

Experience and Prediction of Seismic Studies in Azerbaijan

Gurban Yetirmishli¹, Sabina Kazimova², Rugiya Kerimova³, Saida Ismaylova⁴

Republican Seismological Survey Center of ANAS, Baku, Azerbaijan

¹seys@azeuotel.com, ²sabina.k@mail.ru, ³rugijak@gmail.com, ⁴ismayilovasaida@gmail.com

Abstract— Seismicity of territory of republic during 2005-2011 is considered. The analysis of distribution of the allocated seismic energy on years, distribution of epicenters of earthquakes on the basis of what the estimation of an intense situation and seismic activity in republic territory is given is given. The analysis of mechanisms of the centers of strong earthquakes for the purpose of revealing of fields of pressure and earth crust deformations in очаговых zones is given. Experience seismic prediction researches for the purpose of revealing of seismo-abnormal effects in geophysical and geochemical fields is considered, the basic characteristic signs of display of seismo-abnormal effects are given. Experience of revealing of tensely - deformed seismogene zones under the geophysical data is considered. The new high-speed model for territory of Azerbaijan according to a network of seismo-telemetering stations is considered.

Keywords— earthquake; seismicity; geophysical fields; geochemical field; velocity model; digital seismic stations

I. INTRODUCTION

The beginning of instrumental seismological observations on the territory of Azerbaijan can be considered the end of the XIX century, when for the period from 1899 to 1905. Here was opened four stations. Further in 1903 by Nobel opened the station "Baki" and "Balakhani." After the catastrophic earthquake in Ashgabat in 1948, during 1949 and 1951. seismic stations were opened "Lankaran", "Ganja" and "Nakhchivan", and in 60-70 years opened the station "Chilov", "Mingechevir", "Pirgulu", "Sheki", "Zagatala" and "Quba". With the creation in 1980, when NC JIGE "Geophysics" network of seismic stations of the republic has expanded and opened another 7 stations. The dramatic qualitative shift in the direction of the seismic upgrade equipment and improve monitoring of seismicity of the territory of Azerbaijan is at the beginning of the XXI century, when, after a strong earthquake Caspian November 25, 2000 g, was purchased 14 sets of modern digital seismic telemetry stations the company «Kinometrics».

In 2008 with the aim of further development of seismological research by the Government of the Republic has been purchased an additional 7, and in 2010 another 10 sets of stations telemeter «Kinometrics» (USA), bringing the total number of telemeter stations of this type in the country to 31. Plans to open 3 telemeter stations in the Caspian Sea based on data from seismographs production «Kinometrics», 4 magneto-variational stations of «Geometrics» and 4 stations geochemical monitoring (Fig. 1). Establishment in 2011, the GPS

network of stations has opened up new prospects for the study of geophysical phenomena. The traditional task of GPS measurements is the study of slow processes in the aged form of the modern movements of the earth's crust and their other symptoms. Acquired particular importance of the problem of the Earth's surface movements of technogenic origin in the aspect of environmental conservation, landscape and environmental monitoring. Current study were the problems of geodynamics of seismically active zones in the territory of Azerbaijan, the study of deformation processes at the stage of fracture (Fig. 1a).

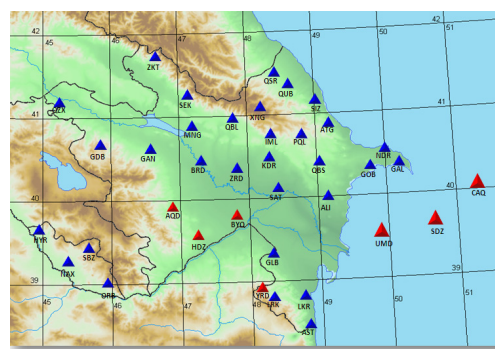


Figure 1. Monitoring distribution map of Azerbaijan seismological Service.



Figure 1a. Map the distribution of GPS stations.

II. SCIENTIFIC AND PRODUCTION ACTIVITIES OF RSSC

Research and production activities of the Centre is carried out in two directions:

1. monitoring of seismic activity in the republic, the study of kinematic and dynamic parameters of the seismic field, the distribution of the epicenters of earthquakes and seismic

energy, seismic risk assessment, focal mechanism of earthquakes and seismotectonics clarification of elements:

2. monitoring the spatial and temporal variations in the geophysical and geochemical fields to identify and study the manifestations seismo-abnormal effects of geophysical and geochemical fields and evaluation of the stress-strain state of seismogenic zones. The subject of research here are the parameter τ (Tau), variations of the geomagnetic field intensity, the increment of the gradient of the geomagnetic field, non-tidal variations in the gravitational field and the second derivatives of the gravitational potential, as well as hydrogeochemical parameters, and gaz-geochemical radio-geochemical fields. Seismic monitoring is conducted in real-time transmission of information via satellite communications.

