mainly on

the basis of his own interpretation of passages from Muslim chroniclers, tried to establish that the desert originated only in medieval times (Raverty, 1892). A detailed examination of his arguments is unnecessary here, for his hypothesis must be discarded in view of the data cited above.

We are, therefore, left to the conclusion that the Rajputana desert is at least two millennia old and its nucleus must be older still. But as yet we have practically no data to trace its history farther back.

Not much is at present known about the archaeology of the desert. We have no doubt got a few standing temples of pre-Muslim times in its midst, and in the eastern part of Rajputana there exist the ruins of a few habitation-sites—some of them fairly extensive—dating from a few centuries before and after the Christian era. But they need not engage our attention here, as they are situated in a region which cannot strictly be regarded as a part of the desert. Within the desert proper, except the northern part of Bikaner, about which I shall speak presently, hardly any ancient site is known, imperfect exploration of the region being no doubt the chief reason.

* * *

During the last two seasons the Department of Archaeology has carried out a systematic exploration of some of the dried-up river-valleys in the northern part of Bikaner, and the results obtained are of great significance. As the drying up of the river-system in the region is no doubt intimately connected with the problem of the desert, I have to give here a few details of the system, which anciently consisted of the Sarasvatī, the Dṛishadvatī and a bed of the Sutlej.

The Sarasvatī, taking its rise in the submontane regions of the Ambala district, at present pursues its feeble course past Kurukshetra, Thāneswar and Pehoā, all of them ancient towns in Punjab, is met by a few other channels and joins the Ghaggar, a more northerly stream, at a place near Shatrāna in PEPSU. Thereafter the combined steam, now known as the Ghaggar, but anciently by the name of the more renowned component, Sarasvatī, flows in a south-westerly direction, enters the Hissār district and, flowing near the town of Sirsā, the name of which owes its origin to the river itself, enters Bikaner. By now, or even before this, it has ceased to be a perpetual stream. During the rains, however,

the flood-water reaches more south-westerly points through the ancient channel.

In Bikaner the dried-up bed is clearly traced in a westerly direction till it reaches the town of Hanumāngarh, renamed in the last decade as Sādūlgarh, but medievally known as Bhaṭner. Here the channel is met by another one from a north-eastern direction now known as Naiwāla and identified as an old bed of the Sutlej, which, in ancient times, formed a part of the Sarasvatī system and had not captured the Beas, thus to flow into the Indus.

South-east of Hanumāngarh, the river-bed, marked by sand-ridges on both sides and locally known as the *nālī*, reaches the tahsīl headquarters Sūratgarh, where it is joined from the east by another dried-up stream, the ancient Dṛishadvatī, which I shall describe later on.

Beyond Sūratgarh, the river, as indicated by the sand-banks now attaining greater heights, flowed past another but smaller tahsīl town Anūpgarh and beyond, 6 miles or so, entered the Bahāwalpur State, now in Pakistan, and threfore beyond the scope of my exploration. It may only be said that during its life-time it flowed into the sea, either independently or as a tributary of the Indus.

Between the sand-banks of the river, separated from each other by 3 to 6 miles, lies a stretch of alluvium, usually covered with wild shrubs, but sometimes absolutely flat and shiny with not a blade of grass growing on it. Wherever, however, the parched alluvium is irrigated by modern canals, it yields a harvest of summer and winter crops as rich as the Indo-Gangetic plain, of which the region anciently formed part.

There is little doubt that the ridges flanking the alluvium represent the ancient banks of the river and are not formed by drifted sand, as was argued by Sir Aurel Stein, who thought that the sand could not cover the dried-up river-bed itself due to the existence of vegetation in the alluvium left by the river. (Stein, 1942). That they represent river-banks is proved by the existence on them of a large number of shells, kindly identified for me by the Zoological Survey of India as *Zootecus insularis* (Ehr.), *Indonaia caerulea* (Lea) and *Parreysia* sp. Some of these, being fresh water shells, must have got deposited on the banks of the river while it was alive. Small dunes, accumulating at the tops of the sand-banks and consisting of finer sand drifted from the banks themselves and outside, are of secondary formation.

So much about the Sarasvatī. The Dṛishadvatī also takes its rise in the submontane Himālayan region, but farther south than the Sarasvatī. Such part of the river as still exists in Punjab is known as the Chautāng, and the river-bed can be traced through Bhādrā, a north-eastern town in Bikaner, with Firūz Shāh's Western Jamna canal flowing through part of its valley. Beyond Bhādrā it flowed through the town of Nohar, and further down, past the site of the modern village of Rāwatsar, from where the northern sand-bank of the river becomes visible. Its bed further west is now a complete wasteland, till it can be seen to have met the Sarasvatī at a place about three miles north of Sūratgarh.

Part of the Sarasvatī valley in Bikaner had already been surveyed by the renowned explorer Sir Aurel Stein, who devoted the winter season of 1940-41 to the investigation of the remains in this region as well as in the adjoining Bahāwalpur State (Stein, 1942). ...(But his) observations have been found to be very incomplete, and his conclusion that there are no 'pre-historic' mounds east of Fort Abbas in Bahāwalpur State with pottery of the chalcolithic period', by which he no doubt means the period represented at Harappā and Mohenjo-daro, has been rendered utterly untenable by the present exploration.

In view of Stein's statement which had led us to believe that nothing very ancient would be found in the region, it was a great thrill for us when even on the first and second days of our exploration we found sites with unmistakable affinities with the culture of Harappā and Mohenjo-daro. And a few subsequent days' work convinced us that the Sarasvatī valley had been really a commingling of many rivers, not only geographically, but culturally.

* * *

The number of ancient sites plotted on the map as a result of my exploration is more than a hundred, and, taking into consideration the limited area explored, the valleys of the Sarasvatī and the Dṛishadvatī must be regarded as very rich indeed in archaeological remains. But the richness does not consist only in the number of the discovered sites, but in their vast chronological and cultural range. For they comprise relics of several millennia of Indian history right from the Harappā period to comparatively recent historical times.

The earliest group of the sites represents the same phase of Indian history as the twin cities of Harappā and Mohenjo-daro

of the third and early second millennia B.C. More than twenty-five mounds of this culture have been identified so far in the explored region, beginning right from the Pakistan border up to midway between Hanumāngarh and Sūratgarh in the Sarasvatī valley, and about 15 miles east of Bhādrā in the Dṛishadvatī valley, near the border between Bikaner and Punjab. In the Sarasvatī valley, as explored, the colossal mound of Kālibangā, midway between Sūratgarh and Hanumāngarh, stands, as it were, as the the easternmost outpost of this great culture, though there is little doubt that more of its remains awaits identification farther east. The discovery of these mounds brings the Harappā culture much nearer the heart of India and reveals how deeply it had taken its roots in the Indian soil.

The Harappā mounds on the Sarasvatī, though most of them the remains of small settlements, yield the same types of pottery and other objects as those farther west in Bahāwalpur, Sind and Baluchistan. Typical food-dishes, goblets with narrow bases, other pottery painted with designs in black against a red-slipped background, disc circular beads, typical terracotta toy-carts, flat triangular and circular double-convex terracotta cakes, long blades of chert,—in fact, all the material features of the Harappā culture —are present on these sites and bespeak an absolute homogeneity of culture. All these finds leave no doubt that it is the true Harappā culture and not offshoot or survival thereof that is represented in the Sarasvatī valley.

In the explored Dṛishadvatī valley also there are a few sites, one of them fairly extensive, with unmistakable Harappā affinities, but there are a few differentiae in pottery fabric and types. They may be regarded as the eastern variety of the Harappā culture, and it is not unlikely that they flourished at a period later than the true Harappā. This phase of the culture requires further investigation. All the same, the sites emphasize the eastern extent of the culture.

* * *

The next group of sites comprises a typical pottery, grey in colour and with or without black painted designs, and a mass of associated pottery quite distinct from that of the Harappā or of succeeding culture. Greyware has recently assumed importance in North Indian archaeology and has been found on many early sites in PEPSU, Punjab and West U.P. To this list has now to be

added about twenty sites now found in the explored region in the Sarasvatī valley in Bikaner. In the Dṛishadvatī valley only one greyware site was found, and that too with a coarser variety of greyware.

The vessels in greyware are restricted in shape, being confined to dishes and bowls. The painted designs also present a limited variety. Along with the grey ware vessels is found an enormous amount of red pottery with shallow impressed designs and with a base besmeared with coarse grits. Some of the red pottery-types are similar to types also found associated with greyware in excavations at Hastināpura, District Meerut. Many, however, are the new types both at Hastināpura and in Bikaner, and they no doubt represent the local creations of the greyware people.

About the other material aspects of this culture we have little evidence as yet. In Bikaner at any rate, these sites are rather small in extent and present few features. The houses appear to have been of mud-walls; the use of mud-bricks, not to speak of baked bricks, is not attested to. On the whole, the culture presents much more primitive features than the Harappā.

The terminal dates of this culture are uncertain as yet. To my mind, it appears that 600 B.C. may represent a very rough central date for this culture. Towards its end it touched the historical cultures of the Mauryan and post-Mauryan times. How much earlier than 600 B.C. it began requires further investigation. One thing appears certain: on practically all the greyware sites in Bikaner and elsewhere, settlement began with greyware. The people of this cultnre broke new ground to build their villages and did not utilize any existing mounds for the purpose.

* * *

The next group accounts for a large number of sites, some of them, especially near about Sūratgarh, of very large dimensions. I propose to christen these sites collectively as Rangmahal and the culture represented in them as the Rangmahal culture, after one of the leading and well-known sites near Sūratgarh.

The Rangmahal pottery-industry was very sturdy and productive. The shapes represented are many, and the painted designs in black, or, rarely, in crimson, on a bright red background consist of innumerable varieties, both naturalistic and geometrical.

The slip, designs and fabric of the Rangmahal pottery are readily distinguishable from the Harappā, but from the existence

of a few types common to both, it appears that the Rangmahal pottery, by a process of 'atavism', which is not yet explained, inherited or imitated a few Harappan traits. On the other hand, some of its features persist in the present-day pottery of the Sūratgarh-Anūpgarh region.

As I said just now, some of the sites of the culture are very extensive; a few of them have mud-fortifications around them. Brick-bats are plentiful on most of the sites, indicating the existence of brick houses. Other finds from the sites include terracotta human and animal figurines, including painted bulls, faïence and shell bangles, a large number of beads of different shapes, etc.

That the culture flourished in the early centuries A.D. there is little doubt. This is borne out not only by one or two similar pottery-types found in equivalent levels at Ahichchhatrā, Hastināpura, Kauśāmbī and other excavated sites, but by the discovery of one or two Kushan coins on the Bikaner sites themselves. But as some of the Rangmahal mound are very high, as much as 35 or 40 feet, they must represent the accumulation of several centuries.

In the Dṛishadvatī valley the Rangmahal culture persists, but, like the Harappā one, in a somewhat modified form.

* * *

I have described the three main ancient cultures in a chronological order, which was apparent from the beginning. But with a view to confirming the sequence by stratigraphic evidence, a few limited excavations were done in both the seasons of my work.

It has been said above that the greyware people were fond of breaking new ground for themselves; this fact makes the getting of stratigraphic evidence in their case difficult. However, I found two fairly representative mounds a few miles north of Anūpgarh, one 8 feet high, representing the Harappā culture and the other, 10 feet high, greyware, with their apexes more than 500 yards of each other, though the washings of sherds from the respective sites very nearly met each other. These two mounds, the Harappā one called Tarkhānawala Dera and the greyware one Chak 86, were also separated from each other by a canal and a road, which made a continuous excavation impossible. Nevertheless, though direct stratigraphic evidence was clearly unobtainable, I made a bid partially to excavate these mounds to obtain whatever stratigraphic clue was available about the sequence of these two cultures.

The results were satisfactory. For the excavation revealed that the Harappā and greyware cultures never came into contact with each other, at least in this particular area. The settlements of each originated, flourished and died out in its own time, entirely independently of the other. But a study of the natural soils carrying the settlements had revealing facts to tell us. On the Harappā side the occupation started on a natural sand-deposit. After this, there were two clay-deposits, due to river-action. It was after all this that the initial greyware occupation in Chak 86 took place. It was, therefore, very clear that the greyware people came to the area later than its desertion by the Harappans, how much later I cannot say, unless scientists can give some clue about the period that might have lapsed between the first flood-deposit and the next.

For the sequence of the greyware and Rangmahal cultures, two sites were excavated. The first, an 18-feet high mound at Reṛ, situated about 15 miles to the northeast of Anūpgarh, revealed successive layers of greyware occupation, superimposed by layers with most of the features of the Rangmahal culture, thus stratigraphically establishing the priority of greyware to Rangmahal.

Excavation in a smaller mound further up, in Chak 40, confirmed the sequence, though the Rangmahal occupation here was more limited than the prior greyware one.

Excavations thus confirmed the relative chronology of the three cultures, Harappā, greyware and Rangmahal, in the explored part of the Sarasvatī valley.

* * *

We have now to turn to the application of the archaeological data as detailed above to the problem of the desert. As is well known, the Harappā culture was mainly a riverine one. The sites on the bank of the Sarasvatī no doubt represent the eastern march of the culture following the course of the river—a fact which would have been impossible had the river been dead during the life-time of the culture.

As has been said above, the next culture, the greyware one, is represented by unpretentious settlements. It seems not unlikely that during this period, *i.e.* the first millennium B.C., the source of water-supply had become somewhat shaky, leading to an impoverishment of the land.

Of the next, Rangmahal culture, there are ruins of a few

flourishing and extensive stations, the inhabitants of which must have been sure of an adequate water-supply. It is not unlikely, therefore, that there was partial resusciation of the river-system in the first half of the first millennium A.D.

After the decay of the large settlements in the Sarasvatī valley in the seventh-eighth century the population seems to have turned largely nomadic. There are no ruins of large settlements thereafter, though there are remains of 'camps', consisting of isolated patches of land strewn with pottery, vaguely reminiscent of the Rangmahal culture. In the part of the Dṛishadvatī valley east of Rāwatsar, however, there are medieval ruins, bespeaking a fairly continued occupation.

* * *

Though the northern part of Bikaner forms only a small part of the Rajputana desert, I have dwelt at length with its archaeology, for it is only this part of the desert in which a systematic, though limited, exploration has been undertaken, as a result of which I have first-hand information not of the archaeology but of the river-valleys and the features of the land. The results of this work have emphasized the archaeological potentialities of the region and the necessity of undertaking similar work elsewhere.

REFERENCES

Nazim, M. (1931). The Life and Times of Sultan Mahmud of Ghazna (Cambridge).

Raverty, H. G. (1982). The Mihrān of Sind and its Tributaries: a Geographical and Historical Study. *Journal of Asiatic Society of Bengal*, 61, 155–508.

Stein, A. (1942). A Survey of Ancient Sites along the 'Lost' Sarasvati-river. *Geographical Journal*, 99, 173–182.

Appendix 2

RECENT ARCHAEOLOGICAL RESEARCH IN THE CHOLISTAN DESERT

By
M. RAFIQUE MUGHAL

Introduction

In 1974, the Department of Archaeology and Museums, Pakistan launched a major program of field research in the Cholistan Desert of former Bahawalpur State in the East-Central Indus Valley. The purpose of this preliminary survey was to locate and identify the full range of archaeological remains in this little-known region. The Cholistan Desert, an area of extreme aridity, was originally watered on its western fringes by a river now called the Hakra in Pakistan and the Ghaggar in India. Of particular interest was the now dry bed of this river.

A part of this region was first explored by Sir Aurel Stein in 1941 (Stein 1942). In 1955 Henry Field (1959) re-examined a part of Stein's track. On the Indian side, the dry bed of the Ghaggar River was surveyed by A. Ghosh (1952) and later by B. B. Lal and B. K. Thapar, who extensively excavated the Harappan site of Kalibangan. A zone along the Sutlej River was explored by K. N. Dikshit and the area near Anupgarh and Nohar on the Ghaggar river reviewed by Katy F. Dalal (1980). The Major work in Haryana and the Punjab (east) was carried out by Suraj Bhan (1973 and 1975) which he continued in 1977 with Jim G. Shaffer (Suraj Bhan and Shaffer 1978).

Recent Surveys

Our surveys were concentrated along 300 miles of the dry bed of the Hakra River, within an approximately 10 to 15 mile-wide strip (Mughal 1980a. b). The project was directed by the author for four seasons between 1974 and 1977. Beginning at the Indian border near Fort Abbas, we covered 110 miles, to Fort Derawar,

during the first season. The settlement pattern that emerged from the first season's work was most encouraging in terms of understanding the character, distribution and location of various sites of the Harappan Civilization. The highest concentration of sites was found around Fort Derawar and to its southwest, an area which had not been previously explored. As the work progressed, the pivotal importance of this region began to emerge. It is now clear that this is a key region for understanding the developmental stages of the Harappan (or Indus) Civilization.

The Sites

A total of 414 sites have been mapped along 300 miles of the Hakra River bed. They range in time from at least the fourth millennium B.C. to the Medieval Period. The protohistoric sites fall into the various periods of development (Table 1).

The sites cover the long, continuous sequence of development and change of the Indus Civilization, encompassing the period from the fourth to the beginning of the first millennium B.C. The protohistoric settlement pattern in Cholistan has largely remained undisturbed to the present time and it is an important laboratory for the study of prehistory. The main features of each cultural phase are briefly reviewed in the following pages.

Table 1

Approximate time range	Cultural association	Number of sites
Fourth millennium B.C.	Hakra Wares (Jalilpur I related)	99
Early third millennium B.C.	Early Harappan (Kot Diji related)	40
Mid and late third millennium B.C.	Mature Harappan (Mohenjodaro and Harappan related)	174
Early second millennium B.C. and later	Late Harappan (Cemetery H related)	50
End of second and early first millennium B.C.	Post or non-Harappan (Painted Gray and Black-and-Red Wares related)	14

Note: Some sites have more than one cultural phase.

