Synthetic Seismic Modeling of the Mixed Carbonate-Siliciclastic Quintuco Formation, Neuquén Basin, Argentina

Michael Zeller, Gregor P. Eberli and Jose L. Massaferro[1]
[1] *YPF, Buenos Aires, Argentina*

Project Purpose

In this ongoing study, a new model for the mixed carbonate-siliciclastic system of the Neuquén Basin has been proposed. This model is based on outcrop and seismic data (year 1) and a detailed assessment of the heterogeneous reservoir properties in subsurface data (year 2). Reservoir heterogeneities are the result of the complex variations of facies and diagenetic history. These variations can only be observed adequately in outcrops but must be considered when making larger scale seismic interpretations. Seismic images can be calibrated to the observed smaller scale variability of depositional geometries in outcrop by using a key tool: Synthetic seismic models. The goal of the proposed research effort is to develop a predictive model that incorporates the outcrop variability of the Upper Jurassic-Lower Cretaceous mixed system in the Neuquén Basin (Figure 1).

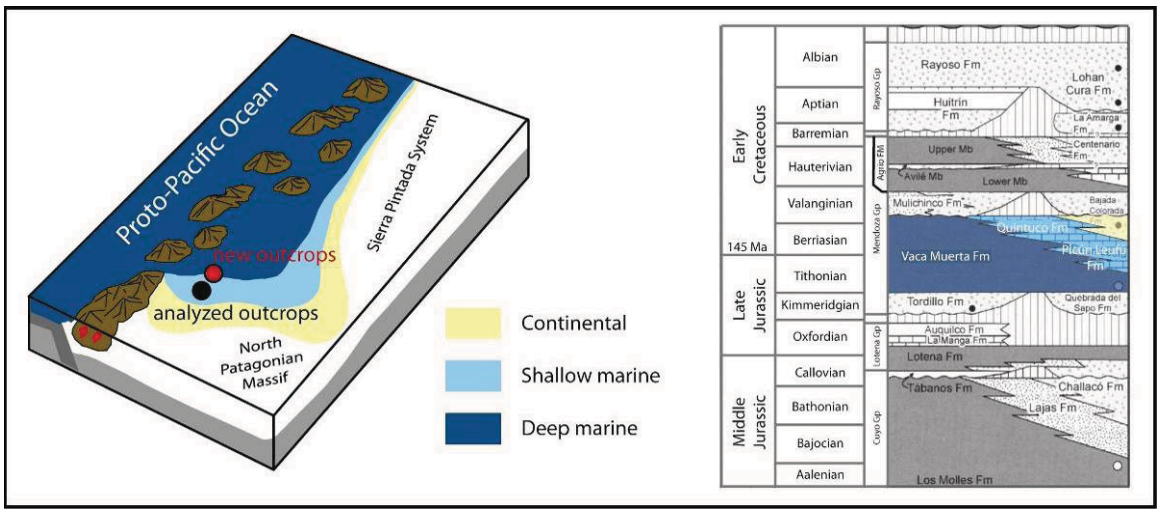

Figure 1: Left: Paleogeographic setting of the Neuquén Basin with locations of analyzed and new outcrop sections. Right: Middle Jurassic to Lo wer Cretaceous Stratigraphy of the Neuquén Basin, studied interval colored (both modified from Howell et al., 2005)

The Mixed System

The prograding to aggrading mixed carbonate-siliciclastic successions of the Quintuco Formation and the time equivalent basinal shales of the Vaca Muerta Formation comprise the studied interval. These two formations form a mixed system that consists of a lower prograding unit composed of siliciclastics with a coarsening upwards trend (Figure 2). The aggrading middle unit can be subdivided into a lower mixed carbonate-siliciclastic interval capped by a clean carbonate interval, which in turn is overlain by an aggrading upper unit in which siltstones and sandstones alternate with minor carbonates.

