Method of Spatial Observations of RNP Under the Conditions of the Reef Zone of the Orenburg Cis-Urals

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The main trend in geophysical work in the Orenburg Cis-Ural area is toward exploration for reef masses in the Sakmaro-Artinsk sediments. At the present time a geophysical exploration program has been formulated that consists of gravity and electrical surveying and also seismic surveying using refraction and reflection (in the RNP modification).

The necessity for such a program is governed first of all by the complex seismogeologic conditions of the Cis-Ural downwarp: the sharply expressed salt tectonics of the halogen Kungur, the discordance of structural plans of the Kungur and Sakmaro-Artinsk sediments, and the non-reflecting, non-uniform seismic character of the interfaces.

The presence in the section of boundaries with complex configuration, steep angles of dip (up to 70° and more) with sharp angular discordances relative to one another, cause the appearance in the seismic record of waves that arrive not in the vertical plane of the profile, “lateral waves.” During the process of profile observations by the RNP (Regional Directional Reception) method such waves (identified by means of transverse “cross” observations) are eliminated from detailed interpretations; this reduces the quality of the seismic material and consequently also the geological results.

In connection with this, an important practical task of seismic surveying in the area of the Cis-Ural downwarp is the testing of schemes of spatial (three-dimensional) observation as well as methods of spatial interpretation. The present paper describes work carried out toward these ends in 1960-61 by parties of VNIIgeofizika.

Spatial observations by RNP were carried out in a region of reef uplifts revealed by data of RNP profile observations. The region selected was characterized by favorable surface conditions and gentle, practically horizontal dips of the top of the Kungur sediments (depth of 350-400 m).

The scheme of observation secured a maximum interrelationship between short profiles and individual cross soundings. See Fig. 1. The main parameters of the scheme of observations were the shot intervals at 200-400 m and the distance between seismic receivers at 25 m. The cross soundings, consisting of two or four receiver bases, were set up for each shot point simultaneously. All observations were carried out on rectilinear bases.

Analysis of materials on spatial observations and cross sounding that are introduced into the usual scheme of observations on RNP profiles showed that most of the summation bands register lateral waves largely in the 0.8 to 1.2 sec interval; this corresponds to the time of arrival of the Artinsk waves.

On a single summation band the increment of time ($\delta t$) at non-longitudinal stations has both positive and negative values, varying over a considerable range.

In comparing the summation bands it is often not possible to distinguish one and the same wave on different bases of cross sounding.

In comparison of the gradients of time of a reflected wave $\tau = \delta t / \delta x$ for different azimuths (Fig. 2, f), rarely was their regular distribution observed (Fig. 2, c). Generally with determination of the values and alignment of $\tau_s$ according to its projection, an area of dispersion was obtained, the value of which served as a criterion for the reliability of determining the total vector $\tau_s$. See Fig. 2, d. Further, soundings are encountered for which the complete vector-gradient $\tau_s$ determined by projection is in sharp disagreement with other projections (with one and the same time of registration $\tau_s$). See Fig. 2, e.

With comparison of the values of the time gradients on reception bases of different length (from 100 to 200 m), a disagreement in these values was generally observed as to magnitude and sometimes also in direction.

The factual data are not yet completely clarified. Nevertheless the main factors affecting the character of the data can be stated. As has been mentioned, the work on spatial RNP observations was carried out in sectors with simple relief and a well expressed thin zone of low velocity; therefore, the effect of the relief and of surface irregularity could not greatly affect the results. Under similar conditions the main factors affecting the character of the information obtained appear to be the presence in the section of sharp, rough interfaces of complex configuration which give rise to seismic waves with irregular form of oscillation behind the front, with complex “surface” traveltime curves (1). This may be related to some of the inconsistencies obtained on receiver bases of different