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TWO-PHASE POROSITY-PRESERVING CHLORITE CEMENTS IN SHALLOW-MARINE VOLCANICLASTIC SANDSTONES: EVIDENCE FROM CRETACEOUS SANDSTONES OF THE SAWAN GAS FIELD, PAKISTAN

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Sandstones with high porosity and permeability at great burial depth and high temperatures are of economic importance, as a significant amount of hydrocarbons have been discovered in such reservoirs. The Sawan gas field, with an expected ultimate recovery of more than 1 Tcf lies in the Middle Indus basin. The reservoir rocks, Cretaceous volcaniclastic sandstones of the lower Goru Formation, show very high porosities at a reservoir temperature of 175° C and depths of 3000 to 3500 m. The sandstones are mostly feldspathic litharenites. Strongly altered volcanic rock fragments are the most important lithic component. The clay fraction consists of Fe-rich chlorite (chamosite) and illite.

Diagenetic features such as compaction, quartz overgrowths, carbonate cements and feldspar dissolution are observed. The most distinguishing feature is a double layer of authigenic chlorite, lining the pores of the sandstones. Chlorite additionally occurs as pore-filling cement and as chloritized detrital components, all having similar chemical composition. The pore-lining cement clearly developed in two stages; an earlier, poorly crystallized and a later better crystallized growth. Missing rims at grain contacts show that precipitation occurred after an initial stage of compaction but early relative to other diagenetic phases. Both chlorite rims grew by direct precipitation from pore waters, using products derived from volcanic rock fragments. In areas with no, thin, or discontinuous chlorite rims, quartz cementation is common. Well-developed chlorite rims inhibited quartz cementation, preserved porosities of up to 20% and good permeabilities. Porosity-preserving chlorite cementation in Sawan is restricted to sediments of a shallow-marine environment. While reported examples from shallow marine environment have formed through clay mineral precursor phases, the chlorites in the volcaniclastic sandstones of the lower Goru Formation can be traced back to the dissolution of detrital grains.