

# SOME RESULTS OF WORK WITH “ZEMLYA” STATIONS IN TASHKENT\

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## Abstract

## Full Text

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*GEOPHYSICS*

**I. V. POMERANTSEVA, L. S. SHUMILINA**

# SOME RESULTS OF WORK WITH “ZEMLYA” STATIONS IN TASHKENT\*

*(Presented by Academician M. A. Sadovskii on 25 II 1967)*

From June 18 to December 20, 1966, the All-Union Scientific Research Institute of Geophysics, together with the Pritashkent geophysical expedition of the Uzbek Geophysical Trust of the Ministry of Geology

**Fig. 1.** Schematic layout of the “Zemlya” recording stations in the city of Tashkent (based on the map of Vol’ fson, N. B., and Khvalovskii, A. T.). 1 —aeromagnetic-survey anomaly zones; 3 —epicenters of Tashkent earthquakes according to data from the “Zemlya” stations; 4 —isoseismals of destruction (data of V. T. Rasskazovskii, T. R. Rashidov, et al.); 5 —central blocks of elevated bedding of the surface of the Paleozoic basement; 6 —“Zemlya” stations

of the UzSSR began a systematic study of the deep structure of the Earth’ s crust beneath the city of Tashkent and its environs with the aid of “Zemlya” stations (1) in order to clarify the causes of the Tashkent earthquake of April 26, 1966.

Thirteen “Zemlya” recording stations were arranged along systems of profiles intersecting the city in northwestern and northeastern directions

\* The following took part in the work: A. N. Mozzhenko (author of the stations), V. P. Danilin, V. I. Voropaev, E. S. Eidel’ man, S. P. Borodin, L. N. Kagalova, E. P. Isanina, A. V. Suvilova, and others.

**Fig. 2.** Deep section of the upper part of the Earth’ s crust through the central part of the city of Tashkent.  $I$  —Earth’ s surface,  $d_1^0$  —surface of the Paleozoic basement,  $d_2^0$  and  $d_3^0$  —first and second boundaries in the “granite” layer,  $d_1^*$  —Conrad surface. 1 —reliable segments of exchange boundaries, 2 —less reliable segments of exchange boundaries, 3 —foci of the Tashkent earthquakes,

Fig. 4. Graphs  $\bar{V}_p = f(H)$  and  $\bar{K} = \varphi(H)$  according to the processing data for the Tashkent earthquakes (after I. A. Sokolova and D. A. Kuzina). 1 –values of the mean velocities and  $\bar{K} = \bar{V}_p/\bar{V}_s$  in the focal zone; 2 –averaging curves; 3 –curves of  $\bar{V}_p$  and  $\bar{K}$  in zones corresponding to the focal zone.

Figure 2: Fig. 4. Graphs  $\bar{V}_p = f(H)$  and  $\bar{K} = \varphi(H)$  according to the processing data for the Tashkent earthquakes (after I. A. Sokolova and D. A. Kuzina). 1 –values of the mean velocities and  $\bar{K} = \bar{V}_p/\bar{V}_s$  in the focal zone; 2 –averaging curves; 3 –curves of  $\bar{V}_p$  and  $\bar{K}$  in zones corresponding to the focal zone.

4 –fracture zones on the surface of the Paleozoic basement, 5 –locations of “Zemlya” stations.

**Fig. 3.** Map of the relief of the surface of the Paleozoic basement beneath the city of Tashkent. 1 –contour lines according to data from the “Zemlya” stations, 2 –epicenters of local Tashkent earthquakes, 3 –fracture zones according to data from exchange waves *PS*. *I* –Chinabad uplift, *II* –Chirchik swell, *III* –Tashkent depression, *A, B* –uplifts in the city center.

(Fig. 1). Five or six stations were installed in fixed positions over an area in the center of the city. The recording stations registered, around the clock on magnetic tape, all waves excited by earthquakes and explosions in the frequency band 0.5-20 Hz. The records were then reproduced from the magnetic tape onto oscillograph paper in the frequency band 0.5-10 Hz.

During the period from June 16 to December 22, the “Zemlya” stations in Tashkent recorded 150 distant ( $\Delta \sim 23-81^\circ$ ), 189 nearby ( $\Delta$  up to  $10^\circ$ ), 356 local ( $\Delta$  up to 20 km) earthquakes and 110 explosions.

**Fig. 4.** Graphs  $\bar{V}_p = f(H)$  and  $\bar{K} = \varphi(H)$  according to the processing data for the Tashkent earthquakes (after I. A. Sokolova and D. A. Kuzina). 1 –values of the mean velocities and  $\bar{K} = \bar{V}_p/\bar{V}_s$  in the focal zone; 2 –averaging curves; 3 –curves of  $\bar{V}_p$  and  $\bar{K}$  in zones corresponding to the focal zone.

