CONDITION REPORT ON MOENJODARO

By

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1987

Condition report on Mohenjo-Daro

According to the decision taken in July 1986 at Paris at the seventh meeting of the UNESCO Executive Board for the Safe- guarding of Mohenjo-Daro, a con- dition-report has to be carried out on the structural remains of Mohenjo-Daro. The author was asked to carry out this report with a team of experts. Team members:

- Prof. Dr. M. Jansen, Aachen, director
- Mrs. U. Franke, M.A., Berlin, archaeologist
- Mrs. A. Ardeleanu, Aachen, art-historian, architectural historian
- Prof. J. Bunse, Oldenburg, architect, specialist in preservation of architecture

-Dr. R. Oswald, Aachen, architect, specialist for preservation of architecture,

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History of research

The archaeological research carried out at Mohenjo-Daro since its discovery 1922 can be divided into six phases:

1. The initiative research under Sir John Marshall marked by large horizontal excavations during which most of the nowadays' visible structures in the northern citadel and the southern lower town with VS and HR area were excavated[1].
2. The research under Ernest H. Mackay after 1926 in DK-G area to trace the vertical extent of the site marked by a deep digging of more than 6 meters with more than 150.000 cubic meters excavated ground and marked by several test trenches outside the daro'£
3. The research under Sir Mortimer Wheeler 1950 in the west and south-east of the citadel to trace the fortification of Mohenjo-Daro[2]
4. remains[1]. The research of George Dales 1964-5 to study the slope situation west of HR area in the search for the port[3]
5. The research of the Aachen University Mission to Mohenjo-Daro from 1979 till

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'Marshall, Sir J. 1931

[2] Mackay, E.J.H. 1937

[3]Wheeler, Sir M. 1968

[4] Dales, G. 1965 New Investigations at Mohenjo-Daro. in: Archaeology 18/2:- 145-150

1987 which concentrated on the complete re-documentation of the excavated
6. The research of the joint Aachen University-IsMEO Rome Mission from 1983 till 1986 based on geophysical, geo-botanical surveys and surface analyses4, structurally resulting in the discovery of the supporting substructures today covered by the alluvium and a detailed study of the forma Urbis.

The interim results at present point towards a gigantic system of substructures which seem to have been erected in a perfectly planned manner to support the habitational zone on top. At least for the citadel area a mud brick platform 200x 400 m, nowadays approx. 7 m in the alluvium could be traced. With dry core drilling (Lerici) pure alluvium soil under the mud brick wail excavated by Wheeler could be reached at approx. 9m depth (40m alms). Research for the lower town is at present under operation (Cucarzi, Jansen).

With these results Mohenjo-Daro has become a unique research object in the world not only for bronze-age city planning but also for developing adequate analytical methods to deal with such an extraordinary structural phenomenon. The general structural study of such a site covering at least 800.000 m2 the lower part of which is covered by approx. 6-7 m alluvium of the river Indus can hardly be carried out anymore with conventional archaeological methods. Therefore new methods of exploration and prospecting were developed in the last years.

In 1982/83 the Aachen University Mission developed an unmanned hot air- balloon for taking aerial stereo photos, in 1983-85 tests with geophysical methods were carried out by IsMEO and this year the methods were finally improved with dry core deep-drilling, Pirckhauer subsurface-drilling, surface stripping and geo-botanical survey.

Starting with horizontal by-chance excavations in the early twenties Mackay continued 1927 with a systematic approach to build up a complete chronology without being able to reach virgin soil5.

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[5]Jansen , M. 1984 Preliminary Result of Three Year ‘ Documentation in Mohenjo-Daro in: Jansen , M. Urban, G. (eds) Documentation in der Archaeologie Aachen

Jansen , M. 1984 Architectural Remains in Mohenjo-Daro. In : Frontiers of the Indus Civilization .New Dehli

[6]see contributions of M. Cucarzi, M. Vidale and M. Halim and M. Tosi in: Jansen, M. Urban, G. (eds) 1984 Interim Reports vol.1.

[7]e.g: Jansen, M. 1985 Mohenjo-Daro city’ de I’ Indus. In: La Recherche 163/16:166-176 , Paris translated into English (Endavour) and into Italian (Sci-en Duemilla)

Cucarzi , M. 1984 Geophysical Investigation at Mohenjo-Daro city. In: Interim Re-ports Vol Aachen

A second attempt by Wheeler 1950 to reach the lowest levels also failed. Wheeler added to the already known structures of the citadel the "granary"6. Wheeler's search for the fortifications within the citadel area was not as successful as expected. He finally was unable to prove that Starting with horizontal by-chance excavations in the early twenties Mackay continued 1927 with a systematic approach to build up a complete chronology without being able to reach virgin soil7.

