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High-grade metamorphism in metapelites from the western East European Craton, western Lithuania: challenges of deciphering and dating multi-stage metamorphism

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The Precambrian basement of the western East European Craton (EEC) in western Lithuania is covered by ca 2 km thick sediments. The rocks are mostly charnockitoids and granitoids with a large area of metasedimentary rocks crosscut by the Lk1-5, Pc1-7, Sh3, Ls1-3, Ml1, Tr11, and other drillings. The metasediments are mostly Fe-rich pelites with subordinate calcic-silicic and mafic rocks.

The rocks were metamorphosed in granulite facies with a variable degree of partial melting resulting in domain-like structure. Most of the granulites contain garnet, biotite, sillimanite, plagioclase, K-feldspar, quartz, and opaque minerals with or without cordierite and hercynite spinel. The earlier geothermobarometry investigations in several drillings have revealed a complex nature of the granulite facies metamorphism. Peak conditions of 800-850^{o} C at 8.5 -9 kbar (samples Tr11, Lk2, 5, Pc1) were obtained from large garnet, biotite, and plagioclase grains with the presence of sillimanite. A second stage of 600-770^{o}C at 6-7 kbar was recorded mainly by the second garnet and cordierite. It was followed by a stage of 550-600^{o}C at 4-5 kbar (Skridlaite et al., 2014).

Using a pseudosection approach (Thermocalc 3.5.0), the preliminary modelling results are the following: in Lk5 sample, the T increases from 790^{o}C at 5.5 kbar to 840^{o}C at 5 kbar; in Tr11 sample, the garnet is stable at 800^{o}C and 7 kbar; in Pc1 sample, a drop of P from 6.5 7.5 to 5 kbar at 760-770^{o}C is prominent.

No metamorphic zircon was produced during the peak metamorphism except for a single metamorphic grain of ca. 1.80 Ga in Lk 2 sample (Bogdanova et al., 2015). Metamorphic overgrowths were too thin to date them. Instead, numerous monazite grains seemed to be promising for dating metamorphic peaks and distinct stages. Two age groups of monazites were distinguished from the preliminary EPMA dating results in Lk1, 2, and 5 samples: 1.79-1.77 Ga and 1.66 Ga - 1.63 Ga. In Tr11 sample, the cores of 1.80-1.79 Ga monazites were overgrown by 1.77-1.76 Ga rims.

After preliminary attempts to model and date distinct stages of metamorphism, we could evaluate advantages of all the methods applied and to look after some solutions of the arising problems. First, the whole-rock chemistry of distinct domains might be helpful to model PT evolution of those domains. More careful mineral analysis in a greater number of samples should be helpful for finding peak and other assemblages in a local equilibrium. HREE, especially Y-content investigations in monazite grains might provide some clues on monazite and garnet behavior during the distinct stage of metamorphism. Some other solutions would be very welcome.

Bogdanova, S. et al., 2015. Precambrian Research, 259, 5–33.

Skridlaite, G. et al., 2014. Gondwana Research, 25, 649-667.