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

SGL041-01 Room:203 Time:May 25 08:30-08:45

Prediction of Palaeoenvironment and Geologic Stratigraphy after Pleistocene in the Western Seto Inland Sea

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Japanese only

Keywords: western seto inland sea, alaeoenvironment, fluctuation of sea level due to climate change, boring survey, geologic stratigraphy

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SGL041-02 Room:203 Time:May 25 08:45-09:00

Application of the finer-separated illite in fault gouge for K-Ar dating

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Direct dating of fault gouges can be critical for the age determination of brittle deformation when the timing is difficult to constrain from stratigraphical and geomorphological methods. We present the K-Ar age data for two fault gouge samples corrected from the Mizunami Underground Research Laboratory. The gouge samples were separated into four grain-size fractions of $<$0.1, $<$0.4, $<$2, 2-6 micrometer by using high speed centrifuge. The finer-size fractions yield younger K-Ar ages, suggesting that the finer-size fractions contain a high degree of authigenic illite. And, the K-Ar ages of the finer-size fractions were bracket by fission track ages of zircon and apatite separated from the wall rocks, indicating the illite grew at temperatures in the range about 100-250 degree Celsius, consistent with the stability of illite. These observations demonstrate the applicability of this method for direct dating of brittle deformation.

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SGL041-03 Room:203 Time:May 25 09:00-09:15

Zircon thermochronology of fault zones:A case study of the Okitsu region, Shikoku Island

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Quantitatively understanding of heat generation and transformation associated with faulting is a key to understand not only dynamics of faults but also heat budget, temperature structure and range records. To understand thermal history along faults, geologic thermometers such as thermochronometers, homogenization temperatures of fluid inclusions and vitrinite reflectances have been used. Zircon fission-track thermochronology has been one of the most powerful tools to reveal thermal history along faults (e.g., Murakami et al., 2004; Tagami and Murakami, 2007). Zircon fission-track thermochronology has advantages as below: (1) fission tracks are annealed only by heating, (2) zircon is physically robust and chemically stable and can occurs along fracture zones, and (3) short-term annealing kinetics of zircon fission tracks is well understood based on laboratory experiments.

In the Okitsu region, annealed ziercon fission tracks were observed for all samples collected across the fault. This observation is consistent with results of ZFT analysis reported by Sato (2004 MS) and Inoue (2010 BS). It implies that wide area along the fault was heated.

Keywords: Thermochronology, Fault, Shimanto belt, Zircon

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SGL041-04 Room:203 Time:May 25 09:15-09:30

Thermochronology of bentonite

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Bentonite consists mainly of montmorillonite and caused by diagenesis or hydrothermal alteration of tuff rock. In the geological disposal of high-level radioactive waste, compacted bentonite is planned to be used as the covering of carbon steel overpack. However, Fe(II)-bearing fluid originated from carbon steel may cause the alteration of bentonite. To predict what will happen in nature, natural analog study in the field where bentonite was altered by iron in nature is important. In Kawasaki and Shirosaki bentonite deposit, northeast Japan, one can find the greenish veins which may indicate the presence of interaction between iron bearing fluid and bentonite. To discuss the alteration temperature and period of bentonite, eruption event of parent rock of bentonite and formation event of bentonite, samples (greenish vein, altered bentonite, unaltered bentonite, original tuffaceous rock found in bentonite and so on) were collected, and fission track (FT) and 238U-206Pb dating were applied.

Apatite FT age could be calculated from samples both Kawasaki and Shirosaki deposit except for samples bearing no apatite grains. However, apatite FT age derived from most of the samples have large error because of small amount of apatite grains and low track density caused by relative low 238U content. Zircon FT and 238U-206Pb age was calculated for 6 samples (greenish vein, unaltered bentonite and original tuffaceous rock for each deposit). Samples from Kawasaki deposit were additionally FT dated by conventional method using neutron irradiation after FT dating using LA-ICP-MS. Apatite FT length data of all samples was not enough to discuss the thermal history of bentonite in detail, although 252Cf irradiation method was used. Because samples from Shirosaki deposit contained small amount of apatite grains and apatite FT length data, it is difficult to discuss in detail using analyzed data derived from Shirosaki samples.

Apatite from bentonite samples in Kawasaki deposit may indicate 238U diffusion or crystal dissolution and recrystallization process. Timing of these processes was probably consistent with formation of bentonite. Considering the results of this study and previous study, if 238U diffused, formation age, temperature and period of bentonite was estimated at about 15Ma, 46-48oC and more than 1m.y. If apatite dissolved and recrystallized, alteration temperature and period of bentonite was estimated at about less than 100oC and more than 1m.y. It may be considered from distribution of 238U-206Pb age that mixing of different rock into parent rock prevented parent rock from bentonite formation.

