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MANAGING AND CONSERVING LARGE OASES IN SOUTHWEST KAZAKHSTAN

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ABSTRACT

The landscape of the middle course of the Syrdarya is scattered with numerous oases that prospered between the 1st and the 18th century AD. Some of them, like those of the Turkestan oasis (Yasi-Turkestan, Sauran) are characterised by complex and autochthonous water supply systems that relied on the use of groundwater and the digging of *karez* (wells). Others, like the ones of Otrar on the Arys delta, and Baltakol and Chilli on the Syrdarya branches, are based on the implementation of large irrigation canals fed by flood and active waters. Today most of the ancient landscape has been reduced to a semi-desert, the medieval towns are in ruins, and the ancient irrigation systems are out of use.

The aim of the paper is to underline the wide issues related to the management of such large sites, and to report about the smaller-scale conservation activities carried out in that perspective as part of the UNESCO/Japan Trust Fund project for the Preservation and Restoration of the Ancient City of Otrar (2001–2004). Detailed description is given on the conservation of a fired brick mosque of the 14th-15th century AD and on the problematic interventions carried out before perestroika.

KEYWORDS

Irrigation and urban systems, Middle Ages, fired brick, conservation, Kazakhstan

BIOGRAPHIES

Enrico Fodde (MA, PhD) is Lecturer at the BRE Centre for Innovative Construction Materials, Department of Architecture and Civil Engineering, University of Bath (UK). He worked as consultant for the Division of Cultural Heritage (UNESCO Paris), the World Heritage Centre (UNESCO Paris), and the Abu Dhabi Authority for Culture and Heritage (UAE). He was formerly International Project Director of Moenjodaro (Pakistan) and Field Director for several UNESCO projects in Central Asia.

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[H1] INTRODUCTION

Otrar is a rather large oasis of about 200 square km containing more than one hundred other sites and cities (Figs 1-2). It is located in the Otrar district of the South Kazakhstan Oblast region, 170km north-west of Chimkent and 60km south of the city of Turkestan.

The oasis enters history at the turn of our era with simple water management techniques but already hosting the headquarters of the Kangyu confederation (2nd century BC – 4th century AD). The last was a blend of local farmers and steppe horsemen adjoined by successive waves of pastoral tribes pushed westward by the Huns. During the Western Turkic kaghanate (6th-8th century AD), with the development of irrigation schemes and the rise of international trade, Otrar grew as an important economical and political center on the road linking Byzantium to China across the Eurasian steppes, more specifically on the branch running along the Syrdarya and the Northern Aral-Caspian region. The Mongol conquest did not change the productivity and importance of the oasis, and the fame of Otrar was at its peak when Timur died in the city in 1405. Its decay happened during the following three centuries, under the spell of the constant conflict between Kazakhs, Sheibanids and Kalmyks.

The site was first identified by Russian scholars of oriental studies N. Veselovski (1884), I.T. Poslavskii and V. Lykoshin¹ (1898-99). They were members of the “Circle of amateurs of the archaeology of Turkestan” and worked in connection with V. Barthold, the great Central Asia historian².

Other important archaeological excavations were carried out in the early 1900 and a second campaign was undertaken in the late 1940s under the direction of A. Bernshtam (Bernshtam 1951). The most extensive digs were carried out in the 1970-80s when the archaeological base of Otrar became the largest in the Soviet Union.

More recently, full mapping and scientific documentation of the oasis has been completed: the geo-archaeological setting was studied by the Laboratory of Geoarchaeology of Almaty in the context of an INTAS project (Clarke et al 2005), whilst the oasis was documented between 2001-2004 in the context of the UNESCO/Japan Trust Fund project for the “Conservation and restoration of the ancient city of Otrar”. The present paper relates to another article on Otrar that was published in this journal (Fodde 2007). A detailed explanation of the UNESCO project structure and objectives is provided there.

