An Integrated Approach to Estimate Reservoir Diagenesis

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Reservoir quality prediction in siliciclastic reservoirs is commonly based on forward diagenetic modeling (TouchstoneTM) coupled with thermal and stress histories to estimate reservoir quality at a certain depth of interest (1D prediction). This project demonstrates an integrated approach among three software programs (PetroMod3DTM, DionisosTM and TmapTM) to better predict quartz cementation in a Jurassic clastic reservoir.

A regional scale basin model developed in PetroMod3DTM was calibrated with temperature, pressure and porosity data in addition to Fluorescence Alteration of Multiple Macerales (FAMM), and Fission Track (FT) data. This regional model provided the basis to sub-regional (field) scale model but with a greater resolution.

Processed-based stratigraphic forward modeling developed by IFP (DionisosTM) provided the framework for the three-dimensional architecture of the reservoir. Facies maps at key reservoir and source rock intervals were populated for the semi-regional scale basin model (214 km x 150 km). Well-log data, core, biostratigraphy and mapped seismic surfaces were key input data into the Stratigraphic Forward Modeling (SFM).

In order to quantify the amount of authigenic quartz cement, SEM-CL (Scanning Electron Microscopy - Cathodoluminiscence) based point count was conducted on selected samples, in addition to the conventional petrographic analysis, such as measurement of grain size and grain coating. The quartz diagenetic model was developed in TouchstoneTM and was calibrated with 22 samples from the 4 wells to derive one value for the quartz activation energy. Integration of TouchstoneTM TFC (Touchstone Configuration File) files in TmapTM (Reservoir Quality Mapping Tool) aimed to simulate reservoir quality variation in a 3D basin (thermal model + facies).

Through the integrated workflow approach and limited analysis, this study demonstrates that temperature history is the fundamental control on the precipitation of quartz cement (long-term process) in the studied Jurassic reservoir. Early hydrocarbon migration to the traps did not contributed to the preservation of porosity. High poro-perm reservoir intervals are more likely related to depositional facies.