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Kitab as One of the Five Stations of the ILS: History and Present

Sh. A. Ehgamberdiev, S. K. Eshonkulov and E. A. Litvinenko

Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences
Astronomicheskaya 33, 700052 Tashkent, Uzbekistan
e-mail: shuhrat@astrin.uzsci.net

Abstract. The Tashkent Astronomical Observatory (Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences since 1966) was involved to the International Latitude Service (ILS) in September 1899, when the regular latitude measurements were started at Tschardjui ($\phi = +39°08'11'', \lambda = -63°29'$). Because of the Civil War in Central Asia, the latitude observations were ended at Tschardjui in May, 1919. A new latitude station was established at Kitab (Uzbekistan) at latitude $\phi = +39°08'40''$ and longitude $\lambda = -66°53'$, in November 1930. The Kitab Latitude Station was equipped with two visual zenith telescopes (1929, 1957) and the photographic zenith tube removed from the Pulkovo observatory in 1978. The Kitab station provided the ILS with more than 250000 instantaneous latitude measurements. Since the early 90s Kitab has hosted the ground-based beacons of GPS, PRARE and DORIS satellite tracking systems, providing the IERS data center with precise coordinates at subdaily frequency.

1. Introduction

The Tashkent Astronomical Observatory (TAO) was founded in 1873. The primary aim of the observatory was determination of the geographical coordinates of Central Asian cities. For this purpose it was equipped with portable instruments such as Repsold's large vertical circle, Wagener and Pistor's mirror circle, and a transit instrument [1]. It is important to note that D. D. Gedeonov, director of TAO from 1890 to 1900, suggested that Repsold make a vertical circle providing the same accuracy, but half the size, which was important for a portable instrument. The first instrument made by Repsold according to the order of Gedeonov was sent to Tashkent in 1892. (It is now exhibited at the museum of UBAI). Measurements made with that instrument after some minor adjustments demonstrated its very high accuracy. The accuracy of determination of latitude using one pair of stars (16 settings) was about $\pm 0''.64$, whereas clock corrections using one pair of stars (Zinger method) was $\pm 0''.059$ [2]. These instruments became known as Repsold's small vertical circles. They were described by Repsold in [3], but unfortunately without mentioning the role of Gedeonov. Nevertheless, it was a notable contribution of Tashkent astronomers to the development of geodetic instrumentation. During geodetic expeditions as-

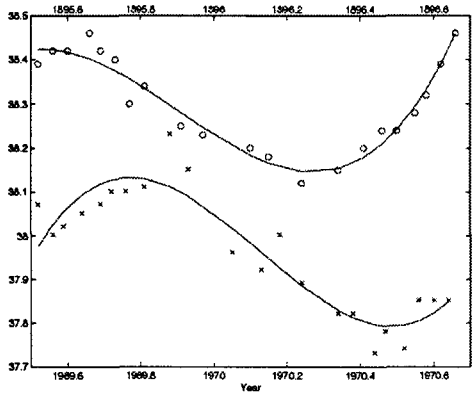

Figure 1. Latitude variations observed at Tashkent from July 1895 to Sept. 1896 (top) with VZT by Gedeonov [4] and 75 years later (bottom) by Kaganovski [5] using a transit instrument. The difference of mean latitude of Tashkent for those dates appears to be in good agreement with the value predicted from ILS data.

tronomers of the Tashkent Observatory carried out the geographical coordinates determination of a few hundred sites in the territory of the Central Asia.

In May 1893 the Tashkent observatory had received the visual zenith telescope (VZT) made by Wanschaff in Berlin. This gave an opportunity to carry out precise measurements for the latitude variation in Tashkent. The Italian astronomer, Giovanni Schiaparelli, and Pulkovo astronomers had a big interest in such measurements in Tashkent, which is far from European observatories. Although the main duties of Gedeonov, who was employed by Russian military-topographical department, didn't allow him to carry out this work before summer 1895, measurements of the latitude of Tashkent from 1 July 1895 to 1 Sept. 1896, were careful and accurate. Fig. 1 shows the variation of Tashkent's latitude. These results were used also for estimation of the secular variation of latitude of Tashkent. In 1969–70 G. M. Kaganovski carried out measurements of the latitude of Tashkent [5] using the same method as Gedeonov. However, the VZT which Gedeonov used was not preserved, and Kaganovski used a transit instrument. But the tower of the VZT and the pier were preserved, and latitude difference between two these instruments was determined as $8\overset{''}{.}132$. So, recalculated (using more precise catalogues), the mean latitude of Tashkent was

$$\phi = 41^\circ 19' 38\overset{''}{.}295 \pm 0\overset{''}{.}011 \ (1896)$$

whereas Gedeonov's published [4] value was

$$\phi = 41^\circ 19' 38\overset{''}{.}29$$

The mean latitude determined by Kaganovski in 1970 (with above mentioned correction for distance) was

