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U-Pb SHRIMP-II Baddeleyite and Zircon Dating of the Early Proterozoic Monchegorsk Layered Mafite-Ultramafite Complex (Kola Peninsula): Evidence of Synchronous Magmatism

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The Early Paleoproterozoic Monchegorsk Complex is exposed over an area of 550 km^2 and comprises two layered mafite–ultramafite intrusions: the Monchepluton of ultramafic and mafic rocks and the predominantly gabbroid Main Range Massif (or Monchetundra), which are separated by a fault. Both massifs were produced by similar melts of siliceous high-Mg series but differ sharply in their cumulative prevalence: while the Monchepluton is dominated by ultramafites, the Monchetundra Massif consists mostly of gabbroids (Sharkov, 2006). The Complex is located in the southern part of the transform zone connecting Imandra and Pechenga segments of Pechenga-Imandra-Varzuga rift system and intrudes the Archean gneisses and is overlapped by the middle Proterozoic volcanogenic-sedimentary rocks. The Complex is spatially restricted to the Middle Paleoproterozoic regional Central Kola Fault and is now a tectonic collage of variably affected by overprinted metamorphism rocks (Sharkov et al., 2006). Geological position and structure of individual blocks from the Monchetundra fault zone are not well understood and there is no consensus as to the identity tectonized blocks of rhythmically layered rocks from junction zone to a particular massif (Smolkin et al., 2004).

Today it has been considered the time of Monchegorsk Layered Complex formation to be 2450-2510 Myr ago, but geological character and age relationships between Monchepluton and Monchetundra have been interpreted differently. The first researchers on the base of strongly metamorphosed rocks of the Main Range Massif and fresh appearance of the most rocks of Monchepluton believed that the Main Range is older. Later isotope-dating has shown that both massifs have Early Proterozoic age of 2501 ± 3 to 2453 ± 4 Ma (Smolkin et al, 2004). Least altered rocks from the upper zone of the Monchetundra have been recently dated by zircon and baddeleyite multigrain U-Pb isotope dilution analysis and the existence of closely spaced in time but independent intrusive phases within massif is assumed: gabbronorites (2476-2471 Ma) and gabbro-anorthosites (2456-2453 Ma), while the most young anorthosite injections could be as later as 2420 Ma (Bayanova et al., 2010). However, the age of zircons from Monchetundra gabbronorite previously has been identified as 2505-2501 Ma (Smolkin et al., 2004) and U-Pb zircon age of the Monchepluton corresponds to 2493 ± 7 Ma (Balashov et al., 1993). Thus, simultaneous formation of both magmatic massifs remains debatable.

To resolve this contradiction, we have studied by U-Pb SHRIMP-II zircon and baddeleyite separated from 3 gabbroid hard-rocks sampled from the same outcrops as (Bayanova et al., 2010)–two samples from the Monchepluton: (1) melanocratic coarse-grained norite-gabbronorite (M-64) and (2) olivine-gabbronorite (M-61) from regional dyke synchronous with Monchepluton outcropped at Olenegorsky open-pit; and one sample from middle zone of Monchetundra: gabbronorite-anorthosite (MT-1, mainly plagioclase cumulate) (3). One of the studied gabbroid sample (M-61) had enough (>20) grains of baddeleyite while other two contained a few zircon (2 grains in M-64 and 30 grains in MT-1) only (Fig.1).

Analytical method: Analysis of samples made possible during the continuous session to eliminate the problem of mutual correlation between the various sessions measurements and intercalibration of standard data. Baddeleyite studied grains randomly oriented with respect to the surface and mounted with 91500 standard zircon and baddeleyite «Phalaborwa» standard with the average age of 2060 Ma. Thus obtained for the standard error - 1.2% (2s) was generally comparable to those obtained for zircon measurements.

Results and Conclusions: 26 SHRIMP-II analyses for 20 baddeleyite grains of olivine gabbro (M-61) from regional dyke have been obtained but only 20 or 18 measurements were used for 208Pb-corrected age calculation: 2491.4 ± 3.9 Ma - $^{207}Pb/^{206}Pb$ averaged age or 2490.5 ± 8.9 Ma - concordant age (Fig.2). Up to 8 analyses have a very large

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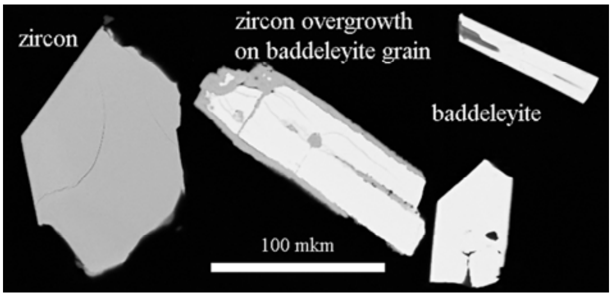

Fig.1. Typical zircon BSE (M-64) and baddeleyite CL (M-61) views

excess of common Pb and some U deficit that is probably connected with influence of later zircon intergrowth (Fig.1). U-Pb analyses of two evidently magmatic zircon grains (Th/U=1.5, [U]: 200-300 and [Pb_{rad}]: 50-130 ppm) from Monchepluton gabbronorite gave the same in error-limits concordant age 2500 ± 11 Ma (Fig.2).

