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Porosity-preserving chlorite cementation in volcanoclastic sandstones, Sawan (Pakistan)

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The Sawan gas field, which is situated 500 km northeast of Karachi in the Middle Indus Basin, was discovered in 1998 by the OMV AG. The gas reservoir rocks are Cretaceous sandstones (Albian-Cenomanian) of the Lower Goru Formation. These volcanoclastic sandstones show anomalously high porosities (20 %) at depths of 3000 to 4000 m. A detailed investigation of the diagenetic evolution of the sandstones has been undertaken to establish the cause of the porosity.

23 core samples, from three different drillings and originating from depths of 3258.6 - 3447.85 m of the Sawan gas field have been analyzed. The methods used include thin-section microscopy, X-ray diffraction analysis, electron microprobe analysis, cathodoluminescence microscopy and scanning electron microscopy (SEM).

The sandstones are subarkoses to arkoses and sublitharenites to litharenites. The main mineralogical components are quartz (mono- and polycrystalline grains and quartz cements), strongly altered volcanic rock fragments, feldspar (more K-feldspar than plagioclase), chlorite cements and carbonates (mainly calcite and dolomite cements). Of secondary importance are muscovite, strongly altered biotite, glauconite and chert. The clay fraction in the sandstones (< 2 μm) consists of Fe-rich chlorite (chamosite) and illite. Diagenetic features such as compaction, quartz overgrowth cements, carbonate- and chlorite cements and dissolution of feldspars have been observed.

Authigenic chlorite is present in three areas; pore lining cement, pore filling cement and chloritized components. Electron microprobe analyses show these all haves similar chemical compositions.

The pore lining chlorite cement is unusual in that it consists of a 5-10 μm thick rim

covering all detrital grains. Two generations of authigenic chlorite rims have been identified in the SEM; an older, poorly crystallized one and a younger better crystallized one. The latter comprises euhedral, pseudohexagonal crystals, oriented with their faces perpendicular to the host detrital grain surface.

The timing of the chlorite rim precipitation relative to all other diagenetic phases was early, but after an initial phase of compaction. In areas with thin or discontinuous chlorite rims, quartz cementation is common. Well developed chlorite grain coatings seem to have inhibited quartz cementation and hence acted as porosity preserving material. Pore lining chlorite did not inhibit carbonate cementation.

The alteration and dissolution of the volcanic rock fragments seem to have been the source for the Fe, Mg, Si and Al ions for chlorite authigenesis.