ACOUSTIC PROPERTIES OF SHALE-TOC-LIMESTONE MIXTURES IN THE VACA MUERTA FORMATION

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PROJECT OBJECTIVES

- Determine the acoustic and electrical response of both outcrop and sub-surface, samples from the Vaca Muerta Formation, Argentina.
- Systematically determine the samples mineral composition and TOC content in an attempt to assess the acoustic and electrical response of the various mixtures.
- Correlate acoustic properties to carbonate content and TOC to assess: a) the degree of enhanced fracability of carbonate-bearing shales and b) the seismic response of potential sweet spots in shale basins.

PROJECT RATIONALE

Unconventional plays rely, to a large extent, on recognizing sweet spots on seismic data and the success of fracturing the shale intervals. Successful exploitation of such plays requires its reservoir zones to be brittle, porous, and rich in kerogen. These properties are largely dependent on composition of the mudstone, and the TOC content and carbonate content. Modeling results show that an increasing clay and/or kerogen content, or increasing porosity, will decrease the rocks brittleness. In addition, variation of compressional and shear velocity as a function of propagation direction plays in important role during seismic interpretation and inversion. Laboratory measurements of acoustic velocity from mudrocks in both horizontal and

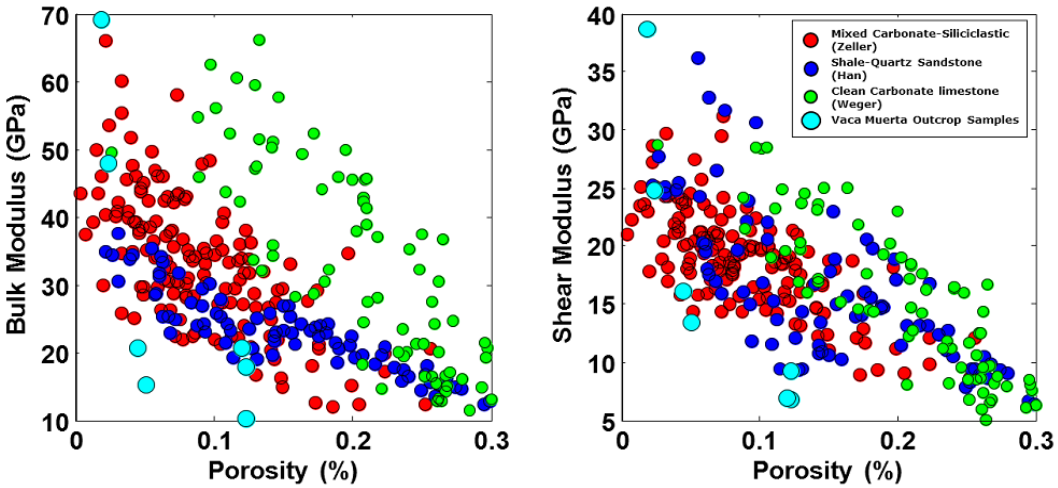

Figure 1. Measured outcrop samples in context of published datasets. All of the Vaca Muerta outcrop samples are extremely slow, even when considering their unconventional mineral compositions.

vertical directions will aid assessing their respective influence on mechanical properties of the rock. In particular, acoustic measurements will allow us to evaluate the usefulness of forward modeling of rock brittleness using unconventional mineral combinations.

SCOPE OF WORK

We plan to measure porosity, permeability, velocity, and resistivity under variable confining pressure of both horizontal and vertical mudrock samples taken from several different outcrop locations and subsurface cores in the Neuquén Basin (Vaca Muerta Fm). The measured physical properties will be correlated to chemical measurements like carbonate content, TOC, and clay proportion. In addition, the composition of the mineralogy of the shale will be determined by XRD.

A new sampling campaign is planned in the Neuquén Basin early this year. In addition, samples from the mixed system in the Dominican Republic (Gurabo Fm) and from the basinal portions of the Bahamas Transect that consist of marl-limestone alterations with variable amounts of TOC will be incorporated into the study.

Completed acoustic measurements of Vaca Muerta outcrop samples display extremely low compressional and shear velocities when compared to other published data (Fig. 1). In addition, Vaca Muerta outcrop samples increasing brittleness is associated with a decrease in porosity and an increase in quartz/carbonate content. Furthermore, previously performed Gassmann fluid substitution analysis suggests that none of the measured samples show abnormal amounts of shear weakening and that homogeneous clay-quartz-lime should behave in compliance with Gassmann's theory. These initial results will also be re-evaluated based on the larger sample set. The new, larger dataset will allow us to analyze anisotropy trends in Vaca Muerta mudrocks based on comparison between horizontal and vertical samples.

EXPECTED RESULTS

The proposed study will add much needed information on the controls of petrophysical properties of mudrocks containing variable amounts of carbonates, clays, and TOC, and their seismic and log response. Together with the expected XRD and TOC measurements, weak anisotropy parameter estimates should enhance the ability to distinguish frackable intervals desirable high TOC intervals on seismically derived velocity/anisotropy estimates.