Natural carbonate precipitation rates from bomb-pulse radiocarbon dating

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Precipitation of carbonate minerals is one of the most stable methods to remove carbon dioxide (CO_2) from the atmosphere and sequester it within a solid crystal structure, but the process is slow relative to rates of global CO_2 production. Mineralization of atmospheric CO_2 occurs naturally during alteration of Mg-rich minerals (e.g., mining waste piles, fractured ultramafic systems). Previous studies have confirmed that actively precipitating systems incorporate modern atmospheric CO_2 by measuring $F^{14}C > 1$. We report here on our efforts to develop a ^{14}C bomb-curve dating method for comparing mineralization rates of secondary carbonate minerals from both natural and anthropogenically-influenced systems.

Carbon mineralization occurs through reaction of aqueous cations (Mg^{2+}, Ca^{2+}) and dissolved bicarbonate (HCO_3^-). If atmospheric CO_2 is the sole carbon source, radiocarbon dating utilizing the "bomb curve," or rise in atmospheric ^{14}C content due to weapons testing, should provide the year (± 1 year) of carbonate precipitation. We first validate this hypothesis by analyzing fresh ("zero-age") carbonates collected from both an ultramafic-hosted landslide in northwestern Washington (USA) and an alkaline spring in coastal California (USA). Method accuracy is tested on carbonate samples with known ages of precipitation at three time-points along the ^{14}C bomb curve, and is then applied to mine tailings in Australia and Canada. Future application of the method along transects of a single sample may provide information on the natural rate of precipitation.

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