Sequence of deformation phases recorded in the low-grade metamorphic rocks of western Mt. Papuk (Croatia)

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Low-grade metamorphic rocks outcropping at the southwestern flanks of Mt. Papuk in Ravna Gora area belong to a Variscan crystalline complex called "Progressively Metamorphosed Complex" (Pamić & Lanphere, 1991). The studied samples are extremely interesting rocks due to complex microstructural relations, various types of developed foliations, pervasive folding, crenulation and cleavage. These rocks grade toward low- to medium-grade schists exposed in laterally more distant area toward the northwest where biotite, garnet and staurolite zones outcrop, grading eventually to migmatites.

In general, all samples show consistent mineral composition comprising chlorite, muscovite, quartz, feldspar, opaque minerals (± calcite) but with various microstructural features.

The complexity of relations between foliations is apparent in the samples from the outermost zone comprising three foliations (Fig. 1.).

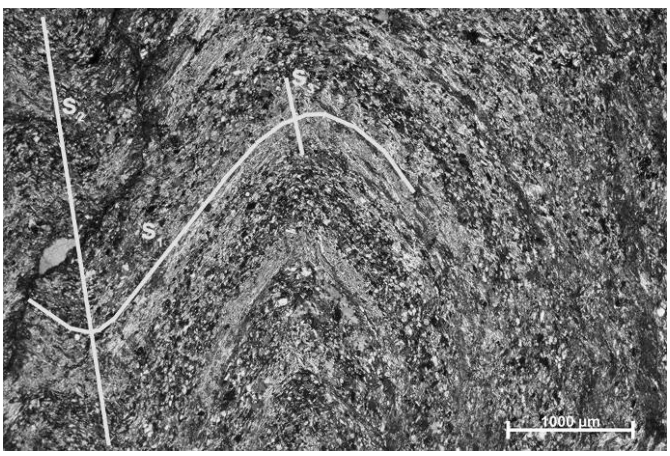

Fig. 1.: Primary foliation with distinctive muscovite-rich and quartz-rich domains containing developed secondary foliations, PPL, N+.

Thin sections are characterized by spaced foliation and two mineralogically distinct domains: muscovite-chlorite and quartz-feldspar-calcite. At the hinge points of highly folded muscovite-chlorite domains micro-folding is visible (Fig. 2.). Opaque minerals occur in both domains, but are slightly more concentrated within muscovite-chlorite domain. Calcite veins generally follow the main foliation and aggregates are also present, defined by larger polygonal crystals. Also, sample contains organic matter which occurs as thin layers parallel and oblique to the main foliation.

Further to the northwest samples display disjunctive foliation defined by chlorite-muscovite (cleavage domains) and quartz-feldspar-muscovite layers (microlithons). In the cleavage domains elongated fibrous (although somewhere clustered) chlorite occurs accompanied by fine-grained muscovite and thin calcite veins. Quartz grains dominate in microlithons showing a grain shape preferred orientation oblique to the foliation, but also minor amounts of feldspar, fine-grained muscovite and chlorite are present. Larger grains of dynamically recrystallised quartz with lack of preferred orientation form several aggregates throughout the thin sections and those are usually surrounded by elongated fibrous chlorite. Opaque minerals are mostly associated with muscovite.

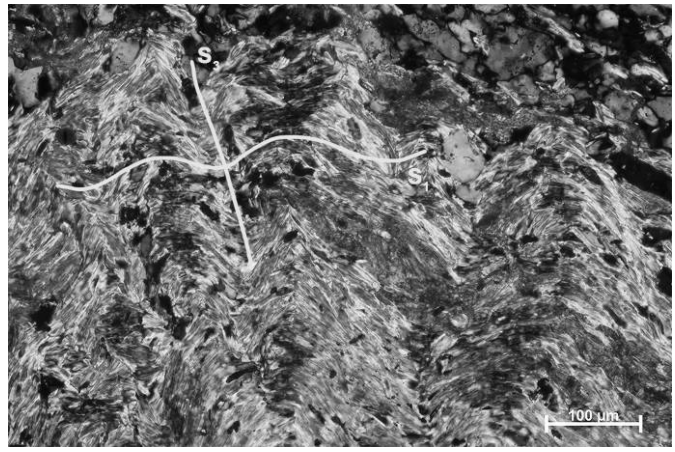

Fig. 2.: Well-formed micro-folding of muscovite-rich domain, PPL, N+.

The northernmost samples i.e. toward the higher grade zones in the field, display spaced foliation by which three main domains can be distinguished: muscovite-chlorite, quartz-feldspar-muscovite-chlorite and quartz-rich domains. Opaque minerals are evenly distributed through the thin sections, but slightly higher concentrations in muscovite-chlorite domains are noticeable. Muscovite-chlorite domains are characterized by distinctive crenulation cleavage and several larger sin- to post-kinematic chlorite crystals (Fig. 3.). Minerals in quartz-feldspar-muscovite-chlorite domains occur as equant fine-grained. The last domain is defined by dynamically recrystallised quartz aggregates and veins accompanied by clusters of large, fibrous chlorite.

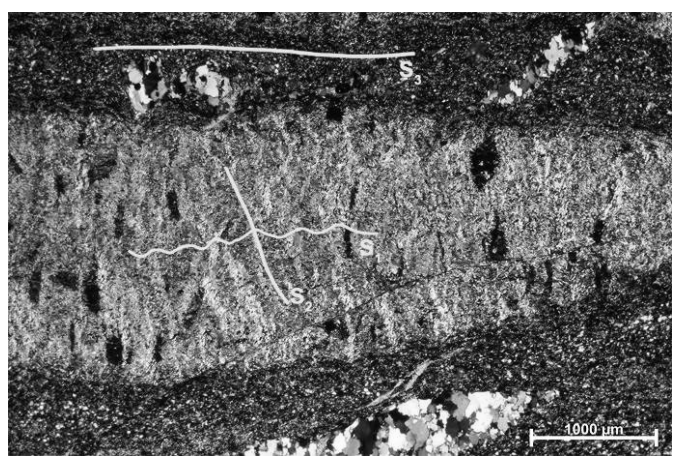

Fig. 3.: Sin- to post-kinematic chlorite grains developed within crenulated muscovite-chlorite domain, PPL, N+.

Observed foliation sequence has potential to be a marker of relative succession of regional geological events. Further research will be concentrated on the age dating of accessory minerals with exact position in respect to the foliations.