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# Federovo Pansky Pt-bearing layered intrusion (N-E Baltic Shield): new U-Pb zircon ages of the different rock types.

E.Nitkina, G.Vursiy, T.Bayanova

Geological Institute, Kola Science Center, Russian Academy of Sciences

## Abstract

The new established precise zircon U-Pb isotope ages for the earliest intruded phase (orthopyroxenite and gabbro) are 2526-2516 Ma and for the last intruded phase (norite) is  $2485\pm9$  Ma for the Federov block of the Federovo Pansky Pt-bearing layered intrusion. The magmatic nature of zircons for the different rock types of the Federov block and the increase of crust contamination to the end of crystallization are postulated.

# Introduction

It is reported isotope U-Pb ages for zircons and baddeleyite of West Pansky block rock of the Pt-bearing layered Federovo Pansky intrusion for gabbronorite are  $2491\pm1.5$ Ma [Bayanova, 2004] and  $2501.5\pm1.7$  Ma [Amelin et al., 1995] and for gabbropegmatite from low layered horizon is  $2470\pm9$  Ma [Bayanova, 2004]. Zircons from magnetite gabbro of the central part yielded the U-Pb age  $2498\pm5$  Ma [Chistyakova et *al.*, 2000] and from anorthosite of the upper layered horizon gave the U-Pb age  $2447\pm12$ Ma [Bayanova, 2004]. The U-Pb zircon age of gabbro zone of East Pansky block is  $2487\pm10$  Ma [Karpov, 2004]. Based on these U-Pb data the West and East Pansky blocks are characterized by the next phase of the intrusion: the main stage of gabbronorite magma have the U-Pb ages from 2501 to 2487 Ma, the concluding stage have the U-Pb age at 2470 Ma. The age of anorthosite is 2447 Ma and it indicates the second stage of magma intrusion [Bayanova, 2004] or the postmagmatic events [Karpov, 2004].

This paper focuses on precise U-Pb isotope zircon dating of different rock types of

Federov block. The investigation also was aimed to study morphology, internal structure and chemical composition of zircon from these rocks.

## **Geological setting**

Proterozoic Pt-bearing layered Federovo Pansky intrusion is one of the largest layered intrusions in the northern Kola belt of layered intrusions known in the Baltic Shield [Mitrofanov et al., 1997]. Federovo Pansky massif is located along the contact between the Archaean Kola block gneisses and Keivy Terrain with alkaline granites (2.76 Ga) in the north and earlier Proterozoic Imandra-Varzuga zone volcanic rock in south. The intrusion is situated in the north-eastern part of the Baltic Shield/ It has the total area of 4000 km<sup>2</sup> and includes from west to east Federov, Lastjavr, West-Pansky and East Pansky blocks [*Schissel et al.*, 2002]. The massif consist of marginal zone, taxitic gabbronorite zone, norite zone, main gabbronorite zone, lower layered zone, gabbro zone, upper layered zone and uppere gabbronorite zone according to Dokuchaeva [1994].

Taxitic gabbronorite zone is known only to the Federov block and west Lastjavr block. The Federov block lacks the lower layered horizon zone [*Schissel et al.*, 2002]. Zagorodny and Radchenko [1982] also reported about the presence of the earliest phase rocks in the Federovo block.

## Analytical techniques

The samples were crushed and the zircons were extracted using electromagnet and bromoform at the Geological institute of the Kola Science center of RAS. The features of zircon morphology such as habitus, facets, color and internal structure were investigated under binocular microscope. The zircon chemical composition was studied on MS-46 "Cameca". Taking into account the findings the zircons populations for precise U-Pb isotope dating were hand picked. In order to study U-Pb isotope ages the chemical extraction of uranium and lead was done by the technique developed by Krogh (1973). The isotope measurements were fulfilled using mass-spectrometer Finnigan MAT-262 (RPQ) with a single filament mode, mixed 208U/235Pb tracer and silicagel. The U-Pb point coordinates and isochron parameters were computed according to Ludwig (1991, 1999) with the use of standard decay constants (Steiger&Jager, 1977), the total Pb and U blanks are 80 pg and 40 pg accordingly. Correction for common lead for zircons was done by Stacey and Kramers (1975).

