Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-01 Room:201B Time:May 19 09:00-09:15

Paleomagnetic results from the Himaka Formation of the Morozaki Group (Early Miocene sediments), central Honshu

Hiroyuki Hoshi[1*], Tomoki Namikawa[1]

[1]Aichi University of Education

We present new paleomagnetic results from the sedimentary rocks of the lowest formation (Himaka Formation) of the Lower Miocene Morozaki Group. The paleomagnetism of the upper formations of the group has been previously reported, but there have been no published data for the Himaka. Oriented cores were collected from 16 stratigraphic sites (horizons) from the ca. 90 m sequence on the Saku-shima (Saku Island), 4 sites from the ca. 110 m sequence on the Himaka-jima (Himaka Island), and 2 sites from the ca. 60 m sequence on the southeastern tip of the Chita Peninsula. The sampled sites consist mostly of felsic fine tuff layers, with minor siltstone units. Cylindrical specimens were subjected to stepwise alternating-field or thermal demagnetization in order to extract characteristic remanent magnetization (ChRM) components. With the exception of a few sites where the remanent magnetization has been seriously affected by a normal-polarity secondary overprint, the Himaka Formation sites have reverse-polarity ChRM directions. Taking the magnetostratigraphy of the upper formations of the Morozaki Group into consideration, the Himaka Formation is correlative with Chronozone C5Dr (18.056-17.533 Ma). The site-mean ChRM directions are marked by a paleo-declination that is consistently southwest (reverse polarity). This is compatible with site-mean directions of the upper formations and can be explained by assuming a clockwise tectonic rotation. The paleo-declination of the Himaka Formation is deflected 10-20^o counterclockwise relative to the strike of the nearby Median Tectonic Line (MTL). This is also the case for the Shitara area (ca. 70 km to the northeast) and the Chichibu area (Kanto Mountains), indicating that the MTL had the same strike direction in these three areas in the late Early Miocene.

Keywords: paleomagnetism, Himaka Formation, Morozaki Group, Median Tectonic Line, tectonic rotation, Early Miocene

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-02 Room:201B Time:May 19 09:15-09:30

Paleomagnetic study of the Okhotsk-Chukotka Volcanic Belt at Magadan, Kolyma-Omolon Superterrane, Russia

Yo-ichiro Otofuji[1*], Gen Shogaki[1]

[1]Kobe University

Post-Cretaceous tectonic deformation of Eurasian continent can be estimated by comparison of Cretaceous paleomagnetic pole positions from its western and eastern extreme areas. We choose the Kolyma-Omolon Superterrane as one of the eastern extreme. Late Cretaceous ignimbrites are collected at 19 sites from the Kholchan Suite in the Okhotsk-Chukotka Volcanic Belt at the north of Magadan (60.4N, 151.0E) in the terrane. Characteristic paleomagnetic directions are isolated from 16 sites by AF demagnetization and their primary nature is ascertained through presence of both normal and reversed polarities. Late Cretaceous paleomagnetic direction after tilt correction is D=17.6, I=82.5, k=13.1, a95=10.5, N=16 at Magadan, corresponding to a paleomagnetic pole at Long. = 166.7, Lat. =72.4, A95=18.9. This pole falls on the pole position for the Chukotka, indicating the Kolyma-Omolon Superterrane and Chukotka behaved as a tectonic unit since Late Cretaceous. Compared with Late Cretaceous poles from Europe and the Mongolia block, pole positions from the Mongoria block, Eurasia and Magadan are arranged from the north to south along longitude of 170E. Disagreement of pole positions of western and eastern extreme areas suggests occurrence of deformation of the Eurasian continent later than Late Cretaceous. Pole positions from the Kolyma-Omolon-Chkotska block and Mongol block implies southward displacement of the Kolyma-Omolon-Chkotska block and northward displacement of the Mongol block. Continuation of closure of the Mongol-Okhotsk Ocean is one of post-Cretaceous tectonic deformation aspects within Eurasian continent.

Keywords: paleomagnetism, tectonics, Cretaceous, Asian continent

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-03 Room:201B Time:May 19 09:30-09:45

Updated three-component spinner magnetometer with thermal demagnetizer ”tspin”

Koji Fukuma[1*], Masaru Kono[2]

[1]Dept. Env. Sys. Sci., Doshisha Univ., [2]Global Edge Institute, Tokyo Institute of Technology

A three-component spinner magnetometer equipped with a thermal demagnetizer, which is called ”tspin”, is finally used for routine remanence measurements involving thermal demagnetization and the Thellier paleointensity method. The original instrument design and the data reduction procedure based on the spherical harmonic analysis were already developed by Kono et al. (1991).

Three components of a remanent magnetization of a standard size (1-inch) specimen can be measured by a single fluxgate sensor without changing specimen orientation. A specimen mounted on a quartz tube holder is rotated by a single axis and translated along the axis. We can obtain the magnetization components on the plane perpendicular to the rotating axis like a conventional spinner magnetometer, and also the axial component determined by the translation. This time the quartz tube is redesigned to be connected to the rotating axis by a chuck, so we can precisely set the specimen by using a laser level and then calibrated the declination value of the in-plane components. The effective sensitivity is currently of 5e-8 Am2 but should be improved by one order if housed in a magnetic shield room.

An electric furnace is available in line to heat a specimen up to 700 deg.C by translating along the axis. Cooling position is located between the furnace and the sensor. After a measurement step, the specimen is inserted into the furnace that is already maintained at the next temperature step. This procedure makes sure that the specimen always follows the same heating treatment, which is especially important for zero- and in-field processes during Thellier experiments. We have done temperature calibrations by attaching K-type thermocouples into and onto a dummy basalt specimen.

Now stepwise thermal demagnetization and the Thellier experiments can be automatically performed using a home-made software coded on LabVIEW. We just need to specify temperature steps and a dwell time in the furnace before running the software. Zijderveld and Arai diagrams are drawn on a display in the course of measurements. Because we do not need to change the specimen orientations and a series of heating, cooling and measurement is performed without taking out the specimen from the mu-metal shield, we can see extremely beautiful straight lines on Zijderveld or Arai diagrams. By introducing ”tspin”, we expect laborious Thellier paleointensity experiments are carried out much more easily and precisely.

Keywords: paleointensity, Thellier method, magnetometer, thermal demagnetization

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-04 Room:201B Time:May 19 09:45-10:00

Rock magnetism of the volcanic materials recovered from Louiville Seamounts during IODP Expedition 330

Yuhji Yamamoto[1*], Toshitsugu Yamazaki[2], Hiroyuki Hoshi[3]

[1]Center for Advanced Marine Core Research, Kochi University, [2]Atmosphere and Ocean Research Institute, University of Tokyo, [3]Aichi University of Education

Integrated Ocean Drilling Program (IODP) Expedition 330 recovered volcanic materials from seamounts along the northwestern part of the Louisville hotspot track (50-74 Ma). The recovered materials include basalts which are considered to be erupted under subaerial or shallow submarine conditions. We have been trying absolute paleointensity measurements on them, and we in parallel have studied rock magnetic properties to assess the paleointensity results. In the present study we mainly focus on thermomagnetic properties.

