Japan Geoscience Union Meeting 2014
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SEM37-P01 Room:Poster Time:April 30 18:15-19:30

Environmental rock-magnetism of red clay in the South Pacific Gyre during the Cenozoic: relation with rare-earth content

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Red clay occupies ˜40% of the global ocean floor. Paleoceanographic and paleomagnetic studies of red clay were limited so far because red clay does not yield microfossils that can be used for precise age estimation and sedimentation rates were extremely low, less than a few meters per million years. However, red clay has attracted interest since Kato et al. (2011) reported that red clay rich in REY (rare-earth elements and yttrium) distributes widely in the Pacific Ocean. Among the cores studied by Kato et al. (2011), especially REY-rich mud (2110 ppm at the maximum) of ˜40 m thick occurs below 13.5 m below seafloor (mbsf) at the Deep Sea Drilling Project (DSDP) Site 596 at the western edge of the South Pacific Gyre. However, the core sections have large gaps, and rock- and paleomagnetic studies were not conducted. In 2010, Integrated Ocean Drilling Program (IODP) Expedition 329 Site U1365 occupied at almost the same position as Site 596. Continuous pelagic red clay cores of ˜76 m thick was recovered above the basaltic basement of ˜100 Ma in age.

We conducted an environmental magnetic study using the Site U1365 cores to investigate long-range climatic and paleoceanographic changes during the Cenozoic. We also investigate a relation between magnetic properties and REY of the red clay. On the basis of rock magnetic analyses and transmission electron microscopy, magnetic mineral assemblages are dominated by bacterial magnetites (magnetofossils) throughout the cores (Yamazaki and Shimono, 2013). In the uppermost several meters, terrigenous maghemite probably transported as eolian dust increases. High REY mud (2470 ppm at the maximum) of ˜40 m thick occurs below 8 mbsf. The variation pattern of REY constant is similar to that at Site 596. The ages of the Site U1365 cores were transferred from those of Site 596, which is based mainly on a constant Co-flux model at Site 596 (Zhou et al., 1992), by inter-core correlation using magnetic susceptibility and REY variation patterns. Paleomagnetic stratigraphy is available for the uppermost several meters at Site U1365.

We discuss a possible relationship between REY content and magnetic properties. The REY peak coincides with a sharp upward decrease in the ratio of κ_{ARM} to SIRM, which indicates an increase of the mean magnetic grain size and/or an increase in the proportion of detrital to biogenic magnetic mineral component. A peak of REY content occurs just below an interval of high magnetic susceptibility. These characteristics are similar to those of red clay cores near Minami-Torishima (Yamazaki et al., 2014, JpGU). This suggests that the increased REY concentration may have occurred in association with a common paleoceanographic event. Eolian dust supply may have increased since ˜30 Ma. The Eocene/Oligocene (E/O) transition (˜34 Ma) is known as the time when major ocean gateways (the Drake passage and Tasmanian gateway) opened and the Antarctic Circumpolar Current was formed (Scher and Marting, 2004, 2006; Stickley et al., 2004). The onset and increase of dust supply in the South Pacific may have occurred after this time. Northward movement of Australia continent to an arid region (middle-latitude) may have also contributed an increase of dust supply. Hyeong et al. (2013) suggested that phosphatization on the Mid-Pacific mountains took place between 36 and 12 Ma, and it peaked at the E/O transition. They connected the results to paleo-deepwater circulation. A REY peak occur near the E/O transition at Site U1365, which may be related with the phosphorus budget.

Keywords: Red clay, REY, South Pacific Gyre, Cenozoic, Environmental Magnetism

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SEM37-P02 Room:Poster Time:April 30 18:15-19:30

Regional differences in magnetic properties of topmost sediments of the Northern Lake Biwa

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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 eight 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.

