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TECHNICAL NOTE 30464

Extra high resolution option for MC-ICP-MS

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Keywords

Cl, Hydride, K, Mass resolving power, Mass resolution, MC-ICP-MS, Mg, Si

Introduction

The Thermo Scientific™ Neptune™ XT MC-ICP-MS is optimized for transmission. Medium Resolution and High Resolution modes are used to make measurements for a variety of isotopic systems, including Mg, Si, S, Ca, Fe and Cr for example.

The most challenging interferences to resolve are from hydrides, and these can affect high-precision isotope ratio measurements of Si, Mg, Cl and K. The new Thermo Scientific™ XHR™ Extra High Resolution Option is tailored for resolving hydride interferences, and achieves an impressive 15,000 resolving power. When combined with the peak position and mass bias stability that is expected from the Neptune XT MC-ICP-MS, more accurate measurements can be made.

One of the isotope systems which suffers from hydride interferences in MC-ICP-MS is potassium. The stable isotope system of potassium has applications in various fields, including terrestrial geochemistry, planetary sciences, and potentially for agricultural and biomedical research. With the new XHR Option, accuracy for $^{41}K/^{39}K$ measurements can be improved by providing broad, interference-free plateaus.

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Instrumentation

The new XHR Extra High Resolution Option was fitted to a Neptune XT Series MC-ICP-MS. The XHR Option includes an intermediate aperture that can be switched in and out of position by a pneumatic control, as well as a narrowed entrance slit. A mass resolving power of over 15,000 can be achieved using this combination (5, 95% edge definition) with ≥ 1% transmission.

Sample introduction was via an Elemental Scientific™ apex Ω™ high sensitivity desolvation system, with 25 mL/min N_2 addition to suppress $^{40}Ar^+$ and $^{40}Ar^1H^+$. Standard cones and 1200 W RF power were used. The $^{40}Ar^+$ beam was collected in a Faraday cup connected to ground via the relay matrix.

Samples

Potassium was purified using a Thermo Scientific™ Dionex™ ICS-5000+ Capillary HPIC™ System at Princeton University. Two materials were processed: NIST SRM™ 70b Potassium Feldspar and Bermuda seawater (BSW). The purified solutions were diluted to 2 µg/g concentration in 3 wt.% HNO_3 acid (Thermo Scientific™ Optima™ Nitric Acid, Thermo Scientific™ Barnstead™ Ultrapure Water, Thermo Scientific™ Nalgene™ Bottles, Alfa Aeser™ SpecPure™ Plasma Standard Solutions, and Thermo Scientific™ Finnpipette™ Pipettes complete the workflow).

Results

A mass scan on the $^{41}K^+$ peak is shown in Figure 1A. The mass resolving power measured from this peak is ca. 18,000 (5, 95% edge definition). $^{41}K^+$ is clearly resolved from the polyatomic interference $^{40}Ar^1H^+$. The precise alignment of movable collectors for the simultaneous measurement of $^{39}K^+$ and $^{41}K^+$ is shown in Figure 1B. $^{39}K^+$ is also resolved from $^{37}Cl^1H_2^+$.

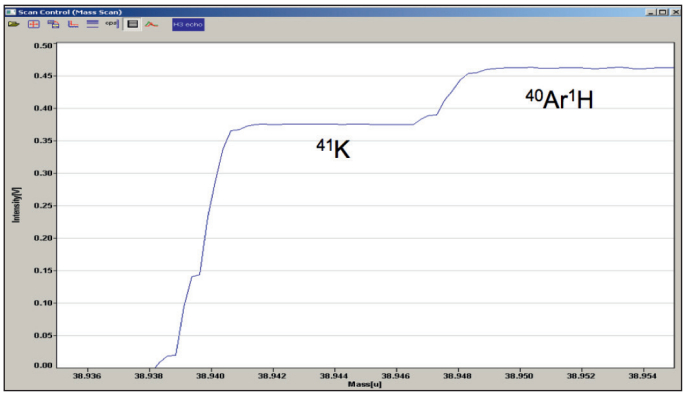

Figure 1A. A mass scan on the $^{41}K^+$ peak using the new XHR Extra High Resolution Option for Neptune XT MC-ICP-MS. The mass resolving power is 18,000 (5, 95% edge definition) and $^{41}K^+$ is clearly resolved from the polyatomic interference $^{40}Ar^1H^+$.

