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Evolution history of the Neoproterozoic eclogite-bearing complex of the Muya dome (Central Asian Orogenic Belt): Constraints from zircon U–Pb age, Hf and whole-rock Nd isotopes

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U–Pb dating and Hf-isotope analysis of zircons and whole-rock Nd-isotope analyses were carried out on country rocks of the eclogite–gneiss complex of the North Muya dome in the Anamakit-Muya zone of the Baikal Muya accretionary fold belt. Zircons from garnet–biotite gneisses (Qtz + Kfsp + Pl + Bt + Grt) and garnet–biotite–muscovite schist (Pl + Kfsp + Bt + Mu + Grt + Qtz) were dated using the LA-ICP-MS technique. Based on U–Pb isotope data and CL images zircon grains were divided into three groups: detrital, magmatic and metamorphic zircons. Metamorphic zircons display no zoning or the cloudy zoning. The grains morphology together with the well-developed oscillatory zoning clearly identifies the igneous origin of magmatic zircons. The metamorphic zircons (ages 576–680 Ma) have Th/U ratios varying from 0.271 to 0.004, whereas the ratio in magmatic zircons ranges from 0.779 to 0.11. Magmatic zircons from granite-gneisses of the North Muya dome exhibit a relatively narrow spread in the crystallization age with the major peak at *ca* 764 Ma. Younger ages are interpreted as due to the partial resetting of U–Pb system during the subsequent metamorphic evolution. Detrital zircons from two-mica schist sample Mu-93-10 give ages of 1.88–2.66 Ga. The oldest detrital zircon from this sample plots near concordia and has a $^{207}Pb/^{206}Pb$ age of 3.2 Ga. Zircons from this sample are characterized by the widest scatter of $\varepsilon_{Hf}(t)$ values (from +13.9 to −15.3) and T^{C}_{DM} model ages (0.82–3.86 Ga). Zircons from other samples have a much narrower ranges of $\varepsilon_{Hf}(t)$ (+11.6 to −0.7) and T^{C}_{DM} (0.85–1.52 Ga). The involvement of older crustal material is also evident from the whole-rock Nd isotopic compositions. The gneisses and schists exhibit a range of Nd isotopic compositions with $\varepsilon_{Nd}(t)$ values ranging from −3.5 to +3.6 and $t_{Nd(DM)}$ from 1.64 to 1.09 Ga. The integration of the Hf-isotope data with the age spectra provides with the first evidence for the existence of Mesoarchean crust in the Baykal-Muya sector of the Central Asian Orogenic Belt.

1. Introduction

Continental subduction plays an important role in the evolution of accretionary orogens (Cawood et al., 2009) at the final stage of an ocean's closure and collision. In this context, studies of eclogite-bearing metamorphic complexes of orogenic belts, which mark these final stages of subduction and collision of continental crust, is of great interest (Ernst, 2001; Liou et al., 2009). In the Central Asian Orogenic Belt, which is one of the largest accretionary terranes on the Earth (Windley et al., 2007), eclogite-bearing complexes occur in the Hercynian (Middle-Late Paleozoic), Caledonian (Early Paleozoic) and Baikalian (Neoproterozoic) orogens (Dobretsov et al., 1989). The oldest eclogites are found in the North Muya dome (Shatsky et al., 2012), located in the Anamakit-Muya zone of the Baikal Muya accretionary fold belt (BMB) within the Baikalian orogen (Rytsk et al., 2011, 2007) (Fig. 1). Reconstruction of the geodynamic evolution of the Baikal Muya Belt is still a subject of intense debate (Rytsk et al., 2011).

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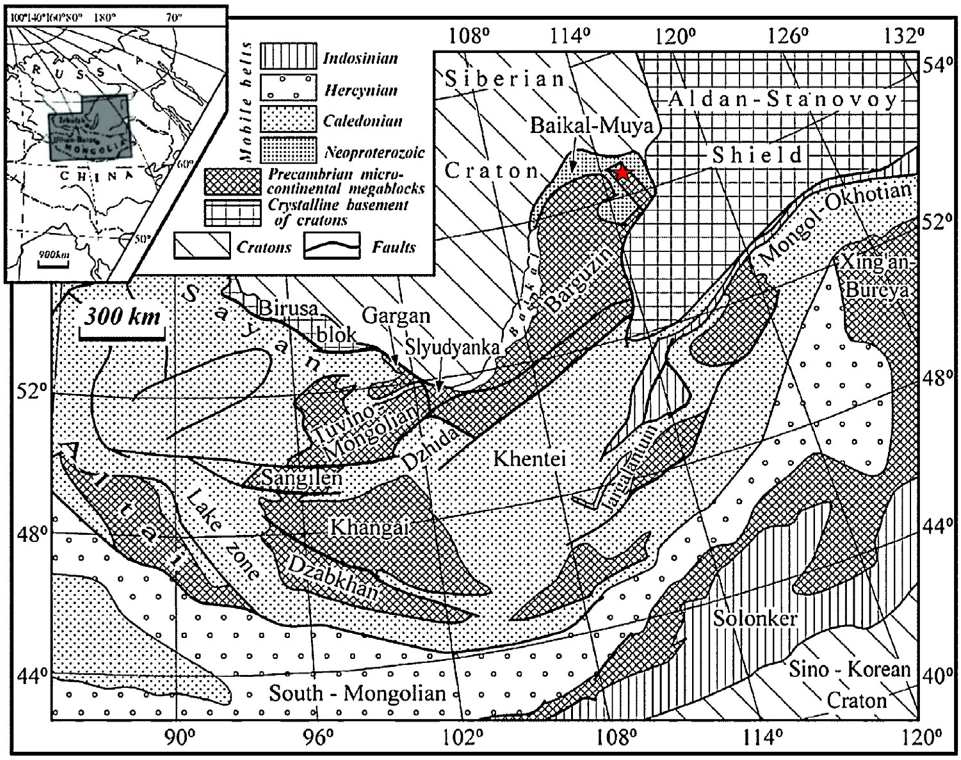

