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Iridium Coincidence Spectrometry in the University of Vienna Gamma Spectrometry Laboratory: Determination of Iridium in Very Low Abundances in geological Samples

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The search for an extraterrestrial component in, e.g., impact-melt rocks, impact breccias, or in sedimentary layers at stratigraphic boundaries, is mainly done by geochemical analyses of the contents of siderophile elements Ni, Co, and Cr, as well as the platinum group elements (PGEs). Iridium is the most studied PGE in the search for, and confirmation of, extraterrestrial events. Its low concentration in the sub-ppb (parts per billion) range, however, demands an analytical method with a very low detection limit. Such a sensitive analytical technique is, besides radiochemical neutron activation analysis (RNAA) and inductively coupled plasma source mass spectrometry (ICP-MS) - both of which need chemical separation from the bulk sample - iridium coincidence spectrometry (ICS).

About 10 years ago, a multiparameter γ-γ coincidence spectrometer for iridium was constructed at the Department for Lithospheric Research for the non-destructive study of small amounts of geological materials with iridium concentrations in the ppt-range (parts per trillion) (Koeberl and Huber, 2000; Huber, 2003). The ICS method aims to reduce the background radiation and to remove spectral interferences. The decay of ^{192}Ir due to thermal neutron activation yields to the emission of gamma rays at 1201.05, 920.92, 784.58, 612.47, 468.07, 416.47, 316.51, 308.46, and 295.96 keV. The system consists of two low energy planar HPGe-detectors, which measure two γ-rays of the cascading decay of ^{192}Ir within a coincidence window.

Powdered sample material is weighed (≤150 mg) and sealed in Suprasil® quartz glass vials. Additionally, a series of iridium standards for calibration purposes, with a variety of Ir contents, ranging from low to high, are used as well. These standards are made by diluting the powder of the Allende meteorite standard, a carbonaceous chondrite with 740 ppb Ir (Jarosewich, 1987), with ultrapure SiO_2 powder. A series of samples and the respective standards are placed into an irradiation vial (usually aluminum) and irradiated for 24 - 48 h at a flux of about $7 \cdot 10^{13}$ n • cm^{-2} • s^{-1}. About ten weeks after the end of the irradiation, equivalent to about one half-life of ^{192}Ir (73.8 days) the individual samples and standards are measured for 12 - 48 hours each. After calibration with a ^{152}Eu source with γ-emission at 344 and 444 keV, the counted signals are plotted in a 1024 x 1024 channel matrix, from which the iridium peak regions of interest (316.5 x 468.1 keV) are taken for calculations and corrections (live time -, decay time -, and flux corrections, background subtraction). Data reduction of the acquired spectrum is done with a custom-made evaluation program, which provides the net peak volume and the background value as output. These data, as well as the sample weight, date, time and duration of measurement, are entered into an Excel template to calculate the iridium content of the samples. The ICS method takes several months from the sample preparation to the final results, but is nevertheless a very sensitive and non-destructive method for determining the iridium concentrations in very small geological samples.

Huber (2003): Application of gamma, gamma-coincidence spectrometry for the determination of iridium in impact related rocks, glasses, and microtekites. PhD thesis, Univ. Vienna, 340 p.
Jarosewich et al. (1987): Smithson. Contrib. Earth Sci. 27: 1-49.
Koeberl & Huber (2000): J. Radioanal. Nucl. Chem. 244: 655-660.

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Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: Berichte der Geologischen Bundesanstalt

Jahr/Year: 2009

Band/Volume: 78

Autor(en)/Author(s): Mader Dieter, Koeberl Christian

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