$^{40}Ar/^{39}Ar$ Analyses of Authigenic Muscovite, Timing of Stylolitization, and Implications for Pressure Solution Mechanisms: Jurassic Norphlet Formation, Offshore Alabama

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Abstract: Three authigenic muscovite morphologies are associated with Norphlet Formation stylolitization observed in the Texaco Mobile Area Block 872 #1 well: 1)large crystals of 1M muscovite, which grew in the stylolites with their c-axes parallel to the plane of maximum compressive stress; 2) fine-grained bundles of muscovite that occur as pore-fillings near stylolites; and 3) pods of fine-grained muscovite that exist within stylolite insoluble residue and that were precipitated as pore-filling muscovite before the host sandstone pressolved.

The population of large crystals of 1M muscovite grew at 51 ± 9 Ma, pore-filling muscovites precipitated at 77 ± 22 Ma, and muscovite pods have ages of 86 ± 16 Ma, as indicated by $^{40}Ar/^{39}Ar$ laser fusion. Apparent ages indicate that stylolitization was coincident with the beginning of organic maturation Zone 5 and could be the product of reservoir fluid pressure fluctuations induced by gas leakage. The lower Smackover Formation source/seal rock, acting as a pressure relief valve, could have been compromised by microfractures occurring during hydrocarbon generation and expulsion. Decreases in reservoir fluid pressure would have acted upon the sandstone framework by increasing the effective overburden pressure, thus making the rock more susceptible to pressure solution.

Stylolite frequency and quartz cement volume increase in the finer grained portion of the conventional core. Quartz cement volume correlates inversely to percent sandstone porosity. Apparent muscovite ages indicate that stylolitization occurred after hydrocarbon migration. Silica mobility was limited because pressure solution mineral products were precipitated from within grain films of irreducible water within the sandstone.

Stylolitization of quartz grains accounts for a minimum of 34% of the quartz cement in the upper cored section of the Norphlet Formation and minimum of 17% of the quartz cement in the lower cored Norphlet Formation. Quartz cement volumes are based on stylolite insoluble residue thickness and weight measurements of pyrobitumen within and nearby the insoluble residue seams. Stylolitization of K-feldspar and precipitation of muscovite can release additional silica which may have precipitated as quartz cement.

Key Words: $^{40}Ar/^{39}Ar$ dating • Muscovite • Norphlet Formation • Pressure solution • Quartz cement • Sandstone • Stylolites

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