Dependency of Quartz Precipitation Rates on Crystal Domain Size: An Explanation for Porosity Preservation by Microcrystalline Quartz Coatings?

Lander, R. H.[1], Richard E. Larese[2], Linda Bonnell[1] (1) Geocosm, Austin, TX (2) Clastic Petrology Consultant, Durango, CO

Microquartz coatings may preserve reservoir quality by inhibiting "normal" quartz overgrowth development (Aase et al, 1996). Previous explanations for this counter-intuitive observation involve diminished mass flux of silica into microquartz bearing sandstones due to the heightened solubility of the micron-scale crystallites (Aase et al 1996, Jahren & Ramm 2000).

Kinetic modeling by Bonnell et al (2006), however, indicate that there is no discernable difference in the surface area normalized precipitation rates for quartz overgrowths in Miller Field samples with and without microquartz when the nucleation surface area of monocrystalline quartz grains is taken into account. Furthermore, our hydrothermal experiments on natural microquartz bearing samples from the Fulmar and Ula Formations indicate that quartz overgrowths that form on "naked" grain contact scars grow at substantially greater rates than immediately adjacent parts of the grains that are coated by microquartz. Thus it appears that microquartz coatings impede quartz cementation because the micron-scale crystallites grow at significantly slower rates than larger overgrowths.

To better understand this rate effect we conducted additional hydrothermal experiments involving quartz overgrowth formation on a single crystal that was covered by copper foil with holes ranging from 50 Ìm to 3.2 mm. The experiments show a near linear dependence between surface area normalized growth rate and nucleation substrate size. The evolution in crystallite morphologies with growth indicates that this dependence reflects an ~20x decrease in growth rate that occurs when non-euhedral surfaces become euhedral. The dependency of net growth rate on nucleation substrate size occurs because, by Steno's Law, overgrowths that form on smaller substrates achieve euhedral termination with less growth. Our 2-D model of quartz cementation that accounts for this effect (Prism2-D) reproduces both the experimental observations and the inhibitory effect of microquartz coatings in Miller Field sandstones.