PLAGIOCLASE-HOSTED Fe-Ti-OXIDE MICRO-INCLUSIONS AND BULK-ROCK MAGNETISM OF OCEANIC GABBRO

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We present mineralogical and magnetic data of 11 oceanic gabbro samples dredged from the Mid-Atlantic ridge at 13° to 17° N. Their natural remanent magnetization (NRM) is primarily controlled by two microstructural types of Fe-Ti-oxides. A first type is represented by several millimeters sized, isometric cumulus/intercumulus grains. The second type is represented by micro-inclusions hosted by pyroxenes and plagioclases. During post-magmatic evolution, the two Fe-Ti-oxide types behaved differently, affecting the bulk-rock NRM in different ways. Understanding the primary NRM and its transformation in the dynamic environment of the Mid-Atlantic ridge is important for interpreting paleo-magnetic data and for assessing information from marine magnetic anomalies.

For all studied gabbros, the Curie temperature (Tc) is in the range of 570-575 ºC, indicating that magnetite is the dominant carrier of the NRM. In some samples, additional magnetic phases with T_C ~330-340 ºC corresponding to either titano-magnetite or monoclinic pyrrhotite and with T_C ~700 ºC corresponding to hematite are distinguished. The intensity of the bulk rock NRM is 0.3 to 7 A/m and shows a correlation with the quantity of cumulus/intercumulus Fe-Ti-oxide grains and with the abundance of the Fe-Ti-oxide micro-inclusions in the rock-forming silicates. Based on the presence of the different microstructural Fe-Ti-oxide types, two groups of gabbro are distinguished: The first group has both cumulus/intercumulus grains and silicate-hosted Fe-Ti-oxide micro-inclusions. The second group shows silicate-hosted (mostly plagioclase) Fe-Ti-oxide micro-inclusions at low and intermediate concentrations. In the Day diagram (Mrs/Ms vs. Bcr/Bc) both groups fall into the field of pseudo-single domain (PSD) grains, but the first group plots closer to the multi-domain (MD) field and the second group plots closer to the single-domain (SD) field. The NRM in the second group amounts to 0.4 to 0.8 A/m, indicating that the micro-inclusions play a key role for the bulk-rock NRM. In the second group, the bulk coercivity (B_C) is 15-28 mT and the saturation magnetization ratio (Mrs/Ms) is 0.15-0.25, which is much higher than in the first group. This gives evidence of hard magnetization in the second group, which is due to the dominance of micro-inclusions. Moreover, with k = 100-160 the samples of the second group have a higher Fisher statistics parameter of the NRM vectors than the first group (k = 3-46). Importantly, in the second group almost all pyroxene grains have been replaced by late amphibole in the course of low-temperature hydrothermal alteration, which also destroyed the cumulus/intercumulus Fe-Ti-oxides. Plagioclase remained largely unaltered during the hydrothermal overprint and the plagioclase-hosted micro-inclusions preserved the primary NRM. Although the Fe-Ti-oxide micro-inclusions may be present at low concentrations, they are robust carriers of the primary NRM. When cumulus/intercumulus Fe-Ti-oxide grains and inclusion-bearing pyroxene are missing, the record of remanence is only provided by plagioclase-hosted micro-inclusions. In this case, the rocks yield accurate information on the direction of the primary NRM.