A second attempt by Wheeler 1950 to reach the lowest levels also failed. Wheeler added to the already known structures of the citadel the "granary"[8]. Wheeler's search for the fortifications within the citadel area was not as successful as expected. He finally was unable to prove that the discovered structure in the south-east of the citadel was, as discovered in Harappa 1946, the fortification. From nowaday's point of view his most important discovery was a big mudbrick wall west of the "granary" starting immediately below the surface (48.5m alms) and continuing down for more than seven meters[9].

Dales' attempt to build up a new chronology and to solve the problem of the sloping area west of HR was interrupted by the Pakistan- Indian war 1966. Though researching only for less than three months he collected excellent data which 1986 have been published[10].

With the Aachen University Project at Mohenjo-Daro a new typus of field studies was introduced in redocumenting already excavated structures of an archaeological site. In six years 300 house- units covering more than **100.000** sgm were redocumented, measured, photographed and levelled. The documentation was finally the basis

[8] Mackay's chronology consisted of three periods (early, middle and late) differentiated in to three phases (I, II, III) each based on a horizontal growth modei.

[9] All his unpublished plans of the excavation are due to the help of Dr. Hammond London and Professor Tosi, Rome available with the Aachen University Mission.

[10] Wheeler 1968:45

[11] Dales G.F., Kenoyer, J.M. 1986 Excavations at Mohenjo-Daro, Pakistan: The Pottery. Pennsylvania

for the study and interpretation of the threedimensional growth of architectural clusters[11] in relation to the distribution-

[12] Jansen M. 1984 Theoretical Aspects of Structural Analyses for Mohenjo-Daro. in ISterim Reports vol.1, Aachen
Jansen. M. 1986 House I, HR A a Temple? in: South Asian Archaeology 1983, Bruxelles

Tion of their excavated artifacts according to computer interpretation[12]. A further major step forward was undertaken, when the Government of Pakistan issued 1983 an additional licence to the joint Aachen University- IsMEO Rome Mission to Mohenjo-Daro to carry out surface surveys in the non-excavated areas, as well as geophysical and geobotanical surveys for further studies and to improve non-destructive methods of archaeological research. This research soon showed the huge potential of the archaeological site, both, on its unexcavated surface, and below it, clearly indicating that Mohenjo-Daro is a monument of unique importance which has to be protected not only its excavated parts but as whole including all archaeological and structural aspects.

Preservation-reports carried out up to present (see appendix II)

The on the physical preservation of walls carried out up to present by experts (see appendix II and selected bibliography) dealt with the problems of conservation in general, differentiated according to:

- rise of humidity in walls
- affection through salts
- erosion forms
- problems of standing water in the ruins after rains

Executed conservation programs: their results and their problems

The main conservation measures being applied till today (according to the report submitted by the Government of Pakistan UNESCO/MO/EX-VHI/3:5): 1. Conservation of remains (to keep them in the condition they are without any adding)

Ad 1 The main applied conservation methods are:

1.1 underpinning of endangered walls
1.2 provision of horizontal and vertical damp proof courses (DPC)
1.3 Brick work on edge flooring in the rooms of the houses.
1.4 Mud brick capping of excavated walls.
1.5 Removing and replacing salt affected soil with sweet earth and river sand.

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[13] Jansen, M. Urban, G. 1985 Mohenjo-Daro. Data Collection vol 1, Fieldbooks and Concordance of HR Area. Leiden, Brill

1.6 Making sound and proper drainage arrangements for rain water all over the sites.

1.7 Removal of debris lying adjacent to the excavated remains.

2.1 Replacing and exchange of bricks in still existing walls, specially in the bottom part (during the process of introduction of DPC) and on the top of the walls.

2.2 Consolidation of wall tops with bricks in cement mortar

According to this condition report following comments on the execution of the different points can be made:

In addition to the conservation measures also restoration measures have been carried out

2. restoration (to replace destroyed parts by areconstruction)

Ad 2 The main applied restoration methods are:

2.3 Re-building of collapsed walls

ad 1. The underpinning has to be carried out in a bonding method with the remaining wall. Otherwise the underpinned part will bulge out after a short period.

adl .2 With the introduction of DPC the rising water capillarity should be stopped.

