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MONAZITE IN PRECAMBRIAN GRANITES OF THE UKRAINIAN SHIELD: SELECTED ASPECTS OF GEOCHEMISTRY AND CHEMICAL AGE DATING

Abstract: Monazite was found in conventional polished thin sections of granites from six Precambrian granitoid complexes of the Ukrainian Shield, using BSE images and EDS spectra. The mineral differs, from sample to sample, in abundance, habit and internal structuring but, typically, it displays zonation or domain structure in BSE images: brighter domains are richer in Th and U than darker ones. Our preliminary microprobe ages (e.g. 2048±26 Ma for the Kapustinsky granite, Novoukrainsky Massif) fit well with the published conventional U-Pb isotope zircon data (2020 to 2080 Ma for the same granite).

Key words: monazite, chemical dating, granite, Precambrian, Ukrainian Shield

INTRODUCTION

Monazite, a REE phosphate, is an accessory mineral quite abundant in granitoids and high-grade metamorphic rocks. Apart from its high light REE concentrations, the mineral often contains considerable amounts of Th and U, and thus offering a convenient tool in microprobe chemical age dating, and being used as a very useful indicator of rock-forming processes.

In this paper we present preliminary data from Precambrian granites of the Ukrainian Shield (for overview, see Scherbak et al. 1993). Our studies were carried out within an international project "AGE" which aimed in using accessory minerals, in particular monazite, as a petrogenetic tool to investigate selected aspects of geodynamic crustal processes. We report our observations on the occurrence and distribution of monazite in Ukrainian granitoid massifs, present our experiences concerning methods of identification of that mineral and of investigation of its internal structure and chemical variation, and preliminary microprobe chemical age dating results.

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SAMPLING AND MONAZITE IDENTIFICATION

We sampled 15 localities in 9 selected granitoid complexes across the whole area of the Ukrainian Shield. Most of the granitoids were reported to comprise monazite as an accessory phase. Based on published results, the granitoids display a range of conventional isotopic U-Pb zircon ages, from c. 1800 to 2800 Ma, clustering mostly around 2000 Ma (Scherbak et al. 1993, and data compiled by K.I. Sveshnikov, pers. comm.).

Our samples were thin sectioned and investigated in BSE images combined with EDS identification. This technique revealed the presence of monazite in 6 of total 19 sectioned specimens. Detailed observations from two granites, the Anadolsky and Kapustinsky granites, are used here to exemplify selected phenomena and research problems.

RESULTS

Anadolsky granite – Priazovie, east Ukraine (sample U8)

Monazite is fairly common in this granite (10 grains in one standard thin section). It is found as 50 – 200 microns inclusions, mostly in feldspars, often close to zircon crystals, and associated with magnetite and ilmenite. The monazite grains are oval-shaped, with rather smooth, subrounded edges and, usually, with distinct irregular or recurrent concentric zonation. In BSE images, one can see brighter domains in the grain interiors, mantled by darker areas, and followed again by brighter rims. The brighter areas correspond to high Th and U (and, consequently, Pb) concentrations, while the darker ones are poor in these elements and richer in light REE and Y (Fig. 1).

Kapustinsky granite – Novoukrainsky Massif, central Ukraine (sample U5x3)

This granite is rich in monazite (c. 25 grains in one thin section) which is associated with zircon, apatite and ilmenite, and forms 30 – 200 microns inclusions in biotite, quartz and feldspars. The monazite grains are subrounded to irregular, and display distinct reaction coronas against feldspar and biotite. BSE images (Fig. 2) also reveal a fairly distinct zoning pattern: darker interiors and brighter rims which correspond with chemical variation (Tab. 1): the darker domains contain c. 7 – 8 wt. % ThO_2, whereas the brighter ones have 10 – 12 wt. % ThO_2. Despite these differences, both types of domains yield similar ages, roughly within the analytical errors (the brighter areas, seemingly, by 2-3 % older than the darker ones). Our preliminary chemical monazite age for this sample, based on 18 points in six grains in one thin section, is 2048±26 Ma, and it fits well with the published conventional U-Pb isotope zircon ages of 2020 – 2080 Ma (data compiled by K.I. Sveshnikov, pers. comm.).