Key to the Map of Sites

Site No.	*Name of site*	*Site No.*	*Name of site*
1.	Raowali	36.	Jathewali
2.	Chak 258 HL	37.	Chak 353 (West)
3.	Chak 265 HR	38.	Mansura
4.	Ahmadwala Toba	39.	Chak 323 HR
5.	Channanwala Ther	40.	Satwali
6.	Theriwala	41.	Gharanwali
6A.	Bahadrianwala	42.	Jalwali
7.	Phulra Fort	43.	Trillar
8.	Chak 270 HR	44.	Akhera
9.	Chak 271 HR	45.	Malhalewala Ther
10.	R.D. 66	46.	Bokharaiwala
11.	Rajuwala	47.	Mojgarh Fort
12.	Sandhanawala	48.	Mojgarh Ther
13.	Satkui (East)	49.	Chipwala
14.	Satkui (West)	50.	Kalepar (Bhoot)
15.	Chak 280 HR	51.	Khewtal
16.	Chak 281 HR	52.	Wariyal Ther
17.	Quraish Ther	53.	Wariyal-E
18.	Chak 285 HR	54.	Wariyal-F
19.	Chak 298 HR	55.	Wariyal-H
20.	Mirgarh Fort	56.	Wariyal-G
21.	Jamgarh Fort	57.	Hanaswala
22.	Chak 308 HR	58.	Guddal-B
23.	Chak 314 HR	59.	Guddal Ther
24.	Kirarwali	60.	Guddal-A
25.	Chak 315 HR	61.	Wakkarwala
26.	Marot Fort	62.	Bokhariyanwala
27.	Gamanwala	63.	Bokhariyanwala-A
28.	Ladulai	64.	Bazariwala
29.	Gujranwala	65.	Jatoiwala-A
30.	Chak 337 HR	66.	Jatoiwala-B
31.	Kandianwali	67.	Kuchanwala
32.	Chapliwala (West)	68.	Ahmadwala Ther
33.	Chapliwala (East)	69.	Lal Patel
34.	Chapuwala	70.	Tarsoolwala
35.	Chak 341	71.	Jatoiwala Ther

Site No.	Name of site
72.	Hakim Ali Ther
73.	Chak 88
74.	Chak 88A (West)
75.	Chak 69
76.	Kudwala
77.	Wariyal-A
78.	Wariyal-B
79.	Wariyal-D
80.	Wariyal-C
81.	Gharaiyanwala
82.	Ali Mohd Wala Ther
83.	Chak 45
84.	Maujhalwala
85.	Chak 45B (North)
86.	Chak 45A (South)
87.	Chak 44
88.	Boharwala Ther
89.	Chak 51
90.	Kaliyar
91.	Rohatwala
92.	Chak 103
93.	Chak 107
94.	Chak 61 (East)
95.	Chak 61 (West)
96.	Lurewala
97.	Ratta Ther
98.	Dunkkian
99.	Turanwala
100.	Phukhi Ther
101.	Kuruwala
102.	Shahiwala
103.	Sui Vihar
103A.	Zahir Pir Tibba
104.	Kotla Musa Khan
105.	Uchh Sharif
106.	Mehmudabad
107.	Sukkarwala
108.	Chak 75
109.	Chak 76
110.	Dundkianwali
111.	Shaikhanwala Ther
112.	Dabli Theri
113.	Chak 97
114.	Siddhuwali-E (or Lumrywala)
115.	Siddhuwali-F
116.	Bulbaliwala
117.	Khohi Siddhuwali
118.	Siddhuwala Ther
119.	Siddhuwali-B
120.	Siddhuwali-C
121.	Siddhuwali-D
122.	Khatranwali-II
123.	Khatranwali-I
124.	Chak 131
125.	Mirana
126.	Rawewala
127.	Bagrauwala Ther
128.	Bara Fort
129.	Bara Ther
130.	Dingarh Fort
131.	Dabli (West)
132.	Dabli (East)
133.	Sullewala
134.	Cheelanwali
135.	Cheelanwala-B
136.	Killianwali-D
137.	Jiwaiwali
138.	Waddanwala
139.	Bahilawala-C
140.	Bahilawala-B
141.	Bahilawala Ther
142.	Nahranwala
143.	Turawewali-C
144.	Turawewali Theri
145.	Turawewali-B

Site No.	*Name of site*
146.	Khingarwali
146A.	Naharwali–B
147.	Khan Kandewala–A
148.	Khan Kandewala–E
149.	Akkanwali Theri
150.	Khan Kandewala–B
151.	Khan Kandewala–D
152.	Achharwala
153.	Wavriwala
154.	Waddanwali
155.	Killianwali–C
156.	Killianwali–B
157.	Killanwali
158.	Bandwali
159.	Lundwali–III
160.	Dhedaniwala Ther
161.	Lundewali–IV
162.	Lundewali–II
163.	Lundewala Ther
164.	Jalwali–B
165.	Khan Kandewala–C
166.	Jalwali–B
167.	Changalawala–C
168.	Changalawala Ther
169.	Naharwali
170.	Oinwala Ther
171.	Changalawala–B
172.	Daiwala
173.	Gopawala
174.	Hotewala–II
175.	Hotewala Ther–A
176.	Hotewala Ther–B
177.	Garakwala
178.	Jamuwali–A
179.	Jamuwali–B
180.	Mubarakwala Ther
181.	Butewala
182.	Lunida–II
183.	Lunida–I
184.	Sanukewala–II
185.	Sanukewala
186.	Sanukewala–III
187.	Kalharwala
188.	Drigwala
189.	Kalharwala–B
190.	Kaiyanwala–II
190A.	Trekoe
191.	Kaiyanwala–I
192.	Dilwashwala
193.	Payunewali Bhit–II
194.	Payunewali Bhit–III
195.	Payuna Bhit
195A.	Mehruband Ther
196.	Qadir Bux Theri
197.	Shikarwala Ther
198.	Litanwala
199.	Goongal Mar
200.	Magrejewali
201.	Bazariwali–C
202.	Bazariwali–B
203.	Bazariwali–A
204.	Singharwali
205.	Gadiwali
206.	Mahiwali
207.	Thoom Thali
208.	Derawar Fort
209.	Derawar Ther
210.	Chaudhryanwala
211.	Jhumtiwala
212.	Charhoyanwala
213.	Ghumharianwala
214.	Marechiwala
215.	Merechi Kanda
216.	Merechi Kanda–II
216A.	Garewala
217.	Merechi Kanda–III

Site No.	Name of site
218.	Luppewala–III
219.	Lathwala
220.	Lathwala–II
221.	Luppewala
222.	Luppewala–II
223.	Chiheywali
224.	Baggewali
225.	Gajjuwala–II
226.	Gajjuwala Ther
227.	Sadwala Kanda
228.	Hasilwala Ther
229.	Niwaniwala Ther (West)
230.	Niwaniwala Ther (East)
231.	Niwaniwala–II
232.	Niwaniwala–III
233.	Azimwala–II
234.	Azimwali
235.	Azimwali–A
236.	Azimwali–B
237.	Azimwali–C
238.	Shidiwala–A
239.	Batoorwala
240.	Khanpuri–II
241.	Sauransanda
242.	Khanpuri
243.	Kikriwala Ther
244.	Abduwali
245.	Kikri
246.	Kikri–II
247.	Bhagriwala
248.	Qasaiwala
249.	Tharulawala Ther
250.	Janiwali
251.	Dadwala–II
252.	Dadwala Ther
253.	Runwali
254.	Darkhanwala Ther
255.	Darkhanwala–II
256.	Sheruwala–II
257.	Sheruwala Ther
258.	Chandnewala Ther
259.	Chandnewala–II
260.	Sheruwala–III
261.	Chikrala
262.	Parhara
263.	Parharewala–A
264.	Chore
265.	Wasuwala Ther
266.	Musafarwali–II
267.	Musafarwali
268.	Gamuwala Ther
269.	Gamuwala Dahar
270.	Gamuwali
271.	Mehrianwala Ther
272.	Mehrianwali–II
273.	Adhi–III
274.	Adhi–II
275.	Adhi–I
276.	Bhootanwala–C
277.	Bhootanwala–A & B
277A.	Bhootanwali–II
278.	Bhootanwali
279.	Noor Shah Ther
280.	Ambrawala Ther
281.	Ambrawali
282.	Ghaziwala Ther
283.	Laluwala Ther
284.	Baghwala Ther
284A.	Sanghewala
285.	Sohniwali
286.	Sohniwali–II
287.	Khiplewala–II
288.	Jawaiwala–II
289.	Jawaiwala Ther
290.	Kuppianwala
291.	Chorewala

Site No.	*Name of site*
292.	Lakhman
293.	Jhalar
294.	Jafawala–III
295.	Chandnewala–III
295A.	Jafewali Theri
296.	Jafawala
297.	Jafawala–II
298.	Rahmanwali
299.	Barriwala Ther
300.	Rappwala Ther
300A.	Chakwali
301.	Badalwala–II
302.	Badalwala
303.	Jangipar
304.	Badalwala–III
305.	Badalwala–IV
306.	Badalwala–V
307.	Mehrindawala Ther
308.	Sheikhri–II
309.	Bootewali
310.	Khiplewali–III
311.	Khiplewali-II
312.	Khiplewali
313.	Khiplewala
313A.	Khiplewala
314.	Jhandewala–II
315.	Jhandewala Ther
316.	Burhanewala Ther
317.	Mashinewala
318.	Develiwala–II
319.	Develiwala Ther
320.	Mehwali
321.	Mehwali–II
322.	Mahawala Ther
323.	Barula–II
324.	Barula–I
325.	Ganweriwala
326.	Bilewali
327.	Thoriwala
327A.	Tharwala
328.	Safuwala–III
329.	Safuwala–IV
330.	Safuwala Ther
331.	Safuwala–II
332.	Valwala–II
383.	Valwali
334.	Thakowala
335.	Dhuhinwala Ther
336.	Dhuni
337.	Duhienwala Qila
338.	Dhuni (South)
339.	Moniwala
340.	Gaddawala Ther
341.	Jejalam
342.	Rajbai
343.	Shadiwala Ther
344.	Sheikhwali
345.	Karowala
346.	Sanasiwala
347.	Khairgarh Fort
348.	Khairgarh Ther
349.	Malluwali–I
350.	Malluwali–II
351.	Onchi Ther
351A.	Kot Ghunia
352.	Shah Garh Ther
353.	Ratta–I
353A.	Chak 124
354.	Ratta–III
354A.	Chak 121
355.	Ratta–II
356.	Baggapura Ther
357.	Baggapura–II
358.	Chak 112P
359.	Machki Fort
360.	Ghatoro

Site No.	*Name of site*	*Site No.*	*Name of site*
361.	Pattan Minara	366.	Chak 143 P
362.	Bhagla Fort	367.	Kot Murid
363.	Jummewala Vibba	368.	Nawan Kot
364.	Chak 139 P	369.	Khangarh Fort
365.	Falji Fort	370.	Rukanpur

Note : Among 414 sites listed, the map shows 385 sites. In the map, an area about thirty miles long on southwest and entire desert on south containing sites of the Medieval Period are omitted. The sites not shown on the map are: Medieval/Early Historical = 14, Hakra = 5, Mature Harappan = 8, and Late Harappan = 2. The final report on Bahawalpur Survey, however, contains details of all the listed sites.

The Hakra Wares Period

The oldest known cultural assemblage in Cholistan is represented by 99 sites of varying dimensions. These settlements are generally low mounds in lesser Cholistan (Bahawalnagar and Bahawalpur Districts) and are located close to, or in, the *dahars* (mud flats). In greater Cholistan (Rahimyar Khan District), they also occur on sand dunes. This assemblage has been called "Hakra" because of the initial area of discovery and the great concentration of sites along the Hakra flood plain.

Hakra ceramics are very distinctive. They are both wheelmade and handmade red wares with a variety of surface treatments. The most frequent and conspicuous pottery types include: (a) those treated on the external surface with a secondary coating of mud mixed with bits of pottery called "mud applique"; and (b) pottery with a series of incised lines on the external surface called Hakra Incised. Most of the Hakra Mud Applique Ware consists of handmade, thick-bodied vessels tempered with clay. There are also some wheelmade, thin-bodied pots with a fine fabric. The thin-bodied pottery has an everted rim and is painted in black on a deep red or chocolate slip which is confined to the shoulder just below the rim. The resemblance of the Hakra Mud Applique Ware in vessel form and surface treatment to some of the handmade pottery from the earliest levels of Amri IA (Casal 1964: Fig. 45) is most striking. At Amri, this pottery occurs in levels which would certainly date to earlier than 3500 B.C. by radiocarbon. Also included in the Hakra Wares is red pottery with a black slip

all over the body. The black slip on many specimens appears to be burnished to a glossy finish. A Hakra Wares site called RD 89, located just few kilometers east of Pakistan's border in Anupgarh Tehsil in Indian territory, has yielded precisely identical black-slipped or burnished pottery along with Hakra Mud Applique and Incised Pottery (Dalal 1980: Figs. 8 and 9). Material comparable to this Hakra black-slipped or burnished pottery is not yet known in the Greater Indus Valley at fourth millennium B.C. sites. However, the exposed levels at Periano Ghundai in the Zhob Valley of northern Baluchistan (west of the Gomal Pass) that have been grouped under the term "Periano A" (Mughal 1972a: 140) yielded black burnished/slipped pottery in association with a handmade basket-marked ware.

The Hakra Wares assemblage also inclues a small percentage of distinctive buff wares. These were wheelmade and painted black in a style that recalls the fourth millennium B.C. ceramic tradition of the Pakistan-Iranian borderlands.

It is too early to say whether or not the combined form and decorative styles of the Hakra Wares indicate the beginnings of the diagnostic Kot Dijian ceramic assemblage. It is known, however, that such pottery forms overlap the Kot Dijian Wares at Jalilpur (Mughal 1972b and 1974),

Other finds of the period include: animal figurines with short, joined legs including those of bulls and cows; shell and terracotta bangles with triangular and rectangular sections; fragements of grinding stones; bits of copper and great number of other implements. The lithic industry has parallel-sided blades, most of which have reworked edges; microblades, borers, leaf-shaped arrowheads. scrapers and cores. Typologically it appears to compare well with the lithic materials from Jalilpur I and II, the Neolithic Period I of Sarai Khola (Halim 1972), Gumla I (Dani 1971) and even Rahman Dheri (Khan 1979).

The Hakra Wares sites are heavily concentrated around Derawar Fort and to the southwest with a few sites to the east of Derawar. Most of the sites are single period settlements with only Hakra Wares; but two (Nos. 67 and 142 on Fig. 1) were occupied in the succeeding Early Harappan Period and four sites (Nos. 184, 233, 327 and 336) have Mature Harappan remains. None of the Hakra Period sites was occupied during the Late Harappan Period. Among 99 sites, 52.5 percent were camp sites; 45.4 percent were

settlements; while 2 percent contain kilns within the settlement areas.

The Early Harappan Period

The cultural phase that follows the Hakra Wares Period in Cholistan is represented by characteristic Kot Dijian ceramics and associated materials. These are already well known from other sites in the Greater Indus Valley and can be assigned by radiocarbon dating to the early third millennium B.C. Within the Greater Indus Valley there is a basic similarity of material culture at this time, despite the presence of some regional variation. Equally to the point, however, is the apparent continuity of development in the material culture between this Early Harappan and the succeeding Mature Period. Thus, Kot Diji and Kot Diji-related sites in Pakistan and parts of India together constitute the fully Early Harappan Period, or the early urban, formative stage of the Harappan Civilization. It was during the Early Harappan Period that cultural process leading to full urbanization began (Mughal 1980b).

In terms of material culture, continuity of several ceramic forms in the Early Harappan and Mature Harappan levels of Kot Diji is fully documented. A very recent reanalysis of small finds from the type site (Kot Diji) also clearly demonstrates this continuity throughout the lower (Early Harappan) and upper (Mature Harappan) levels. There are, however, certain exceptions (Mughal 1980a: 95 and 1980b).

Forty sites of the Early Harappan Period have been located in Cholistan. Most of these have a single occupation with ceramics related to the Kot Dijian, Kalibangan I, Siswal A (Suraj Bhan 1972) and Binjor 1 and 3 (Dalal 1980). They are also comparable in form and surface treatment to pottery from Jalilpur II, Sarai Khola II, Gumla II-IV, Rahman Dheri and other contemporary sites in Bannu Basin and Taxila Valley. Only three sites (Nos. 12, 109 [and 270) were re-occupied during the Mature Harappan Period in Cholistan. This is a pattern found elsewhere in the Greater Indus Valley and Baluchistan.

The Early Harappan Period is marked by an increase in the size and number of functionally articulated sites, at least as compared to the preceding Hakra Wares Period. There is a very sharp decline in the number of camp sites: 7.5 percent to the total dur-

ing the Early Harappan Period against 52.5 percent during the Hakra Period. There is a slight increase (57.5 percent) in the frequency of purely settlement sites. But, the interesting change is an increase to 35 percent in multifunctional settlements, that is, those combining residential functions with specialized/industrial activities. In the Hakra Wares Period only two percent of the sites were of this type. This shift seems to be significant in terms of socio-cultural changes that occurred by the beginning of the Early Harappa Period in Cholistan.

About 60 percent of the Early Harappan sites here are smaller than five hectares in overall size. Twenty-five percent are between five and ten hectares. One site, Gamanwala (No. 27 on Fig. 1) spreads over an area of 27.3 hectares, while another Early Harappan site, Jalwali (No. 42) is 22.5 hectares in size. Gamanwala is so far the largest known settlement of the Early Harappan Period. It is larger than Rahman Dheri (21.7 hectares), and also Kalibangan, where the total area occupied during the Early (KLB-I) and Mature (KLB-II) Harappan Period measures 22 hectares, including the cemetery area. Gamanwala is close to half the size of Harappa (which is 65 hectares or 160.6 acres without cemeteries) and was certainly not a small town. It is thus evident that during the Early Harappan Period, large settlements —towns, if not large cities—emerged amidst a cluster of smaller settlements. This is a distinctive feature of Harappan settlement patterns, especially in Cholistan, where original cultural patterns have remained largely intact.

During the Early Harappan Period the main focus of occupation appears to have been between Yazman and Fort Abbas, where there are few settlements of the Hakra Wares Period. This pattern seems to extend across the border in India past Kalibangan, to Banawali near Fatehbad, and even beyond, along the ancient course of the Chautang River in Hissar and Rotak districts. The succeeding Mature, or fully urbanized stage of the Harappan Civilization, is marked by a major shift in the settlement pattern along the Hakra as regards area of settlement concentration.

The Mature Harappan Period

This phase of cultural development is best represented at the cities of the Indus Civilization and at 174 sites in Cholistan. The

most striking aspects of the Mature Harappan Period in Cholistan are: (1) a general shift of sites from the northeast to the southwest, around and beyond Derawar Fort, (2) an increase in the number (47.7 percent of the total), size and height of settlement sites, among which at least one (No. 325), Ganweriwala at 81.5 hectares in size, is essentially the same size as Mohenjodaro, and (3) a profusion of industrial sites (45.4 percent) and their clear separation from habitation areas. However, sites combining both residential and industrial functions (19 percent out of 47.7 percent total settlements) also occur. In the preceding Early Harappan Period industrial areas were located close to, but outside the residential area at fourteen sites or 35 percent of the total number in that period. Although this feature persists in the Mature Harappan Period, some industrial areas at this time were demarcated exclusively for craft activities such as the firing of pottery, bricks, small terracotta objects, the glazing of faience objects and the melting, if not smelting, of copper. Cholistan, it may be pointed out, is located close to the copper sources of Rajasthan. The Khetri-Singhana source in Jhunjhunu District was reportedly worked during Mauryan and Mughal times; although it is not certain that these sources were also worked in the proto-historic times. It may, however, be added that Sir Aurel Stein found a copper ingot at the (Late) Harappan site of Siddhu-Ther (No. 118 on Fig. 1), located near Derawar. This site also contains numerous kilns.

The emergence of separate Mature Harappan industrial sites, or production centers, and the increased number of kilns during the Mature Harappan Period are indicative of: (1) marked social stratification, (2) the intensification of specialized activities responsible for making standardized products on a large scale, and (3) the existence of intersettlement trade or exchange.

The maximum expansion of the Harappan Civilization outside the primary Indus River Valley occurred in Mature times. After reaching a fully urbanized stage at its core, which may have been the central part of the Indus Valley, it spread towards the Baluch Hills, and along thc Arabian Sea Coast. This corresponds in time to intense Harappan long distance sea trade or exchange.

The Late Harappan Period

But about the middle of the second millennium B.C. there are

changes in Harappan material culture. These resulted from readjustments or changes in the socioeconomic and political organization of Harappan society. These may have been caused by: (1) the gradual depletion of economic resources resulting from the overutilization of land, (2) changes in the hydrographic pattern of the Indus Valley, (3) increased population pressures, (4) insecurity created by invading or intruding groups of people, or (5) a combination of various causes. But, whatever the reasons, it is certain that the pan-Indus integration of the Greater Indus Valley, which climaxed during the Mature Harappan Period, was weakened but not destroyed by the mid-second millennium.

The population regrouped and adjusted to the changed situation in the three principal regions. It thus managed to survive in a recognizable form for a considerable period of time, but some changes are reflected in the material culture found in each region of Harappan concentration: the Cemetery H Culture in the Punjab; the Jhukar Culture in Sind; and the Degenerate, Post or Late Harappan Culture in Gujarat. Regional differentiation, still within the Harappan ceramic tradition, can be seen in the pottery of each group. However, the characteristic square steatite seals with script, standard cubical weights, "mother-goddess" figurines and most metal tools disappeared.

In the upper Indus Valley, a distinctive body of ceramics was recovered from the surface of Harappa, as well as from a cemetery designated "H" at the same site. Similar material has been reported from two sites found by Stein in Bahawalpur. Indian archaeologists have also located and probed several sites with the Cemetery H Ware. These are generally located in the Punjab (east), even to the east of the Yamuna River, suggesting a spread of the Harappan tradition during the second millennium B.C. Until this research in Bahawalpur, the Late Harappan Phase was virtually unknown in Pakistan.

The recent survey of Bahawalpur has brought to light 50 sites with Cemetery H-related materials. Cemetery H material is essentially confined to the upper Indus Valley, just as the Jhukar-related materials of the Late Harappan Period generally occur in the lower Indus region.

In Cholistan the sites of the Late Harappan Period (Cemetery H-related) are large, high settlement mounds near the Hakra bed. There are also small sites concentrated around Derawar

where the Hakra River once formed an inner delta as with the Helmand River in Seistan. There is an apparent constriction of site concentration in Cholistan during the Late Harappan occupation, as compared to that of the Mature Harappan (see Fig. 1). But it should be emphasized that Late Harappan sites are concentrated in the very same area where Mature Harappan sites are located, but where there are few Early Harappan settlements.

Exclusively industrial sites account for only 18 percent of the total of Late Harappan sites. Settlement sites, and settlements with kilns or specialized activities areas, represent 28 percent of the total. Camp sites which decreased to only 5.7 percent in the Mature Harappan Period, increase markedly to 26 percent in the Late Harappan times.

Some sites with classic Cemetery H materials are high mounds. For example, the highest parts of Lurewala (No. 96), Shahiwala (No. 102) and Kudwala (No. 76) are respectively 41, 42, 46 feet above plain level. Without excavation, it has not been possible to determine how much of the occupation on these high mounds belongs to the Late Harappan Phase. Some sites, however, are quite extensive, spreading over 20, even 38 hectares.

The beautiful red pottery is often treated with a thick glossy slip and painted with black designs. Many vessel forms and other materials from the Late Harappan settlements in Cholistan compare well with what is known from contemporary sites in Pakistan and India. New wares of the Late Harappan Period include one with raised knob-like, elongated decorations. These form regular patterns on the external surface which appear to have been made on a thick secondary layer of clay. This type of ware has been christened "Harappan Wet." Its parallels in the Greater Indus Valley come only from Harappa where a complete vessel with similar surface treatment was found in association with burial pots of Stratum I (Vats 1940; Pl. LIX, 10).