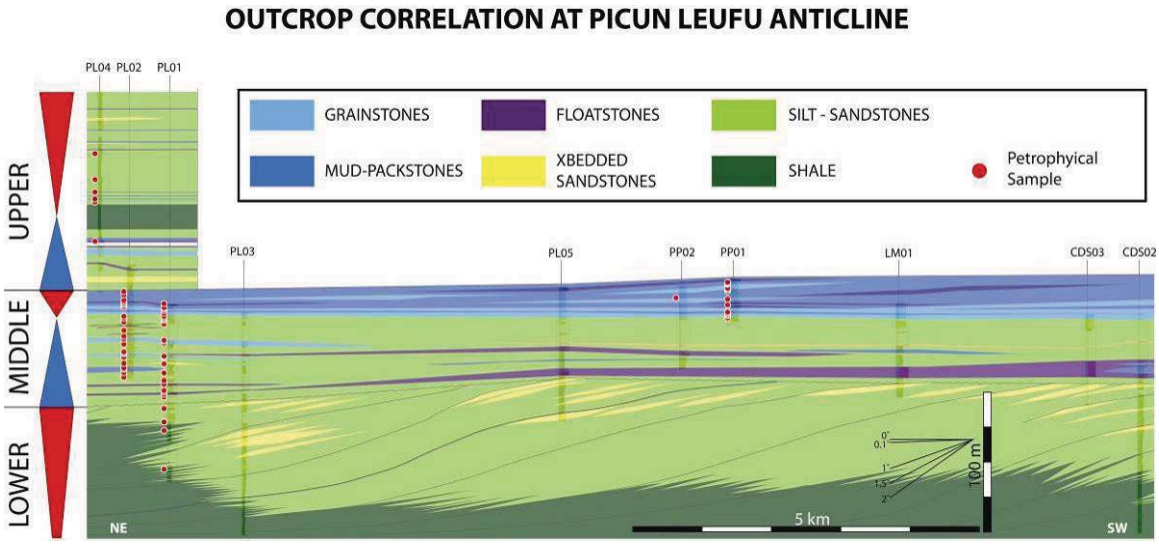

Figure 2: Outcrop correlation based on logged sections along a 15 km long cross section across the prograding-aggrading strata of the Quintuco Formation. The basinal shales are the Vaca Muerta Formation. Red dots display sample locations for the petrophysical analyses.

Scope of Work

In year 1 and 2, we examined the lithologic character and the stratal architecture of the Vaca Muerta – Quintuco Formations in outcrop. In addition, we evaluated several core intervals from a producing field in terms of sedimentological and petrophysical properties. Comparison of the lithofacies character and geometries demonstrated that there are general similarities in the stratal architecture and lithology types of the outcrop and subsurface units. Additionally, initial seismic correlation allowed common unconformities across the basin to be identified.

In year 3, we will analyze the petrophysical properties of 150 outcrop samples and integrate them with the observed outcrop geometries to develop a synthetic seismic model of the Quintuco - Vaca Muerta Formations. This approach has been proven to upscale heterogeneities observed in the outcrop to seismic data (e.g. Janson et al, 2007). The synthetic model will be compared with seismic data from producing fields and, thereby, allow the integration of outcrop-scale variability into the seismic interpretations and reservoir models. In order to assess the lateral evolution and variability of the facies belts, we will also visit, analyze, and sample new outcrop sections, located in a more distal paleogeographic position and in closer vicinity to the producing fields. The goals of this additional fieldwork are 1) to gain more insight into the spatial carbonate-siliciclastic facies distribution along the paleoshelf, and 2) to build a more robust model for an outcrop-subsurface correlation.

Project Tasks

The following tasks will be carried out:

1. Petrophysical analyses that include acoustic velocities, density, and porosity of collected outcrop samples
2. Assessment of the mineralogy, in particular the respective amounts of carbonates and siliciclastics in the various facies
3. Synthetic seismic modeling of the Picún Leufú Anticline using outcrop geometry and facies distribution
4. Comparison to subsurface datasets, in particular seismic sections from the producing fields
5. Extension of the outcrop database to more distal sections to assess longshore facies variability.

Expected Results

In this project we expect:

1. To assess a) the factors controlling the dispersal clastic sediments on the Neuquén shelf and in the basin, and b) the causes for the onset and end of the carbonate deposition. The resulting geological model will help to understand processes generally involved with mixing carbonate and siliciclastics.
2. To assess the seismic record of facies heterogeneity in a mixed shelf system for an improved seismic interpretation of this and similar mixed systems.
3. To predict reservoir facies distribution within the Upper Jurassic - Lower Cretaceous mixed carbonate siliciclastic system in the Neuquén Basin by integrating lithologic and petrophysical parameters that can be effectively correlated within the established sequence stratigraphic framework. This model/workflow will provide guidelines to enhance reservoir predictability in other fields with mixed carbonate-siliciclastic characteristics.

References

Howell, J.D., Schwarz, E., Spalletti, L.A., and Veiga, G.D., 2005. The Neuquén Basin: an overview. Geological Society of London, Special Publication, 252, 1-14.

Janson, X., Eberli, G.P., Bonnaffe, F., Gaumet, F., and De Casanove, V., 2007. Seismic expressions of a Miocene prograding carbonate margin, Mut Basin, Turkey. AAPG Bulletin, 90 (5), pp. 685-713.