Selenium isotope analysis using a Nu Sapphire collision cell MC-ICP-MS

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ABSTRACT

GAIA Lab — Geoscience Applications of Isotopic Analysis

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Why selenium?

- micronutrient
- environmental toxin
- redox-sensitive element
- 6 stable isotopes (74,76,77,78,80,82)

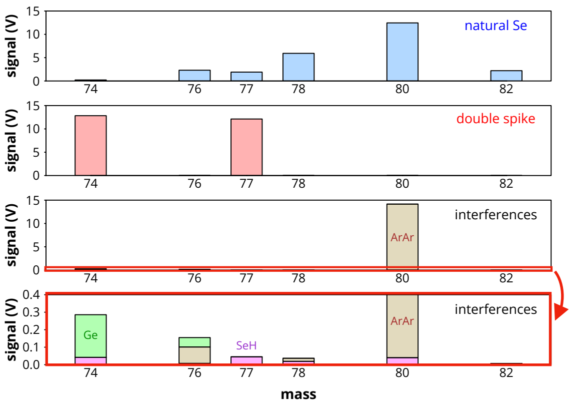


Figure 1. Selenium and isobar abundances. Signal intensities representative of a 50 ppb Se analysis with 1:1 DS and Ge/Se = 0.1.

Why CRC-MC-ICP-MS?

- eliminate ArAr interferences
- measure ALL Se isotopes
- superior precision?

Nu Sapphire

- dual-ion flight path design (Fig. 2)
- collision/reaction cell
- explored He-N_2 and He-H_2 cell gases
- 16 Faraday detectors (mass 73 to 83)

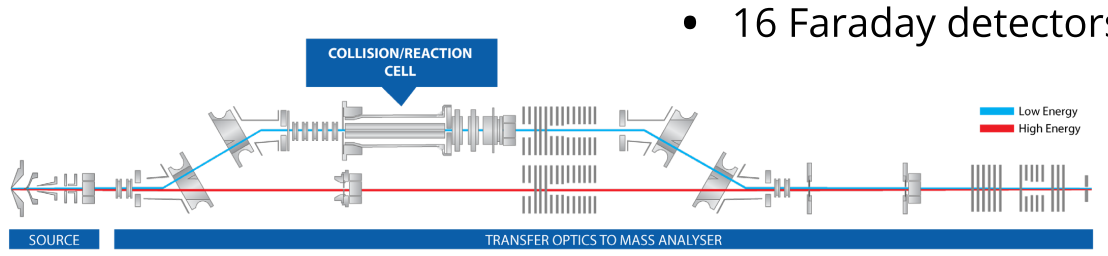
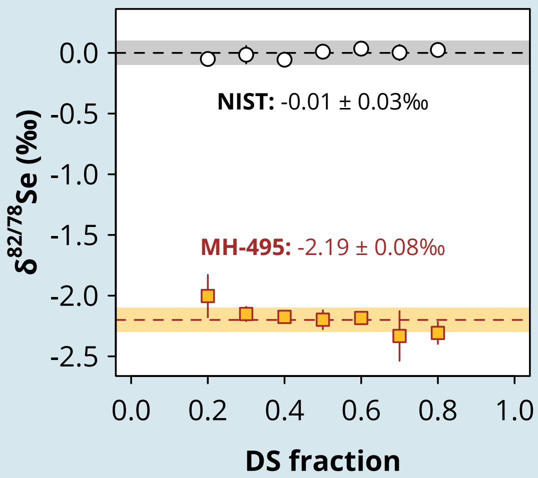


Figure 2. Schematic of Nu Sapphire MC-ICP-MS. CRC ion flight path shown in blue; no CRC path shown in red.

Analytical conditions

- tested non-CRC vs. CRC analyses
- standard-sample bracketing (SSB) and double-spike (DS) data reduction
- validated with analyses of NIST SRM 3149, MH-495 and USGS SCo-1

➡ CRC measurements with He-N_2 cell gas mixture are accurate & precise



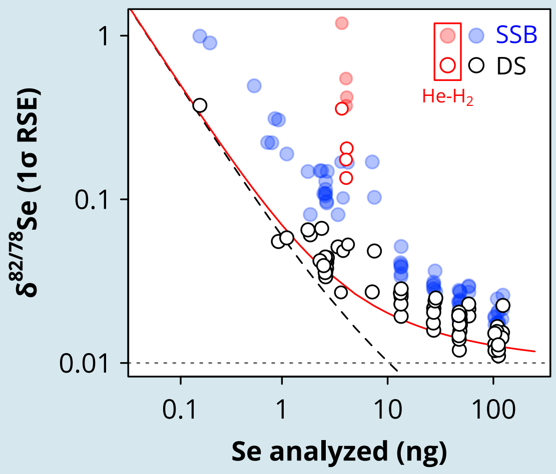


Figure 3. (A) Double spike calibration and (B) internal analytical precision. Standard error of individual analyses follows predicted trend from Johnson noise + counting statistics (dashed line), including an unknown error contribution of 0.01‰ (dotted line). DS data are more precise than SSB-only.

