macla nº 16. junio '12
revista de la sociedad española de mineralogía

PGM and Zircon in Al-Rich Chromitite: New Insights by Applying Hydroseparation Technique

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INTRODUCTION

Accessory heavy mineral phases like Platinum Group Minerals (PGM) and zircons found within chromitites are essential for understanding the genesis and timing of ophiolite complexes. Re-Os and Pt-Os geochronometers applied to PGM and base metal sulfides have recently become indispensable tools for dating ultramafic rocks (Coggon et al., 2011 and Marchesi et al., 2011). However, Al-rich chromitites [Cr/(Cr+Al)<0.6] are very poor in Platinum Group Elements (PGE). They commonly display chondrite-normalized PGE patterns typical for ophiolitic chromitites with a characteristic steep negative slope from the Ir-group (IPGE: Os, Ir and Ru) to the Pt-group (PPGE: Pt, Pd and Rh). This general PGE depletion of Al-rich chromitites can theoretically be explained by their crystallization from S-satured tholeiitic melts (Zhou et al., 1998 and Hamlyn et al., 1985). As a consequence Platinum group minerals (PGM) are rare in high-Al chromitites and reflect geochemical data by small sized (<10 µm) Ru–Os–Ir dominated mineral phases.

The dating of ophiolitic complexes is challenging as tectonic fragmentation of rocks of different ages as well as the extreme shortage of radiogenic components within ultramafic rocks (Saverlieva et al., 2007) cause a lack of concrete ages for many ophiolite massifs. Geochronical data from the Finero Massif, Western Alps, (Grieco et al., 2001) as well as the ages of the ophiolitic complexes from the Polar Urals (Saverlieva et al., 2006; 2007) were obtained by U-Pb dating of accessory zircons found within chromitite and chromite segregations in dunite, respectively. Barring these unique chromitites from Finero, with 10-25 zircon grains (up to 600 µm long) within a single polished section, the U-Pb dating method is limited by the general infrequency of chromitite-related zircons. Therefore, innovative concentration techniques have to be applied to achieve a sufficient number of grains for serious radiometric studies.

In this work we present the preliminary results of the PGM and zircons found in HS-11 heavy mineral concentrates obtained from extremely PGE-depleted (<150 ppb total PGE) Al-rich chromitites from the Mercedita deposit, Cuba. We demonstrate how the precise hydroseparation technique HS11 can successfully be applied to challenging rock types like Al-rich chromitites, thus highlighting the great potential of this unique separation method also for geochronical studies.

METHODOLOGY

Up to 2.7 kg of massive chromitite were crushed down to a grain size <125 µm using a RETSCH vibratory disc mill (RS 100) equipped with an agate grinding set. A rough pre-concentration was achieved by ultrasonic decantation followed by a carefully performed wet sieving by hand through standard screen series (53, 75, 106, 125 µm). The <53 µm and 53-75 µm fractions were processed by hydroseparation, using the computer controlled device CNT HS 11 at the HS laboratory in Barcelona (see: Rudashevsky and Rudashevsky, 2001, 2007; Aiglsperger et al., 2011; and http://www.cnt-mc.com/, for technical details). The separation process was accomplished with ascending flow rates and changing impulse regimes in two steps: (1) production of a preliminary concentrate (PC) using a 30 cm long glas separation tube (GST) (inner diameter Ø=8 mm); (2) production of the final concentrate (FC) using a short (10 cm long) GST (inner Ø=5 mm). Several monolayer polished sections (Ø=2.5 cm) were produced from 0.2 mg of each final concentrate, which were later analyzed by optical and scanning electron microscope (SEM) at the University of Barcelona.

PRELIMINARY RESULTS

Abundant accessory heavy mineral phases were found within the investigated Al-rich chromitites and these include native copper, sphalerite, pyrite, cerite and different Ni-sulfides. Native gold, PGM and zircons are scarce.

PGM occur as small (<10 µm) inclusions of laurite (RuS_2), irarsite (IrAsS) and RuOsS mineral phases within NiS (Figs. 1, 2).

