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Catalogs of ground motion parameters for earthquake-prone regions in Kazakhstan

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Abstract: The catalogs of ground motion parameters for earthquake-prone regions of Kazakhstan used for modeling seismic effects in seismic hazard assessment and microzonation are presented.

Key words: ground motion parameters; analog and digital recording; strong motion network; stations with continuous recording

1 Introduction

Records of real ground motions during earthquakes, the processing of which provides data for databases and catalogs of parameters, form the experimental basis for predicting seismic effects in earthquake-prone areas. Regional observational networks allow us to study the dependence of seismic effects upon source characteristics and the wave propagation medium to enable ground motion predictions within the scope of general and detailed seismic zonation. Data from local networks can be used to study the nature of how local factors influence seismic effects to increase the effectiveness of seismic microzonation.

The most important part of our ground motion database comprises the parameters of accelerograph records provided by the local digital strong motion network that covers the territory of Almaty city and vicinity. In addition, record parameters of the earlier operated analog regional and local strong motion networks are available. Because of the relatively low recurrence of strong and medium events and locality of the digital strong motion network, the available data are not sufficient to model seismic effects for the required range of magnitudes and distances. To increase the amount of experimentally observed ground motion parameters in addition to strong motion records, we also parameterize the appropriate velocigrams recorded by the regional digital network with continuous registration.

All these parameters are included in 1) The catalog and the database of ground motion parameters from the strong motion networks and 2) the catalog of ground motion parameters from the continuous registration network.

2 Analog strong motion networks

In Kazakhstan, installation of strong motion instruments with analog registration of acceleration, velocity, and displacement began in 1970. The strong motion network was created after 1980. That analog network included a regional part consisting of 28 points in southern, southeast, and eastern Kazakhstan and a local part consisting of 8 sites located in different engineering-geological conditions within Almaty city and vicinity. In Almaty, in addition to stations of the Institute of Seismology, the engineering-seismological points of the Kazakh State Research Experimental Design Institute on Earthquake Engineering and Architecture (KazNIISSA) were operated. Sensors in the regional network were installed in the free field and in adits in rock; in the local network sensors were installed in the basements of

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two- to five-storey buildings on separated concrete pedestals, and the KazNIISSA instruments were installed in basements, on different floors, and on roofs of buildings. The layout of the analog regional and local strong motion networks, together with the recorded earthquakes (1970–1995), is shown in figure 1.

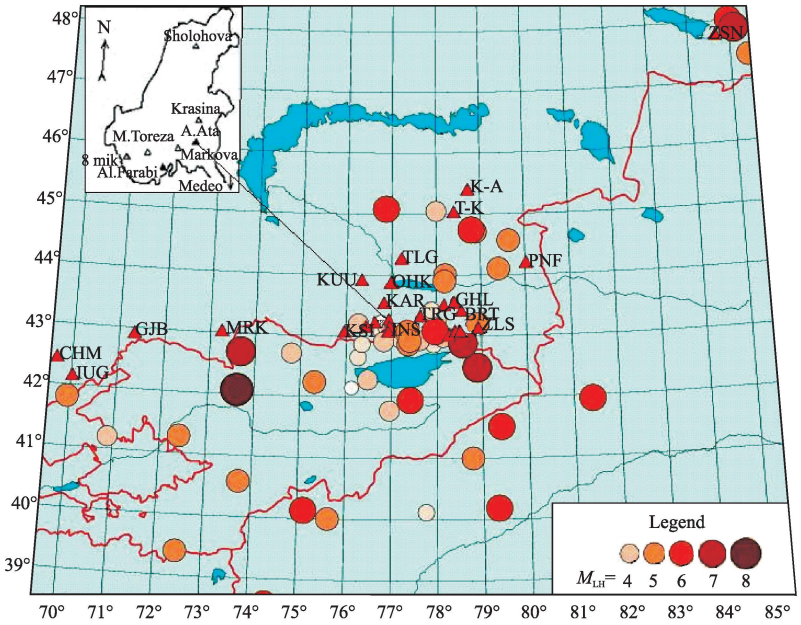

Figure 1 Analog regional and local strong motion networks together with the recorded earthquakes (1970–1995)

For the period of analog recording (1970–1995), parameters from 547 records of horizontal and vertical components from 69 earthquakes with magnitudes M_{LH} (magnitude from horizonal surface waves) of 2.0–7.5, epicentral distances of 28–600 km, and depths of 5–25 km are available[1]. Several deeper earthquakes occurred outside the Northern Tianshan territory. Recorded acceleration amplitudes varied from 0.1 to 80 cm/s^2. Peak ground accelerations of 675 and 537 cm/s^2 (Fig. 2) were recorded for the horizontal components by the KRM station located in close vicinity to the source of the 12.11.1990 Baisorun earthquake (M_{LH} = 6.3, R_e = 35 km). Other stations also recorded their strongest ground motions during that earthquake. The maximum directly recorded velocity of 14 cm/s was obtained by the KRM station during the same earthquake.

In addition to the catalog of parameters of the analog records[2], a complementary electronic catalog was compiled for events with energy classes $K \geqslant 12$ ($M_{LH} \geqslant 4.5$) recorded in 1970–1995 by the local and regional analog strong motion networks of Kazakhstan. A fragment of this catalog is shown in table 1.

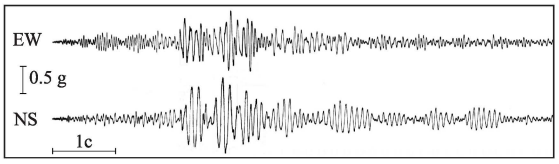

Figure 2 Analog accelerogram (SSRZ) recorded by the KRM station during the November.12.1990 Baisorun earthquake

3 Digital strong motion network

Since 2000 the digital strong motion network has operated within Almaty city and vicinity. The network includes 15 sets of accelerographs (Altus Etna, Kinemetrics, USA). The stations are located in different engineering-geological conditions. Their position with respect to fault systems and generalized types of subsurface sediments is shown in figure 3. Shear wave velocity and density characteristics of the upper 20 m soil layer at the stations[3] are shown in figure 4.

During the operation period of the digital strong motion network, 388 three-component records from 66 earthquakes were obtained and parameterized. Their magnitudes ranged from 2 to 5.9 (M_{PV}(magnitude from