Low-temperature magnetometric results indicate that a partially-maghemitized magnetite is a principal magnetic mineral in the sediments. 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 more slightly remarkable in the sites with shallower water depth. The degree of maghemitization may be lower in the site. Samples from sites with deeper water depth below about 70m show another IRM decrease between 20 and 30K with the inflection point at about 29K. The IRM drop disappears in samples with hydrochloric acid treatments. These low-temperature IRM behaviors may imply the presence of ferro-rhodochrosite. The IRM drop is detected in samples above about 18 cmbss, and the samples in two zones of 0-3 cm-bss and 6-15 cm-bss show the IRM drop more clearly. The IRM drop is more remarkable in samples with deeper water depth. The occurrence of the magnetic mineral with the characteristic low-temperature magnetic behavior seems to be influenced by the DO values and its seasonal change.

As common characteristics in downcore changes of magnetic properties, 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. The presence of magnetic minerals with finer grain size and higher magnetic coercivity in the sediments above 10 cm-bss is more remarkable in sites with deeper water depth.

Keywords: rock magnetic property, Lake Biwa, topmost sediment, early diagenesis

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Magnetic properties of the sediments and suspended solids in the sea surface water at the Hiroshima bay station.

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Suspended solids (SS) in sea water are consisted of planktons and insoluble particles, and are an indicator of transparency. SS particles adsorb and incorporate metallic ions. Iron is a metallic ion, and an essential element for phytoplankton. It is supplied from river to sea as bivalent or trivalent ions, and exists as iron compounds as organic complexes in sea water. Aeolian dusts are consisted of SS, and also consists of iron compounds. They will deposit on seafloor, and be sediments as the climatic record. It is important to investigate the distribution and mode of iron compound in SS for the present and past environmental studies. This study aims to diagnose magnetic minerals in SS. Enough amount of SS sample for magnetic measurements are collected by magnetic separation from seawater at the Hiroshima bay station. 4 L of seawater is filtrated, and the particles above 0.45 um in diameter are recovered for XRF analysis. The amount of magnetic particles in sea surface water shows relatively high values from April to July in the bay. The maximum value is found at the station, which is located near an iron works (the supply source). The particle is opaque minerals and looks like needle. The values of IRM imparted at 0.3 T and 2.5 T are not stable. It suggests that SS has strong anisotropy. Results of thermo-magnetometry indicate that magnetic carriers of SS samples are mainly magnetite, and goethite and hematite is also recognized. Magnetic minerals in the sediments at the station are magnetite, hematite, and greigite. It is implied that goethite present in the sea surface water and it may be dissolved on sea floor.

Keywords: Suspended solids, Iron compounds, Goethite

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SEM37-P04 Room:Poster Time:April 30 18:15-19:30

Paleomagnetic study of the turbidite sediments around the Daini Atsumi Knoll

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This study is a part of the program of the Research Consortium for Methane Hydrate Resource in Japan (MH21 Research Consortium)

Keywords: Paleomagnetic study, Paleomagnetostratigraphy, Anisotropy of magnetic susceptibility, Paleocurrent analysis, turbidite sediments, Dainii Atsumi Knoll

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Emplacement mechanism of marine volcaniclastic sediments (IODP Site U1397, 1398) based on rock magnetic properties

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Large numbers of marine volcaniclastic sediments with various origins were recovered from the sites U1397 and U1398 during IODP Expedition 340. They were most likely derived from volcanoes on Martinique and possibly from Dominica, Lesser Antilles volcanic arc. Some volcaniclastic units were transported and deposited as turbidites, some were as thin tephra fall deposits and others show both characteristics. They contain various amounts of bioclastic component, pumice and lithic fragments and hemipelagic mud clasts. Therefore, these volcaniclastic sediments are suitable for investigating transport and emplacement mechanisms of volcanic materials and the resultant sedimentary and petro-facies in marine settings. This study focuses on magnetic minerals in the marine volcaniclastic sediments and carried out rock magnetic measurements.

