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GEOLOGY

Fault Structure of the Tunka Rift as a Reflection of Oblique Extension

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The internal structure, stress state, and possible formation mechanisms of the unique Tunka Rift has been discussed in many works [1–4 and others]. It is noteworthy that this structure is located in the transitional zone and the rift-type features are least manifested here as compared with other similar structures of the Baikal rift zone [5]. In such an intricate geodynamic setting, the knowledge of the fault structure of elements of the Earth's crust is crucial for deciphering their tectonic history. The results of experimental studies, which are recently often used in the analysis of structural systems developing under different conditions of stress, contribute much to the solution of the issue mentioned above [6–9 and others]. This communication presents the results of structural and tectonophysical studies in the Tunka Rift, which made it possible to compile a new map of its fault–block structure supplemented with data on the kinematics and geometry of many mapped fractures (Fig. 1). Thus, the presented map has both theoretical significance for geodynamic interpretations and a practical implication for the coordination of earthquakes and reconstruction of their focal mechanisms.

The history of the study of faults in the Tunka riftogenic basin and adjacent territory is limited by state geological mapping (scale 1 : 200 000) in the 1970s and schematic maps of active faults compiled by Sherman *et al.* [1], Lukina [3], and Levi [10], which were mainly based on topographic analysis. In most other works, the fault structure of the Tunka Rift is rather schematic. In contrast to previous reconstructions, we compiled a new map of the fault–block structure using data on structural observations of fault zones and jointing, the lineament analysis of topographic maps, maps of the state geological survey, the above-mentioned schematic maps, and some other schemes. In total, 270 observation points, including 65 points confined to Cenozoic sediments, have been documented in the study area. These field data formed the major basis for defining new and confirming known faults. The mapped fractures are active, which is evident from their manifestation in the relief and registered displacements of markers in Upper Pleistocene and Holocene sediments.

The analysis of the map (Fig. 1) shows that the fault–block structure of the study area is determined by fractures with four different directions: sublatitudinal (80°–100°), northeastern (30°–70°), northwestern (290°–330°), and submeridional (350°–10°). The submeridional fractures are least widespread (Fig. 2a). Detailed analysis of fault orientations in the study area reveals a certain trend in their distribution. In the riftogenic basin, the main role belongs to northeastern and sublatitudinal fractures (Fig. 2b). The third insignificant maximum in the rose diagram characterizes the northwestern fractures in areas located mainly between basins. Beyond the Tunka Basin, northwestern faults predominate, while the northeastern fractures are subordinate (Fig. 2c). The northeastern faults are most common in the Khamar-Daban Range and near Lake Baikal. The abundance of sublatitudinal faults is similar both beyond and inside the basin. Thus, the fault–block structure of the study area reflects the superposition of the Tunka Rift over an older structure that represents the northwestern branch of the Sayan–Baikal foldbelt. The Tunka Rift formation was probably accompanied by faulting along the sublatitudinal and northeastern directions, whereas the northwestern fractures were activated. It should be noted that most of the faults are confined to areas located between basins where the preceding fractures were preserved and new fractures were superimposed. As a result, these crustal blocks were the most crumbled.

The comparison of modeling data [6–9] with the real structural setting indicates that the fault structure of the Tunka Rift is a result of oblique extension. This conclusion agrees well with the known data on the NW–SE direction of the axis of regional extensional stresses. Experimental works show that under orthogonal rifting, when the angle α between the vector of extensional stresses and rift axis is equal to 90°, destructive zones are represented by a single system of

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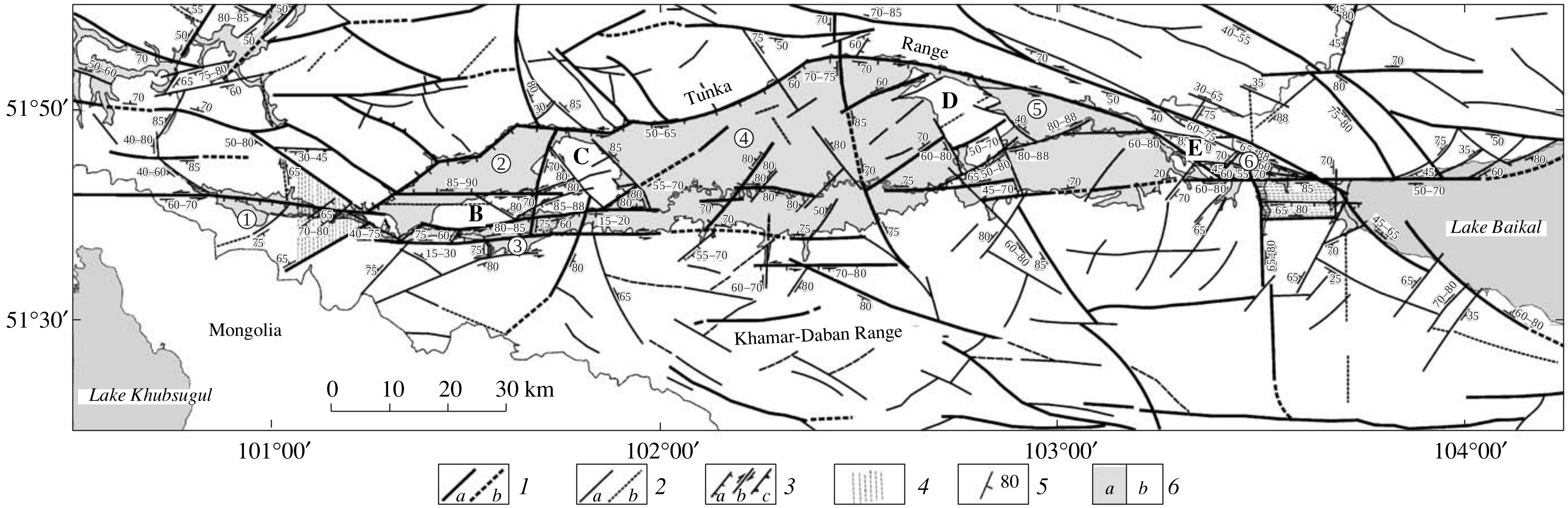

