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Abstract

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PROPAGATION VELOCITIES OF LONGITUDINAL SEISMIC WAVES ALONG THE MOHOROVIČIĆ DISCONTINUITY FOR THE TERRITORY OF THE USSR

(Presented by Academician A. L. Yanshin, October 3, 1968)

In recent years, at the All-Union Scientific-Research Institute of Geophysical Methods of Exploration, thematic work has been carried out on the generalization and analysis of seismic sections obtained in conducting DSS investigations on the territory of the USSR and in neighboring countries. One element of these investigations was the compilation of a map of the distribution of the limiting velocities of longitudinal seismic waves along the Mohorovičić discontinuity, V_{Γ} . The value V_{Γ} is one of the most accurately and stably determined velocity parameters of the medium in DSS.

In compiling the map, all DSS profiles carried out in the USSR from 1949 to 1968 on which values of V_{Γ} were determined were used, as well as the results of deep seismic investigations in neighboring countries (Hungary, Norway, USA (Alaska), Finland, Japan) ⁽¹⁾. The overwhelming majority of determinations of V_{Γ} values in the USSR were made quite reliably, using reciprocal traveltime curves of refracted (weakly refracted) waves from the Mohorovičić discontinuity, P . In some cases the values of V_{Γ} were determined less accurately—from apparent velocities measured from single traveltime curves of P waves. The absolute errors in determining V_{Γ} , caused by errors in determining wave travel times and by various random factors, may on average be estimated as being on the order of ± 0.1 km/sec.

In the geological-geophysical interpretation of the parameter V_{Γ} , it should be borne in mind that it characterizes the propagation velocity of waves in the very upper part of the mantle, in a layer with a thickness on the order of several kilometers. As studies of recent years have shown, P waves in most cases are not head waves, but weakly refracted waves, and in their propagation penetrate into the upper part of the mantle.

In compiling the map of V_{Γ} values (Fig. 1), isolines were drawn, taking into account the accuracy of determining V_{Γ} , at intervals of 0.2 km/sec; greater weight

was assigned to values of V_T obtained from more complete and detailed observation systems. In addition to isolines, this map uses hatching to distinguish zones of normal ($V_T = 8.0\text{--}8.2$ km/sec), high ($V_T \geq 8.2$ km/sec), and low ($V_T \leq 8.0$ km/sec) values of V_T .

The map indicates significant seismic heterogeneities of the upper mantle, which undoubtedly have a regional distribution. At the same time, the distribution of such heterogeneities reveals a connection with major elements of the geological structure. Thus, within the continental regions (the western part of the map), an extensive block of structures is distinguished for which high values of V_T are characteristic. It encompasses the area of distribution of the Paleozoic folded structures of the Urals and Trans-Urals, as well as Central, Northern, and part of Southern Kazakh-

stan. This block also includes the Cis-Ural marginal trough and the adjoining part of the East European Precambrian platform. Within this block, which occupies an extensive area, the values of V_T vary from 8.3 to 8.7 km/sec. Common to most of this block is the unity of age (Caledonides and Hercynides) and strike of the structures of the consolidated basement, as well as the strike of the isolines of V_T .

This block is contrasted by the regions of ancient (Precambrian) platforms—the East European and Siberian platforms and the eastern half of the West Siberian epi-Paleozoic plate (with a Baikalian complex developed in the basement)—where the values of V_T vary within a narrow range (8.0–8.2 km/sec), which apparently indicates a significant homogeneity of the upper-mantle material in zones of ancient platform stabilization. Most likely, the same features in the distribution of V_T values are also characteristic of the areas of neotectonic activation of the Paleozoic folded structures of Central Asia (Tien Shan, Northern Pamir) and southern Siberia (Kuzbass, Gornaya Shoriya, possibly Altai), which probably points to the closeness of V_T values in zones of mountain roots (usually 8.0 km/sec). As the available data show, analogous values of V_T are also observed at the base of the mountain roots of the Caucasus, the Carpathians, the Alps, and some other mountain-folded structures of Europe ^(1,2).

The Turanian and Scythian epi-Paleozoic platforms, together with the southern margin of the East European platform adjoining the latter, are characterized by substantially different features. Here a banded distribution is observed of average (8.0–8.2 km/sec) and higher (8.3 km/sec and above) values of V_T , which apparently controls the position of large structural elements of the folded basement. In particular, high values of V_T are located in the marginal (fault) zones that bound the Dnieper–Donets aulacogen. They are observed within the Karabogaz arch and the Buzachi uplift, apparently in the area of the Karpinsky swell. The zone of Alpine folding in the south of the USSR is also characterized by distinctive features, where elevated values of V_T are confined to comparatively small areas of negative structures—namely, to the central part of the Black Sea, Kurinsko-Rion, and South Caspian depressions, as well as to the Cis-Kopetdag marginal trough. It is noteworthy that here the maximum values of V_T occur ei-

Map of the territory of the USSR showing velocities of longitudinal seismic waves along the Mohorovičić surface. Legend: 1-6.

