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

SGL40-01 Room:201A Time:May 19 14:15-14:30

Application of laser-heating 40Ar/39Ar dating to the studies of subduction initiation process

Osamu Ishizuka[1*]

[1]Geological Survey of Japan/AIST

Submarine volcanic rocks are known to give ages different from their true eruption ages in some cases (e.g. Seidemann 1977). This is due to the existence of excess ^{40}Ar in the rapidly quenched glass or Ar loss and K remobilization caused by reaction with seawater or hydrothermal fluids. Stepwise-heating analysis in ^{40}Ar/^{39}Ar dating is particularly useful for dating submarine volcanics because:1)it can provide means of detecting contribution of non atmospheric component (isochron plot), 2)extensive pre-analysis sample treatment (i.e., acid leaching, pre-heating of samples at relatively high temperature before analysis) is possible to reduce contribution from alteration phases, 3) by combined with laser-heating procedure, it can be applied on very limited amount of suitable material for dating.

We are applying this dating technique to reveal time scale and timing of process of subduction initiation along the Philippine Sea Plate, i.e., initiation of Izu-Bonin-Mariana arc. Dating of forearc crustal section of this arc revealed that the first basaltic magmatism at subduction initiation was produced by decompression melting of the mantle and took place at 51-52 Ma. The change to flux melting and boninitic volcanism took 2-4 m.y., and the change to flux melting in counterflowing mantle and more normal arc magmatism took 7-8 m.y.

These dating results also provide implication about the location and cause of subduction nucleation. The 51-52 Ma age of subduction nucleation in the IBM system strongly implies that the IBM arc initiated before the onset of sea-floor spreading in the West Philippine Basin. The potential location of subduction nucleation could be along the Mesozoic-aged arc terrane that is now found along the margins of the West Philippine Basin. This implication could be significant when along-strike variation of crustal structure and geochemical characteristics of arc magma are considered.

The contemporaneousness of IBM forearc magmatism with the major change in plate motion in Western Pacific at ca. 50 Ma suggests that the two events are intimately linked. Published numerical models of subduction initiation require at least 100km of convergence before a subduction zone nucleates, and self-sustaining subduction occurs (Hall et al., 2003). During the earliest stage of subduction, rapid trench retreat causes extension and decompression melting to generate forearc basalts from asthenospheric mantle. If this is correct, then 51-52 Ma age for onset of the basaltic magmatism can be considered as the age of initiation of slab sinking followed by self-sustaining subduction.

This age nearly coincides with the best estimate of the change in motion of the Pacific Plate deduced from the age of the Hawaiian-Emperor bend (c. 50 Ma: Sharp and Clague, 2006). Because the volcanism appears to be nearly synchronous with the change in plate motion, it appears that it was the onset of subduction that changed the plate motion. But it is still too early to reach this conclusion since we need to understand the period of subduction nucleation along the entire length of western Pacific margin with better precision. Systematic chronological study of ophiolite sequence (corresponding to early arc crustal section) in this area as well as the submarine forearc section will provide critical constraints to this discussion, and could contribute to finalize the discussion about whether subduction initiation is spontaneous or induced (e.g., Stern, 2004).

Keywords: 40Ar/39Ar dating, subduction initiation, Izu-Bonin-Mariana arc

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

SGL40-02 Room:201A Time:May 19 14:30-14:45

Argon isotope mass fractionation to light isotope enrichment in volcanic rocks

Tetsumaru Itaya[1*], Ryu, Sunyoung[1]

[1]Okayama University of Science

The basalt magma generated in the upper mantle must be in excess argon environment by the radiogenic 40Ar derived from 40K decay in the upper mantle as suggested from mantle-derived materials reported by Kaneoka and Takaoka (1980). In fact, the submarine basalts from the crest of the East Pacific rise give the older K-Ar ages up to 460 Ma (Funkhouser et al., 1968). The submarine pillow basalt lavas from Kilauea volcano, Hawaii give the extremely old K-Ar ages (43 Ma) in the quickly cooled rim part in comparison with the ages (1 Ma) in the slowly cooled core part (Dalrymple and Moore, 1968). Ryu et al. (2011) reported the quarse-grained olivine phenocrysts in the basalts from the central part of Korean Penissula were extremely older (38 Ma) than the groundmass feldspar (0.5 Ma). These results suggest the source magma had the excess argon, which has remained in the quick cooled pillow lavas and the coarse-grained olivine phenocrysts.

The island arc type magma is produced through the partial melting of mantle wedge peridotite (Tatsumi, 1986). This suggests that the magma were also in excess argon environment because the magma formed in the wedge mantle. The argon diffusion process from magma during the eruption makes more excess argon environments. However, the historical lavas have experienced the argon isotope mass fractionation to light isotope enrichment (Matsumoto et al., 1989) and the late Pleistocene volcanic rocks in Japan, New Zealand, Hawaii and China have frequently the ratios of 38Ar and 36Ar lower than the atmospheric ratio (0.187). This confirms the mass fractionation to light isotope enrichment is common in volcanic rocks.

When, where and how the mass fractionation from the atmospheric argon isotopes takes place during the magma generation and eruption process? Itaya and Nagao (1988) and Itaya et al. (1989) pointed out that the most likely location for the mass fractionation from the atmospheric argon could be in the magma reservoir in the earth crust, probably in the shallow reservoir where the magma may easily interact with the atmospheric argon transported from out of the reservoir through underground water or seawater based on Ueda and Sakai (1984) who revealed that there was a significant interaction between magma and seawater in the magma reservoir of Satsuma Iwojima volcano, south of Kyushu, Japan. We have a working hypothesis that the magma just before eruption has already the mass fractionated isotopes. Itaya and Nagao (1988) and Itaya et al. (1989) reported that the post caldera stage lava of Aso volcano has significantly different 36Ar content and the same ratio of 38Ar and 36Ar in the slowly cooled part and in the quickly cooled basement part. This shows that the mass fractionation did not take place during the degassing process in the lava flowing and the isotopic ratio in the magma reservoir did not change in the process. On the basis of this hypothesis, we propose a mixing model for the mass fractionation to light isotope enrichment. We interpret that the mass fractionation to light isotope enrichment takes place during infiltration of groundwater or seawater with the atmospheric argon isotopes into the magma reservoir with the mass fractionation law analyzed numerically (Ryu et al., 2010). When the water with mass fractionated argon isotopes interact sufficiently with the magma having the excess argon isotopes in the reservoir, the magma will have the argon isotopic ratios on the fractionation line. In this case, the mass fractionation correction is valid to get reliable ages. The insufficient interaction makes the isotopic ratios above the mass fractionation line, giving unreliable ages.

Keywords: volcanic rocks, argon, mass fractionation, light isotopes, mass fractionation correction age

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

SGL40-03 Room:201A Time:May 19 14:45-15:00

Terrestrial radiocarbon calibration dataset from Lake Suigetsu 1993 and 2006 varved sediment cores

Takeshi Nakagawa[1*], BRONK RAMSEY, Christopher[2], STAFF, Richard[2], BRYANT, Charlotte[3], SCHLOLAUT, Gordon[4], MARSHALL, Michael[5], BRAUER, Achim[4], LAMB, Henry[5], TARASOV, Pavel[6], HARAGUCHI, Tsuyoshi[7], GOTANDA, Katsuya[8], YONENOBU, Hitoshi[9], TADA, Ryuji[10], YOKOYAMA, Yusuke[10], Suigetsu Varves 2006 project members[11]

[1]University of Newcastle, [2]University of Oxford, [3]NERC Radiocarbon Facility (Environment), [4]GeoForschungsZentrum, Potsdam, [5]Aberystwyth University, [6]Free University Berlin, [7]Osaka City University, [8]Chiba University of Commerce, [9]Naruto University of Education, [10]University of Tokyo, [11]www.suigetsu.org

See Japanese abstract (the presentation will be in Japanese).

