Hydrothermal rutile at Clarke Head, Minas fault zone (Nova Scotia, Canada) constrains the age of Windsor Group evaporites

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At Clarke Head in the Minas Fault Zone, igneous megablocks include a syenite pegmatite intruding gabbro, and diorite with(?) lower Horton Group siltstone xenoliths. This study investigates the age and hydrothermal alteration of rutile in the syenite and the origin of the scapolite. It contributes to the current debates about the age of the lower Windsor Group and Ti mobility in the presence of halogens in subduction zones. Rutile was studied by SEM and dated by in situ U–Pb analysis. Syenite has magmatic K-feldspar, albite, quartz, rutile, and late stage analcime. Most feldspar is replaced by scapolite, which forms veins in gabbro and diorite. Millimetre-scale crystals of magmatic rutile in the syenite are rimmed by magmatic titanite and magnetite, and rutile also occurs interstitially. Hydrothermal alteration occurs preferentially along crystal margins and fractures as a layer-by-layer dissolution-reprecipitation process resulting in high Zr contents (~5000 ppm) in the rutile, enrichment in U, and depletion in high-field-strength elements. The magmatic emplacement age of the syenite is ~360 Ma (oldest dated rutile) and no younger than 353.9 ± 5.7 Ma (mean concordia age of interstitial rutile), synchronous with later regional A-type granite plutonism. Although this regional plutonism was Na- and halogen rich, with late-magmatic albitization and other Na metasomatism, only at Clarke Head is there extreme Na- and Cl-rich metasomatism, indicated by scapolite and Cl-rich hastingsite. Deformation of halite in the Portapique fault, well south of the basin margin Kirkhill fault zone, supplied Na^+, Cl^-, and lesser F^- to the metasomatizing system. These fluids produced the widespread metasomatic Na-rich scapolite in the syenite and leached Ti and other HFSE, together with REE, from large fractured rutile crystals. The U–Pb system in the altered rutile was reset at 337.4 ± 3.5 Ma. Oxygen isotopes in the bulk rocks, and scapolite-analcime mixtures suggest an important component of magmatic fluids in the metasomatizing system. Biostratigraphy favours an age of ca. 347–343 Ma for the lower Windsor Group evaporites. The St. Peters gabbro, with a 339 ± 2 Ma age, has been correlated with a geochemically similar pre-Windsor gabbro in Toms Brook, suggesting a younger age for the Windsor evaporites. However, small mafic bodies along the Minas Fault Zone range from 369 to <310 Ma. We propose that our new date of 337 Ma for hydrothermal rutile at Clarke Head corresponds to the mid-Windsor hiatus following the deposition of thick halite in central Nova Scotia.

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