SYSTEMATICS OF FACETED INTERFACES BETWEEN ORIENTED MAGNETITE MICRO INCLUSIONS AND PLAGIOLCASE HOST

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Oriented needle- and lath-shaped magnetite (Mt) micro-inclusions in plagioclase (Pl) are robust carriers of natural remanent magnetization. Systematic crystallographic and shape orientation relationships (CORs, SORs) between Mt and Pl may lead to magnetic anisotropy and thus are of pivotal importance for paleomagnetic reconstructions. The unusual needle or lath morphology of the Mt inclusions and their SORs and CORs are due to the alignment of important oxygen layers across the Mt-Pl interfaces that are parallel to the inclusion elongation direction. Typically, the Mt needles are elongated parallel to Mt<111>, and Mt{222} is parallel to one of several oxygen layers in Pl, including Pl(112), Pl($\bar{3}$12), Pl(150), Pl(1$\bar{5}$0). All these lattice planes have nearly identical *d*-spacings so that they are coherent across the Mt-Pl interfaces (AGEEVA et al., 2020). This alignment allows one rotational degree of freedom around the needle elongation direction. The rotation is, however, not continuous, but clusters around several specific positions. In this context, the atomic structures of Mt-Pl interfaces are of key interest. We used high angle annular dark field scanning transmission electron microscopy (HAADF-STEM) to determine the atomic structure of the Mt-Pl interfaces of two needles with Mt<111> parallel to the normal direction to Pl($\bar{3}$12). In projections parallel to the needle elongation directions, one inclusion has a hexagonal cross section and, in addition to Mt<111>//Pl($\bar{3}$12), satisfies the relation Mt<100>//Pl[$\bar{1}\bar{4}$,10,$\bar{7}$]. This ensures perfect fit of FeO_6 octahedra of Mt in channels of the Pl crystal structure, which is considered an important match during the nucleation phase and defines the *nucleation orientation*. The other inclusion has a quadrilateral cross section and, in addition to Mt<111>//Pl($\bar{3}$12), satisfies Mt{220}//Pl(150), where both planes form facets of the Mt-Pl interface. This is likely the energetically most favourable configuration and defines the *main orientation*. The interface facets can be rationalized based on a modified exact phase boundary model. In nucleation orientation, Mt{220}//Pl(131) and Mt{220}//Pl(2$\bar{3}$4). In main orientation, Mt{220}//Pl(112) forms the facets or meets Pl(150) with a ratio of 4:3. For the inclusion in nucleation orientation, the elongation direction Mt<111> deviates by <1° from the normal direction to Pl($\bar{3}$12), while in main orientation the deviation is up to ~6°. The transition from the nucleation to the main orientation corresponds to a two-step rotation: (i) ~6° rotation around Pl(150)n, (ii) ~30° rotation around the inclusion elongation direction. This transition is probably driven by minimizing interfacial energy while keeping the coherent oxygen layers across the Mt-Pl interfaces along the needle elongation direction aligned.

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