Behaviour of impurity elements during the weathering of ilmenite

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Abstract

X-ray spectromicroscopy has been applied to the characterization of weathered ilmenite sand samples from Australian localities. XANES studies were performed at the *K*-edges of the major elements Fe and Ti and minor impurity elements Mn and Cr. An extended suite of reference samples with crystallite sizes ranging from 1 nm to μm size were measured to establish if the absorption edge characteristics were influenced by crystal size effects. No changes were detected for oxides of Cr^{3+}, Fe^{3+} or Ti^{4+}, but the mixed Fe^{2+}/Fe^{3+} oxide, Fe_3O_4, showed an edge shift to higher energies (by 1.5 eV) in a nanocrystalline sample. The XANES study of a composite ilmenite grain with an unweathered primary ilmenite core and a highly weathered rim showed that iron was present as Fe^{2+} in the core and Fe^{3+} in the rim whereas Mn was present as Mn^{2+} in both core and rim. Chromium, which is incorporated into the grains during weathering, is present predominantly as Cr^{3+}, although minor (~15%) Cr^{6+} also occurs in highly weathered grains. The absorption *K*-edges of Fe^{3+} and Mn^{2+} are shifted markedly (by 2-3 eV) to higher energies in titanate phases relative to the binary oxides Fe_2O_3 and MnO.