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Yu. N. Godin, I. S. Volvovskii, V. Z. Ryaboi

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Abstract

Full Text

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GEOPHYSICS

Academician of the Academy of Sciences of the Turkmen SSR **Yu. N. Godin**, I. S. Volvovskii, V. Z. Ryaboi

SOME RESULTS OF THE USE OF DEEP REFLECTED WAVES IN THE STUDY OF THE EARTH' S CRUST

Work on deep seismic sounding (DSS) ([1]) up to 1957 was carried out using a system of piecewise-continuous profiling (on land) and point soundings (at sea). Observation systems in piecewise-continuous profiling and point soundings make it possible to carry out only group correlation of waves and cannot provide great detail in interpretation. At present, the DSS methodology is based mainly on the recording of head waves and post-critical reflected waves during their continuous tracing. The latter leads to the need to use correlation systems of travel-time curves extending up to 300 km or more and a large number of shot points. The size of the explosive charges used in this case reaches 2–3 tons of explosive material. Naturally, the solution of a number of such tasks as crossing mountain ranges and hard-to-access regions, and conducting DSS investigations on short profiles (less than 100–150 km), proves to be very difficult, and sometimes impossible.

Fig. 1. Comparison of hodographs of post-critical reflected waves with hodographs of head waves and post-critical reflected waves (shot point

Diagram of hodographs of reflected and postcritical waves.

Figure 2: Diagram of hodographs of reflected and postcritical waves.

Tedzhen). Hodographs of head waves corresponding to boundaries of the section: 1 –in Mesozoic-Cenozoic deposits, 2 –in Upper Paleozoic deposits, 3 –in Lower Paleozoic deposits, 4 –in "granite-

In this connection, in 1960-1961 the All-Union Institute of Geophysical Prospecting Methods, in collaboration with the Department of Exploration Geophysics and Seismology of the Academy of Sciences of the Turkmen SSR, carried out experimental-methodological studies in southeastern Turkmenia on the recording of deep reflected (postcritical) waves.

The experimental studies were conducted in the southeastern part of the Predkopetdag trough along the Dushak–Dzhu–Dzhu–Klu profile, which is the southwestern continuation of the G.S.S. profile Tedzhen–Karabekaul, on which observations were carried out in 1958 ([3]). The development of the methodology was carried out simultaneously with the study of the deep structure of the Earth' s crust in the area of junction of the Alpine folded zone of the Kopet-Dag with the Epigercynian platform.

"nom" layer, 5 –in the "basalt" layer, 6 –in the subcrustal layer (the Mohorovičić surface and deeper), 7 –hodographs of waves reflected from the Mohorovičić surface at the critical angle, 8 –hodographs of postcritical reflected waves, 9 – hodographs of reflected waves constructed from data of laboratory application of the R.N.P. method, 10 –theoretical hodographs of reflected (postcritical) waves

The observation system that was used ensured continuous correlation tracing of postcritical reflected waves corresponding to interfaces located within the crystalline mass of the Earth's crust. To distinguish deep reflected waves against the background of regular wave disturbances, directional reception was used (grouping of seismoreceivers and sources exciting seismic oscillations), as well as a laboratory modification of regulated directional reception (R.N.P.) of seismic waves.

The grouping parameters used (grouping base 200-400 m, number of elements in the group 9, distance between elements in the group 25-50 m) were calculated on the basis of the frequency theory of grouping ([2]). The kinematic and dynamic characteristics of disturbance waves and reflected waves in the region of their joint recording, used in these calculations, were obtained from data of the laboratory application of the R.N.P. method. As a result of the use of these methodological techniques, three main groups of deep reflec-

reflected waves corresponding to discontinuities in the "granite," "basalt," and "subcrustal"layers. Waves having similar values of apparent velocities and recording times, as well as dynamic characteristics that differed little (amplitudes, frequencies, trace forms), were combined into groups.

Fig. 2. Composite seismic section along the DSS profile, Dushak–Tedzhen–Karabekaul.

Figure 3: Fig. 2. Composite seismic section along the DSS profile, Dushak–Tedzhen–Karabekaul.

Identification of the selected waves was carried out by comparing the travel-time curves of precritical reflected waves with the corresponding travel-time curves of head waves and postcritical reflected waves recorded from the Tedzhen shot point during the 1958 DSS investigations along the Tedzhen–Karabekaul profile (Fig. 1).

Fig. 2. Composite seismic section along the DSS profile, Dushak–Tedzhen–Karabekaul. **1** –boundaries of discontinuities in the Earth' s crust according to reflected-wave method (RWM), correlation refracted-wave method (CRWM), and DSS data; **2** –conditional reflecting horizons according to DSS and RWM data (1961); **3** –boundaries constructed from uncertain material; **4** –zones of anomalous attenuation of the seismic record, possibly associated with deep faults; **5** –disjunctive disturbances according to geological data

Each of the wave groups, in turn, consisted of 2-3 groups corresponding to intermediate boundaries in the layers of the Earth' s crust. In addition, waves reflected from discontinuities located in the basement and in the lower part of the platform formations in the depth range of 5-15 km were distinguished. Assignment of the selected waves to single reflected waves was carried out on the basis of studying their kinematic and dynamic characteristics and analyzing the values of effective velocities.

As a result of the investigations, velocity and seismic sections of the Earth' s crust were studied and constructed (Fig. 2). The seismic section is presented as···

locally with the results of DSS studies on the Tedzhen–Karabekaul profile*. As is clear from consideration of this section, the identified reflecting horizons correlate well with the principal boundaries of the Earth' s crustal section constructed from data on head waves and postcritical reflected waves. The use of postcritical reflected waves makes it possible to study the structure of the Earth' s crust in greater detail and to identify intermediate boundaries of the section not only in the layers of the Earth' s crust, but also in the upper part of the subcrustal layer down to 60 km and more.

It was found that, toward Kopet-Dag, all deep boundaries of the section subside, and the thickness of the Earth' s crust increases to 55 km. In the southwestern part of the profile there is a sharp increase in the dip angles of the reflecting horizons from 2-3° to 5-8°. A zone of complication and anomalous attenuation of the seismic record, possibly associated with a deep fault, is also confined to this same segment.

Department of Exploration Geophysics and Seismology
Academy of Sciences of the Turkmen SSR

All-Union Scientific Research Institute
of Geophysical Methods of Exploration

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* The materials of DSS studies on the Tedzhen–Karabekaul profile (1958) were reinterpreted in 1961 on the basis of the currently existing concepts of the physical nature of the recorded deep waves.

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