POLSKIE TOWARZYSTWO MINERALOGICZNE – PRACE SPECJALNE
MINERALOGICAL SOCIETY OF POLAND – SPECIAL PAPERS
Zeszyt 26, 2005; Volume 26, 2005

Joanna KOSTYLEW[1]

MÉLANGE AND METAMUDSTONES FROM STANISŁAWÓW (KACZAWA COMPLEX, SUDETES): SELECTED PETROLOGICAL ASPECTS

Abstract: Mélange and metamudstones from Stanisławów (Chełmiec Unit, Kaczawa Complex) show considerable textural and mineralogical similarities. Mineralogical features, such as the presence of albite, illite – illite/muscovite and Fe-Mg chlorite (often forming chlorite-mica stacks), Ca-Mg-Fe and Fe-Mg-Mn carbonates and authigenic monazite confirm earlier suggestions that all these deposits were metamorphosed under very low- to low-grade metamorphic conditions. The chemistry of the carbonates is similar to that of authigenic carbonates from recent accretionary prisms. Detrital apatite may be a potential source of phosphorus for the authigenic phosphates.

Keywords: K-mica, chlorite, chlorite-mica stacks, carbonate, apatite, very low-grade metamorphism, mélange, metamudstone, Kaczawa Complex, Sudetes.

INTRODUCTION

In the area of the barite deposit at Stanisławów (Chełmiec Unit, N part of the Kaczawa Mountains, W Sudetes) deep boreholes were drilled in 1986-1989 (Fig. 1; see also Baranowski *et al.* 1998). A few cores of these boreholes, stored at the Institute of Geological Sciences of Wrocław University, represent large sections of the profile down to over 900 m depth (e.g. core 35/S). The upper part of the profile comprises mélange (Devonian - Early Carboniferous) whereas the lower part consists mainly of various fine grained metasediments. Baranowski *et al.* (1998) subdivided these rocks into three informal lithostratigraphic units: 1) *mélange association* (*zm*), 2) *association of metamudstones and diabases* (*zmmd*), and 3) *association of metavolcaniclastic rocks* (*zmwk,* Fig. 1). All these rocks have been subjected to very low- to low-grade metamorphism.

Two cores (35/S and 38/S) were chosen for detailed investigations (Fig. 1). Based on sedimentological logging, three main facies were distinguished in the *zm*, while the *zmmd* rocks show considerable textural and petrographical similarities to mélange-type deposits (Kostylew *et al.* 2003). The present research is focused on selected petrological and mineralogical aspects of these two associations (*zmmd* and *zm)* and aims at better understanding of the origin and evolution of the Kaczawa Complex.

METHODS

Laboratory work comprised standard petrological microscopy, cathodoluminescence (“cold” cathode), X-ray diffraction (XRD), BSE imaging and electron microprobe analyses (EDS and WDS). The investigations were performed at the Institute of Geological Sciences, Wrocław University (Cambridge MK-9 microprobe, Citl CCL 8200 „cold” cathode, Siemens D5005 X-ray diffractometer), Institute of Geological Sciences –

[1]*Institute of Geological Sciences, University of Wrocław, ul. Cybulskiego 30, 50-205 Wrocław, Poland, e-mail: joko@ing.uni.wroc.pl*

Petrology, University of Vienna (Phillips X-ray diffractometer, CAMECA SX 100 microprobe) and Institute of Geography, Geology and Mineralogy, Salzburg University (JEOL Superprobe JXA 8600).

