



## **The mechanism of hydrothermal alteration of ilmenite.**

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Ilmenite ( $\text{FeTiO}_3$ ) undergoes weathering through oxidation and removal of Fe to form an apparently continuous series of compositions from ilmenite to pseudorutile (ideally  $\text{Fe}_2\text{Ti}_3\text{O}_9$ ), and with further weathering, to leucoxene (essentially rutile and/or anatase). We have carried out an experimental study of ilmenite alteration in autoclaves at  $150^\circ\text{C}$  in HCl solution, and studied the resulting products by X-ray diffraction, scanning electron microscopy, electron microprobe and Raman spectroscopy. In some experiments the solution was initially enriched in  $^{18}\text{O}$  and the distribution of the isotope in the alteration products mapped from the peak shift in the Raman spectra. The results indicate that the alteration proceeds in two distinct stages, each with a sharp interface between the parent phase and the product. The alteration begins at the original ilmenite crystal surface and along cracks through which the fluid can migrate. The first alteration product is pseudorutile – no phases intermediate between ilmenite and pseudorutile were detected. The textural relationship between ilmenite and pseudorutile suggests a coupled dissolution-precipitation mechanism rather than a solid state continuous oxidation and Fe diffusion mechanism. The second stage involves a further dissolution-precipitation step to form rutile. Raman spectroscopy shows that the  $^{18}\text{O}$  is incorporated in the rutile during the recrystallisation. Throughout the alteration process the original morphology of the ilmenite is preserved although the product is highly porous. The rutile inherits crystallographic information from the parent ilmenite, resulting in a triply-twinned rutile microstructure.