Extraction of Co and formation of high-value by-products from laterite ore.

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Dissimilatory metal reducing bacteria, such as the gram negative anaerobe *Geobacter sulfurreducens,* have the potential to process lateritic ore expanding resource bases for the critical metal cobalt. In laterites Co is predominantly in Mn(IV)-oxyhydroxides with minor amounts hosted in Fe(III)-oxyhydroxides. Bioreduction initially reduces and solubilises Mn(IV) to Mn(II) releasing associated Co to solution[1, 2]. Released Co is then sorbed to Fe(III)-oxyhydroxide mineral surfaces and, as these are subsequently bioreduced, incorporated into reduced Fe-phases e.g. magnetite [3, 4].

Sample	Co in sample (g)	Co solubilised (g)	% of total Co
1	0.0224	0.0074	33.03
2	0.0333	0.0076	22.82
3	0.2208	0.0124	5.62

Table 1: Amount and percentage of total Co released from microcosms with 10g solid laterite material.

Bioreduction of synthetic Co- and Ni-doped asbolane, an Mn(IV)-oxyhydroxide, with pure cultures of *Geobacter sulfurreducens* induces complete dissolution of Mn(IV) to Mn(II) releasing Co and Ni to solution. Analogous results seen in natural samples, through stimulation of bacteria indigenous to ore from the Nkamouna laterite (Cameroon), show near complete dissolution of the Mn(IV)-oxyhydroxides lithiophorite and cryptomelane and generation of magnetite and maghemite. Up to ~33wt% Co has been released into solution from solid phases with the remainder uptaken by Fe-oxides (Table 1). Increasing Fe/Mn mineral ratios could streamline creation of transition metal-doped ferrites with applications in catalysis [5], data storage [6] and targeted drug/medical treatments [7] while decreasing the Fe/Mn ratio should generate more solubilised Co.

[1] Lloyd, (2003). *FEMS Microbiol Rev*. **27** (2-3), 411- 425. [2] Lovley, et al. (2004). *Adv Microbial Phys*. **49**, 219-286. [3] Smith, K.S. (1999). Society of Economic Geologists. p161-182. [4] Byrne, et al. (2015). *Journal of the Royal Soc Interface*. **10**(83). [5] Polshettiwar et al, (2011). *Chem. Reviews*. **111** (5), 3036-3075. [6] Zeng et al, (2006). *Phys Rev B*. **73**, 020402-1-020402-4. [7] Johannsen et al, (2005). *Int. Journal of Hyperthermia*. **21** (7), 637-647.