Thermomagnetic analyses using a magnetic balance (Natsuhara Giken NMB-89) in vacuum condition have been made on 57 rock chips from Site U1372, 28 chips from Site U1373, 140 chips from Site U1374, 44 chips from Site U1376, and 19 chips from Site U1377 (288 chips in total). The resultant curves can be classified into the five types (A, B, C, D, and E).

Type A: almost reversible thermomagnetic curves observed in 38 specimens. They show a single phase of Ti-poor titanomagnetite with Tc (Curie temperature) higher than ~ 500 degC.

Type B: almost reversible thermomagnetic curves recognized in 18 specimens. The difference from type A curves is existence of Ti-rich titanomagnetite phases with Tc lower than ~ 500 degC, in addition to the high Tc (> ~500 degC) phase.

Type C: somewhat irreversible thermomagnetic curves found in 49 specimens. They show a single phase of Ti-poor titanomagnetite with Tc higher than ~ 500 degC, however, cooling curves result in reduction in induced magnetization relative to heating curves in most cases. At ~ 50 degC, amount of the reduction is about 20-60 percent.

Type D: irreversible thermomagnetic curves seen in 50 specimens. They are usually characterized by two phases of titanomagnetite, one with moderate Ti content (Tc ~ 150-300 degC) and the other with low Ti content (Tc > ~ 450 degC). Cooling curves outweigh heating curves in most cases.

Type E: irreversible thermomagnetic curves occurred in 133 specimens. They exhibit relatively low Tc (~ 200-300 degC) components followed by bumps of high Tc (~ 400-500 degC) in heating curves. The bumps are considered to originate from inversion of titanomaghemite. Cooling curves outweigh heating curves in most cases.

Some of the selected specimens will be analyzed using scanning electron microprobe and other instruments. We will report these results together with the thermomagnetic ones.

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SEM36-05 Room:201B Time:May 19 10:00-10:15

Rockmagnetism of submarine basaltic rocks from IODP Site C0012

Hirokuni Oda[1*], Yuhji Yamamoto[2], Yuzuru Yamamoto[3], Weiren Lin[3], Xixi Zhao[4], Huaichun Wu[6], Masayuki Torii[6], Toshiya Kanamatsu[3], Osamu Ishizuka[1]

[1]Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology, [2]Kochi University, [3]Japan Agency for Marine-Earth Science and Technology, [4]University of California, Santa Cruz, [5]China University of Geosciences, Beijing, [6]Okayama University of Science

The IODP Expeditions 322 & 333 penetrated sediments-basement boundary and recovered successive cores at Site C0012 situated on a topographic high named Kashinosaki Knoll. The collected basement samples are composed of alternating beds of pillow basalts and hyaroclastite and were retrieved by rotary core barrel drilling system. Paleomagnetic measurements on basaltic basement rocks from Site C0012 show that the stable magnetization has reversed polarity. Rock magnetic experiments were conducted to understand the magnetic minerals contributing to the primary magnetization. Thermomagnetic curves during heating in air shows a hump around 500degC which cannot be seen for the curve in vacuum, Ar or He atmosphere. This can be interpreted as a result of oxidation of the magnetic mineral. The results in air, vacuum, Ar and He show maximum curvatures at 326degC, 332degC, 328degC and 303degC, which might show a Curie temperature of the natural magnetic mineral (titanomaghemite). The peaks at around 402degC, 392degC and 424degC in vacuum, Ar and He might correspond to break down (decomposition) of magnetic minerals (titanomaghemite) by heating. A hump at 493degC for the heating curve in He could not be resolved enough in the heating curve up to 527degC. This might be a result of the multiple heatings and heating rates, which suggest the progressive production of titanomagnetite (from titanomaghemite) and subsequent hematite production (reduction in magnetization intensity). Low-temperature magnetic measurements were also conducted and will be interpreted together with Curie temperatures.

Keywords: rock magnetism, submarine basalt, low temperature magnetometry, Curie temperature, Kashinosaki Knoll

Japan Geoscience Union Meeting 2013
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SEM36-06 Room:201B Time:May 19 10:15-10:30

Paleomagnetic study of the Holocene volcanic rocks from post-caldera central cones of Aso Volcano

Takanori Yato[1], Nobutatsu Mochizuki[2*], Yasuo Miyabuchi[3], Kyohei Kubota[4], Hidetoshi Shibuya[1]

[1]Department of Earth and Environmental Sciences, Kumamoto University, [2]Priority Organization for Innovation and Excellence, Kumamoto University, [3]Faculty of Education, Kumamoto University, [4]Mifune Junior High School

We have conducted a paleomagnetic study on Holocene volcanic rocks from post-caldera central cones of Aso Volcano. On the basis of the previous studies (e.g. Miyabuchi, 2009), these volcanic rocks (lavas and scoria cones) were considered to be formed above the K-Ah tephra (7300 cal year BP). Except a ^{14}C age, no radiometric age is reported for these young lavas and scoria cones.

Paleomagnetic sampling was made at 25 sites of seven units. Nineteen sites gave reliable mean paleomagnetic directions that had a 95% confidence circle of lower than 5 degree. The other sites of large ($>$ 5 degree) 95% confidence circle tend to have a strong natural remanent magnetization, which suggests that local magnetic anomaly at the sites may to be related to the large scatter of natural remanent magnetization (NRM) directions.

Interestingly, different sites from a few lavas, which had been treated as a single unit in the geological map of Aso Volcano (Ono and Watanabe, 1985), gave distinct mean directions at 95% confidence level. For Kishimadake lava, Ojodake lava, lavas from Nakadake young edifice, two or three different mean directions were obtained from multiples sites. These differences in mean directions indicate that multiple flows were extruded with a temporal gap of more than 10 or 100 years. We also found that Kamikomezuka scoria, two sites of Kishimadake lava, two sites of Ojodake lava, and two sites of Nakadake lava gave identical mean directions at 95% confidence level. The concordance of the mean directions suggests that the multiple vents erupted simultaneously, in a time interval of the order of 10 years, and these lavas were extruded over a wide area of the post-caldera central cones. On the basis of the volcanio stratigraphy, the event of the simultaneous eruptions appeared to occur between 3000 and 5000 years BP.