The Post or Non-Harappan Period

Settlements of this period are concentrated in north-eastern Cholistan where 14 sites with the well-known Painted Gray Ware (PGW) have been identified. This is the first time that PGW has been found in Pakistan. It is reported from 320 sites in India. These are located in northern Rajputana, Haryana, the Punjab and western Uttar Pradesh (Tripathi 1975). The date of PGW

and its cultural association have provoked a great deal of controversy that has led to considerable field research in India. It is generally assigned to the end of the second and the beginning of the first millenium B.C. (Lal 1977–78; 1978), although differing opinions still exist. Early excavations revealed a hiatus between the Late Harappan and the PGW assemblages, but recent work at Bhagwanpura, Dadheri and a few other sites has led to the claim of continuity between the Harappan tradition and the PGW Period (Joshi 1978). Connected to this is the question of the Black and Red Wares as regards their association with PGW in western Uttar Pradesh and eastern Rajasthan and their significance in the context of contemporary assemblages of East Punjab.

PGW sites in Cholistan are generally located in the middle of the former Hakra River bed. With the exception of one site (Satwali, No. 40), which covers 13.7 hectares, all the settlements are less than four hectares in size.

The classic PGW ceramic never constitutes more than five percent of the total surface collections from any site. The remaining pottery consists of red wares, often with stamped and relief designs on the external surface, few black and red potsherds and dishes in red ware resembling the PGW form.

Conclusion

This survey of Cholistan has yielded a wealth of information on the cultural sequence in the central Indus Valley. It has given a new perspective and orientation for planning future research on the Indus Civilization. Sites of various periods, and their concentration or distribution, provide a reliable basis for reconstructing various changes in the course of the Hakra River, often identified with the Sarasvati of the Vedic period. The hydrographic history of the Sutlej-Yamuna Divide has often been discussed during the last one hundred years. This is summarized by Lambrick (1964) and Wilhelmy (1969). However, the most recent reconstruction of the changing courses of the Sarasvati, as proposed by Bimal Ghosh and his colleagues (1979 and 1980), will require confirmation by archaeological or other dateable evidence.

On the Pakistan side, archaeological evidence now available overwhelmingly affirms that the Hakra was a perennial river through all its course in Bahawalpur during the fourth millennium B.C. (Hakra Period) and the early third millennium B.C. (Early

Harappan Period). About the middle of the third millennium B.C., the water supply in the northeastern portion of the Hakra, roughly between Fort Abbas and Yazman (near Kudwala) was considerably diminished or cut-off. But, abundant water in the lower (southwestern) part of this stream was still available, apparently through a channel from the Sutlej; this is attested by the heavy clustering of sites in that area during the late third and early second millennium B.C. (Mature and late Harappan Periods respectively). About the end of the second, or not later than the beginning of the first millennium B.C., the entire course of the Hakra seems to have dried up and a physical environment similar to that of present day in Cholistan set in. This forced the people to abandon most of the Hakra flood plain. A few Painted Gray Ware settlements, most of them smaller than four hectares in size, are located along the upper part of the Hakra River. These were sustained by a meager water supply reaching there with seasonal regularity from the Ghaggar.

Though the physical environment of Cholistan has changed since protohistoric times, the original mosaic of the settlement pattern is well preserved. The recent field research reported here has revealed functionally differentiated sites within chronologically defined cultural horizons. This will enable one to recognize and reconstruct changes in this region that have not yet been recognized elsewhere in South Asia. Furthermore, archaeological evidence is a reliable guide for the history of dune formation in Bahawalpur. For example, the presence of Hakra Ware sites on top of old, reddish-brown sand, as observed on the south and southwest of Derawar, would seem to indicate that the Cholistan part of the Thar Desert had already advanced close to Derawar prior to the fourth millennium B.C.

BIBLIOGRAPHY

Casal, J.M., 1964; *Fouilles d' Amri.* 2 vols. Paris: Commission des Fouilles Archeologiques.

Dalal, Katy Feroze, 1980; A Short History of Archaeological Explorations in Bikaner and Bahawalpur Along the 'Lost' Sarasvati River. *Indica* 17(1): 1–40.

Dani, Ahmad Hasan, 1971; Excavations in the Gomal Valley. *Ancient Pakistan* 5: 1–177.

Field, Henry, 1959; An Anthropological Reconnaissance in West

Pakistan. Papers of the Peabody Museum, 52. Cambridge Mass.: Harvard University.

Ghose, B., A. Kar and Zahid Hussein, 1979; The Lost Course of the Sarasvati River in the Great Indian Desert: New evidence from Landsat imagery. *The Geographical Journal* 145 (3): 445–51.

Ghose, B., A. Kar and Zahid Hussein, 1980; Comparative Role of the Aravalli and the Himalayan River Systems in the Fluvial Sedimentation of the Rajasthan Desert. *Man and Environment* 4: 8–12.

Ghosh, A., 1952; The Rajputana Desert: Its Archaeological Aspect. *Bulletin of the National Institute of Sciences of India* 1: 37–42.

Halim, Muhammad Abdul, 1972; Excavations at Sarai Khola (Part 2). *Pakistan Archaeology* 8: 1–112.

Joshi, J. P., 1978; Interlocking of Late Harappa Culture and Painted Grey Ware Culture in Light of Recent Excavations. *Man and Environment* 2: 98–101.

Khan, Farid, 1979; A Preliminary Report on the Microlithtc Blade Industry from Rahman Dheri. In *South Asian Archaeology* 1977, M. Taddei, ed. 1: 375–403. Instituto Universitario Orientale, Seminario di Studi Asiatici, Series Minor VI, Naples.

Lal, B.B., 1978; The Indo-Aryan Hypothesis vis-a-vis Indian Archaeology. *Journal of Central Asia* 1: 21–41.

Lal, B.B., 1977-71; Did the Painted Grey Ware Continue up to the Mauryan Times? *Puratattva* 9: 64–80.

Lambrick, H.T., 1964; *Sind: A General Introduction.* Vol. 1. Hyderabad, Pakistan, Sindhi Adabi Board.

Mughal, M.R., 1972a; Explorations in Northern Baluchistan. *Pakistan Archaeology* 8: 137–51.

Mughal, M.R., 1972b; Excavations at Jalilpur. *Pakistan Archaeology* 8: 117–24.

Mughal, M.R., 1974; New Evidence of the Early Harappan Culture From Jalilpur. *Pakistan Archaeology* 27 (2): 106–13.

Mughal, M.R., 1980a; New Archaeological Evidence From B hawalpur. *Man and Environment* 4: 93–98.

Mughal, M.R., 1980b; The Origins of the Indus Civilization. *Sindhological Studies*, Summer: 1–10.

Mughal, M.R., Archaeological Survey in Bahawalpur. *Pakistan Archaeology.*

Stein, Sir Mark Aurel, 1942; A survey of ancient sites along the "lost" Sarasvati River. *The Geographical Journal* 99: 173–82.

Suraj Bhan, 1973; The Sequence and Spread of Prehistoric Cultures in the Upper Sarasvati Basin. In *Radiocarbon and Indian Archaeology*, D.P. Agrawal and A. Ghosh, eds. Pp. 252–63. Bombay: Tata Institute of Fundamental Research.

Suraj Bhan, 1975; *Excavations at Mitathal (1968) and Other Explorations in the Sutlej-Yamuna Divide*, Kurukshetra: Kurukshetra University.

Suraj Bhan and Jim Shaffer, 1978; New Discoveries in Northern Haryana. *Man and Environment* 2: 59–68.

Tripathi, Vibha, 1975; *The Painted Grey Ware: An Iron Age Culture of Northern India.* Delhi: Concept Publishers.

Vats, M.S., 1940; *Excavations at Harappa.* 2 vols. Delhi: Government of India.

Wilhelmy, H., 1969; Urstromtal am Ostrand der Indusebene und der Sarasvati-Problem. *Zeitschrift fur Geomorphologie*, Supplementband 8: 76–93.

Appendix 3

CLIMATE, A FACTOR IN THE RISE AND FALL OF THE INDUS CIVILIZATION—EVIDENCE FROM RAJASTHAN AND BEYOND

By
V. N. MISRA

About fifty years ago, Sir Aurel Stein (1931) and Sir John Marshall (1931), on the basis of their evaluation of the multiple archaeological evidence from Baluchistan and Sind, proposed that climate in these regions during the Indus Civilization period was more wet than it is at present. This theory was accepted and supported by archaeologists like Stuart Piggott (1950) and Mortimer Wheeler (1953), and it held unquestioned sway for three decades. Then in the fifties, American archaeologists began taking an interest in the archaeology of the Indus Valley and neighbouring regions and they brought an anthropological approach to bear on the archaeological problems of this region. Briefly put, this approach looked at cultural evolution in terms of cultural processes in contrast to the older British historical approach which laid more emphasis on events (Fairservis 1961: 51). The introduction of this new approach led to a questioning of several interpretations previously held more or less as facts (Dales 1964, 1966; Raikes 1964). One of these interpretations was the theory of a more wet climate during the Indus Civilization. Robert L. Raikes, a hydrologist with keen interest in archaeology and Robert H. Dyson, an archaeologist, teamed up in 1961 to critically examine various kinds of evidence adduced by Stein and Marshall in support of their climatic theory (Raikes and Dyson 1961). They came to the conclusion that alternative explanations were possible for each piece of evidence, and therefore, the theory of a more wet climate could not be accepted as proven fact. As an interesting coincidence, another American anthropologist, Walter A. Fairservis, Jr. (1961) also examined the same

evidence at the same time and reached a similar conclusion. F. A. Durrani (1965) who did a similar exercise for the lower Indus Valley a few years later, also arrived at an identical conclusion.

Except for a weak meteorological defence of the older theory by Ramaswamy (1968), the matter rested there for a decade until, in 1971, Gurdip Singh revived the theory of a more wet climate and re-kindled interest in the subject (Singh 1971; Singh *et al* 1974). Singh's theory differed from that of Stein and Marshall in three important respects:

(1) The evidence for climatic change was based on palynological rather than on archaeological data.

(2) The climatic change consisted of several fluctuations which covered almost the entire Holocene period in north-west India and not just the Harappan period.

(3) The fluctuations in rainfall were related not only to the growth and decline of the Harappan culture, but also to the origin of agriculture-based life in the 8th millennium B.C. and to its expansion in the 4th and 3rd millennia B.C. in north-west India.

The palynological evidence for Singh's theory came from three salt lakes, namely, Sambhar (27° N; 75° E), Didwana (27° 20′ N; 74° 35′ E) and Lunkaransar (28° 30′ N; 73° 45′ E), and one fresh-water lake, Pushkar (26° 29′ N; 74° 33′ E) in Rajasthan. The first two lakes are situated in the semi-arid belt (25–50 cm average annual rainfall), the third in the arid belt (less than 25 cm rainfall), and the last in the semi-humid belt (50–60 cm rainfall). The climatic evidence from the first three lakes only is relevant to archaeological history.

The climatic sequence based on the pollen record from these three lakes can be briefly summarized as follows:

Phase I: Before 8000 B.C.

Phase I, represented by wind-borne sand deposits at the base of lake sediments, was characterized by a severely arid climate which was unsuitable for habitation for a long time during at least the later part of the last glacial period.

Phase II: Pollen Zone A: c. 8000 B.C.—c. 7500 B.C.

Phase II is represented by the first sedimentation in the lakes. Rainfall at this time was at least 25 mm more than the present annual precipitation in western Rajasthan.

Phase III: Pollen Zone B: c. 7500 B.C.—c. 3000 B.C.

A slight decline in rainfall is indicated at the beginning of Phase III, but it was not severe enough to substantially alter the ecological pattern established in Phase II. A noteworthy feature of this phase is an extraordinary rise in carbonized vegetable remains in the lake sediments at all sites. This rise is accompanied by the appearance of the *Cerealia* type of pollen. These two phenomena indicate scrub burning which probably formed the basis of a primitive cereal agriculture.

Phase IV: Pollen Zone C: c. 3000 B.C.—c. 1000 B.C.

Phase IV can be divided into three subphases: IVa (c. 3000 B.C.—c. 1800 B.C.); IVb (c. 1800 B.C.—c. 1500 B.C.); and IVc (c. 1500 B.C.—c. 1000 B.C.).

Subphase IVa: Pollen subzone C1: c. 3000 B.C.—c. 1800 B.C.

Subphase IVa is characterized by a rather sudden and considerable increase in rainfall. Annual average rainfall during this phase was probably at least 50 cm more than the present rainfall in the arid belt. Pollen of the *Cerealia* type, of the same size range as seen in the earlier phase, and the evidence of scrub burning in the form of carbonized remains, continue in this subphase. In chronological terms, subphase IVa sees the rise of Pre-Harappan and, later on, of Harappan culture throughout north-west India. The presence of *Cerealia* type pollen of the same size range in Pre-Harappan levels at Kalibangan together with the unbroken record of *Cerealia* type pollen in the pollen profiles and the evidence of forest burning from three different sites, would lead one to believe that cereal cultivation perhaps, does not start with the Indus Valley Civilization after all. It would seem, in fact, that the practice had existed in the region for a long time, indeed, as has been suggested, from the beginning of Phase III.

It can in fact be argued that the significant increase in rainfall at the beginning of the third millennium B.C. attested by the palaeoecolgical evidence, played an important part in the sudden expansion of the Neolithic-Chalcolithic culture in north-west India, ultimately leading to the prosperity of the Indus culture (Singh 1971: 188).

Subphase IVb: Pollen subzone C2: c. 1800 B.C.—c. 1500 B.C.

Subphase IVb is a short dry period. In the arid belt the Lunkaran-

sar lake had started drying out while, in the semi-arid belt, the lakes began to turn saline. The beginning of aridity was not synchronous in the arid and semi-arid belts. At Lunkaransar it began around 2000 B.C. while at Sambhar it began around 1000 B.C.

Commenting on the effect of aridity on Harappan culture, Singh says:

> The present evidence would suggest that the onset of aridity in the region around 1800 B.C. probably resulted in the weakening of Harappan culture in the arid and semi-arid parts of north-west India but that the peripheral areas of the culture, such as in Gujarat and the Himalayan foot-hills were not affected to the same degree. The extinction of the Indus culture may thus have been initiated through gradual decline as a result of climatic change, but the process may yet have been completed by successive invasions from the north-west by the Aryans (Singh 1971: 188).

Further,

> This dry period (2000 B.C.–1000 B.C.), as already pointed out was perhaps responsible for the wide cultural gap between the decline of the Harappan culture and the beginning of the succeeding Painted Grey Ware culture, generally put between 1000 and 600 B.C. and tentatively associated with the colonization of impoverished land (Ghosh 1952). The weight of analytical and stratigraphic pollen evidence favours a climatic determination of the events of this period (Singh *et al* 1974: 498–99).

Subphase IVc: c. 1500 B.C.—c. 1000 B.C.

Subphase IVc is represented by a slight reversal to a relatively weak wetter interval, lasting up to about 1000 B.C.

Phase V:? Early Centuries A.D. to the Present

Phase V is known only from Lunkaransar, and is dated, in the absence of ^{14}C dates, on the basis of the rate of sedimentation. The pollen assemblage reflects more or less the present conditions in the area. There is hardly any evidence of either cereal cultivation, tree vegetation or the existence of any aquatic species in the area. The vegetation, on the whole, seems to comprise a typical 'Sand Formation' type, as presently seen in the Lunkaransar region (Singh *et al* 1974: 496).

Singh's evidence for a wetter climate during the Harappan period has been questioned by scholars on palynological (Vishnu-Mittre 1972, 1978), archaeological (Thapar 1977; Pande 1977) and a combination of these and other grounds (Flam 1976; Seth 1978).

The purpose of the present paper is not to examine or question the evidence for climatic changes put forward by Singh. For one thing, not being a palynologist, I am not qualified to assess the pertinent data. For another, having examined the stratigraphic record at several salt lakes (Pachpadra, Sambhar, Kuchaman, Didwana, Tal Chhapar and Malhar) and on numerous sand dunes in Rajasthan during the last five years, I am aware that the sedimentological evidence supports the palynological one for an increase in rainfall during the Holocene period though the degree and duration of this increase is a matter for debate.[1]

My purpose here is to examine the archaeological evidence in so far as it relates to the following hypotheses that Singh has put forward:

(1) A rise in rainfall around 8000 B.C. in Rajasthan was responsible for the emergence of cereal agriculture in north-west India around 7500 B.C.

(2) An exceptional rise in rainfall around 3000 B.C. accelerated the expansion of farming-based settlements in the region and also caused the prosperity of the Harappan culture.

(3) A decrease in rainfall around 1800 B.C. led to the decline of the Harappan culture; and

(4) The aridity between 2000 B.C. and 1000 B.C. was responsible for the cultural gap between the Harappan and the Painted Grey Ware cultures.

To test these hypotheses, we will :

(i) Review and examine the available archaeological evidence from Rajasthan, particularly from the semi-arid and arid zones (the

[1]Since 1977, this writer is directing a multi-disciplinary research project on 'Early Man and his Environment in North-West India'. Other members taking part in this project are S.N. Rajaguru (Deccan College, Pune), D.P. Agrawal (Physical Research Laboratory, Ahmedabad), R.P. Dhir (Central Arid Zone Research Institute, Jodhpur), and R.J. Wasson and Gurdip Singh of the Australian National University, Canberra. Besides conducting extensive explorations in western Rajasthan and excavation at Jayal and Didwana, in the district of Nagaur, the research team has examined the stratigraphy of all the major salt lakes of Rajasthan. In January 1980, largely on the initiative of Wasson and Singh, we dug two wells in the Didwana lake to collect fresh samples for palynological, sedimentological and radio-carbon analysis. The palynological data is being analysed by Gurdip Singh, sedimentological by Wasson and Rajaguru, and radio-carbon samples by Agrawal. Preliminary results of these studies show that the lake had already started carrying water in the oterminal Pleistocene.

area in which the lakes that produced the climatic sequence are located). If cereal agriculture had emerged in the area as early as 7500 B.C., we should expect to find, in the archaeological record of c. 7500 B.C. —c. 4000 B.C., mounds, pottery, querns and rubbers, bones of domesticated animals and other traits traditionally associated with an agriculture-based life;

(ii) Examine the evidence for the diffusion of Harappan settlements in a diachronic perspective in and around Rajasthan and see whether climatic fluctuations or some other factor—like the shifting of river courses—explains the fluctuating fortunes of the Harappan Culture better; and

(iii) Examine the archaeological evidence to discover whether there is a gap between the Harappan Culture and the Painted Grey Ware culture.

Environmental Setting of Rajasthan

Before proceeding with the review of the archaeological evidence, it will be helpful if we briefly summarize the present environmental situation in Rajasthan.

Rajasthan is fairly and neatly divided into two distinct physiographic, climatic and, to some extent, cultural regions by the Aravalli hills which run across the state in a northeast-southwest direction. The Aravallis attain their maximum width and height in the southern part around Udaipur. They narrow and flatten considerably in the central part around Ajmer, but again widen near Alwar. Much of the eastern part is a rocky upland ranging in height from about 600 m in the south to 150 m in the north and east. There is a large network of mostly seasonal rivers all of which rise in the Aravallis. The rivers in the extreme south flow into the Mahi-Sabarmati, in the centre into the Chambal and in the extreme northeast into the Yamuna. Annual rainfall varies from 300 mm in the west to 600 mm in the east. Because of adequate moisture the vegetation cover is fairly abundant and the soil produces rich crops of rice, cotton, sugarcane, maize, wheat, mustard, etc. Rocky uplands provide pasture for sheep, goats, cattle and camels.

In contrast, the larger western part is essentially a flat alluvial plain ranging in height from 100 m in the south to 250 m in the north. A large area in the centre along the Aravallis, comprising parts of Jodhpur, Nagaur, Sikar, Jhunjhunu and Churu districts is, however, between 300 and 400 m high. It has either been tectonically

uplifted in recent geological times (Cenozoic) or, more likely, was an extension of the eastern uplands from still earlier times. The flat monotony of the plain is relieved by occasional isolated hills and by numerous dunes in the northern and western parts.

The south-eastern corner of the plain is drained by the Luni and the Banas rivers which rise in the Aravallis and flow into the Rann of Kutch. These rivers as also the many tributaries of the Luni, are all seasonal monsoonal streams. The greater part of the plain, north and west of the Luni, is conspicuous by the total absence of any flowing drainage or even dry channels. Only in the extreme north-west corner is present the dry bed of the Ghaggar which originates in the Himalayas and, passing through the Punjab, Haryana and Rajasthan, crosses into Pakistan. This part is geographically, therefore, an extension of the Punjab-Haryana plains. In the north-eastern part, a number of ephemeral streams rise in the Alwar Aravallis and flow east and north into the Yamuna or north to dry up in the sands in Haryana. In the drainage-less plain there are, however, a number of dry salt lakes or *playas* of varying sizes which receive the scanty run-off from surrounding hills and dunes.