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$$\phi = 41°19'37''.986 \pm 0''.018 \ (1970)$$

The difference

$$\Delta\phi(1970 - -1896) = -0''.309 \pm 0''.021$$

was in good agreement with the value

$$\Delta\phi = -0''.252$$

obtained for secular motion for Tashkent from ILS data [2].

One can conclude that at the end of 19th century astronomers of the Tashkent observatory had a good experience and were familiar with contemporary polar motion problems.

2. Tschardjui and Kitab stations of ILS

During the 12th General Conference of the "International Erdmessung" held in Stuttgart on Oct. 1898, it was decided to start a new series of latitude measurements in the frame of the International Latitude Service. Four stations (Mizusawa (Japan), Carloforte (Italy), Gaithersburg and Ukiah (USA)) were supported by the "International Erdmessung" and equipped with visual zenith telescopes (VZT) made by Wanschaff. Apertures of the objectives of those VZT were 108 mm, focal lengths 130 cm. However, TAO was assigned responsibility for organizing permanent observations in the Central Asian area, so it equipped Tschardjui station with Wanschaff VZTs, used by Gedeonov in the Tashkent observatory. It had an aperture of the objective 68 mm and focal length 87 cm. Building of the Tschardjui station was begun in July 1898 and first observations were made on Sept. 1898. Tschardjui station was situated on the riverside of Amu-Darya at the distance of 3 km from its course. Because the landscape in that area was mostly sandy, the river changed its course. In 1908 the river neared the instrument. It was decided to reinstall the instrument on the right riverside. At the new site observations were continued until 1919. During 20 years of operation the Tschardjui station had provided ILS with more than 35,000 instantaneous latitudes.

Tashkent Observatory was also responsible for choosing a new site for ILS. The site was chosen near Kitab city (Uzbekistan). The Kitab station inherited from the Tschardjui station the Wanschaff VZT and Strasser-Rohde pendulum clock, but it was also equipped with an Askania-Werke VZT (D=110 mm, F=1290 mm). Telescopes of the Kitab Latitude Service (KLS), dates of their installation and number of instantaneous latitudes are given in Table 1.

Since its foundation the Kitab Station permanently continued latitude observation over the whole period of the ILS. During World War II the Pulkovo observatory was evacuated to Tashkent, and the Semeiz observatory (Crimea) to Kitab. Participation of highly qualified experts as A. N. Mihailov, S. I. Belyavski, G. N. Neuimin and others in the scientific activity of UBAI and KLS has played an important role in the improvement of the quality of astronomical research in Uzbekistan. In memory of that period of fruitful cooperation Prof. Neuimin had named the asteroid (N1351) "Uzbekistaniya."

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Table 1. Telescopes of the Kitab Latitude Station.

Instrument	Aperture/ Focal Length (mm)	Date of installation	Observations
Zenith telescope Wanschaff	68, 870	29 Aug. 1899 - 25 May 1919 Tschardjui	35 000 instantaneous latitudes
Zenith - telescope Askania-Werke Bamberg	110, 1290	14 Nov. 1930 Kitab	127 000 instantaneous latitudes
Zenith - telescope ZTL -180	180, 360	17 Aug. 1957	73 000 instantaneous latitudes
Photographic zenith tube	250, 400	1978	50 000 instantaneous latitudes and 46 000 clock corrections

Co-workers of the KLS carried out research on non-polar variation of the latitude, systematic instrumental and personal (observer's) errors.

The following scientific conferences were organized in Kitab:

1. "Results of the Latitude observation analysis," 20–22 Oct., 1964.

2. "Earth Rotation and Geodynamics," 12–14 Nov., 1981 (Devoted to the 50th anniversary of KLS).