The cra~.mon method applied, is to introduce bitumen coated concrete slabes — rbe vails, in removing ca. 5 layers of bricks to enable proper installat-

results in the destruction of a part of the wall, In some cases, wholes which had been broken in the walls had not been refilled again, enfourcing the deterioration of the wall. To avoid further destruction more sensitive cutting devices should be introduced to bring in the DPC, which should be a PUR or polymere sheet. Almost everywhere, the DPC has been installed at a wrong height (that means: ca. 50 cm- 100 cm above ground.) instead of placing it much lower (see also in: Clifton 1980:fig 1). A DPC above ground results in the extraordinary high concentration of salts and humidity below the DPC, causing the even faster destruction of this part of the wall which finally tilts as a whole (see e.g. Clifton 1980:4, report of R. Oswald app.3). The proposal by UNESCO (e.g. Clifton 1980:7) to introduce vertical DPCs lead to serious destructions in unexcavated ground and partly to even faster deterioration of structures.

Adl .3 A brick work on edge flooring inside rooms might not be advisible as non- experts might think of the flooring being original. Already the brick paving in the streets creates confusion as no street originally was paved with bricks

Ad 1.4 This method, already introduced in the 50th has been one of the most effective ones. Walls protected by mud-coating deriving from mud capping (floating of mud after rains) show an excellent state of preservation[1] *.

Ad 1.5 The removing of salt affected soil should be concentrated only on the uppermost layers which are already in secondary position to avoid the penetration in archaeological ground. One never should forget that original archaeological layers to be protected as a part of the monument Mohenjo-Daro are continuing immediately below the surface!

Ad 1.6 The draining of rain water inside the ruins is besides the protection of the walls against the rising humidity one of the most important measures to be undertaken. Specially in depressions like DK-G which in the lowest part is only 47m amsl, water collects after rains like in a mud hole and creates heavy, destruction. Here an outlet (if possible through a drain along first street to the north of DK-G which is connected with the channel) for the standing water has to be arranged.

For each other sites (100.000 sqm1) a net of inter connected drains has to be planned which allows a proper draining without mayor destruction of archaeological ground.

Ad. 1.7 Archaeologically speaking, it is extremely difficult (as can be studied in already "cleaned" areas of Mohenjo-Daro) to remove debris of former excavations, as, after the many years, it is hardly possible to differenciate between primary and secondary deposits. Only by careful studies of the topographic change between the original (1925) topographic map (Francis map) and the latest (1968) topographic map (Wanzke Plan) the deposit mounds can be traced. A plan (Khan 1970:opp. page 40) showing the mounds of debris is partly wrong. It therefore has to be reviced if further debris should be removed.

[14] Therefore it is advisable to rethink Cliftons comment (1980:4) that the discolouring by mud film on the walls is felt to be aestetically unacceptable. Scientifically speaking, most of the walls originally were covered by a mud coating.

Ad 2.1 The rebuilding of collapsed walls is a tradition which goes back to the twenties (e.g. Urban, Th 1983). Not only the Great Bath in its whole western part (about 40% of the structure) had been conject- urally reconstructed by Marshall in 1926, but also the Buddhist monastry. In the early 50th Mayor parts of walls in the First Street and HR- area were replaced by new ones. Often the nasons did not follow the original pattern as can be proved by the older original photographs. The tradition of rebuilding walls is even practiced today. The restoration should be executed according to the original structure. Therefore in each case a study is advicable and a drawing should show how the walls have to be reconstructed. Ad 2.2 The same accounts for the replacing of bricks in walls, as the bonding technique is an important indicator for the archaeologist to date a wall.

Ad 2.3 The consolidation of wall tops with bricks layed in a mixed cement- lime mortar is basically very successful. It is advisable to keep a natural "ruinous" silhouette instead of a straight one and the visitors off the walls.

If one goes through the different reports of UNESCO experts dealing with the preservation of the archaeological remains, somehow one is missing, besides a comment on the importance of the archaeological site as a whole, including the nan excavated areas, horizontally as well as vertically, a detailed study in situ a£ the areas to be treated, and a systematic approach towards specific treatments according to different physical conditions (see the report of R. Oswald app. Ill)

The problem in principle

Caases of deterioration[13] can be differentiated according to
Intrinsic and extrinsic ones.

[15] According to Angelis d'Ossat, Rome 1972

Extrinsic causes

Nature action. **Human action**

Prolonged	**occasional**	**environment**	**conformation**
Physical	do	vibration	variation of
Chemical	do	botanical	original part.
Botanical	do	sociological	destruction mechanical
Biological	do		

For an optimal treatment of the site a long- term observation of the different agents and their influence in the destructive forces has to be carried out. Different observations regarding climatic changes, salt concentration in the ground-water etc. are already carried out through the local laboratory. These observations should be extended to a systematic and complete observation concept, carried out regularly according to e.g. the above mentioned "intrinsic- extrinsic" causes diagrams.

The optimal treatment of the site is dependant from different parameters of these diagrams.

A simplified version shows the relation between the chemical agent (mostly the sodium sulphate mineral phase thenardite) which under specific climatic conditions (see below) and with the help of water destroys mechanically the building material (here burnt bricks).