The annual rainfall ranges from 400 to 300 mm in the east through 300–200 mm in the centre to less than 200 mm in the west. The relatively moist country near the Aravallis is known as *Godwar* while the semi-arid and arid region to the west is known as *Thal* (from which the anglicized Thar). Because of the low rainfall, vegetation cover is thinner than in the eastern part. Both alluvial and aeolian soils are quite fertile, but except where irrigation facilities have been created in recent times, no winter crops can be raised. Agriculture consists of rainy season crops like *bajra* (*Pennisetum typhoideum*), *Jowar* (*Sorghum vulgare*), *moth* (*Phaseolus aconitifolius*, Jacq.) and *sesamum* (*Sesamum indicum*). Pastoralism based on cattle, sheep, goat and camel is the mainstay of rural economy. Because of frequent failures of rain and consequent droughts, both animal and human populations are forced periodically to migrate to greener regions to the south and east.

Pre-Neolithic Cultural and Environmental History of Western Rajasthan

Research during the last forty years has produced considerable evidence for the geomorphic environmental and archaeological history of both western and eastern Rajasthan. Our concern here is mainly

with the former region though we will briefly summarize the evidence from the eastern part as well to show the parallelism between the two. With respect to western Rajasthan—despite the differing opinions on details held by various workers—the broad picture can be briefly summarized as follows.

In the early Quaternary, the semi-arid and arid regions had a well-integrated and high energy bedload, braided, drainage system originating perhaps both in the Aravallis and the Himalayas. Geomorphic evidence of this system survives in the form of an extensive and massive gravel ridge (Jayal Formation) in Nagaur and Jodhpur districts (Agrawal *et al* 1980a; Misra *et al* 1980, 1982a). Subsequent to its formation, this ridge was tectonically uplifted. The rejuvenation of the alluviated land surface induced by tectonic activity helped the rivers to carve out new valleys in the Jayal Formation. This post-Jayal formation drainage sytem is represented by low gradient, highly sinuous streams with wide flood plains and associated lakes and pools. In these streams and lakes extensive and thick deposits of calcareous silts and clays were formed (Amarpura Formation). Man appeared in the region at this stage. Rich Acheulian assemblages are found in the middle levels of the Amarpura Formation as well as on the surface of the gravel ridge of the Jayal Formation. (Agrawal *et al* 1980a; Misra *et al* 1980, 1982a, 1982b). In the upper part of the Amarpura Formation, Middle Palaeolithic assemblages are found in the semi-arid region (Misra *et al* 1982a). Similar assemblages also occur in the palaeo-channels in the arid region (Allchin *et al* 1978). Probably during the earlier part of the Upper Pleistocene, this drainage became dis-organized and eventually totally defunct, possibly due to a combination of climatic deterioration and tectonic events which diverted the Himalayan drainage westwards. The resultant scarcity of surface water apparently forced the Middle Palaeolithic man to migrate south where the Luni system continued to function. Middle Palaeolithic assemblages are found in the Luni alluvium as well as on lime-stone rock outcrops (Misra 1961). The *playas* of north and west Rajasthan are, in our opinion, remnants of this drainage system. The series of palaeo-channels located in the Thar Desert in recent years with the aid of aerial photographs, landsat imagery and field work (Ghose *et al* 1979, 1980; Pal *et al* 1980) probably belong to this drainage system.

Sometime during the later part of the Upper Pleistocene, the deterioration in climate and extinction of the drainage sytem seem

to have caused a near total depletion of vegetation cover and triggered powerful aeolian activity. This activity caused the extensive formation of sand sheets and sand dunes over much of the western Rajasthan plain as well as in the territories to its north, west and south. (Allchin and Goudie 1971, 1978; Allchin *et al* 1978; Goudie *et al* 1973). The scarcity of archaeological remains of this period shows that environmental conditions supported far fewer people than in preceding periods. This period was not, however, continuously dry. Calcrete deposits at several levels in the dunes at Didwana suggest a number of short wet episodes (Misra *et al* 1982a). A ^{14}C date (PRL-651) obtained on calcium carbonate from one of the upper calcrete deposits is 24710 $\pm$ 1220 B.P. The *playas* also occasionally carried water as suggested by a ^{14}C date of c. 26,000 B.P. from Malhar, north of Phalodi. The intercalation of aeolian and fluvial sediments at Shergarh trijunction and Gudlai Nadi, both located at the eastern fringe of the arid zone and dated between 38000 and 22000 B.P. and 40000 and 12000 B.P., respectively, also shows the occurrence of wet spells during the arid period (Agrawal *et al* 1980a, 1980b).

Towards the close of the Pleistocene period, a shift in climate leading to increased rainfall seems to have taken place. Initially, the shift was unsteady as indicated by the alternating silt, clay, sand and halite layers in the Didwana lake. A ^{14}C date (PRL-650) from a horizon 1.5 m below the zone dated by Singh (1971; Singh *et al* 1974) to c. 10000 B.P. gives a reading of 12820 $\pm$ 370 B.P. But from the beginning of the Holocene, the increase in railfall was greater and its duration longer. This is seen in the thick polleniferous deposits of dark clays (locally known as *Kajalia* because of their *Kajal-* collyrium- like black colour) in the *playas* at Sambhar, Kuchaman, Didwana, Tal Chappar, Malhar, Lunkaransar and Pachpadra. The stabilization of the dunes formed during the arid Upper Pleistocene seems to have taken place during this period. The widespread occurrence of microliths on dunes (including in the core of arid zone) is ample proof that the climate was conducive to supporting large human populations (Misra 1976; Misra *et al* 1982a). The limited faunal material available from Tilwara (Misra 1971) includes both domestic and wild forms. The far richer fauna from Bagor on the eastern side of the Aravallis (Misra 1973a; Thomas 1975) is composed largely of domestic sheep and goat. In eastern Rajasthan at least, the subsistence pattern based on pastoralism

had come into existence as early as the fifth millennium B.C. It would be quite reasonable to expect that this same pattern, present even today, was introduced in drier western Rajasthan, around the same time.

The evidence for climatic and geomorphic changes from eastern Rajasthan is less dramatic, but that for cultural evolution is equally rich and runs on fairly parallel lines (Misra 1977). Human occupation during the Lower Palaeolithic period was widespread in the Banas and Chambal basins. Middle Palaeolithic cultural remains are less profuse but occur in both these river valleys, while the evidence for the Upper Palaeolithic is as scanty as in western Rajasthan. During the Mesolithic, however, resurgence in human population was marked as in the semi-arid and arid regions west of the Aravallis. A large number of sites of this period have been found in Mewar upland on rocky eminenses, local dunes and alluvial flats along river banks (Misra 1973b, 1976).

Evidence for Pre-Harappan Farming Cultures in Rajasthan[1]

Against this geographical, palaeo-environmental and cultural background, we will examine the archaeological evidence pertinent to the various hypotheses put forward by Gurdip Singh.

Singh's first hypothesis is that the increase in rainfall in the semi-arid and arid belts of Rajasthan around 8000 B.C. led to the emergence of cereal agriculture in north-west India soon after. On the basis of the evidence from the Near and Middle East, it would be expected that such incipient agriculture would soon lead human populations to a certain sedentariness which would be reflected in formation of archaeological mounds. And on such mounds one would expect to find vestiges of cultural traits—mud or stone structures, pottery querns and rubbers, animal bones, terracotta objects, stone and terracotta beads—which are usually associated with early farming settlements. Since the increased rainfall postulated by Singh would have been most strongly felt in the area surrounding the lakes that produced the evidence for such rainfall, one would expect to find farming settlements in those areas. As the headwaters of the Luni lie within 80 km of Sambhar lake (which is the type locality of Singh's climatic sequence), one

[1]The term 'Pre-Harrapan' is here used for Neolithic-Chalcolithic cultures antedating Kalibangan I, Kot Dijian and Amarian cultures for which this term has traditionally been used in archaeological literature. For these latter cultures I have used, following R.M. Mughal, the term 'Early Harappan'.

would particularly expect to find such settlements along the Luni and its tributaries. One would also expect to find such settlements on the north Gujarat alluvial plain drained by the Mahi, the Sabarmati and other rivers.

What is the archaeological evidence for such settlements? In western Rajasthan, early farming settlements (of the Harrapan, Painted Grey Ware and Rangmahal cultures) have been found along the dry course of the Ghaggar river in the north-western corner of the state. But this river, as has been said earlier, originates in the Siwaliks and, passing through Punjab, Haryana and Rajasthan, continues its course into Pakistan. This part of Rajasthan is geographically a part of Indo-Gangetic Divide (or the Punjab, Haryana and Bhawalpur plains). It would, therefore, be more appropriate to consider the archaeological evidence from this corner of Rajasthan along with that from the rest of the Indo-Gangetic Divide. At this stage it is more relevant to look for evidence of farming settlements in the rest of western Rajasthan.

In the vast expanse of western Rajasthan (comprising districts of Sirohi, Pali, Jodhpur, Didwana, Jhunjhunu, Churu, Bikaner, Jaisalmer and Jalor) such settlements are conspicuous by their total absence. Not only are no settlements of the Neolithic-Chalcolithic age known but even settlements of the Painted Grey Ware (PGW) or Northern Black Polished Ware (NBPW) cultures or any others of comparable age are unknown. The earliest settlement in this region is Bhimmal in the district of Jalor which does not date earlier than the Gupta period. Several mounds located by us during our explorations over the last four years (Barawas near Tilwara, district Barmer; Dhanpur, south of Jalor, district Jalor; Got-Manglod, east of Jayal, district Nagaur) all appear to be less than two thousand years old. The site of Sambhar on the eastern margin of the Sambhar lake in the district of Jaipur is datable at the earliest to c. 4th century B.C. (Sahni 1941) and falls outside the desert region.

The only archaeological evidence from the region which can be related to the Chalcolithic period consists of (a) one flat copper celt from Elana in the district of Jalor (Agrawala 1979: 92); (b) a hoard of 103 copper objects (celts, chisels, ordinary and channel-spouted bowls, curved thin blades and rings) from Kurada, in the district of Nagaur (Agrawala 1980); and (c) two flat copper celts from Sabania, tehsil Lunkaransar, in the district of Bikaner (*IAR.* 1968–69:69). My personal examination of the find spot of the Elana celt in

1979 revealed that it was found in an interdunal cultivated depression. No other archaeological material was present at or around the find spot. A low mound, a couple of hundred metres away from the spot and now under cultivation, appears to be of a fairly late age. R. C. Agrawala (1980: 89–91) who examined the site of Kurada also did not find any habitation remains there. The Sabania celts were found by a farmer while ploughing his field, and no other archaeological material is reported to be associated with them. The context of these copper objects is similar to that of the Copper Hoards of the middle Ganga plains. At this stage, we do not know their age or cultural association. They may, however, be related to itinerant metal smiths who may have occasionally travelled through the desert to supply the metal needs of the Harappans in Kutch, Saurashtra and the Ghaggar valley.

In informal discussions with Gurdip Singh on several occasions over the last few years both in India and Australia, this author has pointed out to him this lack of archaeological evidence necessary to support his hypothesis. His answer has been twofold: (1) this may be due to a lack of adequate field work; or (2) the mounds of sites may have been buried under sand. Neither of these answers seems justified.

The Luni valley has been intensively explored, since 1958, by us but we never came across any mounds of Neolithic-Chalcolithic or the Early Iron Age. In 1966–67, Leshnik and this author carried out an intensive exploration of the north Gujarat plains and the lower Luni valley with the express aim of looking for early farming settlements, but we failed to find any evidence of them. In all this area but particularly in the lower Luni valley, bordering the Rann of Kutch, we came across scattered pottery at many places, but all these were of very recent date and were evidently the result of frequent abandonment of villages due to drought and famine so endemic in this region. Between 1971 and 1976, both the north Gujarat and west Rajasthan plains were extensively explored by B. Allchin, A. Goudie and K.T.M. Hegde (1978), but they too did not come across any prehistoric or early historic mounds. From 1976 onwards the greater part of the westem Rajasthan plain has been intesively and extensively explored by archaeologists and other scientists from the Deccan College, Pune; the Physcial Research Laboratory, Ahmedabad; the Central Arid Zone Research Institute, Jodhpur; and the Australian National University, Canberra (Agrawala

et al 1980; Misra *et al* 1980, 1982a, 1982b), but this search too, has been quite fruitless as far as early farming settlements are concerned.

Gurdip Singh's second explanation appears equally untenable. For one thing, there is no evidence of massive aeolian activity after 2000 B.C. that would have buried all older mounds under sand. A large number of still older Mesolithic sites are preserved on the surface of the dunes. Secondly, if sand has engulfed the mounds in western Rajasthan, one would expect it to have done the same more effectively in more arid Cholistan to the west. But Mughal's explorations, in recent years, have brought to light, several hundred farming sites of different periods in that region (Mughal 1981).

Though one can never rule out the possibility of new archaeological evidence turning up even in an intensively explored region, the position, as it stands today, is that there is absolutely no evidence of farming-based cultures in western Rajasthan (outside the Ghaggar valley) and the north Gujarat plain in prehistoric times.

It can, therefore, be safely asserted, on presently available archaeological evidence that increased rainfall between 8000 B.C. and 2000 B.C. did not lead to the emergence of agriculture in western Rajasthan and north Gujarat.

This archaeological situation from the region of the salt lakes that produced the evidence of higher rainfall is in sharp contrast to that from the semi-humid region of eastern Rajasthan. Here, in the valleys of the Banas and its tributaries in the districts of Udaipur, Chittorgarh, Bhilwara, Ajmer and Tonk, a large number of settlements of the Ahar culture dated between 2100 B.C. and 1200 B.C. have been found (Misra 1968). Further north in Bharatpur, Jaipur and Sikar districts, a number of settlements of Ochre Coloured Pottery (OCP) and Ganeshwar cultures have been found in the valleys of the rivers Banganga, Gambhir, Dohan, Krishnavati and Kantli that rise in the northern flanks of the Aravallis and flow north-east into the Yamuna or northward into the sandy plains of Haryana (Agrawala 1981). The Ganeshwar culture sites in this area, particularly those in Sikar district, are very rich in copper objects (Agrawala 1978, 1981). Obviously, the ecological explanation for these sites lies in the plentiful availability of copper in the Khetri belt which may have been exploited since Harappan times. Because of limited published evidence, our knowledge of the nature of these sites (their size and the archaeological material available on them) is very inadequate. Their relationship with the Early and Mature

Harappan sites of the Ghaggar valley and with the Late and Degenerate Harappan sites of the Yamuna valley is far from clear. However, it would be unrealistic to relate the early farming settlements of Mewar and north-east Rajasthan to increased rainfall in western Rajasthan, particularly in the light of the total absence of such settlements in the latter region.

The Geographical Distribution of the Harappan Culture

The second hypothesis of Singh is that increased rainfall around 3000 B.C. was a causative factor in the development of Harappan culture. To examine this hypothesis it is necessary to have a clear picture of the geographical extent of that culture and its relationship with the ecology of the regions where it is found.

Harappan culture, however, is no longer the unitary phenomenon it was thought to be even as late as thirty years ago. In its comprehensive definition, this culture covers a period of more than one millennium and a geographical area of nearly 800,000 sq. km. It did not happen over all this area at one and the same time. As the culture diffused from its nuclear area, it underwent evolution and transformation. The differences between the earlier and later phases of this culture are clearly marked. To speak of the Harappan culture without reference to its evolutionary stages can, therefore, be quite misleading (Possehl 1980: 2). Although this is not the place to go into details of various evolutionary stages of this culture, a brief outline of them is essential to understand the role of climate *vis-a-vis* other factors in the rise and fall of the Harappan culture.

On available evidence four phases have been distinguished: (1) Early Harappan, (2) Mature Harappan, (3) Late Harappan, and (4) Degenerate Harappan.

The essential characteristics of these phases can be summarised as follows:

Early (Pre-Urban) Harappan

This phase can be equated with R.J. Braidwood's (1960:150) 'sub-era of the expanded village-farming community' hovering on the threshold of urbanization. The terms commonly used for this phase in archaeological literature are Pre-Harappan, Kot Dijian, Amrian, and Kalibangan I, but Mughal (1970, 1980, 1981) has emphasized the commonness of several cultural traits between this and the Mature Harappan phase. These traits include pottery shapes and

designs, fortifications, developed domestic architecture, occurrence of the bull in faunal remains and in terracotta, toy cart frames and wheels, triangular terracotta cakes, chert blades and presence of lapis lazuli at least at some sites showing long distance trade. Pottery of this phase is wheel made, sturdy and varied, and is decorated both by painted and incised designs. Though the process of evolution from this phase to that of full urbanised Harappan culture is still unclear, the near complete geographical overlap between Pre-Harappan and Mature Harappan phases, the chronological priority of the former, and the continuity of cultural tradition from the former to the latter are strong enough reasons to agree with Mughal in calling this stage Early (or Formative) Harappan.

Mature (Urban) Harappan

This phase is characterized essentially by the development of cities and towns and, by implication of such traits as writing, a high degree of craft specialization, and monumental architecture. There was remarkable standardization and homogeneity of material culture throughout the Harappan geographical region during this phase. It represents the peak of economic, social and political achievement of the Harappan society. Archaeological criteria for identifying this phase of the Harappan culture can be taken to be the same which Sir Mortimer Wheeler (1961: 250) considered essential for a culture to qualify for the use of the qualification of 'Indus'. These are: (i) Indus seals; (ii) Indus script, whether on seals or on pottery; (iii) certain distinctive decorative motifs on pottery, e.g. intersecting circles, scale-pattern, pipal leaves, rosettes and peacocks in the Indus manner; (iv) certain distinctive ceramic forms, e.g. goblet with pointed base, cylinderical vessels with perforations (colanders), tall jars with S-shape profile and ledged rims, and 'fruit-dishes' or 'dishes-on-stand', though these last may occur outside the Indus culture proper; (v) triangular terracotta 'cakes'; (vi) kidney shaped inlays of shell or faience; (vii) certain beads, notably discoidal with tubular piercing.

Late (Post-Urban) Harappan

This phase is marked by a decline and abandonment of cities and a reversal to rural economy. (Dikshit 1976b; Ghosh 1979; Gupta 1979). There was, however, a considerable expansion of the settlements to the south and east for reasons which will be briefly touched later

on. Perhaps as a consequence of the collapse of the political system the standardization and homogeneity of the material culture of the earlier phase disappeared. It was replaced by regional styles in ceramic shapes and designs as well as in other aspects of material culture. These regional styles are represented by Jhukar culture in the lower Indus valley, Lustrous Red Ware culture in Saurashtra, Cemetery H culture in central Indus (including Hakra) valley, and Late Harappan in eastern Panjab, Haryana, and upper Yamuna-Ganga doab. A number of distinctive Harappan pottery shapes and designs either disappeared or became scarce. Stone blades made on Rohri chert were replaced by small blades made on locally available siliceous rocks. Though there is certainly a decline in material prosperity, a basic continuity of the Harappan cultural tradition is clearly discernible (Possehl 1980: 13–21).

Degenerale Harappan (Ochre Coloured Pottery/Ochre Coloured Ware)

By the time Harappan expansion extends into the Yamuna-Ganga doab, most Harappan traits disappear and the culture is so impoverished that its ties with the ancestral Harappan are definitely blurred. The settlements of the degenerate phase are small and of short duration, and the evidence for domestic architecture is poor. The pottery is ill-fired and susceptible to easy wear. However, links in pottery shapes and designs not only with the Late Harappan culture but sometimes also with the Early Harappan culture are clearly discernible (Dikshit 1979a). Indeed, in the former region on a number of sites both Late Harappan and Ochre Coloured Pottery (OCP) or Ochre Coloured Ware (OCW) cultures are represented. Because of this situation, a tremendous confusion prevails (Sharma 1971–72). Some scholars would like to designate most OCP sites Late Harappan (Sharma 1971–72: 21–24; Suraj Bhan 1971–72: 16–21), and restrict the use of the term OCP only to a few sites like Bahadarabad, Atranjikhera, Lal Qila and Saipai; others would regard all OCP as nothing but Late or impoverished Harappan (Ghosh 1965; Possehl 1980: 17–18); and a third group (Lal 1954–55, 1968, 1971–72; Gaur 1971–72; Gupta 1971–72; 7–8) would treat OCP as a distinct and indigenous culture associated with Copper Hoards and totally unrelated to Harappan culture. In my view, OCP is only a final and impoverished stage of the Late Harappan culture, and its Harappan likeness is progressively hazier as the Late

Harappan colonization proceeded further east into central doab and beyond. For this reason I would like to designate this phase as Degenerate Harappan.

