Iron biogeochemical cycling in ferruginous duricrust (canga)

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Weathered banded iron formations (BIF) and supergene iron ore deposits are typically blanketed by goethite-cemented ferruginous duricrust, also known as canga [1]. In the process of canga formation, goethite undergoes recurrent dissolution–recrystallization via the biogeochemical cycling of iron, a common process that occurs in surface to near-surface environments [2]. This pattern of goethite partial dissolution and reprecipitation in canga is hypothesized to be organically catalyzed, specifically by plants and bacteria [2]. Therefore, understanding the contribution of endemic metallophyte plants and the associated rhizosphere microorganisms to the iron biochemical cycle is crucial when trying to elucidate the biological factors involved in the process of canga formation.

Field observations from the elevated plateaus within the Quadrilátero Ferrífero and Carajás regions in Brazil, where canga can range from 1-30 m in thickness, suggest past and present biological cycling of iron within canga. Naturally occurring, fine loose lateritic grains, in proximity to plant bases, showed partial consolidation within a 20 month sampling interval. Further, electron microscopic analysis reveals intimate intergrowth of roots with Fe-oxides. Evidence of ferruginized roots, biofilms and other organic matter, analysed using energy dispersive spectroscopy, indicates a strong link between organic activity and iron cycling. This correlates to the roots' ability to form micro-environments within canga (e.g., acid-reducing conditions) which favours Fe reduction and dissolution followed by oxidation and reprecipitation once exposed to atmospheric oxygen.

Our current work focuses on harnessing this existing biogeochemical iron cycle in order to promote the formation of canga in a laboratory setting, aiming for post-mining rehabilitation of iron ore sites by promoting the recreation of these unique ferruginous duricrusts and the ecosystem it supports.

[1] Dorr (1964). Supergene iron ores of Minas Gerais, Brazil. *Economic Geology 59*, 1203-1240.
[2] Monteiro, Vasconcelos, Farley, Spier & Mello (2014). (U–Th)/He geochronology of goethite and the origin and evolution of cangas. *Geochimica et Cosmochimica Acta 131*, 267-289.