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Clay mineral diagenesis in interbedded sandstones and shales (Aderklaa-78, Vienna Basin): Comparisons and correlations

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Investigations of burial diagenesis, involving separate studies of either sandstone or mudstone sequences have been the subject of many publications in recent years. In addition to dissolution and/or cementation processes, involving silica and carbonates, much attention has been given to clay mineral alteration, transformation and precipitation.

The aim of this study was to compare clay mineral diagenesis in interbedded sandstones and shales and to examine to what extent the diagenetic processes in the sandstones and shales are linked.

The drilling Aderklaa-78 in the Vienna Basin involved continuous coring and is, therefore, especially useful for carrying out burial diagenetic investigations on both sandstones and shales. Aderklaa-78 was drilled in 1958 by the OMV AG, in the course of which oil deposits were discovered in the Upper Lagenid Zone (Badenian). The Vienna Basin is located in the NE part of Austria, it represents a pull-apart basin along the junction of the Eastern Alps and the Western Carpathians. The evolution of the basin started during the early Miocene with a subsidence along NE trending sinistral faults.

For the present study 35 Miocene sandstone cores and 15 intercalated shale cores from depths of 780-2802 m were compared. The methods used to investigate sandstone and shale diagenesis are X-ray diffraction analysis, thin section microscopy, cathodoluminescence microscopy and scanning electron microscopy.

The average framework composition of the sandstones is 60 % quartz, 22 % feldspar

and 18 % rock fragments. The feldspars in these sandstones are mostly alkali feldspars, which are more or less altered. The replacement of feldspars by kaolinite is most common. The rock fragments are mainly sedimentary, they consist of calcite and dolomite particles; metamorphic rock fragments and chert fragments are of secondary importance. The authigenic clay minerals in the pores of the sandstones consist of mixed layer illite/smectite, illite, kaolinite and chlorite. The illitization of smectite proceeds with depth, I/S minerals from a depth of 892 m (25 % illite in I/S) are randomly interstratified (R=0), regular interstratification (R1 ordering) of I/S occurs already at a depth of 2150 m. Illitization increases to about 80 % illite layers in I/S in this profile. The primary porosity of the sandstones is additionally diminished by quartz overgrowth cements and calcite cement. Secondary porosity results from dissolution of feldspar and carbonate particles.

Extensive studies of the intercalated shales have been carried out previously. The essential components of the shales are similar to the sandstones: quartz, feldspars, carbonates and the phyllosilicates illite, chlorite, kaolinite and illite/smectite mixed layers. The fine clay fraction of the shales is dominated by mixed layer illite/smectite, here the main clay mineral transformation with depth, the change from smectite to illite involving mixed layer I/S intermediates, is observed. The percent illite layers in the I/S mixed layer increase, like in the sandstones, from around 25 % at 780 m to 80 % at 2800 m.

In relation to depth, the illitization of the I/S mixed layer mineral is proceeding faster in the sandstones than in the shales. The explanation for this is probably the higher porosity and permeability of the sandstones which allows better pore-fluid migration.