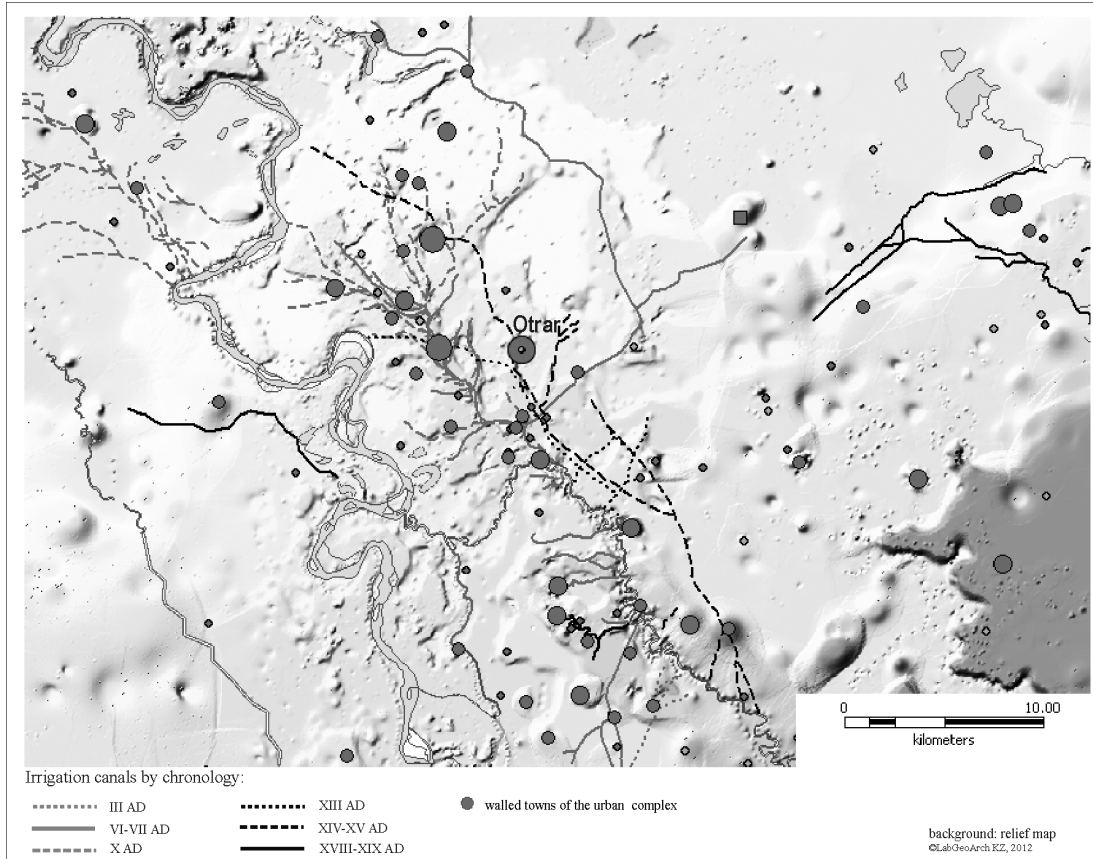


Fig. 1: Satellite map of Otrar showing six generations of irrigation canals (3rd-19th centuries AD). See also Sala and Deom (2008) and Clarke et al (2010)



Fig. 2: Aerial picture of Otrar Tobe³ with main archaeological features (© R.Sala, 2002)

[H2] HISTORY OF IRRIGATION AT OTRAR

The enormous concentration of medieval settlements in the Otrar oasis and their development during more than 1500 years is related to the natural hydrological conditions of the region and to technogenic changes in irrigation practices. In fact the Otrar oasis is located along the Arys delta (at its confluence with the Syrdarya) whose distributaries, meandering through the flat plain, provided excellent preconditions for the development of an irrigated farmland. The history of the oasis is of peculiar type. Circa 60% of the total urban area (within the city walls) was built during the 1st century AD and reached the absolute peak of 90 hectares during the 8th century AD. After this time the urban complex starts to contract in terms of settlements number and occupied area, in three major steps (9th, 13th, and 19th century AD). This long phase of contraction must not be interpreted as a period of progressive abandonment of the oasis, but as an alternation of periods of decay and periods of restructuring and urban reoccupation. In fact, behind the urbanization process of the oasis lie the exhaustion and restructuring of three generations of irrigation schemes. The hydrological features of the Otrar oasis can be classified as:

