



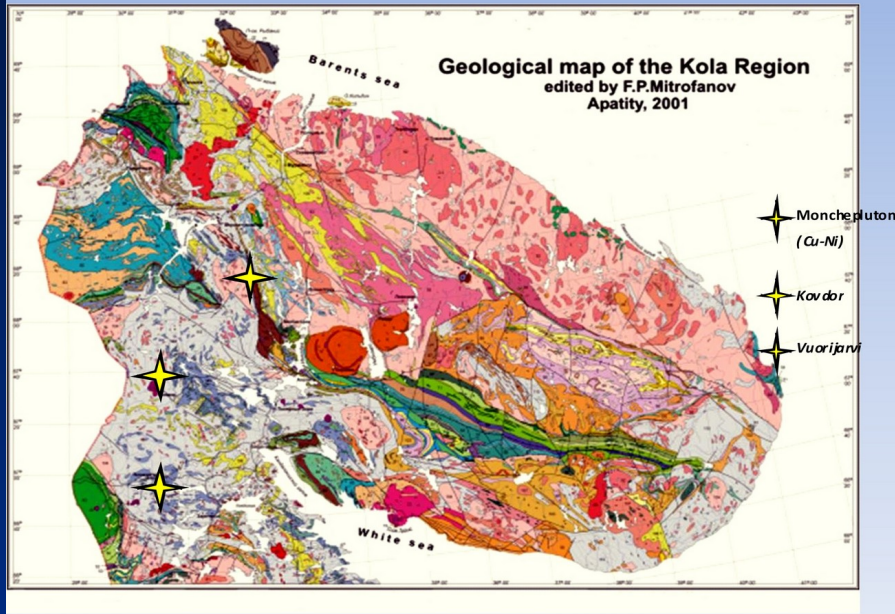
Geochemical researches in situ (LA-ICP-MS) of accessory and ore minerals from multimetal (PGE, Cu-Ni) deposits in the Arctic zone (Fennoscandian Shield) of the Russian Federation

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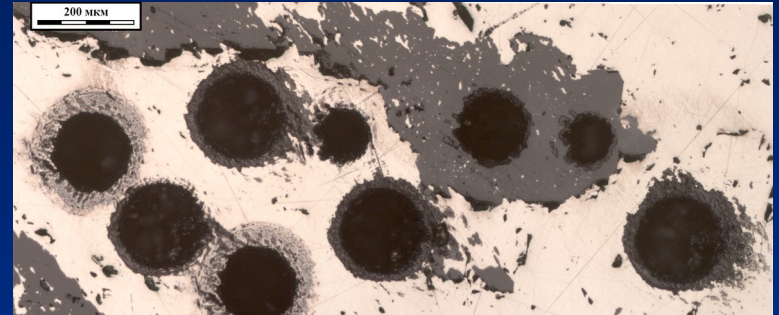
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The Baltic Shield



The laser ablation inductively-coupled plasma mass spectrometry (LA-ICP-MS) is a unique method for local analysis that allows studying mineral grains in situ.



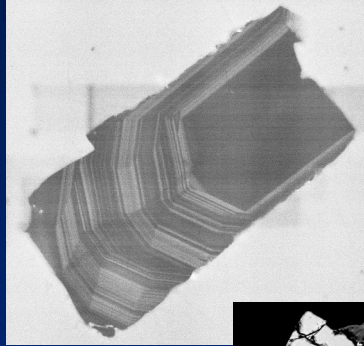
The aims of these geochemical researches are to estimate concentrations and distributions of REE, Hf, U, Th, Y, Ti, PGE and other elements in accessory and ore minerals from complex deposits in the Arctic region (Fennoscandian Shield), using the LA-ICP-MS local analysis of trace elements.

Accessory minerals of zircon and baddeleyite are much valued to study distributions of rare and rare earth elements (REE). Besides, pyrite, pentlandite, pyrrhotite and other sulfides are important for determining platinum-group elements (PGE), REE, etc.

