

A new method for rapid characterization of carbon sequestration potential using thermogravimetric analysis

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Quantifying brucite abundance and variability across an ultramafic deposit is an essential first step for determining the carbon sequestration capacity of many mine sites, as high reactivity means even minor brucite will often be the most significant source of divalent cations for carbonation [1]. Multiple methods are employed to quantify brucite abundance but they each have issues. For example the presence of chlorite in some ultramafic deposits interferes with quantitative X-ray diffraction. Previous thermogravimetric analysis (TGA) methods for quantifying brucite abundance via mass loss have been proposed and are highly accurate however they require multiple long analyses per sample [2].

Here, we develop methods for rapid quantification of brucite using TGA, employing linear extrapolation and exponential interpolation models to fit the data and account for mass loss from other ultramafic minerals. The methods were tested using serpentinite and kimberlite standards with known quantities of brucite, hydrotalcite group minerals (another potential cation source) and hydrated Mg-carbonates (the most likely products of ex-situ carbon sequestration in mine wastes).

Our results show that brucite can be detected using TGA down to abundances of ~0.3 wt% in samples without hydrotalcites or hydrated Mg-carbonates. Using linear and exponential models improves the accuracy of the brucite estimates, with the exponential interpolation method proving most accurate, with ≤4% (relative error) in standards that contained >3 wt% brucite. Relative errors increased in samples with low brucite abundances, approaching the detection limit. In standards that also contained hydrotalcites or hydrated Mg-carbonates their structural and thermal behavioural similarities to brucite mean that the abundance of brucite could not be as simply delineated, but is the subject of ongoing investigation.

These TGA methods provide a way to rapidly quantify brucite variability within an ultramafic deposit or tailings pile, a necessity when considering the sample volumes required to quantify the variable brucite abundance of a deposit [3], and urgent time frames needed to begin implementing carbon sequestration and other carbon emission reductions.

[1] Lu X. et al., (in review) *Applied Geochemistry*.

[2] Assima G.P. et al., (2013). *Thermochimica Acta*, 566, 281–291.

[3] Vanderzee S.S.S. et al., (2019). *Geoscience BC summary of activities*.