

Silicate weathering and the apparent Arrhenius activation energy of CO₂ consumption at Coweeta Hydrologic Laboratory, western North Carolina, USA

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The weathering of silicate minerals is a natural mechanism by which atmospheric CO₂ is consumed over geologic time-scales. This study provides detailed calculations of atmospheric CO₂ consumption ($\dot{O}CO_2$) by the weathering of silicate minerals ($\dot{O}CO_{2min}$) for seven small forested watersheds underlain by granitic bedrock at Coweeta Hydrologic Laboratory, North Carolina, USA. Relatively accurate mineral weathering rates have been determined for each watershed using stream flux-based mass balance methods and the influence of biomass on stream water chemistry has been quantified. $\dot{O}CO_{2min}$ values have been corrected for sulfuric acid which can dissolve silicate minerals without drawdown of atmospheric CO₂. $\dot{O}CO_{2min}$ have also been calculated specifically for the weathering of Ca²⁺-Mg²⁺-silicate minerals ($\dot{O}CO_{2Ca+Mg}$).

For comparison, $\dot{O}CO_2$ has been determined using $2\dot{O}Si$ and $\dot{O}TZ^+$ which are widely used in studies of large rivers. The $2\dot{O}Si$ values are consistently higher than $\dot{O}CO_{2min}$ values by up to nearly a factor of four. $\dot{O}TZ^+$ values of measured stream water fluxes are typically lower than the $\dot{O}CO_{2min}$ values as biomass is not included in the $\dot{O}TZ^+$ metric.

Apparent Arrhenius activation energies (E_a) have been calculated for both $\dot{O}CO_{2min}$ and $\dot{O}CO_{2Ca+Mg}$ at Coweeta. The $\dot{O}CO_{2min}$ E_a range is 73-78 kJ mol⁻¹, and the E_a $\dot{O}CO_{2Ca+Mg}$ range is 50-55 kJ mol⁻¹. The lower $\dot{O}CO_{2Ca+Mg}$ E_a relative to that of $\dot{O}CO_{2min}$ reflects that at Coweeta the influence of temperature on Ca²⁺-Mg²⁺-silicate is lower than that for total silicate weathering. This differs from previous work [1]. This apparent disparity may reflect that the weathering of Ca²⁺-Mg²⁺-silicate minerals in felsic rocks are less sensitive to temperature effects than those found in mafic rocks. The Coweeta $\dot{O}CO_{2Ca+Mg}$ E_a is also lower than that of 63 kJ mol⁻¹ derived from laboratory experiments and utilized in the GEOCARB III model [2]. However, field-based E_a values are likely minimums because the watershed temperature used is ambient air temperature determined from the mean free atmospheric thermal lapse rate.

[1] Brady (1991) *J. Geophys. Res.* **96**, 18,101-18,106. [2] Berner and Kothavala (2001) *Am. J. Sci.* **301**, 182-204.

Molybdenum content and isotopic composition of the Buzzard Coulee Meteorite

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The Buzzard Coulee meteorite fall on November 20, 2008, was observed from three Canadian Provinces with immediate findings in Saskatchewan [1]. First petrographic analyses have classified the Buzzard Coulee Meteorite as a H3/4 chondrite [2]. With the first pieces found only 7 days after the fall, giving the meteorite the weathering grade W0 [2], the Buzzard Coulee meteorite constitutes outstanding material for isotopic analyses.

In this study we investigate the molybdenum (Mo) concentration and isotopic ratios of the Buzzard Coulee Meteorite. Molybdenum has seven stable isotopes: ⁹²Mo, ⁹⁴Mo, ⁹⁵Mo, ⁹⁶Mo, ⁹⁷Mo, ⁹⁸Mo, and ¹⁰⁰Mo. Isotopes of Mo are synthesized by p-process (⁹², ⁹⁴Mo), s-only process (⁹⁶Mo), r-only process (¹⁰⁰Mo) and a combination of s- and r- process (⁹⁵, ⁹⁷, ⁹⁸Mo). Molybdenum isotopes have been recently found to be indicators of not only biogeochemical processes but also of isotopic heterogeneity in the early solar nebula [3]. With improving analytical techniques, small molybdenum isotopic anomalies have been found in e.g. iron meteorites as a result of nucleosynthetic effects.

We apply ion exchange and double spiking techniques [3] followed by the Mo analysis using multiple collector inductively coupled plasma mass spectrometry (MC-ICPMS) to realize measurements with high accuracy and precision. Bulk Mo concentration and isotopic ratios will be presented as well as the Mo content and isotopic compositions of different fractions and grains to further constrain the Mo heterogeneity within the Buzzard Coulee Meteorite. This will allow us to explore changes in Mo content and isotopic composition as a result of heating or other processes.

[1] Hildebrand, Milley, Brown, McCausland, Edwards, Beech, Ling, Sarty, Paulson, Maillet, Jones & Stauffer (2009), *40th Lunar and Planetary Science Conference*, Abstract #2505. [2] Hutson, Ruzicka, Milley & Hildebrand (2009), *40th Lunar and Planetary Science Conference*, Abstract #1893. [3] Wieser & DeLaeter (2009), *International Journal of Mass Spectrometry* **286**, 98-103.