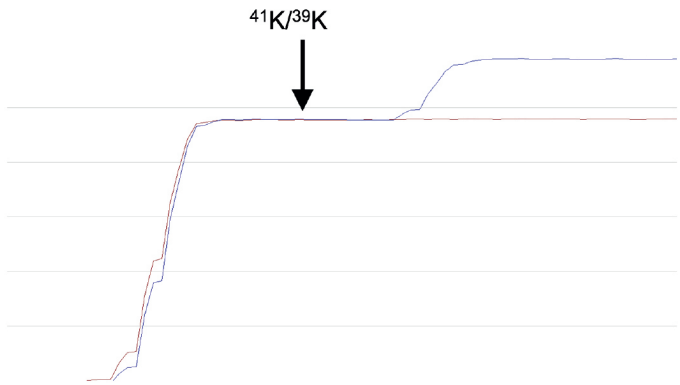

Figure 1B. The precise alignment of the movable collectors for the simultaneous measurement of $^{39}K^+$ and $^{41}K^+$ is shown.

The results of sample standard bracketing analyses of the two potassium solutions is shown in Figure 2. Each measurement was of 3 minutes duration. Precise and accurate determination of $\delta^{41}K$ is demonstrated using the enhanced resolution setup.

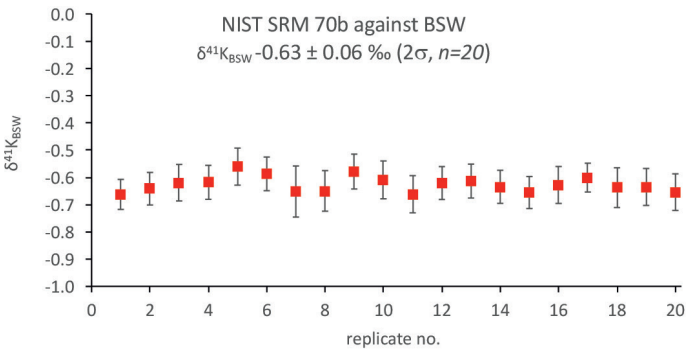

Figure 2. External precision (2SD) for $\delta^{41}K$ is reported for 0.8 µg sample aliquots. The measurements were made by sample standard bracketing. The data agree within uncertainty of Morgan et al. (2017, DOI: 10.1039/c7ja00257b). Note: the data presented are not warrantied because they exceed product specifications.

Conclusion

The new Thermo Scientific™ XHR™ Extra High Resolution Option for the Thermo Scientific™ Neptune XT™ MC-ICP-MS offers a mass resolving power of over 15,000 (5, 95% edge definition) with ≥ 1% transmission. Quantitative separation of $^{40}Ar^{1}H^{+}$ from $^{41}K^{+}$ allows for the precise and accurate determination of $\delta^{41}K$. Other applications that are expected to benefit from this new option include high-precision Mg, Si and Cl isotope ratio measurements, where hydride interferences could otherwise affect accuracy.

Acknowledgments

The potassium data and methodology were previously presented in Lloyd N, Field P, Morgan L, Santiago Ramos D & Higgins J (2017) Goldschmidt Abstracts, 2017 2439.

We would like to thank M. Paul Field and Paul Watson (Elemental Scientific Inc.) for method development relating the sample introduction; Danielle Santiago Ramos & John A. Higgins (Princeton University) for the sample preparation; Leah E. Morgan (USGS Denver) for pioneering the measurement of the potassium stable isotope system.

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