Petrographic Study of 50 Potential Tight Gas Reservoir Samples, Tertiary, Cook Inlet, Alaska

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Fifty conventional core samples from Tertiary reservoir rocks have been examined in thin section as part of a larger effort to characterize the potential for gas production from low-permeability Cook Inlet sandstones.

The sandstones and pebbly sandstones have undergone variable burial histories and exhibit a wide range of texture and composition. Sand composition is dominated by quartz with common feldspars, volcanic rock fragments, low-grade metasedimentary fragments, and mica flakes. The provenance is interpreted as dissected volcanic arc (Alaska Range) and accretionary wedge (Chugach terrane) settings. Mechanical compaction dominates the diagenetic evolution of these sandstones, and the relatively lithic-rich and micaceous framework grains deform plastically during burial. The median intergranular volume is 14%, with a 25% median ductile grain content.

Authigenic phases are minor, consisting of patchy pore-filling calcite or kaolinite. Volcanogenic sandstones include secondary smectite, corrensite, and clinoptilolite. Preliminary burial history reconstructions indicate authigenic phases formed at about 8,000 feet. During ongoing burial, pores evolve from intergranular macropore-dominated (pore diameters ~100 microns and pore apertures ~10 microns) to less well-connected mesopore-dominated (<20 microns across with micron-scale apertures) and microporosity. Both intergranular microporosity and intragranular microporosity are significant proportions of the total porosity in more deeply buried sandstones.

The combination of strongly compacted grain frameworks, small intergranular pores, and common microporosity yield poor capillary properties. A typical fine- to medium-grained sandstone with a maximum burial depth of 9,000 feet would have an average porosity of about 13%, an absolute permeability of just under 3 md, and an irreducible water saturation of over 30% (at 400 feet above the free water level). Very fine-grained sandstones are compacted to sub-millidarcy permeabilities after less than 3,000 feet of burial, whereas coarser -grained sandstones do not fall below 1 md until they approach depths of 12,000 feet. The average loss of intergranular volume with depth is about 3.6 percent per 1,000 feet. The primary controls on reservoir quality are maximum burial depth, grain size, and ductile grain content.