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Morphotectonics of the Tunka rift and its bordering mountains in the Baikal rift system, Russia

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ABSTRACT

The Tunka section of the Baikal rift system presents a uniform alternation of the following neostructural forms: tilted horsts and asymmetrical block uplifts on the northern flank; the central system of the rift valleys; and the arched uplift of the southern flank. This is a standard set of morphostructural elements for the Baikal rift system. The main morphological feature of the Tunka rift is the strong inclination of its floor, ranging from 900 m to 200 km in general elevation above Lake Baikal. Such traits of recent geodynamics as volcanism, thermal activity, and seismicity are also different from other parts of the rift zone. All of these features of the Tunka rift are related to the deep structure of the rift zone.

The peculiarities of the neotectonic structure of the Tunka rift, which are clearly expressed morphologically as is typical of the Baikal rift system, as well as its unique features are in accordance with deep geodynamic processes of the region. On the other hand, the development of the rift basin structures of the southwestern area near Baikal is complicated by inversion deformations. Local uplifts followed by deformations of the basin sedimentary cover and inverted morphostructures expressed in relief are fixed against the background of the general subsidence of blocks of the pre-Cenozoic basement grabens. The Tunka rift has repeatedly experienced inversion deformations throughout its history. The last wave of such deformations involved the southwestern region near Baikal in the second half of the late Pleistocene. During the Quaternary, the positive component prevailed in the whole range of vertical movements of the inter-rift and interbasin blocks; since the late Neogene, these structures have experienced a slow but steady uplift, accompanied by their extension at the expense of the bordering basins. The remote influence of the India-Asia collision on the formation of the southwestern section of the Baikal rift system is very significant and well pronounced in the development of the morphostructural elements of the Tunka rift and its bordering mountains.

1. Introduction

The Tunka rift is a main element of the neotectonic structure in the southwestern section of the Baikal rift system (Fig. 1). It is unique among grabens in having the standard elements of recent structure and geodynamics (Florensov, 1960, 1969; Sherman et al., 1973; Ufimtsev, 1992; Shchetnikov and Ufimtsev, 2004) as well as distinctive features that do not fit with the general mechanism of Baikal rifting and are repeated nowhere else in the intracontinental rift systems of the Earth (Ufimtsev and Shchetnikov, 2002; Ufimtsev et al., 2009; Shchetnikov et al., 2012b). This characteristic renders the Tunka rift and the entire southwestern section of the rift zone a good testing ground for the study of the phenomena of intracontinental rifting in all of their diversity.

The basic features of the Tunka rift and its recent tectonic structure and dynamics have been described in a number of works (Florensov, 1960, 1969; Sherman et al., 1973; Logatchev, 1974, 1993; Solonenko, 1975; Lukina, 1989; Ufimtsev, 1992; McCalpin and Khromovskikh, 1995; Delvaux et al., 1997; Arzhannikova et al., 2004, 2005, 2011; Shchetnikov and Ufimtsev, 2004; Parfeevets and San'kov, 2006; Vogt and Vogt, 2007; Lunina et al., 2009; Shchetnikov et al., 2009, 2012b). The Tunka rift has been considered to be an extensional structure (Florensov, 1969) and a pull-apart structure (Lunina et al., 2009), as well as a transpressive structure (Arzhannikova et al., 2005) that underwent a transtensive geodynamic regime at an early stage of its development (Parfeevets and San'kov, 2006). The recent tectonic evolution of the Tunka rift (as well as the Baikal rift system as a whole) is discussed, and mutually exclusive models of active or passive rifting are proposed.

The fact that many of the neotectonic structures in the near-surface and deep parts of the regional lithosphere defy explanation only through the influence of the India-Eurasia collision is a stumbling block here (Zorin et al., 1990, 2003; Logatchev, 1993; Baljinnyamt et al., 1993).

The present paper addresses geomorphological peculiarities of the tectonic development of the Baikal rift system in its southwestern section.

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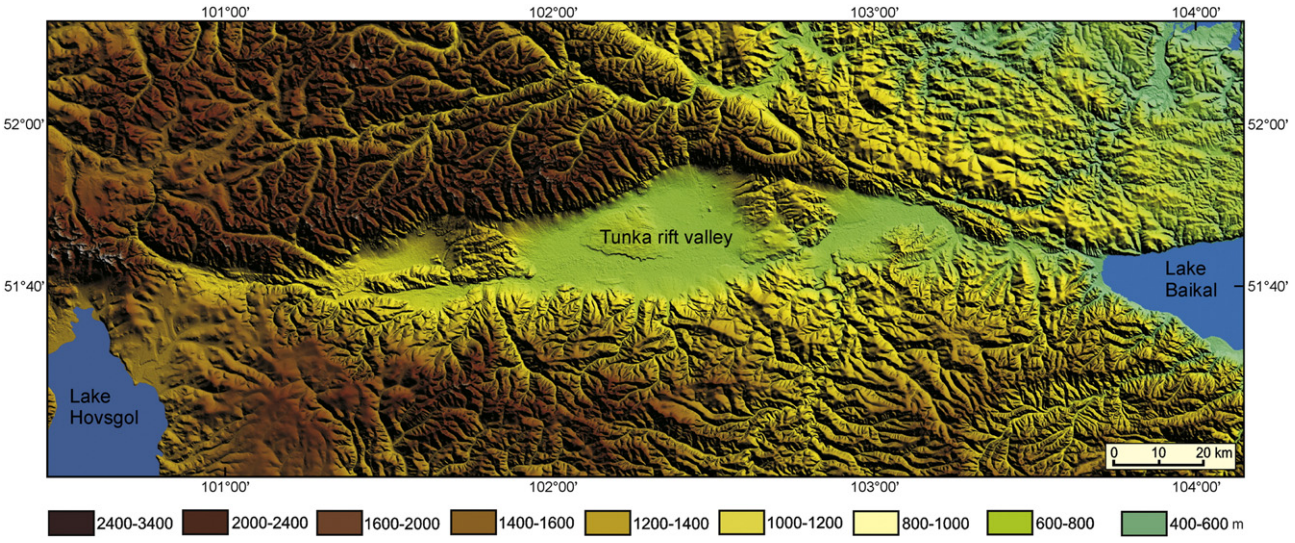

Fig. 1. Digital elevation model of the Tunka rift and bordering regions (based on SRTM digital elevation data).