Thermomagnetic measurements showed almost reversible curves and induced magnetization decayed to almost zero below 580 ℃, suggesting little contribution of maghemite or hematite. Two Curie temperatures (Tc) with 350-400 ℃ and 500-550 ℃ indicate that the main magnetic carriers are Ti-rich titanomagnetite and Ti-poor titanomagnetite. The proportion of low-Tc titanomagnetite in central and bottom part of thick turbidite units was larger than that in hemipelagic sediments and in the topmost part of turbidite units, suggesting Ti-rich titanomagnetite is derived from volcanic events. Tephra fall deposits also showed large contributions of Ti-poor titanomagnetite, resulted from large amount of volcanic materials. On the other hand, thin turbidite units showed small contributions of Ti-poor titanomagnetite. This suggests that thin turbidite units are derived from diluted flows which contain few heavy Fe-bearing magnetic minerals.

Magnetic susceptibility and hysteresis measurements showed that heavy and large magnetic minerals in most thick turbidite units were concentrated at the lower part of the unit. Samples from the topmost and bottom part of turbidites showed higher degrees of anisotropy than those from the central part, indicating strong influence of suspension settling at the topmost part and shearing at the bottom part. Bottom parts of fall units contain heavy and large magnetic minerals, whereas upper parts of fall units contain fine magnetic minerals. On the other hand, in thin turbidite units such features cannot be observed and hysteresis parameters and susceptibility values were almost concentrated. Probably thin turbidite units did not experience segregation of specific particles during transportation and settling under the relatively calm condition.

These preliminary results suggest that magnetic minerals are useful indicators of volcanic events and rock magnetic approaches can identify various types of depositional processes about marine volcaniclastic sediments.

Keywords: turbidite, fall deposit, marine sediment, titanomagnetite, magnetic mineral

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SEM37-P06 Room:Poster Time:April 30 18:15-19:30

Paleomagnetic direction of the Tomikusa Group in southern Nagano Prefecture and its tectonic significance

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We report here a new paleomagnetic direction from Early Miocene (18-17 Ma) sediments of the Tomikusa Group in southern Nagano Prefecture, and discuss the formation of curvature of the Median Tectonic Line (MTL) in central Honshu. Sedimentary rock samples collected from 24 sites were demagnetized stepwise, and site-mean directions were determined for 23. Rock magnetic experiments suggest that the main magnetic minerals are magnetite and maghemite. The site-mean directions pass a reversal test, indicating primary remanent magnetization. The overall mean direction with a northerly declination is indistinguishable from the Early Miocene reference direction derived from the Asian continent. This comparison suggests no significant rotation in the study area with respect to the continent since 17 Ma. The mean declination is deflected about 15 deg counterclockwise with respect to the strike of the nearby MTL. The same angular relationship is also found in other sedimentary basins in central Honshu (Ichishi in Mie Pref., Chita Peninsula in Aichi Pref., Shitara in Aichi Pref., and Chichibu in Saitama Pref.). Thus we conclude that the MTL was straight in the late Early Miocene (18-17 Ma).

Keywords: paleomagnetism, Tomikusa Group, Median Tectonic Line, Miocene, rock magnetism, tectonics

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Rock magnetism and its petrological charactization of fossil Porites coral frameworks in Ishigaki island, Japan

