Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.24299

In-situ dating of black shales with the Re-Os geochronometer using LA-ICP-MS / MS

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The Re-Os geochronometer is widely used to date Re-rich phases such as molybdenite and organic-rich shales. Conventional Re-Os ID-TIMS isotopic analysis can produce accurate results but requires specialized and labor-intensive chemistry to fully digest and extract all Os from the sample. The amount of material required for ID-TIMS necessitates bulk sampling and a loss of spatial resolution; potentially losing spatial context Re and Os host phases. Recent advances in ICP-MS/MS technology allow the chemical separation of parent ^{187}Re from daughter ^{187}Os using CH_4 reaction gas (Hogmalm et al., 2019). In-situ analysis with laser ablation ICP-MS/MS of Re-rich phases is possible at the 100 µm or ≈1.5 µg scale.

Presented here are LA-ICP-MS/MS analyses using a combination of CH_4, He, and H_2 collision gases to chemically separate parent ^{187}Re from daughter ^{187}Os by mass shifting ^{187}Os to mass 201. Previous work by Hogmalm et al. (2019) demonstrated ≈2% of ^{187}Re also reacts to mass 201, limiting analyses to Proterozoic and older molybdenite. Our new methodology lowers this residual ^{187}Re reaction to ≈0.4%; allowing younger samples to be accurately dated. Using this methodology, we present LA-ICP-MS/MS Re-Os analyses of Paleozoic black shales (e.g., Stark Shale) using the Moly Hill molybdenite as the primary calibration material. The results demonstrate Re-Os ages that are consistent with known stratigraphy. Precision of Re-Os ages is limited by the amount of radiogenic Os in a sample as well as the spread of data points along the isochron. For shales with ppm Re, the precision of the Re-Os age is similar to ID-TIMS. For shales with 10s to 100s of ppb Re, the precision is between 5% and 10% 2s. While counting statistics are lower than Re-Os isotopic measurements by ID-TIMS, the LA-ICP-MS/MS technique takes advantage of natural sample variability at the micro-scale to produce isochrons with significantly more variation in radiogenic to initial Os composition, therefore producing relatively precise Re-Os ages.

Hogmalm, K. J., Dahlgren, I., Fridolfsson, I., & Zack, T. (2019). First in situ Re-Os dating of molybdenite by LA-ICP-MS/MS. *Mineralium Deposita*, *54*(6), 821-828. https://doi.org/10.1007/s00126-019-00889-1