2. The Tunka rift in the recent structure of northern Inner Asia

Mountain structures of northern Inner Asia — Khangai and Khentei, the Sayan and Stanovoe Highlands, and the ridges of Baikal and the Baikal region — constitute a connected grouping of large neostructural forms of near-surface lithospheric parts composing the Mongolia-Siberia orogenic belt (Fig. 2). Its southern flank is composed of the large Khangai, Khentei, and Olekma Stanovik arches; the northern flank is composed of the Western and Eastern Sayan arches and the Baikal rift system; there is a system of intermontane depressions and arched-block uplifts representing zones of linear warping and moderate tectonic crowding of the upper parts of the lithosphere of Transbaikalia and northern Mongolia (Ufimtsev, 1990). Orogenic belts with close sets of structural elements are common in Lavrasia: the Verkhoyano-Kolymskii

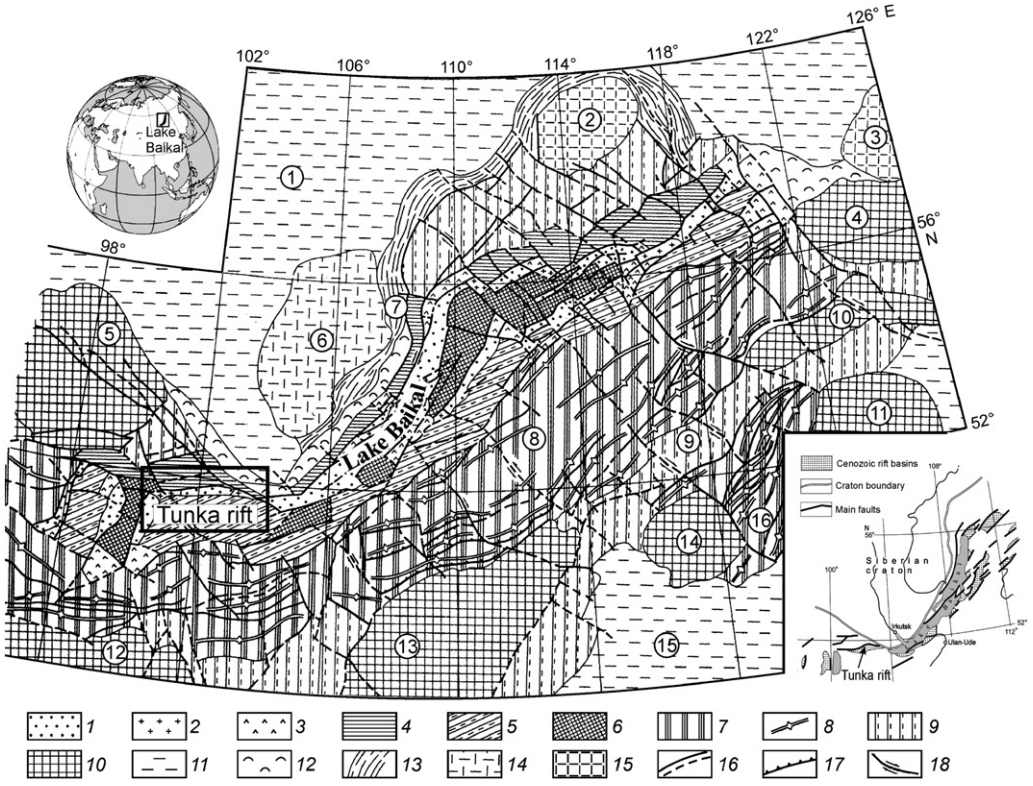

Fig. 2. Baikal rift system in neotectonic framework of East Siberia and Northern Mongolia, after (Ufimtsev et al., 2009). 1–10, areas of mountain morphostructures: 1–6, Baikal rift system: Baikal-type basins (1), interbasin and interrift saddles (2), marginal large steps (3), tilted horsts of rift flanks (4), marginal arched uplifts (5), and stepped block uplifts (6); 7, 8, zones of linear warping (7) with isolated arched uplifts (8); 9, block fields; 10, major arched uplifts; 11–15, plainland terrains: zones of general uplift (11), piedmonts (12), zones of piedmont folds (13), uplifted major steps (14), marginal shield-like uplifts (15); 16–18, young and rejuvenated faults: normal faults (16), thrusts (17), and strike-slip faults (18). Arabic numerals in circles stand for names of tectonic units: 1, Siberian craton, 2, Patom arched uplift, 3, Central Aldan arched uplift, 4, Stanovik arched uplift; 5, East Sayan arch, 6, Upper Lena step; 7, Baikal Foredeep; 8, Selenga-Vitim zone of linear warping; 9, Upper Amur block field, 10, Olekma Stanovik arch, 11, Great Khingan arch, 12, Khangai arch, 13, Khentei-Dauria arch, 14, East Transbaikalian arch; 15, East Mongolian plainland platform terrain; 16, Shilka-Argun' zone of linear warping.