In the last three decades there has been a phenomenal increase in the number of newly discovered Harappan sites, and today more than 800 sites of various phases are known (Jansen 1980). We owe this important addition to our knowledge of the Harappan culture mainly to the explorations and excavations done by J.M. Casal (1964), G.F. Dales (1964, 1965, 1966, 1981), A.H. Dani (1970–71, 1975), W.A. Fairservis, Jr. (1979), Henry Field (1959), Louis Flam (1981), J.F. Jarriage (Jarrige and Enault 1973), R.M. Mughal (1970, 1972, 1973a, 1973b, 1974 and 981), and J.G. Shaffer (1978) in Pakistan, and by R.S. Bisht (1976, 1977), Katy F. Dalal (*nee* Frenchman) (1972, 1980, 1981), M.N. Deshpande (1977), K.N. Dikshit (1979c, 1980, 1981), A. Ghosh (1952), J.P. Joshi (1972a, 1972b, 1974, 1977, 1978, 1981; J.P. Joshi and Madhu Bala 1979), B.B. Lal (1977, 1979; Lal and Thapar, 1967), Madhu Bala (1981), G.L. Possehl (1980), S.R. Rao (1963, 1973), Y.D. Sharma (1977), U.V. Singh (1977), Suraj Bhan (1971–72, 1972, 1973, 1975, 1977; Suraj Bhan and Shaffer 1978), and B.K. Thapar (1973a, 1973b, 1975) in India.

The picture of the distribution of the four phases of the Harappan culture can be summarized as follows:[1] Early Harappan culture has a very wide distribution in Pakistan and north-

[1]A comprehensive and up-to-date map of Harappan sites is an essential prerequisite for an understanding of the geographical distribution of Harappan culture. Unfortunately, no such map exists. Maps presently available of the entire Harappan zone (Mughal 1973a; Thapar 1981) or parts of its (Madhu Bala 1978; Suraj Bhan 1972, 1973; *I.A.R.* 1976–77), are highly unsatisfactory because of their incompleteness, very small size and poor quality printing, the last often rendering them illegible. Jansen (1980) has done a commendable job in listing 331 sites, most of them with their geocoordinates and dimensions, but the map published by him suffers from most of the defects noted earlier about other maps. For these reasons I had intended preparing a large and comprehensive map of the entire Harappan region, but unfortunately, this could not be possible because of the constraint of time. I have therefore, prepared two maps: One, a small and general map, showing the total area of Harappan culture and reletive regional density of sites, and the other a large and more comprehensive map of Harappan sites in Rajasthan, Punjab, Haryana and Uttar Pradesh. (figs. 48.4 and 48.5 in the *Frontiers of the Indus Civilization*, ed. by B. B. Lal and S. P. Gupta). Due to deficiencies inherent in the published site data, the larger map cannot be totally accurate, but it does succeed in giving us a reasonable clear picture of the distribution, pat tern of Harappan sites in north-west India.

west India. However, the number of sites of this phase on the Indus river both in Sind (Balakot, Amri, Kot Diji and Mohenjodaro) and Punjab (Jalilpur, Harappa, Gumla, Sarai Khola) is very small. In contrast, there is a great density of sites of this phase along the dry bed of the Hakra-Ghaggar. Mughal (1981) has loeated 41 sites on the Hakra in the Cholistan desert (Pakistan), and more than 60 sites are known on the Ghaggar and its tributaries in Rajasthan, Punjab and Haryana. From this distribution pattern it is clear that the focus of this phase of the Harappan culture was the Hakra-Ghaggar valley. The extension of this farming-based village culture into the Indus and Hakra valleys obviously occurred from northern Baluchistan where this pattern of life was already known to exist from the fourth millennium B.C. at sites like Kile Ghul Mohammad and Damb Sadaat (Shaffer 1978), and has now been extended back to the sixth millennium B.C. by excavations at Mehrgarh (Jarrige and Lechevallier 1979). The recent discovery of sites associated with Hakra Ware and dated tentatively to the fourth millennium B.C. in the Hakra-Ghaggar valley by Mughal (1981) and Katy Dalal (1981) shows that the village-farming way of life had already been firmly established on this river before the Early Harappan period.

Perhaps contemporary to this phase as also to the ensuing Mature Harappan culture is the culture represented at some forty sites in the Sikar Aravallis which we have designated Ganeshwar culture. These sites are located on the Sabi, the Dohan, the Kasaunti (Krishnavati) and the Kantli rivers which, rising in the Sikar Aravallis, flow eastward into the Yamuna or northward to dry up in the sands in Haryana, though the Kantli may have, of old, flowed into the Drishadvati. From the limited data available from these sites, it would appear that they were essentially settlements of metal smiths who catered to the metal requirements of the Harappan and other contemporary societies.

The geographical area of the Mature Harappan culture largely coincides with that of the Early Harappan except for considerable expansion into Kutch in the south and into the Punjab and Haryana in the north. There is, however, a higher density of settlements in all regions. In the Hakra valley in Cholistan, Mughal (1981: 34) has recorded 166 sites of this phase as against only 41 of the Early Harappan. Further south in the lower Sind, Flam (1981) has located several sites on this river. In Gujarat there are 18 sites of this phase as against only 1 or 2 of the Early Harappan (Possehl 1980: 9). In

the Indus valley proper, there are some 16 sites as against only 4 of the Early Harappan. A very noticeable increase is seen in northern Punjab where there are 34 Harappan sites, mainly along the Sutlej, as against only 8 or 10 of the Early Harappan.

The distribution pattern of Late Harappan sites is very different from that of the earlier two phases. In Sind and Punjab (Pakistan) this phase is represented by the Jhukar culture and Cemetery 'H' culture, respectively. Only a few sites of these cultures are known in these areas. In Cholistan too where this phase is represented by Cemetery 'H' culture there is a decline in the number of sites. Mughal (1981: 34) has recorded only 72 sites of this phase as against 166 of the Mature Harappan. In contrast, there is a dramatic expansion of settlements in Gujarat, northern Punjab, and northern Haryana. And, for the first time, the Harappans cross the Indus valley to found settlements in the Yamuna-Ganga doab. In Gujarat there are 95 sites of this phase as against only 18 of the Mature Harappan (Possehl 1980: 9). In Haryana there are 30 sites of this phase as against 24 of the Mature Harappan; in Punjab 85 as against 34 of the Mature Harappan; and, in Yamuna-Ganga doab, 66 as against none of the Mature Harappan. In Haryana and Punjab settlements are located on the upper courses of the several tributaries of the Ghaggar, on the Sutlej (upper course) and its tributaries, and on the tributaries of the Ravi, and in Uttar Pradesh on the tributaries of the Yamuna, mainly in the district of Saharanpur.

A considerable decrease in the number of settlements in Sind, Punjab (Pakistan) and Cholistan and a much higher increase in their number in Gujarat, Punjab (India), Haryana and north-western Uttar Pradesh during the Late Harappan phase can only be explained by large scale migration of Harappan populations from the former to the latter regions. We will look into the probable causes of this migration later on.

Of the final or Degenerate phase of the Harappan culture some 171 sites are known. Only two of these are located in the Ghaggar valley in Punjab and Haryana. The vast majority of these sites are, however, located in Saharanpur, Muzaffarnagar, Meerut and Bulandshahr districts of Uttar Pradesh on the Yamuna and its tributaries. A few sites are found in the district of Bharatpur of Rajasthan, west of the Yamuna, and a few in the central Yamuna-Ganga doab.

The following important points emerge from this survey of the geographical distribution of Harappan sites:

1. As in the case of the Pre-Harappan farming-based settlements, Harappan sites are conspicuous by their total absence in west Rajasthan (except on the dry bed of the Ghaggar) where the lakes that produced the climatic sequence are located. This area receives an annual rainfall from less than 200 mm in the west to 400 mm in the east. Its southern part is drained by the Luni and its tributaries but not a single site of any phase of the Harappan culture has been found on any of them.

2. Similarly, Harappan sites (of all phases) are practically absent on the north Gujarat plain which is an extension of the west Rajasthan plain. This area receives an annual rainfall ranging from 400 mm in the west to 800 mm in the east and is drained by the Banas, the Sabarmati, the Mahi and their tributaries.

3. In sharp contrast to the total absence of Pre-Harappan and Harappan sites (of all phases) in these two areas is the great density of settlements of Pre-Harappan, Early Harappan, Mature Harappan, Late Harappan, and even later sites (P.G.W. and Medieval) in the Cholistan desert in Pakistan. This region has no active streams today. It receives less than 100 mm annual rainfall and is the most arid and inhospitable part of the Thar desert (Mughal 1981).

If increased rainfall was a causative factor in the emergence of agriculture, in the expansion of farming-based life, and in the development of Harappan culture, surely one would expect a greater density of Neolithic-Chalcolithic and Harappan sites in the relatively congenial west Rajasthan and north Gujarat plains than in the hyper-arid Cholistan. But the archaeological evidence is quite contrary to that expected by Singh's hypothesis. It can therefore be safely asserted that increased rainfall was not a decisive factor in the rise and growth of the Harappan culture.

4. The densest distribution of Harappan sites is not on the Indus river and its tributaries but on the extinct Hakra-Ghaggar and its equally extinct tributaries. Of the over 800 Harappan sites (not including Degenerate Harappan or OCP) known at present (Jansen 1980), more than 530 sites are located on the Hakra-Ghaggar system. If we add to this the nearly 200 Harappan sites from Kutch-Saurashtra and the nearly 70 Late Harappan sites from the Yamuna valley in Uttar Pradesh (U.P.), probably less than a hundred sites are left in the Indus valley proper and in Baluchistan.

The Harappan culture is, therefore, essentially a culture of the Hakra-Ghaggar valley, and any search for the cause or causes of the

rise and fall of this culture must embrace an investigation into the fluctuations of the fortunes of this river as was rightly pointed out by Gupta (1978). Before doing this, however, it will be useful to have a look at the Harappan agricultural economy, for it may provide some clue to the pattern of Harappan colonization.

An examination of the limited data available for the Harappan agricultural economy (Vishnu-Mittre and Savithri 1979) shows the following crop pattern: wheat (*Triticum compactum* and *Triticum sphaearococum*) in Pakistan Punjab (Harappa), Sind (Mohenjo-daro and Chanhu-daro) and Haryana (Banawali); barley (*Hordeum vulgare*) in Pakistan Punjab (Harappa) and north Rajasthan (Kalibangan); black gram (*Phaseolus mungo*) in north Rajasthan (Kalibangan); peas (*Pisum arvense*) in Sind (Mohenjo-daro and Chanhu-daro), Punjab (Harappa) and north Rajasthan (Kalibangan); millet (*Eleusine corcana* and *Setaria italica*) in Kutch (Surkotada); and rice in Saurashtra (Rangpur and Lothal). It is thus seen that, except in Saurashtra and Kutch, Harappan agricultural economy was mainly based on wheat and associated winter crops. Today too, the same crops are grown in these areas, mainly with the help of artificial irrigation. However, the same crops can be and are grown without artificial irrigation in areas where annual monsoon floods provide adequate moisture and fresh fertile silt to the land. Since there is no evidence of artificial irrigation during Harappan times it follows that these crops were grown with the aid of moisture and silt provided by river floods.

It is significant that, in spite of a fairly similar annual rainfall pattern, Punjab, Haryana and the Indus valley are major wheat growing areas in the subcontinent while west Rajasthan and north Gujarat grow no wheat at all (except in pockets where artificial irrigation has been developed). The crucial difference between the two areas (wheat growing and non-wheat growing) is not rainfall but the availability of water from Himalayan rivers.

The different agricultural picture in Kutch and Saurashtra needs explanation. Kutch must have had adequate moisture for wheat and rice cultivation during Harappan times since, besides the Banas and the Luni, the Hakra was discharging into the Rann of Kutch. It is true that we have no evidence for the cultivation of these crops but that may be due to the accident of non-preservation of botanical material at excavated sites. The Harappan colonization of Saurashtra took place mainly during Late Harappan times through migration from the lower Indus valley (and probably also from Kutch) after

the decline and abandonment of cities in the latter region. The immigrant population must have been forced to adapt its agricultural strategy to local environmental conditions by resorting to the cultivation of rice in river valleys and to dry farming of millets elsewhere.

It is, however, significant that, even during this critical period of large-scale migration from the Indus and Hakra valleys, the Harappans did not find the environmental conditions in west Rajasthan and north Gujarat sufficiently conducive for settling down.

It has been shown earlier that the largest concentration of Harappan sites of the three earlier phases is on the Hakra-Ghaggar river in the Cholistan desert (Pakistan) and on its tributaries in north Rajasthan, Haryana and Punjab (India). In comparison, the Indus valley, especially its upper course is very poor in Harappan sites (Fentress 1979). Today, the Hakra is a totally dead river. Its bed has been much encroached upon by sands, showing that the river has been extinct for a very long time. However, the bed of the river has been traced from its source in the Siwaliks through Punjab, Haryana, Rajasthan, Bahawalpur and Sind to its mouth in the Rann of Kutch with the help of surviving geomorphic traces and the presence of numerous archaeological sites along its course. Sir Aurel Stein (1942) discovered many archaeological sites along its course in the former Bikaner and Bahawalpur states. A. Ghosh (1952) traced a branch (Drishadvati) of this river in north Rajasthan and located many Harappan, P.G.W. and Rang Mahal culture sites along its course. Later, Henry Field (1959) continued the work of Stein in Bahawalpur and located more sites further east. More recently, Mughal (1981) has discovered nearly 400 sites of Pre-Harappan Hakra Ware, Early Harappan, Mature Harappan, Late Harappan (Cemetery 'H'-Related), Painted Grey Ware and Medieval period cultures on this river between the Indian border and south of Rahimyar Khan. On the lower course of the river, Louis Flam (1981) has located several Harappan sites. In the Indian part of this river in recent years a large number of Harappan and P.G.W. sites have been discovered on its various tributaries by Suraj Bhan (1971–72a, 1972, 1973, 1975), U.V. Singh (1977), Katy F. Dalal (*nee* Frenchman) (1972, 1981), and several officers of the Archaeological Survey of India (Bisht 1976, 1977; Dikshit 1979b, 1981: Joshi 1978a, 1978b; Joshi and Madhu Bala 1979; Lal 1977; Madhu Bala 1981; Thapar 1973a).

In its upper course, the bed of this river runs in a more or less east-west direction, up to the Indo-Pakistan border and is known

variously as the Ghaggar (Ghosh 1952), Hakra and Sotra (Oldham 1893). From this point onward, it takes a south-westerly course into Bhawalpur and is known as the Hakra or Wahind. After entering Sind, it turns southward and flows in that direction right down to its mouth in the Rann of Kutch, and is known variously as the Narra (Nara), Hakra of Sagara, Wahind, and Dahan. For the greater part of its course, the bed of the Hakra runs parallel to, and east of, that of the Indus.

The width of the Hakra bed varies from 3 to 10 km in different parts of its course. It was obviously, therefore, a very large river during its lifetime. The large number of settlements found along its course dating broadly to the period 4000–600 B.C., also shows that it must have been a perennially flowing mighty river. Today no permanent settlement along its course is possible except where artificial irrigation has been provided. It is also significant that, except in the uppermost part, the river receives no feeders, and, therefore, the only source of its waters must have been the rainfall and snowmelt in the Himalayas. No amount of increased rainfall (as compared to today's) could have, however, filled such a wide and enormously long bed. Indeed, as Oldham (1893: 52) pointed out nearly a century ago,

> It would have involved the existence, previously, of such meteorological conditions as must have rendered the holy land of the Brahmanas an uninhabitable swamp. The neighbouring large rivers, too, must in such case have been vast in proportion. This, as their channels show, they were not. Some of them, in fact, which are mentioned in the Vedas as being fordable, are so with difficulty at the present day.

It is, therefore, clear that the Ghaggar-Hakra could have flowed as a mighty perennial river from its mouth to the sea only if some other equally large river was flowing in its channel in the past.

Hydrological Fluctuations : Yamuna and Sutlej

What was this river? And where did it go leaving the Hakra as a dry channel?

The question has attracted the attention of geographers, historians and archaeologists now for more than a century (C.F. Oldham 1874, 1883; R. D. Oldham 1886; Stein 1942; Ghosh 1952; Erikson 1959). The ancient river has been identified by most scholars with the Saraswati of Hindu tradition. Saraswati is one of the holiest rivers of the Hindus. According to living Hindu tradition, the river flows

through a subterranean channel and joins the Yamuna at Prayag (Allahabad) to form, together with the Ganga, the Triveni Sangam (confluence of three holy rivers). This myth or legend would appear to enshrine the folk memory of a period when the Saraswati and the Yamuna did actually converge above ground. Subsequently, the Yamuna probably shifted its course leaving the Saraswati in possession of a dry channel, and helped create the myth of the river having gone underground. In the *Rig Veda*, the Saraswati is described as a large and rapid river flowing from the mountains to the sea. It is called 'the mother of rivers' and a river that 'surpasses in greatness all other waters' (Oldham 1893: 49). But in the *Mahabharata*, the river is described as having lost itself in the sands. Although it is not possible to assign precise dates to these events, most scholars put the beginning of the Vedic period around the middle of the second millennium B.C. The Mahabharata period has, on archaeological grounds, been shown to coincide with the P.G.W. culture (Lal 1954–55, 1981) which can be dated broadly to c. 1000–600 B.C. It can, therefore, be said that the Saraswati was a fully flowing river in the second millennium B.C. (and by implication earlier) but had dried up by c. 1000 B.C.

At present, the Saraswati is a small stream which originates in the Siwaliks a llttle to the west of the point where the Yamuna enters the plains. After flowing for nearly 150 km it joins the Ghaggar. Although below the confluence, the combined stream is shown on the maps as the Ghaggar,

> 'it was formerly the Saraswati; that name is still known amongst the people, and the famous fortress of Sarasuti or Saraswati was built upon its banks, nearly 100 miles below the present junction with the Ghaggar' (Oldham 8893: 51–52).

This small Saraswati which carries water for only a short distance, still possesses thc sacred character assigned to the river of that name since Rig Vedic times. There can, therefore, be little doubt that the existing Saraswati is the Saraswati of the Vedic and Epic periods. The names Ghaggar, Sotra, Hakra, Nara, etc. which the river carries in different parts of its course do not occur in ancient literature. They all seem to have been acquired in later historical or recent times.

What river did then flow into the Saraswati (or present day Hakra) channel to make it a functioning river, and when and how did it leave the Saraswati bed?

There are only two large rivers—the Sutlej and the Yamuna—which are close enough to the Saraswati to have performed this role. Between these two Himalayan rivers there is no other gap in the Siwaliks through which a third large river could have entered the plains and flowed into the Saraswati bed. It is also significant that there are no Harappan sites on the Sutlej except in its upper course near the Siwaliks. Nor are there any Harappan sites on the present Yamuna channel. It, therefore, seems certain that neither the Sutlej nor the Yamuna flowed in their present respective channels during Harappan times (3rd-2nd millennia B.C.). Both of them could, therefore, have flowed in the Saraswati channel. C.F. Oldham (1874, 1893), considered both these alternatives and came to the conclusion that the Sutlej rather than the Yamuna was flowing in the Saraswati channel. However, we have to remember that when Oldham wrote, he did not have, at his disposal, the enormous volume of archaeological evidence pertaining to Harappan and other cultures that has become available in last sixty years. His historical reasoning depended mainly upon the information available in Vedic and Epic literature and from the ruins of the antiquity of which he had no clear idea. The new archaeological evidence has made it possible to consider the question in a new perspective. Besides, recent research, specially by Raikes (1968) and Suraj Bhan (1972, 1973, 1975, 1977), has produced archaeological, geomorphic and sedimentological evidence to show that the Yamuna did flow into the Saraswati in the past. It has, therefore, become necessary to examine the alternatives in the light of this new cumulative evidence.

For such a re-examination, it is necessary to have a clear picture of the living and defunct river courses of the area in which the postulated vital changes in the course of the Sutlej and the Yamuna must have taken place.

There are a number of, mostly dry, river-beds between the Yamuna and the Sutlej in Haryana, Punjab and Rajasthan. They all rise within a very limited area on the western slopes of the Siwalik Range, bounded on the south by the drainage area of the Yamuna, and on the north by that of the Sutlej. None of them ever had any connection with the glaciers of the higher levels nor with other, larger, catchment areas. The upper courses of these rivers run through steep narrow gorges in the mountains, but below the 500 m level they broaden considerably and gradually peter out further westward where the head of water diminishes rapidly as the landscape

levels out. Below the 250 m contour, the country is almost horizontal with only a slight westward cant. Here the width of these rivers varies from 2 to 10 km. They carry water, however, seasonally or throughout the year only in a narrow channel of the bed and only for short distances. Over most of their courses, the rivers meander through a flat, dry, hot and sterile desert. Because of its flat topography, the vast area covered by these rivers is, and has always been, susceptible to flooding by the waters of the Sutlej. This leads to the formation of vast lakes and their filling up by abundant silt and clay sediments brought in by the rivers. This process sometimes necessitated the scouring out of new courses by spring floods. This is the only way one can explain the presence of so many river courses in a very limited supply of water. The lower courses of these rivers, already silted up, have been, and are being encroached upon by sands (Oldham 1893; Erikson 1959).