Keywords: paleomagnetic direction, Aso Volcano, lava, scoria, simultaneous eruptions

Japan Geoscience Union Meeting 2013
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SEM36-07 Room:201B Time:May 19 11:00-11:15

Paleomagnetic secular variation record from the Holocene sediment of the Ichi-no-megata marr, Akira Prefecture

Akira Hayashida[1*], Kazuhiro Anraku[1], Yukie Hata[1], Noriko Fujioka[1], Kazuyoshi Yamada[2], YOSHITSUGU SHINOZUKA[3], Hitoshi Yonenobu[4], Katsuya Gotanda[5], Tsuyoshi Haraguchi[6], Yoshinori Yasuda[7]

[1]Doshisha University, [2]Waseda University, [3]Hokkaido University, [4]Naruto University of Education, [5]Chiba University of Commerce, [6]Osaka City University, [7]Tohoku University

The Ichi-no-megata is a maar lake located in the Oga Peninsula, Akira Prefecture, which has a maximum water depth about 45 m. In 2006, core samples of the sub-bottom sediments were obtained at three holes in the central part. The core sediments, mostly composed of laminated clay or silt intercalating sandy turbidite layers and tephra deposits, provided a composite sedimentary profile of about 37 m long. Results of tephra analysis and radiocarbon dating suggested that the interval above the volcanic products from the adjacent San-no-megata maar (23.7 to 32.3 m deep) covers a time period since about 25 ka with a nearly constant sedimentation rate about 0.71 m/ky.

Using pass-through methods, we measured magnetic susceptibility and natural remanent magnetization (NRM) of u-channel samples. The magnetic susceptibility data confirmed the hole-to-hole correlation based on lithologic observations. Stepwise AF demagnetization of the NRM showed that the remanence is essentially composed of a single stable component. Because the studied sequence comprises of core segments typically about 80 cm long, a continuous record of declination change was not obtained. Inclination data is characterized by an average value about 50 degree and amplitudes comparable with a paleomagnetic secular variation (PSV). In particular, the inclination variation above 9 m deep shows a good similarity with the Holocene PSV record reported from Lake Biwa. Occurrence of the Kikai-Akahoya tephra (7.3 ka) in both sequences support correlation of the two records, suggesting usefulness of PSV records in high-resolution stratigraphic correlation at a regional scale.

Keywords: paleomagnetic secular variation, annual verve, remanent magnetization, magnetic susceptibility

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SEM36-08 Room:201B Time:May 19 11:15-11:30

Paleodirections and intensities from two old kilns in Okayama prefecture

Yu Kitahara[1*], Yutaka Tamai[1], Tadahiro Hatakeyama[1], Masayuki Torii[1], Yuhji Yamamoto[2]

[1]Okayama University of Science, [2]Kochi University

The archaeological remains such as kilns of Sueki type potteries record very stable thermo remanent magnetization (TRM), because they were baked at a high temperature more than 1,000 ^{o}C. In addition, their age are well estimated with very high precision in many cases, by using pottery type morphology. Thus, the archaeomagnetism can be used widely to examine the magnetic secular variation of the past several hundred to thousand years. However, there is very little number of data (direction 682 and intensity 63) which are used to construct the standard curve of the magnetic secular variation in Japan. This study aims to estimate a paleomagnetic directions and intensities of two old kilns (Sayama Shin-ike 1st kiln, Sayama Higasiyama-Oku kiln) of Bizen city, Okayama prefecture and contribute to the improvement of archaeomagnetic database.

For the paleomagnetic direction, we got samples of baked earth obtain from two old kilns (floor and wall; remanent magnetization intensities are 10^{-1}~10^{1} A/m) and we decided a principal components of measurements of remanent magnetization with stepwise AF-demagnetization under 0~100mT conditions. In the result, we obtained average magnetization directions, of D=-13.8+-1.8^{o} I=51.6+-1.6^{o} a_{95}=1.1^{o} k=261.7 from Shin-ike (n=59) and D=-11.6+-2.8^{o} I=46.7+-1.9^{o} a_{95}=1.9^{o} k=253.7 from Higasiyama-Oku (n=24).

From rock magnetic analyses, the characteristic magnetic mineral recording the remanent magnetization is likely be magnetite. In addition, these samples were almost not influenced by the heating. These results suggest that these samples are suitable for paleointensity measurements (IZZI method and Tsunakawa-Shaw method). In the paleointensity result, obtained average magnetization intensity by IZZI method is 61.3+-3.2uT (Shin-ike, n=4) and 53.6+-7.1uT (Higashiyama-Oku, n=8). intensity by Tsunakawa-Shaw method indicates the results of 54.1+-10.6uT (Shin-ike, n=2) and 67.1+-10.7uT (Higashiyama-Oku, n=2).

The estimated ages from comparison the average magnetization directions and the secular variation curve are consistent with archaeological era (Sin-ike; latter half of 8C, Higasiyama-oku; 9 to 11C) in the range of errors. Field intensities obtained by IZZI method shows the values that is nearer to intensity standard curve of Japan than Shaw method. Thus, as for the samples used in this study, it is supposed that IZZI method is suitable for the measurement of paleointensity.

Keywords: Archaeomagnetism, Paleomagnetic direction, Paleomagnetic intensity, Old kilns of Sueki Potteries

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SEM36-09 Room:201B Time:May 19 11:30-11:45

Searching a paleomagnetic record of the Laschamp excursion in the Hikageyama lava of the Sanbe volcano

Hiroto Nishiyama[1*], Akira Hayashida[2], Yoshihiro Sawada[3], Tohru Danhara[4], Shigenori Kawano[5]

[1]Sci. Environ. Math. Model., Grad. Sci.&Engi., Doshisha Univ., [2]Dept. Environ. Sys. Sci., Doshisha Univ., [3]Shimane University, [4]Kyoto Fission Track Ltd., [5]Shimane Nature Museum of Mt.Sanbe

The Laschamp excursion is one of the best-known geomagnetic excursions in the late Brunhes chron, which was first recognized in lavas from the French Massif Central. According to recent radiometric dating of the lava flows and stratigraphic correlations of the Atlantic sediments with the Greenland ice cores, the Laschamp excursion is dated at about 41 ka and assigned with the interstadial 10. Among widespread tephra deposits in Southwest Japan, the Sanbe-Ikeda (SI) volcanic ash layer is dated at 43 to 46 ka. It is expected therefore that the Laschamp excursion is recorded in volcanic rocks or sedimentary sequences overlying the SI tephra.

We made paleomagnetic study of the Hikageyama dacite, which is overlying the Ikeda Pumice Deposit, the source of the SI tephra deposit. We collected oriented samples at 9 sites and measured natural remanent magnetization (NRM) on a spinner magnetometer. Stepwise alternating field (AF) demagnetization revealed that NRM of most samples are essentially composed of a single component, while some samples showed highly stable remanence which cannot be demagnetized at peak AF of 100 mT. We also obtained a fission-track date of zircon crystals at 36+/-7 ka.

Among the 9 sites, 4 sites in the eastern part of the Hikageyama yielded consistent site mean directions characterized by shallow inclinations and easterly deflection. These site means exceed a common range of paleosecular variation, providing virtual geomagnetic poles (VGP) at around 50 N and 100 W. It can be assumed therefore that the Hikageyama dacite recorded anomalous geomagnetic field at the time of the Laschamp excursion.