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Radiocarbon (^{14}C) is produced by the cosmic rays in the atmosphere and is utilized for analysis of the past sun activity. But the Earth's geomagnetic field also controls radiocarbon variability, suggesting that a strong field would shield the planet from high energy charged particles. This mimics lower sun activity. Also, the short-term (in decadal or centennial scale) movement of the geomagnetic pole to the low latitude, such as geomagnetic jerk, could lead to an increased cosmic ray flux impinging on the terrestrial atmosphere and thus to a higher ^{14}C production rate. Therefore, in order to study the past sun activity from the ^{14}C production rate, we need to know the movement of geomagnetic pole position, its field strength and the variability of radiocarbon production during decadal to centennial periods. Many researches, which aim to reveal the paleomagnetic secular variation (PSV), have been performed using datasets obtained from volcanic rocks, sediment, and fired kilns. The some reconstruction models of geomagnetic dipole moment are also established from these data sets. But there are few recorders that can be used for the reconstruction of PSV in a decadal or centennial scale. Here we propose an alternative candidate of fossil coral frameworks as a possible paleomagnetic recorder for PSV research. The coral framework has an advantage in reconstructing both the radiocarbon variability and the geomagnetic field, although usual corals show extremely weak intensity of remanence and its low stability. However, it is shown that our recently-ceased coral framework samples from Ishigaki island possess a remanence intensity of 10^{-5} -10^{-4} A/m and a single-domain like stability from Lowrie-Fuller test. We prepared the standard 1-inch core samples cut parallel to the growth direction of coral *Porites*, including coral's growth bands for a ten to several tens of years. Our thermal and AF demagnetization experiments of oriented coral samples show that a characteristic remanence direction is parallel to the present Earth's magnetic field with some fluctuations. On the other hand, some samples exhibit different remanence directions from the present geomagnetic field with a calcite peak of X-ray diffraction analysis. The presence of calcite indicates that the meteoric diagenesis which changes aragonite coral frameworks into calcite affect the direction of initial magnetization. To constrain the remanence carriers, we are conducting a first order reversal curves (FORC) measurement and petrologic observations by a Schottky field-emission scanning electron microscope (FE-SEM) of acid-treated residuals of our corals. Our results suggest that Porites coral framework samples provide a role as a potential use for paleomagnetic recorder for annual to decadal scales with careful examination of calcite content.

Keywords: fossil Porites coral frameworks, paleomagnetism

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Effect of thermal expansion on Neel's relaxation nomograph of magnetite and its agreement with the radiocarbon age

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Age gap between the paleomagnetic viscous dating and the radiocarbon age of tsunamigenic boulders in Ishigaki Island is focused. Recent researchers have conducted radiocarbon dating to label tsunami age, being able to calibrate the paleomagnetic viscous dating. These ages should be the same for the initial tsunami event. In the paleomagnetic viscous dating, time-temperature relation assuming Neel's single domain (SD) theory of magnetite is used. This monograph shows the older remagnetized component in nature can be erased by the higher temperature in the laboratory, and younger is its reverse. Thus, we can predict the age acquired the secondary magnetization by calculating demagnetization temperature and heating time. Our viscous dating results sometimes represented that the unblocking temperature of viscous components for tsunamigenic boulders is higher than the temperature predicted from Neel's relaxation theory of single domain magnetite, suggesting the older age than the one determined from the calibrated radiocarbon age. Previous numerous studies confirmed that the departure from Neel's theory is attributed to the presence of multi-domain magnetite. However, Lowrie-Fuller test, FORC (first order reversal curves) experiments and Low-temperature demagnetization of tsunamigenic boulders confirmed the presence of single domain magnetite. To solve this problem, we consider the thermal expansion of magnetite during stepwise thermal demagnetization process and propose a modified time-temperature relation to be able to fill the age gap. Currently, thermal expansion coefficient of magnetite is reported by some researcehrs (e.g. Nikolaev and Shipilin, 2000; Levy et al, 2004). If magnetite volume is bigger than initial volume during thermal demagnetization, unblocking temperature should indicate higher value under the assumption of constant coercive force. To confirm this hypothesis, we conducted stepwise thermal demagnetization to a boulder emplaced by 1771 Meiwa tsunami (242 years ago) and compare them to our new modified time-temperature relation.

Keywords: thermal expansion, Neel's theory, single domain, viscous remanence, blocking temperature

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Rock magnetic study of single zircon crystals sampled from river sands

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Geomagnetic field paleointensity data provide critical information such as thermal evolution of the Earth (Stevenson et al., 1983). Also a state of geomagnetic field closely relates to a surface environment (Kulikov et al., 2007). It is pivotal to know the variation of geomagnetic field intensity throughout the history of the Earth. Until now we have not yet obtained, however, enough data to resolve billion-year-scale geomagnetic field variation (Tauxe and Yamazaki, 2007) and need to obtain more paleointensity data.

