Origin of chlorite rims in reservoir sandstones of the Lower Missisauga Formation, offshore Nova Scotia

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Diagenetic chlorite rims on quartz grains preserve porosity and permeability by preventing the formation of secondary, pore-filling quartz overgrowths in wells from the Venture and Thebaud fields. Elsewhere, such chlorite rims have been interpreted as early diagenetic related to a high input of iron (Fe) from rivers or volcanic activity, or alternatively to later diagenesis by basinal fluids. The purpose of this study is to evaluate which of these hypotheses is applicable to the Scotian Basin. It has been suggested that detrital altered ilmenite is responsible for the unusually high titanium (Ti) content of Cretaceous shale in the Scotian Basin and might be an important source of labile Fe.

A set of 45 sandstone samples from conventional cores was analyzed for mineralogy in thin section, mineral composition by electron microprobe, whole-rock chemistry, and mineralogy of the <2 μm fraction by X-ray diffraction. This petrographic data has been integrated with facies description of conventional core and with wireline log data. Electron microprobe analysis shows that the chlorite rims are Fe rich and resemble chamosite in composition.

Seven sandstone types are distinguished: 1) well-sorted with chlorite rims; 2) well-sorted with chlorite rims and pore-filling clays; 3) carbonate-cemented; 4) partially dissolved carbonate-cemented with chlorite rims; 5) silica-cemented; 6) muddy; and 7) poorly sorted from transgression surfaces. Most well-developed chlorite rims are found in shoreface facies.

Factor analysis of geochemical and mineralogical data shows the following factors: i) detrital heavy minerals; ii) carbonate-cement; iii) K-feldspar ± clay; iv) chlorite rims; v) sulphides; and vi) barite drilling mud contaminant. Using only elements exclusively found in detrital minerals, three types of source are distinguished by factor analysis: a) ultrastable heavy minerals (Zr, Hf, Cr); b) granitic source (Ti, Y, HREE); and c) mafic source (Ni, Co, Sc).

The abundance and thickness of chlorite rims correlates positively with phosphorus (P) and are most abundant in type (4) sandstones. Phosphorus correlates strongly with Ti content of sandstone. Ti is generally immobile during diagenesis and in our samples covaries with elements related to detrital heavy minerals. Sedimentary rocks with higher Ti content due to alteration products of ilmenite can release more labile Fe, which favours the early diagenetic precipitation of phosphorite. High Ti content of sandstones in this study is restricted to the deeper sandstones of the Venture field.

This preliminary data suggests that the abundance of detrital ilmenite, varying stratigraphically and geographically, plays a role in providing labile Fe to the early diagenetic system. This Fe favours growth of early diagenetic berthierine, which alters to chamosite on burial. In marine facies with a low sedimentation rate, the high ambient Fe also favours growth of phosphate minerals.