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Magnetic fabric analyses in analogue models of clays

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Anisotropy of magnetic susceptibility (AMS) studies in sedimentary rocks subjected to deformation indicate that magnetic fabrics orientation can be conditioned by multiple factors: sedimentary conditions, magnetic mineralogy, successive tectonic events, etc. All of them difficult the interpretation of the AMS as a marker of the deformation conditions.

Analogue modeling allows to isolate the variables that act in a geological process and to determine the factors and in which extent they influence in the process. This study shows the magnetic fabric analyses applied to several analogue models developed with common commercial red clays. This material resembles natural clay materials that, despite their greater degree of impurities and heterogeneity, have been proved to record a robust magnetic signal carried by a mixture of para- and ferromagnetic minerals. The magnetic behavior of the modeled clay has been characterized by temperature dependent magnetic susceptibility curves (from 40 to 700ºC). The measurements were performed combining a KLY-3S Kappabridge susceptometer with a CS3 furnace (AGICO Inc., Czech Republic). The obtained results indicate the presence of an important content of hematite as ferromagnetic phase, as well as a remarkable paramagnetic fraction, probably constituted by phyllosilicates. This mineralogy is common in natural materials such as Permo-Triassic red facies, and magnetic fabric analyses in these natural examples have given consistent results in different tectonic contexts.

In this study, sedimentary conditions and magnetic mineralogy are kept constant and the influence of the tectonic regime in the magnetic fabrics is analyzed. Our main objective is to reproduce several tectonic contexts (strike-slip and compression) in a sedimentary environment where material is not yet compacted, in order to determine how tectonic conditions influence the magnetic fabric registered in each case. By dispersing the clays in water and after allowing their subsequent decantation, we were able to reproduce the acquisition of a depositional magnetic fabric (oblate geometry of the magnetic ellipsoid with the minimum susceptibility axis perpendicular to the deposit plane). In a strike-slip deformation model (Riedel experiment), magnetic lineation is parallel to the stretching direction, at 45º to the shear direction. In a compressional model, magnetic lineation orients perpendicular to the compression direction, and parallel to thrusts trend. The obtained results illustrate the great potential of these commercial red clays to be used in this type of analogue models, as well as their capacity to register a coherent magnetic fabric in each case.