Because of the excessive silting and encroachment by sand of these river-beds, they are only discontinuously visible on the ground. For this reason, there are some discrepancies in the courses as traced by different scholars. All the courses may probably be visible on 1: 50,000 sheets, but this author has not had access to them. The map[1] showing the river courses of the area has been drawn from 1.1,000,000 National Atlas sheets. It shows only some of the river-beds. C.F. Oldham (1893), however, has shown many more beds, specially between the Ghaggar and the Sutlej. His map is probably based on the work of R. D. Oldham (1886). B. M. Pande (1977) has also shown the same rivers though his alignments differ slightly from those given by C. F. Oldham. The picture that emerges from a study of these maps as also from the accounts of Ghosh (1952), Erikson (1959) and Suraj Bhan (1972, 1973) can be summarized as follows:

The Ghaggar or Hakra is formed by a combination of two rivers which meet near Wallur (Oldham 1893: 57) or to the west of Anupgarh (Erikson 1959: 23) on the Indo-Pakistan border. These are named the eastern and western Hakra by Oldham, while Ghosh (1952) who explored the 'eastern Hakra' uses the name Ghaggar for it. The eastern arm of the Hakra is formed by a combination of four rivers which are named, from east to west: (1) Chautang (Chitrung of Oldham) or Drishadvati; (2) Saraswati; (3) Ghaggar; and (4) Wah or Sonamwal or Sirhind Nadi. The Chautang flows almost parallel and close to the Yamuna from the hills down to a little north of

[1]Published in the *Frontiers of the Indus Civilization* (fig. 48.5).

Karnal where the two rivers diverge, the Chautang taking a south-westerly course and the Yamuna turning south. At present, the Chautang dries up near the village of Safidom, but Ghosh (1952) was able to trace its course for a considerable distance further to the south-west, past the towns of Bhadra and Nohar to near Suratgarh where it must have joined the Ghaggar. The Hansi branch of the Western Yamuna Canal runs through this dry bed. Another river running west of, and parallel to it, is also known as Chautang (Erikson 1959: 22, fig. 3) and joins the Saraswati at the town of Pehowa. The Harappan site of Banawali is probably located on its dry bed. To its west is the Saraswati (also known as the Markanda in its upper course) which joins the Ghaggar near the village of Rasula, a few kilometers south-east of the small town of Shatrana. Although the Ghaggar is the smaller of the two rivers, from the confluence it takes the name of the combined river. Wah, the westernmost branch of the eastern arm of the Hakra, at one time joined the latter east of Sirsa, but today it dries up nearly 100 km north-east of this town.

The western arm of the Hakra is formed by a combination of three rivers each of which is known as Naiwal. They are designated eastern, middle and western Naiwal. According to Oldham (1893: 58) these streams meet near Kurrulwala (29° 33′ N: 73° 52′ E) south of the town of Abohar in Punjab. In the map published by Pande (1977: fig. 2.21) the eastern and middle Naiwals are shown joining the Ghaggar south of Hanumangarh, as well as the western Naiwal a little further west. Between the western Naiwal and the Sutlej, Oldham has shown two more dry beds both of which join the Sutlej. The eastern of these beds is known as the Dhunda.

Oldham was of the opinion that the Sutlej flowed into the Hakra or Saraswati through each of these dry beds, gradually shifting its course from east to west. When the Sutlej shifted its course westward

'and abandoned the eastern arm of the Hakra, the Saraswati, which had been a tributary, was left in possesion of the deserted channel, in the sands of which its waters were swallowed up' (Oldham 1893: 59).

This event took place between the period of the *Rig Veda* and that that of the *Mahabharata*. After this, the Sutlej flowed into the western arm of the Hakra through each of the three Naiwals, and finally changed its course more or less due west in the thirteenth century A.D. to flow into the Beas valley through the two dry beds between the western Naiwal and the present Sutlej.

Oldham's arguments in support of his hypothesis are quite convincing, and can be summarised as follows.

1. The application of the name Sutlej to the combined Beas-Sutlej stream, below the confluence, is a modern innovation, and is not to be found in old writings, Hindu or Mohammedan. The united stream of Beas and Sutlej was never known as Satadru or Satludra. Instead it has been known as Vipasa, Beas and Beah. Even to this day, the river below Ferozepur is known to the boatmen as Beah or Garrah. All this seems to show pretty clearly that the Sutlej is an interloper, and the Beas the original stream. Had it been otherwise, the greater river must have retained its name throughout its course.

2. Several of the old river beds which combine to form the Hakra have been traced to within so short a distance of the Sutlej that they could not possibly have belonged to any other stream.

3. All the old channels of the Hakra diverge from the direction of Ropar where the Sutlej enters the plains and each is said to have been in turn the bed of that river. On the banks of each of them are towns which, though now more or less decayed, were once places of importance.

4. The local traditions of the land between the Sutlej and the Saraswati all agree that until Muslim times, the Sutlej flowed into the Hakra channel and that till then the country along its banks was fertile and prosperous.

5. There is a tradition that the Wah was once the old bed of the Sutlej.

Oldham's another inference that the Yamuna could not have flowed into the Saraswati bed is, however, not based on convincing arguments. In fact, he does admit that:

> It is not beyond the bounds of possibility that the Jumna may at some very remote period have taken a westerly instead of an easterly course and joined the Hakra; for, as observed by R.D. Oldham of the Indian Geological Survey, this old riverbed lies between the fan or talus of the Jumna, and that of the Sutlej (Oldham 1893: 55).

Elsewhere (*Ibid:* 58) he says:

> Near Bhatnair the eastern arm of the Hakra is joined by a dry river bed, marked in our maps as Chitrung. If the Jumna ever joined the Hakra it must have been by this channel, which however is only traceable for a short distance. It is supposed to have once been continuous with the Chitrung stream, which has been identified with the Drishadvati.

Yet, he is disinclined to accept this alternative because '*Tradition*,

however, is silent on the subject, and so are the Vedas' (Ibid: 55).

What Oldham means by tradition in this context is not very clear, for as has been mentioned earlier and is indeed too well known, Hindu tradition strongly associates the Saraswati with the Yamuna but never with the Sutlej. How a percipient scholar like Oldham culud be unaware of this is difficult to comprehend.

Oldham's view in this matter is mainly influenced by the references to Yamuna in the Vedic and Epic literature, namely:

(i) In the only place in which the river Ganga is mentioned in the *Rig Veda* (X. 75.5) the Yamuna is coupled with it; and

(ii) There is ample evidence from the *Mahabharata* and the *Ramayana* to show that the Yamuna was flowing in its present channel during the period of these epics.

In other words, since literary tradition says that the Yamuna was flowing in its present course, it could not have flowed elsewhere.

Here it is important to remember that Oldham was writing at a time when the history of India was not known to extend beyond the period of the Epics and the Vedas. With our present archaeological knowledge, however, we know that there is no contradiction in the Yamuna having flowed during the Epic and probably even during the Early Vedic time in its present course, and during pre-Vedic or Harappan times in a different course.

The available archaeological evidence suggests that this indeed was the case:

(1) The total absence of Harappan sites along the present course of the Yamuna shows that the river was not flowing in its present course during the Harappan period.

(2) The presence of many Painted Grey Ware (P.G.W.) sites on the Yamuna shows that the river had shifted to its present channel by P.G.W. time. The association of the P.G.W. culture with the *Mahabharata* epic has been fairly convincingly demonstrated (Lal 1954–55, 1981).

(3) Raikes (1968) has shown, on geomorphic and sedimentological evidence that the Yamuna was actually flowing in the Ghaggar channel during Harappan times. The geomorphic evidence consists of the migration of the meandering channel of the Yamuna across the 10–15 km width of the plain. To the west, the plain slopes gently towards the Indus. The present Western Yamuna Canal evidently incorporates considerable parts of a former channel that followed the extreme western boundary of the plain. The

sedimentological evidence consists of the discovery of

'a coarse, greyish sand very similar in mineral content to that found in the bed of the present-day Yamuna'

in bore holes in the Ghaggar bed at Kalibangan 11 m below the present flood plain level (Raikes 1968: 287). Above the 11 m depth, Raikes found mainly clays and silts typical of present-day flood-plain deposits. Basing his arguments on calculations for the rates of sedimentation, location of archaeological sites of early cultures (Harappan, P.G. Ware and Rang Mahal or Kushan)in the Ghaggar valley, and the thickness of the deposits at these sites, Raikes has postulated alternate captures of the Ghaggar channel by the Indus and the Ganga systems. In effect, these episodes imply simply the capture or abandonment of the Ghaggar channel by the Yamuna. Raikes has correlated these episodes with archaeological cultures in the following manner:

1. Westward diversion to Indus (coinciding with Harappan occupation)	2500–1750 B.C. (750 years)
2. Eastward diversion to Ganga (coinciding with abandonment)	1750–1100 B.C. (650 years)
3. Westward diversion to Indus (coinciding with Painted Grey Ware)	1100–500 B.C. (600 years)
4. Eastward diversion to Ganga (coinciding with abandonment)	500–100 B.C. (400 years)
5. Westward diversion to Indus (coinciding with Early Historic)	100 B.C.-A.D. 500 (600 years)
6. Eastward diversion to Ganga in about A.D. 500 (coinciding with abandonment)	

Raikes' second and third westward diversions take into consideration only the archaeology of the Ghaggar valley and totally ignore the archaeological and historical evidence of the Yamuna valley. They appear to be forced upon to explain the presence of Painted Grey Ware and Rang Mahal cultures on the Ghaggar. However, basing on the total archaeological evidence both on the Ghaggar and the Yamuna, there seems little doubt that, during Harappan times the Yamuna was flowing in the Ghaggar channel and subsequently, it has always flowed in its present channel.

The question then arises as to through which of the many

existing and obsolete channels of the Ghaggar did the Yamuna flow into the Ghaggar (or Saraswati). From the archaeological point of view, the most important of these channels appears to be the Chautang or the Drishadvati since a large number of Early and Mature Harappan sites have been located on it. Though today the Chautang dries up east of Safidom, Ghosh (1952) was able to trace its course right up to the Ghaggar near Suratgarh. As suggested by Oldham also, Yamuna is most likely to have flowed through this channel during its westward course in prehistoric times.

The eastward shift of the Yamuna must have taken place through the channels which have recently been traced by Suraj Bhan (1972). One of these starts from near Indri, 20 km north of Karnal and is traceable for a distance of 180 km up to Tigrana near Tosam in the south-west. This channel runs along the course of the West Yamuna Canal up to Mundak and then along the Jind branch of the same canal up to Safidom. The channel is marked by sand dunes along its banks, a regular band of fresh water vegetation in its course and thick deposits of the grey sands so typical of the Yamuna, in the wells dug along the channel. Local tradition also associates this channel with the old course of the Yamuna. East of Tigrana the channel is lost in the sands. Suraj Bhan has located 18 Harappan and 2 P.G.W. sites on this channel. The scarcity of P.G.W. sites here suggests that the Yamuna had already shifted eastward during the Late Harappan period. Suraj Bhan has located two more channels further east with late Harappan and P.G.W. sites on them, thus providing further evidence for the eastward shift of the Yamuna. This eastward diversion of the Yamuna to its present channel and the westward diversion of the Sutlej into the western arm of the Hakra, sometime in the Late Harappan times, must have left the channel of the Ghaggar (Saraswati) dry over a long distance (up to Wallur where the western arm of the Hakra joined it). This must have created the myth that Saraswati went underground to join the Yamuna.

Decline of Indus Civilization—Fresh Look

The third hypothesis of Singh's, namely, that a decrease in rainfall around 1800 B.C. led to a decline of the Indus Civilization can now be examined.

Here it may incidentally be mentioned that the date of the decline in rainfall is not certain. While at Lunkaransar in the arid

belt, the lake had started drying up around 2000 B.C., the same event at Sambhar, in the semi-arid belt, took place a thousand years later. It is difficult to explain such a long time difference between two points only 200 km apart. Singh's dating of this event therefore seems to be influenced by the need of reconciling the climatic evidence with archaeological data.

But first let us examine the evidence for the decline of the Indus Civilization.

It is undeniable that in the 18th-19th centuries B.C., Harappan cities declined, and some of them were even abandoned. In the lower Indus valley many causes for this event have been suggested: reduction in rainfall (Marshall 1931); exhaustion of the economic resources (Wheeler 1968; Fairservis 1961, 1967); excessive flooding (Raikes 1964; Dales 1966) and Aryan invasion (Wheeler 1953). Though some of these explanations have been questioned (Dales 1964, 1966; Possehl 1967; Lambrick 1967), the fact of decline and abandonment of the cities is accepted by all critics. There is also an undeniable decline in material prosperity and in civic standards. But this decline did not lead to a decrease in population. It only forced the population to migrate from the lower Indus valley into Saurashtra and from the Hakra-Ghaggar valley into north Punjab, Haryana and the upper Yamuna-Ganga doab. The sudden proliferation of Late Harapan sites in Saurashtra, north-east Punjab and Haryana and the upper Yamuna-Ganga doab attests to this migration.

At least in the case of north Punjab and the upper Yamuna-Ganga doab, rainfall is not significantly higher than in the adjoining parts of Punjab and Haryana which had witnessed dense human settlements during the Early and Mature Harappan times. Therefore, these new regions of colonization could not have conferred any significant advantages to the immigrants. On the other hand, the shift of the courses of the Yamuna and Sutlej to the east and west, respectively, would have considerably reduced the availability of both surface and sub-surface water in the Ghaggar valley. This would, in due course, have adversely affected both natural vegetation and agriculture, and forced the population to shift to areas like north Punjab (Sutlej channel) and the upper Yamuna-Ganga doab where the rivers provided the ecological conditions the Harappan had long been accustomed to exploit. It is, therefore, quite unnecessary to invoke the deterioration of climate to explain this migratory phenomenon.

In the case of the lower Indus valley, some or all of the various explanations suggested, could have accounted for the shift of the Harappan population into Gujarat.

The phenomenon of Degenerate Harappan (same as OCP or OCW) culture represents a continuation of the eastward migration of the Late Harappans. This would appear to be due to excessive population pressure in the limited land available in the upper doab. The density of Late Harappan sites in the districts of Ludhiana and Saharanpur is eloquent proof of this demographic pressure.

Aridity: Second Millennium—Fresh Look

The fourth and final hypothesis of Singh is that aridity between 2000 and 1000 B.C. is responsible for the 'hiatus' between the Harappan and P.G.W. cultures. This too does not stand the scrutiny of new archoeological evidence. Recent excavations by the Archaeological Survey at Bhagwanpura, in the district of Kurukshetra (Haryana), Dadheri in the district of Ludhiana, Nagar and Katpalon, both in the district of Jullandur (Punjab), and Manda on the Chenab in Jammu have shown that the P.G.W. culture co-existed with the Late Harappan at these sites (Joshi (1977, 1978; Lal 1979). Gupta (Gupta and Ramachandran 1977) suggests 1300 B.C. for this overlap phase. This new evidence eliminates the 'hiatus' between the Harappan and P.G.W. cultures and effectively knocks the bottom out of the desiccation hypothesis of Singh. Even in the north Rajasthan part of the Ghaggar valley, the new evidence available suggests that there was no 'hiatus' between the Harappan and the P.G.W. cultures. Black-and-red Ware has been found in profuse quantities in association with Painted Grey Ware both in surface explorations and in the excavation at Sardargarh in this region (Pande 1977: 56). Archaeological research during last two decades has amply demonstrated that in north-east Rajasthan (Jodhpura and Noh) and in the central Yamuna-Ganga doab (Atranjikhera), Painted Grey Ware was preceded by an independent phase of Black-and-red Ware culture which, in turn at many sites, was preceded by OCP or Degenerate Harappan. Fresh field research in Ghaggar valley in Rajasthan and a re-evaluation of the older evidence is most likely to show a continuity of occupation in this area from Harappan to Painted Grey Ware.

However, there is evidence to show that population during the Painted Grey Ware period was much sparser in the Ghaggar valley.

In Pakistan part of the this valley, only 14 sites of this culture have been found and all these occur in the eastern part (south-east of Bahawalpur) near the Indian border. This is in sharp contrast to the dense concentration of Mature Harappan sites further down in the same valley (south-west of Bahawalpur) (Mughal 1981; map). Further, Ghosh (1952) has shown that the Painted Grey Ware sites are often located on the Ghaggar bed. These two factors show that during the P.G.W. period: (i) the Ghaggar (or Saraswati) no longer flowed all the way to the sea, but only in the upper part of its course; and (ii) that its original bed had considerably shrunk. This must naturally have been the consequence of the diversion of the Yamuna from the Ghaggar channel to its own present channel.

Summing Up

We can now summarize the conclusions of this lengthy review of archaeological and palaeo-environmental evidence as follows:

(1) The sedimentological evidence from the *playas*, the stabilization of extensive sand dunes formed during the arid Upper Pleistocene, and widespread appearance of microlith-using and hunting-gathering-pastoral populations in West Rajasthan supports Gurdip Singh's hypothesis based on palynological evidence that rainfall had increased in early Holocene times.

(2) The complete absence of farming-based sites earlier than 2000 B.P. in western Rajasthan (the area of the lakes that produced the climatic sequence) and on the north Gujarat plain does not support the hypothesis that cereal agriculture had appeared in this region as early as 7000 B.C.

(3) Harappan sites are totally absent in western Rajasthan except on the Ghaggar river in the north-western corner of this state. Similarly, such sites are missing on the north Gujarat plain drained by the Mahi and the Sabarmati rivers. Both these areas are agriculturally very fertile provided necessary moisture for crops is available. The failure of the Harappans to colonize these extensive alluvial plains shows that the increase in rainfall postulated by Singh around 3000 B.C. was not strong enough to make these areas cultivable.

(4) The Ghaggar river originates in the Himalayas and its channel passes through Punjab, Haryana, Rajasthan, Bahawalpur and Sind to its mouth in the Rann of Kutch. It should therefore be possible to explain the presence of Harappan sites on this river in the

north-east corner of Rajasthan by factors which are also applicable to other sites on the rest of the course of this river.

(5) The geographical distribution of the Harappan sites reveals the following pattern: most of the Early Harappan sites are located in the middle Ghaggar-Hakra vally and a few in the lower and upper Indus valley. The Mature Harappan sites occur on the Indus, in Kutch-Saurashtra, and on the Ghaggar, but the greatest concentration is again in the middle Ghaggar-Hakra valley. In Late Harappan times, there is a decline in the number of sites in the middle Hakra valley (Cemetery 'H'-related) and in the Indus valley (Jhukar-culture), but there is a remarkable expansion of settlements in Saurashtra and in the upper Ghaggar-Sutlej valleys. The Harappans also cross the Indus system to colonize the upper Yamuna-Ganga doab during this period. The Degenerate Harappan (OCP) sites are mainly located in the upper Yamuna-Ganga doab but there is also a sporadic expansion in the central doab and even further east.

(6) This pattern of settlements shows that, except in Saurashtra, Harappan culture was essentially a riverine culture, flourishing in the valleys of the Himalayan rivers whose flood plains are annually inundated by monsoon floods which spread fresh fertile silt and provide adequate subsoil moisture for agricultural crops.

(7) The Harappan agricultural economy was mainly based on the cultivation of wheat, barely, gram and peas which are winter crops and can be grown in the flood plains of large, annually inundated rivers without artificial irrigation. This pattern of agriculture could have been practised in the river valleys existing in the Harappan zone in the present climatic conditions. Higher rainfall during Harappan times was not necessary for the flourishing of this economic pattern in these river valleys.

(8) The Ghaggar-Hakra today is a dead river, except near its source in the Siwaliks. But during the time of the *Rig Veda* (middle of second millennium B.C.) it was a mighty river and was flowing from the mountains to the sea. Its very wide bed (up to 10 km) also shows it to have been a mighty river like the Indus. This bed can be traced right from its source in the Siwaliks through Punjab, Haryana, north-east Rajasthan, Bahawalpur and Sind to its mouth in the Rann of Kutch. The river could have supported the large populations represented by the dense concentration of Hakra Ware, Early Harappan, Mature Harappan and Late Harappan (Cemetery 'H'-related) sites only if it was perennially flowing with the volume of water

commensurate with the width of its bed.

(9) No amount of reasonably possible higher rainfall in the Himalayas could have filled this bed, unless one or more of the large Himalayan rivers flowed through its channel. For geomorphic considerations, this function could have been performed only by the Sutlej and the Yamuna.

(10) The absence of Harappan sites on the Sutlej (except in its uppermost course along the Siwaliks) and on the Yamuna shows that these rivers were not flowing in their present channels during Harappan times. Indeed, the Sutlej was not flowing in its present course until the late medieval period. There is geomorphic, archaeological and folkloristic evidence to show that both the Sutlej and the Yamuna were flowing into the Ghaggar channel in the past, and that they shifted to their present channels during early medieval times and Late Harappan times, respectively.

(11) The shifting of the Yamuna from its ancient course must have considerably reduced the volume of water in the Ghaggar bed. This would have reduced the extent of annual flooding and consequently the potential for agriculture along the Ghaggar course. The Harappan population must, therefore, have been forced to move eastwards along the course of the perennial rivers and into areas with more assured rainfall. The sudden proliferation of Late Harappan settlements in the upper reaches of the Sutlej and of the Ghaggar tributaries, and in the upper Yamuna-Ganga doab is symptomatic of this hydrological change.

