

# Isotopic measurement of lead in one-ten nanogram quantities on magnetic sector inductively coupled plasma mass spectrometry

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## Abstract

Lead isotopes have been used as geochemical tracers in Earth Sciences, such as geochemistry, paleoclimatology and chronology, due to the diverse ratios and variable elemental abundance. Determination of Pb isotopic composition,  $^{204}\text{Pb}$ - $^{206}\text{Pb}$ - $^{207}\text{Pb}$ - $^{208}\text{Pb}$ , with external precisions of 2.1‰ in 1-10 ng quantities on an inductively coupled plasma sector field mass spectrometer (ICP-SF-MS), Thermo Electron Element II, and of 50-300 ppm on an multi-collector ICP-MS (MC-ICP-MS), Thermo Electron Neptune, has been developed. Lead blanks, from acid, labware, and airborne particulate, was effectively reduced to less than 5 pg ( $10^{-12}$  g), causing an isotopic ratio bias of 30-50 ppm. Isobaric interference of  $^{204}\text{Hg}$  on  $^{204}\text{Pb}$  was corrected by monitoring  $^{202}\text{Hg}$ . Mass dependant instrumental fractionation was normalized to  $^{205}\text{Tl}/^{203}\text{Tl}$  value. With concentration of 1 ppb Pb and uptake rate of 50  $\mu\text{l}/\text{min}$ , one million counts per second of  $^{208}\text{Pb}$  ion beam could be generated on ICP-SF-MS, combined with a desolvation nebulization system, Cetac Aridus. The ICP-MS was operated at low resolution of 300 ( $M/\Delta M$ ) in electrostatic peak hopping mode. One-to-two nanogram of lead was consumed using a 15-20 minutes data acquisition method with 3000 mass scans. This method offers the external reproducibility of 1.5-2.1‰ ( $n = 27$ , 2 RSD) for all isotope ratios. Analytical results of NIST-Pb 981 standard are:  $^{206}\text{Pb}/^{204}\text{Pb} = 16.943 \pm 0.035$ ,  $^{207}\text{Pb}/^{206}\text{Pb} = 0.9141 \pm 0.0015$  and  $^{208}\text{Pb}/^{206}\text{Pb} = 2.1669 \pm 0.0045$ . The MC-ICP-MS techniques provided a 5-fold enhancement in sensitivity while using the same introduction system. A Faraday-cup protocol in static mode, offers 1-V signal on  $^{208}\text{Pb}$  and a short-term precision of 50-300 ppm for isotopic determination of 5-10 ppb NIST-Pb 981 ( $n = 10$ ). The key merit of the both techniques is to offer a possibility of analyzing Pb isotopic composition in trace-quantity of 1-10 ng, mainly for sample with limited Pb content.