Rutile as a Kimberlite Indicator Mineral: Minor and Trace Element Geochemistry

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An empirical method has been developed to distinguish between crustal- and mantle-derived rutile using simple chemical screens based on the concentrations of minor and trace elements. This classification scheme is based on analyses of rutiles from 115 mantle-derived xenoliths (63 eclogites from Blaauwbosch, Roberts Victor, Kelsey Lake, Schaffer, Fort a la Corne; 47 metasomatic rutile-dominated nodules from Orapa, Balmoral, Jagersfontein; five MARID xenoliths from Kimberley) and 208 crustal rutiles selected from heavy mineral sands from six different localities (sands from Florida, Kerla (India), Arkansas, Athabasca Tar Sands (Alberta) and two Australian localities). Two variations of this scheme were derived using 1) concentrations of Cr, Mg, V, Al, Nb, and Si based on electron microprobe data and 2) concentrations of Cr, Sn, Mg, Zr, Hf, Mn, Mo, Si, and V from LA-ICP-MS data which correctly classify 98% and >99% of the analyzed rutiles, respectively. Differences in the two classification schemes are due to differences in detection limits between the two methods and the fact that larger analytical volumes with the laser method incorporate Mg-ilmenite lamellae that can be avoided with the smaller beam of the electron microprobe. The presence of sigmoidal ilmenite lamellae are a nearly ubiquitous feature of mantle-derived rutiles. These lamellae are thought to represent either decomposition of rutile or replacement by ilmenite (Haggerty, 1991) and contain a significant geikielite component ($MgTiO_3$). Eclogitic rutile was found to contain high concentrations of Al. This allows for a clear distinction between crustal and mantle rutile using LA-ICP-MS, shown in Fig. 1. Within the suite of mantle-derived rutiles, distinction between the various parageneses (eclogite, metasomatic, MARID) is possible using Cr, Nb and Al concentrations with either electron microprobe or LA-ICP-MS data.

Though the abundance of rutile in Earth's upper mantle is relatively low, it is extremely chemically and physically resistant in the sedimentary environment and will remain present even in extremely mature sediments. Thus, rutile can now be used as a new indicator mineral in kimberlite exploration in the same manner that other upper mantle minerals, such as pyrope garnet, picroilmenite, chrome diopside and chrome spinel, are currently employed.

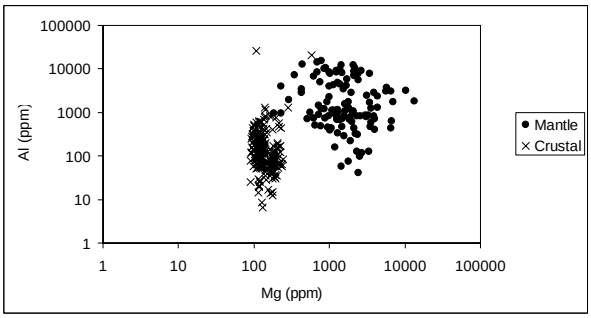

Fig.1: Variation of Mg (ppm) and Al (ppm) concentrations, based on LA-ICP-MS data, of rutile from crustal and mantle sources.

Reference

Haggerty, S.E., 1991. Oxide mineralogy of the upper mantle. In: Lindsley, D.H. (Ed.), Oxide Minerals: Petrological and Magmatic Significance. Reviews in Mineralogy, vol. 25, pp. 355-416.