Geophysical Research Abstracts
Vol. 18, EGU2016-17956, 2016
EGU General Assembly 2016

Magnetic mineralogy of the Mercurian lithosphere

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Mercury and Earth are the only inner solar system planets with present-day core-dynamo magnetic fields, in contrast to the past fields of Mars and the Moon and the absence of evidence for a past or present field at Venus. Recently, the MESSENGER mission also measured magnetic fields from lithospheric magnetization on Mercury for the first time. These fields are consistent with remanent magnetization held by rocks exposed to an ancient, internally generated planetary magnetic field. However, the conditions for magnetization in the lithosphere of Mercury are unique among terrestrial planets, and the mechanisms for the acquisition (induced versus remanent) and alteration of magnetization are still unknown.

We investigate the physical and chemical environment of Mercury's crust, past and present, to establish the conditions in which magnetization may have been acquired and subsequently modified. Three factors are particularly crucial to the determination of crustal composition and iron mineralogy: the temperature profile of the lithosphere and its evolution over time, redox conditions in the planet's crust and mantle, and the iron content of the lithosphere. We explore potential mechanisms for remanence acquisition and alteration on Mercury, whose surface environment is distinct from that of other inner solar system planets in that it is both very hot and highly reducing. The long-term thermal history of Mercury's crust plays an important role in the longevity of any crustal magnetization, which may be subject to remagnetization through thermal, viscous, and shock mechanisms.

This thermal and compositional framework isused to constrain plausible candidate magnetic mineralogies, which can then be analyzed in terms of their capacity to acquire and retain magnetic remanence that is detectable from satellite orbit. We propose a suite of minerals and materials that could be carriers of remanence in the lithosphere of Mercury, including iron alloys, silicides, and sulfides.