



Tectonic imprint in magnetic fabrics in foreland basin settings (Southern Pyrenees and Ebro Foreland Basin, Spain)

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Anisotropy of Magnetic Susceptibility (AMS) and other magnetic fabrics has been applied to the identification of deformational processes in places without strain indicators at outcrop scale. AMS have revealed its sensibility in many geological contexts, in the Southern Pyrenees the process of Layer Parallel Shortening is widespread distributed North to the Frontal Thrust (FT). A detailed analysis to the South of the FT have been developed looking for the limit of tectonic imprint in the magnetic fabrics along two different cross-sections ranging from the frontal thrust to the foreland basin. The magnetic fabrics in the Northern sector show magnetic foliation parallel to the bedding, and magnetic lineation parallel to the structures. In some cases, when the bedding does not have the main Pyrenean trend, the magnetic lineation recover Pyrenean trend when the bedding is untilted. In these cases AMS predate the tilting, indicating that it was acquired during a pre-tilting process where the magnetic lineation was developed normal to the Pyrenean tectonic shortening. To the South, the magnetic fabrics show a decrease in the definition of the lineation (lower values of L parameter and increase of the ϵ_{12} angle) while the clustering of axes remain along the cross-section. In the central part of the cross-section (30 to 40 km from the frontal thrust), the clustering of AMS axes decrease along the next trend: increase of the α_{95} cone of clustering of each type of axes (parallel to the decrease of the L parameter and increase of the ϵ_{12} angle), interchange of axes (two different clusters of the same kind of axis at 90°) and guirdle of axes (k_1 and k_2 , with K_3 normal to the bedding) and in the southern sector scattering of the three axes in stereographic projection.

The sites showing two different clustering of K_1 axes, have been tested in detail in order to analyze the influence of the lithology changes at outcrop scale. The two clustering represents a magnetic lineation parallel to the Pyrenean trend (or structures if they are present) and a second magnetic lineation, at 90° , which is apparently parallel to the Pyrenean shortening. The number of samples with magnetic lineation parallel to the shortening direction is higher in the coarser levels while it is present in the main part of the levels. The samples that show this magnetic lineation parallel to the shortening direction, show the lowest values of L. This situation suggests that these fabrics develop an interchange of axes.

The most southern magnetic fabrics (ranging from 40 to 80 km from the FT) show, in the main part of the cases, scattering of axis, while a preferential subvertical k_3 can be observed. The LTAMS usually follows the same trend of the AMS with independence of the paramagnetic contribution to the susceptibility. The AARM usually does not show clustering of axes, with independence of the reliability of the data (not clustering of axes even with high strength of the remanence or low values of residual fittings exist). The main carrier of the remanence is magnetite, while in the southern position high coercitivity phases can be present (haematite or goethite). The change in the presence of one or two clusters of K_1 , happens with the same mineralogical sources and similar paramagnetic contribution to the susceptibility (80 to 90%).

The magnetic pattern along the cross-sections and ranging from the FT to the foreland basin follow a scheme from magnetic lineation normal to the shortening (in untilted conditions and compatible with a process of layer parallel shortening: LPS), two different clustering of axes and finally scattering of axes. This pattern show that the decrease in the tectonic imprint in the fabrics follows an scheme of clustering of axes, decrease in the magnetic lineation parameter and decrease in the accuracy of definition of the axes. But the change in the magnetic ellipsoid orientation happens sharply, from magnetic fabrics compatible with LPS, scattering of k_1 and k_2 axes and the scattered fabrics. This progression happens due to three different factors: a) increasing the distance to the FT, b) more modern materials to the South (fabrics does not show the expected patterns if they are sampled in more modern units with independence of the sampling position) and c) the paramagnetic contribution to the

susceptibility. The main responsible of the magnetic fabrics are paramagnetic particles, while AARM show scattered fabrics with independence of the results in the AMS and not clustered fabrics exists when ferromagnetic contribution to the susceptibility is higher than 90%).

These results show the possibility to detect a tectonic imprint in the magnetic fabrics at distances of more than 80 km respect to the main thrust front. On the other hand, it has been demonstrated that paramagnetic particles are the responsible of the magnetic fabrics and record an early process acquired in pre-tilting conditions, while diagenetic ferromagnetic particles does not develop an ordered disposition.