In this study we focus on a paleointensity experiment using single zircon crystal. Since river sand originates in rocks widely distributed in river basin, detrital zircons in the sand have various ages (Rino et al., 2004). Therefore 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 the present study were sampled from sands of the Nakagawa River, Tanzawa Mountain. The Nakagawa River flows along bodies of tonalite, which is a representative rock of the continental crust. Using coarse-grain single zircon crystals with weight of about 0.1 mg, a suite of rock magnetic measurements were conducted: low-temperature demagnetization (LTD) and stepwise alternating field demagnetization (AFD) of saturation isothermal remanent magnetization (SIRM), and low-temperature cycle using an Magnetic Property Measurement System (MPMS).

SIRM intensities of the single zircon crystals vary four orders of magnitude ranging from $1x10^{-12}$ - $2x10^{-9}$ Am^2, and especially a few percent of the grains have strong SIRM larger than $1x10^{-10}$ Am^2. The zircon crystals contain nearly pure magnetite (Fe_3O_4), and they are in both single-domain (SD) and multidomain (MD) states. The SD magnetite contained in the zircon crystals has the potential to record the paleomagnetic information. The existence of MD magnetite suggests that stepwise-demagnetization after LTD treatment is an efficient approach for paleomagnetic measurement. Taking into account the relation between SIRM intensity and thermoremanent magnetization (TRM) intensity for magnetite (e.g., Yu, 2010), TRM of single zircon crystal may be measured with a high-sensitivity magnetometer such as a SQUID magnetometer.

Now we plan to sample river sand at the Mississippi River and to conduct rock magnetic measurements of the zircon crystal collected from the sand. On the basis of the rock magnetic studies for the zircon crystals from the Nakagawa River and the Mississippi River, we will discuss the feasibility of the paleointensity experiment using single zircon crystal.

Keywords: Zircon, Rock magnetic study, Paleointensity

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Development of the Japan Archeomagnetism Database

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Here we will report the online service of Japan Archeomagneitsm Database which is developed since 2012. Now the database includes about 700 site archeodirection dataset, and we are working to add new data from the backyard stocks which has uncertainty about the independent archeological chronology. Therefore we have to confirm that with searching the dating in the original excavation reports.

Moreover we have added new archeomagnetic data from the archeological archives. More than 100 archeomagnetic data have been manually discovered in the reports.

Now we are also providing a paleomagnetic direction at the Far-East region calculated from the Japanese geomagnetic secular variation models.

Keywords: Archeomagnetism, Database, Geomagnetic secular variations

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Medium soscale crustal structure based on magnetic and gravity anomalies in the eastern part of Hokkaido, Japan. -part 2

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The Pacific coast of the eastern Hokkaido (from Kushiro to Nemuro Peninsula) is characterized by high gravity and high magnetic anomalies. However, it was difficult to get a suitable model due to gravity anomalies on land and aeromagnetic anomalies. We sampled basalts in this area and measured densities, natural remanent magnetization, susceptibilities and other magnetic properties. These results were presented in Japan Geoscience Union Meeting 2007. Moreover, new gravity and magnetic anomaly maps of offshore of cape Ochiishi were published by GSJ, AIST (2012). We picked up profiles and modified previous models. Data including new profiles suggested similar models to previous studies.

Keywords: magnetic property, magnetic anomaly, gravity anomaly, Nemuro, Hokkaido

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Seismogenic shear-induced thermal turbulence in Nojima fault gouges: micro-textural and rock magnetic considerations

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Nojima fault gouges exhibit a characteristic flow microtexture of laminated slip zones, billow-like wavy folds and turbulent disordered structures. Power spectral analysis of the wavy folds indicates that the geometry roughly obeys a power-law of -1.9, agreeing well with the previously measured value of Kelvin-Helmholtz (KH) turbulence in natural environments. 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 in Nojima fault gouges 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. 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 ℃. Therefore, we suggest that the KH wave is generated through KH instability in a high-temperature (>400 ℃) granular dense layer with different densities and different slip velocities. This result suggests that shear-induced thermal turbulence in the fault gouge plays an important role to weaken a frictional strength during earthquake slip dynamics.