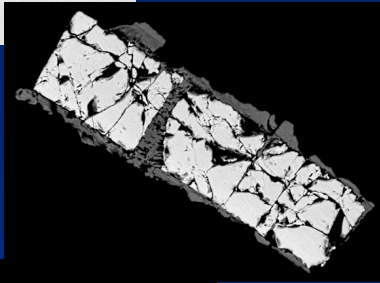
Analytical technique...

The electron (LEO-1415) and optic (LEICA OM 2500 P, camera DFC 290) spectroscopy have been applied to study the morphology of the samples.

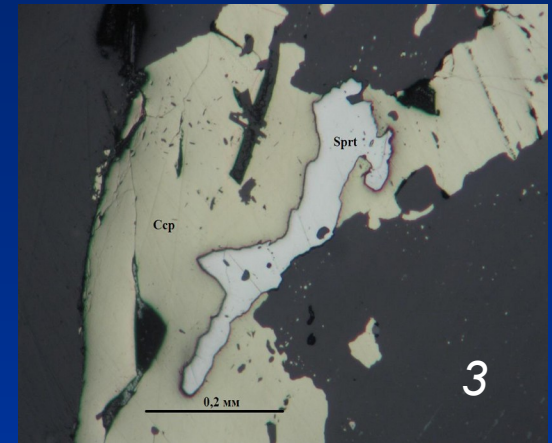
Analytical points have been selected on baddeleyite (1), zircon crystals (2) and sulfide minerals (3) based on analyses of their BSE, CL and optical images.



1



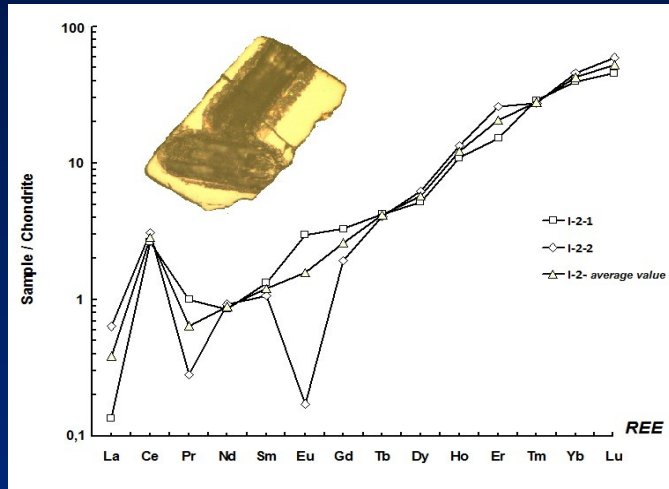
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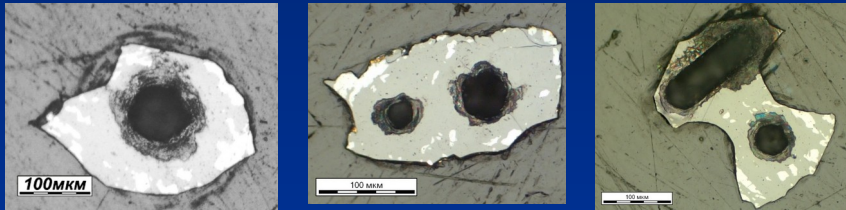
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REE, PGE and other elements have been estimated in situ by ICP-MS, using an ELAN 9000 DRC-e (Perkin Elmer) quadrupole mass spectrometer equipped with UP-266 MACRO laser (New Wave Research).

Elements in zircon and baddeleyite ...



Chondrite normalised REE distribution on baddeleyite (Sun,1989), scanning in different directions

