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LAM-MC-ICPMS Analysis of Mantle-Derived Sulfides: the Key to Re-Os Systematics of Mantle Peridotites

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The Re-Os isotopic system is widely used to study the timing and nature of melting and metasomatism in the lithospheric mantle. Petrographic and micro-analytical data show that essentially all of the Os, and most of the Re, in mantle peridotites is concentrated in sulfides. Two types of sulfide occur in mantle samples (Alard et al., 2000): (1) silicate enclosed Ni-rich monosulfide solid solutions enriched in Os+Ir and having Pd/Ir<1; (2) interstitial Cu-rich S-poor sulfides depleted in Os+Ir and relatively enriched in Pd±Pt. The mixture of these two types has major implications for interpretation of whole-rock PGE and Re-Os data.

A technique has been developed for the *in-situ* measurement of Os isotopes in sulfides using a Merchantek LUV266 laser microprobe and a Nu Plasma multi-collector ICP-MS with 12 Faraday cups and 3 ETP ion counters. We use two combinations of collectors: Masses 194, 192, 190, 189, 188, 187, 186, 185 in Faraday cups Masses 194, 193, 192, 191, 190, 189, 188, 186 in Faraday cups; 187 and 185 in ion counters.

Mass discrimination is corrected by normalisation of ^{189}Os/^{192}Os =0.39593 for measurements with the Faraday array. The mixed Faraday-ion counter setup allows the use of ^{191}Ir/^{193}Ir for this correction, using either (1) the Ir in the sulfide; (2) addition of Ir to the nebuliser gas as a 'dry' vapour from a CETAC MCN6000. Analysis of an Os standard spiked with Ir shows that this procedure gives the correct Os isotope ratios. The overlap of ^{187}Re on ^{187}Os is corrected using a ^{187}Re/^{185}Re = 1.6723, determined iteratively by repeated measurements of an Os standard spiked with Re. Typical precision (±2se) for analysis of a 25 ppb Os solution is ±0.0002 for the Faraday setup and ±0.00005 for the combined Faraday-IC setup. The accuracy of the Re correction can be demonstrated up to ^{187}Re/^{188}Os = 1.6 using the Faraday array and up to ^{187}Re/^{188}Os = 0.26 using the Faraday-IC setup. Typical precision on ^{187}Os/^{188}Os with ^{187}Re/^{188}Os = 0.26 is ±0.0001 (2se).

Repeated LAM analysis of a synthetic NiS bead with 200 ppm Os demonstrates the precision expected for peridotite sulfides as a function of signal intensity, laser spot size and analysis duration (Fig. 1). Precision equivalent to N-TIMS is achieved using the Faraday array for Os > 200 ppm and the Faraday-IC setup for Os > 50 ppm. Better precision is obtained when Ir is used to correct for mass discrimination. Three sulfide inclusions in olivine macrocrysts (%Fo>92) derived from disaggregated peridotites from Udachnaya Pipe (Siberia, Russia) have ^{187}Os/ ^{188}Os from 0.1072-0.1118 and ^{187}Re/^{188}Os of 0.006-0.081. T_{RD} ages vary from 3.6-2.3 Ga and T_{MA} from 2.9-3.6 Ga. These ages are equivalent to the oldest T_{RD} model ages (3.0-3.2 Ga) obtained by conventional analysis of Udachnaya peridotite xenoliths (Pearson et al., 1995), and agree well with Re-Os data for three sulfide inclusions in a single diamond from the same pipe (3.1 to 3.5 Ga; Pearson et al., 1999).

Several large (50-200 µm) sulfide inclusions from olivine macrocrysts (Fo92), peridotite xenoliths and diamonds from the Lac de Gras area (Slave Craton, Canada) yielded. ^{187}Os/^{188}Os from 0.1080-0.1131 (T_{RD} ages =3.0-2.1 Ga, T_{MA} = 2.6-3.3 Ga). These ages are equivalent to the oldest model ages (3.1 Ga) reported for xenoliths in the nearby Jericho pipe (Irvine et al., 1999).

Enclosed sulfides in peridotite xenoliths in alkali basalts (Mt. Gambier, S. Australia) give model ages within uncertainty of the 1.9 Ga model ages obtained by Handler et al. (1998) for the same locality. Interstitial sulfides give modern asthenosphere ^{187}Os/^{188} Os; these rocks contain two generations of sulfides with different Os isotopic compositions and Re/Os ratios.

With current technology, the best results are obtained from sulfide grains ~50 µm in diameter with Os contents ~40 ppm. These data have a precision equivalent to N-TIMS data on whole rock samples. The lower-precision data obtained on low-Os interstitial sulfides are still very useful in understanding the movement of Os within the lithosphere (Alard et al., this volume). The major advantage of the LAM-MC-ICPMS technique lies in providing *in-situ* analyses with the spatial and microstructural context required for meaningful interpretation. The application of this technique will make Re-Os analysis of mantle-derived rocks more rapid and less expensive, and enable larger-scale surveys of the age structure of the continental lithosphere.

