EAGE

NHF05

Keynote Address:Characterizing Fractured Reservoirs with Seismic & Structural Attributes

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SUMMARY

Taking the risk of being a little bit provocative, I would say that we don't care about fractures: we are only interested in their impact on subsurface flow forecast by flow simulators. There are two possible approaches to flow modeling in the subsurface: either a "small scale" approach based on "correct physical laws" governing the trajectory of fluid particles (the Navier-Stokes equations) or a "large scale" approach based on a "phenomenological law" (the Darcy law) where the exact trajectories of fluid particles are irrelevant. Taking fractures into account can be addressed similarly: we can either consider the problem at the "fine scale" of fractures or at the "large scale" of the "flow cells" used by the Darcy law in flow simulators. Both approaches have pro and cons. Today, a lot of research is dedicated to fine scale fracture modeling and everyone has already seen nice pictures of stochastically generated fracture networks. Modeling fractures at fine scale involves the knowledge of many parameters controlling the density, orientation, dimensions, spacing and physical properties of fractures which, most of the time and unfortunately, are beyond measurement capacities. Moreover, upscaling the impact of fine scale fractures to the "effective permeability" used at large scale by flow simulators is all but simple.

Einstein said "make everything as simple as possible but not simpler". In this talk I defend the thesis that we must not forget our primary objective which is to model flow at the large scale of Darcy law and not to model the complexity of fractures at fine scale. To that end, a simple approach consists of looking for reservoir attributes which are correlated with large scale "effective permeability" observed at well locations and, most importantly, which can be measured and/or estimated everywhere in the reservoir. There are two families of such attributes: seismic attributes deduced mathematically from a seismic cube and geometric attributes deduced mathematically from a structural model. After giving a quick review of some seismic attributes, I will focus on attributes deduced from the structural model. I will show how structural attributes linked to curvatures, strain/stress tensors and tectonic work can be deduced from a new mathematical model of the subsurface involving a transformation (called the uvt-transform) from the current geological space, as observed today, and the depositional space as it could have been observed at time of deposition.

In a final step, I will suggest how to gather all the attributes into one single "combo attribute" which can next be used as a driver by any geostatistical method to interpolate or generate equiprobable models of effective permeability in the reservoir.