The Making of a High-Porosity, High-Permeability Reservoir - The Murrysville Sandstone of Pennsylvania

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Reservoir characteristics of the Upper Devonian Murrysville Sandstone in southwestern Pennsylvania are outstanding: porosity exceeds 20% and permeability approaches 1000 md. The purposes of our study are to document the petrographic features of this sandstone—interpreted as a high-energy braid delta—and to explain the origin of its very good porosity and permeability. The porosity is so very good for a number of reasons. (1) Delta-plain sands were moderately sorted and well washed. Original porosity was thus high. (2) Currents also destroyed many mechanically unstable lithic grains, and the resulting sediment became quartz-rich. Consequently, during shallow burial the sandstone suffered just a moderate degree of compaction and porosity loss. (3) The mixing of river water and sea water in the deltaic environment allowed iron mineralization to take place during deposition and early diagenesis, creating thin chlorite coatings on the detrital grains. Access of fresh water to the Murrysville, however, soon ended because of an ensuing transgression. Nevertheless, chlorite coatings proved effective in preserving much of the remaining porosity in that they inhibited the precipitation of destructive quartz overgrowths. (4) Leaching of chemically unstable lithic grains and feldspars in the deep subsurface generated additional porosity. (5) Porosity reduction by late-stage calcite cement was volumetrically unimportant because of the limited amount of carbonate imported from outside the formation. Permeability in the Murrysville Sandstone is so very good because of the rocks' very good porosity, coarse grain size, and the low clay content, both detrital matrix and authigenic chlorite.