TCRM Induction And Thellier Experiments With Titanomagnetites

Shcherbakov, V.P.[1], Gribov, S.K.[1]

[1] Borok Geophysical Observatory of the Institute of Physics of the Earth, Russian Academy of Sciences, Borok, Nekouz region, Yaroslavl oblast, Russia

Corresponding author: shcherbakovv@list.ru

Abstract: Basaltic samples containing TM with T_c around 300°C were heated in air in fields (30–50) μT at temperatures T_{ch} =400, 450, 500and 530°C for times as long as 200 hrs with the purpose to impart the TCRM. Products of the oxidation were monitored by thermomagnetic and hysteresis properties measurements completed with the electron microscopic studies and of X-ray spectra analysis obtained on different stages of the annealing. Fresh samples contain partially oxidized coarse (30-70 μm sizes) and fine (up to 10 μm sizes) TM grains. For 400 and 450°C runs further single-phase oxidation takes place resulting in increase of T_c up to (450-550)°C leading to increase of Ms and accompanying by widening spinel X-ray spectral lines. No sign of the rhombohedral phase are found by electron microscopic studies and of X-ray spectra analysis. Annealing at 500 and 530°C also leads first to the increase of T_c due to the single-phase oxidation but after a few hours exposure changes for the heterophase oxidation. The last process results in appearance of a set of fine magnetite- ilmenite intergrowths as follows from the consideration of thermomagnetic curves, X-ray spectra and electron micrographs. The monitoring of the TCRM acquisition in time mapped with the similar monitoring of the spontaneous magnetization Js values at the room temperature T_r revealed a rather good correlation between them (Fig. 1, left). This observation suggests that the TCRM value is simply proportional to the concentration of the ferromagnetic material which means that TCRM specific susceptibility does not depend on the grain volume. Another fact which can be induced from these experiments is that the TCRM is mainly acquired on the stage of single-phase oxidation, the subsequent exsolution plays only a secondary role, modifying the already existing TCRM. TCRM and TCRM+pTRM(T_{ch},T_r) acquired T_{ch} =400, 450, 500and 530°C were subjected to Thellier-type experiments with help of a fully automated vibrating and/or rotating sample thermomagnetometers. The resulting Arai-Nagata TCRM–TRM plots usually have a slightly negative curvature with a substantial blocking temperature range where they can be regarded as linear ones (Fig. 2). However, pTRM checks are not perfect when the high T_b are considered and this observation can be used for the detection of possi-

ble TCRM presence in practice. An apparent strength of the acquisition field of TCRM inferred from these diagrams is usually underestimated by 30-60 %. A theory based on the suggestion of thermofluctuational nature of the TCRM acquisition (i.e. on the modification of Neel's and Kobayashi models) mechanism is developed. The results of this modelling proved to fit the experiments reported here.

Keywords: chemical magnetization, paleointensity, oxidation, titanomagnetite

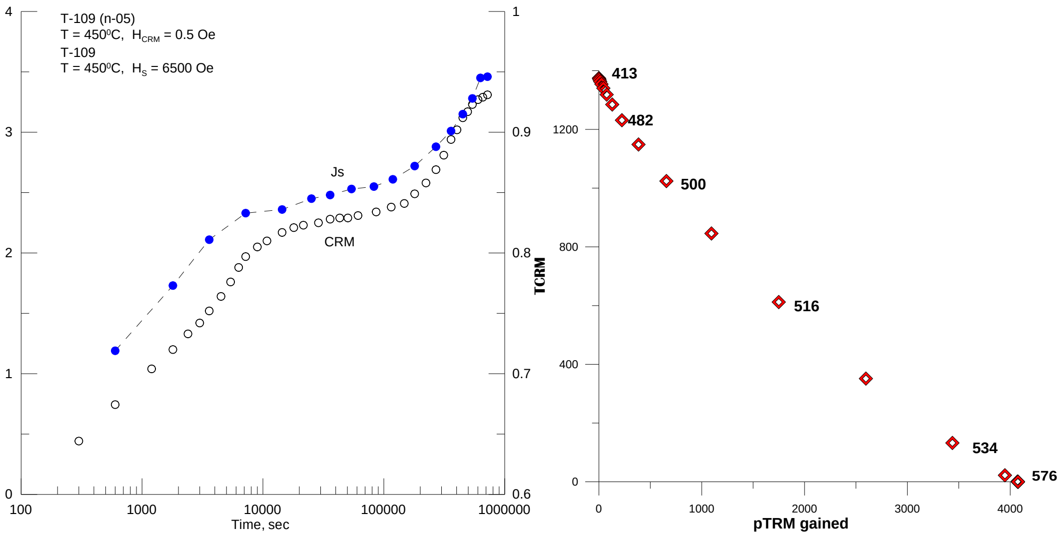

Figure 1: T_{ch} = 450°C. Left axis. TCRM acquisition curve versus time (hollow circles). Right axis. Saturation magnetization Js measured at room temperature T_r versus time.

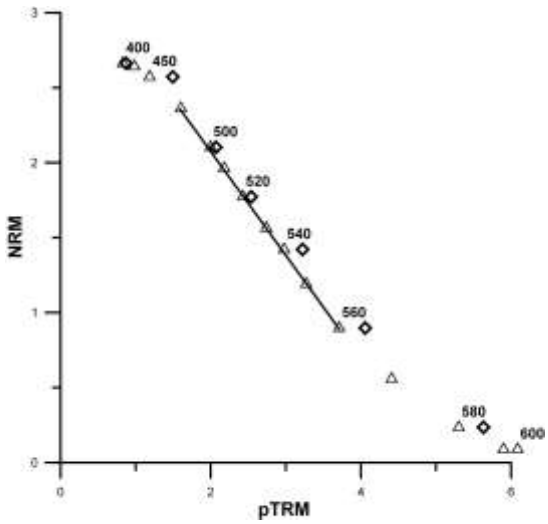

Figure 2: Arai-Nagata plot for TCRM acquired during annealing at T_{ch} = 400°C for 200 hrs in field B = 50 μT. The apparent "paleointensity" found from the segment depicted in the Figure by solid line is 21.5 μT.