Keywords: Geomagnetic excursion, Laschamp excursion, Virtual geomagnetic pole, Hikageyama lava

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SEM36-10 Room:201B Time:May 19 11:45-12:00

A preliminary study on the geomagnetic paleointensity experiments using single zircon crystal

Masahiko Sato[1*], Shinji Yamamoto[2], Hideo Tsunakawa[3], Yuhji Yamamoto[4], Yoshihiro Okada[3], Masao Ohno[1]

[1]Kyushu University, [2]Tokyo University, [3]Tokyo Institute of Technology, [4]Kochi University

Geomagnetic paleointensity data provides critical information such as thermal evolution of the Earth [1]. Also a state of geomagnetic field closely relates to a surface environment [2]. It is pivotal to know the variation of geomagnetic field intensity throughout the history of the Earth.

Paleointensity have been intensively recovered from whole rock samples for several decades [3]. Recently, high-sensitivity superconducting quantum interference device (SQUID) magnetometer has enabled us to measure natural remanent magnetization (NRM) of single silicate crystal extracted from a rock sample [4], increasing the success rate of the paleomagnetic experiments. However, until now, we have not yet obtained enough data to resolve billion-year-scale geomagnetic field variation, and need to obtain more paleointensity data, especially older than 5 Ma [3].

In the present study, we focus on a single zircon crystal. Since river sand originates in rocks widely distributed in river basin, detrital zircons in the sand have various ages [5]. If the geomagnetic paleointensity can be measured using the single zircon crystal, we will probably obtain paleomagnetic data enough to resolve the long-term geomagnetic field variation.

Zircon crystals used in this study were sampled from sands of Nakagawa River, Tanzawa Mountain. We have conducted a suite of basic rock-magnetic measurement on assemblage of 26 zircon crystals: isothermal remanent magnetization (IRM) acquisition, stepwise alternating field demagnetization (AFD) of saturation IRM (SIRM), and low-temperature cycle using a Magnetic Property Measurement System (MPMS). Magnetic properties of the zircon crystals have been resulted in as follows: (1) the crystals contain nearly pure magnetite (Fe_3O_4), and they are in both single-domain (SD) and multi-domain (MD) states, (2) SIRM intensity is about 1 x 10^{-3} Am^2/kg (1x10^{-3} Am^2/kg x 1 mg = 1 x 10^{-9} Am^2), and (3) SIRM has high-coercivity fraction up to 20 mT.

Existence of the SD magnetite contained in the zircon crystals has the potential to recover the paleomagnetic information. Taking into account the existence of MD magnetite, stepwise-demagnetization after low-temperature demagnetization (LTD) is an efficient approach for paleomagnetic measurement. Now, our plan is to conduct LTD/stepwise-AFD measurement of NRM and IRM for single zircon crystal by using SQUID magnetometer. On the basis of the rock-magnetic studies and the NRM/IRM measurements, we will discuss the feasibility of the paleointensity experiment using single zircon crystal.

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Keywords: Single Zircon Crystal, Geomagnetic Paleointensity

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-11 Room:201B Time:May 19 12:00-12:15

Paleointensity determination of welded tuffs: Investigation on the curved NRM-TRM1∗ plots

Satomu Fujii[1∗], Nobutatsu Mochizuki[2], Takeshi Hasegawa[3], Makoto Okada[3], Hidetoshi Shibuya[1]

[1]Department of Earth and Environmental Sci., Kumamoto Univ., [2]Priority Org. for Innovation and Excellence, Kumamoto Univ., [3]Department of Earth Sci., Faculty of Sci. Ibaraki Univ

There are some widespread tephras identified in marine sediment cores which have been correlated with the oxygen isotope stratigraphy. If we could obtain absolute paleointensites from the welded tuffs which were formed with these tehpras, we can correlate the absolute paleointensites to the oxygen isotope stratigraphy. That is, we can compare the absolute paleointensity and a relative paleointensity on oxygen isotope stratigraphy with no error in age. For this purpose, we are measuring absolute paleointensites from welded tuffs which have been correlated with widespread tephras. In the JpGU 2012 Meeting, we reported paleointensities from Funakura, Ito, Kakuto, Imaichi and Yabakei welded tuffs which were correlated to K-Ah, AT, Kkt, Ss-Az and Ss-Pnk, respectively using the LTD-DHT Shaw method.

In addition to the data noted above, we have been conducting paleointensity measurements on 11 units (19 sites). To date, we have have collected samples from 16 units (30 sites) in total. We have obtained reliavle paleointensities from 9 unis (18 sites). On the other hand we have obtained no paleointensity estimate from 8 sites. In these sites, NRM-TRM1∗ plots are curved, where the correlation coefficient r_N is lower than 0.995. We considered that the cause for the curved NRM-TRM1∗ plots might be NRM, and checked the distribution of blocking temperature and coercivity. Two peaks are observed in the distribution of blocking temperature for the samples from the sites which gave the curved NRM-TRM1∗ plots, while a single peak is observed for the samples from the sites which gave the straight NRM-TRM1∗ plots. We are going to conduct rock magnetic measurements and discuss possible causes of the curved NRM-TRM1∗ plots.

Keywords: paleointensity, welded tuff, LTD-DHT Shaw method, blocking temperature, rock magnetism

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(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-12 Room:201B Time:May 19 12:15-12:30

Modelling the Earth's core from geomagnetic observations: toroidal magnetic field near the core surface

Seiki Asari[1*]

[1]University of Potsdam, Germany

The subject of this study is revealing the structure and dynamics of the Earth's core based on direct observations of the geomagnetic field. In this presentation, we report on an attempt to image the toroidal magnetic field near the core surface. The toroidal field may be predominant inside the core, and play a substantial role in spherical shell dynamos. It is desirable to know the toroidal field distribution for discussing the core dynamics, including the geodynamo. However, the toroidal field is absent at or above the Earth's surface. There is no straightforward way of envisaging the toroidal field in the deep Earth from magnetic observations, contrary to the poloidal field for which a simple downward continuation can be used.

In this work, we develop a method that takes advantage of the magnetohydrodynamics theory for observational imaging of the toroidal field. Inverse modelling of the core surface flow from a secular variation model has already been established by previous studies. Here, we perform the flow modelling while imposing the "tangential magnetostrophy" (TM) constraint (Asari & Lesur, 2011), so the horizontal Lorentz force may be computed from them. Then the poloidal component of the electrical current density is derived from the Lorentz force. Having this as a boundary condition at the core-mantle boundary, we eventually obtain the toroidal field by solving the induction equation in the mantle.

We implement the above procedure in the spectral domain, with all the involved parameters expanded in the spherical harmonics. For the main field model, GRIMM2 (2000.0-2010.0) built from CHAMP satellite data is adopted. The toroidal field imaging is subject to ambiguity, due to the non-uniqueness of the core surface flow modeling. We derive various images of the toroidal field by changing the flow constraint such that the subsequent TM flow models get gradually closer to tangential geostrophy (TG) flow.