Keywords: Lake Suigetsu, SG06, Radiocarbon, IntCal, Varve

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

SGL40-04 Room:201A Time:May 19 15:00-15:15

U-Th dating of sulfide minerals from a hydrothermal vent -comparisons with other dating methods-

Asako Takamasa[1], Shun'ichi Nakai[1*], Shin Toyoda[2], Fumihiro Sato[2], Taisei Fujiwara[2], Jun-ichiro Ishibashi[3]

[1]ERI, University of Tokyo, [2]Okayama University of Science, [3]Kyushu University

The time scale for hydrothermal activity is an important factor controlling the size of hydrothermal ore deposits and the evolution of chemosynthesis-based communities in a submarine hydrothermal system. Radioactive isotopes with short half lives such as ^{210}Pb have been mainly used for dating of sulfide minerals in seafloor hydrothermal systems. Lalou et al. (1985) obtained young ^{210}Pb-Pb ages (<100a) for sulfide minerals from axial ridge of East Pacific Rise (12°N 50') where the spreading rate is large. However, they could not detect ^{230}Th for the minerals with alpha spectroscopy. ^{234}U-^{230}Th ages were successfully obtained for sulfide minerals from TAG area on the slow spreading mid-Atlantic Ridge using a thermal ionization mass spectrometry (TIMS). We applied ^{234}U-^{230}Th radioactive disequilibrium dating to sulfide minerals from a sulfide crust collected in South Mariana Trough where spreading is fast with the use of MC-ICP-MS. We also compared the ^{234}U-^{230}Th ages of sulfide minerals with ESR and ^{226}Ra-^{210}Pb ages of barite from the same sulfide crust. A slice of the crust which was further cut into 13 pieces were used this study.

^{234}U-^{230}Th and ESR methods yielded age of 0.27 ~ 2.2 ka. Two ages are consistent in most of samples. The crust also showed continuous ^{234}U-^{230}Th ages which suggest continuous growth. Noguchi et al. (2011) applied ^{226}Ra-^{210}Pb dating to barite from the same crust and reported young (30-40 years) ages. The different ages of ^{226}Ra-^{210}Pb system may have been caused from continuous growth of the sulfide crust. Here we assume a volumetrically continuous growth model of a sulfide crust to examine the behaviors of ^{234}U-^{230}Th and ^{226}Ra-^{210}Pb pairs. When each part of the sulfide crust precipitates, it contains ^{234}U and ^{226}Ra but no ^{230}Th and ^{210}Pb. The precipitated part is kept as a closed system. After the continuous growth for 2,000 a, the crust with a mean age of 1,000 a is sampled for analysis. If all part of the sulfide crust mixed thoroughly, ^{234}U-^{230}Th system yields 997 a, while ^{226}Ra-^{210}Pb system yields 84.9 a. The result of the calculation demonstrates that ages based on a shorter-lived radioactive isotope are biased by younger material addition. The discordant ages found between the ^{234}U-^{230}Th and ESR ages obtained in this study and ^{226}Ra-^{210}Pb ages reported by Noguchi et al. (2011) could be caused by continuous growth of the sulfide crust. The similar disconcordant ages were reported for opals precipitated from ground water (Neymark et al., 2000).

Our results demonstrated that sulfide deposits of a $>$ 10 cm thickness can record the evolutional history of hydrothermal activity of $>$ 1 ka. The application of MC-ICP-MS allowed improved geochronological resolution of U-Th disequilibrium ages and has lowered the required sample amount to less than 2 g.

Keywords: hydrothermal vent, U-Th radioactive disequilibrium dating, ESR dating, inconsistent age

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

SGL40-05 Room:201A Time:May 19 15:15-15:30

History of Hakusan volcano studied by multi-chronology

Noriko Hasebe[1*], Yasuyuki Nakano[1], Hikaru Miyamoto[1], Toshio Higashino[2], Akihiro Tamura[1], Shoji Arai[1]

[1]Kanazawa University, [2]Hakusan Nature Conservation Center, Ishikawa

The Hakusan volcano locates at the border between Ishikawa, Fukui and Gifu Prefectures. Existence of a magma reservoir is recognized by the seismicity (Takahashi et al., 2004), so that possibility of future eruption has been worried in recent years. Therefore, detailed analysis on the magmatic and volcanic history of the Hakusan volcano is necessary. The Hakusan volcano consists of Kagamuro (300˜400ka), Ko-hakusan (100˜140ka), Shin-hakusan (volcanic activity is further divided into two stages: the first (30˜40ka) and the second (˜10ka) activities), and Uguisudaira (˜20ka) volcanoes. The eruption age of each volcano has been estimated mainly by the K-Ar method (Higashino et al., 1984, Sakayori et al.,1999, etc.). However, except for Kagamuro volcano, their ages are relatively young for the age range applicable by the K-Ar method. Therefore, cross-check by other dating methods is important to confirm their eruption ages.

The purpose of this research is to date Hakusan volcano by the thermoluminescence (TL), fission track (FT), U-Th, and U-Pb methods to argue the volcanic activity. Obtained ages for the time of eruption are concordant with reported K-Ar ages.

It seems that eruption activities had occurred over a period of 60˜100 ka in the Ko-hakusan volcano, ˜50 ka in Shin-hakusan I volcano, and younger than ˜10 ka in Shin-hakusan II volcano. Crystallization ages within magma chamber is 50˜100 kyrs younger than the eruption ages.

Keywords: Luminescence dating, U-Th dating, Fission track dating, U-Pb dating

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

SGL40-06 Room:201A Time:May 19 15:30-15:45

Development of submicron CHIME dating

Takenori Kato[1*]

[1]Center for Chronological Research, Nagoya University

CHIME (U-Th-total Pb Chemical Isochron Method) dating[1][2][3] provides an U-Th-Pb age in microvolume using electron probe microanalyzer (EPMA). It is impossible to analyze submicron grain or domain because of X-ray generation volume at the normal analytical conditions (E0 = 15 - 25 keV). Submicron CHIME dating has been developed to perform dating of submicron size grain or domain using smaller energy of incident electron.

[1] Suzuki, K. & Adachi, M. (1991) J. Earth Planet. Sci. Nagoya Univ., 38, 11 - 37.
[2] Suzuki, K. & Adachi, M. (1991) Geochem. J., 25, 357 - 376.
[3] Suzuki, K. & Kato, T. (2008) Gondwana Res., 14, 569 - 586.

Keywords: CHIME dating, U-Th-Pb dating, submicron dating, quantitative electron probe microanalysis, matrix correction

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

SGL40-07 Room:201A Time:May 19 15:45-16:00

Incremental granitic magma emplacements in the Hida Mountain Range as revealed by comprehensive zircon U-Pb data

Hisatoshi Ito[1*], Ryuji Yamada[2], Akihiro Tamura[3], Shoji Arai[3], Kenji Horie[4], Tomokazu Hokada[4]

[1]CRIEPI, [2]NIED, [3]Kanazawa University, [4]National Institute of Polar Research

The Hida Mountain Range (HMR) is the largest and highest mountain system in Japan. The HMR is known to have the highest uplift and denudation rates during the Quaternary in Japan. Granite is the dominant lithology in the HMR and many stages of granitic magma intrusion from Mesozoic to Quaternary have been recognized, while exact timing of magmatic intrusion has been unclear because ages were mostly determined by K-Ar and fission-track dating methods with relatively low closure temperatures.

In this study, a total of 34 granitic rocks were dated by the U-Pb method on zircons using LA-ICP-MS. All of the samples were collected in and around the Kurobegawa Granite. Some zircons were dated both at the center and rim of a grain by LA-ICP-MS and SHRIMP U-Pb dating was also performed. These experiments corroborated the reliability of the dating results.

