

High-Precision Analysis of Clumped Isotopes Δ_{47} and Δ_{48} Using the Ultra and Kiel IV Instrument

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Clumped isotope thermometry with carbonate, particularly the use of both Δ_{47} and Δ_{48} , has emerged as a powerful tool to reconstruct paleotemperatures and understand the complex carbonate formation processes [1]. The integration of both proxies refines temperature estimates and provides deeper insights into non-equilibrium effects and diagenetic alterations [2].

The traditional approach uses Thermo Scientific 253 plus with manual preparation line for carbonate digestion and CO₂ extraction, which can yield precise and reliable Δ_{47} measurement. However, accurate Δ_{48} requires more advanced analytical capabilities that can resolve subtle isotopic differences with high accuracy.

In this study, we report the first use of the Thermo Scientific 253 Ultra high-resolution mass spectrometer, coupled to the Kiel IV Carbonate Device, to perform simultaneous analyses of Δ_{47} and Δ_{48} in the carbonates. We will show data sets from international clumped standards, isotope standards, and the calibration of our in-house standards used for measuring unknown samples. This work method we will apply to carbonates from different environments. The Ultra instrument's superior resolution allows for clear separation of overlapping peaks, static measurement at desired position, minimizing background noise and enhancing the reproducibility of clumped isotope measurements.

This presentation will discuss the methodological advancements enabled by the Ultra and Kiel IV systems, present calibration data across different carbonate matrices, and highlight the robustness of the combination of the Ultra and online preparation via Kiel IV on the precise and reliable measurement of Δ_{47} and Δ_{48} . As we apply our method further, our findings underscore the value of integrating both clumped isotope measurements and set the stage for broader applications in paleoclimate, sedimentology, and geochemical research.

References

- [1] Fiebig, J., Wacker, U., Bernecker, M., & Staudigel, D. (2021) Temperature-dependent differences between Δ_{47} and Δ_{48} in carbonates: A new approach to calibrating clumped isotope thermometers. *Geochimica et Cosmochimica Acta* 305, 314-330.
- [2] Eiler, J. M., Schauble, E., Fiebig, J., and Thiagarajan, N. (2014) Application of clumped-isotope thermometry to terrestrial carbonates. *Reviews in Mineralogy and Geochemistry* 78, 399-427.