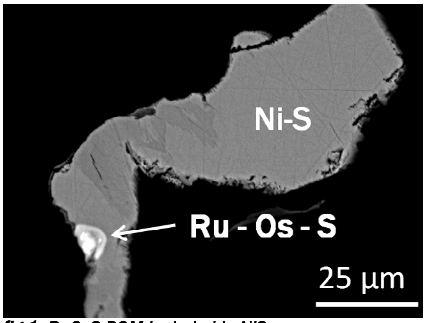

fig 1. RuOsS PGM included in NiS.

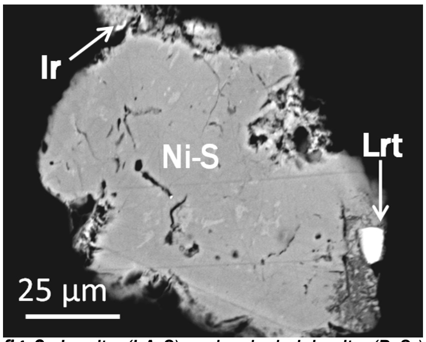

fig 2. Irarsite (IrAsS) and euhedral laurite (RuS_2) included in NiS.

Zircons were easily recognized under the binocular microscope due to their characteristic elongated, pyramidal

palabras clave: MGP, Zircón, Hidroseparación, Cromitita ofiolitica. | *key words:* PGM, Zircon, Hydroseparation, Ophiolitic chromitite.

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shape and transparency (Fig. 3). For this study the optically identified zircons have not been separated from the final concentrates. Although the euhedral zircon crystals located are up to 100 µm long and show a clear zonation in BSE images (Fig. 4).

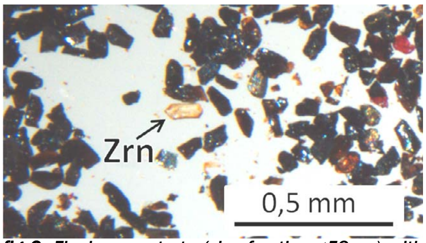

fig 3. Final concentrate (size fraction <53µm) with zircon (Zrn) observed by binocular microscope.

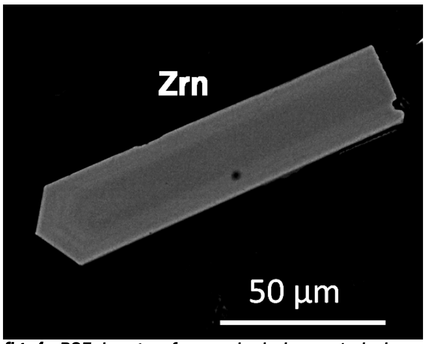

fig 4. BSE image of an euhedral, zonated zircon crystal.

CONCLUDING REMARKS

Dating of ophiolite massifs is notoriously problematic when using traditional geochronology methods (Coggon et al. 2011). The fact that PGM, zircons and a variety of sulfides were found within heavy mineral concentrates from Al-rich chromitites certainly opens the door for further radiogenic investigations. Determination of Re – Os and Pt - Os isotope systematics of sulfides and PGM by LA-MC-ICP-MS analysis will help to explain better how podiform chromitite deposits and ophiolitic complexes were formed. Ages resulting from Re – Os and Pt – Os geochronometers can be compared with ages obtained by U – Pb dating of zircons found within chromitites. However, PGM, zircons and other important accessory minerals may be invisible in thin polished sections due to their small size and scarcity. Shi et al. 2007 have reported the mineral processing of 2.5 t of chromitite using a combination of vibration, magnetic, flotation and electronic conductivity techniques to achieve a total number of not more than 170 grains of PGM for Re – Os analyses. Hence innovative separations techniques have to be applied to ensure a sufficient number of required heavy minerals for a reliable interpretation of isotopic data.

Hydroseparation technique HS-11 has proven to be highly suitable for this scope of work.

ACKNOWLEDGEMENTS

This research has been financially supported by the Spanish research project CGL2009-10924. We thank L. Cabri and V. Rudashevsky from CNT - Mineral Consulting Inc. for their help during installation of our HS-11 laboratory.

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