

Thermomagnetic analyses of oceanic basalts - Testing a new approach to differentiate oxidation degree from the primitive composition of titanomagnetites

Silva, P.F.¹, Almeida, F.¹, Waerenborgh, J.C.², Madureira, P.³, Henry, B.⁴, Neres, M.⁵, Petrovský, E.⁶

¹ ISEL/DEC and IDL (Universidade de Lisboa), Lisboa, Portugal

² *C²TN, Instituto Superior Técnico, Universidade de Lisboa, Bobadela, Portugal*

³ Centro de Geofísica de Évora and Departamento de Geociências, Universidade de Évora, Évora, Portugal

⁴ Palaeomagnetism, IPGP and CNRS, Saint-Maur cedex, France

⁵ IPMA and IDL (Universidade de Lisboa), Lisboa, Portugal

⁶ Institute of Geophysics, Acad. of Sci. of the Czech Republic, Prague, Czech Republic

Corresponding author: pmfsilva@fc.ul.pt

Abstract: Low-field magnetic susceptibility as a function of temperature – $\chi(T)$ is one of the most powerful techniques to assess the main magnetic mineralogy of rocks from distinct geological settings. For the specific case of titanomagnetite solid solution, the dependence of Curie temperature (T_c) on their composition and oxidation degree imposes limits to the application of thermomagnetic methods as a tool to assess independently one of the variables, i.e., the pristine composition and/or quantification of the oxidation degree. In order to overcome this ambiguity several authors resorted to independent methods, like microprobe, scanning electron microscopy (SEM) and transmission electron microscopy (TEM) analyses. The study here presented seeks to establish a new approach able to correlate the oxidation degree with T_c variations of partially oxidized submarine basalts, only supported by the thermomagnetic analyses conducted between -190°C and 650°C. 40 thermomagnetic signatures were evaluated along cross-section profiles of four pillow-lavas, sampled from the Mid-Atlantic Ridge and from the Terceira Rift (Azores plateau). For each one a lamellae with a thickness of 2 to 3 mm was collected along each centimeter of the profile. All the experiments were made using the same experimental conditions (atmosphere, heating rate). Our thermomagnetic curves of partially oxidized oceanic basalts are characterized by a peak of susceptibility between 300-350°C and 520-550°C, which mostly results from the inversion of the thermally metastable titanomaghemite into a complex multiphase intergrowth. From our experiments, we were able to obtain a good linear correlation (positive) between the amplitude of this peak and the T_c for each sample profile.

Moreover, these results are well correlated with the oxidation degree determined by Mössbauer Spectroscopy analyses and with microscopic observations, which show an increase of oxidation degree towards the margins of the pillow lavas. Therefore, these results indicate that the method here conducted could provide an important approach to assess more accurately the main pristine composition of basalts Fe-Ti oxides and permit a qualitative inference of oxidation degree.

Keywords: Basalts, pillow lavas, Atlantic Ocean, Oxidation, Titanomagnetites