Japan Geoscience Union Meeting 2011
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SEM036-P01 Room:Convention Hall Time:May 26 10:30-13:00

Seasonal changes of magnetic minerals and their grain sizes in the Hiroshima Bay sediments

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Frequent outbreaks of red tide have been reported since 1970 in the Hiroshima bay, and the red tide is caused by a bloom of dinoflagellates. Iron is an essential element for dinoflagellates, and is supplied as bivalent or trivalent ions and iron compounds from lands to sea. For damage predictions of red tide, it is important to research the distribution of iron in the bay. The acidification of seawater during summer has been also observed in the Hiroshima Bay. Increase of CO_2 concentration and decrease of dissolved oxygen (DO) content in seawater cause an anoxic condition in the bay. It is known that iron oxides are dissolved and sulfides are formed in an anoxic condition. For clarifying variations of the distribution and mode of iron in sediments and bottom water in the Hiroshima Bay, we investigated kinds of iron compounds in the sediments and the amount of dissolved iron in the bottom and interstitial waters. Sediment cores of 5cm in depth were taken at several sites in the Hiroshima Bay by using a multiple corer from June to August in 2010. Data of oceanographic observations at these sites showed that during the sampling period the temperature of the bottom water increased, whereas DO and pH values decreased. The sediment samples were composed of sandy silt with clay at shallower sites and clayey silt at deeper sites. We measured dissolved iron concentration in interstitial and bottom waters filtered above 0.45 um grains, and performed magnetic hysteresis measurements and high temperature magnetometry on the sediment samples. The presence of magnetite (Fe_3O_4) and hematite (Fe_2O_3) were recognized in all analyzed samples, whereas greigite (Fe_3S_4) appeared at the deeper sites with an anoxic condition in the bottom water. At the deeper sites, the magnetic grain size increased from June to August, while iron concentration increased in the interstitial and bottom waters. It is suggested that magnetite and hematite were dissolved and greigite was formed, associated with the proceeding of the anoxic condition in the bottom water, and that the grain-size of magnetic minerals and the iron concentration of the interstitial and bottom waters also changed. Irons moves between sediments and seawater in the brief period, which may occur sensitively in the bottom of the Hiroshima Bay.

Keywords: marine sediments, iron, magnetic properties

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Paleomagnetic and rock magnetic records of 90-150ka obtained from sediment core BIW08-B in Lake Biwa.

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We obtained a series of core sample (BIW08-B) from central part of Lake Biwa (water depth 53 m) in 2008, intending to reveal detailed records of paleoenvironmental and paleomagnetic variations.

Among core samples of BIW08-B of 100 m long in total, we conducted paleomagnetic and rock magnetic analysis of an interval from 25.48 m to 45.10 m. This interval corresponds to a time period from 90 ka to 150 ka, which is expected to include the Blake excursion (Smith and Foster,1969; etc). It is also suggested that this interval holds environmental record of rapid warming which is represented by variations of oxygen isotope ratio (e.g., Imbrie et al.,1984).

Low and high temperature magnetic measurement show the existence of the maghemitized magnetite and the hematite. The experiment of progressive thermal demagnetization (PTHD) of the anhysteretic remanet magnetization (ARM) indicates that the main ferromagnetic mineral is maghemitized magnetite.

Assessment of stability of natural remanent magnetization (NRM) was made with progressive alternating field demagnetization (PAFD) experiments. Inclination values change from about 30 to 60 through the core, and the average inclination was lower than the expected value (54.7) at the drilling position. Deviations of NRM directions occurring in low intensity interval in about 93ka, 104-108ka, and 133ka may correspond to excursion.

The downcore variation in X_{ARM} / X values, except for volcanic ash, was similar to that of the X_{ARM} ones. It was found that the increase (decrease) in the amount of magnetic minerals was accompanied with their grain re?ning (coarsening) in the grain size of magnetic minerals. The characteristic minimum boundaries were observed at 101-105 ka, 122-125 ka and 132-136 ka. These periods are corresponding to warm and humid interval.

