PROVENANCE OF CHROMIAN SPINELS OF THE SZCZAWNICA (MAGURA NAPPE) AND THE JARMUTA (PIENINY KLIPPEN BELT) FORMATIONS IN THE LIGHT OF THEIR CHEMICAL COMPOSITION

D. SALATA

Institute of Geological Sciences, Jagiellonian University, Oleandry 2a, 30–063 Krakow, Poland; agat@ing.uj.edu.pl

Abstract: Spinels occurring in sandstones of the Jarmuta and Szczawina formations were studied. Chemical investigations have revealed that they belong to the group of chromian spinels, although the pure ones were not found. Chemistry of the spinels indicates that they derive from Alpine-type peridotites or ultramafic and mafic rocks building probably an ophiolite sequence.

Key words: Jarmuta and Szczawina formations, chromian spinels, provenance.

Geological setting

In literature dealing with chromian spinels occurring in sediments in the South of Magura nappe their occurrence was associated with existence of a subduction zone in the South of the Pieniny Klippen Belt (Birkenmajer, 1986, Oszczypko, 1992, Winkler & Ślączka, 1994). The aim of the study was to analyse chemical composition of the spinels and, on that base, to confirm this theory.

Samples for investigations were taken from sandstones occurring in the Szczawnica Fm in Krościenko - Zawodzie and Krościenko - Łąkcica and in the Jarmuta Fm outcropping in Krościenko - Zawiasy, Szczawnica - Zabaniszcze, Sielski stream and Black Water stream.

The Szczawnica Fm (Palaeocene-Lower Eocene) in the Krościenko - Zawodzie and Krościenko - Łąkcica sections belongs to the Krynica Subunit of the Magura nappe (Birkenmajer & Oszczypko, 1989). The Jarmuta Fm (Maastrichtian-Palaeocene) in the Krościenko - Zawiasy section represents the Branisko succession of the Pieniny Klippen Belt, while sediments occurring in Krościenko - Zabaniszcze and Sielski stream belong to the Magura succession of the Pieniny Klippen Belt.

Jarmuta Fm in the Black Water stream is a part of the Grajcarek Unit (Birkenmajer, 1977, 1986).

All the formations were supplied with the clastic material from SE direction.

Methods of investigations

The chemical composition of chromian spinels was analysed in polished grain mounts using scanning electron microscopy (SEM) JEOL 5410 equipped with an energy dispersive spectrometer (EDS) Voyager 3100 (NORAN). According to the "standard less" procedure of calculation (i.e. using standards from the software library supplied by the manufacturer) the data were normalised to 32 oxygens. The content of ferrous and ferric iron was approximately estimated assuming a total of three cations and a stoichiometric spinel formula AB_2O_4.

Composition of chromian spinels

In analysed heavy mineral fractions of the investigated sandstones significant amounts of chromian spinel have been detected. They comprise up to 9 % and 6 % of number of grains of the transparent heavy mineral spectra in the Jarmuta and the Szczawnica formations respectively.

Spinel grains are reddish brown but their colour is visible only in thin grains, while the thicker grains are transparent only at the edges. They are present mostly as platy angular fragments and splinters.

The EDS analyses have revealed that chemical composition of spinels from the two investigated formations does not vary significantly.

The chromian spinels can be characterised as solid solutions between $FeCr_2O_4$-$FeAl_2O_4$-$MgCr_2O_4$-$MgAl_2O_4$. Points representing their chemical composition on the compositional diagrams locate in the field determined by beresovskite, Cr-picotite, picotite, and Cr-pleonaste. Pure chromian spinels were not detected. Compositional zoning and chemical variability as well as inclusions and admixtures of other phases in investigated spinels were not found.

In the majority of grains Cr>Al c.p.f.u. (cations per formula unit). The approximately estimated Fe^{+3} content is very low and ranges from 0.0 to 0.19 c.p.f.u. The Al_2O_3 and Cr_2O_3 amounts vary between 6-46 wt % and 22-67 wt % respectively.

Other oxides like TiO_2, MnO_2, V_2O_5 and CaO occur only as touches and their amounts do not exceed 0.5 wt %. The Cr/(Cr+Al) ratio varies in the range of 0.3-0.8 c.p.f.u., the Mg/(Mg+Fe) ratio from 0.3 to 0.6 c.p.f.u. and the $Fe^{+3}/(Cr+Al+Fe^{+3})$ ratio from 0.0-0.07 c.p.f.u.

The problem of provenance

Chemical composition of the investigated spinels is relevant to composition of those deriving from ophiolite sequences or Alpine type peridotites.

Because there is no certainty weather the Alpine-type peridotites represent orogenically emplaced upper mantle diapirs or obducted slices of oceanic crust spinel deriving from Alpine-type peridotites, abyssal peridotites and ophiolites in discrimination diagrams are grouped together (Haggerty, 1991).

Composition of studied spinels displays the greatest concordance with chemistry of chromian spinels occurring in Cr-rich ultramafic and mafic cumulates but correlates also with those from lherzolites and harzburgites. Such mixture is probably the result of gradual erosion of rocks building an ophiolite sequence. If type of ophiolite is considered the analysed chromian spinels represent type I as well as transitional type II of peridotites. It can reflect lateral facies changes and/or multistage opening of ocean basin (Dickey, 1975; Dick & Bullen, 1984, Pober & Faupl, 1988, Haggerty, 1991).

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