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Scaling-up Diagenesis : Petrographic Micro-samples to Engineering Macro-simulations

How reliable is the scaling-up of reservoir quality from core plugs to an engineering-scale flow simulation? We have taken an unusually close-spaced suite of diagenetic micro-analyses in two well-studied reservoirs from the North Sea to test this question.

From coarsening-up units in a shallow marine sandstone, we have: sedimentary logs, conventional core analysis, thin section modal analysis, SEM petrography, magnetic susceptibility and Rietveld quantitative XRD data. Sample-spacing as close as tens cm (6 inches) were used to determine authigenic cement and reservoir quality distribution. Samples were also analysed using SIMS to determine variation in authigenic quartz $\delta^{18}O$ values, with respect to cement distribution. The main diagenetic controls in the reduction on reservoir quality are quartz cement, and fibrous illite.

From "channelised lobe" boxcar sands in a deepwater gravity-flow reservoir, we have a similar sample suite, in a 3 well dip-section from reservoir crest, to below OWC. Three models exist in explaining cement origin and distribution as being: pre-, syn-, or post-oil. Each model generates very different predictions concerning macro-scale distribution of cements and reservoir quality. Our dense sampling has targeted critical zones to discriminate between these hypotheses.

With each data set, we have statistically tested for normality, and then sought correlations between parameters. We have also assessed the Coefficient of Variation and Stationarity, so to predict away from our sample point with known confidence, and populate grids for basin models more reliably. 2-D basin modeling lines are being utilised to scale-up and assist in predicting within the fields and regionally.