Keywords: Environmental magnetism, paleomagnetism, lake sediment

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Magnetic behaviors of sediments including maghemitized magnetite in thermal demagnetizations of artificial remanences

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Low-temperature oxidized magnetite (maghemitized magnetite: Magh-Mt) has been recognized as a common magnetic mineral in sediments and soils. It is important to identify the presence of Magh-Mt and to clarify its magnetic property for environmental-magnetic and paleomagnetic investigations on sediments and soils. We present results of thermal experiments performed on Magh-Mt bearing sediments, especially progressive thermal demagnetization (PTHD) experiments of artificial remanences. Analyzed samples were taken from a sediment core (BIW07-5) obtained by piston coring in Lake Biwa, central Japan. The core consisted of homogeneous lacustrine clay with 6 tephra layers. Freeze-dried clay samples were used for thermomagnetic experiments.

Low-temperature magnetometric results showed the presence of Magh-Mt in the clay samples. Warning curves from 5 to 300K of isothermal remanence (IRM) imparted at 5K in 1T after zero-field cooling showed a large decrease of IRM between 5 and 40K and suppressed Verway transition of magnetite between 90 and 120K. As S-ratios (maximum field of 2.5T and back filed of 0.3T) of the samples were higher than 0.965, Magh-Mt was regarded as a principal magnetic mineral.

PTHD experiments of artificial remanences in air and Ar were carried out for clarifying magnetic mineralogy. Samples were packed in small quartz cups. IRM was imparted along the cup axis in a DC field of 1.9T, and then anhysteretic remanence (ARM) was imparted perpendicular to the axis by a peak alternating-field of 100mT and a DC field of 0.1mT. PTHD up to 680 or 700^{o}C were performed using a noninductively wound electric furnace in a six-layer mu-metal magnetic shield; the internal stray field was less than 5 nT. The initial magnetic susceptibility (Xo) was measured using a KLY-3S susceptibility meter at each demagnetization step.

During the PTHD in air, decay curves of ARM and IRM components showed inflections at about 280 and 360^{o}C, respectively. The ARM components were unblocked at 620^{o}C. The IRM components were unblocked at 680^{o}C after small or no decrease at 620^{o}C. Xo decreased gradually up to 680-700^{o}C. During the PTHD in Ar, the ARM components increased at 280^{o}C, accompanied with increase of Xo, and were unblocked at 560^{o}C. The IRM components decreased at 560^{o}C and were unblocked at 640-680^{o}C. Xo increased from 280 to 680-700^{o}C. The ARM component is carried initially by Magh-Mt, and carriers of the IRM component are likely carried by Magh-Mt with higher coercivity and primary hematite. It is suggested that the conversion of Magh-Mt occur from 280^{o}C and that magnetite converted during heating in Ar may acquire remanence newly or inherit remanence from parent Magh-Mt.

Additionally, PTHD experiments above 500^{o}C in Ar were performed after demagnetizations in air at lower temperatures (200, 300, 400 and 480^{o}C). Decay curves of ARM and IRM components above 500^{o}C from samples demagnetized at 200^{o}C in air were quite similar to the curves during the PTHD in Ar at all steps, indicating the complete conversion of Magh-Mt to magnetite. Samples demagnetized at 300-480^{o}C in air provided the presence of remanence unblocked between 540 and 620^{o}C during the PTHD in Ar. The amount of the unblocked remanence increased with increasing the demagnetization temperature in air. It is implied that a converted product from Magh-Mt during heating in air is stable for heating and carries the remanence unblocked up to 620^{o}C.

A PTHD experiment of artificial remanences is a simple and useful method for identifying magnetic minerals. However, in the case of Magh-Mt bearing samples, it is inferred that decay curves of artificial remanences do not represent initial magnetic mineralogy because a converted product carries remanence during heating.

Keywords: maghemite, rock magnetism, magnetite

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Magnetic properties of tephra in Lake Biwa sediments

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We conducted a series of magnetic and chemical analysis of 27 tephra to examine methodology for identification and to understand the relation between volcanism and magnetic properties. We examined volcanic ashes in a drilling core from Lake Biwa sediments: K-Ah, U-Oki, Sakate. DHg, DSs, AT, SI, DNP, DAP2, Aso-4, K-Tz, Aso-ABCD, Ata, BT29, BT34, BT37, Aso-3B, Aso-2, BT44, BT45, BT48, Ata-Th, BT59, Aso-1, Tky-Ng1, BT67, and Ss-Pk. The followings are results from magnetic measurements of bulk samples and analysis of magnetic minerals using EDS (Electron Dispersive System) electron microprobe.