Two FT datings of same apatite grain from Kawasaki deposit using LA-ICP-MS and neutron irradiation indicated different FT age. Because this may suggest significant problem of FT dating using LA-ICP-MS, further discussion about this result is required.

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SGL041-05 Room:203 Time:May 25 09:30-09:45

Pb-Pb dating of Middle Permian carbonate rocks from an accretionary complex in Kyushu, Japan

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Pb isotope data and a resulting age are obtained on Guadalupian (Middle Permian) carbonate rocks from Kamura, N-Chichibu belt, in Kyushu. The study section is composed of the Guadalupian Iwato Formation and Lopingian Mitai Formation, spanning across the Guadalupian and Lopingian (G-L) boundary characterized by a major biotic crisis. Because the limestone in Kamura area primarily deposited on ancient mid-oceanic seamount, it does not contain any zircons or appropriate minerals for isotopic dating. Direct Pb-Pb dating of carbonate rocks provides a useful tool to constrain the age of the Middle-Upper Permian sedimentary sequence where no volcanic beds are available for isotopic dating. We analyzed 11 samples of fine-grained limestones in bulk from the Upper Iwato Formation that is constrained to the Capitanian interval (265.8-260.4 Ma), Guadalupian, by fusulines. The limestones yielded Pb-Pb isochron ages of 252 +- 24 Ma that is interpreted to date the time of early diagenesis as it correspond to the published biostratigraphic age. The data points form a reasonably good linear array, and the geologically meaningful age could be obtained for the Permian limestones as an application to the youngest limestones of the previous works, despite relatively high age uncertainties.

Keywords: Permian, Pb-Pb dating, limestone

Japan Geoscience Union Meeting 2011
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SGL041-06 Room:203 Time:May 25 09:45-10:00

Merits of LA-ICP-MS U-Pb zircon dating method: From two case studies

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LA-ICP-MS has an advantage of inexpensive, simple and quick technique to obtain U-Pb ages over conventional TIMS and SIMS (SHRIMP) techniques. It also has a merit to obtain fission-track ages using the same zircons prepared for U-Pb dating and vice versa. Here, two case studies are presented using LA-ICP-MS equipped with 193 nm excimer laser in Kanazawa Univ.

As zircon U-Pb method has a closure temperature of as high as ~1000 degree C, it is useful to estimate the crystallization age of granitic magmas. As for the Ryoke granite in Awaji Island, a K-Ar hornblende age of 87.7 Ma had been the age of the highest closure temperature (~500 degree C). A newly obtained LA-ICP-MS U-Pb zircon age of 87.6 Ma could further constrain the crystallization age of the granite and also helped to reveal the entire cooling history of the granite from crystallization age to the present. As for granitic xenoliths from clastic dykes in Matsukawa geothermal area, Iwate Prefecture, a LA-ICP-MS U-Pb zircon age of 1.30 Ma was obtained. Because the zircons were previously dated as 1.0 Ma by the fission-track method (closure temperature: ~240 degree C), the crystallization age of the granite was constrained ranging from 1.3 to 1.0 Ma. The U-Pb age was better in quality than the fission-track age in that individual grain U-Pb ages were more uniform than individual fission-track ages. This demonstrates that LA-ICP-MS can easily yield reliable U-Pb zircon ages as young as 1 Ma and promises a bright future for this method.

Keywords: LA-ICP-MS, U-Pb dating, zircon, granite, Quaternary

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SGL041-07 Room:203 Time:May 25 10:00-10:15

3D subtraction imaging and U, Th concentration measurement of single grain of zircon

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(U-Th)/He age is calculated from helium content in a crystal generated by alpha decay. Alpha particles, nuclei of helium, are emitted with high kinetic energies and typically require about 20 micrometers to stop within zircon. These long stopping distances partly cause helium loss from near surface zone in the crystal and underestimation of (U-Th)/He age. This effect is corrected from the size and shape of crystals at present, called ”alpha correction”. Although this correction assumes a homogeneous distribution of decay precursor, it is not always appropriate, especially in zircon.

Therefore we need to measure 3D distribution of U and Th in the crystal for more accurate alpha correction before (U-Th)/He dating, and the measurement have to be performed without destruction of the crystal for following (U-Th)/He method. 3D subtraction imaging of micro X-ray computed tomography is one of such methods. However, a high-flux source is required for this application because a bulk zircon crystal absorbs/scatters X-rays. In this study, we tried to take the images of ten grains using a micro X-ray computed tomography facility in the large synchrotron radiation facility ”SPring-8”. At the result, we succeeded to detect a 3D varied distribution without destruction of the crystal. We also measured concentrations of U and Th using laser ablation ICP-MS in some of the crystals to investigate the sensitivity or detection limit of subtraction imaging of U and Th in zircon, and the effect for (U-Th)/He age.

