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New Approaches to Detect and Consistently Manage Subscale Geological Features in Reservoir Modeling

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Abstract

Subsurface reservoirs can be prone to intricacies which are difficult to forecast from the data at hand. Indeed, millimetric to metric clinoforms, fractures, faults, karstic or diagenetic features may all have an impact on reservoir flow and deformation, especially in multiphase settings and energy transition applications such as CO_2 sequestration and high-energy geothermal settings.

In this context, we argue that the ability to update reservoir models is essential to reduce the computational and operational time cost. Such model updates generally include local petrophysical changes, less often geometrical changes, and very rarely topological changes. This presentation mainly addresses geometrical and topological model updates.

As a use case of such a local model updating, we present a non-parametric sequential Bayesian method that leverages the concept of relative geological time to maintain the consistency between logging while drilling measurements and reservoir model during geosteering. This approach efficiently updates the drill bit position in depositional space, which allows operators to trigger time-consuming model updates only when needed. As this method may hint at the presence of sub-seismic faults, we also present recent and ongoing work to address local finite fault insertion into the subsurface model. Elastic homogenization opens a new promising pathway to keep this type of model update compatible with subsurface images obtained by full waveform inversion.

The above workflow illustrates some of the benefits (and challenges) of local model updates to assimilate subsurface data. While the proposed approaches may not be readily applicable in real time to all situations, they also provide an interesting basis for uncertainty quantification purposes and for training or specializing fit-for-purpose machine learning models.