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URANIUM DETERMINATIONS IN SERPENTINITES FROM LOWER SILESIA (POLAND) USING FISSION TRACK METHOD

Abstract. Uranium contents in selected ultrabasic rocks from dismembered ophiolite complex of Lower Silesia (SW Poland) were determined using FT method. It was found that the ultramafics in question are often enriched in this element, containing up to several tenths ppm U. Particularly high in uranium was nephrite sample from Jordanów (Ślęża (Mt.) Massif), being product od calcium metasomatism. On the other hand, no distinct correlation between uranium concentration and the degree of serpentinization of ultrabasic was established.

INTRODUCTION

The knowledge of uranium contents in ultramafic rocks is important because of attempts to evaluate radiogenic heat of the mantle since this element, apart from thorium, is the main producer of the latter. It should be taken into account that whole-rock estimations of uranium (eg. Lovering and Morgan 1963, Wakita *et al.* 1967) may give too high results since even apparently fresh rocks usually contain U-enriched components introduced after their formation. This eventual error can be eliminated by the use of fission track (FT) method allowing to determine this element contents in individual minerals. The principles of this method with its geological applications were presented by Fleischer *et al.* (1975) whilst among Polish publications on this subject worth mentioning is, first of all, Skowroński's (1976) monograph. The present author applied this procedure for estimation of uranium contents in loesses (Przybyłowicz and Skowroński 1978).

FT method was applied by Seitz and Hart (1973) in examining serpentinized and weathered parts of ultramafic rocks from midocean ridges. They found that these altered rocks were considerably enriched in uranium (0.5—2.4 ppm) when compared with typical minerals of parent ultramafic rocks: orthopyroxene (0.4—1.4 ppb), clinopyroxene (2.5 ppb), chromium spinel (0.6 ppb) and olivine (7—40 ppb). It was concluded that maximum U contents in non-altered material should not exceed 40 ppb. The authors have criticized higher results reported by Aumento

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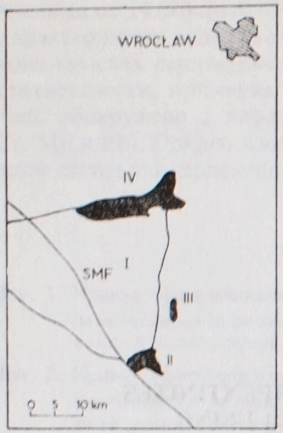

Fig. 1. Sketch map showing the location of basic-ultrabasic rock massifs in Lower Silesia, SW Poland

I — Sowie Góry (Mts.) Block, *II* — Gabbro-serpentinite Braszowice—Grochowa massif, *III* — Szklary serpentinite massif, *IV* — Serpentinite-gabbroamphibolite massif of Ślęża (Mt.), SMF — Sudetic Marginal Fault

and Hyndman (1971) for primary ultrabasic rocks (up to 1 ppm in orthopyroxene).

The above divergence of data inclined the present author to determine uranium in selected samples of ophiolitic Lower Silesian serpentinites, first of all in their less altered samples, using the same analytical procedure. They were collected from three mafic-ultramafic rock bodies situated in the surroundings of the Sowie Mts. Block (Lower Silesia, SW Poland) i.e. from Braszowice—Grochowa, Szklary and Gogołów—Jordanów (Ślęża Mt.) Massifs (Fig. 1). More details on their geological setting and petrology are presented e.g. by Narębski *et al.* (1982). On the basis of alteration degree, the examined samples were subdivided into three types: I — serpentinized peridotite, II — serpentinite with relict olivine, and III — serpentinite (Kubicz 1966, Przybyłowicz 1985).

