Investigation of magnetite lamellae within plagioclase in granite and gabbro, Tanzawa and Iritono Complex, for single crystal paleointensity study

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Since plagioclase includes fine needle-shaped magnetite as an exsolution lamella, single plagioclase crystals are used for recently paleointensity study (e.g. Tarduno et al., 2006; Usui et al., 2015). Especially, plagioclase in plutonic rocks can record average paleointensity due to their long cooling time scale(Tunakawa et al., 2009). However, such magnetite lamellae in plagioclase were not observed in any plutonic rocks, nor uniform state in each plagioclase crystals. According to previous studies, magnetite lamellae exists in plagioclase in Iritono granite, Abukuma massif, on the other hand, they are scarce in those in Azegamaru granite, Tanzawa pluton. As a general, exsolution lamellae are formed by the decrease of maximum solubility with cooling or change of oxygen fugacity, and its formation is restricted by whole rock and crystal’ s chemical compositions, but little is known about the formations of magnetite lamellae in plagioclase. In this study, we investigate magnetite lamellae existence in plagioclase crystals, analyzed the composition of plagioclase in Iritono granite and Tanzawa granite, and discuss main factors of magnetite lamellae formation in plagioclase.

Samples from Abukuma used in this study were two sister sample, investigated in Wakabayashi et al. (2006), two granite and one gabbro which we sampled at Iritono granite. Samples from Tanzawa were tonalite and gabbro which were analyzed in whole rock composition by Takahashi & Kanamaru 2004. In other to describe fine exsolution lamellae, we made thin sections polished up both surfaces. We observed those by polarizing microscope and electron microscope, and analyzed the composition of plagioclase by Electron-Probe-Micro-Analyzer.

In polarizing microscope observation, however magnetite lamellae are included in every sample in plagioclase, those are few in Abukuma gabbro and Tanzawa tonalite, but are a lot in Abukuma granite and Tanzawa gabbro. Notably, in some plagioclase, magnetite lamellae exist along zoning structure. In EPMA analysis, we found a positive correlation between anorthite content and Fe wt%, but there is no relation between the existence of magnetite lamellae and composition of plagioclase.

All plagioclase we analyzed by EPMA contains Fe, 0.09~0.76wt%, and there is no correlation between magnetite lamellae and plagioclase composition. Furthermore, amount of magnetite lamellae within plagioclase in Tanzawa granite and Abukuma gabbro is less than those in Abukuma granite, but Fe concentration in that of Abukuma gabbro and Tanzawa granite is higher than that of Abukuma granite.Therefore, Fe concentration in plagioclase is not the main factor of magnetite lamellae formation. Also, one plagioclase crystal shows area with and without exsolution lamellae, their formation is not regulated by cooling rates. And moreover, since magnetite lamellae existence follows zoning structure, those existence is controlled by around situation of plagioclase during crystal growth as oxygen fugacity or Fe distribution to each crystal. Especially, oxygen fugacity relates $Fe^{3+}$and Fe^{2+} ratio. Magnetite needs

both Fe^{3+} and Fe^{2+} for its formation. It is necessary to investigate the Fe^{3+}/Fe^{2+} ratio and distribution of Fe^{3+} to crystals.

References

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