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DEEP STRUCTURE OF THE CENOZOIC BASINS FROM MICROSEISMIC SOUNDING DATA: TUNKA BASINS GROUP (BAIKAL RIFT SYSTEM) CASE STUDY

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ABSTRACT

In this paper, the horizontal-to-vertical spectral ratio method of spectral ratios used to refine the structure of the group of rift basins.

INTRODUCTION

This work is devoted to the study of the sedimentary basins and structures of the Tunka group of south-western flank of the Baikal rift system. Basins form a latitudinal chain and separated by low spures-uplifts. In cross-section of basins have typical rift lacustrine, alluvial, volcanogenic sediments and basalt flows. In the largest basin – Tunka – the thickness of sedimentary cover is greater than 2000 meters (Logatchev, Zorin, 1978).

We used the data of microseismic sounding in comparison with the data of drilling and structural observations. The Horizontal-to-Vertical Spectral Ratio (HVSR) method, also called Nakamura's method (Nakamura, 1989), is a single-station approach using ambient vibration measurements to estimate the fundamental frequency of a site. For site conditions where there is a strong contrast in velocity between the surface layer and a deeper material a peak will be observed in the HVSR plot that closely corresponds to the fundamental frequency of the site. This method has been used extensively in microzonation studies of cities around the world. The method allows to evaluate of the angle of incidence faults, forms the basement, to reveal heterogeneity of medium.

In the present study we consider three profiles: An_profile (in Bystraya basin), T_profile (Tory basin) and sub-longitudinal N_profile (Fig. 1). Sounding profiles were traversed in the inner parts of basins, as well as across strike limiting their faults.

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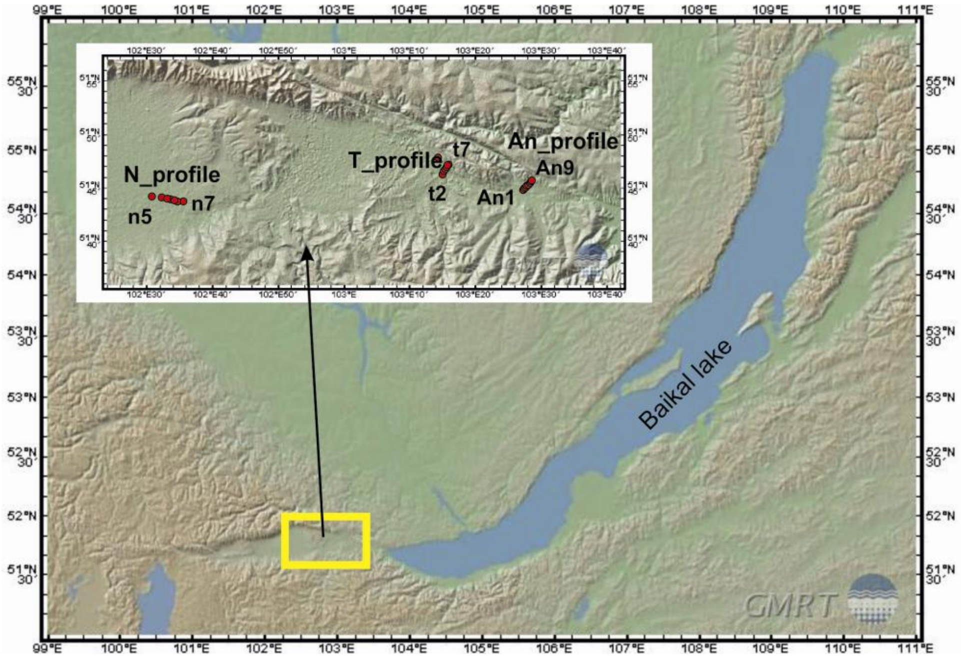

Figure 1. Study region (shown by yellow box).

RESULTS AND DISCUSSION

Sublatitudinal cross-section along the left side of the Irkut river valley in the Tunka basin showed large differences in the composition and the constitution of one in the eastern and western parts (Fig. 3). West, the deepest part of the basin, is composed by mainly of soft enough, and at the bottom - denser sediments. Basement here is at a depth of 1000 meters. To the east reveals a sharp uplift of basement along the fault of reverse or thrust type, which corresponds to the oblique bedding of sedimentary layers in the lower part of the section. Still further to the east there is a gradual rise of the basement, which corresponds to the modern relief of the western slope Elovsky spur. Here, in the upper part of the section are allocated high density layers, which correspond to basalt flows established by drilling and geological observations.

