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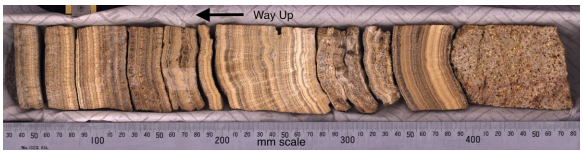

Do Anthropogenic Tufas record Chemical Weathering and Carbon Capture at Legacy Steel Slag Heaps?

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Slag is a waste product from steel production and is comprised of silicate minerals and metal oxides. Recent studies demonstrate slag's potential use for carbon capture and storage (CCS) through natural chemical weathering reactions: slag dissolution, carbon dioxide (CO_2) hydroxylation into carbonate, and calcium carbonate precipitation. This results in atmospheric CO_2 being sequestered in mineral form for thousands of years which will aid in reaching global negative carbon emission targets.

In Consett, Co. Durham, UK, the local iron and steel works was in operation from 1864 to 1978, producing >20 million tonnes of slag over its lifetime. The stream that drains the Consett slag heap is highly alkaline (pH > 11) and rich in dissolved metals from the weathered slag. This has resulted in the rapid precipitation of calcium carbonate as layered tufa deposits smothering the streambed. A 37-year long dataset of streamflow and water chemistry at this site has estimated 280-2900 tonnes of CO_2 have precipitated from the slag heap's drainage waters since 1980 [1]; however, such datasets are uncommon at other legacy slag heaps, thus requiring proxy measurements to calculate CCS at these sites.

To extend the carbon sequestration record in the past beyond the existing dataset, we can use the Consett tufa deposits as a temporal record. These anthropogenic tufas appear to have alternating seasonal layers similar to other naturally occurring tufas which are commonly used in reconstructing paleoclimate and environmental conditions.

Here we present preliminary δ13C, δ18O, and trace element data from a ~35 cm long core of Consett tufa. We hypothesize that seasonal variations in stream water chemistry are also reflected in the geochemical composition of the tufa layers. Thus, temporally paired tufa and water chemistry data will be extrapolated based on the tufa geochemical record to estimate stream elemental fluxes that extend back in time before the steelworks' closure and eliminate seasonal sampling bias. If successful, this tufa-based water chemistry reconstruction method will calculate the site's lifetime total CCS and may be applicable at other legacy slag sites with limited drainage water data.

[1] Mayes et al. (2018) *Environmental science & technology*, *52*(14), 7892-7900.