Multiphase magmatic history of the Oman-UAE ophiolite

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The Oman-United Arab Emirates (UAE) ophiolite is the largest ophiolite complex in the world. The majority of the ophiolite lies in Oman, but it has a northerly extension into the UAE. This has been mapped and studied in detail by the BGS since 2002, funded by the UAE's Ministry of Energy.

The Oman-UAE ophiolite was traditionally interpreted as a classic mid ocean-ridge ophiolite, but more recently it has been recognised that a second, voluminous phase of magmatism is superimposed upon the early MORB-like ophiolite sequence. In the UAE, our field mapping has shown that this later magmatic phase forms extensive intrusions including large gabbro plutons, tonalite bodies and mafic dyke swarms throughout the crustal sequence and the mantle transition zone. The later magmatism has been dated at 96.4 to 95.2 Ma [1], coeval with similar magmatism in the Oman sector of the ophiolite [2]. The age of the early magmatism is not yet known.

Petrology and mineralogy of the early magmatic phase are consistent with formation at a spreading ridge, but the magmas of the later phase were more hydrous. Dykes and lavas from the early magmatic phase have MORB-like geochemistry, whereas those from the later magmatic phase show geochemical features of subduction-related magmatism, such as lower Ti/V and Zr/Y. Whole-rock Pb isotope data also distinguish the two phases, and support a supra-subduction zone setting for the later phase.

The youngest, volumetrically minor magmatism, recorded in the UAE sector of the ophiolite as localised mafic dykes, has geochemical and isotopic signatures more like those of ocean island basalts, and may be associated with an extensional, post-obduction event. This magmatism is tentatively dated at about 91 Ma.

[1] Goodenough, K M *et al.* (2010). Architecture of the Oman-UAE ophiolite: evidence for a multi-phase magmatic history. *Arab. J. Geosci.* **3**, 439-458. [2] Warren, C J *et al.* (2005). Dating the geologic history of Oman's Semail ophiolite: insights from U-Pb geochronology. *Contrib. Min. Pet.* **150**, 403-422.

Vadose zone controls on weathering intensity and depth: Observations from granitic and basaltic saprolites

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An investigation of vadose zone weathering processes has been undertaken on saprolites developed in Californian granitoids and Hawaiian basalts. Granitoid observations have been made across a drying gradient (declining precipitation, increasing temperature), from the coast inland to the Sierra Nevada foothills. Observations of basalt weathering have been made across strong precipitation/hydrological gradients on Kauai and Hawaii and along a chronosequence of weathering profiles developed on lava flows ranging from ~10–40 ka on Hawaii to >4 Ma on Kauai.

Results indicate strong climatic control, through infiltration, on the depth and intensity of weathering in both lithologies. Dry, lower infiltration sites display only thin saprolites, strongly influenced by rock texture. At wet, higher infiltration, sites, the vadose zone is comprehensively altered to saprock and saprolite. In both granitoids and basalt, vadose zone and weathering depth appear to be governed by local base level. This is demonstrated by weathering to just above sea level, sharp contrasts between unweathered bedrock in perennial streams and weathered rock on adjacent slopes, and the presence of deep saprolites on steep slopes.

In addition, laboratory analyses of granitoids indicate that vadose zone hydrology exerts a fundamental control on the effective operation and relative dominance of the key weathering reactions. In zones of matrix permeability, oxidation of Fe-bearing phases comprehensively disaggregates the rock but results in minor mass loss and clay mineral formation. Conversely, the higher transient flow rates that characterize zones of fracture permeability result in plagioclase hydrolysis, significant mass losses and accompanying clay mineral formation. A variable hydrological regime may also contribute to high partial pressures of O_2 in vadose zone pore waters and pore spaces, thereby enhancing the oxidative environment and predisposing grussic saprolite formation in granitoids.