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Can platinum be incorporated in the structure of goethite?

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There is a strong positive correlation between Pt and Fe in PGE enriched laterite formations and marine ferromanganese crusts. Nonetheless, the oxidation state and speciation of Pt, whether incorporated in the Fe oxide fraction, adsorbed or present as inclusions, has not been fully determined. We conducted experiments to test the possibility that Pt can be incorporated in the structure of goethite (alpha-FeOOH), a stable and ubiquitous Fe oxyhydroxide that is strongly associated with Pt in lateritic terrains. We explored two different co-precipitation pathways: 1.) Titration of Fe(III) and Pt(II) or Pt(IV) solutions to high pH (~11), with coprecipitation of Pt and ferrihydrite (FH) followed by hydrothermal maturation (T = 60^{o}C) to goethite, and 2.) oxidative hydrolysis of Fe(II) and Pt(II) or Pt(IV) solutions at circum neutral pH to FH, followed by maturation to goethite at RT. Pt L_{III}-edge XANES of the run products showed that Pt was in the majority tetravalent state following the high pH hydrolysis pathway but in the divalent state following the oxidative hydrolysis pathway, regardless of the initial oxidation state. Analysis of the EXAFS spectra provides evidence that Pt(II) was incorporated in the structure of goethite, but in four-fold coordination. In contrast, Pu(IV) appeared to precipitate as a separate PuO_2-like phase, possibly of low dimensionality. Implications for the formation of Pt enriched laterite terrains are discussed.