

High sensitivity determination of iridium contents in ultra-basic rocks by INAA with coincident gamma-ray detection

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Iridium belongs to platinum group elements (PGEs). PGEs are one of the most informative element groups in geo- and planetary sciences. Because of their strong siderophile nature, PGEs are highly compatible with metallic phase. In the Earth, therefore, PGEs were mostly concentrated in the core during the differentiation of the Earth at early stage of the solar system formation. Such a process, in turn, yielded severe depletion of PGEs in mantle and, especially, in crust. For determining very low contents of PGEs in the Earth silicate samples, analytical methods having high sensitivity for the PGE quantification are needed. In the past, radiochemical neutron activation analysis (RNAA) was actively applied to accessible Earth silicate samples. Nowadays, inductively coupled plasma mass spectrometry (ICP-MS) has taken the place of RNAA. In determining very low amounts of PGEs in silicate samples by ICP-MS, the target elements (here, PGEs) need to be concentrated through chemical separation procedures after decomposing silicate materials either by acid digestion or by alkaline fusion. An isotope dilution technique (ID) is often applied for obtaining accurate analytical results. Even with ID, final data cannot be accurate when contamination of analytes and/or incomplete decomposition of solid samples occur. RNAA with strong alkaline flux like Na_2O_2 can mostly avoid these analytical difficulties. For dissipating all these analytical problems, non-destructive methods like instrumental neutron activation analysis (INAA) can be the best choice. Among PGEs, iridium has a high sensitivity as implied by relatively large neutron capture cross section for thermal neutrons (954 barn) and can be reliably determined for its contents in primitive meteorite samples, where iridium contents are around 500 to 800 ng/g, not being depleted along with other PGEs. For the terrestrial silicate samples, however, their iridium contents can hardly be determined by conventional INAA method. In this study, we have determined low contents (several ng/g) of iridium in komatiite, a volcanic rock derived from ultra basic mantle by INAA using a sophisticated Ge-semiconductor detector system for counting gamma-rays emitted by ^{192}Ir produced via (n,g) reaction on ^{191}Ir . The detector system consisted of multiple Ge detectors, through which only coincident gamma rays emitted by ^{192}Ir were to be counted. (Here, this method of INAA is called INAA-CG.) An aliquant of each komatiite sample was analyzed for six PGEs including iridium by using a quadruple ICP-MS instrument. Samples were decomposed with an alkaline flux of Na_2CO_3 and PGEs were extracted with NiS. Iridium was quantified by means of ID. A total of five komatiite samples were analyzed by INAA-CG and ICP-MS. Obtained data were mostly consistent between the two methods and also with literature values. Under the experimental conditions of this study, similar detection limit values of iridium concentration (10 pg/g) were derived for both methods, while INAA-CG yielded more than ten times lower detection limit of absolute contents (1 pg).

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