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The Mongol–Okhotsk Belt in Mongolia — An appraisal of the geodynamic development by the study of sandstone provenance and detrital zircons

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ABSTRACT

The Mongol–Okhotsk Belt formed in a late stage of Jurassic orogeny in the composite Central Asian Orogenic Belt. The present paper investigates the Late Palaeozoic–Mesozoic sandstones associated with the belt in Mongolia, aimed at reconstructing the time and mode of ocean formation, subduction and collision. We apply provenance analysis including (1) heavy mineral and sandstone framework grain analysis, (2) U/Pb laser ablation ICP-MS dating of detrital zircons for identifying contemporaneous volcanic arc activity and the recycling of older crustal material, and (3) on dated zircon grains, we analyze trace element contents and Hf isotopic ratios in order to characterize the rock types in which they crystallized and the magma sources, respectively.

The investigated samples are derived from (1) the Adaatsag and Doschgol terranes, which represent the suture zone, (2) the Hangai–Hentei belt to the northwest, and (3) the Ereendavaa terrane and the Middle Gobi volcanic belt to the southeast of the suture. The latter two are concurrent with the northern and southern margins of the Mongol–Okhotsk Ocean. Tectono-stratigraphic arguments suggest that the Mongol–Okhotsk ocean opened during the Silurian within the Early Palaeozoic collage. In the suture zone, Permian syn-sedimentary zircon trace element contents confirm mafic rock sources, and the mantle involvement in the magmatism (epsilon Hf(t) from +13 up to +20). N and S directed, bi-vergent subduction developed as revealed by contemporaneous zircons: (1) along the northern margin (Hangai–Hentei), from Silurian–Early Carboniferous, subduction and accretion prevailed (epsilon Hf(t) from +3 up to +12 in associated zircons), which was re-initiated during the Permian, and (2) the contemporaneous Silurian–Devonian southern margin (Ereendavaa–Middle Gobi) still represented an extensional continental margin showing reworking of Neoproterozoic–Early Palaeozoic zircons from the basement. It turned into an active continental margin with starting arc magmatism in the Carboniferous (zircon mean epsilon Hf(t) +5.75).

1. Introduction

The Central Asian Orogenic Belt (CAOB) is a spectacular example of long-lasting continental growth between the Eastern European, Siberian, Tarim and North China continental blocks (e.g., Sengör et al., 1993). It formed by multiple ocean subduction associated with continental margin magmatism, accretion and collision of intraoceanic volcanic arcs, and continental fragments with the large bounding continental plates (e.g., Jahn et al., 2000; Khain et al., 2003; Parfenov et al., 1995; Windley et al., 2007). In plate tectonics terms, the CAOB generally is considered to be the product of evolution of the Palaeo-Asian Ocean at least since the Neoproterozoic until the Permian. The Mongol–Okhotsk Belt (MOB) represents a young, still enigmatic division within the CAOB. It formed by the closure of the Mongol–Okhotsk ocean (Natal'in, 1993; Parfenov et al., 2001; Zonenshain et al., 1990; Zorin, 1999).

The MOB as a major structural element extends over 3000 km from central Mongolia in northeastern direction to the Gulf of Okhotsk. The core is represented by a ribbon-like ophiolite-bearing suture zone and accretionary wedges (Natal'in, 1993). Parfenov et al. (2001) termed it the Aga terrane, which includes the Onon and Tukuringra terranes, and the Nilanskiy fragments (Fig. 1). The Onon terrane comprises the intra-oceanic Onon arc of assumed Devonian–Early Carboniferous age (Zorin, 1999). The suture is considered as a relic of the Mongol–Okhotsk ocean (MOO), which was closed as a result of the collision of the continental Amurian superterrane with the North Asia (Siberian) craton (Natal'in, 1993; Parfenov et al., 1995, 2001) (Fig. 1).