Chemical agents

Warter (soil) climate

Building material

As J. Clifton (1980:5) has already shown, the main destruction agent is the sodim sulphate mineral thenardite[14] after hydration reaction. U. Ludwig came 1983 to the same results after a brick had been analysed at Aachen University (Ludwig, U. 1983).

According to Ludwig (1983: Abb. 15) the christallisation pressure is at 32.38° C =0 and increases in lower temperatures (and not in higher ones as mentioned by Cliftqn (1980:5)

The hydration reaction is dependant from 1: temperature and 2. humidity.

Even in winter and early spring heavy dew occurs in the morning

hours where the temperature can fall down to 0° C. As this is a dayly repeating

[16] Not the thenadire (Na_2 So^4) but the mirabilite (Na_2 So^4) 10 H_2O) is the destructive agent.

situation, this seems to be the most dangerous situation.

If we differentiate the process we come to the following results:

1. The destruction of bricks is the primary danger for Mohenjo-Daro
2. This destruction mainly takes place through a specific mineral phase of the sodium sulphate under specific climatic conditions.

3 The sodium sulphate in the bricks is in secondary position.

To conserve the archaeological structures, therefore, two measures have to be undertaken:

1. to avoid further transport of salts in the remains
2. to remove the existing salts from their secondary position

A further protection against other agents and further consolidation of weak material is another question which cannot be dealt with here. Measures which have been undertaken up to now to avoid further salt transport into the bricks:

1.1 Lowering of the water-table

1.2 installation of damp proof courses

1.3 Treatment of bricks with chemicals for consolidation purpose

1.4 Exchange of salty soil

1.5 Plantation of trees (not yet executed) I. £ Draining of areas after rain

1.6 Draining of areas after rain

The water plays an extraordinary role in the whole process. At first it transports trie salts, not only from the lower underground levels, but also from the core of the structures to their surface. And secondly acts the water as main agent in the changing of the mineral phase from thenardite to mirabilite which finally causes the destruction. As Ludwig could show (1983:Tab.5) there is a clear concentration of salts near the surface.

While further transport of water through rising capillarity can be controlled, the influence of dew on the surface is hardly controllable. And this water source seema to be the most dangerous one, as it forms the mirabilite. If we pinpoint actions as close as possible to the parts to be treated we can differentiate at a wall 1. teh parts in direct contact with the soil from where the T»»-»—j actions comes and 2. The surface, where the salts concentrate and from where the dew and rain can enter the wall.

Is the problem of stopping water-transport already recognized in principle within jam wails and from earth contact-zones Into the walls, the problem of the wall surface with its salt concentrations and water penetration mainly through dew

Hardly has been recognized.

As there is no technical adequate solution (specially for the enormous amount of 50 km! of walls) either to avoid evaporation of water from the inside of the bricks on their surface or to avoid the penetration of water (dew or rain) into the brick, there seems to be only on possible solution for the time being: to change the surface of the walls by clay packing[15] during specific periods of the year where the site is most endangered.

This has a double effect: the salts chrystallize not on the brick- surface but on the clay surface and the clay- packing can be used at the same for the leaching of salts. A regular exchange of the clay- packing results in reuction of salts under the condition that no further salt is transported into the wall.

The qualitative- quantitative condition report[16] 1987

Based on the documentary prepared by ARPM RWTH and in close cooperation with the Pakistani authorities involved, an adequate analysis of the structural remains of Mohenjo-Daro could be executed and maps be prepared showing the state of condition wall by wall (appendix IV).

Besides the mapping of the wall conditions some smaller tests on the applicability of mud-packings for the extracting of salts on the surface and subsurface could be carried out with the representative of the chemical laboritory Mohenjo-Daro. The analysis of the structural remains

Due to the shortage of time and finances it was decided to prepare preliminary maps of the different excavated areas marking the following criteria:

- structures which have been treated
- structures which are still endangered
- horizontal DPCs
- vertical DPCs

The Condition Report is based on the parameters: 1. treated walls, 2. endangered walls.

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[17] J. Bunse made some tests with different clay packings in cooperation with the site laboratory at Mohenjo-Daro. The best results were obtained with a sand- tempered or straw- tempered packing which has to be kept slightly moist.

[18] This report is based on a set of maps (appendix 1) of all excavated remains documented by the Aachen Research Project Mohenjo-Daro carried out from 1979 till 1985.