- the main course of the Arys river (with the Karakunchuk Tobe in Shoulder);
- the system of left distributaries of the Arys delta (with Kok-Mardan);
- the system of right distributaries of the Arys delta constituting the main and central part of the oasis, which can be further divided in a western (with Kuiryk-tobe, Altyntobe, Mardan-kuyuk), central (Otrar) and eastern part (Shol-tobe);
- the lacustrine landscape at the northern end of the Arys delta, constituted by some paleo-courses of the Syrdarya river (Masliakhat Tobe);
- the inter-riverine zone between the Arys and the Bogun deltas and the Bogun delta itself (Buzuk, Aktobe-Buzuk);
- the Syrdarya floodplain corridor (Shitte);
- the wide alluvial plain on the left bank of the Syrdarya near the old towns of Shanshar (in the south) and Oksus (opposite to the Arys delta where Al-Farabi was probably born in 878 AD).

Each zone is characterized by a specific kind of surface water and by a different sensibility to hydrological and climatic changes, to floods and draughts. Furthermore, each of them grew on the base of different kinds of land and water use, different strategies of water catchment and distribution, different irrigation and agricultural systems. Each zone has its own kind of settlement pattern, territorial/political integration and historical phases of building and abandonment.

As a whole the process of irrigation and urbanization of the oasis can be divided in seven phases and these are discussed in the following sections.

1ST PHASE (500-0 BC)

This phase is characterized by primitive agriculture based on basin-irrigation practices and concerns particularly the left bank of the Syrdarya. This is associated to the construction of the first walled settlements, among which the large and heavily fortified town of Shanshar Tobe.

2ND PHASE (0-750 AD)

This is a period of high development, at the beginning under the rule of the Kangyu confederation and then, in the 6th century AD, under the early Turkic empire. A large number of villages and towns rose in this period, together with the first water catchment devices and irrigation lattices along both the left and right distributaries of the Arys delta, i.e. in zone 2 (Kostobe, Kokmardan) and zone 3 (the eastern and central and parts of the right bank delta, comprising Karaultobe, Koktobe 1-2, Otrar, Kuyruktobe, Altyntobe). During this phase the alluvial plains of the left bank of the Syrdarya and the Bogun delta are characterised by the construction of main towns. Around 70% of the historic settlements of the Otrar oasis are built during this phase, mainly during the 1st century AD and again during the 4th and 6th century AD, under the early Turkic empire and in connection with the improvement of the irrigation system. In fact a major restructuring of the irrigation schemes takes place around the end of this phase: the 3-10km long Durtobinsk, Kok-Mardan and Pshukmardan canals are built on the left bank of the Arys (6th-8th century AD), and the 50km long Sangyl canal (7th-9th century AD) is dug north of the right bank.

3RD PHASE (750-900 AD)

This phase is characterized by a contraction of the oasis due to the Arabic invasion and to the conflict between Karluks, Oghuz and Samanids. The occupied urban area is reduced by 30%, zone 2 being the most affected, and the area never recovered, a fact that supports the conjecture of an irreversible exhaustion of the former irrigation schemes and fields.

4TH PHASE (900-1200 AD)

This phase, under the Karakhanid rule, shows a total urban area of 60 hectares. It corresponds to a period of real development of the entire oasis, with the exception of zone 2 where canals are totally abandoned and the only towns that resist are the ones located in strict proximity of the active river course (zone 1). The urban area of the right distributaries of the delta (zone 3) is concentrated around six main large towns: Otrar, Kuyruktobe, Mardan-Kuyuk, Altyntobe, Jalpaktobe and Buzuk. The irrigation scheme is renewed by the implementation of the 30 km long canal Altyn-Aryk. On the left bank of the Syrdarya the digging of canals Ak-Aryk (10th-15th century AD) and Kaugan-Aryk (10th-17th century AD) supports a longstanding development of zone 6. The trunk canals of these new systems are directly connected to active river waters and their patterns change from naturally adapted to more artificial forms that replace and run parallel to the natural delta distributaries. Furthermore, the terminal lattices connected to the fields acquire a more angular and developed morphology. This period marks the highest economical and cultural blossoming of the oasis, with a surplus production and with agricultural and commercial networks ruled by a well-organized statehood.

