Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SEM001-P02 会場:コンベンションホール 時間:5 月 26 日 10:30-13:00

Ultrafine-scale magnetostratigraphy with SQUID microscope: Application to ferromangenese crust and other materials

Ultrafine-scale magnetostratigraphy with SQUID microscope: Application to ferromangenese crust and other materials

小田 啓邦 [1*], 宮城 磯治 [1], Akira Usui[1], Benjamin P. Weiss[3], Franz J. Baudenbacher[4], Eduardo A. Lima[3]
Hirokuni Oda[1*], Isoji MIYAGI[1], Akira Usui[1], Benjamin P. Weiss[3], Franz J. Baudenbacher[4], Eduardo A. Lima[3]

[1]Geological Survey of Japan, AIST, [2]Kochi University, [3]Massachusetts Institute of Technology, [4]Vanderbilt University
[1]Geological Survey of Japan, AIST, [2]Kochi University, [3]Massachusetts Institute of Technology, [4]Vanderbilt University

Scanning SQUID microscopy enables us to do mapping of magnetic field over thin sections of geological samples at submillimeter scale. With this new technique, ultrafine magnetostratigraphy can be achieved on geological sample which we could not observe the polarity pattern due to the limitation of the spacial resolution. In the presentation, we show a successful example on marine ferromanganese crust and extend the possibility in the future. Hydrogenetic ferromanganese crusts are iron-manganese oxide chemical precipitates on the seafloor that grow over periods of tens of millions of years. Their secular records of chemical, mineralogical, and textural variations are archives of deep-sea environmental changes. However, environmental reconstruction requires reliable high-resolution age dating. Earlier chronological methods using radiochemical and stable isotopes provided age models for ferromanganese crusts, but have limitations on the millimeter scale. For example, the reliability of 10Be/9Be chronometry, commonly considered the most reliable technique, depends on the assumption that the production and preservation of 10Be are constant, and requires accurate knowledge of the 10Be half-life. To overcome these limitations, we applied an alternative chronometric technique, magnetostratigraphy, to a 50-mm-thick hydrogenetic ferromanganese crust (D96-m4) from the northwest Pacifi c. Submillimeter-scale magnetic stripes originating from approximately oppositely magnetized regions oriented parallel to bedding were clearly recognized on thin sections of the crust using a high-resolution magnetometry technique called scanning SQUID (superconducting quantum interference device) microscopy. By correlating the boundaries of the magnetic stripes with known geomagnetic reversals, we determined an average growth rate of 5.1 +- 0.2 mm/m.y., which is within 16% of that deduced from the 10Be/9Be method (6.0 +- 0.2 mm/m.y.). This is the finest-scale magnetostratigraphic study of a geologic sample to date. Ultrafine-scale magnetostratigraphy using SQUID microscopy is a powerful new chronological tool for estimating ages and growth rates for hydrogenetic ferromanganese crusts. It provides chronological constraints with the accuracy promised by the astronomically calibrated magnetostratigraphic time scale (1-40 k.y.). The technique can be extended to other geological objects such as stalagmite, hydrothermal deposites, desert varnish, etc. An analogue of dersert varnish would be found on Mars, which might have recorded ancient Martian magnetic field.