

Tectonics

Scientific note

Tectonic processes are very effective in creating preferred orientation of minerals in rocks. The AMS therefore enables these processes to be investigated.

AMS is very powerful in investigating progressive modification of the sedimentary magnetic fabric by ductile deformation, often taking place in accretionary prisms. After deposition, the AMS ellipsoid of sedimentary rock is oblate with magnetic foliation near the bedding and magnetic lineation near the water current direction. In initial stages of deformation, represented by bedding-parallel shortening, the AMS ellipsoid changes to triaxial, the magnetic foliation remains parallel to bedding, but the magnetic lineation reorients perpendicular to the shortening direction. In progressing deformation, spaced cleavage develops and the magnetic lineation becomes parallel to the bedding/cleavage intersection line, while the AMS ellipsoid becomes prolate. If the deformation continues, giving rise to the development of slaty cleavage, the AMS ellipsoid becomes oblate again, the degree of AMS considerably increases, the magnetic foliation pole reorientates parallel to the cleavage and the magnetic lineation remains parallel to the bedding/cleavage intersection line. If the deformation is very strong, the magnetic lineation may be dip-parallel in the cleavage plane.

AMS can be used in revealing the origin of folds. Various types of folds differing in terms of the relation of the magnetic fabric to the fold curve were found and simple techniques for the recognition of unfoldable and homogeneous folds were elaborated.

Some granites suffered tectonic ductile deformation after their emplacement and their originally intrusive magnetic fabrics were overprinted by the deformational magnetic fabrics. This resulted in increasing degree of AMS and deviating magnetic foliations and lineations from the directions of the intrusive fabric elements towards the directions of the principal strains. A nice example is shown by the granites of the West Carpathians whose magnetic fabrics are coaxial with those of surrounding metamorphic rocks and covering sedimentary rocks as result of ductile deformation associated with retrogressive deformation acting during creation and motion of the West Carpathian nappes.

Strain analysis is one of the most laborious techniques of structural analysis being confined to rocks containing convenient strain indicators (oolites, concretions, reduction spots, lapilli, fossils). For this reason, many attempts have been made to use the AMS as a strain indicator. The quantitative relationship between the AMS and strain has been investigated theoretically through mathematical modelling, empirically through examining natural rocks with known strain, and experimentally through deforming rocks and rock analogs in the laboratory. Even though a great majority of the empirical studies revealed a relatively close correlation between AMS and strain, some studies obtained results suggesting no or even inverse correlation between the AMS and strain. This implies that some rocks may have had complex deformation histories in which various rock components responded in different way to overall strain and such rocks should not be used in the strain determination via AMS. Nevertheless, it is believed that in homogeneously deformed rocks the AMS can serve as a quantitative strain indicator, which is evident from the great majority of empirical and experimental studies.

References

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