The Use of Reservoir Analogues to Better Constrain Geobody Architecture, Genesis and Petrophysical Characteristics of Continental Carbonate Reservoirs

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ABSTRACT

With the discovery of hydrocarbons in continental carbonates of the pre-salt play offshore Brazil and Angola, the need for a better insight in the origin and geobody architecture of these reservoirs has become apparent. In the framework of a JIP, a research project was launched in which continental carbonates were studied at sub-seismic scale near Ballik (Denizli, Turkey), Sütto (N-Hungary) and Tivoli (central Italy). Based on Lidar/photogrammetric reconstructions of the quarries, by which sub-seismic scale models were created, the samples could be placed in a georeferenced framework, thereby allowing geostatistical analyses of the acquired data. The sedimentological analyses allowed us to constrain the depositional conditions of these carbonates. For example a depositional model was proposed for Tivoli shrub-dominated lithologies, where flow rate of thermal sulphate-rich waters and morphologic relief elements like rimming dams turned out to be key parameters. In the Ballik area the model showed the evolution at the scale of >3 by >5 km of a sub-aqueous dominated system towards a complex aggradational and sub-areal dome system, in between which sub-aqueous ponds developed. Here also the interplay with non-carbonate geobodies (e.g. channelized conglomerates, lacustrine marls, paleosoils, sandstones with coquina interlayers, …) was unraveled. In Hungary, geophysical measurements and drilling allowed us to refine the position of major faults with regard to the continental carbonate geobody development. Based on trace element geochemistry, stable C & O-isotope and Sr87/Sr86 isotope geochemistry the type of paleo-fluids involved could be constrained as well as their origin, allowing us to propose for the different study areas, large scale fluid flow circulation models. Based on He-porosity, N2-permeability, NMR and MICP data acquired from plugs, the petrophysical characteristics of the different lithofacies were constrained and in conjunction with medical CT (Computed Tomography) as well as µCT, the pore network properties of the lithofacies could be addressed. Based on the digital rock models and physics, the acoustic properties of these continental carbonates could be better constrained. Finally one of the biggest rock as well as digital databases on continental carbonates has been constructed by the team. The database, among other purposes, serves as starting point for the upscaling strategy based on multiple point geostatistics that is under development.