Submeridional section across the Tory basin revealed a number of interesting features of its internal structure (Fig. 3). Southern side of basin is limited by a step-like system of normal faults. The maximum depth of the basement reaches 2000 meters. In the middle part of the section under the horizontally lying soft sediments revealed a thick lens-like dense body. It can be compared with basalt flows in the Tunka basin. The presence of basalts in sedimentary infill of the Tory basin was not known before. From the north basin is bounded by a series of sub-vertical faults, some of which are morphologically related to reverse faults. Geomorphological and structural data established the presence of left-lateral strike-slip component of displacement along these faults. Similar structure of the northern border of the Tory basin was confirmed by the data sensing on its eastern edge.

Located to the east Bystraya basin is characterized by low sediments thickness (Fig. 3), indicators of the presence of basalt flows in the basin is also not found. North-west trending faults bounding the northern border of basins and internal faults morphologically expressed as reverse faults. According to structural and geomorphological observations the left-lateral strike-slip component of Late Pleistocene-Holocene displacement is detected along the faults.

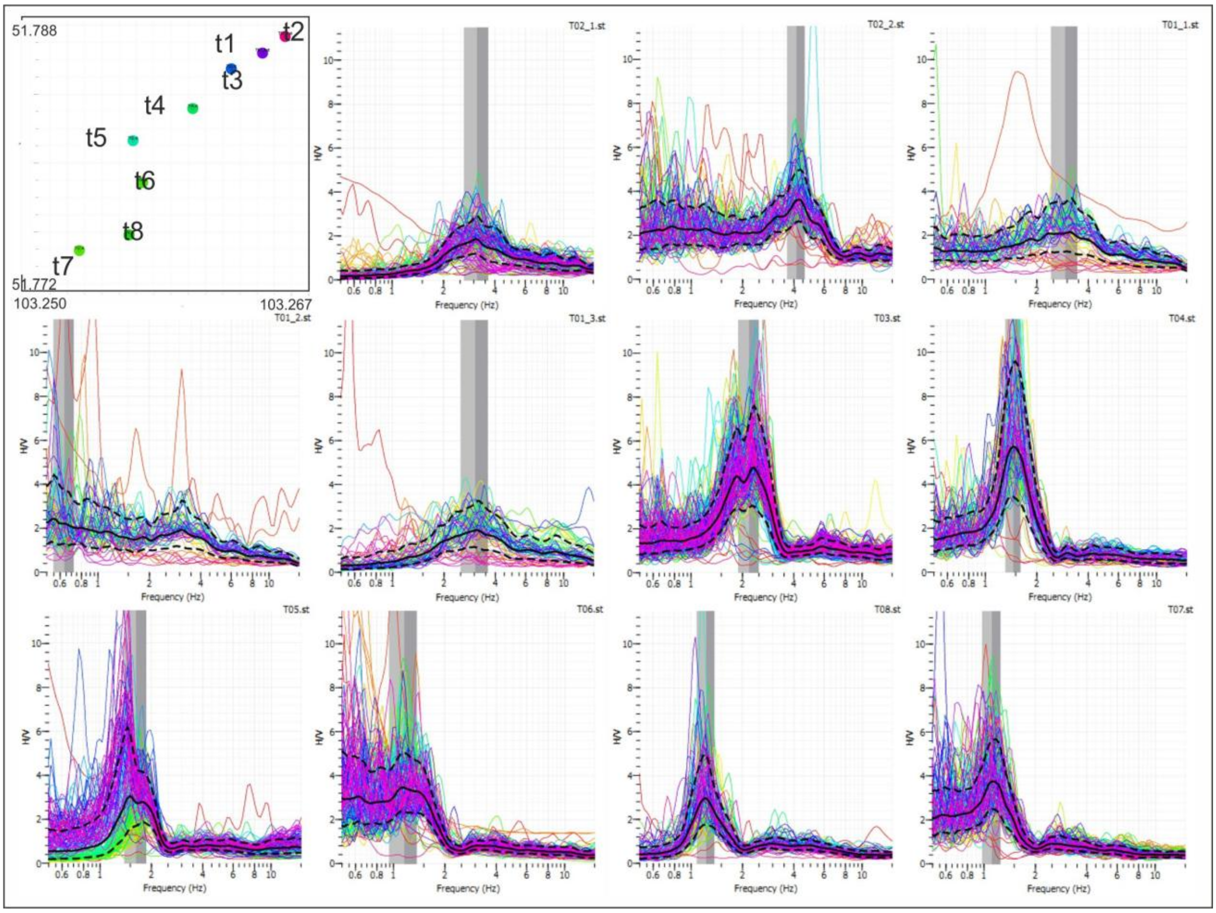

Figure 2. Examples of H/V ratio plots for the profile T (Tory basin).