The estimated models of poloidal current are assessed in reference to an output of numerical dynamo simulation, as there is otherwise little prior information about the core electrical current. When the TM flow models are close, to a certain extent, to TG flow, a characteristic pattern of the poroidal current appears that is much in common with that of the numerical dynamo. The current is concentrated in the low latitudes where geostrophy is relatively weak, and it has convergences/divergences elongated in parallel with the geographical equator. The TM flow models that are strongly magnetostrophic are regarded as ineligible, having significant current at high latitudes, with no noticeable similarity to the current pattern of the numerical dynamo. The toroidal field associated with the qualified TM flow model exhibits such a characteristic distribution that azimuthal flux dominates in low latitude zone. This is in consistency with the scenario of upwelling flows near the core surface; the intense poloidal field patches near the equator in the Atlantic hemisphere are caused by upwelling flows that distort the toroidal field into manifesting above the core surface.

Keywords: core, dynamo, geomagnetic field, satellite magnetic observation, core flow, inversion

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P01 Room:Convention Hall Time:May 19 18:15-19:30

It was not switching global geo-magnetic fields that created the alternating anomalies over oceanic ridges

Shinichiro Mado[1*]

[1]MAROSA

[1] Introduction

The global geo-magnetic field is said to have alternating polarity that switches every some 670 thousand years. However, such a periodically alternating global geo-magnetic field is supported only by observed local geo-magnetic anomalies. Nobody observed directly any global switching geo-magnetic field of the Earth.

The observed anomalies are not global but local. Therefore, it is not necessary to conclude that there is a switching global geo-magnetic field which has a periodically alternating polarity.

In this paper, we will present a mechanism to create the alternating geo-magnetic polarity patterns observed over the oceanic ridges. It will be clarified that it is no use to assume the hypothesis of periodically alternating polarity of the global geo-magnetic field.

[2] Periodically Alternating Global Geo-Magnetic Field and Geo-Magnetic Anomalies

It is said that the global geo-magnetic field of the Earth has periodically alternating polarities which switched its N-pole with S-pole every some 670 thousand years. This fact is derived from the observed data of geo-magnetic anomalies over oceanic ridges and also with the empirical estimations of the age of oceanic bottom.

However, it is not global data but only local data to be observed actually. Is it enough to conclude that there is a global fact which we observed only local evidences?

[3] Geo-Magnetic Anomalies over the Oceanic Ridges

Vine & Matthews(1963) observed actually the geo-magnetic anomalies over the oceanic ridges. They concluded that the oceanic bottom was created by lava flowed out from the oceanic ridges and the oceanic bottom was gladually extended.

According to their estimation, it takes less than 150 million years to build the oceanic bottom.

[4] Another Mechanism by local fields

However, it is promature to conclude the existence of periodically alternating polarity of the global geo-magnetic field of the Earth. Actually, the alternating polarities of lacal geo-magnetic fields was created by another utterly different mechanism (Cf. Figure).

This mechanism is based on a very simple physical phenomenon. We know very well the physical fact that a magnet has necessarily two different poles, namely S-pole and N-pole, and also that a S-pole attracts N-poles of other magnets, and that a N-pole attracts S-poles of other magnets, and that magnet poles with the same charge repel each other.

We know also that the magnetic polarity comes from the magnetic polarities of atoms. Here we call the tiny magnets, composed of each atom, micro magnets. When the magnetic symmetry was broken in the cooling down iron-rich lava, that flowed out from the oceanic ridge, obeying this physical law, micro N-poles point toward the S-pole of the peripheral magnetic field and micro S-poles point toward the N-pole of the peripheral magnetic field.

As a consequence of that, the newly cooled down lava will have the reverse magnetic field to the former peripheral magnetic field.

Therefore, the secondary flowed out lava, when it is cooled down, accepts the reverse local field created by the previously flowed out and cooled down lava. This magnetizing mechanism creates obviously the alternating polarities of the local anomalies. This is the real mechanism to create the observed local geo-magnetic anomalies. In this mechanism it is possible to make not only horizontal anomalies but also vertical anomalies. That fact fits well Vine & Matthews (1963).

[5] Global Geo-Magnetic fields Doesn't Alternate Periodically

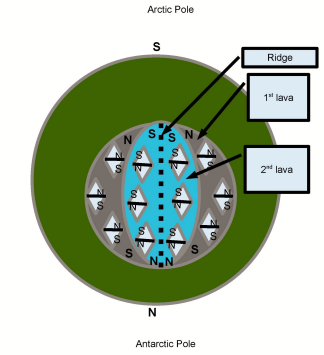
We reached the conclusion that the hypothesis of periodically alternating global geo-magnetic polarity of the Earth should be

rejected because it has no use and no evidence. Instead, we should accept the newly devised mechanism to create the observed local geo-magnetic anomalies over oceanic ridges.

[References]

[1]F. I. Vine and Dr. D. Matthews, 'Magnetic Anomalies Over Oceanic Ridges', ***Nature***, September 7, 1963.

Keywords: Mechanisms of Alternating Geo-Magnetic Anomalies, Geo-Magnetic field, Geo-Magnetic Anomalies, Oceanic Ridges, Oceanic Bottom, Geo-Physics



Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P02 Room:Convention Hall Time:May 19 18:15-19:30

A geomagnetic excursion found at around 2.3Ma from a marine sequence in the southernmost part of the Boso Peninsula

Toru Maruoka[1*], Makoto Okada[2]

[1]Graduate School of Science and Engineering,Ibaraki University, [2]Department of Science ,Ibaraki University

The Chikura Group is distributed in the southernmost part of Boso Peninsula corresponding to the lower Pleistocene and the upper Pliocene. Since those intensities of magnetization are quite strong and stable, reliable paleomagnetic records can be obtained in the Chikura Group. We conducted a paleomagnetic study on the middle part of the Chikura group to recover a reliable record of geomagnetic excursions and/or short polarity events such as the period of the sub-normal polarity Reunion, during the Matuyama reversed polarity chron.

After detailed route map and a geologic column section were made for this study, we took 107 mini-cores for paleomagnetic measurements from 46 sites along the studied route.

As the results of thermomagnetic analysis, major magnetic carrier was estimated to be magnetite. The result of AMS (Anisotropy of magnetic susceptibility) measurements showed that the grains of those specimens were slightly rotated by the influence of a fold whose axis is just beside on the sampling route. But we decided to leave this result out of consideration, because this angle of rotation does not have much influence on identification for polarity events and excursions.

As the result of Paleomagnetic studies, VGP (Virtual Geomagnetic Pole) latitude indicated an excursion at the bottom part of the studied section.

According to an age model created in this study section, the excursion is calculate to have a duration for 8000 years centered at around 2.31Ma. There are no polarity reversal and excursion observed above that at this section.

