The Search Beneath the Urcusique Fault: A Seismic Imaging Exercise

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In the foothills of the Putumayo Basin, Colombia, prospective Cretaceous oil reservoirs are difficult to image due to complex overlying structures. Commonly, pre-Cretaceous faults have been reactivated by Andean compression resulting in over-ridden anticlines such as the structure containing the recently discovered Moqueta oil field, one of the largest light oil discoveries in Colombia of the last decade. The field is over-ridden from the north by basement rocks carried on the regional, south-vergent Urcusique Thrust. The motivation of the seismic processing was to improve the imaging of the reservoir section beneath this fault to support full-field development planning.

Direct observation of the fault plane is not possible due to data limitations. Quality and accessibility of outcrops is difficult, and the fault plane is not imaged in the original seismic. Indirect constraints for the fault angle were used including thick-skinned thrusts from worldwide analogues and documented Andean-inverted former rift-faults in the Putumayo Basin. Most normal faults have dips of ~65°, which likely decreases as the faults pass from rigid basement into softer overburden.

The challenge was to process a recently acquired 3D seismic data volume to image the Cretaceous reservoirs believed to exist under the Urcusique Fault, bringing basement to surface. Significant signal to noise issues, source coupling and static issues needed to be resolved. The seismic imaging team included a range of geoscientists from structural geologists to seismic-imaging specialists. The multi-disciplinary team approach provided geologic constraints to the seismic velocities for both time and depth imaging. For the prestack time migration (PSTM), the team collaborated on inspecting the velocity panels to focus on the images that make the most geologic sense. Prestack depth migration (PSDM) was driven by the model, as opposed PSTM, which was driven by focussing the image. The multi-disciplinary approach produced a geologically constrained model for PSDM resulting in imaging improvements below the main overthrust.

Whereas we were not able to image the Urcusique fault plane itself, we were able to use the seismic images to constrain the fault interpretation of the sub-thrust structures. Additionally, in certain areas beneath the thrust, correlatable reflective energy tied to the stratigraphic sequence encountered in the ongoing drilling appraisal program was recognized as results of our efforts.