It was found that in the HMR 65 Ma granite is widespread and several discrete magmatic activities occurred since 10 Ma. The latest activity was ˜0.8 Ma, which indicates the Kurobegawa Granite is the youngest exposed pluton on Earth.

Keywords: U-Pb dating, zircon, granitic magma, Hida Mountain Range

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

SGL40-08 Room:201A Time:May 19 16:15-16:30

Mechanism of eruption of Kumano mud volcano, Nankai accretionary prism

Yoshiro Nishio[1*], Akira Ijiri[1], Tomohiro Toki[2], Yuki Morono[1], Fumio Inagaki[1]

[1]JAMSTEC, [2]Ryukyu Univ.

Deep-rooted fluids in the accretionary prism play an important role in the occurrence of earthquakes near trench. The fluid samples from forearc mud diapirs help us to delineate possible fluid origins and/or sediment?water interactions at depth within the accretionary prisms. It is, however, difficult to research deep-seated fluids from pore water samples using traditional hydrogen and oxygen isotopic compositions owing to contamination from seawater. Lithium (Li) is relatively unsusceptible to contamination from seawater because the Li content of deep-rooted fluid is significantly higher than that of seawater. In addition, Li has two stable isotopes, 7Li and 6Li, with respective relative abundances of 92.5% and 7.5%, and 7Li/6Li ratios may provide further insight into the origin of deep-rooted fluids. We therefore analyzed 7Li/6Li ratios of pore fluids in mud volcano in the Kumano forearc basin to investigate the fluid regime in Nankai accretionary prism. In this study, we analyzed two different drilled mud cores at site C0004 and site C0005 that were recovered from center and margin of the Kumano #5 mud volcano, respectively. These samples were recovered using D/V CHIKYU that was equipped with a riser drilling system. The results show that delta 7Li values of analyzed Kumano mud volcano fluid vary from +5.5 to +10.6 per-mil (delta 7Li = [[7Li/6Li]sample/[7Li/6Li]L-SVEC standard - 1] x 1000). Judging from the delta 7Li values were correlated with the Rb/Li ratios, we argued that the lowest delta 7Li value, +5.5 per-mil, as that of a deep-derived end-member fluid. It has already reported that the delta 7Li value of decollement fluid in Nankai subduction zone is +10 per-mil (You et al., 1995. Geology 23, 37-40). Because the Cl/Li ratios are significantly lower than seawater value, the Li isotopic difference between Kumano mud volcano fluids and Nankai decollement fluids are not due to seawater contamination. Thus, our Li isotopic data revealed that the Li in Kumano mud volcano fluids are originated from deeper (higher temperature) than those in the Nankai decollement fluids. Based on the Li isotopic data, we further estimated the fluid-sediment reaction temperature is 300 degree C. Based on the results, we discuss the mechanism of eruption of the Kumano #5 mud volcano.

Keywords: lithium isotope, mud volcano, Nankai, earthquake, accretionary prism, deep-rooted fluid

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

SGL40-09 Room:201A Time:May 19 16:30-16:45

Restoration of the 3.2-3.1 Ga sea floor: Local analysis of S isotope of micro-scale spherical shell pyrite in DXCL core.

Tsubasa Miki[1*], Shoichi Kiyokawa[1], Naoto Takahata[2], Takashi Ito[3], Minoru Ikehara[4], Kosei E. Yamaguchi[5], Ryo Sakamoto[6], Yuji Sano[2]

[1]Kyushu University, [2]Tokyo University, [3]Ibaraki University, [4]Kochi University, [5]Toho University, [6]Mitsui Oil Exploration Co.,Ltd.

In the Western Australia Pilbara coast green stone belt, low-grade metamorphic Dixon Island Formation and Cleaverville Formation of 3.2-3.0 Ga is exposed. In these sedimentary rocks, information of the earth's surface environment of Archean and a trace of the initial life which are very important to solve geological and bilological evolution of the initial earth are left.

DXCL land drilling (Kiyokawa et al., 2012) was performed in 2007 and 2011 for the purpose of the high-resolution reconstruction of the change of past sedimentation environment in this area, and four rock core samples (DX, CL1, CL2, and CL3) were acquired.

S isotopic measurement is performed for DX, CL1, and CL2. Delta 34S value was very heavy (-1.9 - +26.8 permille: Sakamoto, MS2010), and this is different from the negative isotope fractionation of the creature source usually seen. Change of the value was in particular big in the DX core. As a result of microscopic observation of DX, we found the layer of tens-hundreds micrometer euhedral pyrites and the layer of the micro-scale spherical shell pyrites(=MSSPs; about 10 micrometer in diameter) which are fulfilled with silica.

In this study, we measured S isotope of these MSSPs planarly and observed micro-scale distribution of isotopic ratio for the purpose of revealing to what extent minutely the fractionation occurred and how these pyrites grew.

(Classification of the MSSPs) We measured 11 samples and classified them under 3 types: A type(1 sample) is pyrite shell whose inner side is filled with silica, B type(7 samples) is pyrite shell which has a pyrite grain in its center, and C type(3 samples) is spherical pyrite which is fulfilled with pyrite. We suppose that these pyrites grew from A type to C type, via B type, based on this morphological classification.

(Method) We buried a thin section of DX124.34 which includes MSSPs and a working standard in resin, and performed imaging analysis to this sample using NanoSIMS. A type was measured an enlarged part of the spherical shell in the area of 3x3 square micrometer. B type and C type were measured a whole particle in the area of 10x10 square micrometer. Measuring time varied according to a measuring domain, but we can compare the results with the same precision by regulating the number of pixels to show in either 4x4, 8x8, or 16x16.

(Result of a measurement) 1. Standard: in the measurement of the standard with isotopic homogeneous composition, measured value was not stable. However, dispersion of the value in one analysis domain was small; we reproduced the homogeneity. Therefore, not the absolute value but the relative value, or difference of the isotopic ratio in one analysis domain is important in our mapping data.

2. MSSPs: in A type, isotopic ratio showed patch-like distribution. In B type, the inner edge was higher than the outer edge, and concentric structure was seen. However, patch-like distribution like A type was also seen. In addition, pyrite grain in the center was heavier than spherical shell. In C type, a heavy domain was seen in the shape of a ring.

(Summary) 1. In A type, isotopic ratio showed patch-like distribution. However, this is only a result of 1 sample.

2. In B type, an inner edge was higher than outer edge. We suppose that spherical shell grew toward inner side and got heavy isotopic ratio because of further fractionation in closed environment. Moreover, heavy pyrite grain in the center can be thought to have been formed for the same reason. Because some B type pyrite had patch-like distribution, we suppose that MSSPs grew from A type to B type in generally.

3. In C type, the center and the outer edge was light and a heavy domain was seen in the shape of a ring. This is because heavy pyrite grew from both the inner edge and the center, and the heaviest pyrite filled the inner space at last. Therefore, we suppose that B type pyrites grew into C type.

From Summary1 to Sumaary3, we claim that MSSPs grew from A type to C type, via B type.

Keywords: micro-scale spherical shell pyrite(=MSSP), sulfur isotope, local analysis, sulfate reduction bacteria, Archean, Pilbara

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

SGL40-10 Room:201A Time:May 19 16:45-17:00

Sr and Nd isotope systematics of metacarbonate rocks as proxies for extinct oceans in continental collision zones

Naho Otsuji[1*], Satish-Kumar Madhusoodhan[1], Atsushi Kamei[2]

[1]Niigata University, [2]Shimane University

Geochemistry of chemically deposited sedimentary rocks, especially neodymium isotopes, is often used as an indicator to understand paleo-oceans, its relationship with continents and so on. Because of the infinitely low concentration of neodymium in sea water than that of continental material and a very short residence time in the seawater, the Nd budget of the ocean is dominated by continental source and sedimentary rocks record its local differences. In particular carbonate rocks are good indicator for understanding the relationship between continents and surrounding oceans, because it is commonly deposited in a platform environment surrounding a continent.

