Measurement of calcite crystallographic-preferred orientations by magnetic anisotropy and comparison to diffraction methods

Vortrag

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AMS as a petrofabric tool

The anisotropy of magnetic susceptibility (AMS) of rocks reflects the preferred orientations of minerals. Therefore AMS is a quick and easy way to characterize rock fabrics (Hrouda 1982, Borradaile 1988); the obtained result is also called the magnetic fabric of the rock. The method has been often used to measure the orientation of ferromagnetic minerals, mainly magnetite, but in recent studies it has been increasingly used to measure textures of paramagnetic minerals as phyllosilicates (Lüneburg et al. 1999, Cifelli et al. 2004).

AMS of calcite textures A further application is the measurement of diamagnetic textures, especially calcite textures. Calcite is suitable for the AMS method, because it has a high magnetic anisotropy with the minimum susceptibility along the crystallographic c-axis. Therefore a preferred orientation of the c-axes, which can be induced by deformation, generates a magnetic fabric. The relationship between AMS and deformation of marbles has been investigated in laboratory (Owens & Bamford 1976) and field studies (de Wall et al. 2000). However, the diamagnetic fabric of calcite is relatively weak and easily overprinted by paramagnetic and ferromagnetic phases. In natural carbonate rocks the ferromagnetic and the paramagnetic subfabrics should be separated to assure a correct interpretation of the AMS. This separation can be made by torque measurements in high fields at different temperatures (see Schmidt et al., this volume).

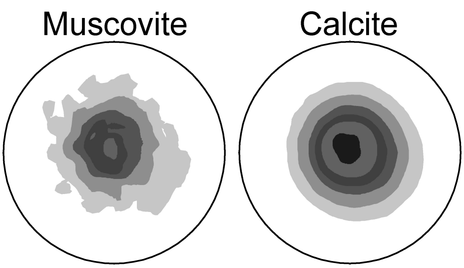

Figure 1: Example of neutron diffraction pole figures (equal-area, lower hemisphere projection). Compaction direction is normal to the pole figure. Lowest contour line is equal to 1.0 multiple of random distribution (m.r.d.); contour interval is 0.25 m.r.d.

Textures of artificial calcite-muscovite aggregates

To test how well AMS reflects the actual mineral texture, we produced a series of artificial calcite-muscovite aggregates. Powders made from Carrara marble and muscovite single crystals were mixed in different proportions and compacted uniaxially at room temperature to obtain a texture. The samples were further compacted hydrostatically to reduce the porosity and to improve the mechanical properties. The samples show a c-axis preferred orientation of

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the calcite and muscovite along the compaction direction (Fig. 1). The textures were measured with different methods as AMS, X-ray diffraction and neutron diffraction and the results are compared. Sample volumes of more than 11 cm^3 were used to measure AMS as well as neutron diffraction; the same specimens could be used for both methods.

Low- and high-field AMS measurements were made on all samples. The high-field measurements reflect more accurately the weak dia/paramagnetic fabrics. A nearly perfectly oblate AMS ellipsoid with minimum susceptibility axis sub-parallel to the compression direction developed even at very low pressures, and the principle axes of the AMS ellipsoid are co-axial with the calcite fabric ellipsoids. A general increase in AMS is observed with an increase in compaction. The quantitative correlation between the strength of the texture and the AMS will be investigated in the future. Moreover the separation of magnetic sub-fabrics will be tested on these artificial samples. The first results show that AMS can reflect the textures of the individual phases in a multiphase rock.

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