Magnetite exsolution in ilmenite derived from sub-solidus re-equilibration of Fe-Ti oxides

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Ilm-Hem_{ss} plays an important role in the acquisition of natural remanent magnetization (NRM) in different types of rocks. As temperature decreases, Ilm-Hem_{ss} commonly separates into hematite-rich and ilmenite-rich end-member phases due to a miscibility gap at 600–700 °C. However, an enigmatic intergrowth, magnetite lamellae and ilmenite host, occurs in the Fe-Ti oxide gabbro from the Xinjie layered intrusion, SW China. Raman spectra and micro-XRD analyses confirmed that the exsolved phase in ilmenite is magnetite. The exsolved magnetite lamellae in the ilmenite contain nearly pure Fe_3O_4 with ~1 wt% TiO_2 and exhibit an crystallographic orientations, $\{111\}_{Mag}$ // $(0001)_{Ilm}$ and $<110>_{Mag}$ // $<10\text{-}10>_{Ilm}$, with the host ilmenite.

Titanomagnetite makes up 40-50% and ilmenite makes up 20-30% of the samples in this study, the titanomagnetite is thus the dominant phase in the samples. Therefore, the Fe^{2+} in the magnetite lamellae are probably derived from adjacent titanomagnetite by sub-solidus inter-oxide cation re-equilibration of $Fe^{2+} + Ti^{4+} = 2Fe^{3+}$ on cooling. This study indicates that both magnetite ($Fe^{2+}Fe^{3+}{}_2O_4$) and hematite ($Fe^{3+}{}_2O_3$) can exsolve from host ilmenite when the Ilm-Hem_{ss} precursor experienced different sub-solidus re-equilibration. Detailed characterization for the micro-intergrowth in host ilmenite and intracrystalline exsolved phases is crucial for reconstructing the composition of Ilm-Hem_{ss} precursor and explaining unusual strong NRM in some natural ilmenite.

[1] Tan et al. (2016) *Am. Mineral.* **101,** 2759-2767.