SHRIMP-II data for 19 zircon grains from Monchetundra gabbro-anorthosite form two age-clusters: at about 2500 and 1800-1900 Ma. There isn't any prominent difference between grains of these two populations in morphology but small deviations are: U is a little higher in younger zircons -130-1800 ppm *vs* 230-1150 ppm for elder ones, and Th/U ratio for younger is lower –0.1-0.6 while for 2500 Ma-old grains –0.7-2.5. The calculated concordant age for 11 analyses equals to 2494.6 ± 7.3 Ma and for younger group averaged $^{207}Pb/^{206}Pb$ age is 1841 ± 25 Ma.

The obtained SHRIMP results on studied Monchegorsk Complex gabbroids are similar to previous at around 2500 Ma (Smolkin et al., 2004; Balashov et al., 1993) but significantly differ from 2420-2470 Ma age estimations (Bayanova et al., 2010). Such difference can be explained by multigrain mode of published analyses and by probable involvement of grains underwent by metamorphic overprint during Complex deformation at 2.0–1.9 Ga. The results of such influence can be seen not only in formation of new zircons but in an overgrowth of zircon mantle on baddeleyite grains in studied gabbroids also (Fig.1).

Obtained age coincidence of two spatially close massifs: Monchepluton and Monchetundra, confirms their synchronous intrusion and means that they may represent a genetically related derivatives of a single magmatic chamber which was tectonically upwelling on the surface or there was a very short period of magmatic activity accordant with supposed for plume-like intrusion (1-2 m.y.). Another possibility is an existence of time interval between 2500 Ma Monchepluton intrusion and Monchetundra massif crystallization accompanied by a regional olivine gabbronorite dyke at 2490 Ma ago. In any case the new data indicate that the magma chambers of the Monchegorsk Complex have evolved for less time, <10 Myr, than previously assumed (Sharkov, Chistyakov, 2012; Bayanova et al., 2010).

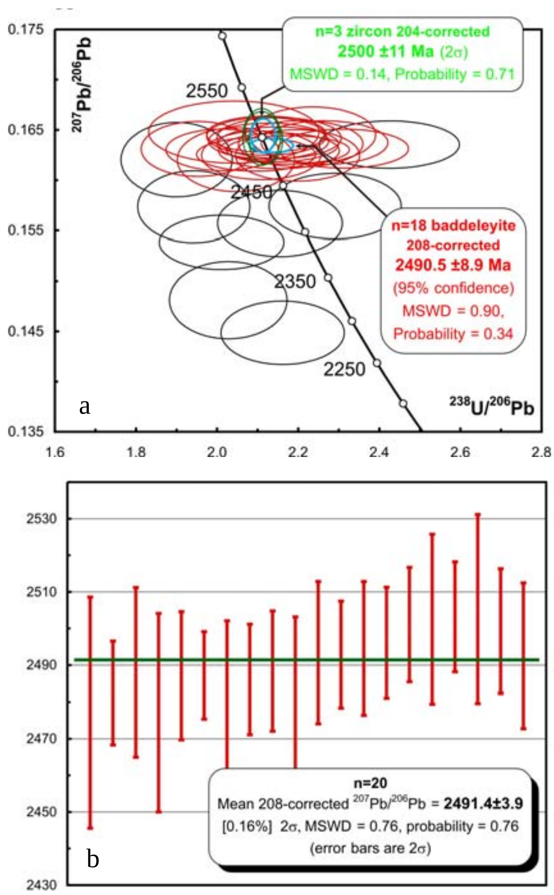

Fig. 2. U-Pb data for zircon (green ellipses, M-64) and baddeleyite (red ellipses, M-61) from gabbroids of the Monchepluton (a) and baddeleyite $^{207}Pb/^{206}Pb$ age distribution corresponds to 2491±4 Ma (b).

References

Balashov YA, Bayanova TB, Mitrofanov FP, 1993. Isotope data on the age and genesis of the layered basic-ultrabasic intrusions in the Kola Peninsula and northern Karelia, north eastern Baltic Shield. Precambrian Research 64, 197–205.

Bayanova TB, Nerovich LI, Mitrofanov FP, Zhavkov VA, Serov PA, 2010. The Monchetundra Basic Massif of the Kola Region: new geological and isotope geochronological data. Doklady Earth Sciences, 431, 288–293.

Sharkov EV, 2006. Formation of layered intrusions and related mineralization. Sci. World, Moscow, 364 p. (in Russian).

Sharkov EV, Chistyakov AV, 2012. The Early Paleoproterozoic Monchegorsk layered mafite-ultramafite massif in the Kola Peninsula: geology, petrology and ore potential. Petrology 20, 607-639.

Sharkov EV, Smolkin VF, Belyatsky BV, Chistyakov AV, Fedotov ZhA, 2006. Age of the Moncha Tundra Fault, Kola Peninsula: evidence from the Sm-Nd and Rb-Sr isotopic systematics of metamorphic assemblages. Geochemistry International 44, 317-326.

Smolkin, VF, Mitrofanov FP, et al., 2004. Layered intrusions of the Monchegorsk ore district: petrology, mineralization, isotope geochemistry, and deep structure. Kola Sci. Center RAS, Apatity, 177 p. (in Russian).