The Sor Rondane Mountains, located in the Neoproterozoic to Early Cambrian East African-Antarctic collisional orogen, are the best location for understanding the Gondwana amalgamation, and recently lots of new information on these mountains have been generated in terms of its geology, lithological variations, tectonic evolution, geophysics and so on. These mountains are composed of medium- to high-grade metasedimentary, metaigneous and intrusive rocks of diverse composition (Osanai et al., 2013 and references therein). Within the metasedimentary rocks, the metacarbonate rocks are considered to have deposited chemically in the so-called the ”Mozambique Ocean” that separated the continental blocks East Antarctica and southern Africa that amalgamated to form Gondwana. It is possible that the metacarbonate rocks record geochemical signatures of contemporaneous seawater. Metasedimentary rocks distribute in Northeastern area of the Sor Rondane Mountains, and the southwestern area is dominated by metaigneous rocks that were derived from the subduction of young hot oceanic crust. Recently, Otsuji et al. (2013) reported 880-850 Ma and 820-790 Ma (late-Tonian and early-Cryogenian age) depositional ages of the metacarbonate rocks by using strontium and carbon isotopic stratigraphy. However, there exist regional variations in the Sr isotopic composition and it is necessary to understand the relation with surrounding continental blocks. To achieve this, we analyzed Nd isotopic composition in pure and impure metacarbonate rocks from the Sor Rondane Mountains, East Antarctica and discuss about the relationship with continent and depositional basin of carbonate sediments before the Gondwana amalgamation. Combining the reported Nd isotopic ratio from various rock units from the Sor Rondane Mountains (e.g. Kamei et al., 2013; Nakano et al., 2013; Shiraishi et al., 2008 and reference therein), we evaluate the possible source characteristics of Nd in the platforms that potentially surrounded the Sor Rondane Basin of the Mozambique ocean.

The epsilon values of Sr and Nd from pure carbonate rocks are lower than metaigneous rocks from the southeastern area in the Sor Rondane Mountains. A clear trend is also visible in the order from metaigneous rocks (rocks in the southeastern area), through impure carbonate to pure carbonate rocks in the Sor Rondane Mountains, suggesting a potential mixing of continental and oceanic source. Additionally, impure carbonate rocks show a narrow range, while pure ones have wide and various distributions in each region. There is also a marked variation in Nd model ages (T_{2DM}) for pure carbonate rocks in the Sor Rondane Mountains. These imply that the age of continents that acted as sources to the surrounding sea water during timing of carbonate deposition, were possibly different. In our presentation we attempt to discuss the pros and cons of using metacarbonate rocks which can lead to review the process during continental collision, and before and after that.

References

Kamei et al., 2013. Precambrian Research (in press); Nakano et al., 2013. Precambrian Research (in press); Otsuji et al., 2013. Precambrian Research (in press); Shiraishi et al., 2008. Geological Society, London, vol. 308, pp. 21-67.

Keywords: Sm-Nd isotopic composition, metacarbonate rocks, chemostratigraphy

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

SGL40-11 Room:201A Time:May 19 17:00-17:15

Timing of regional metamorphism in the Hida Belt and Unazuki area

Kenji Horie[1*], Mami Takehara[2]

[1]NIPR, [2]Graduate School of Sciences, Kyushu University

The Hida Belt is one of crucial sites for deciphering the Permo-Triassic orogeny in East Asia and is important for discussing the eastern extension of the Triassic continental collision between North and South China Cratons in the Japanese Islands. The Hida Belt consists of granitoids and metamorphic complex which consists mainly of paragneisses, orthogneisses, amphibolite and marble with multiple episodes of metamorphism evident, as based on petrography. However, the timing and duration of the regional metamorphism is still controversial, because radiometric ages mainly determined by Rb-Sr and K-Ar methods are scattered from 240 Ma to 220 Ma. The Unazuki area, situated at the northeastern part of the Hida Belt, has experienced the kyanite-sillimanite type metamorphism characterized by a clockwise P-T path. Radiometric ages of the Unazuki schists, previously determined by Rb-Sr and K-Ar methods, are scattered from 248 Ma to 175 Ma primarily because of multi-phase metamorphism and deformation. In this study, U-Pb zircon geochronology was applied to Hida gneiss in the Kagasawa area and the Unazuki schists to discuss about timing of the regional metamorphism in the Hida Belt and the Unazuki area.

Zircon grains of the Hida gneiss sample are rounded to well-rounded in habit. Cathodoluminescence images of zircon revealed that overgrowth rim surrounds oscillatory zoning core. The oscillatory zoning core yieled ca. 251 +/- 2 Ma. U-Pb age of the overgrowth rim with low Th/U ratio is ca. 247 +/- 1 Ma, which suggests that the regional metamorphism started between 251 and 247 Ma in the Kagasawa area.

On the other hand, in the Unazuki area, U-Pb data of quartzo-feldspathic schist derived from felsic volcanics yield an eruption age of 258 +/- 2 Ma, indicating that regional metamorphism occurred after 258 Ma. U-Pb age of a granite in north part of the Unazuki area is 253 +/- 1 Ma. The granite contains some xenoliths of the Unazuki schist, in which staurolite is replaced by andalusite and cordierite due to thermal flux from granitic magma. Therefore, regional metamorphism occurred between 258 and 253 Ma, suggesting a rapid metamorphic progression. 251 +/- 1 Ma of gneissose quartz diorite containing the Unazuki schists supports the timing of the regional metamorphism.

Keywords: zircon, U-Pb, Hida Belt, Unazuki, SHRIMP

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

SGL40-12 Room:201A Time:May 19 17:15-17:30

U-Pb ages of Cretaceous granitic and mafic rocks of SW Japan and their geological implication

Takashi Nakajima[1*]

[1]Geological Survey of Japan

The Cretaceous granitic province in Southwest Japan has been subdivided into San-yo zone in back-arc side and Ryoke zone in fore-arc side. The granitoids in the Ryoke zone are classified into Younger Ryoke granitoids and Older Ryoke granitoids.

It has been noticed since old days that the granitoids from the eastern part of SW Japan (Chubu district) give relatively young ages compared to those from the western part (Yanai district). Since 1990s, eastward younging along-arc age variation of these granitoids and a ridge subduction model has provoked hot discussion. But they are based on classical K-Ar and Rb-Sr ages because U-Pb dating had not been done in Japan, then.
After middle 1990s, U-Pb ages of the granitoids and accompanied mafic rocks using ion microprobe and ICP-MS have been documented. They gave the following results.

1) The U-Pb ages of the San-yo zone granitoids and Younger Ryoke granitoids show the polarity of eastward younging from cc.95Ma to 70Ma.
2) The ages of the Older Ryoke granitoids are nearly constant with rather broad range of 98-85Ma all the way from west to east of SW Japan.
3) The ages of mafic rocks including MMEs, synplutonic dikes and layered gabbros in the Chubu and Kinki districts are distinctly younger than the associated Ryoke granitoids. The ages of mafic rocks are similar to those of the San-yo zone granitoids of similar along-arc positions, seemingly following their along-arc polarity.

Along-arc age variation of the San-yo granitoids is clearly shown by also CHIME ages on the Chubu and Yanai districts (Suzuki and Adachi, 1998).
The results 1) to 3) above lead us to another view that we have not seen.

1. The San-yo and Ryoke granitoids should be re-categorized. The Younger Ryoke granitoids have to be re-defined or re-named in another grouping. Or it may be better to quit the name of San-yo and Ryoke granitoids at least in the meaning so far used.
2. Two types of magmatism took place at the site of the Cretaceous Japanese Islands. One is 95-85Ma plutono-metamorphism which prevailed whole SW Japan. Another one is along-arc traveling magmatism which is now exposed in the erosion level of volacano-plutonic complexes.
3. The mafic rocks now exposed in the Ryoke belt were product of the along-arc traveling magmatism.