Keywords: zircon, micro CT, subtraction imaging, (U-Th)/He dating

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SGL041-08 Room:203 Time:May 25 10:15-10:30

Development of un-irradiated and un-spiked laser fusion K-Ar dating: a trial applied to pyrite single grains

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Laser fusion measurements for a single grain of phenocryst or of in-situ measurement of less-abundant minerals found on thin sections are established for K-Ar dating method. For such kind of samples, Ar-Ar dating is applied widely to obtain radiometric ages because the Ar-Ar method is insensitive to the site difference between K and Ar in the specimen. However, Ar-Ar dating at least raises a difficulty that nuclides produced by irradiation mask some of the original isotope ratios in rock and mineral samples. In the cases of small amount of radiogenic 40Ar, large uncertainty is brought to ages useless by the masking. This motivates us to develop an un-irradiated and un-spiked laser fusion K-Ar dating method, with which we can analyze both Ar and K for the individual grains. This has been tested in following two protocols, which is K measurement following/after laser fusion Ar measurement applied to the retrieved single melted mineral grain itself. Especially, in this protocol, the model of the Hitachi Z-5010, which employs double-beam polarized Zeeman method for background correction, is used. The deuterium lamp and the polarized Zeeman method realize less background in atomic absorption photometry and the new optical system and the improved graphite furnace ensure high sensitivities. This method is expected to enable acquisition of precise radiometric ages of single grain K-Ar dating. Here we report a trial of single pyrite grain analyses from Nobeoka area coupled with multigrain analyses.

Keywords: K-Ar dating, laser fusion, in situ, single grain, un-spiked, un-irradiated

Japan Geoscience Union Meeting 2011
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SGL041-P01 Room:Convention Hall Time:May 25 14:00-16:30

U-Pb geochronology in western part of the Rayner Complex, East Antarctica

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The Rayner Complex in East Antarctica was initially defined by Kamenev (1972) to include coastal outcrops and minor inland nunataks in western Enderby Land and Kemp Land adjacent to the Napier Complex and further east into MacRobertson Land where amphibolite-granulite-facies metamorphism occurred at ˜900 Ma (e.g., Sheraton et al., 1987). Shiraishi et al. (1997) and Motoyoshi et al. (2006) reported that western coastal region of this Complex contains younger zircons (537-522 Ma) and monazites (˜500Ma) than inland region (˜1320-760 Ma), and this western coastal region is later defined as Western Rayner Complex (Shiraishi et al., 2008). However, the boundary and the mutual relationship between the main Rayner Complex and the Western Rayner Complex is still remained ambiguity.

U-Pb isotopic analyses of zircon were performed for Mt. Yuzhnaya, Condon Hills, and Mt. Lira using a Sensitive High Resolution Ion Microprobe (SHRIMP II) at National Institute of Polar Research. The studied samples were collected during the field work at the 2004-2005 Japanese Antarctic Research Expedition. 3 garnet-biotite gneisses were collected from Mt. Yuzhnaya and Mt. Lira, respectively. 2 garnet-biotite gneisses and quartzite were collected from Condon Hills.

U-Pb age data of three gneiss samples from Mt. Yuzhnaya are scattered from 572 to 2462 Ma. The gneiss samples show continuous age population ranging from 860-1030 Ma and older inheritances centered at ca. 1940 Ma and ca. 2181 Ma. Two gneiss samples are characterized by young age population at around 580 Ma and lower Th/U ratios. The other gneiss sample does not contain zircons of ca. 580 Ma, and shows the youngest age peak of 890 Ma. Three gneiss samples from Condon Hills contain inheritance older than 2500 Ma. The oldest zircon ages are over 3600 Ma. Main age population of Condon Hills samples are centered at ca. 2073 Ma, ca. 1934 Ma, and ca. 1878 Ma. Overgrowth rim with low Th/U ratio yields a weighted mean $^{206}Pb/^{238}U$ age of 894 +/- 2Ma (95% confidence).

Based on these newly obtained zircon data, we could suggest the following points:

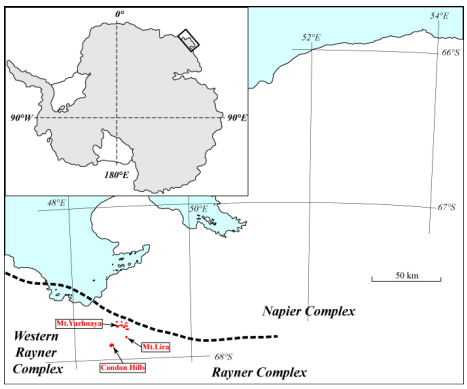
(1) The ca.1000˜860 Ma Rayner metamorphic event is commonly recorded in these areas.