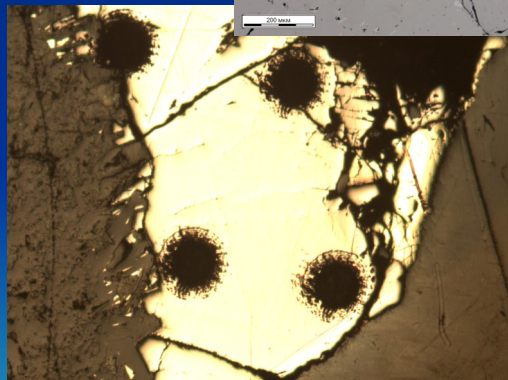
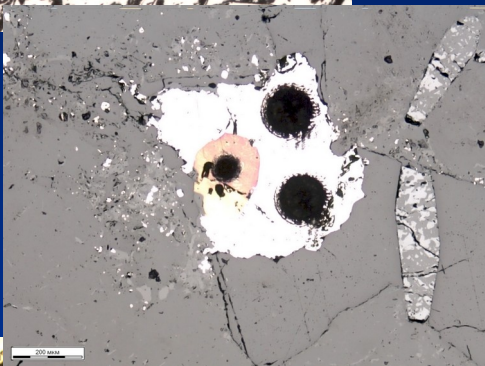
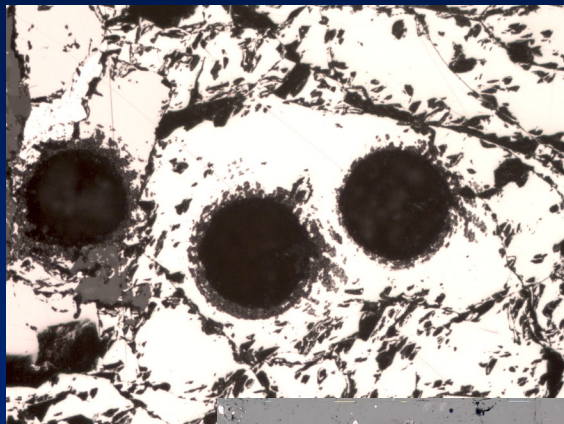


Laser ablation of zircon and baddeleyite have been carried out using argon with a repetition rate of 10 Hz, pulse duration of 4 ns, energy density of 14-15 J/cm² at a spot with a diameter of 35-100 µm. NIST 612 glass with the known concentration of REE, U, Ti, Th of 40 ppm as a multi-point calibration forced through the origin after blank correction. The diameter of the laser beam has been changed, while the rest parameters were stable: from 20 to 155 µm ($r = 0.999$). As for calibration standards, measurements of the elements are in the range of 15 % relative deviations.

Sample NIST SRM 610 with the concentration of 450 ppm has been used to check the accuracy of estimations. This technique has been verified by analyses of internationally approved standard zircon samples 91500, TEMORA 1, Mud Tank, and inter-laboratory cross-checks

More than 19 elements were profiled during each measurement in zircon or baddeleyite.

Elements in sulfide minerals...