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Analyzing the early 19 century's geomagnetic declination in Japan from Tadataka Inoh's Santou-Houi-Ki.

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[1]Japan Cartographers Association, [2]San-in System Consultant, [3]Matsue Municipal comitee of property, [4]Studyies of Inoh's map and writing Assoc

Santou-Houi-Ki national treasure of Japan recorded by cartographer Tadataka Inoh in 1800-1816, is 67 volumes ledger consist of approximately 200,000 magnetic compass land survey azimuth data accuracy of 0 degree 05 min, from eastern coast of Hokkaido to Yakushima Isl in western Japan. We continue the work of analysis that stopped after only analysis in 1917, which done about the survey data at known position of the retirement home of Inoh at Fukagawa in Edo (Tokyo) in 1802-1803.

(1)It is able to change Japan as one of the most concentrated area of accurate geomagnetic declination data in the world, in early 19th century, from insufficient area of data, and supply new data to northeast Asia by analysis of Santou-Houi-Ki.

The total number of analyzed points exceeded 178, and the outline isogonic line in Japan archipelago and the distribution of the declination in every15 minutes in western Japan coast in those days, begun to appear.

(2)Compare the isogonic Atlas by Gauss and Weber (hereinafter Gauss Atlas) consisted of observed data in 1828-1830, with the analysis from Santou-Houi-Ki, the foundational structure of isogonic lines in Japan archipelago is roughly similar. But we recognize the contradiction to reverse with secular variation in Northern Kyushuu area and Tsushima Island. There are no observed data in Japan in the table supplemented with Gauss isogonic Atlas. The recorded observational data in Gauss Atlas in East Asia were inland area from Pekin to Eastern Siberia, Ohotsk, Kamchatka etc. From the analysis of Santou-Houi-Ki, we recognize the magnetic declination supposed as the local geomagnetic anomaly in southern coast of eastern Hokkaido. The isogonic line of declination in surrounding area of Japan in Gauss Weber's Atlas had drawn by calculated estimates, on a matrix of 5 degree in latitude and 10 degree in longitude, one cell of this matrix is 500km long. Therefore the analysis of Santou-Houi-Ki becomes very important. Today it is very important to verify with the isogonic map of Andrew Jackson et al Gufm1 by NOAA (1800-1815).

(3)Procedure and advantage of interdisciplinary and simultaneous analysis of Santou-Houi-Ki across geomagnetism, cartography, and local history. 1.It increase precise evidence to verify the azimuth and the name or short description of the reference point or the target points recorded in Santou-Houi-Ki, with not only the survey diary by Inoh or Inoh map or the survey map of today, add historical local map, historical local source material, the old survey map by former Japan imperial army. 2. Use the recreation software of scenery or digital map of GSI Japan to grasp the outline of particular latitude and longitude of the reference point and target points and real azimuth. 3. Calculate the average of remainder as the declination, to deduct the magnetic azimuth recorded in Santou-houi-Ki from the real azimuth. 4. The important point is to calculate backward the precise position of the reference point should be adjusted to the position, where all of the declination values from the magnetic survey azimuth to different targets at the reference point are approximately equal to each other, to use the consecutive formula of Excel for speed up and keep accuracy. 5. Use GPS transmitter at the reference point to investigate longitude and latitude, and recalculate the position under 0 second in latitude and longitude, minute accuracy declination, more detail and accurate than traditional study. 6.It is able to find areas or points of local geomagnetic anomaly, or to restore the precise position of survey reference point by Tadataka Ino, accuracy of less than second in latitude and longitude, or the objective point of survey in accuracy second where the valuable in local history, including disappeared constructions or big tree etc.

Keywords: declination, Inoh, SantouHouiKI, Reference point, interdisciplinary