Mafic rocks are exposed much less in the San-yo zone compared to those in the Ryoke zone. Mafic magma that intruded in the present San-yo zone may have contributed as a source material of the granitoids of the San-yo zone. Next, we need a tectonic model that allows the apparently crossing two age trends of magmatism in a single geologic site in the tectonic setting of a continental margin.

Keywords: granitic rocks, U-Pb age, SW Japan, Cretaceous, Ryoke/San-yo, gabbro

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

SGL40-P01 Room:Convention Hall Time:May 19 18:15-19:30

Closure temperature of biotite and thermal history

Hironobu Hyodo[1*]

[1]RINS, Okayama Univ. of Sci

In previous report, closure temperature of biotite in K-Ar system has been estimated from the results in laser step heating $^{40}Ar/^{39}Ar$ experiment on a single grain. In the estimate, the cooling rate was assumed to be 1 K/1000 yr, and the data was taken from fraction less than 800 degrees steps where little effect of dehydration is expected. The closure temperature calculated were distributed from less than 0 degrees to over 300 degrees. The average was approximately 250 degrees, being slightly less than the estimate from bulk experiments, whereas the average of activation energy was not much different from the previous value, indicating that the closure temperature obtained from laser step heating experiments is good enough for a rough estimate.

In this paper, increasing the number of data and distinguishing slow (1K/1000 yr) and rapid cooling (1K/1yr) between ”intrusives” (including metamorphics) and igneous ”extrusives” (including tuffs), respectively, closure temperature and activation energy was compared. No significant difference was found in the activation energy, but the closure temperature estimates differed; 270 degrees in intrusives and 330 degrees in extrusives. The difference seems to reflect the effect of cooling rate in the Dodson’s (1973) closure temperature formula. However, if we assume the cooling rate of the intrusives in extrusives, some of the samples show the closure temperature less than 200 degrees. Thus, the difference does not seem to be an apparent effect from the calculation.

There also were samples with closure temperature less than 100 degrees regardless of rock types. This often correlates with alteration, in particular chloritization of biotite, and reflected in age spectra. In most Arrhenius plots, the change of trend, reflecting the dehydration of biotite in bulk experiment was not found in laser step heating results. The difference is considered in view of heating scheme and slightly the lower estimate of closure temperature than bulk experiment.

Keywords: closure temperature, biotite grain, K-Ar system, $^{40}Ar/^{39}Ar$, laser step heating

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

SGL40-P02 Room:Convention Hall Time:May 19 18:15-19:30

Reduction of extraneous 40Ar contamination for accurate K-Ar age determinations: an experimental study in various sample

Seiko Yamasaki[1*], Shotaro Isobe[2], Hiroki Sato[2], Takahiro Tagami[2]

[1]Geological Survey of Japan, AIST, [2]Kyoto University

A fundamental assumption of K-Ar dating is that the samples initially contained no radiogenic ^{40}Ar, but sometimes rocks contain radiogenic ^{40}Ar called extraneous ^{40}Ar. Some previous study reported argon isotopes of historical lavas had anomalously high ^{40}Ar/^{36}Ar ratios, and show old apparent ages. Since extraneous ^{40}Ar is likely contained in the phenocrysts and xenoliths, groundmass samples are generally prepared for analysis. Besides, Ozawa et al. (2005) showed fine-grained grandmas samples had less extraneous ^{40}Ar contamination, and suggested that extraneous ^{40}Ar is contained in fluid inclusions or vesicles and released during crushing. We measure argon isotopic ratios in various sizes of young lava samples, and investigated the reduction of extraneous ^{40}Ar contamination. The finer samples roughly showed lower ^{40}Ar/^{36}Ar ratios but more difficult to handling of the preparation such as mineral separation and wrapping in foils for isotopic measurements.

Keywords: K-Ar dating, extraneous 40Ar, sample size

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

SGL40-P03 Room:Convention Hall Time:May 19 18:15-19:30

Results of Ar-Ar dating for basaltic rocks from Bowers Ridge, Bering Sea at site U1342A&D

Keiko Sato[1*], Hiroshi Kawabata[1], Hironobu Hyodo[2], Hidenori Kumagai[1], David W. Scholl[3], Kozo Takahashi[4], Katsuhiko Suzuki[1]

[1]IFREE, JAMSTEC, [2]Research Institute of Natural Sciences, Okayama University of Science, [3]U.S. Geological Survey, Menlo Park/ University of Alaska, Fairbanks, [4]Hokusei Gakuen University

Basement rocks were drilled down to ca. 42 m into the volcanic sequence directly underneath the sedimentary section at Site U1342 on Bowers Ridge during the IODP Expedition 323 to the Bering Sea. This provided us an opportunity to describe the details of the sequence and to decipher the virtually unknown origin and evolution of the Bowers arc massif. There are two contrasting hypotheses for the origin of the arc, which include formation in the Pacific Basin well to the south of its present location during the Cretaceous and in-situ formation within the Bering Sea in Eocene.

The volcanic sequence recovered from Site U1342D was divided into six major lithological units: Unit 1, vesiculated andesitic lava flow; Unit 2, interbedded volcanic sandstones and polymict volcanic conglomerates; Unit 3: monomict volcanic conglomerates; Unit 4, interbedded volcanic sandstones and polymict volcanic conglomerates; Unit 5, monomict volcanic conglomerates; and Unit 6, polymict volcanic conglomerates. Units 3 and 4 represent hydroclastic volcaniclastics, while units 2, 4, and 6 are epiclastic volcaniclastics (Kawabata et al., 2011). We used the single grain 40Ar-39Ar dating method by step-wise laser fusion for Unit 1 basaltic andesite rocks. dating.We distinguish for the first time two stage (age groups) of activity (34-32Ma and 28-26Ma) from our Ar-Ar data, coupled with those from Wanke et al., (2012).

Keywords: Ar-Ar dating, Bering Sea, Bowers ridge, U1342A&D

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

SGL40-P04 Room:Convention Hall Time:May 19 18:15-19:30

Fission track ages for baked country rocks adjacent to the mafic dikes in the Takato area, central Honshu

Hiroyuki Hoshi[1*], Hideki Iwano[2], Tohru Danhara[2]

[1]Aichi University of Education, [2]Kyoto Fission-Track Co. Ltd

We present new fission track (FT) ages for apatites and zircons separated from baked zones of country rock (granite) adjacent to dolerite dikes in the Takato area, Nagano Prefecture. The dolerite dikes form a dike swarm with a dominant NW-SE strike and vertical or subvertical dips, from which a minimum principal stress (sigma-3) axis trending NE-SW is deduced. The country rock is the Takato granite of late Cretaceous age. There are a number of good exposures where the contacts between the dolerite dikes and the granite can readily be recognizable. In order to determine the age of this dike swarm by FT dating, rock samples were collected from three baked zone sites of the granite that are located adjacent to the dolerite dikes. At the baked zone sites, we carefully sampled tiny rock fragments and mineral grains within 8 mm from the contact. We determined FT ages of ca. 17-16 Ma for zircons from all the baked zone sites, compared with the zircon FT ages of ca. 55 Ma determined for granite samples far from dikes. Confined FT length measurements suggest that the zircon FT ages for the contact zones have totally been reset by the heat from dolerite dikes. These FT results indicate that the dolerite dike intrusion took place at ca. 17-16 Ma and that mafic igneous activity occurred in this area in the latest Early Miocene. This finding has an implication that the 17-16 Ma volcanic front probably lay through or close to this area of central Honshu. For apatites, consistent ages of ca. 4 Ma were determined for both the baked zone and distant sites. Such significantly young apatite FT ages can be explained by assuming (i) significant uplift and denudation in and around the Takato area after 4 Ma, or (ii) a local thermal event at that time.