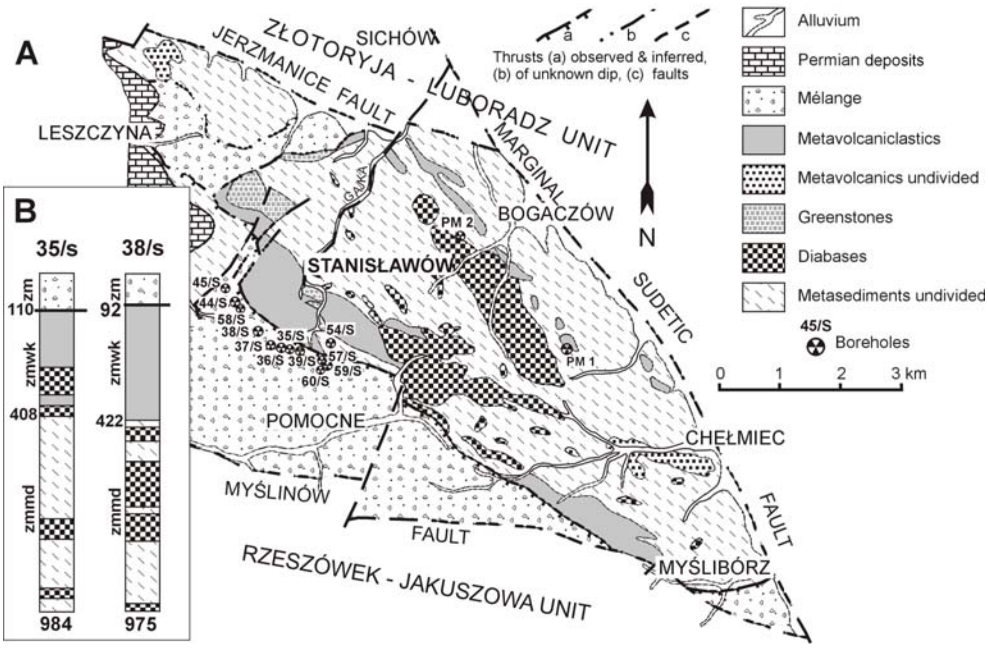

Fig. 1. A – Geological sketch of the Chełmiec Unit (Kaczawa Complex, W Sudetes; Baranowski *et al.* 1998). B – Logs of drill cores selected for detailed investigations: *zm - mélange association*, *zmwk - association of metavolcaniclastic rocks*, *zmmd - association of metamudstones and diabases* (after Baranowski *et al.* 1998).

RESULTS AND CONCLUSIONS

The investigations were performed on samples obtained from different depths of the 35/S and 38/S borehole cores. The samples represent fine-grained metasediments (metamudstones) interlayered with beds from several to tens of centimetres thick, composed of medium- to coarse-grained metasandstones. The fine-grained metamudstones are built of K-mica (illite – illite/muscovite), Fe-Mg chlorite, very small grains of quartz, kaolinite, apatite, titanite and framboidal grains of pyrite. The metasandstones consist of quartz, feldspar (95-100 % albite), white mica, chlorite, carbonates (irregular patches or rhombohedral grains), cubic pyrite, apatite and titanite. The distribution and arrangement of mica and chlorite in the metasediments emphasise the cleavage planes. In many samples of metamudstones considerable quantities of submicroscopic (< 10 μm) grains of monazite are present (Kryza *et al.* 2004). Some samples contain substantial amounts of organic matter.

Microprobe analyses (WDS) of white micas allow their classification as a K-rich variety (rarely K-Na micas; Fig. 2). Their chemical composition, small crystal sizes and X-ray patterns are typical of illite or illite/muscovite. Preliminary results of illite crystallinity (Kübler index) measurements (Kryza *et al.* 2001) reveal that the metamorphic conditions correspond to anchizone (samples 25.9 m and 900.4 m) and epizone (sample 478.8 m).