# Sample description and U-Pb dating

For U-Pb dating ortopyroxenite and gabbro of the earliest phase and norite of the last phase were sampled in the Federov block.

A 42 kg sample of orthopyroxenites was taken, and 12 mg zircon concentrate was

extracted. The zircon crystals with 150-200  $\mu$ m in size show facets of the prism {110} and dipyramid {111}. The colour of zircon grains varies from dark brown to pale and pink. The ZrO<sub>2</sub>/HfO<sub>2</sub> ratio has a high meaning from 30 to 65. Four populations were picked for dating: the first corresponds to the second portion of two-stage solution of dark brown transparent prismatic crystals, the second is dark brown transparent prismatic crystals, and the fourth is pink prismatic zircon. Zircons contain 350-600 ppm of uranium. The U-Pb age, which was obtained from the four zircon populations, is  $2526\pm 6$  Ma (MSWD=1.70), which is interpreted as time of orthopyroxenite emplacement. The lower concordia-discordia interception is at the point of 700 $\pm$ 50 Ma and shows apparently the age of the Grenvil time events [Mitrofanov et al., 1997].

Zircon concentrate with weight of 110 mg was picked out of a 57 kg sample of the gabbro. Crystals with size from 200 to 400  $\mu$ m show facets of prisms {100}, {110} and dipyramid {111}. The ZrO<sub>2</sub>/HfO<sub>2</sub>ratio varies from 43 to 62. For the U-Pb dating three zircon populations were picked: 1 – dark-brown transparent prismatic crystals, 2 – pale transparent crystals, 3 – pale brown grains. Zircons have a high uranium concentration equal 1350 ppm. The coordinates of three points describe a discordia, which intersects the concordia at the point of 2516±7 Ma, MSWD=0.52 and can most likely indicate time of gabbro crystallization. The lower concordia-discordia interception is at the point of 854±50 Ma, which shows the Grenvil time events [Mitrofanov et al., 1997].

Zircon concentrate 14 mg were extracted from norite 67 kg. Zircons grains are characterized by prismatic and di-pyramidal habitus and have 250-450  $\mu$ m in size. Crystals show facets of prisms {100}, {110} and dipyramid {111}. The ZrO<sub>2</sub>/HfO<sub>2</sub>ratio is 57-84. Four types of the zircon crystals were taken from the norite for the U-Pb dating: first – pale transparent crystals, second – dark brawn prismatic crystals, third – pink prismatic crystals and forth - pale brown grains. The uranium concentration varies from 800 ppm to 1200 ppm. Zircon populations yielded the U-Pb age of 2485±9 Ma, MSWD=1.2, which shows time of the norite crystallization. The lower concordiadiscordia interception is at the point of 360±50 Ma, and reflects the time of the tectonic and thermal Palaeozoic events on the Baltic Shield [Mitrofanov et al., 1997].

### Conclusions

The mineralogical research of the zircon shows that all crystals from the orthopyroxenite, gabbro and norite of Federov block of Pt-bearing Federovo Pansky layered intrusion are characterized by magmatic features. And grains have not any admixture that also is evidence of magmatic origin of zircon according to Bibikova [1991].

The growth of  $ZrO_2/HfO_2$  ratios in zircon [Ljahovich, 1990] from the rock of the earliest phase to the rock of the last phase for Federov block reflects the increase the

role of crust contamination.

The geochronological zircon U-Pb data from three different rock of Federov block of Pt-bearing layered Federovo Pansky intrusion show that the orthopyroxenite and gabbro of the earliest phase were formed at 2526-2516 Ma and norite of the last phase were originated at  $2485\pm9$  Ma.

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