MicroCT analysis of mineral phases, total and effective porosity in the Abenaki Formation, Scotian Shelf offshore eastern Canada

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Ongoing research on petroleum reservoirs offshore Nova Scotia includes analyses of carbonate material from the Abenaki Formation utilizing MicroComputed X-ray Tomography (microCT) a non-invasive procedure for imaging the internal structure of opaque objects. This method records spatial variations in the X-ray attenuation coefficient caused by mineralogical and porosity variations in a rock. The large differences between the attenuation of X-rays by solids, relative to that of air (i.e. pore space), ultimately permits the imaging and quantification of interparticle-, intraparticle- and fracture-porosity in a sample.

To date 22 core fragments from 6 wells, namely Panuke H-08, Panuke IA/1, Demascota G-32, Acadia K-62, Margaree F-70 and Albatross B-13, have been sampled in the form of small plugs approximately 11 mm in diameter. A variety of carbonate textures have been sampled in order to identify limitations and error ranges under differing analytical conditions using a Skyscan 1072 MicroCT scanner, with spatial resolution of approximately 10 µm. Textures include intercrystalline limestone with pinpoint vugs, stylolites, inclusions and fractures (H-08), intercrystalline limestone to dolomitic limestone with vugs (Panuke IA/1), intercrystalline limestone to dolomitic limestone having pinpoint vugs (G-32), intercrystalline dolomitic limestone with vugs in association with horizontal fracturing, oolites, pisolites and sporadic stylolites (K-62), intercrystalline limestone to dolomitic limestone with vugs, with sporadic fractures and stylolites (F-70) and pelloidal, oolitic lime grainstone, with intercrystalline pore cement (B-13). With reference to effective porosity, preliminary analysis of sample plug 12 from Panuke H-08 with bulk porosity of ~8% shows an average of 4.44% effective porosity. This means that approximately 50% of the total pore space (for this sample) that are sufficiently interconnected to provide conduits for fluid movement.

Carbonate samples tend to have a limited number of mineral phases present. This leads to the additional possibility of quantifying each phase by recognition of discrete grey-scale values. Preliminary microCT scans of a hydrothermal dolomite were undertaken at relatively low X-ray energy (< 100 keV). At such energies the photoelectric effect is primarily responsible for attenuation and the attenuation coefficient is a function of the effective atomic number (Z_{eff}), with attenuation increasing

Atlantic Geology, 2008, Volume 44, Number 1

with Z_{eff}. Consequently, as well as total and effective porosity, carbonate mineral grains that are sufficiently large to be resolved by the instrument, and display contrasting Z_{eff} can be distinguished. In this case, the contrast in Z_{eff} between calcite (15.88) and dolomite (13.94) is sufficient to distinguish between the two minerals, though the presence of iron in ferroan dolomite decreases the Z_{eff} contrast.