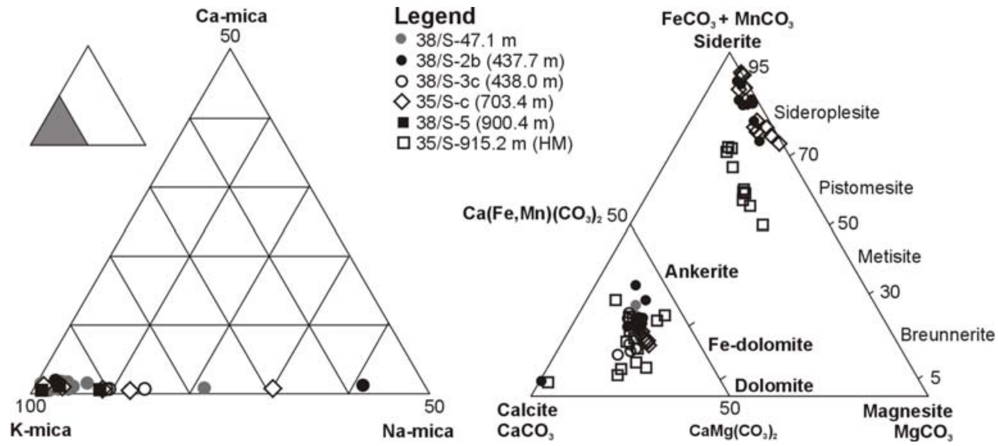

Fig. 2. Chemical composition of white micas (left triangle) and carbonates (right triangle; the graph after Kozłowska 2004); HM – heavy mineral concentrate.

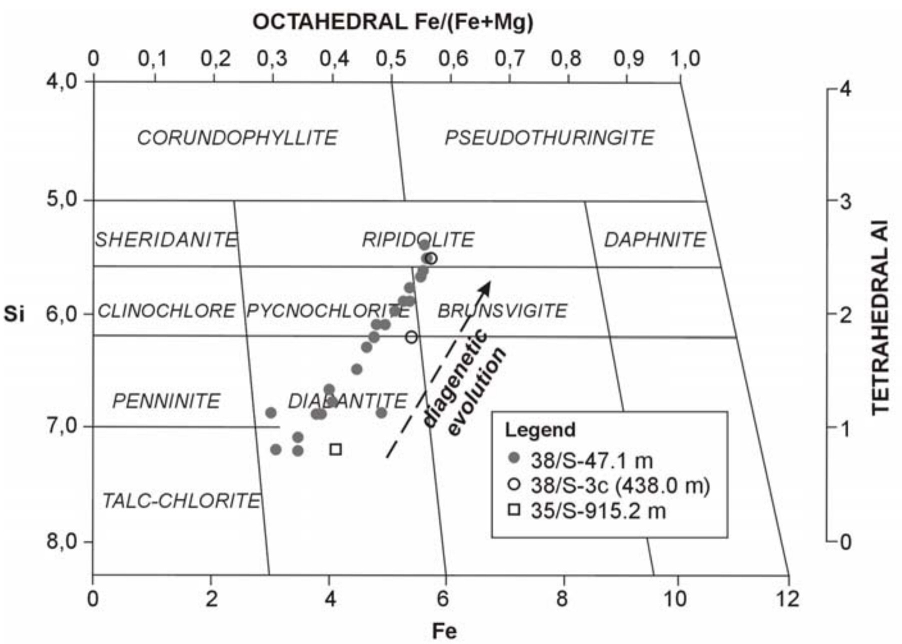

Fig. 3. Variation in chemical composition of chlorites in terms of structural formulae. Arrow shows diagenetic evolution trend (diagram after Hey 1954, fide Milodowski, Zalasiewicz 1991).

In a previous report (Kostylew *et al.* 2003) Fe-Mg layer silicates were described tentatively as altered biotite. New optical microscope, XRD and microprobe data suggest the term chlorite as more appropriate. Chemical compositions of the chlorites investigated show a conspicuous trend on Hey's graph (Fig. 3) running across the diabantite, pycnochlorite/brunsvigite and ripidolite fields. A similar pattern has been interpreted by Milodowski, Zalasiewicz (1991) in terms of increasing diagenetic grade. In some samples, chlorite forms up to 100 µm-large intergrowths with illite: these are chlorite-mica stacks.

