



Volcanism in the Baikal rift: 40 years of active-versus-passive model discussion



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ARTICLE INFO

Article history:

Received 13 August 2014

Accepted 11 May 2015

Available online 22 May 2015

Keywords:

Baikal Rift

Mesozoic

Cenozoic

Volcanism

Geochronology

ABSTRACT

In this review we focus on the volcanism, that occurred in Transbaikalia, Siberia after the closure of the Mongolia–Okhotsk Ocean. The closure happened in the Early Jurassic. After that time, lithosphere in Transbaikalia went through two phases of rifting; in the Early Cretaceous and again in the Late Cretaceous until present. The latter rifting event is known as the Baikal rifting. We consider the chronology of the volcanism and basin formation in the Baikal rift and show that there has been a complex relationship between the two. Extension initiated in the central part of the rift system; this area is now occupied by Lake Baikal. Sedimentary basins initially developed by deepening and widening of the central part of the rift system and then by bilateral propagation of basin formation outwards. Volcanism was generally offset from the axial rift. Considering along axis distribution of volcanism, it initiated in the central part of the system and propagated bilaterally to the modern rift ends. We argue that tectonic stress controlled localization of the eruptive centres. Extension and shearing probably caused melting at mantle depth, suggestive of the passive model of volcanism. However, when considering the Baikal rift and adjacent non-rifted regions of Mongolia in a wider context of tectonics and volcanism of Central and East Asia, it is not possible to rule out that the volcanism may be associated with mantle transition zone diapirs; thus the active model of volcanism may also apply. The diapirs are located by regional isostatic gravity anomalies and considered as upwelling parts of the upper mantle convective cell controlled by the Pacific subduction and slab stagnation in the mantle transition zone. We do not see any geochemical, geophysical and geochronological evidence for involvement of deeper mantle to explain volcanism in either Baikal rift, non-rifted regions of Mongolia or anywhere else within Central and East Asia.

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1. Introduction

Cenozoic volcanism is spread over vast regions of Central Asia (Fig. 1). Some volcanic fields are clearly located close to margins of lithospheric blocks and thus can be associated with lithospheric boundaries, whereas some of them are located within inner parts of the plates quite far from any regional fault systems. Discussion of the origins of the Central Asian volcanism has generally been limited to the assessment of active versus passive models of volcanism and rifting (Kiselev, 1987; Rasskazov, 1994; Ashchepkov et al., 2003; Barry et al., 2003, 2007; Yarmolyuk et al., 2003b, 2011; Hunt et al., 2012, among many others). The passive model assumes that volcanism is controlled by

rifting of the lithosphere and that the sources of the volcanism are limited to fertile (fusible) parts of the lithospheric mantle and uppermost portions of the sublithospheric mantle, passively uplifted due to rifting of the lithosphere. The active model places the source of the magma mainly in sublithospheric mantle diapirs/plumes, which moves up from deeper mantle regions due to their own buoyancy. Seismic tomography, though still limited, constrains low velocity anomalies in the upper mantle (Gao et al., 1994, 2003; Achauer and Masson, 2002; Tiberi et al., 2003; Lebedev et al., 2006; Zhao et al., 2006) and thus expected diapirs/plumes, if exist, have their origin no deeper than the mantle transition zone (~410–650 km depth), probably in association with a stagnant Pacific slab (Zorin et al., 2006). Similarly, discussion of

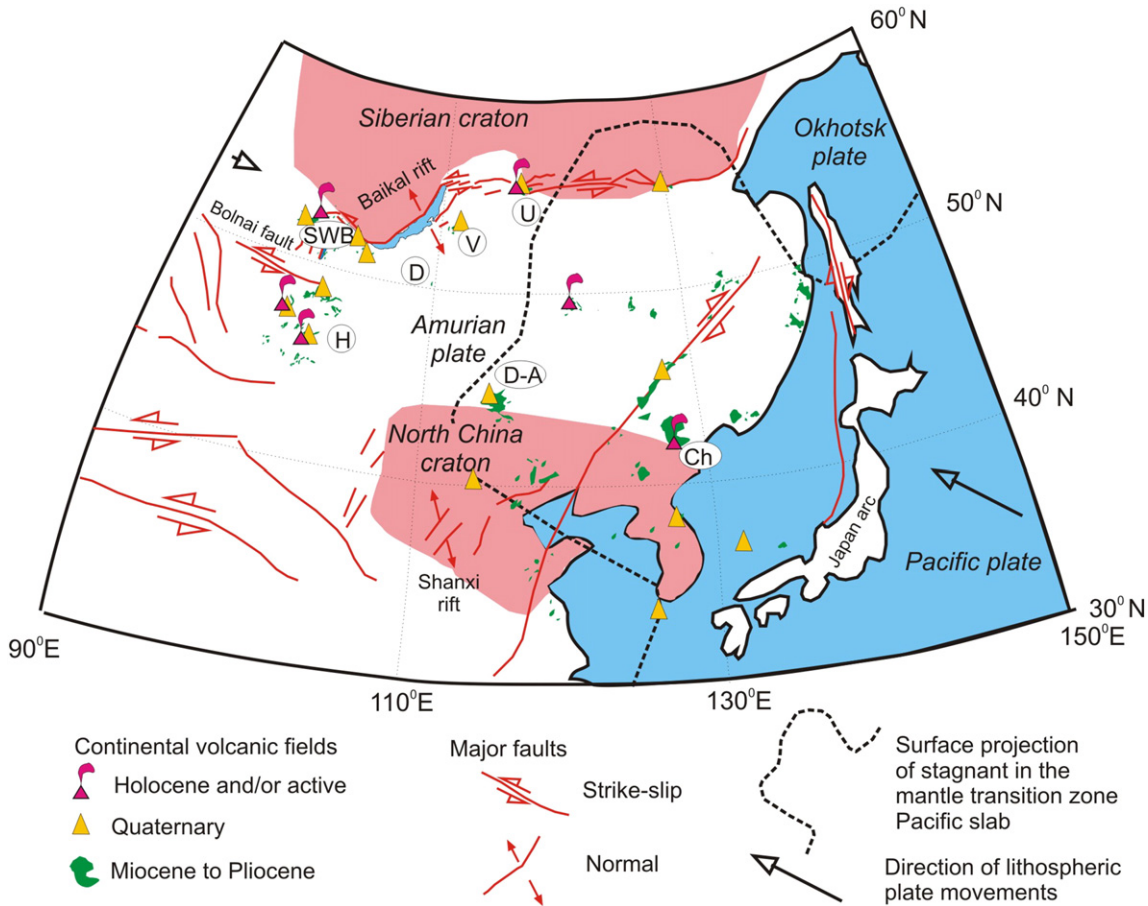


Fig. 1. Distribution of the Late Cenozoic (Miocene and younger) volcanic rocks in Central Asia and East Asia. Surface projection of the Pacific stagnant slab is after Zorin et al. (2006), who reinterpreted original data of Zhao et al. (2004). Acronyms are for volcanic fields and regions: Ch – Changbaishan, D-A – Dariganga-Abaga, H – Hangai, SWB – southwestern Baikal rift, D – Dauria, V – Vitim, U – Udokan.

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