Conditions of Quartz Cementation in Mt. Simon Sandstone: Evidence from In Situ Microanalysis of Oxygen Isotopes

Pollington, Anthony D.[1]; Kozdon, Reinhard [1]; Ushikubo, Takayuki [1]; Kita, Noriko T.[1]; Valley, John W.[1] (1) WiscSIMS Lab, Department of Geoscience, University of Wisconsin, Madison, WI.

Samples of the Mt. Simon Formation have been analyzed in situ for oxygen isotope ratio (δ18O, 10 μm spot) from three depth intervals in Illinois Basin cores as well as outcrop samples from Wisconsin. Diagenetic cements account for a major fraction of the intergranular volume of many samples. Almost all core samples contain quartz cements that occlude between 30 and >90 % of the original porosity, while overgrowths in outcrop samples are quartz and feldspar which fill between 0 and 50 % of original porosity. This reduction in porosity has a significant affect on permeability and reservoir quality. The δ18O of diagenetic quartz cements allow estimation of the variability in precipitation temperature, if δ18O(fluid) is known. Alternatively, changes in fluid source can be detected if thermal history is known.

Values of δ18O of detrital and pore-filling quartz were measured on an IMS-1280 ion microprobe. δ18O values for the detrital quartz are similar across all depths (9.8 ± 3.9 ‰ SMOW) consistent with a source dominated by igneous rocks. The quartz cements are distinctly higher in δ18O than detrital grains and define a trend to lower values deeper in the basin (from 27.9 to 18.0 ‰ for the latest cement in each overgrowth). In a fluid-dominated system, the lower values are expected for quartz precipitated under warmer conditions, suggesting that the decrease in δ18O down-dip in the basin is largely dominated by increasing burial temperature.

In addition to the basin-wide trend to lower δ18O values with increasing depth, most individual overgrowths show a trend of decreasing δ18O from early to late quartz growth. This suggests that cement growth started early in the burial history, continued while rocks were heated during burial, and ceased before unroofing and basin uplift. δ18O zonation was measured in 57 overgrowths. Most overgrowths show a decrease in δ18O, on average by 2.6 ‰ (max. = 6.4 ‰), as growth proceeded. If δ18O(H2O) = 1.5 ‰ for a fluid-dominated system, this indicates that cements grew from 80-150°C consistent with published temperatures from fluid inclusions and vitrinite reflectance in the Illinois Basin.

These results indicate that the majority of quartz cements formed in the Mount Simon sandstone during burial and heating. There is no evidence in these samples of later quartz cementation or crosscutting cements.