RSSC is a member of such international seismological agencies, as IRIS (United Research Institutions for Seismology), Orfeus (Observatory research and services for Seismology in Europe) and EMSC (European-Mediterranean Seismological Center). The Center supports research links with institutions from 13 countries worldwide.

III. SEISMICITY OF AZERBAIJAN DURING 2005-2011 YY.

Seismicity of the territory of the Republic for the period 2005 to 2011.

Seismicity of the territory of the Republic for the period 2005 to 2011. has been uneven both in the number of earthquakes, and released on their hearths total seismic energy (Fig. 2). The number of earthquakes reached anomalous values in 2010. due to the increase of weak seismicity. The greatest energy during this period was allocated in 2007. ($E = 73.9 \cdot 10^{11}C$) [1].

This suggests that activates seismo-tectonic events, there are some shifts in the tectonic structures that are realized in a tangible form of score 6.5 earthquake.

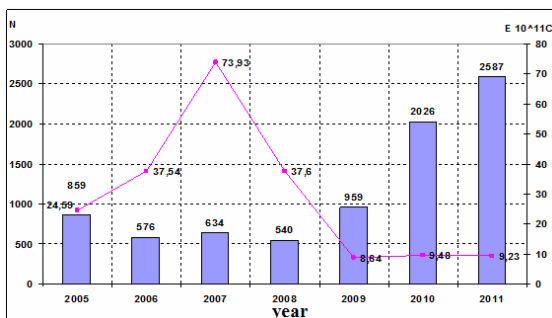


Figure 2. Graph of distribution of earthquakes and released energy on an annual basis over the period 2005-2011 yy.

In order to study stress and strain fields crust we conducted an analysis of earthquake focal mechanisms (Fig. 3). Focal mechanisms were calculated on the program «PPFIT» of «Kinematics.»

In fig. 4 shows an example of the construction of the mechanism of the earthquake source in the format of 3D.

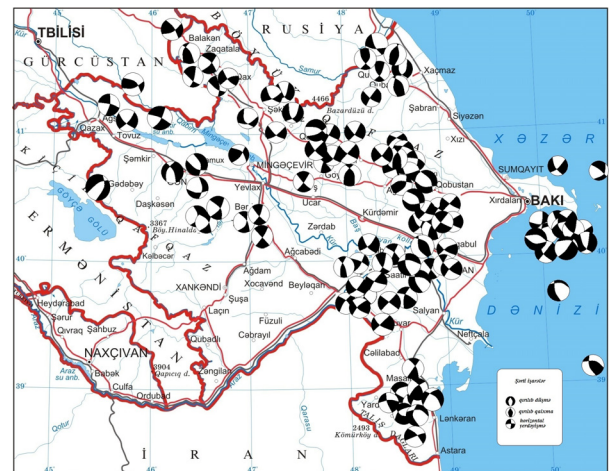


Figure 3. Mechanisms of earthquake Azerbaijan with $m > 2.5$ for the period 2005-2011.

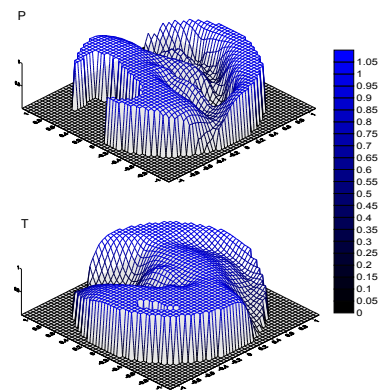


Figure 4. Three-dimensional model of the mechanism of earthquake 01/01/2010 ($M = 4.6$, the Caspian Sea).

In the study of velocity structure of the crust of Azerbaijan on seismic data used in basically two approaches. The first is to clarify the model of the medium on the basis of the observed deviations of travel times of waves from the earthquake relative to the standard locus. The second is based on the difference in travel times from source to the station for groups of closely spaced events (fig. 5).

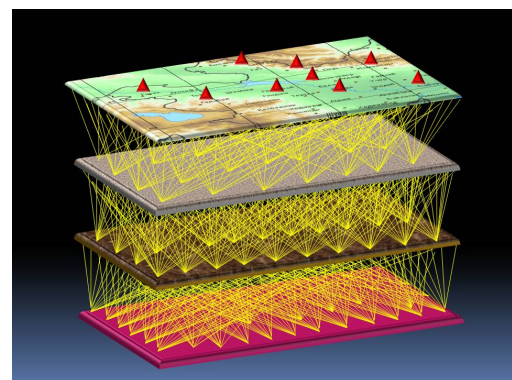


Figure 5. The three-dimensional pattern of distribution of seismic rays in the tomographic inversion.

