Linking geochemistry and texture of mine tailings and soils to the evolution of plant community in a contaminated copper-sulphide mining area

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The adverse physicochemical properties and toxic elemental contamination of mine tailings generally inhibit the plant growth in the mining area. Some other adverse factors like absence of topsoil, drought, surface mobility, compaction, absence of soil-forming fine materials, soil acidity and shortage of organic matter as well as its associated essential nutrients dwarf the spontaneous growth of the diversified plant species in mining affected lands. Therefore, this study made a survey on plant community development at the abandoned São Domingos copper-sulfide mining area in order to understand the relationship of geochemistry and texture of tailings and soils with development of plant community. The results found several communities of plant species dominating in the area depending on geochemistry, mining contamination, soil texture, soil development and distance from the mining activities. The succession of plant communities shows that the plant communities of low height and biomass and bush-type (shrub), mainly *Erica australis*, *Lavandula stoechas*, *Cistus* genus, *Rumex induratus*, *Daphne gnidium*, *Juncus scirpoides*, and *Genista hirsuta* are grown in the mine waste dumps, slags, colluvium, gossan waste, and tailings contaminated lands with thin soil cover, slopes, ditches and acid mine drainage (landscape one). The poor vegetation coverage is clearly noticeable in the severely affected areas that are vulnerable to degradation and aerial dispersion. By contrast, the upland, contaminated to variable degrees (landscape two) just adjacent to the landscape one has good alluvial soil development like loam, and higher vegetation cover. The plant communities are taller, tree-type, and of higher biomass, namely *Eucalyptus globulus*, *Pinus pinaster*, *Pistacia terebinthus*, and *Pteridium aquilinum* etc. The *Erica australis*, *Lavandula stoechas or luisieri*, and *Cistus ladanifer* are found to variable extents in both landscapes. The *Erica australis* is spontaneously grown in the acidic sulfide mining soils; and this species is very specific plant in São Domingos mining area (Anawar *et al.*, 2011). The overall results indicate that the geochemistry and contamination levels of mining activities, soil texture, soil development and landscapes are the species-limiting factors for plant community development and vegetation coverage in the mining area. Although the high concentrations of toxic trace elements (e.g., As, Sb, Cr, Hg, Pb and Zn) and low pH values (soil acidity) are important factors for limiting the plant growth, however, soil texture and good soil development with enriched nutrients can present the high vegetation coverage in the mining contaminated lands and pave a biotechnology-based solution of land reclamation.

Whither the whiff?

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Improved understanding of the rock record indicates that the Great Oxidation Event was the culmination of an extended period of complex redox evolution and biogeochemical change rather than a singular event. We review data emerging from the sedimentary rock record about the timing and tempo of this transition and preview frontiers of investigation.

Attention has focused in particular on high-resolution, multi-proxy analyses of latest Archean black shales in drill cores from the Hamersley Basin in Western Australia, and from the Griqualand West Basin in South Africa. These analyses yielded multiple lines of evidence suggestive of photosynthetic O_2 production at 2.6 – 2.5 Ga, including: (1) patterns of Mo and Re enrichment and Mo and U isotope variations indicating the presence of these redox-sensitive metals in mildly-oxygenated contemporaneous water columns; (2) a shift in S isotopes interpreted as revealing the onset of an oxidative S cycle; (3) ^{15}N enrichments that record the operation of an aerobic N cycle, including nitrification and denitrification; (4) sedimentary Fe speciation and $\delta^{56}Fe$ data documenting anoxic and sulfidic (euxinic) conditions at mid-depths, most likely arising from enhanced oxidative weathering of sulfides, and a redox-stratified water column; and (5) a shift in sterane/hopane ratios suggestive of a transition in microbial ecology to greater participation by O_2-dependent eukaryotes. Alternative interpretations are possible for some of these observations, but collectively, consistent with other studies, they indicate a “whiff” of O_2 in the late Archean environment.

The data prompt new questions. How high did pO_2 rise? Was O_2 persistent in the environment, or do the data represent a transient event? If transient, was this one of many such episodes? Can similar evidence be found in the earlier Archean record? These questions are the focus of ongoing investigations.