Mass-dependent fractionation

- MDF observed for all ratios
- ^{80}Se follows MDF for CRC analyses

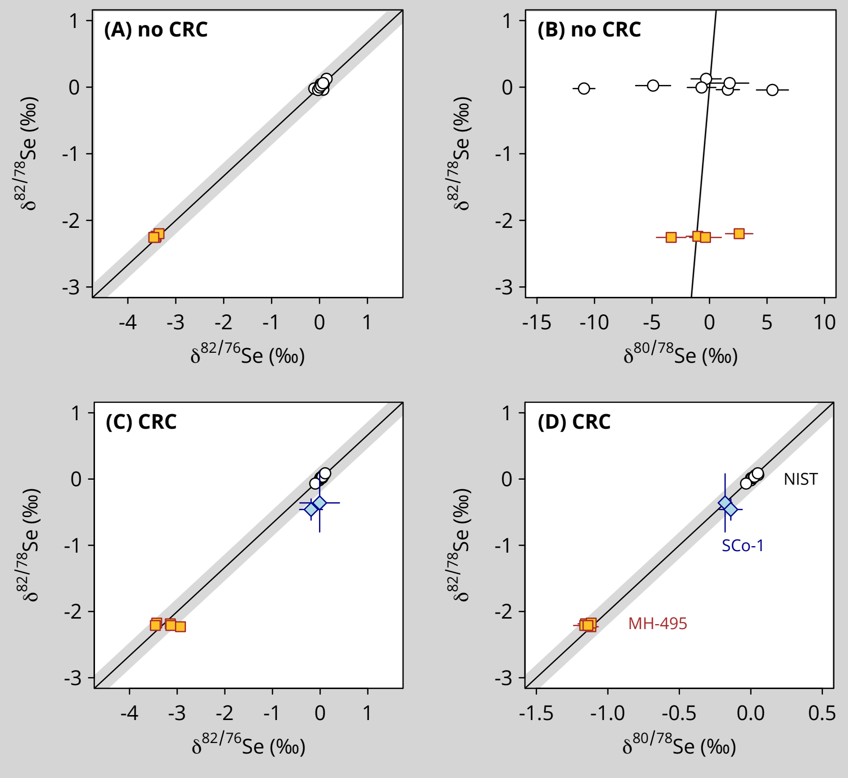


Figure 4. Three isotope plots. SSB-only data are shown.

Sensitivity tests

- molarity mismatch effect negligible
- Ge correction is valid to Ge/Se ~ 0.1
- intensity mismatch effects:
  - **no CRC**: DS more robust than SSB
  - **CRC**: small effect in DS and SSB

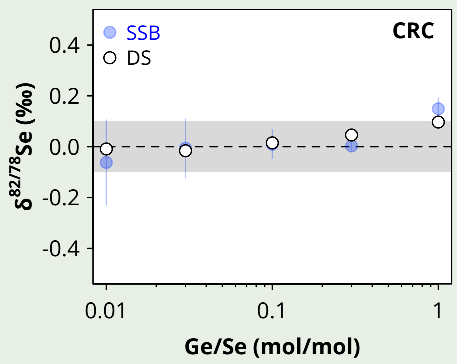
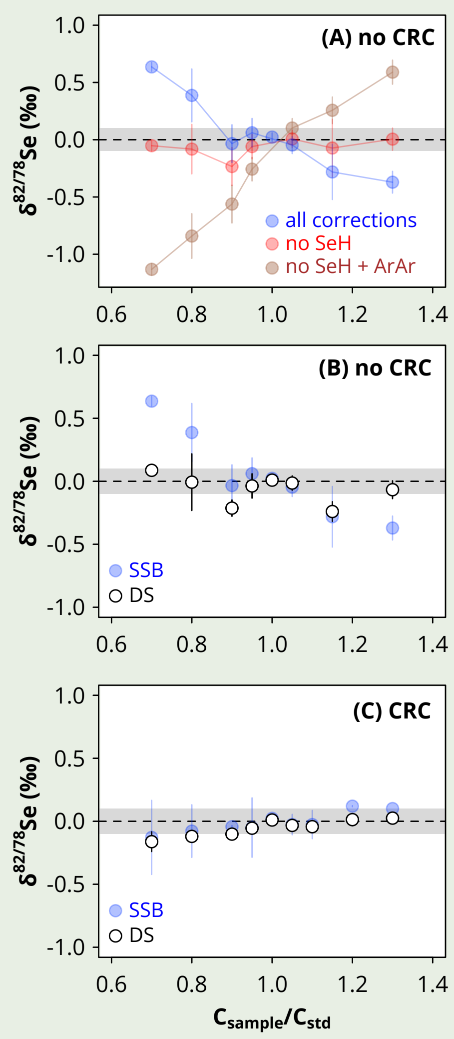


Figure 5. Germanium doping tests. Mass 73 was monitored and used to correct ^{74}Se and ^{76}Se using mass bias estimate. Only CRC data shown.

Figure 6. Intensity mismatch tests. No CRC analyses shown with (A) correction schemes and (B) comparing SSB vs. DS. (C) CRC analyses are less sensitive to mismatch.



Need isotope data? Send us samples!

We offer isotopic analyses to external users at cost, including sample preparation. Current MC-ICP-MS analyses include: Li, Mg, K, Ca, Fe, Cu, Zn, Se and U. We also offer N and C isotope analysis via EA-IRMS. Check out our website for rates & more info!

Take-aways

- CRC analyses match sensitivity of non-CRC
- CRC less sensitive to intensity mismatch & better external precision

➡ **CRC analyses are preferable for precise analysis of low-Se samples**

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