(1) Titanomagnetite (x=0.1-0.6) exists in all samples and titanohematite (y=0.5-0.9) exsits in some samples. There are also hematite and maghemitized magnetite in some samples. These are not materials of tephra origin but represent contaminants from clay beds of Lake Biwa sediments.
(2) We found contrasting magnetic grain-size distribution between the tephra from Kyushu and San-in region based on King plot and Day plot. Moreover, we noted that data from Kyushu region are plotted on PSD (pseudo-single domain) field and data from San-in region are on MD (multi domain) field. Magnetic grains can reflect the distance from source to the place of deposition.
(3) We classified the tephra based on magnetic minerals species utilizing the behavior of Js-T curves (high-temperature), ZFC and FC curves (low-temperature). We finally divided the tephra into six groups: KA & AT (Kikai caldera and Aira caldera), ATA (Ata caldera), ASO (Aso caldera), DAISEN-A (Daisen volcano), DAISEN-B (Daisen volcano), and SAMBE (Sambe volcano). Thus magnetic mineralogy is useful in identifying source volcano of each tephra. We also applied this classification to so far unclassified BT samples and concluded that BT34 and BT59 were from Aso caldera and BT37, BT44, BT45, BT48, and BT67 were from Daisen volcano. Magmatic temperatures at the time of eruptions were estimated with geothermometer based on coexistence of two Fe-Ti oxide series (Ghiorso and Sack, 1991). Approximate magmatic temperatures are estimated to be 750-850 ^{o}C (Kikai caldera and Aira caldera), 800-950 ^{o}C (Ata caldera), 850-1000 ^{o}C (Shishimuta caldera), 700-950 ^{o}C (Daisen volcano), and 800 ^{o}C (Sambe volcano), respectively.

We suggest that precise tephra identification can be possible if we measure magnetic properties such as Js-T curve, ZFC and FC curve, and Curie temperature. Curie temperature higher than 580 ^{o}C can not be used for identification, because of the following two reasons: high Curie temperature can be a result from hematite and maghematized magnetite contaminated from clay beds of Lake Biwa sediments and hematite can be also formed through high-temperature oxidation during experiments.

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Onboard paleomagnetic results of pelagic sediment cores from the South Pacific Ocean, IODP Expedition 329.

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IODP Expedition 329 surveyed and cored the sediment at 6 sites throughout South Pacific Gyre (SPG) and at 1 site its southern margin. The central SPG has been describes as Earth's largest oceanic desert (Claustre and Maritorena, 2003). The dominant lithology of this expedition is zeolitic metalliferous clay at the deeper water sites on older basement (58 to 120 <= Ma) within the gyre (Sites U1365, U1366, U1369 and U1370). Manganese nodules occur at the seafloor and intermittently within the upper sediment column at these sites. The cored sediment at the shallowest site (U1368) is calcareous nanno fossil-bearing clay. The sediment at Site U1367 is transitional between these 2 lithologies. Site U1371 lies out side the low-chlorophyll region, and its cored sediment is dominantly siliceous ooze with abundant diatom debris.

Paleomagnetists of Expedition 329 measured natural remanent magnetization (NRM) of all archive-half sections from Sites U1365 to U1371 using the three-axis cryogenic magnetometer at 2.5-cm intervals before demagnetization. The archive-half sections were demagnetized by alternating fields (AF) of 10 mT and 20 mT. The primary magnetization of pelagic clay generally degrades at a few meters depth below the sediment water interface. The boundary between the primary and stable magnetic records often occurs in the later part of Gauss chron and coincides closely with the late Pliocene onset of northern hemisphere glaciation (Opdyke and Foster, 1970; Kent and Lowrie, 1970; Prince et al., 1980). Magnetic directions of this expedition are not interpretable throughout most of the pelagic clay (Sites U1365, U1366, U1367, U1368, and, U1370) possibly due to magnetic overprint during coring (high positive inclination), viscous remanent magnetization (VRM), or diagenetic changes in the sediment. In addition, appearance of manganese nodules often hampers indigenous magnetic direction in shallow sediment sections. However, fortunately the pelagic clay sediments of Sites U1369 and the top of U1365 (0-6 m) were less these influences.

The lithology at U1367 changed from metalliferous clay (Unit I) at the top to nannofossil ooze (Unit II) at the bottom. The metalliferous clay unit extends from 0-5.5 mbsf in U1367. Consistently, NRM intensities and magnetic susceptibility in Unit I were in the order of 10?-1 to 10?-2 A/m (more than 100?10?-5 vol. SI) and decreased to about 10?-3 to 10?-2 A/m (10 to 50?10?-5 vol. SI) in Unit II (nannofossil ooze).

