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PREFACE

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Special issue on "Recent advances in environmental magnetism and paleomagnetism"

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Introduction

This special issue is based primarily on Session SE04 "Recent advances in paleo-, rock and environmental magnetism" held during the Asia Oceania Geosciences Society (AOGS) 2014 Meeting (28 July–1 August in Sapporo, Japan). The special issue focuses on various topics in environmental, rock, and paleomagnetism including applications, instruments, and databases and is not limited to the presentations at the Session. In total, 13 articles were published in the special issue, which are described below in several categories.

Environmental and rock magnetism: applications

In the special issue, a total of five articles were published on various aspects of environmental magnetism. Liu et al. (2015) presented a characterization of iron oxides in surface sediments from potential dust source regions distributed throughout western and northern China. Magnetic mineral assemblages in the studied samples contain both antiferromagnetic (hematite and goethite) and ferrimagnetic (magnetite and maghemite) minerals with broad grain size distributions indicating multiple origins. Chinese Loess Plateau (CLP) sediments have relatively uniform magnetic properties, whereas the source material does not. The results provide excellent constraints on the initial properties of dust sources that are transported either to the CLP by the Asian winter monsoon or to the North Pacific Ocean by westerly winds.

Huang et al. (2015) presented the environmental magnetic variation around Papua New Guinea for the past 400 ka based on magnetic parameters and the $\delta^{18}O$ record of core MD05-2928. Rock magnetic analyses indicate that magnetic minerals were fewer and finer in interglacial periods, whereas the opposite is the case for glacial periods. Frequency analyses could resolve Milankovitch cycles. The strongest climate signal is the 100-ka period, which indicates that sea-level change played a dominant role in the long-term environmental setting; additionally, the signals of the 40- and 20-ka periods possibly suggest the influence of regional precipitation.

Kars and Kodama (2015) presented a high-resolution rock magnetic record from 169 samples collected at Hole C0008A in the Nankai Trough, offshore southwest Japan, during Integrated Ocean Drilling Program Expedition 316. The rock magnetic study, conducted at a core depth from 110 to 153 m below the sea floor, highlighted the widespread occurrence of magnetic iron sulfides, particularly greigite. Two thick iron sulfide layers containing greigite and pyrrhotite were identified, which are associated with the occurrence of gas hydrate. It is likely that a combination of many factors (availability of reactive iron, microbial activity, etc.) favors the formation of ferrimagnetic iron sulfides in the presence of gas hydrates.

Hayashida et al. (2015) presented the magnetic properties of sediment collected from Lake Ogawara to examine the limnological conditions on the Pacific coast of northeastern Japan shortly after the 2011 Tohoku earthquake and flooding of the lake by tsunami waves. At water depths below 10 m, the magnetic susceptibility and anhysteretic remanent magnetization (ARM) of high organic content greenish-black mud decreased considerably with increasing water depth. ARM increased slightly at water depths greater than 16 m. Although it is not clear whether the ARM carriers were the result of authigenic iron sulfide formation or the deposition of material suspended in the hypolimnion water layer, they suggest that the magnetic properties of the surficial sediments on the lake floor are controlled

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by both their location within the basin and the limnological stratification of the brackish lake water.

Oda et al. (2016) presented volcanic ash particles extracted from tephra-bearing ice samples collected from the Nansen Ice Field south of the Sør Rondane Mountains, Antarctica. Major element concentrations of the volcanic particles show high similarity with those of tephra layers associated with the South Sandwich Islands in the EPICA-Dome C, Vostok, and Dome Fuji ice cores. Rock magnetic experiments show that the magnetic mineral is pseudo-single-domain titanomagnetite, with ulvospinel content of 0.2–0.35, mixed with single-domain (SD) to superparamagnetic (SP) (titano)magnetite. Small blocks of the tephra-bearing ice were magnetized with a DC magnetic field of 25 mT and measured using a SQUID gradiometer, which enabled detection of the magnetic signal including that from samples with imperceptible quantities of tephra particles.

Environmental and rock magnetism: instruments and software

A frontier letter by Kodama (2015) presented an improved method for measuring dynamic magnetizations of bulk volcanic rock samples induced by a pulsed field using inductive differential coils, a preamplifier, integrator, and a high-speed digital storage scope. The measured M–H curves are comparable to the branches of the corresponding hysteresis loops measured in a static field. The pulse provides the rapid exponential decay with time constant corresponding to magnetic relaxation time. The system has the potential to be a versatile and convenient tool for rock magnetism.

