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Heterogeneity of the Proterozoic lower crust and lithospheric mantle beneath the north-western Ukrainian Shield: implications of trace element- and isotopic geochemistries of mafic intrusions

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The crust of the Ukrainian Shield was mostly formed due to the accretion of various Archaean and Palaeoproterozoic terranes at ca. 2.2-2.1 Ga. They were assembled before 2.0-1.95 Ga, when the large Osnitsk-Mikashevichi Igneous Belt (OMIB) developed along the northwestern active continental margin of Sarmatia. Both the mafic and felsic intrusions of the OMIB reveal juvenile Sr- and Nd-isotopic mantle compositions. Xenoliths from Devonian diatremes evidence garnet-granulitic to eclogitic lower crust beneath the OMIB and a subduction-related origin similar to that of other OMIB rocks (Markwick et al., 2001, Tectonophysics, 339). The composition of the upper mantle can be inferred from mantle-derived minerals widely distributed within the sedimentary platform cover of the studied area. Websterites and pyrope lherzolites with high contents of clinopyroxene are most abundant rocks in the upper mantle whereas pyrope- and chrome-spinel-bearing dunites, and harzburgites are less common. Chemistry of the ca. 2.0-1.8 Ga mafic intrusions also indicates such source composition. Between 2.0 and 1.8 Ga, the studied area was subjected to intense mafic magmatism of continental flood-basalt affinity. Numerous swarms of dolerite dykes and some mafic layered intrusions penetrated the crust. These rocks originated in a depleted mantle of a somewhat unusual composition in so far as it was enriched both in radiogenic Nd and radiogenic Sr. This may have been due to preceding subductional events that introduced crustal materials into the mantle. During the period between 1.80 and 1.74 Ga, the Northwest Ukrainian Shield was a region of extensive AMCG-type magmatism. The huge (12 000 sq. km) Korosten pluton was formed by repeated emplacements of

mafic and acid melts into the crust. Numerous related mafic dykes are found hundreds kilometres away. Geophysical data indicate thorough reworking of the Palaeoproterozoic crust (Thybo et al., 2003, Tectonophysics, 371), and particularly its lower and middle parts, where one-time large magma chamber can still be recognized. Rock compositions suggest that a part of the upper mantle can have been involved in the melt production during the early stages of this magmatism. However, isotopic data show that the most probable source of the initial melts in the Korosten pluton were lower-crustal analogues of the OMIB with some admixture of the 2.0-1.8 Ga "flood basalt" pounded and crystallized at the crust-mantle boundary. The formation of the Korosten pluton was the last major magmatic event in the Northwest Ukrainian Shield before the Neoproterozoic flood basalts of the Volyn province were erupted along the SW EEC margin at ca. 550 Ma age. The Nd and Sr isotope compositions of these basalts evidence old lithospheric source enriched in radiogenic Sr but depleted in radiogenic Nd. These compositions do not coincide with those of possible Paleoproterozoic sources in other parts of western Sarmatia. The CHUR and DM model ages of the Volyn basalts indicate that their lithospheric precursors had been formed at 1400-1900 Ma. Taking into account also the presence of ca. 1470-Ma old xenocrystic zircons derived from the source region we conclude that a previously unknown Mesoproterozoic event must have been important for the formation of the Sarmatian lithosphere. This is analogous to what has been found for the southern part of the Fennoscandian crustal segment of the EEC. The compositions of Cr-spinellide in the tuffs that are intercalated with the Volyn basalts point to that the initial melts originated from the partial melting of depleted pyrope lherzolites (Tsymbal et al., 2003, Min. J. Ukr. 25, 5/6). This can have changed the mantle composition substantially. Deep seismic tomography does indicate a significant difference in the velocity structure of the upper mantle in between the Volyn flood basalt province and its surroundings (Geiko et al. 2005, Geophys. J., 27). This is a contribution to the Swedish Institute' research network "Precambrian Evolution of Western Baltica" and the project of the Swedish Royal Academy of Sciences "Isotopic composition of mantle heterogeneity in the Ukrainian Shield".