Keywords: Integrated Ocean Drilling Program, South Pacific Gyre, magnetic stratigraphy, pelagic clay, rock magnetism, viscous remanent magnetization

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Rock-magnetic study on serpentinite from Tokunoshima Island, southern Kyushu, Japan

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Serpentinite occur in Cretaceous Accretionary complex on the Tokunoshima Island. They are intruded by Paleogene granitic rocks, and are covered by Quaternary calcareous sediments. Because of the narrow distribution of the serpentinite, their petrologic and rock magnetic study had been insufficient. Then, we report 1. Original rock of serpentinite in Shimanto Terrane, and 2. Magnetic characterization of contact metamorphosed serpentinite.

The serpentinite distribute along 3 NNE-SSW faults in central to southern part of the Island. The serpentinite shows a hardly sheared, dark green with glossy occurrence or alteration together with pale green layers has become the talc due to thermal effect of contact metamorphism. Based on the relict minerals, dunite and clinopyroxenite are suggested in the original rock. Olivine is finely crashed, and is part of what is altered to the serpentine showing mesh-structure. Fine-beads magnetite is remarkably observed in the former, the latter less extreme.

The serpentinization process is that olivines react with water and produce serpentines and magnetites. The volume of reacting water affects volume of magnetite produced by serpentinization when these rock bodies come from the same peridotite series. We collected samples from three sites in Tokunoshima Island. Main magnetic carrier of these rocks is presumed to be magnetite. Curie temperature of these samples indicates about 560 degrees.

The serpentinite of Tokunoshima Island originated from the dunite and clinopyroxenite, suffering moderate serpentinization and contact metamorphism. Rock-magnetic study revealed that stable magnetization. It may get TRM after contact metamorphism.

Keywords: serpentinite, Tokunoshima Island, rockmagnetism

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Paleointensity study of the 570Ma Grenville dike, Canada: a preliminary result

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Recent numerical simulation for the long-term evolution of the geodynamo revealed that high heat flux at the core-mantle boundary (CMB) generates a continuous high virtual dipole moment of $6*10^{22}Am^2$ throughout an Earth's history (nearly 3.8Ga˜present) and that low heat flux at CMB shows secular weakening of the moment to less than $2*10^{22}Am^2$. The Pre-Cambrian paleointensity study can solve this enigmatic result but is still luck of reliable data due to heavy alteration and metamorphism. Although a single silicate grain paleointensity method is a best way for the study, more primitive but basic test to reveal a reliable primary thermal remanent magnetization is a full paleomagnetic field test such as full baked contact test with hybrid zones. The Grenville dike is of the Ediacaran Grenville dike swarm intruding tonalitic gneiss (1Ga) of the Grenville Structural Province (Ontario, Canada). Hyodo and Dunlop (1993) reported a successful result of full baked contact test with hybrid zone. Here we report a preliminary result of Thellier-Thellier type paleointensity measurement for the chilled margin samples of the 570Ma ($^{40}Ar/^{39}Ar$ age) Grenville dike. The characteristic component of the Grenville dike yields a virtual geomagnetic pole position at 51N and 145W, being different from the compiled VGP positions of the other Grenville dike (Murthy 1971). We obtained paleointensity results of nearly $0.5*10^{22}Am^2$ from three samples of chilled margin (quality factor of 17.00˜74.67), being much lower than low heat flux model at CMB. Although the number of our successful samples is limited, it seems that the Grenville dike samples possess a potential to reveal reliable ancient paleointensity data.

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Frequency spectrum of AC magnetic susceptibility: A new rock magnetic method to estimate grain size distribution

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A new measurement system has been developed for detecting frequency spectrum of low-field alternating current (AC) magnetic susceptibility for rock and mineral magnetic studies. The measurement method is principally the same as that of the previous system developed for obtaining frequency dependence of natural samples (Kodama, G-cubed, 11, 2010, Q11002), but the new system has been improved so as to measure AC susceptibility at frequencies in the range of 10 kHz to 100 kHz. The wide range of operating frequency, along with the capability of measuring both in-phase and out-of-phase components of AC susceptibility, permits to estimate the grain size distribution of superparamagnetic particles. Preliminary measurements were made on natural materials, including volcanic rocks containing SD/MD particles, Chinese loess/paleosol samples, as well as several synthetic materials. The result from the Chinese loess/paleosols, for example, shows a stronger frequency dependence for the paleosol than for the loess, over the frequency range considerably broader than ever reported. This result suggests that the measurement of wide band frequency spectrum of AC susceptibility can be useful, especially in environmental magnetism, as a new rock magnetic experimental method to help quantify the distribution of superparamagnetic nano-particles in a variety of soils and sediments.

