

Additional bibliography

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Case Study 10.2: Ulugh Beg’s Observatory, Uzbekistan

Presentation and analysis of the site

Geographical position: City of Samarkand, Uzbekistan.

Location: Latitude 39° 40′ 29″ N, longitude 67° 0′ 20″ E. Elevation 705m above mean sea level.

General description: The site comprises the remains of a meridian arc that originally formed part of the 15th-century observatory of Ulugh Beg. This colossal quadrant, its white marble slabs containing incised Arabic symbols and numerals, was constructed by cutting its lower part out of living rock while its upper part was supported by a brick structure 40m high.

History of the site: Ulugh Beg, the ruler of Transoxiana from 1409 to 1449, had been interested in astronomy from childhood and had visited the remains of Maragha Observatory in his younger years. In 1420 he established a school in his capital city Samarqand, where mathematical sciences were taught, and after four years he established his own observatory, one of the largest in the pre-modern era.

The observatory was a large round building with three stories, decorated with glazed tiles, majolica and mosaic. Its main instrument was a huge sextant with a radius of 40m, embedded in a trench about two metres wide, dug into a hill in the plane of the meridian. This method of construction made the instrument completely stable and reduced the errors arising from the minor displacements common in movable observational tools. At the same time, the enormous size of the sextant made its graduation very accurate. On the arc of the sextant, divisions of 70.2 cm represented one degree, while marks separated by 11.7 mm corresponded to one minute and marks only 1mm apart represented five seconds.

Following the demise of Ulugh Beg the observatory was reduced to ruins. Its remains, primarily the sextant, were discovered in 1908.

Cultural and symbolic dimension: The main purpose of the observatory was to produce a zīj, and the *Sultānī Zīj* or the *Zīj-i Ulugh Beg* was duly compiled in 1438–39. This became one of the most widespread zījs: it was copied more than a hundred times, translated into Arabic and Turkish, and parts of it were translated into Latin and published in Oxford and London in the mid 17th century.

An important aspect of the *Sultānī Zīj* is its updated values for astronomical parameters and new computational procedures. Samarqand astronomers attempted to calculate the trigonometric tables from scratch and derived new values for essential parameters. The basis of the trigonometric tables of the *Sultānī Zīj* is the very accurate calculation of the sine of 1°, which Ulugh Beg Ghiyāth al-Dīn Jamshīd al-Kāshī, the senior astronomer of the observatory, calculated using new procedures to sixteen decimal places. His work the *Key to Arithmetic* is one of the best treatises written about arithmetic in the Middle Ages.

Under the patronage of Ulugh Beg, Samarqand became an ideal place to study science at an advanced level, and attracted many students from all over the Islamic territories, even including the farthest western regions. As a result of these scholarly exchanges, the influence of Samarqand Observatory, which was itself a continuation of the Maragha School tradition, spread through a vast area from Transoxiana to the Ottoman Empire. The social and political turbulence that followed the fall of Ulugh Beg and continued until the establishment of the Safavid dynasty in Persia in the early 1500s triggered a massive emigration of scholars from the eastern parts of the Islamic territories into the Ottoman Empire. Among them were several astronomers and mathematicians who were either working at the Samarqand Observatory or else trained by Samarqand scholars; and their influence upon the development of science in the Ottoman Empire was considerable.

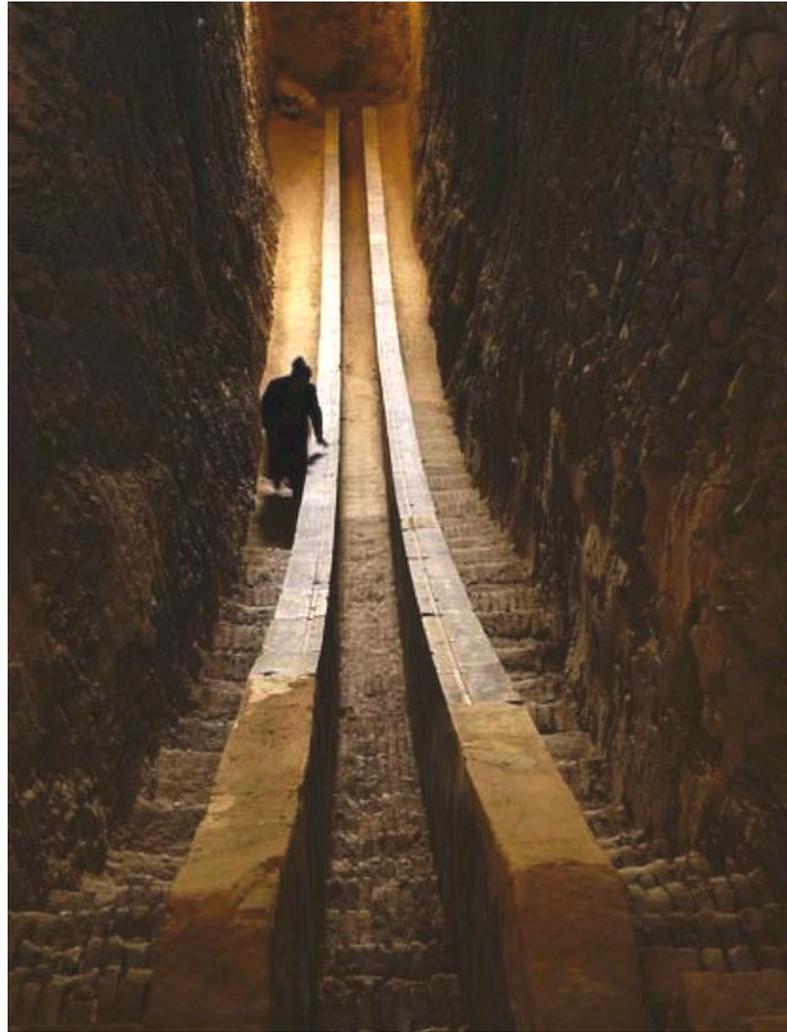


Fig. 10.2.1. Ulugh Beg's Observatory, Samarkand, Uzbekistan. Photograph © OUR PLACE THE WORLD HERITAGE COLLECTION (www.ourplaceworldheritage.com).

Authenticity and integrity: The three-storey building has been destroyed and all that has been preserved is a part of the huge sextant.

Documentation and archives: Al-Kāshī, in his treatise on astronomical instruments, describes some of the instruments used in the Samarqand Observatory. Another treatise, written by 'Abd al-Mum'im al-'Āmili almost a century after the observatory had been reduced to ruins, also gives valuable information about the instruments.

Present site management

Protection and conservation: Ulugh Beg's observatory forms part of the World Heritage Site 'Samarkand—Crossroads of Cultures' (no. 603), inscribed in 2001 under criteria (i), (ii) and (iv). As one of the major monuments of the property, it is afforded Uzbekistan's highest level of cultural protection and conservation. For more details see ICOMOS (2001).

Context and environment: The monument is situated in the north-eastern outskirts of the city of Samarkand at the foot of Chupan-ata mountain.



Fig. 10.2.2. Ulugh Beg and his observatory on a 1987 Soviet postage stamp. After North 2008, fig. 88.

Archaeological/historical/heritage research: The remains of a number of other astronomical instruments were found during excavation work in the 1960s.

Main threats or potential threats to the sites: See ICOMOS (2001).

Management, interpretation and outreach: The global management of the observatory is organised as part of the general management plan of World Heritage Site no. 603. There is a museum at the site, presenting information about astronomical instruments relating to the Timurid epoch.

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