Area	size (sqm)	treated	untreated
Akropolis			
Sd-Arae	16.500	14.000	2.500
L-Area	6.400	-	6.400
Lower City			
Dk-G area	28.000	21.500	6.500
Dk-A,B,C area	12.200	-	12.200
VS-area	13.000	12.500	500
Moneer-area	7.200	2.800	4.400
HR-area	20.600	18.000	2.600
UMP site	2.000	-	2.000
Total	105.900	68.800	37.100
%	100	65	35

All in all ca. 300 house-unite can be counted.

The calculated total length of all excavated walls comes to apper. 50.000 meters (50 kmor 350 miles).

Future analyses to be carried out

Besides the UNESCO guidelines for preservation following priorities for mohen-jo-daro can be formulated :

-original structures should be treated first

-from the original structures those heaviest effected should be treated first

-structures original or not within the major attraction zones should be also treated with priority.

Therefore the complete condition report should include:

1. mapping of original –non original structures of all parts excavated

2. mapping of the physical conditions of each structures differentiated according to foundation , middle part of wall, top part of wall

3. mapping of the concentration of humidity in the different part of the walls during the year

4. and result there-out the concentration of salt

Ad 1. For the mapping of original-non original structures following sources are available:

-The original site-plans of the excavations

-The original photos of the excavations

Ad 2. For the mapping of the physical conditions of the walls a wall by wall survey is suggested.

Ad 3. For the mapping of the humidity in walls without salt a humidity-meter could be used otherwise sample testing is suggested

Ad 4. The concentration of salts could be registered by leaching under similar conditions

To carry out the above mentioned mappings the house-units have to be numbered and each wall to be specified.

The mapping should be accompanied by an index-card system in which the observed criteria are entered. Observations could be accompanied by photography.

Once the inventory system is built up it easily can be used and results of treatments etc. be checked.

As due to the results of the pumping project the water table has been lowered down so that the physical preservation of the architectural remains can be scientifically continued and finalized.

Three aspects are of greatest importance:

5. Mohenjo-Daro exceeds by far the size of a "normal" monument (at least 100 ha out of which 10 ha have been excavated

6. Mohenjo-Daro is an archaeological site with more than 90% unexcavated areas. Also within the excavated area (to be treated) unvaluable ar-chaeological remains are still in situ which should not be destroyed through conservation measurements (e.g. vertical DPC connected with uncontrolled fresh digging).

7. Mohenjo-Daro is a primary archaeological source which has to be conserved in its original setting (e.g walls which have to be replaced (restoration) should be replaced according to their original appearance.)

With the condition report and the wall inventory on the long term the basis for scientific preservation is given.

A well developed local infrastructure" for the preservation of the architectural remains as it already exists for the puming scheme in addition with a continued critical checking of the preservation methods offered by UNESCO finally will lead to the satisfactory result of having preserved Mohenjo-Daro also for futural generations.

Programme for proposed future research.

This programme[20] is based on the following different aims which resulted out of the observations of the Aachen University Mission during the last seven years at Mohenjo-Daro.

- 1. Analysis of the forma urbis
- 2. Analysis of the inner structural orientation
- 3. Analyses of the anticipated structural pre-platform-, platform (urban) - and posturban phase and the devlopment of an adequate new chronology[21].
- 4. Analyses of the different platform-techniques, including analyses of the buildingmaterial and earth mechanics with the development of a typology of platforms. Furthermore the analysis of walls, wells and drains.

Ad 1. The urban form (forma urbis) of Mohenjo-Daro has in the recent past become a major object of studies.

Inspired by Wheeler's deep digging 1950 and by the deep diggings of the excavators[22] the concept of a platform-foundation as an initiative concept for the urban phase was forwarded on the South Asian Archaeology Conference in Bruxelles, Belgium 1983 and Arhus, Denmark 1985 by the author. The basic idea behind this important concept is on the one side, that the ancient plain around Mohenjo-Daro 2400 BC was several meters lower than today. This concept is not new and has been reported by several other authors[23].

The observation of the **founding of the urban phase** of Mohenjo-Daro on gigantic

[19] consisting e.g. of one engineer-archeologist, one head supervisor, one supervisor and several trained labours for each excavated area

[20] Itdoes for the time being not include the extended programme of the IsMEO mission which might be added to this programme.

[21] In coordination of the morphological studies of the excavated remains (cluster analysis).

[22] see Lambrick, H.T.1973 sindh before the muslim conquest. Hyderabad: 56

[23] see eg. Raikes , R. 1964 The end of the ancient cities of the Indus. In: Am An 66/2:284-99 Aryne, S. Khan, M. 1972 The control of groundwater table at Mohen-jo-daro: fig.4

Platforms on the other side is new[24]. The emerging picture seems to be that of a large city constructed on two platforms, one for the akropolis or "citadel" ca. 400x 200 m and 6-7m deep and the other east of the akropolis appr. 1200x 800m with a probably lower platform for the lower town[17].