Keywords: fission track age, dolerite dike, Takato granite, central Honshu, thermochronology, Miocene volcanic front

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

SGL40-P05 Room:Convention Hall Time:May 19 18:15-19:30

Apatite fission-track and (U-Th)/He ages of the Suzuka Range, southwest Japan, and their geomorphological implications

Shigeru Sueoka[1*], Kunimi Yamada[1], Kenji Shibata[1], Hiroyuki Tsutsumi[2], Takahiro Tagami[2], Noriko Hasebe[3], Akihiro Tamura[3], Shoji Arai[3]

[1]Japan Atomic Energy Agency, [2]Kyoto University, [3]Kanazawa University

The Suzuka Range is a fault block mountain distributed along the Isewan-Tsurugawan Tectonic Line, a tectonic boundary between the Kinki and Chubu districts. The Kinki district on the west of the Range is characterized by predominance of reverse faults and alternation of N-S trending mountain ranges and basins (Kinki Triangle; Huzita, 1962, 1983), whereas the Chubu district on the east of the Range has predominance of strike-slip faults and westerly tilting landforms (Chubu tilting block; Kuwahara, 1968). Miyoshi & Ishibashi (2008) mentioned that the Philippine Sea Plate slab beneath the region around the Suzuka Range has shallow subduction angle and form a convex shape (Isewan-Kohoku slab) and proposed this shallow slab resulted in the tectonic boundary between the Kinki and Chubu districts in the region. However, how the slab has affected the landform development and tectonics of the region is not well understood partly because vertical crustal movements in the past few million years are not estimated. Subsidence and its rates in the past few million years in the Ohmi and Nohbi basins can be estimated by the depths and ages of the layers of the Pliocene Kobiwako and Tokai Groups. On the other hand, estimating uplift and its rates of the Suzuka Range requires denudation and denudation rates.

We are attempting revealing denudation history of the Suzuka Range in the past few million years by using thermochronological methods. We used apatite fission-track and (U-Th)/He thermochronology which have low closure temperatures (90-120 deg. C and 55-80 deg. C, respectively) and are generally used to detect recent denudation events. In apatites of granitic samples collected at the Suzuka Range, fission-track densities do not vary systematically along the N-S profile. Assuming that uranium concentrations are homogeneous in the granitic samples, the Suzuka Range should have had spatially homogeneous denudational history. If the apatite fission-track ages reflect the denudation history of the Range in the past few million years, uplift of the Range might be spatially homogeneous although subsistence of the Ohmi and Nohbi Basins started from the south and propagated to the north (e.g., Okada, 1980). On the other hand, if the apatite fission-track ages reflect the denudation history of the Suzuka Range in the past few ten million years, the denudation might be mainly attributed to the regional peneplanation of the Kinki and Chubu districts since the Palaeogene or late Cretaceous time. In a presentation, we are planning to provide more fixed and detailed discussions from the results of apatite fission-track and (U-Th)/He ages.

Keywords: fission-track thermochronology, (U-Th)/He thermochronology, Suzuka Range, denudation

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

SGL40-P06 Room:Convention Hall Time:May 19 18:15-19:30

The alpha effectiveness for formation of SO3- in barite : an application to ESR dating

YUSUKE ISONO[1*], Shin Toyoda[1], Hirotsugu Nishido[2], Masahiro KAYAMA[3]

[1]Department of Applied Physics, Faculty of Science, Okayama University of Science, [2]Department of Biosphere-Geosphere Science, Okayama University of Science, [3]Department of Earth and Planetary Systems Science, Graduate School of Science, Hiroshima University

While Kasuya et al. (1991) first pointed out that ESR (electron spin resonance) dating of barite ($BaSO_4$) is possible, the method was first practically applied by Okumura et al. (2010) to a sample formed by the submarine hydrothermal activity. A subsequent study by Sato et al. (2011) studied the thermal stability of the signal and concluded that the dating signal due to SO_3^- is stable so that dating method is applicable up to at least several thousand years.

Barite crystals formed by submarine hydrothermal activities contains large amount of Ra which replaces Ba in the crystal lattice where all dose rate is due to radiation from Ra. Okumura et al. (2010) reported a concentration of 7.7 Bq/g of Ra in a hydrothermal sulfide including barite where the internal alpha dose rate in barite contributes 40 to 60 % of total dose rate. Determination of alpha effectiveness is thus the one of the essential factors for improving the precision of dating of barite by ESR.

Toyoda et al. (2012) investigated the alpha effectiveness for the ESR signal due to SO_3^- in barite by comparing the dose responses of the signal for gamma irradiation and for He ion implantation with an energy of 4 MeV. A value 0.043 was obtained for a sample from Morocco.

However, the dose response was far from good, where the number of points is not sufficient. The experiments of He ion implantation was repeated in the present study for several samples to determine the precise alpha effectiveness.

As results, a value of 0.0012 was obtained from a sample from Morocco), and 0.00045 from one from Funaoka mine. The results of further repeated analysis will be presented.

Keywords: barite, electron spin resonance

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

SGL40-P07 Room:Convention Hall Time:May 19 18:15-19:30

ESR dating of barite in sea-floor hydrothermal sulfide deposits

Taisei Fujiwara[1*], Shin Toyoda[2], Jun-ichiro Ishibashi[4], Shun'ichi Nakai[5], Ai Uchida[2], Asako Takamasa[6]

[1]Okayama University of Science, [2]Department of Applied Physics, Faculty of Science, Okayama University of Science, [3]Department of Applited Physics Okayama University of Science, Japan, [4]Department of Earth and Planetary Sciences, Faculty of Science, Kyushu University, [5]Earthquake Research Institute, University of Tokyo, [6]National Institute of Radiological Sciences

The temporal change of submarine hydrothermal activities has been an important issue in the aspect of the evolution of hydrothermal systems which is related with ore formation (Urabe, 1995) and biological systems sustained by the chemical species arising from hydrothermal activities (Macdonald et al., 1980). Dating methods using disequilibrium between radioisotopes such as U-Th method (e.g. You and Bickle, 1998), 226Ra-210Pb and 228Ra-228Th method (e.g. Noguchi et al., 2011) have been employed for such studies.

Okumura et al., (2010) made the first practical application of ESR (electron spin resonance) dating technique to a sample of submarine hydrothermal barite to obtain preliminary ages, while Kasuya et al. (1991) first pointed out that barite can be used for ESR dating. Toyoda et al. (2011) determined the optimum ESR condition while Sato et al. (2011) confirmed that the signal is thermally stable enough for an age range of several thousand years. Takamasa et al. (in press) obtained U-Th and ESR ages which are roughly consistent with each other.

The samples were taken by NT11-20 and NT12-06 research cruises operated by JAMSTEC. Barite (BaSO4) was extracted from hydrothermal chimney samples (HPD#1331G01,HPD#1331G03, and HPD#1333G06) taken from two site at Okinawa Trough. Blocks of sulfide deposits were cut into pieces, and about 2.0g was crushed. The samples were soaked in 12M hydrochloric acid, left for approximately 24 hours. Then, 13M nitric acid was added. Finally, after rinsing in distilled water, the sample was filtered and dried. Impurities were removed by handpicking. An X-ray diffraction study was made to confirm that the grains are pure barite. After gamma-ray irradiation at Takasaki Advanced Radiation Research Institute, Japan Atomic Energy Agency, they were measured at room temperature with an ESR spectrometer (JES-PX2300) with a microwave power of 1mW, and the magnetic field modulation amplitude of 0.1mT. The bulk Ra concentration was measured by the low background pure Ge gamma ray spectrometer. Assuming that Ra is populated only in barite, the dose rate was calculated with the alpha effectiveness of 0.043 (Toyoda et al., 2012), where the decay of Ra (a half life of 1600 years) was also taken into account.