The opening of the MOO is a matter of speculation and Late Proterozoic to Late Palaeozoic ages are suggested (e.g., Badarch et al., 2002; Parfenov et al., 2001; Sengör et al., 1993; Zonenshain et al., 1990; Zorin, 1999; Zorin et al., 1993). However, Zorin et al. (1993) advocated that the MOB did not exist yet in the Middle Palaeozoic. On

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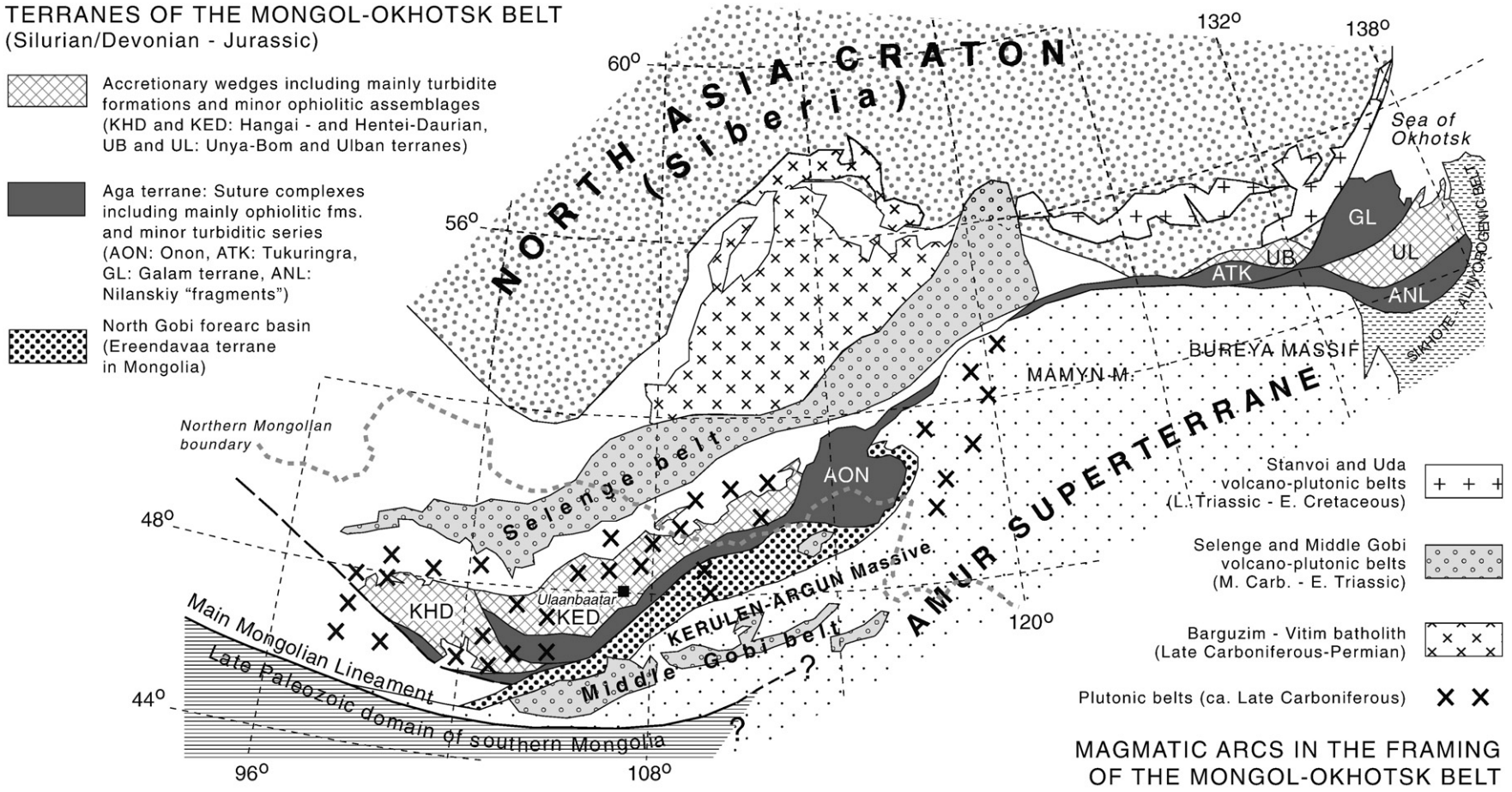

Fig. 1. Tectonic sketch map of the Mongol–Okhotsk Belt and the framing units.
Modified from Parfenov et al. (2001) and Zorin (1999), and including information on the Mongolian sector from Badarch et al. (2002).