NOMBA an Integrated Project for Coupling Basin Modeling and Geomechanical Simulations

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ABSTRACT

Compressional (or even extensional) settings in complex structural domain are still a challenge in basin modeling simulation. In particular, the impact of the regional stresses is very poorly understood, and its impact on compaction or fluid flow seldomly described. Within the framework of a scientific partnership, IFPEN and Total decided to tackle together the challenge of coupling effectively basin models with geomechanics, in an attempt to improve significantly our capacity to address exploration in foothills or areas where stress history is a key to better describe the evolution of the domain.

The project started based on the rationales that lateral stresses where still not properly integrated in basin modeling. The project addresses in particular the following topics:

- Description of the structural evolution of the domain, and the associated stress evolution in subsiding basin and compressive set-up.
- Description of the seal integrity, with a geomechanical approach for the behavior of faulted and fractured shales.
- Description of the hydromechanical behavior of the domain, and the impact on the plumbing of the geomechanics integration.

In order to achieve those objectives, the project put in place the development of new numerical schemes for the optimization of the coupling between the two packages and a common platform.

As proven recently with all the developments in coupling reservoir simulations to geomechanics, the choice of coupling two softwares is never an easy target, and usually raises many issues with the numerical compatibility and the increase in CPU time. In the case of basin modeling simulation, an additional difficulty appears with the evolving geometry. The poster presents some of the solutions that were proposed to reach a satisfactory coupling.

- The computation of the porosity is quite central in the problematic. It is first evaluated by the BM, using a conventional vertical compaction approach, described by porosity-depth or porosity-effective-stress laws. Traditionally, it never takes into account any lateral impact in the evaluation of the porosity, nor pressure evolution. Dedicated works were carried out to propose a new constitutive law which takes into account the specific needs of basin model (compaction and failure mainly), as well as the possibility to be optimized within the numerical scheme.
- One of the main issues when dealing with complex structural set-up was the capacity to model properly the flow along and across the fault, in agreement with a geological scenario for fault activity. Using the kinematic of the fault coupled to fault permeability evaluation with SGR or other methods from the literature, the fault is properly modeled in terms of activity and plumbing impact.

- Finally, the trap integrity is usually confined to very basic tests, with a simple comparison between the pressure and the lithostatic stress. When coupled to geomechanics, the possibility to properly describe the mechanical behavior of the deposited sediments becomes much more descriptive and the possibility to introduce various way of failure increases as well.

The results are quite encouraging and tangible, in both 2D and 3D operational cases. But important efforts are still needed for problems linked to salt tectonics or simply adapted meshing techniques when the geometry becomes too complex.