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Magnetic fabric of fault breccia: Revealing the direction of the Cretaceous nappe-stacking in the Inner Western Carpathians by AMS analyses

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The anisotropy of magnetic susceptibility (AMS) has been recognized as a highly sensitive indicator of rock fabric and is widely employed in the field of structural geology. Brittle faults are often characterized by fault breccia, fault rocks with clast-in-matrix textures. A noteworthy feature of the breccia is the presence of a fabric defined by the preferred orientation of clasts and grains in the matrix. However, this fabric is often not visible in the field or in thin sections but can be detected by AMS analyses.

The sample area of the present study is located within the Cretaceous thin-skinned nappe-system of the Inner Western Carpathians. This Alpine-type orogenic belt is built up by large-scale, few km thick nappes without connection to their root areas. These thin rock slices thrust over large distances without sign of mayor deformation within the nappe slice. All the deformation took place along highly strained, narrow shear zones lubricated by hot fluids. These hydrostatically pressurized zones develop on the bases of the nappes, where basal tectonic breccia was formed. Newly formed, syn-kinematic minerals are growing from the overpressured fluids. These polymict breccias have typical block-in-matrix texture with clast size vary between mm and few cm. The matrix is mainly submillimetre-scale rock fragments and cement.

In spite of detailed studies about the physical conditions of nappe movements, there is no information about the tectonic transport direction. Analyses of brittle fault kinematics within the different tectonic slices suggest either NW-SE or N-S compressional stress field during the nappe-stacking. With this study we want to test if the magnetic fabric of tectonic breccia can help to determine the transport direction. The first results are very promising:

Area 1 (basal tectonic breccia from Tisovec): the magnetic lineation is well defined and plunges gently towards N-NNW. The stretching lineation observable in the field within the uppermost part of the footwall dips towards ENE and is probably related to an ENE-WSW extensional event affecting the whole nappe-pile after the nappe-stacking. However, the detected magnetic foliation fits nicely into the supposed NW/N-SE/S oriented compressional stress field during the nappe-stacking, prior to the extensional event. Following this interpretation the breccia was formed during nappe stacking and its magnetic fabric was not overprinted by the following extensional event.
Area 2 (basal tectonic breccia from Puste Pole): two magnetic fabrics can be measured in different sites: a well-defined magnetic lineation plunging towards NNW/SSE, and a weaker fabric with either WSW or E dipping magnetic lineation. The first fabric can be interpreted in the same way as in area 1. However, the WSW or E oriented magnetic lineation is parallel to the structural stretching lineation associated to the later extensional event.
Area 3 (basal tectonic breccia from Telgárt): the magnetic lineation is well defined and dips gently to W, which is parallel to the post-stacking stretching direction.

This preliminary results show, that AMS-study of the basal tectonic breccia of thin-skinned nappes can be a powerful method in the future for detecting the hidden anisotropic fabric related to the tectonic movements, even if there are several tectonic events with different directions of movement.