Fig. 1. Simplified tectonic division of the central Asia (Kovalenko et al., 2004). Star indicates the position of the North Muya eclogite–gneiss complex.

Sm–Nd geochronology for eclogites and their host gneisses in the North Muya block indicated that the age of high-pressure metamorphism (630 Ma) is significantly younger than U–Pb age of zircons from gneiss-granites (Rytsk et al., 2007), which are host rocks for eclogites and other high-pressure lithologies (Shatsky et al., 1996, 2012). However, there is no agreement among researchers regarding the closure temperature of the Sm–Nd system (Mezger et al., 1992; Kylander-Clark et al., 2007). From the available data, it is difficult to conclude whether the obtained mineral Sm–Nd age reflects the thermal peak of metamorphism or the timing of exhumation of high-pressure rocks. Taking into account the age of gneiss-granites, the question whether the eclogites and the host rocks were isofacial or were tectonically juxtaposed during the exhumation is still open. The host rocks do not demonstrate any features of high-pressure (HP) metamorphism. According to Avchenko et al. (1988), the peak metamorphic stage involved conditions of 650 °C and 9–10 kbars, while pressure estimates for eclogites are higher than 15 kbars and those for kyanite-bearing eclogite exceed 24 kbars (Shatsky et al., 2012).

To resolve this question, U–Pb dating of zircons from the country rocks of eclogite-bearing complex of North Muya dome is of crucial importance. The closure temperature of the U–Pb system is high in zircon; therefore, it can retain information about both the timing of HP metamorphism peak and age of the protoliths (Rubatto and Hermann, 2007). In addition, due to their low Lu/Hf value the calculated initial $^{176}Hf/^{177}Hf$ of zircons is relatively insensitive to age and close to the $^{176}Hf/^{177}Hf$ value of their parental melt. Combined U–Pb dating and Hf isotope information makes zircon an important tracer of mantle–crust evolution and interaction (Scherer et al., 2007).

U–Pb dating, Hf-isotope analyses on zircon and whole-rock Nd isotopes analyses were carried out for country rocks of the eclogite–gneiss complex of the North Muya dome.

2. Geological background

As have been mentioned above the Muya dome is situated in the Anamakit-Muya zone of the Baikal Muya accretionary fold belt (BMB) within the Baikalian orogen (Rytsk et al., 2007, 2011).

The North Muya dome has a heterogeneous structure (Fig. 2). Until now, the Muya dome has been interpreted to consist of several Archean rock units. It contains Early Archean (Dzhaltuk and Osinovka series), Late Archean (Tastakh unit), and Early Proterozoic (Parama series) rocks (Avchenko et al., 1988). The Early and Late Archean rocks form a series of tectonic blocks. Eclogites occur among the Early Archean gneisses of the Dzhaltuk and Osinovka series (Avchenko et al., 1988). Dzhaltuk series consisting of two mica gneisses, marbles and amphibolites. Osinovka series consisting of amphibolites and biotiet-amphibol plagiognesses. Most of the eclogite outcrops are confined to the tectonic contact between the Dzhaltuk and Tastakh units in a belt 10 km wide and 30 km long (Dobretsov et al., 1989). Eclogites occur as boudins or sheet-like bodies.

The granitic gneisses of the Ileir complex of the North Muya block has been dated at 786 ± 9 Ma (TIMS, U–Pb dating), raising some doubts about the Archean age of the rocks in the North Muya dome (Rytsk et al., 2001). However, geochronological data obtained by Rytsk et al. (2007, 2011) confirm the Riphean age of the metamorphic units in the "basement" of Baikal Muya Belt.

So far, there are different views regarding the age and geodynamic evolution of the North Muya dome. According to Tsygankov (2005), the Muya block is an allochthonous sialic block involved in the Late Riphean folding.

Rytsk et al. (2007, 2011) regarded the Anamakit-Muya zone of the Baikal-Muya belt as a continental-margin zone related to an outer subduction zone. According to this model, the Precambrian terrains are fragments of the Rodinia supercontinent, produced during continental rifting. A significant proportion of