Keywords: AC magnetic susceptibility, frequency spectrum, grain size distribution, superparamagnetism

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Paleomagnetic thermal history of faulting: constraints from the Taiwan Chelungpu-fault Drilling Project

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The September 21, 1999, the Chi-Chi earthquake (Mw = 7.6) attacked Taiwan. The Chelungpu fault caused this earthquake, and fault type is a thrust fault with left-lateral component. In the southern part of the fault, ground accelerations were higher, even though the ground velocities and displacements were less than the north at Chi-Chi earthquake (Chung and Shin, 1999). To understand faulting mechanism of the Chi-Chi earthquake, the Taiwan Chelungpu-fault Drilling Project (TCDP) was conducted to obtain shear zone samples at depth. Two cores called as hole A and hole B were drilled and three different shear zones were found in these boreholes.

Many studies to investigate the faulting history of the active Chelungpu fault have been reported, e.g., in-situ temperature measurements by using borehole (Kano et al, 2006); measurements of compositions of elements and isotope ratios (Ishikawa et al., 2008); thermomagnetic analyses (Mishima et al., 2006). These studies imply that these signatures are attributed to the latest event of faulting (i.e. Chi-Chi earthquake), on the other hand this active fault has been activated many times since 0.7 Ma (Chen et al., 2000). Therefore there is a contradiction for the timing of the earthquake occurrence. Electron spin resonance (ESR) signals are also in turn used to reconstruct the temperature rise of frictional heat (Fukuchi, 2003). Although their methods could apply to the estimation of a single event of temperature rise, they give little information for thermal history and its timing on repetitive frictional heating of the active fault. Additionally, ESR is generally accepted as effective dating method, and has been used for fault gouge dating (Fukuchi, 2001; Murakami et al., 2002). However, ESR dating age does not always mean the age of the latest fault movement, because frictional heating not always reach high-temperature to reset ESR. Here, I conducted systematic paleomagnetic analysis of fault zone rocks of TCDP hole B to trace faulting history of the Chelungpu fault. Remanences are very sensitive to feeble thermal changes, therefore it could be useful to trace the thermal history of repeated faulting by thermal demagnetizations.

In my previous work, anomalous high remanent magnetizations had been found from fault rock samples around core surface. I reargued these anomalous remanences by comparison between surface and interior of core, and found they are almost of origin from drilling-induced remanent magnetization (DIRM) except for some gouge in the 1136-m fault zone and BM disk samples. The fault gouge should be exposed frictional heating, so that samples without DIRM carry original faulting-induced remanences. To investigate their thermal history, thermal demagnetizations for these samples were conducted and exhibited mostly three remanent components unblocked 580 ?C, 300 ?C and 250 ?C. Thermomagnetic analyses for these samples yielded that they comprise magnetite and pyrrhotite as remanence carrier. Primary component unblocked at 580 ?C and secondary components unblocked at 300 ?C should be carried by magnetite and pyrrhotite respectively, and acquired during each mineral was produced. From time-temperature relation in remanence, tertiary components unblocked at 250 ?C should be acquired flash reheating about 260 ?C or 300 ?C in the case of pyrrhotite or magnetite being magnetic carrier respectively. Since the initiation age of the Chelungpu fault activity is 0.7 Ma within Brunhes normal chron (Chen et al., 2000), faulting-induced TRM acquired in earth field should indicate normal polarity. However remanent components of some gouge and BM disk samples indicate reverse polarity, accordingly, these reverse components might be acquired in excursion events. The youngest excursion with high reliability is at 0.3 Ma, therefore the formation events to yield major fault gouge zones should have dated back to Mono Lake excursion at least 0.3 Ma.