The ages of the pieces of HPD#1331G01 (Hatoma Knoll) were obtained to be 2600 to 4000 years, where outer pieces tend to be older. The ages of HPD#1331G03 are older to a direction, from 2.2 ka to 10 ka (Hatoma Knoll). HPD#1331G06 (Yoron Knoll) showed much younger ages around 100 years where they are older to a direction.

The results, the ages of the Hatoma Knoll is older than the Hatoma Knoll, are consistent with the landscape observation from the submarine vehicle, which gave such impression such as by number of dead chimneys and amount of sediments on the sulfide deposits, and with the diversity of the creatures inhabiting in the area.

Keywords: barite, hydrothermal activities, electron spin resonance, dating

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

SGL40-P08 Room:Convention Hall Time:May 19 18:15-19:30

ESR dating of tephra with dose recovery test for impurity centers in quartz

mitsuya Asagoe[1*], Shin Toyoda[1]

[1]Okayama University of Science

Determining the age of tephra is an important issue for reconstructing the history of environmental change during the Quaternary epoch. To this end, we consider dating of quartz using the electron spin resonance (ESR) method. Quartz was first found to be useful for ESR dating of fault gouge while the mineral was also used for dating of tephra, heated flints, and sediments.

The first investigation pertaining to ESR dating of tephra using quartz was published using the Al center (a hole trapped at Al site replacing Si). Subsequently, several other successful results on tephra have been reported (e.g. Imai and Shimokawa, et al., 1988, Imai et al., 1992, Toyoda et al., 1995, and Yokoyama et al., 2004). Buhay et al. (1992) reported that the ESR age (45-49 ka) of a tephra from New Zealand is consistent with the 14C age (42-44) within statistical errors.

However, in other studies, systematic discrepancies were observed between the ages obtained using the Al center and Ti-Li center (an electron trapped at a Ti atom replacing Si, accompanying a Li ion as a charge compensator). Toyoda et al. (2006) systematically investigated the ESR and RTL (red thermoluminescence) ages of tephra with a known age range of 30 to 900 ka, and found that ESR dating has problems in obtaining the equivalent doses. Using the same dose rate, the RTL ages were consistent with the expected ages while the ESR based results were inconsistent and involved lage scatter in data. The scatter in ESR ages was found to increase with age. Toyoda et al. (2009) proposed a new protocol, the multiple-aliquot regenerative-additive dose method, which provides equivalent doses estimates with smaller errors than the traditional additive dose method.

In the present paper, we have analyzed the same Nm-Sb tephra and A-Fm tephra and Ikezuki tuff to check the reproducibility of dating results and to test if known doses can be recovered using the multiple-aliquot regenerative-additive dose procedure.

Keywords: ESR dating, quartz, tephra

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

SGL40-P09 Room:Convention Hall Time:May 19 18:15-19:30

Estimate of the origin of the river sediment in the Kurobe River basin using TL and the ESR

Msanori Yoshida[1*], Shin Toyoda[1], Kiyotaka Ninagawa[1], Masashi Takada[2], Aiko Shimada[3]

[1]Department of Applied Physics, Faculty of Science, Okayama University of Science, [2]Department of History, Sociology and Geography, Faculty of Letters, Nara Women's University, [3]JEOL RESONANCE.Inc

While the ESR signals of the E1' center in quartz was used to investigate the origin of the loess in MIS 1 and 2 (Toyoda and Naruse, 2002) and these diments in the Sea of Japan (Nagashima et al., 2007), Shimada (2008)showed that TLCI (thermiluminescence color image) may be useful for similar qualitative study on river sediments.In the present study, the wavelength-temperature two demensional thermoluminescence measurement was employed, together with the ESR measurements, to investigate the origin of the river sediments quantitatively.

Sediment samples were collected from the 23 locations at the prefectural border of Nagano and Toyama and the Kurobe River basin. Eight samples of these were sieved to obtain four grain size fractions of 2-1mm, 1-0.5mm, 0.5-0.25mm, 0.25-0.125m. Quartz grains were extracted using chemicals, heavy liquid, and an is dynamic separator. The obtained quartz grains were heated at 300 degree celsius for 1 hour to erase the inherited signals. Each sample was then separated into 9 subsample aliquots for gamma ray irradiation up to 2640 Gy, which are for ESR measurements. Another separate aliquot for TL measurement was given a dose of 857 Gy where the sample glass tube was wrapped by Al foil to prevent from giving any light.

TL measurements were performed the two demensional TL apparatus which measures the TL emission spectra during heating up to 450 degree celsius. Red emission (538 to 658 nm) was observed between 90 and 390 and Blue emission (379 to 538 nm) was between 70 and 370 . The integrated counts were taken as the intensities of the red and blue emissions. The intensities of the blue emission are roughly constant for all samples of river sediments and river terrace samples while red emission tends to increase with age, i.e., lower in higher terraces and higher in lower terraces and present river sediments. The results of ESR measurements will be given in the presentation together with the TL results.

Keywords: ESR, TL(thermiluminescence), Quartz, river sediment

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

SGL40-P10 Room:Convention Hall Time:May 19 18:15-19:30

Eruption age determination of Kannabe scoria cone using multi-dating method

Yorinao Shitaoka[1*], Takeshi Saito[2], Tsutomu Soda[3], Masaya Miyoshi[4], Hidemi Ishibashi[5], Junji Yamamoto[6]

[1]Institute for Geothermal Sciences, Kyoto University, [2]Shinshu University, [3]Institute of Tephrochronology for Nature and History Co., Ltd., [4]University of Fukui, [5]Shizuoka University, [6]The Hokkaido University Museum

We determined eruption age of Kannabe scoria cone, which is located in southwest Japan. Although the eruption age had been estimated using K-Ar and loess stratigraphy, there is room for improvement in precision of the age determination.

We applied optically stimulated luminescence (OSL) dating, paleomagnetic measurement and tephrochronology on sediments and basaltic rocks associated with the Kannabe scoria cone. The sediment above the Kannabe basalt was formed at 21+/-1.7 ka (OSL dating). The eruption age was tephrochronologically estimated as 7.3-29 ka because the lava exists between two widespread tephras: Aira-Tn ash (ca. 26-29 ka) and Kikai-Akahoya ash (ca. 7.3 ka). The eruption age of the Kannabe scoria cone was before 21 ka and until ca. 29 ka.

We evaluated the eruption age of the Kannabe basaltic by detailed paleomagnetic investigation. The paleomagnetic data of 23 rock samples from 6 locations in the Kannabe basaltic field showed good agreement with each other. The averaged declination and inclination were respectively, 7.5^{o} and 65.9^{o} , which was in accordance with the geomagnetic secular variation of sediments in Lake Biwa at ca. 25 ka.

Consequently we proposed that the Kannabe basalt erupted at ca. 25 ka.