(12) There is definite evidence for the decline of the Mature Harappan culture and the abandonment of the cities in the Indus valley. These phenomena have been explained as due to the depletion of ecological resources caused by over-exploitation, sapping of the population morale due to recurrent and disastrous flooding (caused perhaps by the damming of the Indus by tectonic uplift), and tribal movements. The population from this region spilled over into Kutch and Saurashtra as is seen by the dramatic increase in Late Harappan settlements in these areas. The Harappans here adapted their agricultural strategy by taking recourse to the cultivation of rice (in the Hakra delta and along river valleys) and the dry farming of millet crops.

(13) The 'hiatus' between the Harappan and P.G.W. cultures has been bridged by recent researches in Haryana, Punjab and Jammu. The postulated decline in rainfall between the Harappan and P.G.W.

periods can, therefore, no longer be sustained by archaeological evidence. The smaller number of P.G.W. sites (as compared to Harappan) in the Hakra valley is easily explained due to the reduced volume of water in its bed caused by the shifting of the Yamuna from the Ghaggar to its present channel.

In sum, the enormous volume of archaeological evidence now available from north-west India completely fails to sustain the overall hypothesis proposed by Gurdip Singh that fluctuations in rainfall played a decisive role in the emergence, diffusion, prosperity and decline of farming-based cultures in the region. The only role the increased rainfall played was to arrest the hyper-aridity of the Upper Pleistocene, stabilize the sand dunes, accelerate the growth of vegetation and help in the emergence and spread of a nomadic hunting-gathering-pastoral economy. This pattern of life has persisted in the semi-arid and arid environments to this day. Agriculture based on dry farming of millet and related crops appeared in these regions only during the past 2000 years and was probably a consequence of the increasing population pressure in neighbouring areas. With the appearance of agriculture and permanent habitation, overall vegetation density and cover as also wild fauna was reduced, leading to a decline in the role of hunting in the economy. Pastoralism, however, proved to be the best adaptive strategy and has persisted to this day.

BIBLIOGRAPHY

Agrawal, D. P.; Datta, P. S.; Husain, Z.; Krishnamurty, R. V.; Misra, V. N.; Rajagurn, S. N.; and Thomas, P. K. 1980a. *Palaeoclimate, Stratigraphy and Prehistory in North and West Rajasthan. Proceedings of the Indian Academy of Sciences* (Earth Planetary Science), 89 (1); 51–66.

Agrawal, D. P.; Krishnamurty, R. V.; Dhir, R. P.; Misra V. N. and Rajaguru, S. N. 1980b. Quaternary Studies in Rajasthan: Preliminary Results. *Recent Researches in Geology*. 9; 186–199.

Agrawala, R. C. 1978. Copper Celts and an Indus Arrow-Head from Kulhade-ka-Johad, District Sikar, Rajasthan. *Man and Environment*. 2; 123–24.

——, 1980. Khuradi (?) Copper Hoard from Rajasthan. *Man and Environment*. 4; 82–91.

——, 1981. Recent Exploration in Rajasthan. *Man and Environment*. 5; 59–63.

Allchin, B. and Goudie, A. 1971. Dunes, Aridity and Ealry Man in

Gujarat, Western India. *Man.* 6 (2); 248–265.

——, 1978. Climatic Change in the Indian Desert and North-West India during the Late Pleistocence and Early Holocene. In *The Environmental History of the Near and Middle East.* William C. Brace ed. 307–318. London: Academic Press.

Allchin, B.; Goudie, A. and Hegde, K. 1978. *The Prehistory and Palaeogeography of the Great Indian Desert.* London: Academic Press.

Bisht, R. S. 1976. Transformation of the Harappa Culture in Punjab with special reference to the excavations at Sanghol and Chandigarh. In *Archaeological Congress and Seminar.* U. V. Singh ed. 16–22. Kurukshetra: Kurukshetra University.

——, 1977. *Banawali: A Look Back into the Pre-Indus and Indus Civilization.* 1–14. Chandigarh: Government of Haryana.

Braidwood, R. J. 1961. Levels in Prehistory: A Model for the Consideration of the Evidence. In *Evolution after Darwin.* Sol Tax ed. Vol. 2. pp. 143–151. Chicago: Chicago University.

Casal, J. M, 1964. *Fouilles d'Amri.* Paris: Commission des Fouilles Archaeologiques.

Dalal, Katy F. 1980. A Short History of Archaeological Explorations in Bikaner and Bahawalpur along the 'lost' Saraswati River. *Indica,* 17 (1); 1–40.

——, 1981. RD-89 A New Hakra Ware Site. *Man and Environment.* 5; 77–86.

Dales, G. F. 1964. The Mythical Massacre at Mohenjo-daro. *Expedition.* 6 (3); 36–43.

——, 1965. New Investigations at Mohenjo-daro. *Archaeology.* 18 (2); 145–150.

——, 1966. The Decline of the Harappans. *Scientific American.* 241 (5); 92–100.

——, 1981. Reflections on Four Years of Excavations at Balakot. In *Indus Civilization: New Perspectives.* A. H. Dani ed. 25–32. Islamabad: Quaid-i-Azam University.

Dani, A. H. 1970–71. Excavations in the Gomal Valley. *Ancient Pakistan.* 5; 1–177.

——, 1975. Origins of Bronze Age Cultures in the Indus Basin—a Geographic Perspective. *Expedition.* 17 (2); 12–18.

Deshpande, M. N. 1977. The Harappan Settlements in the Ganga-Yamuna Doab. In the Seminar on *Indus Civilization: Problems and Issues.* Simla: IIAS.

Dikshit, K. N. 1979a. The Ochre Coloured Ware Settlement in the Ganga-Yamuna Doab. In *Essays in Indian Protohistory*. D. P. Agrawal and D. K. Chakrabarti ed. 285–299. Delhi: B.R. Pub. Corp.

——, 1979b. The Late Harappan Culture in India. In *Essays in Indian Protohistory*. D. P. Agrawal and D. K. Chakrabarti ed. 123–133. Delhi: B.R. Pub. Corp.

——, 1979c. Hulas and the Late Harappan Complex in Western U.P. In the Conference on *The Harappan Civilization: A Contemporary Perspective*. Srinagar: AIIS.

——, 1980. A Critical Review of the Pre-Harappan Cultures. *Man and Environment*. 4; 32–43.

——, 1981. The Excavations at Hulas and Further Exploration of the Upper Ganga-Yamuna Doab. *Man and Environment* 5; 70–76.

Durrani, F.A. 1965. Climate of the Lower Indus Valley in Ancient Times. *Journal of the University of Peshawar*. 10; 33–37.

Erikson, K. Gosta. 1959. The Dry Bed of the River Ghaggar. In *Rang Mahal*. Hanna Rydh. 22–40. Lund (Sweden) C.W.K. Gleerup.

Fairservis, Jr. W. A. 1961. The Harappan Civilization: New Evidence and More Theory. *Novitates*. 2055; 1–35. New York: American Museum of Natural History.

——, 1967. The Origin, Character and Decline of an Early Civilization. *Novitates*. 2302; 1–48. New York: American Museum of of Natural History.

——, 1979. Allahdino: Excavation of a small Harappan site. In the Conference on *The Harappan Civilization: A Contemporay Perspective*. Srinager: AIIS.

Fentress, Marcia A. 1979. From Jhelum to Yamuna—City and Settlement in the 2nd-3rd Millennium B.C. In the Conference on *The Harappan Civilization: A Contemporary Perspective*. Srinagar: AIIS.

Field, Henry. 1959. An Anthropological Reconnaissance in West Pakistan. *Papers of the Peabody Museum of Archaeology and Ethnology*. Harvard University. Vol. 3 Cambridge (Mass): Peabody Museum.

Flam, Louis. 1976. Settlement, Subsistence and Population: A Dynamic Approach to the Development of the Indus Valley Civilization. In *Ecological Background of South Asian Prehistory*.

K. A. R. Kennedy and G. L. Possehl eds. 76–93. Cornell: Cornell University.

——, 1981. Towards an Ecological Analysis of Prehistoric Settlement Pattern in Sind, Pakistan. *Man and Environmet.* 5; 52–58.

Frenchman, Katy F. 1972. Prehistoric Pottery Industries along the 'Lost' Saraswati River of the Great Indian Desert. Unpublished Ph.D. Thesis. Pune: Poona University.

Gaur, R. C. 1971–72. OCP and NBP. *Puratattva.* 5; 10–12.

——, 1973. Lal Qila Excavation and the O. C. P. Problem. In *Radiocarbon and Indian Archaeology.* D. P. Agrawal and A. Ghosh eds. 154–162. Bombay: TIFR.

Ghose, B., Kar, A. and Husain, Z. 1979. The Lost Courses of the Saraswati River in the Great Indian Desert: New Evidence from Landsat Imagery. *The Geographical Journal.* 145 (3); 446–451.

——, 1980. Comparative Role of the Aravalli and the Himalayan River Systems in the Fluvial Sedimentation of the Rajasthan Desert. *Man and Environment.* 4; 8–12.

Ghosh, A. 1952. The Rajputana Desert—its Archaeological Aspect. *Bulletin of the National Institute of Sciences of India.* 1; 37–42.

——, 1965. The Indus Civilization. Its Origins, Authors, Extent and Chronology. In *Indian Prehistory. 1964.* V. N. Misra and M. S. Mate eds. 112–156. Poona: Deccan College.

——, 1979. De-Urbanisation of the Harappa Civilization. In the Conference on *The Harappan Civilization: A Contemporary Perspective*, Srinagar: AIIS.

Goudie, A. S., Allchin B. and Hegde, K. T. M. 1973. The Former Extensions of the Great Indian Sand Desert. *The Geographical Journal.* 139 (2); 243–257.

Gupta, S. P. 1971–72. OCP and NBP: 1971. *Puratattva.* 5; 7–8.

——, 1978. Origin of the Form of Harappa Culture: A new Proposition, *Puratattva.* No. 8 (1975–76) 141–46.

——, 1979. The Late Harappa: A Study in Cultural Dynamics. In the Conference on *The Harappan Civilization: A Contemporary Perspective.* Srinagar: AIIS.

Gupta, S. P. and Ramachandran, K. S. 1977 *Mahabharata: Myth and Reality*, Agam Prakashan, New Delhi. Introduction, pt. II, by Gupta.

Indian Archaeology—A Review (I. A. R.) Annual Publication of the Archaeological Survey of India since 1954. New Delhi.

Jansen, M. 1980. Settlement Patterns in the Harappan Culture. In *South Asian Archaeology*. H. Hartel ed.. 251–269. Berlin: Dietrich Reimer Verlag.

Jarriage, J. F. 1979. Excavations at Mehrgarh (Baluchistan): Their Significance for Understanding the Background of the Indus Civilization. In the conference on *The Harappan Civilization: A Contemporary Perspective*. Srinagar: AIIS.

Jarrige, J. F. and Enault, J. F. 1973. Recent Excavation (French) in Pakistan. In *Radiocarbon and Indian Archaeology*. D.P. Agrawal and A. Ghosh eds. 163–172. Bombay: TIFR.

Jarrge, J. F. and Lechevallier, M. 1979. Excavations Mehrgarh, Baluchistan: Their Significance in the Prehistorical Context of the Indo-Pakistani Borderlands. *South Asian Archaeology* 1977. 463–535. Naples.

Joshi, J.P. 1972a. Exploration in Kutch and Excavation at Surkotada. *Journal of the Oriental Institute* 22 (1–2); 98–144.

——, 1972b. Fresh Light on the Archaeology of Kutch. In *Archaeological Congress and Seminar Papers*. S.B. Deo ed. 21–35. Nagpur: Nagpur University.

——, 1974. Surkotada: a Chronological Assessment. *Puratattva* 7; 34–38.

——, 1978a. Overlap of the Late Harappan Culture and Painted Grey Ware Culture in the Light of Recent Excavations in Haryana, Punjab and Jammu. In the Seminar on *Indus Civilization: Problems and Issues*. Simla: IIAS.

——, 1978b. Interlocking of Late Harappa Culture and Painted Grey Ware Culture in the Light of Recent Excavations. *Man and Environment*. 2; 98–100.

——, 1981. Movement of Harappans in Circa Third and Second Millennium B.C. *Man and Environment* 5; 64–66.

Joshi, J. P. and Madhu Bala. 1979. Manda—A Harappan Site in Jammu and Kashmir. In the Conference on *The Harappan Civilization: A Contemporary Perspective*. Srinagar: AIIS.

Khan, F. A. 1965. Excavations at Kot Diji. *Pakistan Archeology*. 2; 1–85.

Lal, B. B. 1954–55. Excavations at Hastinapura and other Explorations in the upper Ganga and Sutlej Basins. *Ancient India*. 10–11: 5–151.

——, 1968. A Deluge? Which Deluge? Yet another Facet of the Copper Hoard Culture. *American Arthropologist*. 70; 857–863.

——, 1971–72. A Note of the Excavation at Saipai. *Puratattva*. 5; 46–49.

——, 1977. Kalibangan's Contribution to the Understanding of the Indus Civilization. In the Seminar on *Indus Civilization: Problems and Issues*. Simla: IIAS.

——, 1979a. Kalibangan and the Indus Civilization. In *Essays in Indian Protohistory*. D. P. Agrawal and D. K. Chakrabarti eds. 65–97. Delhi: B. R. Pub. Corp.

——, 1979a. West was West and East was East, But When and How did the Twain Meet? The Role of Bhagwanpura as a Bridge between Certain Stages of the Indus and Ganges Civilizations. In the Conference on *The Harappan Civilization: A Contemporary Perspective*. Srinagar: AIIS.

——, 1981. The Two Indian Epics vis-a-vis Archaeology. *Antiquity*. 55; 27–34.

Lal, B. B. and Thapar, B. K. 1967. Excavation at Kalibangan: New Light on the Indus Civilization. *Cultural Forum*. 34; 78–88.

Lambrick, H. T. 1967. The Indus Flood Plain and the 'Indus' Civilization. *The Geographical Journal*. 133 (4); 483–495.

Madhu Bala. 1978. A Survey of the Proto-Historic Investigation in Punjab and the Emergent Picture. *Indian Anthropologist*. 8 (2); 89–118.

——, 1981. Recently Explored Sites in Punjab. *Man and Eviron-ment*. 5; 67–69.

Marshall, Sir John. 1931. *Mohenjo-daro and the Indus Civilization* (3 Volumes). London: A Probsthain.

Misra, V. N. 1961. Palaeolithic Culture of Western Rajputana. *Bulletin of the Deccan College Research Institute*. 21; 85–156.

——, 1968. Early Village Communities of the Banas basin, Rajasthan. In *Anthropology and Archaeology: Essays in the Memory of Verrier Elwin*. M. C. Pradhan *et al* eds. 295–310. Bombay: Oxford University Press.

——, 1971. Two Late Mesolithic Settlements in Rajasthan—a Brief Review of Investigations. *Journal of the University of Poona* (Humanities section). 35; 59–77.

——, 1973a. Bagor—A Late Mesolithic Settlement in North-West India. *World Archaeology*. 5 (1); 92–110.

——, 1973b. Problems of Palaeo-ecology, Palaeo-climate and Chronology of the Microlithic cultures of North-West India. In *Radiocarbon and Indian Archaeology*. D. P. Agrawal and A.

Ghosh eds. 58–72. Bombay: TIFR.

——, 1976. Ecological Adaptations during the Terminal Stone Age in Western and Central India. In *Ecological Backgrounds of South Asian Prehistory*. K. A. R. Kennedy and G. L. Possehl eds. 28–51. Cornell: Cornell University.

——, 1977. Prehistory and Palaeo-environment of Rajasthan. In *Ecology and Archaeology of Western India*. D. P. Agrawal and B. M. Pande eds. 31–54. Delhi: Concept.

Misra, V. N.; Rajaguru, S. N.; Agrawal, D. P.; Thomas, P. K.; Husain Z. and Datta, P. S. 1980. Prehistory and Palaeo-environment of Jayal, Western Rajasthan. *Man and Environment*. 4; 19–31.

Misra, V. N.; Rajaguru, S. N.; Raju D. R.; Raghavan, H. and Gaillard, C. 1982a. Acheulian Occupation and Evolving Landscape around Didwana in the Thar Desert, India. *Man and Environment*. 6; 72–86.

Misra, V. N.; Rajaguru, S. N.; Wasson, R. J.; Singh G. and Agrawal, D. P. 1982b. Further Light on Lower Palaeolithic Occupation and Palaeo-environment in Semi-Arid Zone of Rajasthan. *Puratattva*. 10.

Mughal, M. R. 1970. The Early Harappan Period in the Greater Indus Valley and Northern Baluchistan. Unpublished Ph. D. Dissertation; Department of Anthropology, Philadelphia: University of Pennsylvania.

——, 1972. A Summary of Excavations and Explorations in Pakistan. *Pakistan Archaeology*. 8; 113-158.

——, 1973a. *Present State of Research on the Indus Valley Civilization*. Karachi: Department of Archaeology.

——, 1973. Explorations in Northern Baluchistan, 1972: New evidence and Fresh Interpretation. Paper presented at the Second Annual Symposium on Archaeological Research in Iran.

——, 1974. New evidence of Early Harappan culture from Jalilpur, Pakistan. *Archaeology*. 27; 106–113.

——, 1980. The Early Harappan Cultural Phase: A Reply. *Puratattva*, 9; 84–88.

——, New Archaeological Evidence from Bahawalpur. In *Indus Civilization: New Perspectives*. A. H. Dani ed. 33–42, Islamabad: Quaid-i-Azam University.

Oldham, C. F. 1874. Notes on the Lost River of the Indian Desert.

Calcutta Review. 59; 1–27.

——, 1893. The Saraswati and the Lost River of the Indian Desert. *Journal of the Royal Asiatic Society*. 1893. 49–76.

Oldham, R. D. 1886. On Probable Changes in the Geography of the Punjab and its Rivers: an Historico-Geographical Study. *Journal of the Asiatic Society of Bengal*. 55; 322–343.

Pal, Y.; Sahai, B.; Sood R. K. and Agrawal D. P. 1980. Remote Sensing of the 'Lost' Sarasvati River. *Proceedings of the Indian Academy of Sciences* (Earth Planetary Science). 89 (3); 317–331.

Pande, B. M. 1977. Archaeological Remains on the Ancient Saraswati. In *Ecology and Archaeology of Western India*. D. P. Agrawal and B. M. Pande ed. 55–59. Delhi: Concept.

Piggott. Stuart 1950. *Prehistoric India to 1000* B.C. Harmondsworth (Middlesex): Penguin Books.

Possehl. G. L. 1967. The Mohenjo-daro Floods: A Reply. *American Anthropologist*. 69 (1); 32–40.

——, 1979. ed. *Ancient Cities of the Indus*. New Delhi. Vikas.

——, 1980. *Indus Civilization in Saurashtra*. Delhi: B. R. Publishing Corporation.

Raikes, R. L. 1964. The End of the Ancient Cities of the Indus. *American Anthropologist*. 66 (2); 284–299.

——, 1968. Kalibangan: Death from Natural Causes. *Antiquity*. 42 (168); 286–291.

Raikes, R. L. and Dyson Jr., R. H. 1961. The Prehistoric Climate of Baluchistan and the Indus Valley. *American Anthropologist*. 63 (2); Pt. I; 265–281.

Ramaswamy, C. 1968. Monsoon over the Indus Valley during the Harappan Period. *Nature*. 217 (5129); 628–629.

Rao, S. R. 1963. Excavations at Rangpur and other Explorations in Gujarat. *Ancient India*. 18–19 (1962 and 1963); 5–207.

——, 1973, *Lothal and the Indus Civilization*. Bombay: Asia Pub. House.

——, 1979. New Light on the Post-Urban (Late Harappan) Phase of the Indus civilization in India. In a conference on *The Harappan civilization: A Contemporary Perspective*. Srinagar: AIIS.

Sahni, D. R. *Archaeological Remains and Excavations at Sambhar during Samvat 1993 and 1994 (1936–37 and 1937–38* A.D.) Jaipur: Directorate of Archaeology and Historical Research.

Seth, S. K. 1978. The Dessication of the Thar Desert and its

Environs During the Protohistorical and Historical Periods. In *The Environmental History of the Near and Middle East.* William C. Brace ed. 279–305. London: Academic Press.

Shaffer, J. G. 1978. *Prehistoric Baluchistan.* Delhi. B. R. Pub. Corp.

——, 1981. The Protohistoric Period in the Eastern Punjab: A Preliminary Assessment. In A. H. Dani ed. *Indus Civilization: New Perspectives.* pp. 65–102. Islamabad: Quaid-i-Azam University.

Sharma, Y. D. ed. 1971–72. OCP and NBP: 1971. (Proceedings of the Seminar held by the Indian Archaeological Society, on 11 May 1971, at the National Museum, New Delhi, on Ochre Coloured Ware and Northern Black Polished Ware). *Puratattva.* 5; 1–83.