EXPERIMENTAL

The samples were prepared as polished thin sections, covered by external detectors — Estrofol EK foil 80 μm thick (Skowroński 1974). The pack consisting of 12 so prepared serpentinite samples and two powdered samples of SL-1 standard (prepared by International Atomic Energy Agency) were irradiated in the channel no 52, situated in thermal column of the "EVA-10" nuclear reactor of Świerk Institute of Nuclear Research. The thermal neutron fluency (product of thermal neutron flux and irradiation time) was 1.08×10^{16} $n \cdot cm^{-2}$. All the detectors were etched in 6N KOH solution for 13 min at temp. $60 \pm 5^{\circ}C$. Tracks of fission fragments of U-235 nuclei were observed using microscope technique (transparent light).

In the case of homogeneous tracks' distribution their densities were counted in 30 randomly chosen places on this side of detector which was adhering to the sample during irradiation. The ocular with scaled net was used and the magnification applied was from 100 to 400 times, depending on the density of tracks. On the ground of these data, the mean densities of tracks and their standard deviations were computed.

Uranium contents were calculated by comparison with simultaneously irradiated standard using simple formula:

$$C_U = C_{U'} \frac{\varrho_l}{\varrho_{l'}}$$

where:

$C_{U'}$ — uranium contents in the standard,

ϱ_l, $\varrho_{l'}$ — track number density of fission of U-235 nuclei caused by thermal neutrons on the detector foil adhering to the sample analyzed (ϱ_l) and to the standard (ϱ_l) respectively

Total error of uranium estimation was computed using the error propagation law. The errors of *U* determination in the standard and of computation of average track densities in the standard and in the examined samples were taken into account.

RESULTS

The obtained results are presented in Table 1. Serpentinized peridotites from Braszowice (assigned to the least altered type I) contain, on the average, ca. 100 ppb U i.e. approximately one order of magnitude more than the proposed clark for ultramafic rocks (Turekian and Wedepohl 1961). Homogeneous distribution of tracks indicates that uranium concentrations in each mineral of the rock are similar. The same values were obtained for more altered rocks from adjacent Grochowa: *SGR-6* (type II) and *SGR-24e* (type III). On the other hand, only slightly altered rock from Braszowice (sample *SGR-36* — type I) contains distinctly more uranium — ca. 400 ppb. Serpentinite with relics of olivine from Szklary (*SSz-2* — type II) and serpentinite from Jordanów, Ślęża (Mt.) Massif (*SJN-3* — type III) contain ca. 200 ppb *U*. In all the above samples uranium shows homogeneous distribution. On the contrary, local enrichment in this element is observed in serpentinite from Wiry (type III). It is up to 4.9 ppm. In other parts of thin section of this rock *U* content amounts to approx. 180 ppb. Still higher uranium contents was found in serpentinite sample *SB-1* (type III) from Braszowice — its mean concentration is ca. 4.1 ppm whilst locally it increases up to 13—17 ppm. In both these samples, the enriched areas correspond to serpentine minerals but, due to observed intergrowths with other phases, the presence of such minerals as chlorite, talc or magnesite in them cannot be excluded.

The highest concentration of uranium was found in specific sample (*SJN-2*) from Jordanów, consisting predominantly of tremolitic amphibole (nephrite?) accompanied only by opaque minerals. Simultaneously, the distribution of uranium in this

Table 1

Results of uranium determinations in serpentinites from Lower Silesia (Poland) using fission track method

Sample	Locality, rock type	*U* contents ppb
SGR-36	Braszowice, borehole serpentinized peridotite (type I)	440±40
SGR-37		109±11
SGR-38		97±9
SGR-39		97±9
SGR-6	Grochowa, magnesite mine serpentinite with relict olivine (type II)	87±8
SGR-24e	Grochowa, magnesite mine serpentinite (type III)	83±9
SSz-2	Szklary, nickel mine serpentinite with relict olivine (type II)	181±17
SJN-3	Jordanów, nephrite quarry serpentinite (type III)	200±30
SW-1	Wiry, magnesite mine serpentinite (type III)	180±30
		(4.9±0.7) ppm[1]
SB-1	Braszowice, Stróżnik Hill, quarry serpentinite (type III)	(4.1±0.5) ppm
		13—17 ppm[1]
SJN-2	Jordanów, quarry nephrite?	0.00 *X*%[1]

