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Detrital zircon geochronology of gold-bearing black shale sequences in the Baikal-Patom Highlands (Siberia, Russia)

Ekaterina Palenova*, Marina Yudovskaya, and Dirk Frei

Institute of Mineralogy UB RAS, Miass, Russian Federation, *e-mail, palenova@mineralogy.ru

The Baikal-Patom margin of the Siberian Craton is subdivided into two megazones: the outer Baikal-Patom passive margin and the internal Baikal-Vitim-Barguzin. The Baikal-Patom megazone encloses the Lena gold province that includes the giant Sukhoi Log deposit along with three other large and several dozen smaller deposits and occurrences with a total regional endowment achieving 6000 tons of gold. The deposits are located in rocks of the various stratigraphic levels throughout the Mezoproterozoic to late Neoproterozoic turbidite sequences, which are characterized by similar geochemical signatures that reflect common source areas and an inherited sedimentation regime. Mineralization is confined to the compressional syn- or post-metamorphic structures.

We carried out the U-Pb isotope LA-ICP-MS analysis of detrital zircon suites from the Mesoproterozoic Mikhailovsk black shale Formation as well as from the Neoproterozoic Khomolkho, Vacha. and Dogaldyn Formations. The samples were taken from mineralized zones of the Chertovo Koryto, Sukhoi Log, Krasnoe, and Kopylovskoe deposits that are hosted by the listed sequences, respectively. The aim of the study was to constrain ages of the sequences and possible sources of clastic sediments as well as to check on possible zircon recrystallization and transformation during metamorphic and ore-forming events.

The youngest Dogaldyn Formation yielded three zircon age population clusters: Archean (from 2479±18 to 3536±18 Ma, n=9), Paleoproterozoic (from 1797±20 to 2138±21 Ma, n=38), and late Neoproterozoic (from 604±8 to 805±9 Ma, n=52). Zircon ages from the Vacha Formation are clustered into Archean (from 2416±18 to 2588±18 Ma, n=3), Paleo- (from 1811±19 to 2151±18 Ma, n=23), Meso- (from 1179±13 to 1453±21 Ma, n=3), and Neoproterozoic (from 729±8 to 966±1 Ma, n=10) age populations. The age dates on zircon from the Khomolkho Formation showed a presence of a syn-depositional population as young as 613±7 Ma in addition to Archean, Meso-, and Neoproterozoic age clusters that are in good agreement with the previous studies.

The Mikhailovsk Formation yielded three concordant age population clusters: Archean (from 2456±18 to 3242±16 Ma, n=25), Paleoproterozoic (from 1961±20 to 2087±24 Ma, n=13), and Cambrian-Precambrian (from 524±6 to 702±8 Ma, n=8) whereas most of zircon grains analyzed (n=79) yielded discordant U-Pb isotope ages. Black shales and sandstones of the Mikhailovsk Formation underwent multiple progressive and retrograde greenschist facies metamorphism and host quartz-sulfide gold-bearing veins and stockwork. The data on the Mikhailovsk sediments poses a question as to the origin of these young isotope ages. Far away from the sampled Chertovo Koryto deposit, Mikhailovsk sediments are remelted and metamorphosed by ~2.0 Ga old granitoid intrusions that indicates at least a Paleoproterozoic age of Mikhailovsk sedimentation. So far, we envisage two alternative interpretations: (i) U-Pb system of zircon from ancient rocks of the Siberian craton has been disturbed and rejuvenated under high-grade metamorphism, where mineral parageneses were completely replaced during a later retrograde stage or mineralization events and (ii) the stratigraphic column of the Tonoda Uplift where the Chertovo Koryto deposit is situated has to be reconsidered.