Such intergrowths are characteristic of certain mudrocks that have been exposed to very low- and low grade metamorphism: Milodowski, Zalasiewicz (1991) give an extensive review of ideas on the origin of chlorite-mica stacks. In the samles investigated here, the chlorite-mica stacks have a pre-tectonic, early- to late-diagenetic nature and have been derived most probably from weathered (vermiculized) detrital biotite (Dimberline 1986, fide Milodowski, Zalasiewicz 1991).

New microprobe analyses and cathodoluminescence observations confirm earlier suggestions (Kostylew *et al.* 2003, Kostylew 2004) that the carbonates studied represent two major groups: 1) Fe-Mg-Mn carbonates, 2) Ca-Mg-Fe carbonates (Fig. 2). Their chemical composition shows some similarity to carbonates from recent accretionary prisms (Kostylew *et al.* 2003 and refs. therein) which is in accordance with the contemporary interpretation of the Kaczawa Complex as a part of the Variscan accretionary prism (Baranowski *et al.* 1998, Collins *et al.* 2000).

Cathodoluminescence microscopy reveals a complex structure of the apatite grains with a detrial core shining in bright yellow colours and an irregular rim with darker shades. Domains with concentrations of intergranular phosphates are observed in many samples of the metamudstones, often displaying oval or lenticular shapes. Reaction rims around detrital apatite and, probably, secondary concentrations of phosphatic matter suggest remobilisation processes with apatite as a potential source of phosphorus for authigenic phosphates (e.g. monazite), recently described from the rocks investigated (Kryza *et al.* 2004).

The research was financed by KBN grant no. 4777/PB/ING/03 and supported from the CEEPUS A-0105 Network.

REFERENCES

BARANOWSKI Z., HAYDUKIEWICZ A., KRYZA R., LORENC S., MUSZYŃSKI A., URBANEK Z. 1998: Litologia i geneza zmetamorfizowanych skał osadowych i wulkanicznych jednostki Chełmca (Góry Kaczawskie). *Geol. Sudet.*, 31: 33-59.

COLLINS A. S., KRYZA R., ZALASIEWICZ J. 2000: Macrofabric fingerprints of Late Devonian-Early Carboniferous subduction in the Polish Variscides, the Kaczawa complex, Sudetes. *J. Geol. Soc. London*, 157: 283-288.

KOSTYLEW J. 2004: Carbonates in mélanges from Rzeszówek and Stanisławów (Kaczawa complex, Sudetes): chemical, XRD and CL investigations. *Pol. Tow. Mineral. Prace Spec.*, 24: 227-230.

KOSTYLEW J., KRYZA R., ZALASIEWICZ J. 2003.: Mélange at Stanisławów and Rzeszówek in the Kaczawa Mts (Sudetes, SW Poland): preliminary results of new sedimentological and petrographic investigations. *Pol. Tow. Mineral. Prace Spec.*, 23: 90-92.

KOZŁOWSKA A. 2004: Diageneza piaskowców karbonu górnego występujących na pograniczu rowu lubelskiego i bloku warszawskiego. *Biul. PIG*, 411.

KRYZA R., ZALASIEWICZ J.A, CHARNLEY N., MILODOWSKI A.E., KOSTYLEW J., TYSZKA R. 2004: In situ growth of monazite in anchizonal to epizonal mudrocks: first record from the Variscan accretionary prism of the Kaczawa Mountains, West Sudetes, SW Poland. *Geol. Sudet.*, 36: 39-51.

KRYZA R., ZALASIEWICZ J., MERRIMAN R.J., COLLINS A.S., KEMP S.J. 2001: Mudrocks fabrics and mineralogy – clues to evolving conditions within the Variscan accretionary prism; Kaczawa Mountains, SW Poland. *ESF EUROPROBE Meeting*, Ankara 30.09-2.10.2001, Abstracts, p. 36.

MILODOWSKI A.E., ZALASIEWICZ J.A. 1991: The origin and sedimentary, diagenetic and metamorphic evolution of chlorite-mica stacks in Llandovery sediments of central Wales, U.K. *Geol. Mag.*, 128 (3): 263-278.