

Simultaneous precise and accurate measurement of $^{147}\text{Sm}/^{144}\text{Nd}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ isotopic ratios in natural geological samples by MC-ICP-MS without Sm and Nd separation and use of costly spike

Y.-H. YANG*, F.-Y. WU, Z.-Y. CHU, L.-W. XIE AND J.-H. YANG

State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, P. O. Box 9825, Beijing 100029, P. R. China, e-mail: yangyueheng@mail.iggcas.ac.cn (* presenting author)

It's well-known in applications of radiogenic isotopes in the fields of geochemistry and cosmochemistry, not only the determination of isotope ratios of radiogenic daughter elements is needed but also the ratios of parent to daughter elements. In terms of Sm-Nd isotopic system, the precise and accurate determination of $^{147}\text{Sm}/^{144}\text{Nd}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ isotope ratios in rocks and minerals is essential in applications of geochemical tracer and geochronology in the geological and planetary sciences. Generally, $^{147}\text{Sm}/^{144}\text{Nd}$ ratio can be determined by isotope dilution (ID) analysis, which is, without doubt, a well-known technique for its excellent precision and accuracy when properly used. This technique requires the use of artificial and costly enriched spikes (e.g., commonly-used ^{149}Sm and ^{150}Nd spike). This is usually done in two steps: (1) the determination of total concentration of Sm and Nd by ID method; and (2) calculation of the concentration of isotope to evaluate $^{147}\text{Sm}/^{144}\text{Nd}$ ratios from their isotopic abundances. As for $^{143}\text{Nd}/^{144}\text{Nd}$ ratio measurements, owing to its inherent high precision, classic TIMS is still regarded as the benchmark technique for Nd isotope analysis. Recently, MC-ICP-MS has become a competitive technique for $^{143}\text{Nd}/^{144}\text{Nd}$ ratio measurements with high sample throughput and comparable precision to classic TIMS since its commercial advent in the mid 1990s.

MC-ICP-MS has the potential for directly measuring isotope ratios of different elements contained in single solution. The main objective of our work is attempted to study the performance of MC-ICP-MS for simultaneous measurement $^{147}\text{Sm}/^{144}\text{Nd}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ ratios after one-step chemical purification. Up to now, this is the first report of simultaneous measurement $^{147}\text{Sm}/^{144}\text{Nd}$ and $^{143}\text{Nd}/^{144}\text{Nd}$ ratios of real geological sample without used costly spikes. Then we carried out present protocol on several international standard solution and certified reference materials encompassing a wide range of silicate rock type. The results are compared well with those obtained by the conventional approach involving ID methods. Therefore, the Nd and Sm separation and costly spike is unnecessary, allowing for a simple and rapid sample preparation and the high analytical throughput inherent to the MC-ICP-MS can be fully exploited for classic Sm-Nd isotope analyses.

References

[1] Yang, Y. H. *et al.*, (2010) *Anal. Lett.* **43**, 142–150. [2] Fisher, C. M. *et al.*, (2011). *Chem. Geol.* **284**, 1–20.

Magma mixing as trigger for sulfide saturation in the UG2 chromitite (Bushveld, South Africa): Evidence from recrystallized silicate and sulfide melt inclusions in chromite

MEIJUAN YAO^{1,2} AND PEDRO J. JUGO^{1*}

¹Laurentian University, Sudbury, Canada,

²China University of Geosciences, Beijing, China,

yaomeijuan@cugb.edu.cn, yaomeijuan1016@126.com

pjugo@laurentian.ca (*presenting author)

Abstract

Mineral assemblages enclosed in chromite grains from the UG2 chromitite reef (Bushveld Igneous Complex, South Africa) were analyzed to understand the genesis of sulfides in this reef and in chromitite seams elsewhere. Two distinct types of assemblages were found. The first type consists of assemblages containing only sulfides. These range from complex assemblages containing pyrrhotite, chalcopyrite, pentlandite, and pyrite (up to ~60 micrometers in diameter and with roughly circular sections) to chalcopyrite-pentlandite pairs to small and isolated crystals of chalcopyrite or pentlandite (of less than 5 micrometers diameter). The more complex assemblages were likely trapped as an immiscible sulfide melt that produced the sulfide assemblages on cooling. The origin of the isolated sulfides grains in chromite is less certain. They could be the only exposed phase of multi-phase assemblages (with other phases hidden within the grain or removed during polishing) but could be interpreted also as crystalline sulfides that co-precipitated with chromite. The second type consists of assemblages containing quartz, Na-rich plagioclase (An_8 to An_{21}), pyroxene, biotite, zircon, rutile, chalcopyrite, and pentlandite. These silicate-oxide-sulfide assemblages are also interpreted as the result of slow cooling of immiscible melts trapped during chromite growth. However, the proportion of sulfide to non-sulfide phases observed in section is variable and the apparent volume of sulfides to silicates is too large to be explained solely by sulfide saturation from a S-bearing silicate melt. Thus, these assemblages likely represent simultaneous trapping of two immiscible liquids (a sulfide melt and a silicate melt) in variable proportions. The chromitites also contain interstitial (intercumulus) pyroxene, Ca-rich plagioclase (An_{61} to An_{76}), and minor sulfides (mostly chalcopyrite, pentlandite, and pyrite; but no pyrrhotite). The presence of quartz and zircon in the enclosed assemblages and the sharp contrast in composition between interstitial plagioclase (An_{61} to An_{76}) and enclosed plagioclase (An_8 to An_{21}) is consistent with the existence of a felsic silicate melt during chromite crystallization and, therefore, consistent with models proposing felsic-mafic magma mixing as the trigger for chromite and sulfide saturation. Similar features have been documented in the Merensky reef of the Bushveld Igneous Complex [1]. Thus, felsic-mafic magma mixing events could have been a recurrent feature during the crystallization of the Bushveld Igneous Complex.

[1] Li *et al.* (2005) *Contrib Mineral Petrol* **v. 150**, 119-130.