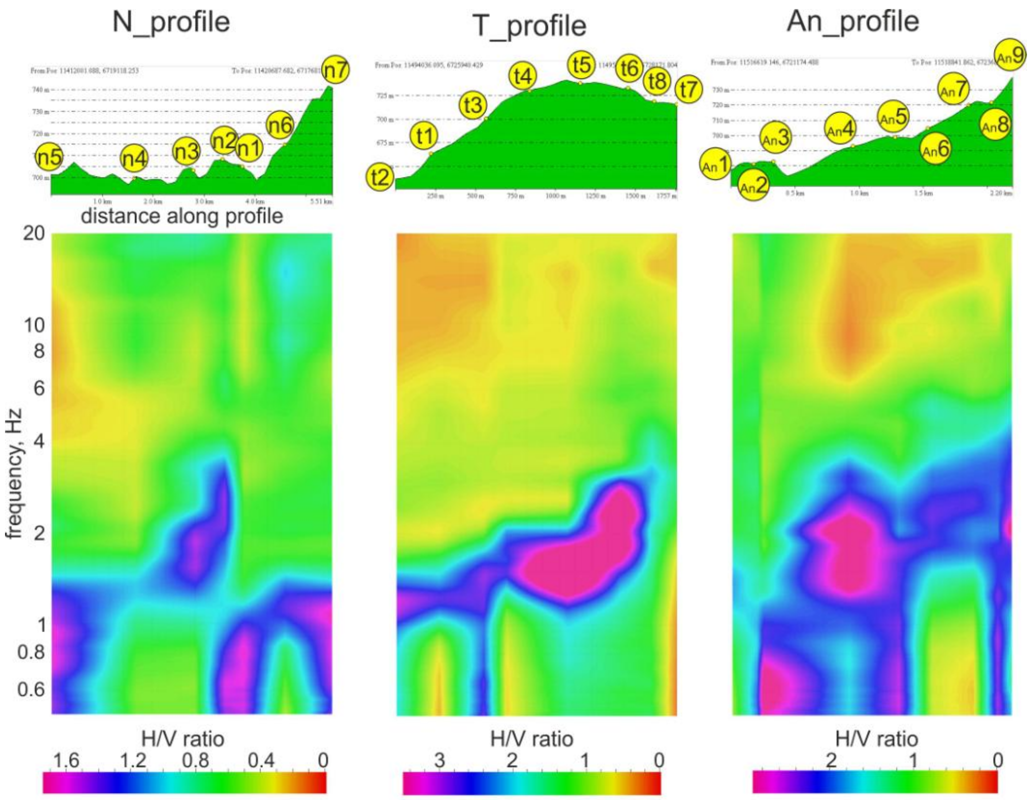

Figure 3. Cross-section along profiles (points of measurements shown by yellow rounds, upper part – elevation).

CONCLUSIONS

As a result of the investigation, we came to the following conclusions:

1. Based on comparable thickness of sediments in the Tunka and Tory basins, as well as the presence in their sections of basalt flows at an early stage of development (Oligocene - Miocene?) basins could be a single structure, which has been divided by Elovsky spur only in the late Pliocene.

2. There are the fundamental differences in the compositions of the section in the western and eastern parts of the Tunka basin. Western (the deepest part) of the basin, obviously does not contain basalt flows.

3. Found that the northern borders of the Tory and Bystraya basins are controlled by steeply dipping strike-slips and reverse faults with strike-slip component. Normal faults with NE and sublatitudinal orientation identified along the southern sides of the basins contributed subsidence of their bottoms. Activation of reverse and strike-slip faulting along north-west trending structures in condition of additional compression contributed to the inversion of the Bystraya basin lifting in the Pleistocene – Holocene basin.

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