The total of the artificial platforms could cover appr. 1.0 Million sgm with more than 7 million cubic meters of filling. All these founding platforms are in Mohenjo- Daro today underground.

To trace their outer form could be one of the primary scientific aims in the near

Future.

The mechanism for the tracing was finally developed this winter in following non destructive methods:

1. For a depth down to three meters a hand drill (Pirckhauer) can be used to trace the mudbricks under the surface.

Once traced, the mudbricks can be cleaned by surface-stripping to study their size and orientation. With the handdrill ca. 15-20 dry core profiles (diameter 18mm) down to three meters can be carried out per day delivering a detailed information about subsoil compositions.

2. For deeper drilling and tests of the sediments down to ca. 15-20 meters dry core drilling can be carried out like the test of IsMEO has shown[18].

3. Prospecting methods like electric resistivity and geomagnetic measuring methods can be applied for tracing structures underground.

4. Aerial photogrammetry either by PAF (special application) or by hot-air balloon (Aachen University) should accompany all activities.

5. Selective trial trenches outside the archaeological remains but in direct contact with them (outer limits) should be carried out to study the sedimentological conditions of the surrounding plains.

6. In connection with these methods tests regarding the earth mechanics (influence of subsoil water on platforms etc.) should be carried out.

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[24] George Dales and Bob Raikes interpreted platforms (mostly belonging to the category III (internal fillings of residential architecture) discovered by them with protective activities during the urban phase against the rising floods of the Indus.

[25] Whether there are earlier settlements below cannot be said at the moment. More detailed analyses have to be awaited.

[26] This programme does not include the detailed concepts of IsMEO.

With these techniques the forma urbis could be well defined. The results would include the horizontal, vertical extent, the intra-extraurban relation of structures and the sedimentological process of the Indus-plain over the last 4000 years.

Ad 2. With the First Street as a main thoroughfare we have a clear indicator of planning within the urban context. It seems, that with the planning and construction of the platforms also the planning of the general lay-out of the city was carried out. This is understandable as the concept of the platforms allowed only limited access e.g. by ramps[27] leading up from the appr. 6-7m lower surrounding plains. It seems to be probable that for example the First Street which is at present tracable in a straight line for more than 800 m from the north (DK-G) down to the south (HR) passing VS-area represents the direct connection of one northern and southern entrance by ramps.

At least two more main axes may exist with a common distance of ca. 170 m each, one in the Dales' excavation, west of HR and First Street and one in the DK B-C area east DK-G area and First Street. With highly selective testing trenches the walls (limits) of these other main thoroughfares might be proved. Furthermore the differentiated inner orientation of the city (streets and lanes) can be traced by aerial photography (after rains) and by laying selective testing trenches. For these studies one has to reconsider that the urban phase is parly covered by = posturban layer which has to be studied carefully at the same time (surface collection).

With the inner orientation we know the structural concept of the lay-out of the city which offers further data for the settlemental behaviour.

Ad 3. Since Mortimer Wheeler[28] criticised the chronology of Mohenjo-Daro deve-loped by Marshall (1931) and Mackay (1938) scolars have been somehow helpless how to cite and how to classify the cultural assemblage at Mohenjo-Daro. Some observations by Mughal[29] point towards an early harappan phase below the lover city of Mohenjo-Daro proved by some sherds of Kot Dijian style in the deep diggings of the late twenties (Mackay 1938).

On the other hand we have clear evidence now that appr. 6-7m of construction, today underground, were completed in a short period to serve as supporting substructure of the mature harappan city. Other elevated structures, especially

[27] wheeler (1947) discovered the ramps of the akropolis platform in Harappa 1946.

[28] wheeler Sir M. 1947 Harappa Chronology and the Rigveda. In: Ancient India No.3:78-83

[29] Mughal, R. 1971 the early Harappa period in the greater Indus valley and northern Baluchistan (ca.3000-2400 BC) Ph.D. dissertation Pennsylvania

On the akropolis, were erected on additional platforms, again 5-6 m high to support single buildings (eg. in L-area). On the other hand we know from Dk-G area that we are dealing here with a complex horizontal-vertical growth system, the lowest levels of which are at 47m amsl[30] and the highest at appr. 54m amsl. All these facts have to be restudied again, especially on the background of the documentation of excavated remains by the Aachen **University Mission** to understand the complex, divergant threedimensional growth of the site. The restudy and cleaning of former trenches may add to a better understanding.

Ad 4. As could be seen, mayor parts of Mohenjo-Daro are dircetly connected with differrent types of platforms.