——, 1976. Transformation of the Harappa culture in the Punjab. In *Archaeological Congress and Seminar.* U. V. Singh ed. 5–15. Kurukshetra: Kurukshetra University.

——, 1977. Bara and the So-called Late Harappa cultures of Punjab. In the Seminar on *Indus Civilization: Problems and Issues.* Simla: IAAS.

Singh, G. 1971. The Indus Valley Culture (Seen in the Context of Post-Glacial Climate and Ecological Studies in North-West India). *Archaeology and Physical Anthropology in Oceania.* 6 (2); 177–189.

Singh, G.; Joshi, R. D.; Chopra, S. K. and Singh, A. B. 1974. Late Quaternary History of Vegetation and Climate of the Rajasthan Desert, India. *Philosophical Transactions of the Royal Society of London* (Biological Sciences) 267 (889); 467–501.

Singh, U. V. 1977. Late Harappan Culture as revealed by the Excavations at Mirzapur and Daulatpur, District Kurukshetra (Haryana). In the Seminar on *Indus Civilization: Problems and Issues.* Simla: IIAS.

Stein, Sir Aurel. 1931. An Archaeological Tour of Gedrosia. *Memoirs of the Archaeological Survey of India.* 43. New Delhi: Government of India Press.

——, 1942. A Survey of Ancient Sites along the 'Lost' Sarasvati River. *The Geographical Journal.* 99 (4); 173–182.

Suraj Bhan. 1971–72a. Siswal: A Pre-Harappan Site on the Drishadvati Valley. *Puratattva.* 5; 44–46.

——, 1971–72b. OCP and NBP: 1971. *Puratattva.* 5; 16–21.

——, 1972. Changes in the Course of Yamuna and their Bearing

on the Protohistoric Cultures of Haryana. In *Archaeological Congress and Seminar Papers*. S. B. Deo ed. 125–128. Nagpur. Nagpur University.

——, 1973. The Sequence and Spread of Prehistoric Cultures in the Upper Saraswati Basin. In *Radiocarbon and Indian Archaeology*. D. P. Agrawal and A. Ghosh eds. 252–263. Bombay: TIFR.

——, 1975. *Excavations at Mitathal (1968) and other Explorations in the Sutlej-Yamuna Divide*. Kurukshetra: Kurukshetra University Press.

——, 1977. The Protohistoric settlement pattern in Haryana. In the Seminar on *Indus Civilization: Problems and Issues*. Simla: IIAS.

Suraj Bhan and Shaffer, J. G. 1978. New Discoveries in Northern Haryana. *Man and Environment*. 2; 59–68.

Thapar, B. K. 1973a. Synthesis of the Multiple Data as obtained from Kalibangan. In *Radio-carbon and Indian Archaeology*. D. P. Agrawal and A. Ghosh eds. 264–271. Bombay TIFR.

——, 1973b. New Traits of the Indus Civilization at Kalibangan: an Appraisal. In *South Asian Archaeology*. N. Hammond ed. 85–104. Park Ridge: Noyes Press.

——, 1975. Kalibangan: A Harappan Metropolis Beyond the Indus Valley. *Expedition*. 17 (2); 19–32.

——, 1977. Climate during the period of the Indus Civilization: Evidence from Kalibangan. In *Ecology and Archaeology of Western India*. D. P. Agrawal and B. M. Pande eds. 67–73. Delhi: Concept.

——, 1981. The Mosaic of Indus Civilization beyond the Indus Valley. *In Indus Civilization: New Perspectives*, A. H. Dani ed. 55–64. Islamabad: Quaid-i-Azam University.

Thomas, P. K. 1975. Role of Animals in the Food Economy of the Mesolithic Culture of Western and Central India. In *Archaeological Studies*. A. T. Clason ed. 322–328. Amsterdam: North-Holland.

Vishnu-Mittre. 1972. Palaeobotany and the Environment of Early Man in India. In *Archaeological Congress and Seminar Papers*, S. B. Deo ed. 206–212. Nagpur: Nagpur University.

——, 1978. Palaeo-ecology of the Rajasthan Desert during the Last 10,000 Years. The *Palaeobotanist*. 25; 549–558.

Vishnu-Mittre and Savithri, R. 1979. Food Economy of the Harappans. In the Conference on *The Harappan Civilization: A Con-*

temporary Perspective. Srinagar: AIIS.

Wheeler, Sir Mortimer. 1953. *The Indus Civilization*. Cambridge: Cambridge Press.

——, 1961. Ancient India: The Civilization of the Sub-Continent. In A. Piggott ed. The *Dawn of Civilization*. pp. 229–252. London: Thames and Hudson.

——, 1968. *The Indus Civilization*. 3rd. Edition. Cambridge: Cambridge University Press.

Appendix 4

REMOTE SENSING OF THE 'LOST' SARASVATI RIVER

By
YASH PAL, BALDEV SAHAI, R. K. SOOD AND D. P. AGRAWAL

The area lying between the rivers Indus and Ganga has been the cradle of many important civilizations. The availability or lack of waters in the rivers flowing in this region determined the growth or decay of these civilizations. The river Sarasvati is said to have been a mightier river than even the Indus in the Vedic and pre-Vedic times. Stein (1942) refers to the fact that in at least three passages in the *Rigveda*, the oldest surviving record in any Indo-European language, a river course has been mentioned which corresponds to the present Sarsuti (Sarasvati) and Ghaggar. *Nadistuti*, the famous hymn, describes the Sarasvati as flowing between the Yamuna in the east and the *Satudri* (Satluj) in the west. Since none of the present rivers obviously fits in with this description, the appellation 'lost' Sarasvati has often been applied to this once mighty historical river.

There is considerable literature on the subject trying to identify the Sarasvati and to explain the desiccation of this region. A variety of hypotheses, often conflicting, have been put forth by various scholars like Oldham (1874), Krishnan (1952), Wadia (1975), Singh (1952), Stein (1942) and Indras (1967). Inadequacy of data has obviously lent itself to a variety of interpretation. To have a fresh look at the problem, Landsat imagery has been used for delineating the palaeo-channels of the Satluj, the Yamuna and the Sarasvati so as to unravel the mystery of the 'lost' Sarasvati. We find that the Landsat imagery with the synoptic views provides quite clear evidence for the delineation of the palaeo-channels and hence the course of the Sarasvati.

Techniques

The present study is essentially based on visual interpretation of the Landsat imagery pertaining to the period 1972–77, in a variety of forms and formats. The imagery used here comprises multispectral scanner (MSS) data in four spectral bands (0.5–0.6, 0.6–0.7, 0.7–0.8 and 0.8–1.1 um). In the interpretation of this imagery the enhancement techniques comprising enlargements, colour comprises prepared by colour additive viewer and the Diazo technique, density slicing, grey scale conversion, contrast stretching, band ratioing, using both the diapositives as well as the negatives, have been used (Sood *et al* 1978).

Apart from black-and-white paper prints and their mosaics, the negatives and diapositives in 70-mm and 23-cm format were enlarged to 1:250,000 scale topographical maps supplied by the Survey of India.

The palaeo-channels, in most of the cases, stand out clearly because of the vegetation patterns on their beds. In other cases, the enhancement techniques help in delineating such channels.

Since the Landsat images any scene on the earth's surface every 18 days, a comparison of multidate imagery helped in making use of the seasonal effects also in demarcating these palaeo-channels.

River Systems

The present river systems of the Satluj-Yamuna Divide which have a bearing on the subjects are the Satluj, the Ghaggar, the Sarasvati, the Markanda, the Chautang, the Yamuna and their tributaries.

The rivers Satluj and Yamuna are perennial rivers, rising from the Himalayas and fed by glaciers. The rivers Ghaggar, Sarasvati, Markanda and Chautang all rise from the Siwalik Hills and are non-perennial. They flow mainly during the monsoon. At present none of them reaches the sea or joins any major river as a tributary.

These river systems can be grouped into two main systems: (i) The Satluj System, and (ii) The Ghaggar System.

The Satluj System

Rising in the Himalayas, the present Satluj River takes a sharp, almost right-angled, turn to the west near Ropar. It continues to flow westward for more than 150 km and is then joined by the Beas, which comes from the northeast, near Harike. Only after this con-

fluence the Satluj turns southwest.

The study of Landsat imagery brings out the following:

(i) The sharp westward right-angled bend in the course of the Satluj is suggestive of its diversion in the past, as at the point of river capture or stream diversion similar elbows develop. No physical obstruction has been reported which could be responsible for this diversion.

(ii) There is a sudden widening of the Ghaggar Valley about 25 km south of Patiala which is obviously a misfit if we take into account the considerably narrow bed of the Ghaggar upstream. This sudden widening can be explained only if a major tributary was joining the Ghaggar at this place. The satellite imagery does show a major palaeo-channel joining the Ghaggar here.

Thus we see that both the sudden diversion of the Satluj westward and the abrupt widening of the Ghaggar bed south of Patiala can be explained only if we assume that the Satluj was coming through the palaeo-channel into the Ghaggar system at some point of time in the past. Our observations are supported by the field data of Singh (1952) who mentions a channel starting near Ropar and leading towards Tohana (29° 3-5N, 75° 5-5E).

The area along this old course of the Satluj is called 'dhaia' meaning an upland or a high bank (Singh 1952).

For the diversion of the Satluj three main causes could be responsible:

(i) Tectonic uplift which forced the Satluj to abandon its channel and to start flowing westward.

(ii) Capture of the Satluj by a tributary of the river Beas through headward erosion; and

(iii) Existence of a fault through which the Satluj diverted.

The physiography of the region shows that there is a depression westward (elevation less that 230 m) of the old Satluj bed and a corresponding uplift eastward (elevation more than 250 m). This may have gradually forced the Satluj to flow through its present channel. It is amply demonstrated by the multitude of small channels into which the Satluj braided till it found its present channel. If one examines the old bed of the Ghaggar (Sarasvati) it shows a peculiar feature: it tends to flow along straight lines joined together at sharp angles. Obviously, this reflects a structural control as the old Ghaggar seems to have flowed into an unstable channel controlled by the

lineaments, probably enechelon faults. It might have required only a little tectonic movement to disturb its previous course and force it into its present channel.

Our studies thus show that the Satluj was the main tributary of the Ghaggar and that subsequently the tectonic movements may have forced the Satluj westward and the Ghaggar dried.

Wilhelmy (1969) considered the second alternative, *i.e.*, river capture. The Satudri might have been a tributary of the Vipasa (Beas) and through headward erosion captured the waters of the river coming down the Himalayas near Ropar. Tectonic movements may have aided the river capture.

The braiding of Satluj seems to have been echoed in a legend related in the *Mahabharata* which says that when Vasishtha threw himself into the Satluj to commit suicide the river broke up into a hundred channels (Oldham 1874).

We have also examined the Landsat imagery of the Indus system and it appears that the confluence of the Satluj with the Indus may not be an ancient feature. The palaeo-channel of the river Beas, which is quite conspicuous in Landsat imagery, joined the Indus independent of the Satluj. There is a distinct palaeo-channel which seems to suggest that the Satluj flowed through the Nara directly into the Rann of Kutch.

The Ghaggar System

We summarise below our observations on the Ghaggar system from the analysis of Landsat imagery.

(i) The ancient bed of the Ghaggar has a constant width of about 6 to 8 km from Shatrana in Punjab to Marot in Pakistan. The bed stands out very clearly having a dark tone in the black-and-white imagery and reddish one in false colour composites.

(ii) There is a clear palaeo-channel southeast of the river Markanda which joins the ancient bed of the Ghaggar near Shatrana Channel Y1 (1 and 2). The present Sarasvati mostly flows through this channel.

(iii) Another channel, Y2, which corresponds to the present Chautang seems to join the Ghaggar near Suratgarh.

(iv) Near Anupgarh the ancient Ghaggar bed bifurcates and both the palaeo-channels come to an abrupt end; the upper one terminates near Marot and the lower one near Beriwala.

These two terminal channels of the Ghaggar seem to disappear in a depression which is suggested by salt encrustation and the physiography of the area.

There is no indication of any palaeo-channel connecting the ancient Ghaggar with the Indus or the Luni.

Discussion

The vast expanse (6–8 km wide) of the Ghaggar bed can be explained only by assuming that some major tributaries were flowing into it in the past. It was mentioned earlier that at some point of time the Satluj was also flowing through it. The other major river system contributing waters to the Ghaggar may have been some prior channel of the Yamuna. The evidence regarding the palaeo-channels of the Satluj-Yamuna Divide can be interpreted in the following manner. The three palaeo-channels Y1, Y2 and Y3 represent courses of some sizable ancient river which flowed south-east of the river Markanda and into the Ghaggar or into the Chambal during different periods. Channel Y1 joined the ancient bed of Ghaggar, Channel Y2 flowed into Chautang (Drishadvati) and Channel Y3 flowed through the present course of the Yamuna down to Delhi and then connected the small lakes south-eastward, past Bharatpur, and finally-joined, probably, the Chambal. One could give this vagrant river the name of Palaeo-Yamuna. It would, therefore, mean that the Palaeo-Yamuna changed its course three times before assuming the present one. In the first instance it flowed through Channel Y1 into the ancient Ghaggar. Later on, it flowed through Channel Y2, which includes the present Chautang, and met the Ghaggar near Suratgarh. The third time it went southward and passed through the Channel Y3, joining the Ganga through the Chambal.

We are working with the archaeologists to date these episodes in the life of the Palaeo-Yamuna. The available data show that the Channel Y3 of the Palaeo-Yamuna was alive during the Painted Grey Ware (PGW) period (c. 800–400 B C.) as indicated by the distribution of the PGW sites on its banks (Gupta *et al* 1977). Both the Chautang and the Ghaggar beds have archaeological mounds on their banks (Pande 1977; Dikshit 1977).

The Ghaggar continued to be a living river during the pre-Harappan (*c.* 2500–2200 B.C.) and the Harappan times (*c.* 2200–1700 B.C.) (radiocarbon dates). Even during the PGW times, there is some

indication of habitation along the palaeo-channel, though the PGW mounds follow a very narrow river bed, perhaps indicating a dwindling water supply. The archaeological evidence for dating the Chautang is not very definite yet, though the late Harappan mounds along it appear to be a clear indication that it was a living river during at least the late Harappan times (*c.* 1700–1000 B.C.). Thus we see that during the last 5000 years or so the rivers of this area have changed their courses several times.

The history of these palaeo-channels seems to be fairly clear now, but there are still some lacunae in our knowledge as to the final date of the ancient Ghaggar. The satellite imagery seems to show as if it debouched into sea or a lake near Marot or Beriwala. But to bring the sea so far inland in the mid-Holocene times looks quite improbable. The work of Agrawal and Guzder (1972) and S. K. Gupta (1972) on the western coast shows that the magnitude of the mid-Holocene marine transgression was only of the order about + 5 metres from the present mean sea-level. Therefore we have to look for some other interpretation.

A profile of the land elevation shows that the Ghaggar ends in a depression: both westward and north-eastward the land elevation rises. For miles and miles around Marot one finds numerous place-names with a suffix *toba*, which in the local language means a *playa*. This area may have been turned into a large lake in the first instance but desiccation led to the formation of *playas*. It is obviously improbable for such a mighty river to vanish into a shallow depression in its heyday. There is, therefore, a good possibility that the Ghaggar flowed into the Nara and further into the Rann of Kutch without joining the Indus.

The chain of tectonic events which diverted the Satluj westward and the Palaeo-Yamuna south-eastward was perhaps also responsible for the subsidence near Marot and Beriwala into which the Ghaggar seems to have vanished. This alone can explain the 'death' of such a mighty river into a lake because its main feeders, the Satluj and the Palaeo-Yamuna, were weaned away from it by the Indus and the Ganga, respectively.

Raikes published a paper in *Antiquity* in 1968 on the vagrancy of the Yamuna. He explained the vagrancy of the Yamuna under the influence of *Coriolis* force. He tabulated six shifts of the Yumuna during the period 2500 B.C.-A.D. 500 giving exact dates. It is difficult to understand as to why Coriolis force should affect the river

Yamuna only and not other rivers around the world and why only during particular periods. We, however, feel the necessity of pointing out that the whole of the north-western India has to be taken into cosideration to understand the vagrancy of practically all the rivers in this region. The causes for this vagrancy lie in neotectonism shown by the enechelon nature of the structural control along the main river systems in this area. The evidence for neotectonism is very clear in the rock-cut terraces on the upper reaches of the Markanda, as pointed out by Rajaguru (1977). We have further evidence of earthquakes and abandonment of the site from the Kalibangan excavations (Lal 1979). The *Mahabharata* episode of Vashishtha mentioned earlier appears to be an echo of the same tectonism.

The short paper by Ghose *et al* (1980) about the fluvial sedimentation in the Rajasthan desert covers palaeo-channel configurations, their chronology and their relationship with the palaeoclimatic changes. Our detailed study of the satellite imagery, employing all the available techniques, has howerver not shown any palaeochannel which could join the river Luni with the old Ghaggar bed. We have thererfore given the original Landsat imagery mosaic so that our maps can be tallied with the observational data.

Conclusions

Palaeo-environmental changes in the north-western subcontinent have been caused by climatic, tectonic and anthropogenic factors. Tectonic factors assumed such overwhelming importance only because the major channels like those of the Sarasvati were structurally controlled by enechelon faults. It was because of this reason that even relatively minor tectonic movements caused considerable changes in the configuration of the palaeo-channels. The distribution of the archaeological sites was also determined by the vagrancy of these rivers.

As discussed above, during the period 4-5 millennia B. P. northwestern Rajasthan was a much greener place with the Sarasvati flowing through it. Some of the present rivers joined to make the Sarasvati a mighty river which probably discharged into the sea (Rann of Kutch) through the Nara, without joining the Indus.

We have thus shown that the Satluj flowed into the Ghaggar once. Some ancient version of the Yamuna (we termed it Palaeo-Yamuna) changed its course, at least three times, before joining the Ganga through its present course.

BIBLIOGRAPHY

Agrawal, D. P. and Guzder, S. 1972. *Palaeobotanist* Vol. 21, 216.

Dikshit, K. N. 1977. *Ecology and Archaeology of Western India*, eds. D. P. Agrawal and B. M. Pande (New Delhi: Concept Pub.) 61.

Ghose, B. Amal Kar and Zahid Husain 1980. *Man and Environment*, Vol. 4, 8.

Ghosh, A. 1952. *Bull Natl. Inst. Sci. India*, Vol. 1, 37.

Gupta, S. K. 1972. *J, Goel.* Vol. 80, 357.

Gupta, S. P., Shashi Asthana and Amarendra Nath 1977. *Ecology and Archaeology of Western India*, eds. D. P. Agrawal and B. M. Pande (New Delhi: Concept Pub.) 79.

Indras 1967. *Lost Sarasvati* (Vallabh Vidyanagar: Sardar Patel University).

Krishnan, M. S. 1952. *Bull. Natl. Inst. Sci. India*, Vol. 1, 19.

Lal, B. B. 1979. *Essays in Indian Protohistory*, eds. D. P. Agrawal and D. K. Chakrabarti (New Delhi: Concept Pub.) 65.

Oldham, C. F. 1874. *Calcutta review*, Vol. 59, 1.

Pande, B. M. 1977. *Ecology and Archaeology of Western India*, eds. D. P. Agrawal and B. M. Pande (New Delhi: Concent Pub.) 55.

Raikes, R. L. 1968. *Antiquity*, Vol. 42, 286.

Rajaguru, S. N. 1977. *Ecology and Archaeology of Western India*, eds. D. P. Agrawal and B. M. Pande (New Delhi: Concept Pub.) 70.

Schumm, S. A. 1971. *River Mechanics*, ed. H. W. Shen (Fort Collins: H. W. Shen) Vol. 1, 4–1.

Singh, Gurdev 1952. *The Geography*, Vol. 5, 27.

Singh S. and Ghose, B. 1977. *Ecology and Archaeology of Western India* eds. D. P. Agrawal and B. M. Pande (New Delhi: Concept Pub.) 135.

Sood, R. K., Baldev Sahai and Subramayam V. 1978. *Proceedings of symposium on Morphology and evolution of landforms* (Delhi: Department of Geology, University of Delhi) 131.

Stein, A. 1942. *Geographical Journal*, Vol. 99, 173.

Wadia, D. N. 1975. *Geology of India* (New Delhi: Tata McGraw-Hill) 52.

Whilhelmy, H. 1969. *Z. Geomorphol. Suppl.* Vol. 8, 76.

LIST OF CONTRIBUTORS

MAIN AUTHOR

Sir Aurel Stein

CONTRIBUTORS OF APPENDICES

1. A. Ghosh, Former Director-General, Archaeological Survey of India, New Delhi.
2. M. Rafique Mughal, Department of Archaeology, Pakistan, Lahore.
3. V. N. Misra, Joint-Director, Deccan College Post-Graduate and Research Institute, Poona.
4. Yashpal, Baldev Sahai, R. K. Sood and D. P. Agrawal C/o Physical Research Laboratory, Ahmedabad.

EDITOR

5. S. P. Gupta, Director, Allahabad Museum, Allahabad.