Fig. 1. Map of the fault–block structure of the Tunka Rift and adjacent areas. (*1*) Regional faults: (*a*) proven, (*b*) inferred; (*2*) local faults: (*a*) proven, (*b*) inferred; (*3*) faults: (*a*) normal, (*b*) strike-slip, (*c*) thrust; (*4*) zones of the intense rock dislocations; (*5*) directions and dip angles of faults; (*6*) (*a*) basins filled with Cenozoic sediments, (*b*) exposed crystalline basement. Isolated local basins: (1) Mondy, (2) Khoitogol, (3) Turan, (4) Tunka, (5) Tori, (6) Bystraya; interbasin links: (A) Kharadabansky, (B) Turansky, (C) Nilovsky, (D) Elovsky, (E) Zurkuzunsky.

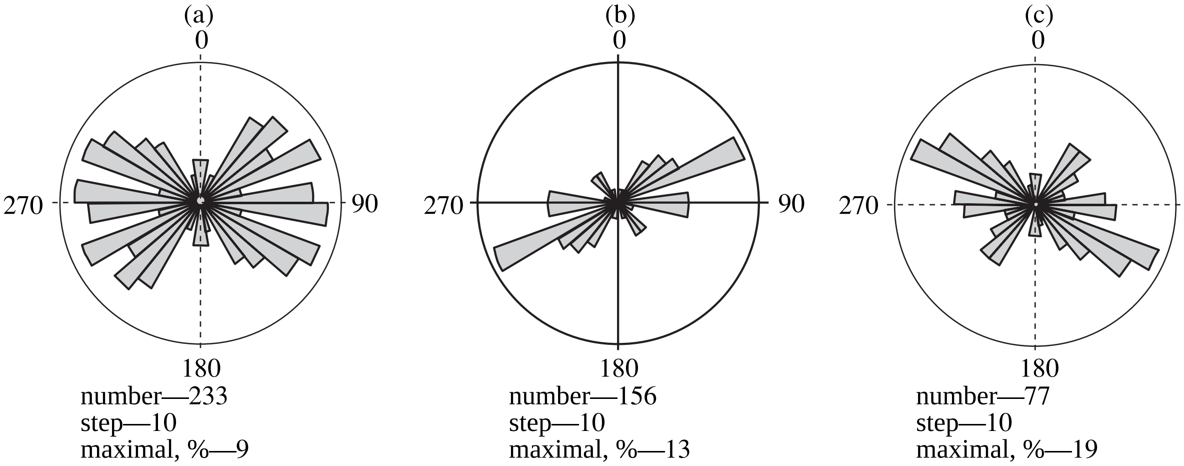

Fig. 2. Rose diagrams of fault strikes for (a) the entire study area; (b) the basin, regional faults bordering the basin, and interbasin links; and (c) areas located beyond the rift valley.

normal faults, the orientation of which follows the strike of the newly forming structure [6, 8]. The scatter of fault azimuths progressively increases with the α decrease and significantly changes when α = 45° and 30°. At α = 45°, the models show the formation of a stable fault system, the orientation of which deviates from the rift orientation by 25°–30°. As applied to the Tunka Rift, such a fault system corresponds to the maximum of the northeastern strike in Fig. 2b. At α = 30° or less, the third fault system appears perpendicular to the rift system and plays a significant role in the infrastructure of the zone, which is of a strike-slip structure in the considered case. It is best manifested in the central block of the model [6]. As is evident from the structural study, submeridional faults play a minor role in the internal structure of the Tunka Rift. Thus, one can suggest that the shear deformations noted in the Tunka Rift, as well as the echelon-shaped basins and interbasin links that constitute its internal structure, resulted from the oblique NW–SE-oriented extension, which played the leading role, at least at the stage of initiation and active development of the southwestern flank of the Baikal rift zone.

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