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Implications of the magnetic mineralogy in the magnetic susceptibility from three granitic plutons of the Axial Zone of the Pyrenees, Spain.

B. Oliva-Urcia (1,2), T. Román-Berdiel (1), E. L. Pueyo (3), B. Antolín-Tomás (4), A. M. Casas (1), I. Gil-Peña (3), R. Soto-Marín (5)

(1) Departamento de Ciencias de la Tierra, Universidad de Zaragoza, Spain, (2) Geological Science Department, University of Michigan, USA, (3) Unidad de Geología y Geofísica, Instituto Geológico y Minero de España, Spain, (4) Institut für Geologie, Universität Tüebingen, Germany, (5) Laboratorio de Paleomagnetismo, Departamento de Física, Universidad de Burgos, Spain.

(boliva@unizar.es / Fax: 34-976761106 / Phone: 34-976762127)

The Bielsa, Millares and Marimanha granitic plutons (Axial Zone of the Pyrenees), provide good examples of zoned granitic bodies with several well-characterised petrofacies, which correlate with different K values. The K values zonation varies among the bodies for similar petrofacies zonation. In order to test the reliability of the magnetic susceptibility data, we perform rock-magnetic analyses to control the influence of different proportions of ferromagnetic minerals in modifying the AMS results. The rock-magnetic analyses comprise isothermal remanent magnetization (IRM) and back-field, three axes IRM and hysteresis curves as well as comparison between low and high field susceptibilities. The selected samples cover the whole range of susceptibility values.

In the Bielsa massif, the samples show the ocurrence of a variety of ferromagnetic minerals. Four samples reach the 70% of saturation of the IRM curve at 0.3 Tesla indicatingthe presence of a low coercivity ferromagnetic mineral. Low Hcr values (between 0.55 and 0.75 mT) from the back-field curves confirm this observation. . The thermal demagnetization of the three axes IRM show unblocking temperatures of 500˚-530˚C supporting the occurrence of a low to intermediate coercivity mineral, probably magnetite. Moreover, one sample shows the presence of a mineral with a

wide range of coercivities and with an unblocking temperature of 400˚C, while other sample show the presence of hematites (unblocking temperature of 680˚C in the hard axis). Hysteresis loops at room temperature show a significant ferromagnetic contribution of a very low coercivity mineral with complete saturation at 0.3 Tesla. The ferromagnetic ranges from low (12% and 25%) to intermediate values (33% and 38%). These results evidence that the Bielsa granite is actually not paramagnetic, since the presence of magnetite is evidenced by the thermal demagnetization of three IRM components and the hysteresis loops. Comparison between low field (≈KLY-3 conditions) and high field susceptibilities performed at a MPMS (Quantun Design, Ltd.) indicates more than 30% contribution of ferromagnetic minerals in all studied samples.

In the Millares pluton, the IRMs show the presence of a low coercivity mineral. They reach 80% of saturation at 0.3 Testa and show low values of the back-field. The decay of the intensity at 300ºC of three axes IRM supports the interpretation that sulphides or rich Ti-magnetite may be the main ferromagnetic minerals present. In addition, one sample show unblocking temperatures of 580ºC for the soft axis, indicating the occurrence of magnetite. High-field susceptibility shows that only two out of ten samples displayed more than 20% of ferromagnetic contribution and consistent hysteresis. This small contribution was found in the petrofacies with highest K values. Thus, a non-significant ferromagnetic contribution can be assumed for Millares pluton.

In the Marimanha body, the acquisition curves of IRM show again a quick saturation: more than 70% of saturation is reached at 0.3 T, although in three out of seven samples saturation was slower. Back-field experiments show low Hcr values in all samples. Three axes IRM curves indicate the occurrence of a mineral with a wide range of coercivity as in Millares. Main unblocking temperatures of all samples are about 330º-360ºC. In addition, two samples show unblocking temperatures of 580ºC for the soft axis, indicating the probable occurrence of magnetite. High-field experiments were done in twelve samples. They display paramagnetic and diamagnetic behaviour. According to rock magnetic data, paramagnetic silicates control the magnetic susceptibility of the Marimanha pluton.

In conclusion: The same ferromagnetic behaviour is observed within the paramagnetic bodies (Millares and Marimanha) where significant ferromagnetic contribution to the low field susceptibility was only found in a few samples. However, in the Bielsa granite there is a higher contribution and variety of ferromagnetic grains controlling the zonation of K values, also different from the paramagnetic bodies.