Keywords: Paleomagnetism, Taiwan Chelungpu-fault Drilling Project (TCDP)

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Multicomponent natural remanet magnetization from red chert in the Tsukumi area, eastern Kyushu

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Middle Triassic (Anisian) red cherts in the Chichibu Terrane were collected at 27 beds for paleomagnetic study. Progressive thermal demagnetization treatment revealed five distinct remanent magnetization components from the cherts. The first remanent magnetization component is demagnetized at around 200degrees. The component is similar to that of the present Earth's geomagnetic field. The second component appears at around 250degrees and is demagnetized at around 420degrees. The directions of the component, before tilt correction, cluster well and have negative steep inclinations and southwesterly declinations. The third and fourth component is revealed between about 480 and 630degrees. The directions of these components, before tilt correction, cluster well and have positive intermediate inclinations and northwesterly declinations. The fifth component is retrieved at the latest stages of the demagnetization from 650 to 690degrees. The majority of the directions of this component show steep inclinations before tilt correction and show northerly shallow directions after tilt correction. A few of the directions, after tilt correction, have southerly shallow directions. This component is considered to be of primary because both polarities are present and the antipodality between the two polarities is observed.

The observed directions are compared with previously reported red chert directions from the Mino-Tamba Terrane (Inuyama area) that yielded four distinct remanent magnetization components. The directions of the first to fourth component in this study (referred to as components A to D), before tilt correction, are well correlated with the in-situ directions of the first to third components from cherts in the Mino-Tamba Terrane (Shibuya and Sasajima, 1986; Oda and Suzuki, 2000; Ando et al., 2001), although the two regions are 500 km apart from each other.

The fifth component, with low inclination values after tilt correction, is well correlated with the tilt-corrected inclinations of the D component observed in the previous study. The cherts in the present study have formed at around the equator during Middle Triassic times.

Keywords: paleomagnetism, red chert, Triassic

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Multi-component magnetization of the Hosokawa-dani rhyolite around the Gauss-Matuyama chronozone boundary

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The garnet-bearing dykes of Hosokawa-dani rhyolite with 2.3 -2.5 Ma K-Ar ages intrudes a green schist of the Tanzawa Group, west Tanzawa Mountains, central Japan. The Hosokawa-dani rhyolite was correlated to garnet-bearing pumiceous tephra beds in lowest Pleistocene around south Kanto Plain. Paleomagnetic and rock magnetic measurements revealed that the Hosokawa-dani rhyolite shows primary normal and secondary reversed magnetization components carried by magnetite in Gauss Chron and maghemite in Matuyama Chron, respectively. Primary reversed magnetization component was found from a silt layer immediately beneath the Mk19 tephra bed in the Nakatsu Group. Such paleomagnetic polarity indicates no correlation between the Hosokawa-dani rhyolite and Mk19 tephra bed. Proximal area of the earliest Pleistocene garnet-bearing pumiceous tephra beds is unknown .

Keywords: Gauss-Matuyama chronozone boundary, secondary magnetization, maghemite, Hosokawadani rhyolite, correlation of dyke and distal tephra, Tanzawa Mountains

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A paleomagnetic study for cores from basement rocks of the Bowers Ridge, in Bering Sea

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The IODP Expedition 323 was done between July 5th - September 4th of 2009. Samples used in this study were collected from Core 8X - 19X of Hole U1342D. The Hole U1342D was drilled 127.7 meters below sea floor at 54.5 degree N in latitude, 176.6 degree E in longitude and 818.2 meters in water depth. This site is located on the crest of western part of the Bowers ridge, that has not been revealed its formation processes including age and location. The purpose of this study is to know the paleolatitude where the Bowers ridge formed with paleomagnetic analyses on collected samples.

Lithology of the cores mainly consists of volcano-clastics including volcanic sands and breccias, and lava fragments. Since there is no thick lava flow, which has not rolled after it settled, has been seen on the cores, we conducted the conglomerate and thermal contacted tests for the specimens to assess the quality of thermal remanences to reconstruct paleolatitude. One-inch diameter mini-cores collected at 26 positions and half-inch diameter micro-cores collected at 101 positions from the Hole U1342D cores. Proogressive alternating field demagnetization from 5m T to 60 mT with 5 mT steps, and/or progressive thermal demagnetization from 100 to 600 degree C with 25 to 50 degree C steps were done for specimens from the all positions. Magnetic susceptibility at each step of progressive thermal demagnetization, and anisotropy of magnetic susceptibility were also measured.