5TH PHASE (1200-1500 AD)

This period starts with the Mongol conquest and develops under the rule of Chagatai, Ak-Orda and the Timurids. At the very beginning a small crisis reduces the occupied urban area to 45 ha, but it is succeeded by a quick reprise connected with the restructuring of the irrigation systems and the concentration of the urban complex of the right bank delta of the Arys (zone 3). Here two main trunk canals are constructed: the 30 km long Karakunchuk-Aryk (13th-14th century AD) and, under Timurid and Sheibanid rule, the 40km long Temir-Aryk (15th-17th century AD). Both canals, one after the other, catch water more upstream than the former implementation (respectively 5 and 20km upstream) and rotate from west to south-east the main bulk of irrigated agricultural land. By the end of this phase, of the former six 'capital towns' only Otrar is left at the very center of the agricultural system, with a citadel of 20 hectares and out-walls circumscribing 150 hectares. Evidently Otrar now constitutes the head of the complex political-economical organization of the whole oasis, and of the hydrological management of zone 3. The size of the irrigation works and the splendor of Otrar town suggest the presence of a skillful political and financial centralized control.

6TH PHASE (1500-1800)

This phase consists of three centuries of progressive decay. By the end of the 16th century AD, apart from Otrar, just six small settlements are left. During the 17-18th centuries, under the spell of an interrupted conflict between Sheibanids, Kazakhs and Kalmyks, the irrigation systems collapsed, the population declined and Otrar town is abandoned. The territory became pasture for nomadic mixed farming herdsmen, with just few small settlements and short hydraulic devices in peripheral areas (on the floodplain of the Syrdarya and in the Bogun delta).

7TH PHASE (1900-TODAY)

Under Russian rule the irrigation system of Otrar is restored to its former potential not by central planning but by initiative of local *kolkhozes*. They reproduced the scheme abandoned during the 6th phase and, between the 1921 and 1955, reclaimed the same land surface of the medieval period. Modern villages are built in the vicinity of the abandoned medieval mounds (tobe), which are now used as cemeteries. Eventually the irrigation system of the 17th century started to be depleted and the Soviet scheme, after less than one century, already shows the signs of structural deficiency.

[H3] MANAGING AND CONSERVING THE LARGE OASIS

The management of the large oasis of Otrar was based on the following preliminary activities:

- Mapping of the oasis main archaeological features such as settlements, burial grounds, irrigation systems and other buildings;
- 3D topographic documentation with total station of the main towns of the oasis: Otrar Tobe (1st-18th centuries AD), Kuyruk Tobe (1st-15th centuries AD), Altyn-Tobe (1st-11th centuries AD), Pshakshi Tobe (1st-12th centuries AD), Mardan-Kuyk (1st-15th centuries AD) and Kok-Mardan (1st-7th centuries AD);

- Aerial survey of the oasis and of the irrigation systems;
- Removal of high salt content spoil heaps that were left by Soviet archaeologists;
- Emergency conservation of mud brick structures (Fig 3);
- Fencing of site in order to avoid cattle to enter the site.

In order to ensure permanent conservation and site management at termination of the project, a management plan was developed. This included suggestions for visitor paths, an information centre, signboards and leaflets, proper facilities and protection of the site's boundaries. Some of these suggestions were implemented before termination of the UNESCO/Japan Trust Fund project (2004). It should be also mentioned that after 2004 the Institute of Archaeology and the state enterprise "Kazrestavratsiya" started a new archaeological and conservation campaign under governmental budget through the State program "Cultural Heritage". Archaeological and conservation work consisted in the undertaking of new excavations (southern gate), in the cleaning of formerly excavated cultural layers around the old mosque, in the building of protection devices (metallic roof above the public baths) and in the carrying out of reconstruction work (pottery workshop). Architects and conservation experts trained during the UNESCO/Japan Trust Fund project were involved in such activities and, as a whole, the documentation of the oasis has been improved through mapping and database recording, allowing the publication of the "Corpus of historical and cultural monuments of the South-Kazakhstan province - Otrar district" (Akylbek 2007). Furthermore, the national UNESCO commission coordinated the preparatory work for the inscription of Otrar in the World Heritage List. This enabled the publication of several books on the monuments of the oasis, which included for the first time the documentation of the irrigation systems and the GIS of the monuments (2005-2007), by employing methods previously introduced by the Laboratory of Geoarchaeology.