Figure 1: Map of the territory of the USSR showing velocities of longitudinal seismic waves along the Mohorovičić surface. Legend: 1-6.

ther in areas lacking a granitic layer, or in areas with a relatively small thickness of the consolidated part of the Earth' s crust.

The data presented on the distribution of V_r values allow one to suppose that tectonic processes exerted a decisive influence on this geophysical parameter. Such a conclusion brings us closer to determining the age of formation of the mantle material and to substantiating the hypothesis concerning the determining influence of the latter on the formation of structures of the Earth' s crust.

In the transition zone from the Asian continent to the Pacific Ocean (the eastern part of the map), a close connection is also observed between the values of V_r and the position of the main elements of geological structure. This is supported by the fact that the plate of the western margin of the Pacific Ocean lacking a granitic layer (the Pacific thalassocraton) is distinguished by high values of $V_r = 8.3-8.7$ km/sec.

Fig. 1. Schematic map of boundary velocities of propagation of longitudinal seismic waves along the Mohorovičić surface V_r for the territory of the USSR and neighboring countries. **1** –values of V_r in km/sec (shown at the places of their determination on DSS profiles); **2** –isolines of boundary velocities; **3** – assumed position of isolines of boundary velocities; **4** –values $V_r \leq 8.0$ km/sec; **5** –values $V_r = 8.0-8.2$ km/sec; **6** –values $V_r \geq 8.2$ km/sec.

Apparently, the deep-water part of the Bering Sea basin, likewise without a granite layer, possesses an analogous feature. The outer (near-oceanic) part of the Kuril-Kamchatka and Japanese deep-water trench zone is distinguished by average values of V_g (8.0-8.2 km/sec), whereas the region of the Aleutian, Kuril-Kamchatka, and Japanese island arcs is characterized by reduced values of V_g (8.0 km/sec and less). At the same time, areas with sharply reduced values of V_g tend toward the main regions of volcanic activity and high seismicity (the Southern Kurils, Kamchatka), as was also recently noted by S. A. Fedotov and L. B. Slavina ⁽³⁾. Reduced values of V_g are found in the broad rear zone of the island arcs, encompassing a considerable part of the structures of the Sea of Okhotsk and the Sea of Japan, where the thickness of the Earth' s crust is small (20 km and less) and where the granite layer has a reduced thickness or is altogether absent.

In the region of Mesozoic folding within the Kolyma Mountains and Sikhote-Alin, and in the region of Cenozoic folding within Sakhalin, where the thickness of the Earth' s crust is considerable and where the granite layer is well developed, as the

still rather few data show, the boundary velocities vary within the range 8.0-8.2 km/sec. The clear separation of the zone of reduced V_g values in the transition from the Asiatic continent to the Pacific Ocean and its association with the region of the most active manifestation of seismicity and volcanic activity most likely testifies to the youth of the processes of reconstruction (or formation) of the material of the upper mantle in this region. As follows from the foregoing, the regularities in the distribution of V_g values within the western regions of the USSR, Kazakhstan, Central Asia, and Siberia, on the one hand, and the transition zone from the Asiatic continent to the Pacific Ocean, on the other, differ substantially; this evidently corresponds to differences in the types and directions of tectonic processes.

Comparison of the results obtained with data on the distribution of V_g values for the USA ⁽⁴⁾ confirms the conclusions drawn. The North American platform, like the ancient platforms of Eurasia, is characterized by values of $V_g = 8.0-8.3$ km/sec, whereas the regions of young tectonic deformations of the Californian rift zone and of the "basins and ranges" province within the Rocky Mountains have lower values of this parameter (7.8 km/sec), as also does the northwestern sector of the transition zone from the Asiatic continent to the ocean characterized above (Fig. 1).

For the regions of the USSR considered, and likewise for the area of the USA, there is apparently no correlation between the values of V_g and the depths to the Mohorovičić surface, which is established by comparing the corresponding maps of the depth of the Mohorovičić surface ^(4,5) with maps of the distribution of boundary velocities along the base of the Earth's crust. Comparison of V_g values with the anomalous gravitational field gives grounds to suppose that the territorial distribution of V_g is almost not correlated with gravitational anomalies in the Bouguer and Faye reductions. The question of a possible correlation between the values of V_g and gravitational anomalies referred to the Mohorovičić surface requires special investigation.

Summarizing the foregoing, it should be noted that the values of the geophysical parameter V_g are unquestionably important both for studying the relations between the Earth's crust and mantle and for elucidating the time of formation of the material of the upper mantle.

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CITED LITERATURE

1. R. G. McConell, P. D. McTaggart, *Cowan Crystal Seismicrefraction Profiles*, Toronto, 1963.

2. N. A. Belyaevskii, *Sov. Geol.*, No. 6, 169 (1968).
3. S. A. Fedotov, L. B. Slavina, *Fiz. Zemli*, No. 2, 8 (1968).
4. L. C. Pakiser, I. S. Steinhart, *Res. in Geophys.*, 2, 1964.
5. N. A. Belyaevskii, A. A. Borisov, I. S. Volvovskii, *Sov. Geol.*, No. 11, 56 (1967).

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