Rock-magnetic studies concerning source of the Martian magnetic anomaly

Rock-magnetic studies concerning source of the Martian magnetic anomaly

*佐藤 雅彦[1]、潮田 雅司[1]、中田 亮一[2]、山本 裕二[3]、西岡 孝[3]、小玉 一人[3]、綱川 秀夫[4]、望月 伸竜[5]
*Masahiko Sato[1], Masashi Ushioda[1], Ryoichi Nakada[2], Yuhji Yamamoto[3], Takashi Nishioka[3], Kazuto KODAMA[3], Hideo Tsunakawa[4], Nobutatsu Mochizuki[5]

1.産業技術総合研究所、2.海洋研究開発機構、3.高知大学、4.東京工業大学、5.熊本大学
1.National Institute of Advanced Industrial Science and Technology, 2.Japan Agency for Marine-Earth Science and Technology, 3.Kochi University, 4.Tokyo Institute of Technology, 5.Kumamoto University

Mars Global Surveyor observed the magnetic field of Mars, and revealed that there are many strong magnetic anomalies. The strong magnetic anomalies suggest an active core dynamo of early Mars (about 4 billion years ago), and some mechanism of crustal formation in the dynamo field. Since magnetic properties of crustal rocks depend critically upon the mineralogical form of magnetic particles, the strong magnetic anomalies can give crucial information about the chemical composition and oxidation state prevailing in the early Martian crust. However, source of the Martian magnetic anomalies, which are originated from thick magnetized layers within the crust, have been poorly understood yet because of the lack of basic information concerning magnetic properties of deep crustal rocks. Here, we report the results of rock-magnetic studies to interpret the source of the Martian magnetic anomaly.
To determine magnetic domain state of the source, we conducted in-situ magnetic hysteresis measurement of magnetite under high pressure up to 1 GPa. The results show that magnetite exhibits various pressure dependences of coercivity with respect to magnetic domain states: multidomain (MD) magnetite (linearly increase with pressure at a rate of +91%/GPa), pseudo-single-domain (PSD) magnetite (increases with pressure as a quadratic function), acicular single-domain (SD) magnetite (constant up to 1 GPa), and equidimensional SD magnetite (decrease with pressure at a rate of −15%/GPa). Taking into account these pressure dependences, relaxation time of remanent magnetization in the Martian crust was calculated as a function of depth and age. Remanent magnetizations carried by MD and PSD magnetites have been demagnetized within 4 billion years, except very shallow crustal part. On the other hand, the SD magnetite can stably retain its magnetization in the entire crust. Therefore, the source of the Martin magnetic anomaly is fine-grained SD magnetite.
As the mechanism that crystallize and maintain fine-grained SD magnetite in the deep crustal rocks, we focus on a plagioclase crystal with magnetite inclusions. The plagioclase crystal with magnetite inclusions is ubiquitous in mafic and intermediate terrestrial plutonic rocks, and should play an important role in controlling the magnetic properties of deep crustal rocks. To evaluate the role of the plagioclase crystal, we prepared plagioclase crystals from gabbroic anorthosite of the Duluth complex at Forest Center, Minnesota, USA, and magnetic measurements combined with microscopic observation and synchrotron radiation study were conducted for the single grain plagioclase crystals. The magnetic hysteresis parameters resulted in SD and PSD range on the Day plot. The low-temperature remanence curves showed pronounced remanence reductions at around 100–120 K, indicating that the plagioclase crystals contained nearly pure magnetite. The magnetite contents ranged from 40 to 680 ppm with an average of 270 ppm in weight, which could be sufficient to the source of strong magnetic anomalies. On the basis of the experimental results, we will discuss the chemical composition and oxygen state in the Martian crust, which was suited for bearing fine-grained SD magnetite.

キーワード：Rock-magnetism、Martian magnetic anomaly
Keywords: Rock-magnetism, Martian magnetic anomaly