3. Present status of the Kitab Station

Since the early 90s the Kitab Latitude Station (KLS) has hosted ground beacons of the satellite tracking systems. In Nov. 1991 the DORIS beacon was installed at the roof of administrative building of the KLS. In Aug. 1992 the GPS ground station was installed next to the pavilion of the VZT. For data transfer the INMARSAT-C system was used. In 1992, 1994, 1995 and 1998 KLS took part in the CATS (Central Asian Tectonic Sciences) program headed by GFZ (Germany). Estimated velocities were determined for about 40 sites in the "Pamir-Tienshan" region. KLS was among the 6 permanent stations of CATS. From 1995 to 1998 KLS took part in German PRARE project.

Updating instrumentation is carried out by experts of GFZ (Germany) and IGN, CNES (France). After 1996 when DORIS became involved in IERS, KLS provided this service with the data from three experiments. Collocation of three independent satellite tracking systems allowed adjustment and calibration of the respective reference systems.

Beside these systems at Mt. Maidanak (60 km south of Kitab) a Satellite Laser Ranging System is in operation since the mid-70s. This station is maintained in cooperation between Uzbek and Russian Space Agencies.

Table 2. Participation of Kitab Station in Space-based Geodesy Projects.

Technique	Year	Partner
DORIS	1991	IGN (France)
GPS	1992	CNES (France)
PRARE	1995–1998	GFS (Potsdam-Germany)
SLR	70s	Russian Space Agency

4. Conclusion

For 100 years the Tschardjui and Kitab sites provided ILS and IERS services with more than 285000 instantaneous latitudes. At present KLS continues this tradition, taking part in satellite tracking systems. Participation of L. N. Shurjetski, D. I. Kravtsov, V. S. Obraztsov, V. P. Shcheglov, G. A. Lange, A. M. Kalmykov, V. A. Naumov, V. S. Shuhorov, G. V. Grinevich, B. I. Zykov, V. M. Shipilova, B. Makhmatgaziev, S. K. Eshonkulov, E. A. Litvinenko and I. Pattahov in the founding of KLS, the latitude observations, data analysis, organization of scientific meetings in Kitab and compiling Proceedings of KLS, is highly appreciated.

At present C. Reigber, R. Galas, A. Orsoni are playing an important role in the development of modern techniques in Kitab.

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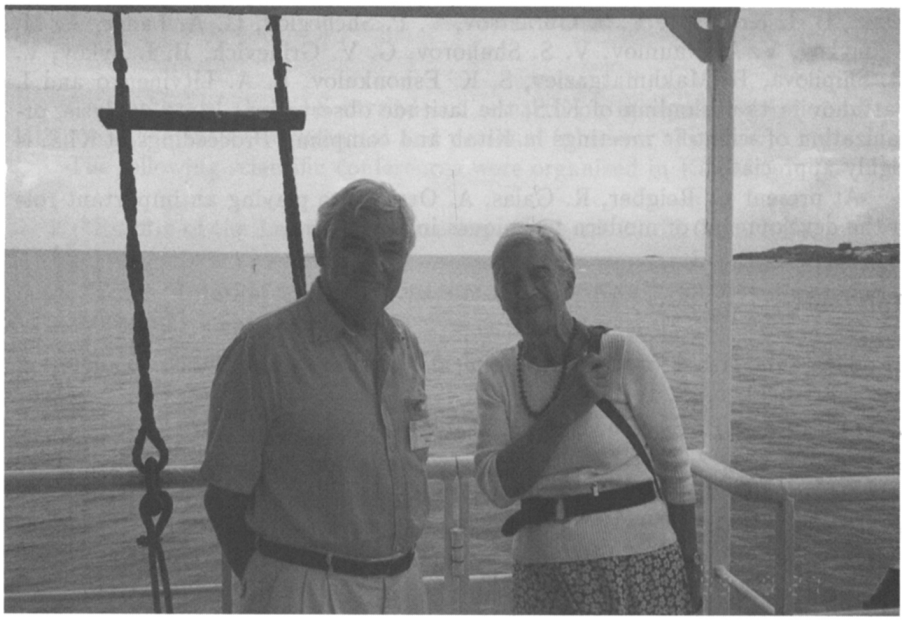

Bernard and Claudine Guinot

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