Keywords: paleomagnetism, Reunion, excursion, Boso Peninsula

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P03 Room:Convention Hall Time:May 19 18:15-19:30

Variance of magnetic properties of Hayachine ultramafic rock body in Tohoku District, Japan

Rie Morijiri[1*], Mitsuru Nakagawa[1]

[1]Geological Survey of Japan, AIST

Serpentinite obtained crystallization remanent magnetization during serpentinization prior to uplifting crust, because of the random orientations from Mitsuishi serpentine belt, Hokkaido, Japan(Morijiri and Nakagawa, 2005). However, some examples of paleomagnetic directions aligned with rocks from the Kitakami Mountains, Japan has been reported. Inferred from geological studies might be suffered from contact metamorphism by intrusion of granite, after uplifting.

During study of the Geological map 1/50000 ” Hayachine-San” (in printing), in the Hayachine ultramafic rocks, Kitakami Mountains, serpentinite samples for petrographic description were taken without orientation. Degree of serpentinization shows 30-80%, in southern than northern-central body, probably lower that percentage. Olivine is generally 1.2-2.0 mm in diameter which, replaced by serpentine along the cleavage and grain boundary. As well, the fine-grain containing beads of magnetite and fine metamorphic recrystallized olivine occur in the southern part. Serpentine occurs in the matrix of mesh-like texture, in fine vein with talc. Chromites are 0.3-1.0 mm in diameter and, been shown as a pseudomorph that subhedral in brown only internal or fully opaque. Often in the southern part, medium-grained (1.0-3.0 mm in length) tremolite with fascicular or tabular, and fibrous anthophyllite recrystallized, cut an original olivine texture. Appearances of metamorphic minerals are considered caused by thermal effect of Tono granodiorite body located in the South. Samples of the stuff in the same complex and slightly different distance from the Tono granodiorite think thermal metamorphic effects 13 more choice carried out various magnetization analysis of heat. In this case, not a paleomagnetic study, but can show examples of thermal magnetization curves of received heat contact metamorphic rocks.

Thirteen rock samples were collected without directions. Some pieces of these samples were measured. The natural remanent magnetizations(NRM) of pieces were measured using a pass-through cryogenic magnetometer (MODEL755R, 2G Enterprise). The alternating field demagnetization(AFD) of each piece was performed stepwisely starting from 0 to 100 mT at 5mT interval. The anhysteretic remanent magnetization(ARM) were also measured. The initial susceptibilities were measured using a susceptibility meter(KLY-3, AGICO). Hysteresis curve measurements at room temperature and thermo-magnetic analysis(Js-T curves) in a vacuum were done using the 0.1 to 0.2 g portion of each rock sample using a vibrating sample magnetometer(VSM, BHV-55L, RIKEN-Denshi).

Samples obtained from near granite were shown significantly different curves. This may be in effect of sulfide minerals, such as microscopic pentlandite in serpentinite, as described by Fujimaki and Yomogida(1986).

The authors thank Dr. Minoru Funaki of National Institute of Polar Research and Dr. Naoko Ueno of Toyo University for their assistance in using magnetometers.

Keywords: Thermomagnetic analysis, serpentinite, contact metamorphism, Hayachine, Kitakami

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P04 Room:Convention Hall Time:May 19 18:15-19:30

Kelvin-Helmholtz wave texture in Nojima fault gouges and its rock magnetic constraint to temperature rise

Norihiro Nakamura[1*]

[1]Depart. Earth Sci., Tohoku University

Nojima fault gouges exhibit a characteristic flow microtexture of a wavy boundary plane, a folding structure and a Kelvin-Helmholtz (KH) wave texture. The flow microtexture has been evident as a product of frictional melting slide (Otsuki et al. 2003) or of steady-state frictional non-melting slide (Mochizuki et al. 2009). It is important to constrain the formation mechanism (melting or non-melting) from these flow microtextures of a natural gouge sample. Ishikawa et al. (2008) proposed the coseismic presence of high temperature fluids during earthquake, resulting in dynamic fault weakening. Such high temperature fluid might liquefy a gouge or thermally pressurize a fault gouge to cause instability of friction. We found a distinct KH instability-promoted wave texture in a granular material of Nojima fault gouge. The well-known example of KH instability is a cloud that the cloud-atmosphere interface becomes an unstable vortex sheet that rolls up into a spiral. The instability occurs at the interface between two fluids of different densities shearing at different velocities (Thorpe 2005). The KH wave was found along a slip plane in a blackish cohesive gouge (pseudotachylyte-like gouge), resulting in the presence of instability at the slip interface during ancient earthquake or creep. The wave instability occurred at c.a. 1.5mm apart and c.a. 0.7mm height. Thin section observations showed the blackish cohesive gouge consisted of granular materials for both sides of the interface and the KH wave occurs in a denser granular material along an earthquake-originated sharp slip plane. Our scanning Magneto-impedance magnetic microscope observation shows the KH wave dense layer is only magnetized in isothermally-magnetized thin section, revealing the production of magnetic mineral in KH wave. Because the Nojima fault gouge contains iron-carbonate (siderite), the thermal decomposition of siderite produces magnetite more than 400 degree C. Therefore, we suggest that the KH wave is generated through KH instability in a high-temperature (>400C) granular dense layer with different densities and different slip velocities. This result constrains our understanding of earthquake slip dynamics.

Japan Geoscience Union Meeting 2013
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SEM36-P05 Room:Convention Hall Time:May 19 18:15-19:30

Magnetic minerals of a sediment core (IODP Site U1314) determined by low-temperature and high-temperature magnetism

Masao Ohno[1], Masahiko Sato[1*], Tatsuya Hayashi[2], Chizuru Miyagawa[1], Yoshihiro Kuwahara[1]

[1]Division of Earth Sciences, Faculty of Social and Cultural Studies, Kyushu University, [2]Mifune Dinosaur Museum

Magnetic minerals in the sediments from IODP Site U1314 in the North Atlantic have been investigated by low-temperature magnetometry and high-temperature magnetometry. Site U1314 is located in the southern Gardar Drift at 2820 m water depth. In the post-glacial Gardar Drift, the source area for the terrigenous material transported by the bottom current is the Iceland Faeroe Ridge and the Faeroe Bank Channel. Thermomagnetic curves of the sediments show reversible curves in heating and cooling with the Curie temperature of ~580 degrees, indicating low Ti-content titanomagnetite (Kissel et al., 2009). In contrast, in the thermomagnetic curves of sediments of 2~3 Ma, although magnetite is considered as the dominant magnetic mineral, contribution of an additional component is suggested from the small decrease during heating in magnetization at around 250 degrees, and higher magnetization (Js/J0) along the cooling curve than along the heating curve (Zhao et al., 2011). A possible explanation for this is the magnetite formation by heating from titanomagnetite, titanomaghemite, or pyrite. In the results of low-temperature magnetometry, magnetite is considered as the dominant magnetic mineral of the sediments (Zhao et al., 2011). The results also indicate that the magnetite suffers surface maghemization but that maghemization is not very severe because Verwey transition is observed at ~110 K.