As the results, characteristic remanent magnetizations (ChRMs) were extracted from 50 one-inch specimens and 72 half-inch specimens. Among those ChRMs, only 5 specimens from one piece of core show that the ChRMs settle in similar direction of which the average inclination becomes -63.8 degree with 19.7 degree in 95% confidence limit. This value indicates 45.5 degree in average with ranging from 27.3 to 73.9 degrees in paleolatitude. However, a paleolatitude assessment requires time averaged paleomagnetic directions at which the time should be much longer than the period of geomagnetic secular variation (c.a. several thousand of years), suggesting that we can not argue paleolatitude using our results.

Keywords: Paleomagnetism, IODP EXP323, Bering Sea, Bowers Ridge

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Analyzing the early 19th century's geomagnetic declination in Japan from Tadataka Inoh's Santou-Houi-Ki The 5th report

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Santou-Houi-Ki,a national treasure of Japan recorded by Tadataka Inoh is 67 volumes data book consisting of approximately 200,000 magnetic compass azimuth data in 1800 to 1816. The recorded points cover almost of mainland Japan. In 1918 the declination of only one point at Inoh's retirement home Fukagawa in Edo(Tokyo)was analyzed,but nobody analyzed the other data.

We've started the analysis of them.

(1)The analysis of the data in Santou-Houi-Ki supplies new data to the northeast Asia and mainland Japan in early 19th century in particular. It makes mainland Japan as one of the area having a lot of accurate data of geomagnetic declination in the World. Currently the number of analyzed points is more than 100,and the outlinne of the distribution of declination in mainland Japan in early 19th century became clear gradually.

(2)The comparison of Santou-Houi-Ki with Gauss and Weber's isogonic Atlas published in 1840,consisted of the observational data in 1830(1828-1832 exactly),it's foundational structure of Gaudd's isogonic lines in Japan is almost similar to the result of analysis from Santou-Houi-Ki. But we can see the contradiction to reverse with secular variation in northern Kyuushuu area and Tsushima Island or the local differences in eastern Hokkaido in Gauss's Isogonic Atlas. The observational data in Japan archipelago did not described in the table of the observational data in the supplement of Gauss's isogonic Atlas. Therefore the supplementation by the result of analysis from Santou-Houi-Ki became very important.To grasp the variation of geomagnetic declination, we concentrated on analysis in western Japan, where easy to grasp the variation of declination because the geographical feature is long from east to west.

(3)Advantages to use the data described in Santou-Houi-Ki. 1.Huge number of survey data. 2.Minute standard of analysis. 3.Data are concentrated in 1800 to 1816. 4.Data cover almost mainland of Japan.

(4)The development and improvwment in analysis method. 1.Calculate the average of remainder as the declination,to deduct the magnetic azimuth recoded in Santou-Houi-Ki from the true azimuth. 2.The important point in deciding the precise position of the reference point should be adjusted so that all of the declination values calculated from azimth to different target at the reference point are approximaely equal to each other. 3.Use GPS transmitter at the reference point for investigation of longitude and latitude. 4.By the request from Motohiro Tsujimoto to make a consecutive formula by use Excel for speed up his process in the above, Akitoshi Omotani realize this important improvement.

(5)Trial to popularize the knowledge of restoring the local geomagnetic declination and the precise position of reference point from Santou-Houi-Ki was started. In Shimane and Totori prefecture,it's inserted in the newspaper San-In Chuou Shinpou's column and the bibliography of local history edited by Takaaki Inui obtain good responce. Their lecture held by Takaaki Inui and Akitoshi Omotani at local lecture class giving very strong impression to the audience.

Keywords: geomagnetic declination, Tadataka Inoh, Santou-Houi-Ki, Isogonic Atlas by Gauss and Weber, secular variation of geomagnetic declination, restoring the precise position of survey's reference point

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Magnetic Charts for the Epoch 2010.0

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The GeoSpatial Information Authority of Japan (GSI) has been conducting geomagnetic surveys in Japan since 1948. As a results of surveys, magnetic charts published every 10 years, and the latest charts are 2000.0. We have a plan to provide the new charts (epoch 2010.0) in this year. The most characteristic point is adopting the new spatial-temporal model created until 2010. By the use of the new model, we can get the magnetic charts for arbitrary epoch. Then, we can realize yearly variation of magnetic components in visible.

The magnetic charts provide accurate geomagnetic field values for Japan and are widely used as a reference for the study of local geomagnetic anomalies, for example, we get magnetic anomaly of Japan by subtract IGRF from spatial-temporal model.

This is the last time to provide printed magnetic charts. Next time, we will provide charts on the GSI web site.

Keywords: Magnetic charts, declination, total force, magnetic anomaly