Fig. 3. The Otrar oasis is characterized mostly by earthen dwellings such as this one located in Altyn Tobe (2002). The structure shows caving as caused by a combined effect of salts attack and wind blown silt.

[H4] FROM LARGE SCALE TO SMALL STRUCTURES: THE CONSERVATION OF THE OLD MOSQUE

Otrar Tobe in itself consist of an 18m high walled mound made of artificially accumulated clay, covering a surface of 20 hectares and surrounded by a second out-wall circumscribing an area of 150 hectares with suburbs, small hamlets and few fields. Possibly a third larger wall existed, of which accounts were given by ancient travelers, and today only unclear traces are visible. The southern corner of the central mound might have constituted the center of the town during the post-Timurid period, because two periods of large public buildings were unearthed, including the old mosque (cathedral mosque, 14th-15th century AD), a palace (same period) and later mosque (16th century AD).

One of the outcomes of the large-scale archaeological excavations that were carried out at Otrar since 1969 was the digging of the old mosque. Similarly to several other non-residential structures of Otrar, the mosque is built of fired brick, whilst domestic buildings are generally made of mud brick. The aim of this section is to describe the conservation activities that were carried out in the mosque. Describing this work is relevant because of the conservation history of the mosque itself before perestroika. Unsympathetic repair was undertaken by Soviet conservators who employed alien techniques and materials such as: insertion of concrete footings,

cementitious repointing, ethyl silicate consolidation, and reconstruction with recycled brick and cementitious mortar. The reconstruction work was investigated by comparing the structures with archival pictures. In some cases up to 70% of the masonry was found to have been reconstructed during the Soviet period.

AUTHENTICATION WORK AND DAMAGE ASSESSMENT

Because the mosque first analysis of spring 2002 did not allow a complete understanding of the authenticity of several structures, it was decided to remove some of the cementitious pointing and capping. This inspection revealed that the previous conservation work was more intricate than expected. The main outcome of the authentication work was:

- some of the Soviet period structures were entirely rebuilt on a platform of cementitious conglomerate, whilst other masses showed smaller reconstruction interventions (Fig 4);
- cementitious conglomerate ring beams (20cm height, 18-30cm depth) were not found in every mass because some had already been removed by the Otrar State Museum before the start of the UNESCO project;
- several masses show clear drilling holes from where a chemical consolidation (95% ethyl silicate and 5% polymethyl phenyl siloxane as hardener, also known as K9) and cementitious grouting were poured into the fabric and on top of the structures (dark patches of chemicals are visible and confirm this conjecture). Injection holes are widespread at the base of the structures, and it was noticed that poorer quality bricks often flaked, especially if treated with chemicals (see Fig 5). This may be due to penetration of water into the structure and to the short life span of ethyl silicate, especially when accompanied by freeze and thaw cycles;
- inspection was carried out partly by removing the hard pointing. This revealed that mud mortar was applied in the interface between the cementitious mortar and the original gypsum mortar, and this seems to have had a beneficial influence on the preservation of the original mortar. Glass fragments were found between the historic mortar and the new intervention, and this is clearly visible also between the capping and the last brick course;
- metal reinforcement (diameter=4mm) was found in the vertical joint of one archaeological structure.

Such inappropriate conservation measures should be considered as typical in the context of Soviet central Asia. An explanation of the wider rationale behind such measures is provided in Fodde (2010).



