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Early Neoproterozoic crust formaton in the Dzabkhan microcontinent, Central Asian Orogenic Belt

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The Dzabkhan microcontinent was defined by [*Mossakovsky et al., 1994*] as a cratonic terrane with an early Precambrian basement that combines high-grade metamorphic complexes of the Songino, Dzabkhan, Otgon, Baidarik, Ider and Jargalant Blocks. However, early Precambrian ages have so far only been recognized in the Baidarik and Ider blocks [*Kozakov et al., 2007, 2011; Kröner et al., 2015*].

The high-grade metamorphic rocks of the *Songino Block* consist of variably migmatized biotite trondhjemitic gneisses and biotite±garnet±sillimanite gneiss with rare interlayers of hornblende gneiss. An age of 802±6 Ma, obtained from zircons of a granite-gneiss, is close to the timing of regional amphibolite-facies metamorphism [*Kozakov et al., 2013*]. The lower-grade rocks are made up of volcanogenic, clastic-volcanogenic, and clastic rocks, variably metamorphosed from greenschist- to upper amphibolite-facies. Moderate- and high-Ti basalts of the volcanogenic sequences are comparable to modern N-MORB and E-MORB-OIB oceanic rocks, whereas a differentiated basalt-andesite-rhyolite volcanic sequence and associated clastic sediments are interpreted as analogues of modern island arcs and accretionary wedges [*Kovach et al., 2013; Yarmolyuk et al., 2015*]. Zircon ages and Nd isotopic data suggest early Neoproterozoic (ca. 890–860 Ma) juvenile oceanic and island arc crust for the lower-grade association and late Meso- to early Neoproterozoic (ca. 1.30–0.79 Ga) continental crust for the high-grade complex. These units were tectonically juxtaposed in the early Neoproterozoic (ca. 0.80–0.79 Ga).

The northwestern part of the *Dzabkhan block* is composed of three zones, which differ in rock associations and their structural-metamorphic evolution [*Kozakov et al., 2014*]. One zone consists of mostly sedimentary rocks, metamorphosed to the amphibolite-facies, and detrital zircons from a garnet-muscovite-biotite paragneiss yielded ages of 820–900 Ma and a whole-rock ε_{Nd}(0.86Ga) value of –6.7, corresponding to a Nd model age of ca. 2.2 Ga.

The second zone consists of intensely deformed and migmatized biotite paragneisses, hornblende±clinopyroxene mafic gneisses, amphibolites, and granite-gneisses that experienced two amphibolite-facies metamorphic events. Detrital zircons from a garnet-biotite paragneiss vary in age from 850 to 962 Ma. Tabular and lens-shaped granite-gneiss bodies occurring within the migmatized paragneisses were emplaced between the above metamorphic episodes at 856±2 Ma. Various gneisses, probably derived from andesite and felsic volcanic rocks or tonalite, trondhjemite, and greywacke, and granite-gneisses of this have variable whole-rock ε_{Nd}(t) values from –2.6 to +3.6 and Nd model ages of 1.8–1.2 Ga. Synmetamorphic hornblende gabbro and gabbrodiorite cut the paragneiss/granite-gneiss association and crystallized at 860±3 Ma. They have ε_{Nd}(t) values from +2.1 to +5.6, suggesting the involvement of juvenile and some crustal material in their generation. Post-tectonic TTGs dated at 786±6 Ma have ε_{Nd}(t) values ranging from –2.1 to +1.5 and late Palaeo- to Mesoproterozoic Nd model ages of 1.7–1.3 Ga. These granitoids probably formed in an active continental margin setting involving juvenile early Neoproterozoic and older crustal sources.

The third zone is composed of tectonic slabs of migmatized gneiss, granite-gneiss and granitoids and slices of greenschist-facies metavolcanic rocks (basalt, andesite, rhyolite), clastic sediments as well as slabs of hornblende schists, trondhjemitic gneiss, marble, conglomerate and quartzite, all metamorphosed to upper amphibolites-facies conditions. Trondhjemites and a gabbro dyke dated at 959±8, 944±6, and 930±6 Ma and yielded positive ε_{Nd}(t) values from +4.4 to +6.1. Zircons from trondhjemites are also characterized by strongly positive ε_{Hf}(t) values. These data suggest that the plutonic rocks formed in an intra-oceanic arc setting with only minor contributions from recycled crustal material.

In contrast to the northwestern part of the Dzabkhan block, zircon ages and whole-rock Nd isotopic data for the southern part indicate extensive early Neoproterozoic crustal reworking [*Kozakov et al., 2015; Bold et al., 2016*].

The *Jargalant block* consists of biotite gneiss, interlayered with marble and thin layers of amphibolite as well as biotite and hornblende gneiss. The rocks of the complex were metamorphosed at ca. 810 Ma to the high temperature amphibolite-facies [*Kozakov et al., 2011*]. Nd model ages of 1.9–1.3 Ga and ε_{Nd}(0.81) values from –1.6 to +1.1 define a maximum age of protolith formation at ca. 1.3 Ga, presumably in an active continental margin setting.

The biotite gneisses (metatrondhjemite) from the *Otgon block* are characterized by a whole-rock Nd model age of 1.2 Ga and low positive ε_{Nd}(0.8Ga) values from +2.8 to +3.0 that suggest an active continental margin setting for the generation of the granitoid protoliths [*Kozakov et al., 2014*].

Combining all ages and isotopic data for the Dzabkhan microcontinent suggests that both crustal reworking and juvenile crustal additions in the Neoproterozoic played significant role in its generation and evolution, and we therefore consider it to be of mixed origin. Furthermore, it is apparent from field geology and the above data that the Dzabkhan microcontinent does not represent a unified large early Precambrian tract of continental crust, overlain by Ediacaran shelf deposits but represents an early Neoproterozoic composite terrane composed of palaeo-oceanic, island arc, active continental margin complexes and reworked early Precambrian continental crust.

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