

High Precision Re-Os Isotope Determinations of Natural Rock and Mineral Samples Using Multicollector ICP-MS

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Re-Os results of natural rock and mineral samples determined by multicollector inductively coupled plasma mass spectrometry (MC-ICP-MS) are presented here with the aim to compare the precision of mainly the Os isotopic determinations to published results of Os standard solution runs using ICP-MS techniques.

Recently several methods describing low memory Os measurements using single- and multicollector ICP-MS have been published; Hassler et al. (1998) describe a device introducing Os as OsO⁴ vapor into their single collector ICP-MS, yielding long-lived (30 to 40 minutes) and constant Os signals, adequate to measure the ¹⁸⁷Os/¹⁸⁸Os ratios for 1.7 ng and 0.2 ng Os standard analytes to an uncertainty of 1.2% and 2.5% (both 2 sigma), respectively. Hemming et al. (1999) present an Os measuring technique on their multicollector ICP-MS using a desolvating nebulizer for sample introduction where the addition of hydroxylamine hydrochloride to the sample solution keeps Os reduced as it passes through the nebulizer, thus hindering an Os memory build up in the desolvating apparatus. These authors demonstrate an average uncertainty for the ¹⁸⁷Os/¹⁸⁸Os ratio of 85 to 500 ppt Os standard solutions (n = 7) of 0.36% (2 sigma) when using the ¹⁹¹Ir signal of doped Ir standard solution for fraction correction. Schoenberg et al. (2000) present Os measurements using multicollector ICP-MS, based on direct evaporation of Os as OsO⁴ from a special evaporation vessel into the plasma torch. Significant improvements of the ionization efficiency and subsequently the 2 sigma uncertainties on the ¹⁸⁷Os/¹⁸⁸Os ratios compared to those described by Hassler et al. (1998) were achieved by using a different solution-oxidizer mixture, from which OsO⁴ is evaporated, and by the ability to measure different Os signals at once in static mode. This method yields 2 sigma uncertainties on the ¹⁸⁷Os/¹⁸⁸Os ratio of single measurements of Os standard analytes ranging from 50 ng = 0.02% (all signals detected on Faraday collectors in a single cycle), 250 pg = 0.15% (all signals detected on multipliers in 2 cycles), 100 pg = 0.4% down to 25 pg = 1.2%. Further, Re isotope dilution measurements on multicollector ICP-MS using the ¹⁹³Ir/¹⁹¹Ir ratio (Ir standard added to the Re sample solution) for fractionation correction makes external fractionation corrections of such runs unnecessary (Schoenberg et al., 2000) and it also overcomes the frequently observed problem of Re release from different filament materials (e.g. Frei et al., 1996, Birck et al., 1997).

Os isotope determinations of 4 different OsIr single grains from Karoo group sediments deposited onto the Zimbabwe Craton containing total amounts of Os in the microgram range (estimates, not determined) yield 2 sigma uncertainties on the ¹⁸⁷Os/¹⁸⁸Os ratio (appr. 0.107) as low as 0.003% with an external reproducibility of replicates (n=4) within the same range. 23 Os runs of different chromite separates from the Great Dike igneous layered intrusion in Zimbabwe with total amounts of measured Os ranging from 460 down to 12 ng, show 2 sigma uncertainties on the ¹⁸⁷Os/¹⁸⁸Os ratios (0.112 to 0.118) from approximately 0.01 to 0.19%, respectively. During all these measurements, Os isotope beams with masses 186 through 190 and 192 were detected simultaneously in Faraday collectors, of which the Nu-Instruments MC-ICP-MS contains 12 in its fixed detector array. Furthermore, low Os concentration runs of granitoid whole rock samples from the crystalline basement of the Dhofar region, Sultanate of Oman, with total Os amounts lying between 10 and 45 pg still gave geologically meaningful results, with uncertainties on the significant ¹⁸⁷Os/¹⁸⁸Os ratios (0.190 to 7.624) ranging from 0.45 to 0.90%. All Os beams of low Os concentration runs are detected on 3 parallel multipliers in a 2-cycle measuring mode (1st cycle = 192Os, 190Os, ¹⁸⁸Os; 2nd cycle = 189Os, ¹⁸⁷Os, 185Re).

Re-Os results on a variety of natural rock/mineral samples using the Schoenberg et al. (2000) methods for Re isotope dilution and combined Os isotope dilution and Os isotope ratio measurements presented above demonstrate the applicability of the method for geological problems.

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