Fig. 4. Concrete platform with reconstructed masonry as carried out before perestroika. The picture shows also salts weathering in the lower courses



Fig. 5. Fired brick spalling (2003) caused by the combined action of ethyl silicate consolidation as applied by Soviet conservators and of salts and water from the brick itself. The depth of the ethyl silicate treatment is shown by the lighter areas that tend to deteriorate and detach

PREPARATORY WORK AND INTERVENTION PROPOSAL

Similarly to what carried out in other structures of Otrar, a survey sheet was designed and employed before starting the conservation work (Fodde 2007). A practical exercise was started in May 2003. This involved some Otrar Museum staff members, and both conservation and documentation teams. After providing trainees with maps, each structure was allocated to one member (Fig 6). Trainees were supplied with a survey sheet and with the documentation of the selected mass. The survey sheet was

intensively used until a final document was produced for every mass. Trainees were given one week for completing the survey sheet and then the group gathered around every mass to ask questions and start discussion. All documents were filled in Russian. To summarise, the reasons for designing such instrument were:

- the survey sheet proved to be a useful tool for raising awareness on the importance of systematic and disciplined work;
- it helped tracking down the work and prevented someone to undertake individual activities (the completed forms being signed and dated by the trainee). Such documents were collected in folders and then typed to form computer files. This made a permanent computer database that could be printed and used in the future. At the end of the Otrar project such files were kept in the main archive for future professionals.

It should be noted that the assessment of structures before removal of cementitious repair was updated with the new details that were revealed after cleaning. Laboratory analysis showed that the mosque pillars were built with *ganch* mortar (a mix of gypsum, soil, and crushed fired brick) with varying composition from structure to structure. The analysis of mortar through x-ray diffractometry⁴ (Table 1) shows that there is a clear difference between lower courses (high content of gypsum up to 69.3%) and higher courses (low content of gypsum down to 34.1%). Analysis of one sample taken from the core of pillar number 18 showed 29.5% content of gypsum.



Fig. 6. Old Mosque: group study of masses through survey sheets. The treatment plan for every structure was discussed and agreed by the interdisciplinary group

Table 1. Old Mosque, Otrar Tobe. Chemical composition of historic mortars through X-ray diffractometry as carried out by Lubov Charlina (NIPI). The table shows great variation in aggregate:binder ratio, probably due to the fact that different mix ratios were allocated to different parts of the building

Mineral	Pillar No 25 (gypsum mortar, SE elevation, second joint from middle top)	Pillar No 22 (gypsum mortar, SE elevation, second joint from middle bottom)	Pillar No 18 (gypsum mortar, core of mass)	Mud mortar (<i>qybla</i> wall)
CaSO ₄ 2H ₂ O	34.1	69.3	29.5	3.1
SiO ₂	29.0	6.9	39.0	46.3
CaCO ₃	17.2	2.8	13.2	16.5
NaAlSi ₃ O ₈	5.5	N/A	5.6	3.7
Complex clay minerals	4.3	8.2	N/A	N/A
Al ₂ O ₃	3.1	4.0	2.5	N/A
KAl ₃ SiO ₈	3.2	N/A	6.7	7.5
FeSiO(OH)	2.4	5.8	1.4	7.7
(Mg ₅ Al)(SiAl)O ₁₀ (OH) ₈	0.7	1.6	1.0	1.5
KAl ₃ Si ₃ O ₁₀ (OH) ₂	0.5	1.4	0.9	N/A

CONSERVATION WORK

Between April and June 2003 conservation work in the mosque concentrated into six main activities (Figs 7-10):

- Removal of all masses from loose cementitious capping so as to be ready for adequate repair intervention;
- Removal of cementitious mortar by means of chiseling. Generally speaking the mortar used for repointing was found to be softer and easier to remove than that employed in the core of masses. All masses but the outer wall (*qybla* wall) were successfully cleaned from such mortar;
- Removal of non-authentic parts in order to allow reconstruction with softer mortar. All masses were cleaned from reconstructed parts and bricks were saved and stored for future re-bedding with softer mortar;
- Tests were carried on selected brick faces in order to choose the most suitable solvent to be used for cleaning chemical treatment runs, which turned out to be toluene;
- Structural consolidation of rubbish pit under minaret area. A trench measuring 1x5m was excavated next to the minaret, with the function of inspecting eventual structural problems caused by a pit and by drainage faults. It was surveyed and a photographic record (both analogue and digital) of elevations and top views was carried out. The trench was consolidated by ramming a mix of soil and gravel, following the same method used previously at Otrar, by decreasing the soil/gravel ratio from bottom to top (Fodde 2007);

- Documentation with both analogue and digital photographs was carried out during the conservation process (elevations and top views).