[1] In places enriched in uranium.

rock is not homogeneous. The density of tracks on detector foil renders impossible any accurate calculation. We may only evaluate the *U* contents in this rock, amounting to several tenths ppm. On the other hand, the lowest *U* contents was found in gabbro sample (*G-24*) from a quarry situated near the Ząbkowice Śl.—Kłodzko road, ca. 2.5 km from magnesite mine in Grochowa. It contains only 24 ppb *U* i.e. the amount generally characteristic of parent ultramafic rock.

The obtained data are consistent with the results reported for ultramafic rocks of mid-ocean ridges (Seitz and Hart 1973). Though some Lower Silesian serpentinites are more enriched in uranium, no simple correlation between the degree of serpentinization and the contents of this element was established. This refers e.g. to the above characterized rocks from Braszowice and Grochowa. Exceptionally high in uranium is specific rock of Jordanów (nephrite?) what is, most probably, connected with calcium metasomatism caused by gabbro intrusion (Heflik 1967).

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OZNACZANIE ZAWARTOŚCI URANU W SERPENTYNITACH DOLNEGO ŚLĄSKA METODĄ DETEKCJI ŚLADÓW FRAGMENTÓW ROZSZCZEPIENIA JĄDER URANU

Streszczenie

Zawartość uranu w wybranych skałach ultramaficznych rozczłonkowanego kompleksu ofiolitowego obrzeżenia Gór Sowich (SW Polska) oznaczono metodą detekcji śladów fragmentów rozszczepienia jąder U-235 (FT). Stwierdzono częste wzbogacenie tych skał w uran, osiągające w pewnych przypadkach kilkadziesiąt ppm. Szczególne wzbogacenie wykazuje próbka nefrytu z Jordanowa (Masyw Ślęży), będąca rezultatem metasomatozy wapniowej. Nie zaobserwowano prostej zależności pomiędzy stopniem serpentynizacji ultramafitów a zawartością uranu.

OBJAŚNIENIE FIGURY

Fig. 1. Występowanie skał mafickych i ultramafickych Dolnego Śląska

I — Góry Sowie, *II* — masyw gabrowo-serpentynitowy Braszowice—Grochowa, *III* — masyw serpentynitowy Szklar, *IV* — masyw serpentynitowo-gabrowo-amfibolitowy Ślęży, SMF — Uskok Sudecki Brzeżny

Войцех ПШИБЫЛОВИЧ

ОПРЕДЕЛЕНИЕ СОДЕРЖАНИЯ УРАНА В СЕРПЕНТИНИТАХ ИЗ НИЖНЕЙ СИЛЕЗИИ МЕТОДОМ ИЗУЧЕНИЯ СЛЕДОВ ОСКОЛКОВ РАСЩЕПЛЕНИЯ ЯДЕР УРАНА

Резюме

Содержание урана в некоторых ультрамафитовых породах расчлененного офиолитового комплекса обрамления Совьих гор (ЮЗ Польша) определялось методом детектирования следов осколков расщепления ядер U^{235}. Обнаружено частое обогащение этих пород ураном, достигающее в некоторых случаях несколько десятков г/т. В частности, обогащение обнаруживает образец нефрита из Иорданува (массив Сьленжа), образованный в итоге кальциевого метасоматоза. Прямая зависимость между степенью серпентинизации ультрамафитов и содержанием урана не наблюдалась.

ОБЪЯСНЕНИЕ К ФИГУРЕ

Фиг. 1. Нахождение мафитовых и ультрамафитовых пород в Нижней Силезии

I — Совье горы, *II* — габбро-серпентинитовый массив Брашовице—Грохова, *III* — серпентинитовый массив Шкляров, *IV* — серпентинитово-габбро-амфиболитовый массив Сьленжи, SMF — Краевой судетский сброс