A technical report by Fukuma and Kono (2016) presented a LabVIEW software program to control an automated three-component spinner magnetometer equipped with a thermal demagnetizer TSpin, which is utilized for routine operations in Thellier paleointensity experiments, enabling an overnight Thellier measurement without any user intervention. Due to a continuous series of remanence measurements combined with thermal demagnetization or partial thermoremanent magnetization (TRM) acquisition in a magnetic shield case without manual handling of a specimen, the chance of an orientation error or acquisition of spurious magnetization is almost completely eliminated.

Paleomagnetism: paleointensity

Two articles in the special issue are related to paleointensity studies. Yamamoto et al. (2015) presented an archeointensity study on baked clay samples taken from a reconstructed ancient kiln. Application of the Tsunakawa–Shaw method to the samples showed that those obtained from the floor surface of the kiln provided accurate archeointensity results. These samples mainly consisted of Ti-poor titanomagnetite grains, approximately 10 nm in size, with SD and/or SP states. They concluded that baked clay samples from a kiln floor are considered to be ideal materials for archeointensity studies.

A frontier letter by Sato et al. (2015) presented the rock magnetic properties of 1037 single zircon crystals sampled from the Nakagawa River, which crosses the Tanzawa tonalitic pluton in central Japan, for the purpose of future paleointensity studies. The isothermal remanent magnetization (IRM) intensities of 161 zircon crystals ($>\sim 4 \times 10^{-12}$ Am), which contained enough magnetic minerals, could be measured in a DC SQUID magnetometer. In the case that the crystals had low coercivity (B_c) values (<10 mT) and low natural remanent magnetization to IRM ratios (NRM/IRM) (<~0.1), the main remanence carriers appear to be nearly stoichiometric magnetite with pseudo-single-domain grain sizes, which are expected to be appropriate for the paleointensity study. TRM acquisition experiments on 12 zircon crystals that fulfilled these criteria show NRM/TRM ratios between 0 and 2, indicating that the NRM intensity is comparable with that of the TRM. The paleointensity estimated using the bulk NRM/TRM ratio for a sample with strong TRM showed a field intensity that was consistent with the geomagnetic field intensity over the last 5 Myr.

Paleomagnetism: tectonics

There are two articles in the special issue dealing with tectonics in East Asia. Based on a paleomagnetic study on Miocene sediments from the Oidawara Formation, eastern southwest Japan, Hoshi et al. (2015) revealed that clockwise rotation of southwest Japan occurred mainly between 17.5 and 15.8 Ma, at a rotation rate of ~23°/Myr. Furthermore, Jeong et al. (2015) presented the tectonic evolution of the Korean Peninsula based on the paleomagnetism and U–Pb geochronology of the late Cretaceous Chisulryoung Volcanic Formation. The weighted mean ages obtained by U–Pb zircon dating from the base and top of the formation are 72.8 ± 1.7 and 67.7 ± 2.1 Ma, respectively. Paleomagnetic results from the late Cretaceous ignimbrites show that Korea has been rigidly attached to China at least since the Cretaceous.

Paleomagnetism: database

Two technical reports on the paleomagnetic database GEOMAGIA50.v3 published in this special issue play an important role in paleomagnetism. Brown et al. (2015a) presented the development of a database dealing with paleomagnetic data for archeological and volcanic materials, which contains 14,645 data (declination, inclination, and paleointensity) from 461 studies published between 1959 and 2014. The web-based interface can be found at http://geomagia.gfz-potsdam.de. In addition, Brown et al. (2015b) presented a new database for sediments built upon the above-mentioned GEOMAGIA50.v3. For sediments, a strong emphasis has been placed on the storage of geochronological data, and this is the first magnetic archive that includes comprehensive radiocarbon age data from sediments. The web-based interface for the sediment database is located at http://geomagia.gfz-potsdam.de/geomagiav3/SDquery.php. The database continues to expand as legacy data are added and new studies are published.

Abbreviations
ARM: anhysteretic remanent magnetization; CLP: Chinese Loess Plateau; IRM: isothermal remanent magnetization; NRM: natural remanent magnetization; SD: single-domain; SP: superparamagnetic; TRM: thermoremanent magnetization.

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