From the *P* and *PS* waves of distant and nearby earthquakes, along five profiles intersecting Tashkent in different directions, time and depth sections [2] of the earth’s crust and upper mantle were constructed (Fig. 2), as well as a preliminary relief map of the surface of the Paleozoic basement beneath the entire territory of the city (Fig. 3).

From records of local earthquakes, the foci of the main Tashkent earthquakes and the velocity characteristic of the upper part of the crust were determined (Fig. 4). From records of accompanying explosions, the velocity characteristic of the crust around the focal zone was determined.

A complex block dissection of the surface of the Paleozoic basement is characteristic of the deep structure of the city. The amplitudes of the blocks vary from 300 to 750 m. The sizes of the blocks vary from 2 to 5 km<sup>2</sup>. In the regional

plan, the basement beneath Tashkent can be divided into three zones\*: the Chinabad uplift ( $H_\phi$  from the Earth's surface 1300-1950 m), the Chirchik swell ( $H_\phi \sim 1650-1950$  m), and the Tashkent depression proper ( $H_\phi$  1.6-3.1 km) (Fig. 3). It should be noted that the depths to the basement within the Chirchik swell may prove to be somewhat underestimated owing to failure to take into account the horizontal gradient of velocities of propagation of longitudinal waves.

In the center of the city, in the area where the three listed structures are joined, two uplifts of the surface of the Paleozoic basement are noted, separated by a graben, along the boundaries of which the foci of the local Tashkent earthquakes are grouped (Figs. 1, 2), with depths from 3 to 8 km.

Sharp bends are observed along the deep boundaries in the region of the focal zone and deeper than it.

\* The configuration of individual isochrons after the 1967 detailed work may change somewhat.

The values of the formation velocities  $V_{p\ pl}$  for the propagation of longitudinal waves in the focal zone are sharply reduced and amount to 4.3-4.5 km/sec.  $k_{pl} = V_{p\ pl}/V_{s\ pl} = 1.58-1.62$ , whereas around the focal zone  $V_{p\ pl} = 6.1$  sec. and  $k_{pl} = 1.73$ .

The recordings of the "Zemlya" stations made it possible to obtain some information about the process of the Tashkent earthquake.

1. Earthquakes at the Earth's surface occurred as a result of the displacement of entire surfaces. The displacements of the surfaces occurred either rapidly, over 1-20 sec., or over the course of several days.
2. The "Zemlya" stations record approximately 30% more seismic shocks than stationary seismological stations. In addition, with a large paper sweep, up to 50% of weak shocks are additionally recorded. Thus, for example, between the main shocks at 16h11m and 16h12m (Greenwich time) on 13 X 1966, of magnitude 2, recorded by the seismogeological station of the city of Tashkent (V. I. Ulomov), the "Zemlya" stations noted 4 intermediate shocks of considerably lower intensity.
3. In a number of records from local earthquakes obtained in the central part of the city, for 1 sec. before the first arrivals, a complete disappearance of the seismic background is observed. This makes it possible to assume that in a number of cases the seismic background is caused not by industrial noise (as was previously believed), but by oscillations of the Earth's surface in the city center, possibly caused by the uplift of crystalline rocks of one of the central blocks of the Paleozoic basement.

To clarify this assumption, it is necessary to carry out borehole observations in the immediate vicinity of the foci of local earthquakes, making it possible to remove the background of industrial noise.

The data obtained on the structure of the crust beneath the city of Tashkent and on the location of the foci of local earthquakes, together with other types of geophysical investigations (magnetometry, gravimetry, repeated leveling of the Earth' s surface, etc.), make it possible to suppose that the cause of the Tashkent earthquake lies in the overthrusting of the northeastern central block of the crust onto the southwestern one in a narrow strip of NE strike.

Great assistance in carrying out work with the "Zemlya" stations was provided by the director of VNIIGeofizika, M. K. Polshkov; member of the collegium of the Ministry of Geology of the USSR, V. V. Fedynsky; Minister of Geology of the Uzbek SSR, Kh. T. Tulyaganov; Corresponding Member of the Academy of Sciences of the USSR, E. F. Savarensky; Deputy Minister of Geology of the Uzbek SSR, V. G. Garkovets; Chief Geologist of the Uzbek Geophysical Trust, B. B. Tal-Virsky; and Chief Engineer of the Tashkent Geophysical Expedition, A. G. Khvalovsky.

It was noted for the first time that high concentrations (0.5–4M) of salts

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*Note: Figure translations are in progress. See original paper for figures.*

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