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GEOLOGY

Tectonic Evolution of the Southwestern Wall of the Baikal Rift Zone

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We investigated the evolution of the southwestern wall of the Baikal Rift Zone (BRZ) based on the seismic structure of the sedimentary cover beneath Lake Khubsugul (Mongolia), a marginal member of the BRZ. The Khubsugul Depression formed along the boundary between the Riphean Tuva–Mongol microcontinent and the Early Paleozoic mobile zone [1]. The Khubsugul Depression is a semigraben with steep western and gentle eastern walls [2]. At present, the depression represents a lake with an average depth of approximately 140 m [3].

Our work is based on the results of high-resolution seismic profiling (more than 390 km of profiles), which makes it possible to examine the structure of bottom sediments with a resolution of ~0.5 m [5], and KDP-01 data on the 53-m-thick core from the lake center [5].

Results of the study of bottom sediments from the Khubsugul Depression indicate that the Brunhes–Matuyama paleomagnetic boundary in the KDP-01 core is located at a depth of 40.5 m and the average sedimentation rate is 5 cm/ka [6]. The core recovered seismic complexes of units 1–6 characterized by the maximal number of destructive surfaces. Extrapolating the data on the sedimentation rate of the subsequent units, we can assume that the lower seismic complex of the sedimentary cover (unit 9) formed not earlier than 5–5.5 Ma ago (Fig. 1a). However, the older units are characterized by coarser-grained sediments and, consequently, higher sedimentation rates. Hence, the age mentioned above may be overestimated. The younger age of Lake Khubsugul is also evident from the overlapping of ~9.5-Ma-old basalts [7] on the western coast of this lake by sediments of unit 9.

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Based on the relationships between the dip angle of units and the number of faults recorded for a certain period, we have defined three stages of the evolution of the Khubsugul Depression (Fig. 1b). Hypsometric positions of units 8 and 9 indicate that the sediments accumulated when the western wall of the depression was higher than the eastern one. It is conceivable that a horst-type structure already existed at the lake center at the initial stage of the depression formation. This conclusion is supported by the dipping of the ~9-Ma-old basalt beds toward the depression [7]. The base of unit 9 incorporates both prodeltaic and lacustrine–floodplain sediments. Hence, the central part of the lake initially incorporated two virtually autonomous basins with alluvial sources. We believe that the basins appeared at the proto-Khubsugul stage with the upper boundary at 5–5.5 Ma. The present-day shape of the depression began to form after this stage.

Tectonic activity (active rifting) of the Baikal Depression started 5–7 [1] or 6.6 Ma [8] ago. Judging from the number of faults and variations in the dip angle of units, active rifting in the Khubsugul Depression began only ~3.2 Ma ago. This phase corresponds to the beginning of the second tectonic stage. It is worth mentioning that the major phase of horst formation in the Central Asian mountain belt is also 3.6 Ma old [9].

The Khubsugul Depression acquired the present-day shape after the accumulation of sediments of unit 7 (3.2–2 Ma) marked by the active uplift of its western wall. This age boundary matches the timing of activation of the mountainous framing of Lake Baikal. The tectonic activity is indicated by the higher content of terrigenous components and the formation of seismic reflector B10 [8].

The second tectonic reactivation (1.5–0.5 Ma ago) was less intense than the previous period (3.2–2 Ma). This is evident from the low dip angle of unit 5 and the insignificant increase in the hypsometric level of the unit roof. The beginning of the second reactivation period is also consistent with the activation stage of the Baikal Depression (1.07–1.31 Ma) marked by the D3B

