VOLGO-URALIA: SHRIMP EVIDENCE OF STRONG PALAEO-PROTEROZOIC REWORKING OF ARCHAEAN CRUST

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Volgo-Uralia (VU) is an enigmatic crustal segment that occupies the eastern third of the East European Craton (EEC). This is because its crystalline crust is buried completely beneath thick Proterozoic to Phanerozoic sedimentary cover. Information on the crystalline basement is therefore solely based on geophysical data and a great number of drill cores, particularly numerous because of the high oil and gas potential of the region.

The crust of VU is dominated by many separate belts of ca. 2.9-2.7 Ga metasedimentary and meta-igneous granulites. In addition there are also greenstone sequences with komatiitic volcanic rocks. Associated with these belts are NE-SW to E-W trending zones of strong shearing and mylonitisation. Superimposed on the Archaean structural pattern are large domal structures featuring circular concentric patterns of magnetic and gravity anomalies, and intense retrograde reworking of the granulites. This is in marked contrast to tectonic style of Fennoscandia and Sarmatia, two other crustal segments of the EEC.

Palaeoproterozoic metasedimentary rocks with rare metavolcanic rocks and numerous granitoids have been intersected in the interior parts of the domes. Apart from that, large areas of Palaeoproterozoic turbiditic metapelitic mica schists, silts, sandstones and carbonaceous shales occur along some of the margins of VU.

Whether the reworking of the Archaean granulites and the formation of the domal uplifts took place in the Archaean or in the Palaeoproterozoic has remained unresolved so far, mainly due to the absence of high quality isotopic age determinations of the overprinting metamorphism. In order to settle the issue, zircons from twelve samples of the most representative VU rocks were subjected to SHRIMP analysis. Among these rocks were meta-igneous and metasedimentary granulites as well as granitoids both from granulite facies areas and from zones of strong retrograde reworking of the Archaean granulites. The newly obtained SHRIMP and available TIMS zircon data confirm Meso and Neoarchaean ages for the protoliths and define the following tectonothermal events: (1) Regional granulite- and amphibolite- facies metamorphism, emplacement of granitoids and deformation at 2.72-2.71 Ga; (2) Granitoid magmatism of uncertain tectonic setting at 2.67-2.65 Ga; (3) Intrusion of post-collisional monzonitic granitoids, gabbro-anorthosites and anorthosites at ca. 2.60 Ga which form large elongated intrusions associated with major thrust zones; (4) sedimentation between 2.30 and 2.10 Ga, followed by high-grade metamorphism and anatectic melting at 2.08 Ga; and (5) metamorphism between 1.90 and 1.80 Ga.

Thus, the Archaean crust in VU was strongly reworked during multiple events between 2.1 and 1.8 Ga, i.e. analogous to similar events in Sarmatia. This suggests that after 2.1 Ga the Sarmatia and VU segments shared a common evolution. The doming, which occurs only in the Archaean crust of VU, is interpreted to have occurred prior to reworking and assembling with Sarmatia between 2.1 and 1.8 Ga. The widespread continental sedimentation recognised in VU between 2.3 and 2.1 Ga may be interpreted as a result of doming, which is potentially linked to convergent processes that eventually lead to the collision with Sarmatia around 2.1 Ga. A role of mantle plume tectonics may also explain the large-scale doming observed between 2.6 and 2.1 Ga.

Geochronological studies of zircon extracted from small drill core samples of VU have highlighted the complexity of zircon growth in multiply reworked granulite facies terranes. All of the thermal events in VU were accompanied by new zircon growth, complicating traditional zircon geochronology. Our U-Pb SHRIMP work clearly demonstrates the presence of several generations of zircon growth in many samples, and widespread zircon inheritance, making an unequivocal determination of protolith ages troublesome. This complexity, combined with the lack of exposure, limiting any study to small core-samples, renders geochronological work on the VU Shield difficult.