The largest ones (type I) are the "founding platforms" underlying the total city, other ones (type II) are those constructed on the founding platforms to support single buildings. A third type (III) is represented by different fillings within the residential-architectural context of the city. They can consist of mudbricks but also of secondary deposits of broken pottery and industrial waste like nodules etc...

The study of these platforms in relation to the building architecture is another major task in the future. Especially for the saving of Mohenjo-Daro a detailed study of those platforms seems to be unavoidable as it would give basic information about horizontal water-flow (rains etc.) water permeability in both horizontal and vertical direction and effection by salts[31].

Besides the platforms also the walls, wells and drains have to be studied from their technological point of view.

More detailed observations for the walls show that in normal houses burnt bricks only were used for the foundation of the walls whereas the upper parts were constructed of mud- bricks. Only mayor architectures were completely constructed out of burnt bricks. The burnt-brick layer in normal walls rested in the late urban phase on foundations made of potsherds and industrial remains (nodules) indicating the need of damp-prooved courses already in those days. For the construction of the wells[32] it is not only remarkable that they were

[30] It was quite interesting to observe that the lowest visible structural level in DK-G is not deeper than the surrounding plain of Mohenjo-Daro, an observation important for the draining of this area

[31] The latest information (15.2.86) regarding the geo-botanical survey inc-ludes possibilities of interpreting the different sub-structures by studies of the vegetation.
[32] One well is under clearance for studying the vertical extent and technology.

constructed in a statically optimized cylindrical form but also that they were constructed within the interial part of the city. Sometimes only less than one meter in diameter with a depth up to 15m and often to be found in small rooms the construction of them must have been an extraordinary task. Many indicators speak for the fact that most of the wells had been erected during the period of the platform construction. Therefore they seem to be an essential part of the initiating founding concept" of the city.

Directly connected with the fresh-water supply which in Mohenjo-Daro for the first time in the history of cities seems to have crossed the threshold from "water-need" to "water luxory" was the draining of the obviously enormous amount of waste-water. Both, water- supply and water drainage seem to be directly connected with the construction of the platforms.

Conclusion

Mohen-jo-Daro even in the present condition obviously represents a unique archaeological place in the world for the study of the typus of a bronze-age necropolis.

The homogeneity of the cultural assemblage, the unique structural concept, easy •d read due to the burnt brick structures, the protected situation since 1923 and the recent national-international attempt to safe it mark this unique position. The availability of all former research-data with more than 5000 old photos, 38.000 field-book registrations and all original plans only adds to it. The research of the **Aachen University** with more than 600 aerial photos taken from hot-air balloon, more than 100 plans of the excavated structures including a complete nivellement with ca. 500.000 level points and a photo-documentation of than than 15.000 new photos has added a documentation of the excavated structures to be preserved which also is unique in the world.

T-je research of the joint Aachen University-IsMEO Home mission has added new aspects regarding the archaeological surface, the horizontal and vertical extent, the inner orientation and environmental conditions.

Taking all these facts into consideration the research on the historical data (old photographs, field-books etc.) of Aachen University, the redocumentation of the excavated remains and the environmental, structural studies by the joint mission seem to be strongly interrelated with the national- international task to safe

[33] In no early harappan site wells are to be found. For Mohenjo-Daro more than 700 wells have been calculated (Jansen).

Mohenjo-Daro physically.

The scientific physical preservation of the site should be based[19] on the study of the historical data including a careful analysis of the old photos to guarantee a critical preservation. Before starting the preservation work according to international standard plans should be presented showing the preservation activities. The study of the historical data should be accompanied by the direct study of the physical remains according to physical conditions (collapsing walls etc.), different concentration of water (humidity meter) and resulting out of it concentration of salts.
For this programme the extensive studies of the site carried out in the past can be used and should be continued for this specific purpose. It should be carried out as a condition report of the structural remains marking the conditions and their change in the site maps (1:200). For each house/wall index cards should be prepared to register activities and their results.
The environmental- structural studies also directly could be continued for this purpose envisaging the joint interest in the site.
In futural research to be carried out at Mohenjo-Daro both aspects, science and preservation should be directly kept in mind as there is only one common aim: the deep understanding and the presentation of Mohenjo-Daro as a unique cultural property of mankind to the world.