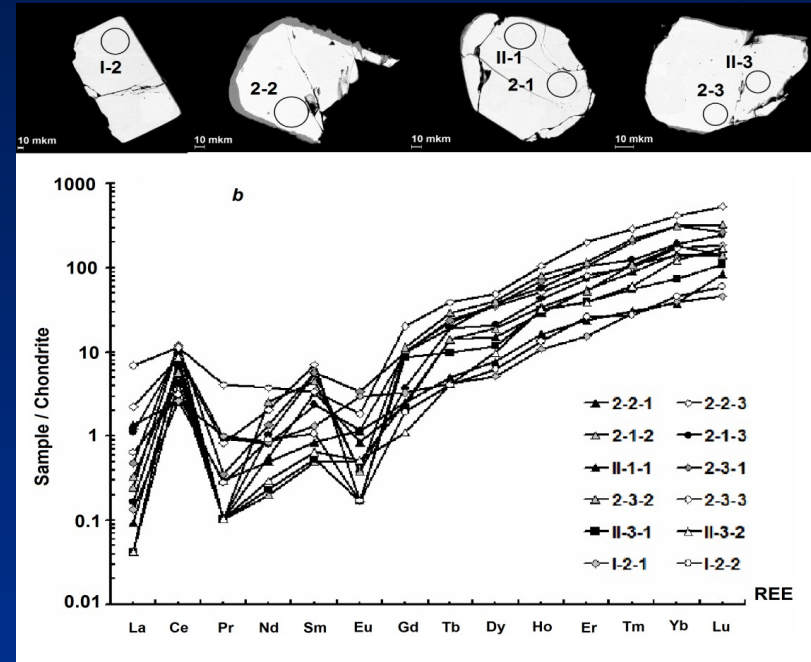
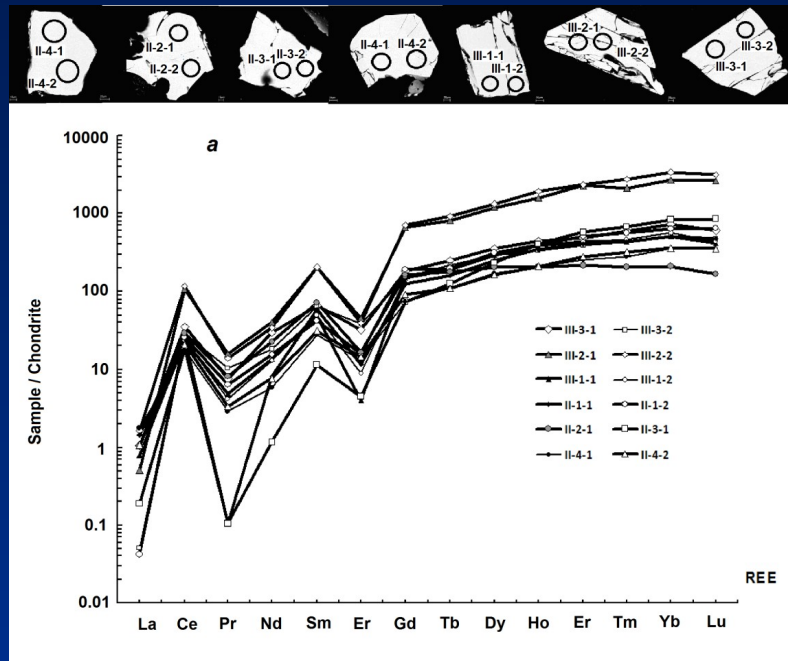


For the first time, LA-ICP-MS techniques have been applied to estimate PGE, REE and other (S, Cr, Fe, Cu, Ni, Co, As, Se, Mo, Cd, Sn, Sb, Re, Te, Tl, Hf, W, Bi, Pb, Th, U) elements in sulfide minerals.

The study was carried out using argon or helium with a repetition rate of 7 to 10 Hz, energy density of 3.0-3.5 mJ at a spot with a diameter of 35-155 μm . NIST 610, NIST 612 and tandem graduation (using solutions). Fe, Ni and Cu was as internal standards for concentrations of elements in sulphides was calculated. The estimates was carried out, using inter-laboratory standards of chalcopyrite, pentlandite and pyrrhotite, which had been preliminarily prepared and studied using micro probe analysis (Cameca MS-46).

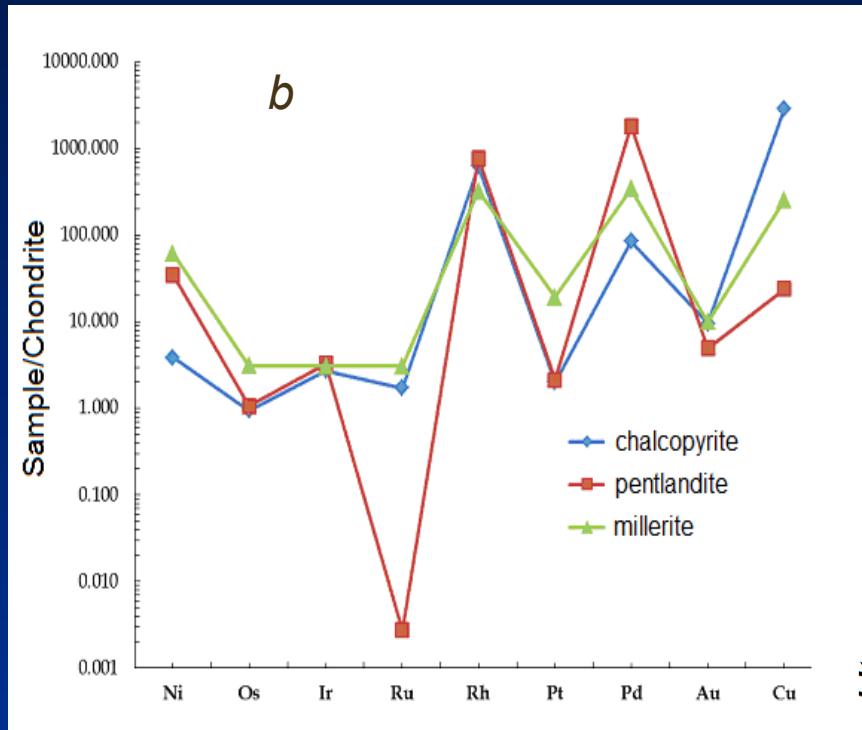
Results ...

