Environmental monitoring of mine sites using portable X-ray diffraction

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Portable X-ray diffractometers (XRD) allow for detailed mineralogical analysis to be conducted in the field, an approach that adds a new dimension to the monitoring of contaminated sites. This study uses portable XRD data to provide a "first look" at the mineralogy of, and identify potential environmental issues at, two derelict mine sites in New South Wales, Australia.

The Woodsreef Chrysotile Mine produced 500,000 t of long fibre chrysotile as well as 100 Mt of mineral waste from 1972 to 1983. The tailings at Woodsreef are highly reactive and can sequester atmospheric CO_2 via the formation of stable carbonate minerals [1, 2]. Portable XRD analysis indicates that carbonate crusts forming on the surface of the tailings contain ~2.1 wt% pyroaurite [$Mg_6Fe^{3+}_2(CO_3)(OH)_{16}{\cdot}4H_2O$] and ~5.8 wt% hydromagnesite [$Mg_5(CO_3)_4(OH)_2{\cdot}4H_2O$], demonstrating that sequesteration of atmospheric CO_2 within carbonate-bearing minerals, can be measured in the field.

The Ottery Arsenic-Tin Mine is a heritage listed site that contains mineral wastes and a ruined processing plant. Formation of mineral efflorescences is degrading the brickwork of the processing plant and is a source of As contamination in local soils and waterways. Portable XRD analysis determined that efflorescences on the exposed walls of the processing buildings are dominated by gypsum [$CaSO_4{\cdot}2H_2O$] with little evidence of the original As_2O_3-rich crusts remaining. Contrastingly efflorescences that are still sheltered by the remains of a roof are dominated by arseonlite and claudetite (As_2O_3). This means that sheltering historical arsenic-rich efflorescences is a key strategy for preventing the future release of As from the Ottery Mine [3].

[1] Oskierski *et al.* (2013) *Chem Geol* **358**, 15-169. [2] Turvey *et al.* (2017) *Am Mineral, in press*. [3] Hebbard et al. (2017) *Appl Geochem* **79**, 91-106.