Evaluating the Handheld XRF as a Means for the Major Element Analysis of Carbonates

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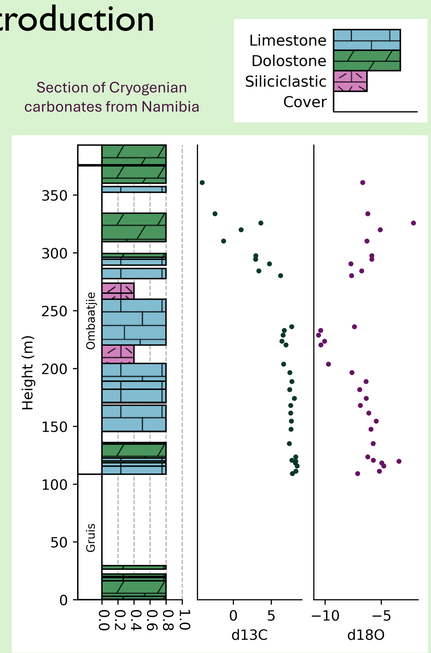
Introduction

- Carbonates were deposited between “snowball earth” events during the Neoproterozoic [1]
- $\delta^{13}C$ values of these carbonate rocks exhibit large excursions (CIEs) [1]
- However, $\delta^{13}C$ & $\delta^{18}O$ also influenced by mineralogy, diagenesis, and other processes [2].
- Major element analysis provides context for interpreting signals
- Analysis typically performed by ICP-MS [3]
- **Can a handheld XRF be used as rapid, cheap, and non-destructive alternative?**

Section of Cryogenian carbonates from Namibia



Sample Preparation

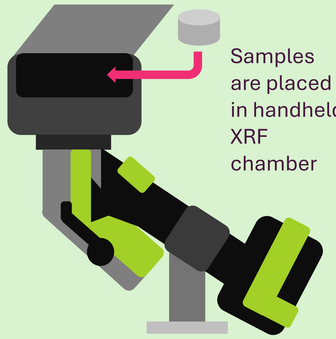
Preparation for XRF analysis

Slabs | Powdered samples | Pressed Powders (~0.25”)

Preparation for ICP-MS analysis

Samples underwent whole-rock dissolution and dilution process necessary for ICP-MS analysis.

Measurement & Calibration



Samples are placed in handheld XRF chamber

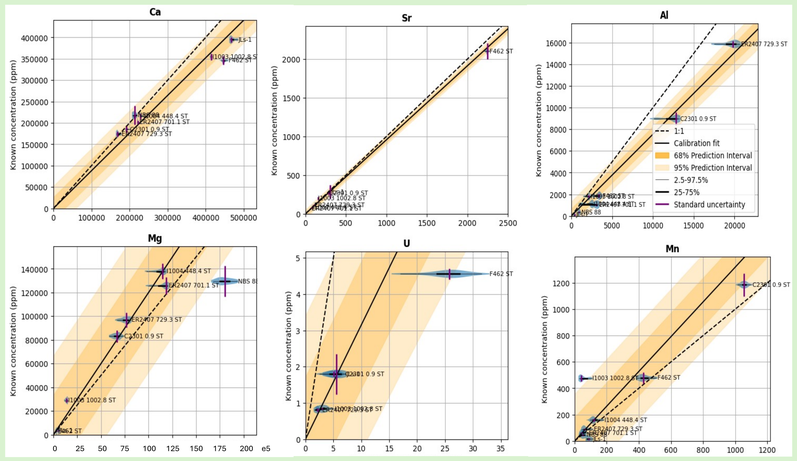
Slab in XRF chamber

Pressed powder in XRF chamber

XRF setup

Standards used for calibration

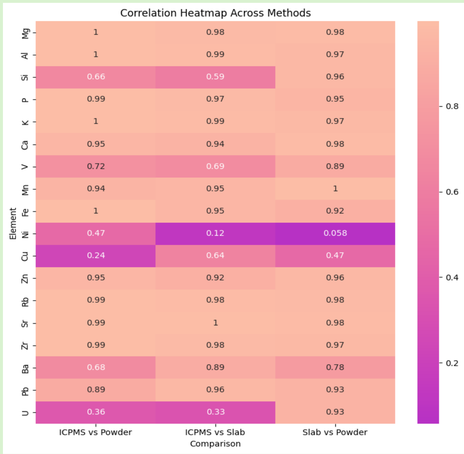
Known values on y-axis (ICP-MS & literature-sourced) and measured values on x-axis (XRF)

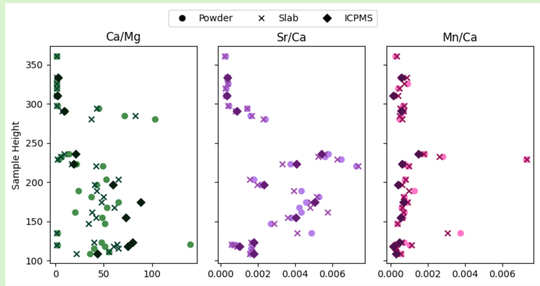


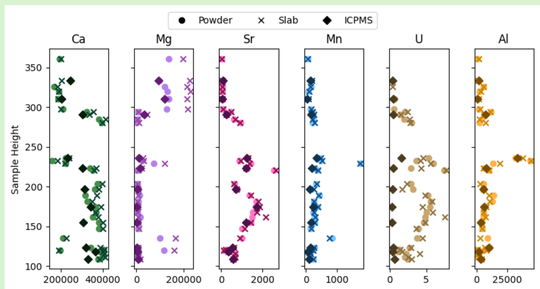
- Calibration code is applied to raw XRF measurements to correct for systematic error
- Standards of known values were measured periodically while measuring the section to quantify needed correction

Results

- Most elements show high positive Pearson correlation coefficients between all analysis methods
- Powder measurements perform closer to ICP-MS measurements
- Weaker correlations exhibited in trace elements, possibly due to low concentrations near detection limits
- Other sources of error include matrix effects, peak overlaps, and inhomogeneity in slab vs powder measurements.







- **Hand-held XRF measurements are seen to be a reliable, accessible and rapid assessment of local alteration processes**
- **Potential for quantitative geochemical applications in both laboratory and field-based studies**

References

[1] Paul F. Hoffmann and Daniel P. Schrag. In: Scientific American 282.1 (2000), pp. 68–75. ISSN: 0036-8733. JSTOR: 26058566.
[2] Anne-Sofie C. Ahm et al. In: Earth and Planetary Science Letters 568 (Aug. 2021), p. 117002. ISSN: 0012-821X. DOI: 10.1016/j.epsl.2021.117002.
[3] J.A. Higgins et al. In: Geochimica et Cosmochimica Acta 220 (Sept. 2017), pp. 512–534. ISSN: 00167037. DOI: 10.1016/j.gca.2017.09.046.

Acknowledgments

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Future Work

1. Measure additional sections to gain a more informed idea of XRF’s performance
2. Extend work to analyze XRF’s performance for other lithologies, such as iron formations
3. Explore settings such as integration times & XRF modes impact on results