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Aeromagnetic anomalies, magnetic petrology, and rock magnetism of hemo-ilmenite- and magnetite-rich cumulate rocks from the Sokndal Region, South Rogaland, Norway

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ABSTRACT

Aeromagnetic maps of the Egersund Mid-Proterozoic igneous province show a spectacular range of positive and negative magnetic anomalies with a contrast up to 15 600 nT. The positive magnetic anomalies are over magnetite norites and overlying mangerites and quartz mangerites of the Bjerkreim-Sokndal layered intrusion. These rocks are dominated by multi-domain (MD) magnetite. The negative magnetic anomalies are over ilmenite-rich norites of the Bjerkreim-Sokndal layered intrusion, the Tellnes ilmenite norite ore deposit, and massif anorthosites. These rocks are dominated by hemo-ilmenite and/or by silicates containing fine-grained oxide exsolution lamellae. Electron microprobe analyzes of coexisting Fe-Ti oxides in the layered intrusion confirm earlier observations that oxides in early magmatic rocks are dominated by hemo-ilmenite with minor end-member magnetite, followed by more reduced oxides dominated by titanomagnetite with minor near end-member ilmenite. What is not fully understood is the property of ilmenite with hematite exsolution lamellae, or, even more striking, hematite with ilmenite lamellae, to produce strong remanent magnetization of high coercivity and with a Néel temperature equal to or above the Curie temperature of magnetite. This property makes the rhombohedral oxides an important candidate to explain some high-amplitude deep-crustal anomalies on earth, or strong remanent magnetization on other planets. A remarkable feature in the Egersund province is that primitive magmas produced rocks rich in hemo-ilmenite causing negative magnetic anomalies related to magnetic remanence, and more evolved magmas produced rocks rich in magnetite related to positive induced magnetic anomalies, all in the course of crystallization-differentiation.