

Illite/smectite diagenesis in Kraków–Zakopane cross-section, Outer Carpathians and Podhale flysch (Poland): preliminary results

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The illitization of smectite is a diagenetic reaction going continuously from smectite to illite through intermediate stages of mixed-layer illite/smectite (I/S), until the temperature of epizone is reached. The reaction seems to be irreversible, independent on time and sensitive to the bulk rock chemical composition and the maximum paleotemperature.

The proportion of illite to smectite and ordering in I/S from shales is applied in this study as paleothermometer.

The <0.2 μ m fractions of shales from four boreholes situated along Kraków–Zakopane cross-section were investigated by XRD method.

In two boreholes from the Outer Carpathians: Trzebunia IG1 and Tokarnia IG1 (the northern part of the Magura nappe), the diagenetic profiles of I/S are similar. Only ordered I/S is present and the percentage of smectite (%S) varies

irregularly in 30–10%S range, down to about 2900–3000 m. In the underlying Miocene strata, randomly interstratified I/S (40–50%S) is observed. In the borehole Nowy Targ IG1 (the southern part of the Magura nappe), randomly interstratified I/S varies irregularly from 72%S to 40%S, down to about 1000 m. Between 1000 m and 2500 m %S in I/S regularly decreases from 73%S to 22%S and ordering appears at about 1800 m. The illitization of the Podhale flysch in the borehole Skocznia IG1 is advanced, only ordered I/S is present, and %S decreases gradually from 26%S to 12%S over 500 m from the top of the borehole.

It appears that the diagenetic model of smectite illitization in Kraków–Nowy Targ cross-section is more complicated than the diagenetic history known from a more eastern cross-section (Skole nappe, Paszowa1–Kuźmina1–Cisowa1). Ordering appears at shallower depths and the illitization profile in flysch seems to have been established before the thrusting of flysch over the Miocene strata.

The transition from randomly interstratified to ordered I/S (at $\approx 40\%S$) proceeds at about 120°C. Thus the present temperatures in boreholes studied cannot be responsible for the observed advanced illitization. Most probably, the detected high degree of illitization is the result of normal burial diagenesis, followed by removal of the upper parts of profiles by the erosion. Assuming the present average geothermal gradients for the Outer Carpathians (2.35K/100 m) and Podhale flysch (Zakopane IG 1 — 2.00K/100 m) as representative of the gradients during maximum burial, it can be estimated that the following thicknesses of sediments have been removed sometimes during the geological history from above the present erosional surface: Trzebunia IG 1 ≈ 5.6 km, Tokarnia IG 1 ≈ 5.6 km, Nowy Targ IG 1 $\approx 3,3$ km, Skocznia IG 1 $\approx 6,5$ km. These estimates could be lower only if higher paleogradients were assumed.