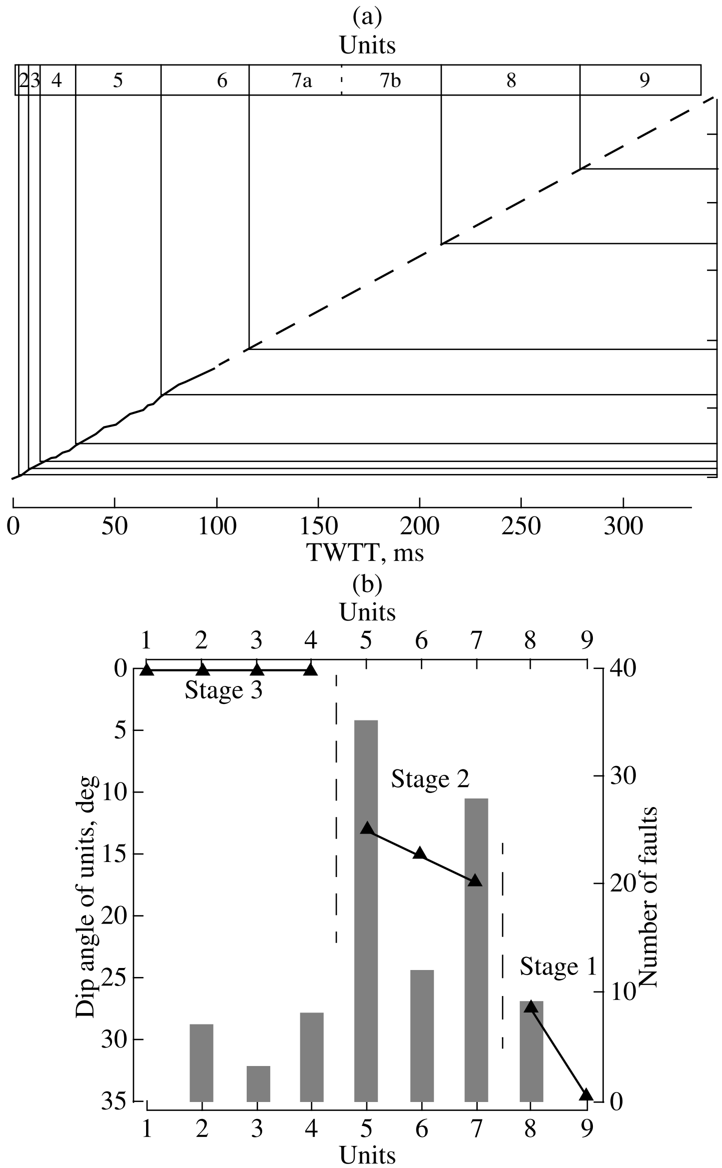

Fig. 1. (a) Depth–age model of sediments and (b) three tectonic stages of the Khubsugul Depression evolution. In (a), solid line indicates age based on paleomagnetic data; dashed line shows linear extrapolation. In (b), gray boxes designate the number of faults; triangles connected by lines show the dip angle of units.

unconformity in bottom sediments and the uplift of the Primorskii Range [8]. Thus, the second tectonic stage of the Khubsugul Depression evolution was irregular with the maximum activity during the accumulation of sediments of unit 7 and the 0.5-Ma-long minimum during the accumulation of sediments of unit 6. Sediments of unit 5 are transitional to the third tectonic stage.

The virtually horizontal bedding of sediments of the third stage (0.5–0 Ma) testifies to not only a change in the tectonic regime but also a redistribution of stress fields. It is known that the geodynamic regime of the Khubsugul region was not constant during and after the neotectonic activation. The formation of Lake Khubsugul was initially governed by stresses along the NW–SE and E–W directions. The recent stage is marked by an inversion of the geodynamic regime and the appearance of the nearly meridional compression [10]. These conclusions are also supported by the structural pattern of sediments. Extension related to normal faulting promoted the compensation subsidence of the depression floor and the formation of units 9–6. Sediments of units 4–1 were accumulated during compression that began 0.5 Ma ago and is continuing today.

In general, relative to the central part of the BRZ, its southwestern sector shows some lag in response to the regional tectonic impulse that triggered the active formation of the Baikal Rift. This sector is characterized by a smaller amplitude of tectonic activity and an attenuation of rifting toward the BRZ periphery.

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