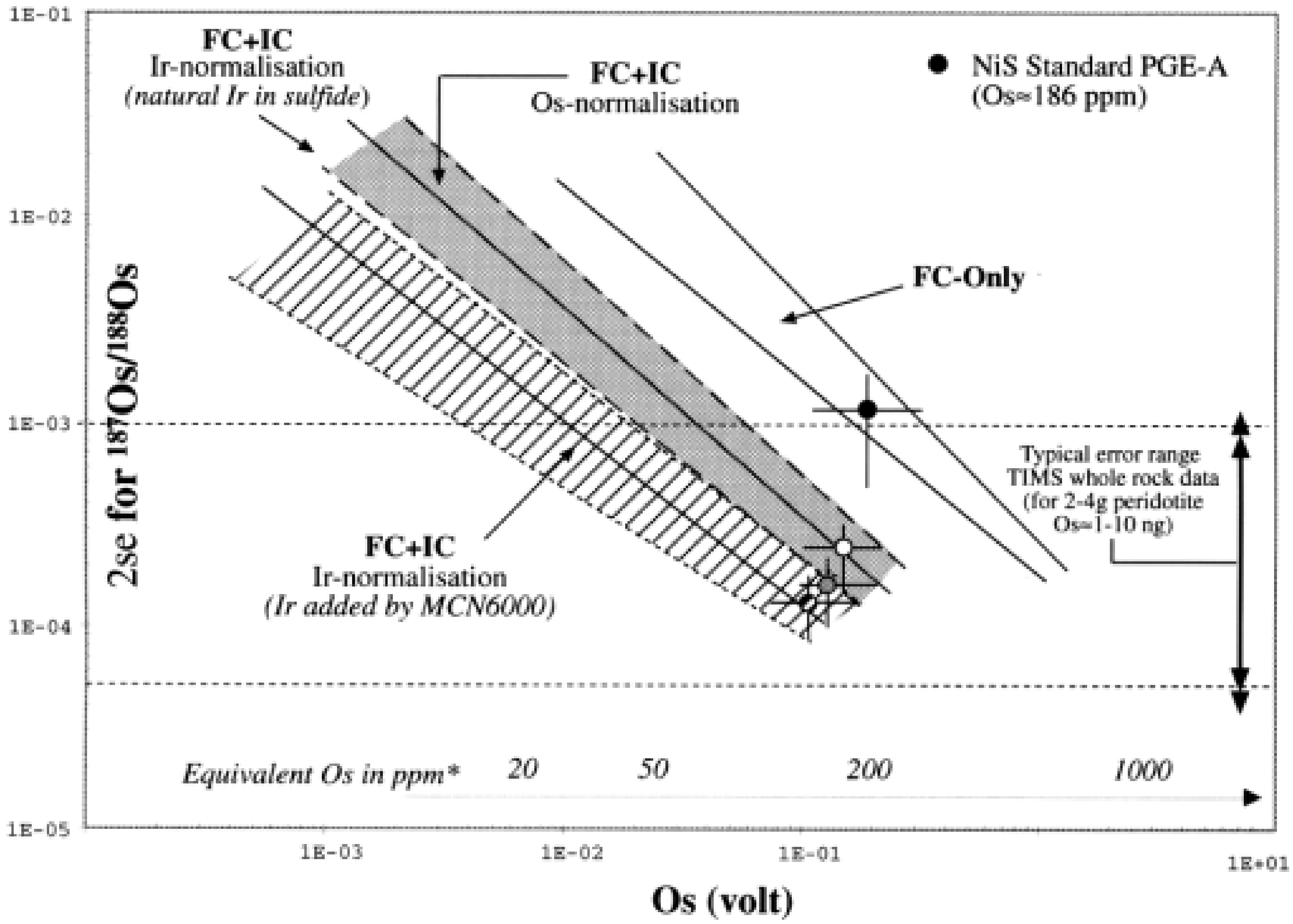

Fig.1 Precision on ^{187}Os/ ^{188}Os (±2se) versus Os signal intensity. 'Equivalent Os in ppm*' relates Os signal and Os concentration as measured by LAM ICPMS. FC = faraday cup; IC = ion counter

Alard O, Griffin WL, Lorand JP, Jackson SE & O'Reilly SY, *Nature* ***(submitted)***, (2000).

Handler MR, Bennett VC & Esat TM, *Earth Planet. Sci. Lett.*, **151**, 61-75, (1997).

Irvine GJ, Kopylova MG, Carlson RW, Pearson DG, Shirey SH & Kjarsgaard BA, *Ext. Abst. 9th Goldschmidt Conf.*, 134-135, (1999).

Pearson DG, Shirey SB, Carlson RW, Boyd FR, Pokhilenko NP & Shimizu N, *Geochim. Cosmochim. Acta*, **59**, 959-977, (1995).

Pearson DG, Shirey SB, Bulanova GP, Carlson RW & Milledge HJ, *Geochim. Cosmochim. Acta*, **63**, 703-711, (1999).