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ZEOLITE AND CLAY MINERALS AT THE CONTACT OF CRETACEOUS MARLS WITH TERTIARY BASANITE (GRACZE QUARRY, OPOLE, SILESIA, POLAND)

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The contact metamorphism of Cretaceous marls (lower Senonian-Coniacian) (Alexandrowicz and Birkenmajer, 1973) and hydrothermal alteration of tuff in neighbourhood of Tertiary basanites from the Gracze quarry were studied.

Samples collected in the Gracze quarry represent marls and tuff conected with the first stage of volcanic eruptions. According to Kapuściński and Probierz (1999), tuff is composed of pyroxene (augite and diopside), olivine, magnetite, nepheline, clay minerals (illite, montmorillonite) and zeolites (chabasite series). Calcite, serpentine and zeolites replace primary olivine.

Recently the progress of exploitation allowed to collect samples under the basanite. Scanning electron microscope with energy dispersive spectrometry, X-ray diffractometry and optical microscopy were used for the investigations.

The studied tuff is composed of pyroxene (augite-diopside), nepheline, Fe-, Ti-oxide minerals, calcite, serpentine and smectite. Zeolites represent two groups: natrolite type (NAT according to International Zeolite Association classification; Baerlocher et al., 2001) and phillipsite type zeolites (PHI according to this classification). Chemical composition of zeolite minerals is strongly variable, especially in the contents of Fe, K and Mg. Natrolite is present in tuff close to the basanite–marls contact and phillipsite dominates in tuff situated between lava flows. Natrolite occurs in marls close to the cotact; phillipsite is present in samples collected from the lower part of the profile (marls and sandstones beneath marls; Fig. 1). Phillipsite is also present in one sample of marl collected in strongly tectonised zone.

Zeolite minerals occur in spherical forms, grown in the tuff and in lower amount in marls. Spherical forms are also present in cracks in marls. Morphology of zeolite crystals is variable: euhedral prismatic crystals (in tuff and marls) often are overgrown by fibrous branchy zeolite (only in tuff). Almost pure smectite was identified in all tuff samples. In marls I/S mixed layer minerals are present together with mica.

It seems that crystallisation of natrolite and phillipsite was not related separately to temperature or chemical composition of solution, but resulted form overlapping of both of these factors. Probably also other factors were important (e.g. solution–rock ratio controlled by rock permeability). Temperatures determined experimentally (Wirsching, 1979; Wirsching, 1981) for growth of Na zeolites (natrolite) were described by as lower than cca. 150°C (at pH $\approx$ 12.5 and surplus of Na$^+$).

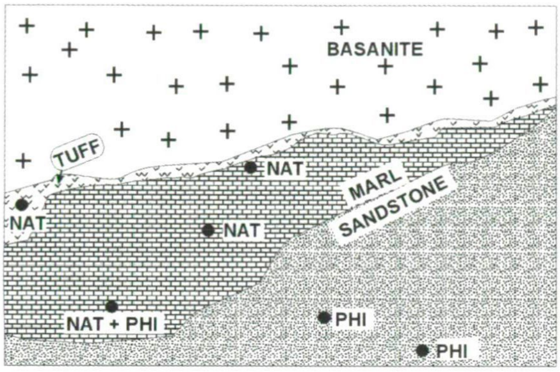

Fig. 1: Sketch of localisation of different zeolite phases (NAT: natrolite, PHI: phillipsite)

Phillipsite crystallises at higher temperature range from 150–250°C (at pH 12–13; Kawano and Tomita, 1997). For growth of phillipsite phase in those temperatures fluids with surplus of K$^+$ ions are necessary (Wirsching, 1979).

Crystallisation of secondary minerals was related to hydrothermal fluids activity. The sequence: euhedral zeolite → fibrous branchy zeolite → smectite was related to the decreasing temperature. Ions necessary to growth of these minerals were supplied from decomposition of primary minerals in tuff and basanite.

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