In the temporal variation in Mr/Ms and Hc during the period including marine isotope stage (MIS) 100, quick decrease associated with IRD events and succeeding gradual recover was observed in these parameters. In the thermomagnetic curves of these sediments, the dip around 250 degrees is observed more clearly for the periods without IRD events than for the periods with IRD events. Further, the dip is more apparent during the interglacial period (MIS99 and 101). The results suggest millennial-scale variability in the bottom current as well as the variability associated with glacial-interglacial cycles.

Keywords: rock magnetism, north atlantic

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P06 Room:Convention Hall Time:May 19 18:15-19:30

Tsunami and seasonal variation records of Sendai Bay sediments revealed by rock magnetic properties and geochemical anal

Hirokuni Abe[1], Noriko Kawamura[1*], Naoto Ishikawa[2]

[1]Japan Coast Guard Academy, [2]Graduate School of Human and Environmental Studies, Kyoto University

The large amount of terrigenous substances is carried to coastal areas by natural disasters, which are Tsunamis and seasonal floods. Therefore coastal marine sediments along island arcs are possible to have information of past Tsunami and seasonal floods. In order to reconstruct those past events from the coastal marine sediments, we need to distinguish between Tsunami events and seasonal variations. Thus this study is aimed to sort both past events based on rock magnetic properties and geochemical analysis. Sediment samples were collected at five stations in Sendai Bay at every season during 2002-2011. For measurements of carbon, nitrogen and sulfur amounts in the sediments, CHNS analyses were conducted. Rock magnetic properties of the sediments were also measured. Results indicated that the amounts of those elements decrease toward offshore stations. The samples taken during spring and autumn show high values in those elements at all stations, suggesting the sediment supply increases in those seasons. These values are diffused at the near-shore stations, while the value ranges are narrow at the offshore stations under the Oyashio current. The sediment particle size is larger at the offshore stations. It suggests that fine sediment particles are transported by the Oyashio current. For discriminations between Tsunami events and seasonal variations, we focused on the samples taken in June 2008 and 2011. The amounts of carbon and sulfur are large in the 2011 samples after the Tsunami event. Thermo-magnetometric results indicate the presence of magnetite and iron sulfide in all samples. Especially, the 2011 samples at the offshore stations under the Oyashio current are found to contain iron sulfide as a dominant magnetic mineral. It may be implied that iron combines sulfur after deposition and that are prevented from the transportation of the Oyashio current.

Keywords: Tsunami sediments, geochemical analysis

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P07 Room:Convention Hall Time:May 19 18:15-19:30

Regional and seasonal variations in magnetic properties of topmost sediments in the Northern Lake Biwa

Naoto Ishikawa[1*], Kanako Ishikawa[2]

[1]Graduate School of Human and Environmental Studies, Kyoto Univ., [2]Lake Biwa Environmental Research Institute

Rock-magnetic investigations have been performed on topmost sediments above about 30 cm below sediment surface (bss) cored in summer (June to July) and winter (November to December) at ten sites with different water depth, where dissolved oxygen (DO) content in bottom water and its seasonal variation are different, in the first depression at the North Basin of Lake Biwa in order to reveal early diagenetic effect on magnetic properties of the sediments. We will report results from the following three sites: N4 (91 m in depth), A (90m) and H70 (66m). The DO value becomes lower than 4 mg/L in winter at N4 and A.

Low-temperature magnetometric results indicate that a partially-maghemitized magnetite is a principal magnetic mineral in samples of the three sites. Warning curves from 6 to 300K of isothermal remanence (IRM) imparted at 6K in 1T after zero-field cooling show a remarkable decrease of IRM between 90 and 120K, which is regarded as a suppressed Verway transition of magnetite. The amount of IRM decrease between 90 and 120K increase downcore at all site, implying the dissolution of maghemite skin covering magnetite. The IRM decrease is slightly remarkable in H70 samples above about 18 cm-bss. The degree of maghemitization may be higher in N4 and A samples. The warning curves of N4 and A samples show another IRM decrease between 20 and 30K with the inflection point at about 29K. The IRM drop is detected in samples above about 18 cmbss, and the samples in two zones of 0-3 cm-bss and 6-12 cm-bss shows the IRM drop more clearly. It seems that the IRM drop is slightly remarkable in samples taken in winter and that the depth of the zone showing the IRM drop changes seasonally. The occurrence of the magnetic mineral with the characteristic low-temperature magnetic behavior may be influenced by the DO values and its seasonal change.

The downcore decrease of magnetic coercivity is observed in the uppermost sediments above about 10 cm-bss, and the amount and grain size of magnetic minerals subsequently decreases and increases downcore below 10cm-bss, respectively. These changes are considered to be associated with the dissolution of maghemitized magnetite by the early diagenetic effect. A seasonal change of magnetic coercivity is recognized in the samples above 10 cm-bss of N4: the samples taken in summer show lower magnetic coercivity, possibly implying a smaller contribution of fine magnetic minerals with higher coercivity.

Keywords: magnetic property, sediment, Lake Biwa

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P08 Room:Convention Hall Time:May 19 18:15-19:30

Paleomagnetic and rock magnetic studies on non-marine and marine sediments in the Osaka Group cored at Kyoto Basin

Kazumasa Hamada[1*], Naoto Ishikawa[1], Keiji Takemura[2]

[1]Graduate School of Human and Environmental Studies, Kyoto University, [2]Beppu. Geo. Res. Lab. Kyoto Univ

Rock magnetic analyses were performed on sediments of non-marine and marine clay in the Osaka Group cored at Kyoto Basin in order to investigate magnetic variations corresponding to environmental changes between freshwater and marine. The Osaka Group is the Pleistcene sequence formed related to sea-level changes in the glacial-interglacial cycles, and consists of alternating beds of non-marine sediment and marine clay.

KD-1 and KD-2 cores including the Osaka Group were drilled at Kyoto Basin. The Ma5 bed of marine clay had been observed between 150.00 and 141.35 m in depth on KD-1, between 190.37 and 182.21 m in depth on KD-2. The lower and upper boundaries of the Ma5 bed have been determined mainly based on the sediment facies and color.

Analyzed samples in this study were collected in 10 cm intervals from between 140.60 and 153.82 m in depth, including the Ma5 bed, and between 155.80 and 157.75 m in depth on KD-1, between 190.40 and 181.56 m in depth on KD-2.

We measured initial magnetic susceptibility, IRM intensity and hysteresis parameters, and performed progressive alternative field demagnetization (PAFD) of NRM for paleomagnetic analysis and progressive thermal demagnetizations (PThD) of IRM. Electristic conductivity (EC) and pH of clayey water stirring the sediment samples were also measured.

EC and pH value showed that the Ma5 beds lie from 151.21 to 142.40 m in depth on KD-1, from 188.60 to 182.19 m in depth on KD-2.

