The use of titania polymorphs as indicators of mesodiagenesis at hydrocarbon charge

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Diagenetic titania minerals are widespread in the Scotian Basin and can potentially provide information on fluid flow and migration of hydrocarbons in the basin. This is because Ti mobility in pore water is enhanced by organic acids and thus, diagenetic titania is most common (a) at lowstands during eodiagenesis and is (b) associated with petroleum maturation and migration. Representative samples at various depths from exploratory wells in the Scotian Basin were selected for detailed study of the distribution of diagenetic titania polymorphs. These polymorphs were identified by Raman spectroscopy as: rutile, anatase, and brookite. Sedimentary facies, burial depth, temperature, and salinity are investigated to evaluate their relationship to the different titania polymorphs. The texture and morphology of the polymorphs were analyzed using scanning electron microscope-backscattered electron (SEM-BSE) images together with transmitted and reflective light microscope images. In general, the abundance of diagenetic titania increases with depth and thermal maturity. Diagenetic rutile is rare and was only seen at shallow depths of approximately 1900 m where it rims detrital quartz crystals. At the same burial depth, detrital ilmenite disappears through dissolution and/ or replacement by rutile. Ilmenite pedogenically altered to rutile is abundant in samples containing high concentrations of heavy minerals. Diagenetic anatase primarily occurs as a replacive mineral, usually replacing rutile and phytodetritus, and demonstrably of eodiagenetic origin. In some cases, neoformed euhedral diagenetic anatase appears to fill pores while anhedral-subhedral crystals of anatase have precipitated adjacent to rutile crystals. Diagenetic brookite is predominantly neoformed, occurring (1) in pores as euhedral crystal clusters, (2) as isolated crystals in secondary porosity in completely silicified sandstones, (3) in secondary enlarged remnants of primary pores, or (4) along enlarged intergranular boundaries. Similar to anatase, some diagenetic brookite has precipitated near altered or dissolved rutile crystals. Brookite is the most abundant titania polymorph and predominantly occurs in sandstones that show evidence of transit of deep basinal fluid based on fluid inclusion data and the presence of hydrothermal sphalerite. These observed regional distributions provide a background against which variability related to the effects of petroleum migration can be assessed.

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