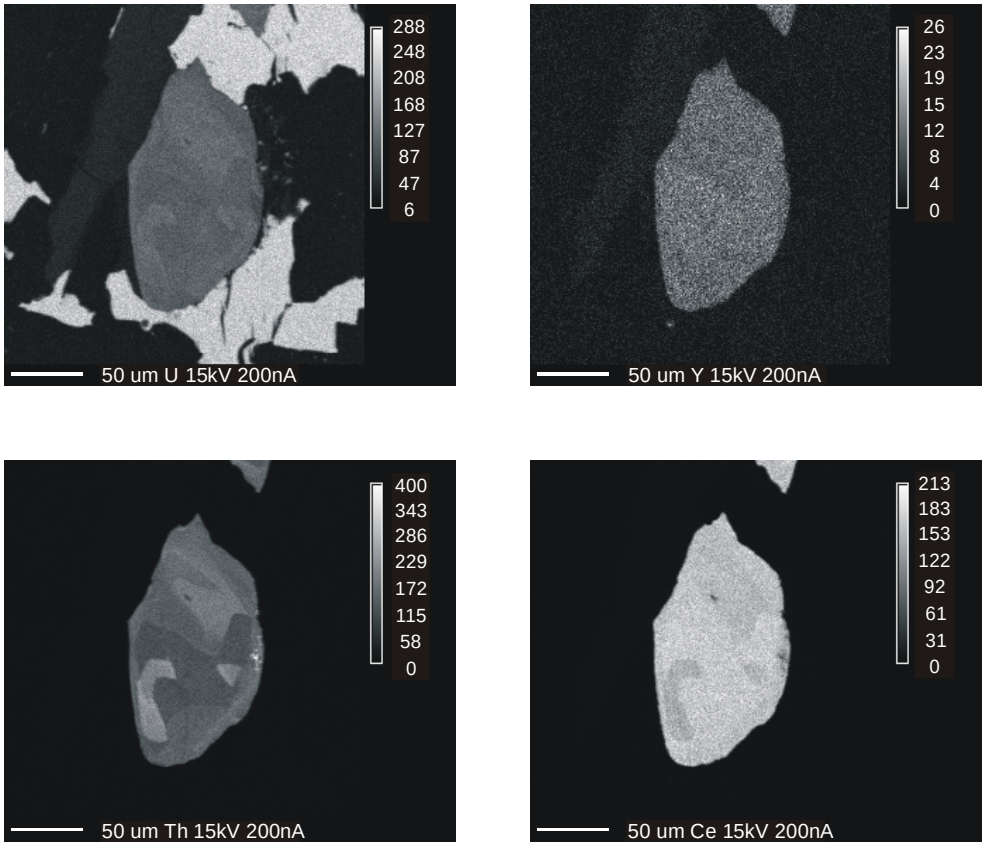

Fig. 1. Monazite from the Volnovakha granite, E-part of the Ukrainian Shield (Anadol quarry, sample U8a). BSE image (monazite grain WBB) and element distribution maps for U, Y, Th and Ce.

The X-ray maps obtained on CAMECA SX100 microprobe at Université B. Pascal, Clermont-Ferrand. Mapping conditions: 200 nA, 100 ms/pixel, four spectrometers, PET1 - Th (M-a), PET2 - Y (L-a), LPET3 - U (M-b; notice: interference with K - line K-a1 in surrounding biotite), LIF - Ce (L-a), map size 256 x 256 pixels, stage movement.

Table 1. Analyses of monazite from Kapustinsky granite, sample U5x-3, grain JFA.

% oxides	JFA/162	JFA/163
ThO_2	7,156	10,350
UO_2	0,070	0,280
PbO	0,642	1,006
P_2O_5	29,152	27,419
La_2O_3	14,260	12,656
Ce_2O_3	29,352	27,768
Pr_2O_3	3,021	2,956
Nd_2O_3	11,409	10,536
Sm_2O_3	0,954	1,208
Eu_2O_3	0,233	0,226
Gd_2O_3	0,806	0,982
Tb_2O_3	0,119	0,127
Dy_2O_3	0,121	0,193
Ho_2O_3	0,322	0,231
Er_2O_3	0,073	0,000
Tm_2O_3	0,042	0,025
Yb_2O_3	0,024	0,065
Lu_2O_3	0,061	0,002
Y_2O_3	0,653	0,506
CaO	1,050	1,233
SiO_2	0,907	1,795
FeO	0,026	0,069
Total	100,453	99,633

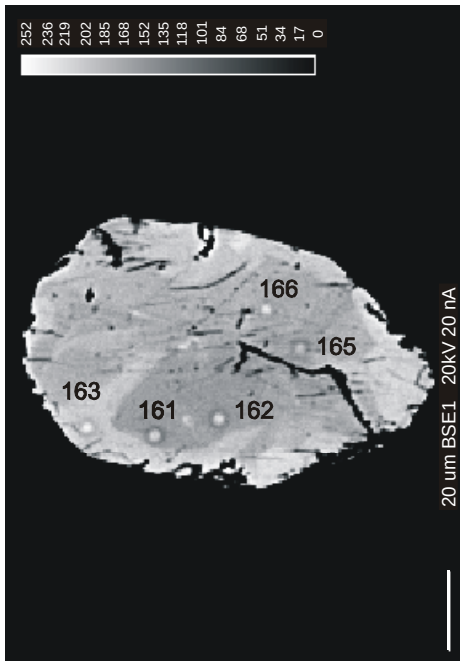

Fig. 2. BSE image of monazite in Kapustinsky granite, sample U5x-3, grain JFA; analyses of points 162 (dark) and 163 (bright) given in Table 1.

CONCLUSIONS

(a) Monazite is fairly abundant in Precambrian granites of the Ukrainian Shield; it was detectable in polished thin sections, using BSE and EDS.
(b) BSE images well reveal common internal structuring, corresponding with chemical zonation (brighter domains are rich in Th, U and Pb).
(c) Preliminary monazite age for the Kapustinsky granite (central Ukraine), 2048±26 Ma, fits well with the published U-Pb isotope zircon ages.

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