Chondrite-normalized distribution of REE on zircon (a) and baddeleyite (b) from pegmatites vein of gabbronorite composition, Cu-Ni Terrace deposit, Nyud Mt. (Monchegorsk pluton)

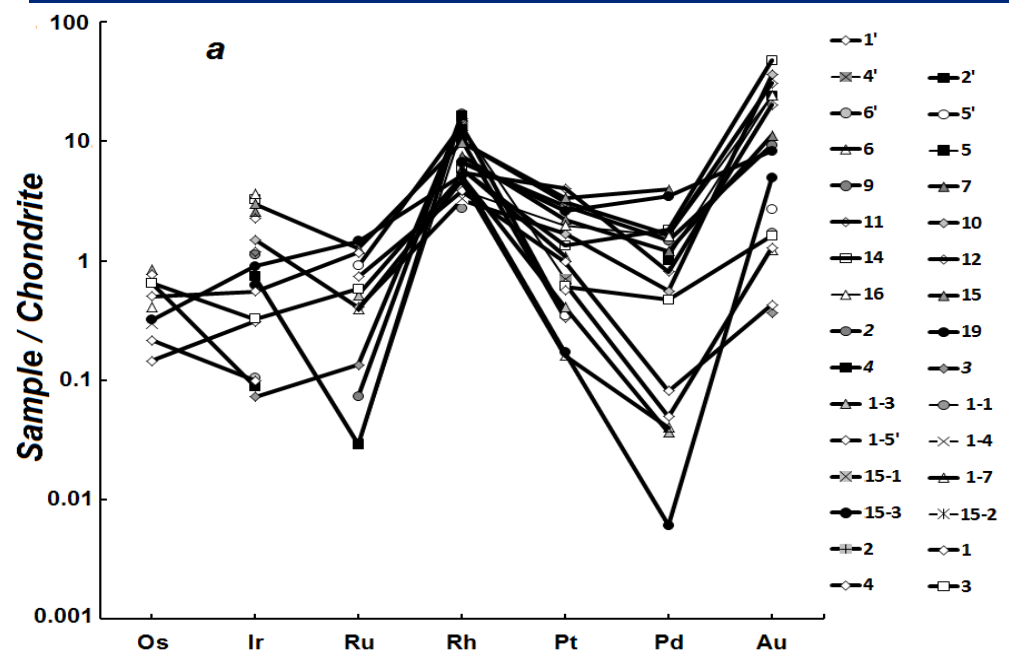


These techniques were used to estimate elements in zircon extracted from basic and acidic rocks of the Lapland belt (1.9 Ga), the Keivy zone (2.7 Ga), the Kandalaksha and Kolvitsa zone (2.45 Ga) and from the Cu-Ni deposit (Terrace, Mt. Nyud, 2.5 Ga). Novel techniques were used to analyze baddeleyite from rocks of layered PGE intrusions of the Monchegorsk mining area (2.5 Ga) and carbonatites of Kovdor and Vuoriyarvi (380 Ma).

Results ...



New LA-ICP-MS techniques were to provide in situ measurements of PGE, Au, Ag, siderophile and chalcophile elements in sulphide minerals from the Pechenga (a) and Allarechka Cu-Ni reefs (1.98 Ga) and PGE reefs of Fedorova Tundra and Severny Kamennik deposits (2.5 Ga) (b).



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