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VOLGO-URALIA: THE FIRST U-Pb, Lu-Hf AND Sm-Nd ISOTOPIC EVIDENCE OF PRESERVED PALEOARCHEAN CRUST

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ABSTRACT. The crustal segment Volgo-Uralia is the least known part of the East European Craton. Its crystalline crust is hidden beneath a thick Neoproterozoic to Phanerozoic cover but disclosed by thousands of drill holes. In conjunction with the recent "Tatseis" reflection seismic profile, we conducted the first isotopic study of the Bakaly granitoid block in eastern Volgo-Uralia, which represents a subsurface section of the layered upper-middle crust. The study included whole-rock Sm-Nd and ion-probe zircon U-Th-Pb (SIMS) and Lu-Hf (LA-ICPMS) analyses of granitoids from seven drill cores. The Bakaly block was also targeted because its rocks have never been subjected to granulite facies metamorphism, making it possible to date pristine, pre-metamorphic zircon. Our study showed that the four principal suites of granitoids in the Bakaly block are different in age, each corresponding to a particular stage of Archean crustal evolution between 3.3 and 2.6 Ga. The Tashliar monzonitic suite, belonging to an alkaline series yielded zircon ages of 3.3 and 3.2 Ga, which are the oldest ages yet found in Volgo-Uralia. The $\varepsilon_{Hf}(T)$ values of the dated zircon and the $\varepsilon_{Nd}(T)$ values of their host rocks indicate that a Paleo- to Eoarchean protolith with model T_{DM} ages up to 3.8 Ga had been involved in the formation of the Tashliar melts. Three Neoarchean rock suites, one comprising quartz dioritic and tonalitic gneisses (the Bak 1), another K-rich granodiorites, granites and migmatites (the Bak 2), and the third monzonitic granitoids (the Aktanysh suite) were formed sequentially between 2.72 and 2.60 Ga. The 2.72 Ga Bak 1 suite is chemically diverse. It includes granitoids of the TTG type related to slab/subduction melts as well as rocks formed by the re-melting of older crust with whole-rock Nd T_{DM} and Hf T_{DM} model ages of 3.4 to 3.2 Ga. The 2.69 to 2.65 Ga Bak 2 suite was probably associated with a major collisional event, which defined the stacked structure of the Archean crust in Volgo-Uralia and its seismic layering. Our data suggest that the Bak 2 melts originated partly from juvenile sources with $\varepsilon_{Hf}(T)$ zircon values up to +4.8, as well as mixed crustal and juvenile mantle materials. Some crustal contamination of the melts appears to have occurred as evidenced by incorporated xenocrystic zircon. The chemical compositions of Bak 2 granitoids from the different plutons, their zircon ε_{Hf} values, and the Hf- and Nd T_{DM} ages all mirror a heterogeneous, collisional, crustal structure. During post-collisional extension at 2.6 Ga, the intrusion of Aktanysh monzonitic granitoids took place. These rocks also bear evidence of a long crustal pre-history with Nd and Hf T_{DM} model ages of 3.3 to 3.5 Ga. The Aktanysh rocks are coeval with the Tuymazy gabbro-norite-anorthosite intrusions, which are widely distributed along post-collisional shear zones in the Bakaly block. They could have provided the heat necessary to melt the crust at this stage. Altogether, the isotopic evidence suggests several episodes of crustal growth and recycling possibly reaching back to 3.6 and 3.8 Ga. Metamorphic zircon rims show that the Archean crust in the Bakaly block were subjected to several tectonothermal overprints in the Paleoproterozoic between 2.4 and 1.9 Ga ago.

Key words: East European Craton, Volgo-Uralia, Paleoarchean, granitoids, zircon, geochronology

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