Fig. 7. Mortar trials were made on new walls before application to the Old Mosque. This was done because it would have been unethical to test repair material on the historic fabric



Fig. 8. Authentication work of the old mosque structures showed that major reconstruction with cementitious mortar was undertaken before perestroika. Demolition of such reconstruction revealed the extent of concrete platforms that were built by Soviet conservators (see also Fig. 9)



Fig. 9. After comparing archival pictures and reconstructed work (Soviet times), demolition of reconstructed parts was carried out. Only the original portions were left, see Fig. 8. The Soviet-period concrete platform could not be demolished because this would have originated damage of the historic masonry



Fig. 10. Old Mosque, minaret area. From top to bottom: fired brick courses, Soviet concrete ring footing, and excavated rubbish pit being consolidated with a conglomerate of gravel and soil

Repair work was carried out so as to guarantee sacrificiality of repair materials (repair mortars being softer than the historic fabric). Reversibility of the intervention, maintenance of authenticity, and marking of added elements are also important guidelines that were followed during the conservation process.

Repointing of the *quybla* and outer wall was started during the autumn 2003 season with the following repointing mix: 50% gypsum (manufactured in Taraz), 20% soil, 15% air lime, 15% crushed fired brick. Cleaning and application of the mortar was carried out by employing the same methods and techniques as in other structures at Otrar (Fodde 2007). Chemical treatment runs were removed by dusting with a bristle brush, brushing with water, and brushing with solvent toluene (Figs 11-12). Then a pack of cloth and water was applied, and after one day the brick surface was rubbed with cloth. Such solvent was tested during the spring 2003 campaign and proved to be effective in removing consolidation runs. However, it was noticed that after the cleaning process several bricks lost some of their patina, but this was considered to be acceptable.



Fig. 11. Removal of ethyl silicate treatment runs from fired brick with solvent



Fig. 12. Picture showing same portion of wall as in Fig 11 after cleaning and application of repointing mortar

[H5] CONCLUSION

The tangible outcomes of the four-year conservation programme at Otrar are several:

- development of methods to guarantee that further excavations are combined with proven conservation techniques and proper management;
- creation of a comprehensive atlas of the Otrar oasis that includes the aerial survey and total station recording of towns and irrigation systems;
- conservation of the south corner and of the bath house at Otrar;
- creation of a manual for the conservation of earth sites in the central Asian Silk Roads. This document was employed as a tool to analyse historic and repair material and to improve conservation practices;
- an important outcome is related to the cooperation and new attitude that was established between the archaeology, conservation, and documentation teams who worked together on the project.

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¹ The first excavations in Otrar were made by N.I. Veselovskii in 1884. Nikolai Ivanovich Veselovskii (1848-1918) was a Russian archaeologist, orientalist and professor at the Saint Petersburg State University. He pioneered archaeological excavations in Samarkand (Afrasiab) and in well known kurgan complexes of the Black sea region (Solokha, Maikop) (Koja 2008, Poslavskii 1898, Lykoshin 1899)

² The Circle was established in 1895 by the eminent orientalist V.V. Bartold after an archaeological survey in Semirechie in 1893-4. The circle was regrouping researchers and officers from the Oriental Languages faculty of the University of St Petersburg, the Oriental Languages Institute of Moscow, the Theological Academy of Kazan, the Department of Oriental Studies of the Russian ministry of Foreign Affairs, and from several other military schools of St Petersburg. The first president was the general governor of Turkestan, baron A.B. Brevskii, and the vice-president was N.P. Ostroumov (1846-1930) who was an orientalist, islamologist, historian, and ethnographer. See website of the Directory of Scientific Societies of Russia: http://www.snor.ru/?an=sc_4824 (accessed January 2013)

³ The term tobe is known as tell in Hebrew or Arabic and as tepe (tepa or tobe) in Turkish. It is an archaeological mound created by several layers of human occupation. If used as toponym, it is written usually in majuscule, whilst if used as concrete noun it is written in minuscule.

⁴ The study of mineral composition of historic materials was carried out at the Institute of Geological Sciences of Almaty (Academy of Sciences of the Republic of Kazakhstan)