**High-Resolution Shallow Seismic Imaging of Upper Miocene Carbonates of the Agua Amarga Basin, SE Spain**

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**STATUS:** Proposed project  
**TIMING:** To be completed in the future if recommended by membership  
**FUNDING:** None  
**STAFFING:** Tsoflias, Franseen, Goldstein, one student

**Purpose**

This project will employ shallow seismic reflection surveying in order to provide high-resolution subsurface imaging of deep-marine carbonate reservoir analogues of the Upper Miocene Agua Amarga Basin, SE Spain. Two-dimensional (2D) seismic profiles will be acquired, processed and integrated with existing three-dimensional (3D) geological models and other proposed synthetic seismic sections. High-resolution seismic imaging will offer insights about internal reservoir architectures, carbonate facies and fractures.

**Project Description**

Upper Miocene carbonates of the Agua Amarga basin in SE Spain are unique analogues for poorly studied deep-marine carbonate reservoirs (Franseen et al., 1998). A comprehensive geologic study of this area (Dvoretsky, 2009) resulted in detailed 3D models of lithofacies and petrophysical characteristics (porosity and permeability) (Figure 1). Two types of reservoirs were distinguished based on mechanism of deposition: 1) dispersed-flow deposits forming thin and highly heterogeneous accumulations and 2) focused-flow deposits resulting in relatively thick and uniform deposits. The first type is widely recognized and it is considered a poor reservoir, while the second one is an attractive target for exploration but it is poorly studied and might be more common than previously thought (Dvoretsky, 2009). Shallow seismic methods can provide high-resolution imaging of the subsurface at the reservoir scale (sub-meter to tens of meters) and can yield information about stratigraphy (e.g. Figure 2; Sloan et al., 2009), facies distribution and fracture properties (e.g. Figure 3; Lu et al., 2009).

Synthetic seismic sections simulating seismic profiles of the existing geologic models will be used to determine the optimum acquisition parameters of the field seismic data. Expanding on the work of Dvoretsky (2009), high-resolution 2D seismic data will be acquired over dispersed-flow and focused-flow deep-marine carbonate reservoir analogues. Three-component (3C) data will be acquired in order to obtain both compressional and shear wave velocities. P- and S-wave velocities are critical in exploration geophysics for predicting lithologies and for estimating the petrophysical properties of carbonate rocks (e.g. Verwer et al., 2008). Although near-surface conditions are drastically different than deeply buried reservoirs, it is expected that reservoir analogue seismic studies will offer insights about relative changes of seismic properties across varying carbonate lithofacies. Seismic signal attributes, such as the dependence of reflectivity to angle of incidence (AVO) will be tested in the field to assess their utility in hydrocarbon exploration of deep-marine carbonate reservoirs.
The multi-channel field data will be processed following exploration seismic methods in order to obtain migrated seismic sections appropriate for ultra-high resolution (sub-meter) seismic stratigraphy interpretation. Delineated geometries will be compared to geologic models by Dvoretsky (2009) and to corresponding seismic models. Finally, seismic attributes relevant to quantitative interpretation of carbonate facies will be examined.

In many carbonate reservoirs fractures control permeability and therefore their orientation and density is of great importance for oil and gas exploration. Radial, 3C seismic survey will be conducted to assess azimuthal velocity anisotropy of the carbonate reservoir analogues as in Lu et al. (2009) (Figure 3).

**Deliverables**
Seismic imaging of the deep-marine carbonate reservoir analogues will assess characteristic elastic properties (e.g. P- and S-wave velocity, AVO) of focused-flow deposits and dispersed-flow deposits on seismic data that could offer insights to the response of exploration scale seismic data. In addition, high-resolution seismic imaging of the reservoir analogues will improve our understanding of the distribution of carbonate lithofacies and fractures.

**References**


Figure 1: Lithofacies fence diagram: large paleovalley is associated with focused-flow deposits; broad trough is associated with dispersed-flow deposits.

Figure 2: Example of high-resolution (sub-meter) 3D seismic imaging of the subsurface showing the water table reflection (blue color 20 ms, ~5 m depth), a clay layer (purple 34 ms) with an incised sand channel (yellow 30 ms), and a limestone bedrock reflection (green 50 ms, ~15 m depth) (from Sloan et al., 2009).
Figure 3: Common offset seismogram gathers showing azimuthal variation in P-wave arrival time (dashed red line) as a result of velocity anisotropy (19%) caused by fractures in the Lower Cretaceous Upper Glen Rose limestone at Canyon Lake, Central Texas (from Lu et al., 2009).