Appendix 1:
The Aachen University documentation consists of:
<u>A Documentation of nowadav's condition</u>
- a site-plan 1:1000 with lm isohypses and a geodetic net of 24 trigonometric points set in concrete with a metric net of coordinates.
- maps of the excavated areas at scale 1:200
- levelling of all structures in heights amsl
- detailed maps up to 1:20 of specific architecture

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[34] As for example mentioned in the recommenadation of Dr. Organ, UNESCO

- 15.000 photographs of wall prospections
- 600 aerial photographs from hot-

air balloon B Documentation of original condition

- Old siteplan with 5 ft isohypses before excavation
- Old siteplan (Francis-map 1927) 1:2000 with 5 ft isohypses
- Original maps of the excavated areas 1:200 (equalized in Aachen) with 100ft

Horizontal orientation grids

- Original maps and cross-sections of Wheeler's excavation 1950
- ca. 5000 photographs taken during the excavations showing the original conditions
- ca. 36000 registrations of the original field-books

With this documentation Mohen-jo-daro is one of the best documented archaeological sites in the world.

Appendix II

Chronologie des Rettungsprogramms

1922 Beginn der Grabungen in Mohenjo-Daro

1925 Freilegung des "Grofien Bades" und hypothetische Erganzung des westlichen Bauteils.

1931 Offizieller Abschlufib der Grabungsa beiten

1934 Erganzungsarbeiten an dem buddhistischen Kloster

1934-37 Fortftihrung kleinerer Grabungen (Moneer-Bereich)

1940 Archaeological Chemist Great Bath washing with water to remove salts (Khan, F.A. 1970:11)

1944 Mortimer Wheeler wird Direktor des indischen Antikendienstes

1947 Teilung der Kronkolonie Britisch Indien in Pakistan und Indische Union

Ab 1948 Mud plaster and mud capping to some of the structures considerably Successful (1970:11)

1950 Excavation west of granary by Mortimer Wheeler

1959 Dammbruch des Indus mit uberflutung grober Gebiete auch um Mohenjo-Daro

1960: Presidential Cabinet takes special note on Mohenjo-Daro

M/s. Hunting Technical Services uberpruft wahrend einer groberenen Untersuchung auch die Deiche um Mohenjo-Daro

1961 First UNESCO expert sent to Pakistan (Dr. A.E. Werner keeper of the British Museum Laboratory, UNESCO appointed expert) six weeks stay in Pakistan. Conservation of cultural property in Pakistan recommandation of brushing of brick work before rainy season- ... (Khan 1970:14)

1962 M/s Hunting and M. Mc Donald first proposals for sinking tube wells and for the banning of rice cultivation

1963 Education Ministry approached the UNESCO for help

1964 (January) First UNESCO mission (technical mission of three experts) for two weeks

1965 Excavations by american mission G. Dales

1966 Second UNESCO Experts Mission

1968 Third UNESCO Experts Mission

1970 Extensive measurements for the safing of Mohenjo-Daro

1971 Konserierung des Bodens vom Grobenen Bad

1972 a team of Pakistani and UNESCO experts prepared a master plan:

- Ground Water Control
- Scheme for Protection against River Erosion
- Scheme for Preservation of Structural Remains

1973 23. Februar: Internationales Symposium in Mohenjo-Daro

1974 11. January Appeal by the Director general, UNESCO to the world to raise fundes for the saveing of Mohenjodaro

1979 Beginning of "Research Project Mohenjo-Daro" Aachen University

1979 10. October signing of the agreement between the Government of Pakistan and UNESCO "for the preservation and development of the monumental site of Moenjodaro", Paris

1980 Executive Committee First Session Paris

1981 Executive Committee Second Session Paris

1982 26-27 July Consultative Committee 6th meeting Karachi/Mohenjo—Daro

1982 4-6 October Executive Committee Third Session, Paris

1983 3. March Visit Mohenjo-Daro of Director General, UNESCO Inter national appeal for the contributions 18-20 July Consultative Committee 7th Session Karachi/ Mohenjo-Daro

5-7 September Executive Committee Fourth Session Paris

1984 27 January Visit of international group of journalists to Mohenjo-Daro

14-15 March Comite de Honneur for the International Camaign in Tokyo. Appeal by its Honorary Chairman H.I.H. Prince Mikasa (Tokyo Appeal)

1984 2 May Meeting for Moenjodaro Exhibition in Paris, ICOM, Aachen Municipality 6. August Consultative Committee 8th Session Karachi/ Mohenjo- -Daro

24- 26 October Executive Committee Fifth Session Paris

1985 23-25 Februar Consultative Committee 9th Session at Karachi/

Mohenjo-Daro

11-13 September Executive Committee Sixth Session Paris

1986 24-26 February Consultative Committee 10th Session Karachi/

Mohenjo-Daro

25- 27 June Executive Committee Seventh Session

1987 Consultative Committee 11th Session

Karachi/Mohenjo-Daro

1987 Executive Committee Eighth Session Paris

Consultative Committee: P. Falkner, Architect (Restoration)

UK (retired 1984)

Dr. Lackner, Civil Engeneer (Water control,

channels, electrification)

Germany

P. Perrot, USA (sporadically)