(2) The presence of common magmatic 2200-1940 Ma zircons in all analyzed samples suggests that the area share the common history after the supply of sediments with these age materials.

(3) Neoproterozoic ˜580 Ma age event, which is relatively older than the previously reported 530-520 Ma ages, is obtained only in two samples from Mt. Yuzhnaya and is typically lacked in Condon Hills samples.

(4) Archean inherited (>2500 Ma) zircon is only found from Condon Hills.

These lines of geochronological evidences combined with the petrographical data can constrain the geologic evolution of Proterozoic-Cambrian boundary region of this part of Antarctica.



Keywords: East Antarctica, Rayner Complex, Western Rayner Complex, zircon, U-Pb geochronology

Japan Geoscience Union Meeting 2011
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SGL041-P02 Room:Convention Hall Time:May 25 14:00-16:30

Paleomagnetic direction of the Pliocene PM tephra, Himi area (Toyama Prefecture), central Japan

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The PM tephra, a prominent felsic tephra bed in the Pliocene sedimentary sequence in Himi, has been sampled for deciphering its rock magnetic and paleomagnetic properties. 10 oriented cores were taken from the uppermost fine-grained vitric ash layer at one locality, and detailed alternating-field and thermal demagnetization experiments were performed for 20 cylindrical samples cut from the cores in order to isolate remanent magnetization components. More than half of the samples had a single magnetic component with a northerly and down direction close to the present geomagnetic field direction (i.e. normal polarity). However, six samples which also provided a normal polarity linear component displayed a directional change along a great circle during stepwise demagnetization, indicating the presence of another higher coercivity/unblocking temperature component. Application of the great circle method disclosed that component which possesses a SSW and up direction (i.e. reversed polarity). A previous study has reported that the PM tephra is normally magnetized; however, I interpret that the normal polarity direction is most likely a viscous remanent magnetization and the primary magnetization is of reversed polarity. This interpretation is concordant with tephrostratigraphic investigations suggesting that the PM is correlated to the reversely magnetized tephras in several areas of central Japan collectively referred to as the Znp-Ohta tephra, a widespread tephra at about 4 Ma (upper Gilbert Chron).

Keywords: paleomagnetism, Pliocene, PM tephra, Znp-Ohta tephra, Himi

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SGL041-P03 Room:Convention Hall Time:May 25 14:00-16:30

Observation of fission-tracks in zircon by Atomic Force Microscope (AFM)

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Fission track (FT) method is a dating technique based on the observation of damages (tracks) by spontaneous fission of 238U left in a mineral. The date is calculated from the track density and the uranium concentration in the mineral because the number of tracks is a function of the uranium concentration and time. Usually the number of tracks is counted under an optical microscope after etching (chemical expansion of a track). However, as the density of FT rises, it becomes difficult to count the number of tracks because FTs overlap each other unable to distinguish. Therefore, the measureable density is limited to some extent due to etching process and the resolution of the microscope. To expand FT methods to date minerals with high FT densities, preventing the tracks from lying on top of each other by shortening the etching time, and observation with the higher magnification and resolution microscope than the optical microscope should be effective. Atomic force microscope (AFM) possesses high resolution with nano order, so that has the potential to count FTs with higher density. This research examines FT dating of zircon by using AFM.

AFM, which is a kind of the scanning probe microscope, observes a sample surface by scanning with the in-depth probe. Unlike electron microscope is able to observe without special pretreatment such as carbon coating, and tracks never disappear because it does not give energy. Moreover, high resolution and three dimensional information on sample surface can be easily obtained in the atmosphere so that it is not necessary to put a sample under the vacuum.

Zircons with track densities of about 4∗106cm-2 and about 11∗106cm-2 are observed. To obtain the AFM image for a sample prepared for FT dating, it is very important to remove the static electricity of the sample and to have flat surface wider than about 30 micro meter. Polishing with fine grained compound is essential. Two scanning methods, the AC(Tapping) mode (Scanning with the in-depth probe vibrating at a constant cycle) and the Contact mode (Scanning with the in-depth probe always approached), were tested to result that the Contact mode shows clearer image. To confirm how tracks can be identified under the AFM image, the image was compared with the image obtained with the optical microscope. When change in track shape and number is observed through step-wise etching, the track expands as the etching time increases, and the etching rate was smaller for tracks with a large size than those of small in size. Moreover the track that was not able to be seen with the optical microscope because the etching is insufficient can already be observed by AFM at same etching stage. As a result, the possibility of FT dating with high track densities using AFM was shown.