The alteration of ilmenite in the Cretaceous sandstones of Nova Scotia

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Detrital ilmenite, generally in the form of its alteration products pseudorutile, leucoxene, and rutile, is widespread in the Chaswood Formation of Nova Scotia and its offshore equivalents in the Mississauga and Logan Canyon formations. This alteration is an important source of Fe for diagenetic minerals. Placer rutile is a potential ore mineral for titanium.

In borehole RR-97-23 in Elmsvale Basin, pseudorutile is the commonest alteration mineral; in boreholes from Shubenacadie, ilmenite, pseudorutile, and leucoxene are all abundant; whereas sands from the West Indian Road pit contain mostly leucoxene. Rutile is common only at the extreme base of the Chaswood Formation (where highest vitrinite reflectance and most lithification are found). In offshore wells, ilmenite is sparse and rutile dominant, with no pseudorutile or leucoxene.

The mineralogical changes involved were tracked using electron microprobe analyses, backscattered electron images, and X-ray maps. Ilmenite grains (Ti/Ti+Fe <0.48) alter patchily to pseudorutile (Ti/Ti+Fe = 0.5–0.7) with volume loss, forming a porous structure and this process continues with the development of leucoxene (Ti/Ti+Fe = 0.7–0.9). Within the pseudorutile and leucoxene, slender crystals of rutile develop, eventually forming a trellis-pattern parallel to the crystal orientation of the original ilmenite grain, leaving empty spaces between them. In more altered crystals, stubby prismatic rutile crystals also appear. Si and Al occur in the altered ilmenite, either (a) inherited from original quartz and muscovite inclusions in the parent crystal or (b) as kaolinite altered from muscovite inclusions or precipitated in the pore space, presumably under pedogenic or early diagenetic conditions.

Four styles of Cretaceous early diagenesis are recognized in the Chaswood Formation: (1) dark grey organic-rich mudstones with pyrite and siderite; (2) oxisols with pedogenic development of kaolinite and hematite; (3) thick porous gravelly sands with limonite and goethite hard pans below intraformational unconformities; and (4) light grey mudstones with development of kaolinite beneath the water table from percolating meteoric water. These four environments show progressively increasing alteration of pseudorutile to leucoxene, with much of the pseudorutile developed during source area weathering or transport. In environment (4), most leucoxene was converted to rutile. Burial diagenesis (to vitrinite reflectance values >0.4%) may not alter ilmenite, but changed pseudorutile and leucoxene to rutile.