

The mechanism of oxidation and “leaching” of ilmenite during natural and experimental alteration

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Ilmenite (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°C in HCl solution, and studied the resulting products by X-ray diffraction, scanning and transmission electron microscopy, electron microprobe and Raman spectroscopy. In some experiments the solution was initially enriched in ^{18}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}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.

The role of crustal assimilation and fractional crystallization in the generation of a hybrid composite dikes suite in the Arabian-Nubian Shield, southwest Jordan

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A suite of hybrid composite dikes from the Arabian-Nubian Shield (ANS) in southwest Jordan is investigated. The petrogenesis of these dikes is discussed on the basis of field, petrographic, geochemical and Rb-Sr isotopic data. These dikes originated from the interaction between basaltic magma and the granitic basement. This interaction ranges from brecciation and partial assimilation of the host alkali feldspar granite to almost complete assimilation of the granitic material. Field structures range from intrusive breccia (i.e. angular granite fragments in a mafic groundmass) to hybrid composite dikes. The rims are mafic (basaltic andesite) in composition with alkali feldspar ovoids (up to 1 cm in diameter); while the central parts are of trachydacitic to dacitic in composition again with alkali feldspar ovoids and xenoliths of the dike rims.

A seven points Rb/Sr isochron from one the composite dikes yields an age of 560 ± 7 Ma and an initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 0.70332 ± 0.00004 (2σ) and MSWD value of 0.59.

Geochemical modelling using major, trace elements and isotopes suggest the generation of the hybrid composite dikes through the assimilation of 30% granitic crustal material by the basaltic magma, while the latter was undergoing fractional crystallization deep in the continental crust.