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Characterization of the Eastern Galicia Magnetic Anomaly. A warning regarding the interpretation of aeromagnetic data

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Regional aeromagnetic data are an excellent diagnostic tool used by geophysicists worldwide. Hidden structures, mineralized areas, depth to the basement, depth to the Curie Point and thus, calculation of thermal gradients are common outcomes of the study of magnetic anomalies. However, these datasets are sometimes interpreted by modeling non-outcropping rocks of unknown magnetic properties. Accordingly, resulting models are largely unreliable.

One of such examples is the Eastern Galicia Magnetic Anomaly (EGMA).This feature, located in NW Spain and overlying the Late Variscan Lugo-Sanabria extensional dome, is one of the most prominent anomalies in the aeromagnetic map of the Iberian Peninsula. Reaching 190 nT, it has been traditionally interpreted by using constraints provided by structural geology, seismic refraction/wide-angle reflection data, and Bouguer gravity anomaly information. Most models suggest that the source of the EGMA is a buried body with a magnetic susceptibility that is, obviously, a trade-off between the size/depth of the magnetic source and the value of the anomaly. Remanent magnetization was never taken into account and the role of structures was overlooked.

Recent detailed surveying and land acquisition of magnetic data in the Xistral Tectonic Window, at the northern part of the EGMA, showed that significant amounts of highly magnetic rocks exist in the area. These are mostly migmatites and inhomogeneous granites but also Late Proterozoic and Early Cambrian metasediments. However, these magnetic rocks show a very heterogeneous distribution that raises the question of their relation with the anomaly.

A wide group of magnetic samples has been studied in order to further characterize the source of the EGMA. Magnetic susceptibilities reach κ=0.2 (SI), although lower values of κ=0.04-0.001 (SI) are more common. Optical, rock-mag and XRD studies suggest that the main magnetic mineral is MD magnetite. However, thermal demagnetization shows that existing hematite is carrying a magnetic remanence, often with low inclination, reverse polarity, and striking $\sim$N160º, consistent with a Permo-Triasic chron. AMS studies show very high anisotropies linked to magnetite, with directions that mimic those of late Variscan extensional shear zones. Finally, high isotopic ratios (δ^{18}O) from magnetic granites and migmatites suggest that the latter are the melting products of metasediments that are themselves magnetic sometimes.

These data have shed new light on the interpretation of the EGMA. The source of the anomaly seems to be linked to metasediments and their melting products but only when affected by extensional detachments. Low pressure inherent to extensional tectonics together with associated high temperatures seem to be key in the crystallization of magnetite in these structures. This fact explains the high AMS values and the heterogeneity of the magnetic rocks. Finally, the existence of remanent magnetization must be taken into account in the models since high Königberger ratios exist (average Qn=0.875). These findings alone imply the need of including a number of significant changes in the EGMA existing models. Ongoing research is focused on the age and origin of the remanence and on the petrochemical processes that led to the formation of magnetite. (Research support, CGL2016-81964-REDE, CGL2014-56548-P, SA065P17)