One-dimensional velocity models of P and S waves were constructed on the basis of one-dimensional models proposed in Gasanov A.G. Construction of the model, the calculation of station corrections and location events produced by the program Velest. The test volume to a depth of 60 km was divided into small sections of a thickness of 2 km in the depth range 0-10 km and 5-10 km thick at depths of 10-60 km. The study dealt with seismological data on the parameters of local earthquakes and the arrival times of P and S waves recorded network of telemetry stations for the period 2004-2011. Data were analyzed with 28 seismic stations in Azerbaijan, covering the entire study area. To calculate the three-dimensional velocity field program was used TomotetraFD [2]. This program implements a classic Seismic method for the case where sources and receivers are located within the study area (fig. 6).

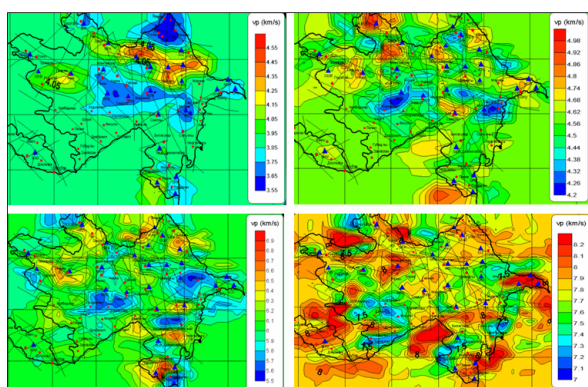


Figure 6. Horizontal shear of velocity model of the territory of Azerbaijan at a depth of 3, 8, 15, 40 km.

In order to identify potential zones of strong earthquakes and the prediction of seismic activity analyzed the results of calculations of the kinematic precursor V_p/V_s [3].

Monitoring and calculation of kinematic parameters (TAU) is estimated in two versions -the short version in the form of the curve parameter variation in time and in the long runs the results of mapping the area of the parameter ξ . Forward curves are calculated and analyzed quickly, in near real time. Found that the kinematic precursors precede the strong events in the time interval from 1 day up to 10-20 days. On the prediction curves of V_p/V_s number of stations observed anomalies in a good strong earthquake with $M = 7.2$ near Van Eastern Turkey. As an example, shows the curves of station Gedebe (fig. 7).

Watching the parameter ξ in space and time, you can identify the time period where the fluctuations are maximal values, and conducting mapping of parameter space, delineate anomalous zone.

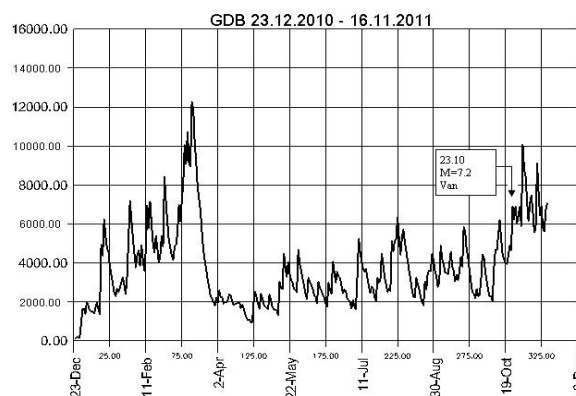


Figure 7.

By comparing the results of calculation of the parameter maps, we can highlight are as where large negative anomalies are observed at several stations for a long time. This is, first of all, the anomaly near Shamakhi. Another predictor of impending earthquakes is the presence of gradient zones - areas of change in the sign of the anomalies from positive to negative. In the presented maps is of Sheki-Shamakhi and the border with Dagestan region (Fig. 10, 10a).

Long-term precursor forms an anomalous zone in the time from several months to 5-10 years, depending on the tectonic structure of the region and the energy of the upcoming events. This allows you to deploy a system of observations of short-term precursors.

IV. CONCLUSION

Analysis of the seismic regime in the republic, allowed to identify the major seismically active area. This is the south-eastern part of Great Caucas mainly Shamakhi-Ismayilli zone, as well as the Oguz-Gabala-Sheki and Zagatala zone. Spotted a new Gobustan zone of seismic activity in the area of articulation and Great Caucas Kur depression. Increased seismic activity persists in northern Less Caucas (Talış) and on the border with Iran, the territory of Nakhchivan Autonomous Republic. Increased seismic activity indicated the central part of the Caspian basin.

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