In variations of inclinations obtained from paleomagnetic analysis, a fluctuation corresponding to the Delta Event in the Marine Isotope Stage 17 was observed on both KD-1 and KD-2 cores. From variations in the magnetic parameters, a characteristic layer with high IRM intensity (High IRM layer) was observed on both cores. By using the High IRM layer and the zone of the Delta event as key layers for the age comparison between the two cores and by the duration of the Delta event observed in sediment cores from the North Atlantic ODP site 980, we estimated the formation age of marine clay bed Ma5. The results were 703-680 ka on KD-1, 704-696 ka on KD-2.

As characteristic magnetic properties in response to depositional environment changes, less variation in the amount of magnetic minerals, smaller particle size of magnetic mineral, and smaller amount of high coercivity magnetic minerals were recognized in the marine beds compared to the non-marine sediments.

In the marine beds, a clear correlation was observed between the particle size of magnetic minerals and EC values. Samples with higher EC value showed the presence of finer magnetic minerals. There was also a clear correlation between the abundance of high coercivity magnetic minerals and EC values. It is suggested that the difference in the amount of particle size and high coercivity magnetic minerals reflects the advanced dissolution of magnetic minerals associated with early diagenesis in marine under a reducing environment.

Keywords: Paleomagnetism, Rock magnetism, Environmental magnetism, Osaka Group, marine clay

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P09 Room:Convention Hall Time:May 19 18:15-19:30

Analyzing the early 19th century's geomagnetic declination in Japan from Tadataka Inoh's Santou-Houi-Ki The 7th report

Motohiro Tsujimoto[1*], Akitoshi Omotani[2], Takaaki Inui[3]

[1]Japan cartographers association, [2]San-in System Consultant, [3]Matsue municipal Comitee of culture property

Santou-Houi-Ki Japan national treasure is the survey data book comprised of 67 volumes consist of magnetic compass azimuth of approximately 200,000 data in 1800 to 1816, cover nearly whole of Japanese mainland cartographic survey, written by cartographer Tadataka Inoh. We continue the work of analysis that stopped after only analysis in 1917, which done about the survey data at Inoh retirement home Fukagawa in Edo (Tokyo) in 1802-1803.

(1)If we analyze the data of Santou-Houi-Ki, we can change Japan as one of the most concentrated area of accurate geomagnetic declination data in the world, back to early 19th century, from insufficient area of data, and supply new data to northeast Asia. The total Number of analyzed points is exceeded by 175, and the outline of the distribution of declination in Japan archipelago and the rough distribution of the declination in every15 minutes in western Japan coast in early 19th century, begun to appear.

(2)Comparison of Santou-Houi-Ki with Gauss and Weber isogonic Atlas which published in 1840, consisted of observational data roughly at the time of 1830(1828-1832), it foundational structure of isogonic lines in Japan archipelago is roughly similar to the result of analysis from Santou-Houi-Ki, But we can recognize the contradiction to reverse with secular variation in Northern Kyushuu area and Tsushima Island, or the local differences in eastern Hokkaido in Gauss and Weber isogonic Atlas, The observational data in Japan archipelago did not described in the table supplemented with Gauss isogonic Atlas. The described observational data in East Asia were from Pekin. Monggol, Baykal, Yakutsk Ohotsk Kamchatka etc. The isogonic line of declination in surrounding area of Japan in Gauss and weber's Atlas had to drawn by calculated estimates. The Gauss and Weber's Atlas was draw to understand the general conditions of geomagnetism of the entire world. The declination data in the table were calculated on a matrix of 5 degree of latitude and 10 degree of longitude, one cell of this matrix is 500km long. Therefore the analysis of Santou-Houi-Ki becomes very important as complement data.

(3)Advantage to use the data described in Santu-Houi-Ki.1.Huge number of survey data. 2. Minute standard of analysis. 3. The Data are concentrated in 1800 to 1816. 4. Data cover nearly whole of Japan Mainland. 5. It include the ability of local abnormality, if there is a remarkable differences between Gauss Atlas and the value of analysis from Santou-Houi-Ki. 6. We can restore the precise position of Tadataka Ino reference point in less than second unit in latitude and longitude from Santou-Houi-Ki.

(4)Analysis method of Santou-Houi-Ki needs the succession to future. 1.Calculate the average of remainder as the declination, to deduct the magnetic azimuth recorded in Santou-houi-Ki from the true azimuth. 2.The important point in deciding the precise position of the reference point should be adjusted to that all of the declination values are calculated from the azimuth to different target at the reference point are approximately equal to each other. 3, Use GPS transmitter at the reference point for investigation of longitude and latitude. 4. Consecutive formula use Excel for speed up and keep accuracy. 5.The result of analysis is useful for global model of geomagnetisism.6.It is available for the analysis of magnetic survey azimuth data in the world. 7.Restorated precise position of the survey reference points contribute to detail study of history. Keywords; 1. geomagnetic declination 2. Tadataka Inoh 3. Santou-Houi-Ki 4. Isogonic Atlas by Gauss and Weber 5. Secular variation of geomagnetic declination 6.Restoration of precise position of survey point

Keywords: geomagnetic declination, Tadataka Inoh, Santou-Houi-Ki, Isogonic Atlas by Gauss and Weber, Secular variation of geomagnetic declination, Resoration of precise position of survey point

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SEM36-P10 Room:Convention Hall Time:May 19 18:15-19:30

Hydromagnetic slow waves and geomagnetic westward drift

Ataru Sakuraba[1*]

[1]Department of Earth and Planetary Science, University of Tokyo

It has been argued that the geomagnetic westward drift is caused or significantly influenced by hydromagnetic waves confined in the Earth's outer core, where balance between Coriolis and Lorentz forces makes it possible for a slow wave to exist with appropriate time scales. Here we investigate linear stability of an axisymmetric toroidal magnetic field in a rapidly rotating fluid sphere and discuss the magnetic instability and the resulting slow waves traveling eastward or westward. The basic magnetic field is equatorially antisymmetric, and we adopt the magnetostrophic approximation in which inertial and viscous forces are neglected. We assume that the mantle is insulating and the magnetic diffusivity is finite. As the basic field is more confined near the equator of the core surface, the basic field becomes unstable at a lower Elsasser number that measures the square of the basic field intensity, and the most unstable mode tends to exhibit faster westward drift with a larger azimuthal wavenumber. The result suggests that it is possible to interpret the recent geomagnetic westward drift seen under the Atlantic hemisphere as manifestation of magnetic instability of a strong toroidal field just below the core equator. We also investigate effects of existence of basic zonal flows, which are chosen so that the flow velocity satisfies either the equation of motion or the magnetic induction equation. The results indicate that the addition of the basic flow makes the dispersion relation so complex that the unstable modes move eastward too. We also discuss interpretation of our recent low-viscosity geodynamo simulations using the linear stability results.