Semi-Quantitative SEM Analysis of the Vaca Muerta Unconventional Reservoir, Neuquén Basin, Argentina

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Abstract

More than 100 samples from two long cores (>200m) from the organic-rich Vaca Muerta Formation in the central Neuquén Basin, Argentina were studied in thin section and SEM. One core is in the volatile oil window (R_o ~1.0) and the other core is in the dry gas window (R_o ~1.6). All features described were captured semi-quantitatively so they can be plotted with logs and correlated within a high-resolution sequence stratigraphic framework. More than ten different rock types are vertically partitioned within the high-frequency sequences. The most favorable facies are silty organic-rich mudstone, radiolarian and coccolith pellet wackestone and the least favorable facies are dolomite, laminated lime mudstone and volcanic ash beds. About half the total porosity is organic porosity, and the other half is found in leached feldspar, interparticle, moldic and inter-clay pores. Organic pores are present in both cores but are larger and better developed in samples from the same facies in the core from the dry gas window. Organic pores and those lined with bitumen are part of the reservoir because the presence of bitumen indicates that hydrocarbons have migrated into those pores. Pores with no OM lining them may or may not be part of the reservoir and may be water saturated. Kerogen can be discriminated from migrated bitumen by its appearance. Kerogen has associated clay and is typically found in subparallel laminations, while bitumen has no associated clay and commonly has well-developed pores. Bitumen migrated into pores and decreases permeability in the heavy oil window but with increasing thermal maturity organic pores grow larger and more abundant and

eventually make up the main porosity system in the lighter oil and gas windows. Most of the clay is in the volcanic ash beds, but there are some beds where terrigenous clay is common. Most clay present in the higher TOC intervals is in intraclasts ripped up from volcanic ash beds rather than disseminated in the matrix which has less of an impact on reservoir quality. Diagenetic quartz is very common in both cores and is more common in intervals with higher organic content. Diagenetic quartz crystals are significantly larger (up to 10μ) in the core from the dry gas area and these larger crystals occur in seams of bitumen with large organic pores. From a reservoir quality perspective, the ideal landing zones for horizontal wells may be where the seams of coarser diagenetic quartz crystals and bitumen with large pores are most abundant.