Keywords: Kannabe scoria cone, eruption age, paleomagnetic dating, OSL dating, tephrochronology

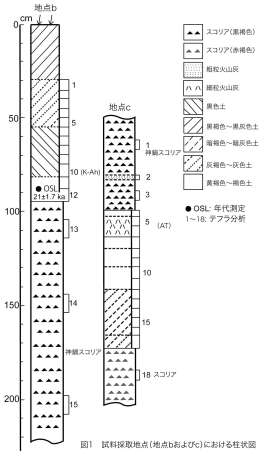

図1 試料採取地点(地点bおよびc)における柱状図

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

SGL40-P11 Room:Convention Hall Time:May 19 18:15-19:30

An assessment for alkaline treatment in ABA method to charcoal sample for 14C dating (AMS)

Shin Atsumi[1*]

[1]Department of applied chemistry, Tokyo University of Sciences

The Acid-Base-Acid (ABA) method is one of charcoal treatment methods for 14C dating. The evaluation of processing conditions of the ABA method based on any chemical indicator does not exist until today. An assessment against wood charcoal using Raman spectrometry has been tried, but the result only suggests that it is possible to detect the inclusion of humic acid in charcoal samples by Raman spectrometry but the relation between pretreatment efficiency and 14C dates has not been investigated. Therefore, this study aims to confirm the error in 14C dating generated by the alkaline pretreatment which is not clarified hitherto. The results show that medians of dates of samples treated with NaOH solution are scattered in the range of 57 14Cyr whereas medians of dates of samples untreated with NaOH solution are scattered in the range of 216 14Cyr. The results of chi-squared test test show T=0.45(df=3; 5% risk rate T $>$12.59) for the treated samples which means high convergent validity, while T=10.74 (df=4; 5% risk rate T $>$ 9.49) for the untreated samples which means large scattering and significant variation. In addition, dates of the untreated samples include younger (3589 plus-minus 41 BP) date and older (3805 plus-minus 40 BP) date in comparison to the average date of the treated samples (3701 plus-minus 43 BP), which suggests that 14C dates are made younger or older by the pollution or contamination of charcoal. Those results stated above partially attests the effectiveness of the ABA method.

Keywords: radiocarbon dating, charcoal, archaeological sample, ABA method

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

SGL40-P12 Room:Convention Hall Time:May 19 18:15-19:30

Application of isotope-geology to ichnology: paleoecology of the Phymatoderma-producer based on carbon-isotope analysis

Kentaro Izumi[1*]

[1]Dept. Earth and Planetary Science, Univ. Tokyo

The present study shows a case study that applies isotopic analysis to ichnology. The ichnogenus Phymatoderma is a subhorizontal branching burrow system consisting of radiating tunnels filled with fecal pellets. This ichnogenus has been interpreted as a product of a deposit-feeding organism, but the question of whether the Phymatoderma-producer was a subsurface deposit feeder or a surface deposit feeder is still a topic of controversy. Here I present evidence for the surface deposit-feeder hypothesis, based on carbon-isotope analyses, for the trace fossil Phymatoderma granulata from the lower Toarcian black shale in southern Germany. Carbon-isotope ratios of organic carbon in the pelletal infill of P. granulata, the surrounding black shale, and the overlying gray mudstone are -26.64 permil, -28.49 permil, and -26.27 permil, respectively. The difference between the pelletal infill and overlying mudstone in terms of C-isotope ratio is much smaller than that between the fillings and black shale; therefore, these data clearly indicate that the Phymatoderma-producer ingested the surface sediments and subsequently excreted fecal pellets into the subsurface sediments. Such a surface deposit-feeding style would be an effective way of absorbing nutrients, because surface sediments contain much fresh organic material, whereas organic matter in subsurface deposits consists mostly of refractory material that is poorly utilized by most marine benthos.

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

SGL40-P13 Room:Convention Hall Time:May 19 18:15-19:30

Correction of initial-disequilibrium on U-Th-Pb system for Accurate Zircon Dating

Shuhei Sakata[1*], Hirakawa, Shinsuke[1], Iwano, Hideki[2], Danhara, Tohru[2], Hirata, Takahumi[2]

[1]Department of Earth and Planetary Sciences, Kyoto University, [2]Kyoto Fission Track Co. Ltd.

During recent years, the improvement of analysing technique provides a more precision in case of dating Quaternary zircons. Major analytical problems associated with age determination of the young zircons are (1) the analytical difficulty to measure extremely low Pb/U and Pb/Th ratios (e.g., ^{206}Pb/^{238}U <0.0001), and (2) initial-disequilibrium in the U-Th-Pb decay systems through the crystallization of zircon in source magma. The ability to measure isotope ratios with high-dynamic ranges could be improved by the suppressor device for ion counting systems in the ICPMS instrument, in which the gain of the ion counting could be changed during the fast mass scanning, and the resulting precision and accuracy for the Pb/U and Pb/Th ratio measurements was be dramatically improved. However, correction of the initial-disequilibrium is highly desired to obtain reliable age data for young (<1Ma) zircons. Because of the different distribution coefficient ($D_{zircon/magma}$) between U and Th, isotope equilibrium was disturbed at the crystallization of zircons in source magma. Among the uranium series decay products, the initial disequilibrium of ^{230}Th can become a major source of systematic error in the resulting ages. To evaluate and correct the contribution of the initial disequilibrium on ^{230}Th, the ratio of the distribution coefficient for Th and U ($f_{Th/U}$ =D^{Th}/D^{U}) must be defined [2]. To achieve this, we have determined both the ^{238}U-^{206}Pb and ^{232}Th-^{208}Pb ages were obtained for three tephra zircon samples collected from Kirigamine rhyolite, Bishop tuff and Toga pumice (^{40}Ar-^{39}Ar ages are 0.945 ± 0.005 Ma, 0.7589 ± 0.0036 Ma, and 0.42 ± 0.01 Ma reported by [3], [4], and [5], respectively) using a LA-ICPMS. The resulting ^{232}Th-^{208}Pb ages were 0.938 ± 0.026 Ma (Kirigamine), 0.757 ± 0.008 Ma (Bishop), and 0.428 ± 0.004 Ma (Toga), respectively, demonstrating that the resulting ages were consistent with the previously reported values. The $f_{Th/U}$ values could be calculated based on the measured ^{206}Pb/^{238}U ratio and the resulting ^{232}Th-^{208}Pb ages, and the calculated $f_{Th/U}$ values were 0.50 ± 0.26 for Kirigamine, 0.51 ± 0.10 for Bishop, and 0.55 ± 0.07 for Toga zircons. The resulting three $f_{Th/U}$ values agreed well within the analytical uncertainties. The disequilibrium-corrected ^{238}U-^{206}Pb age can be calculated under the assumption that the $f_{Th/U}$ value did not vary significantly among the zircons. To evaluate this, we have measured the ^{238}U-^{206}Pb and ^{232}Th-^{208}Pb ages for zircons from Sanbekisuki tephra [6]. The $f_{Th/U}$ values used for the correction was based on the weighted mean of three $f_{Th/U}$ values obtained here ($f_{Th/U}$ = 0.53 ± 0.05). The corrected ^{238}U-^{206}Pb age was 86.2 ± 2.1 ka, which agreed with the ^{232}Th-^{208}Pb age (90.1 ± 2.6 ka) within the analytical uncertainties. It should be noted that the ^{238}U-^{206}Pb dating after the correction of the initial disequilibrium can provide accurate and precise chronological information. To evaluate the reliability of the present correction technique for the U-Pb dating, we have developed a pseudo concordia diagram (plot of ^{206}Pb/^{238}U ratio against the ^{208}Pb/^{232}Th ratio). In this diagram, most of the U-Th-Pb isotope data fall close to a concordia curve, suggesting that the Sanbekisuki zircon did not suffered from significant Pb-loss. In conclusion, we can construct more accurate and effective dating tool based on the U-Th-Pb decay systems based on the $f_{Th/U}$ value defined in this study, especially, for the young zircons.

[1] Y. Sano, Y. Tsutsumi, K. Terada, and I. Kaneoka, J. volcano. geotherm. res, 2002, 117, 285-296.
[2] U. Scharer, Earth and Planetary Science Letters, 1984, 67, 191-204.
[3] K. Wadatsumi, N. Kitada, and A. Deino, Fission Track News Letters, 1994, 7, 7-8.
[4] A.M. Sarna-Wojcicki, J. Geophys. Res., 2000, 105 21,431-21,443.
[5] K. Uto, K. Kano, and O. Ishizuka, Volcano, 2010, 55, 201-206.
[6] H. Machida and H. Arai, Atlas of Tephra in and around Japan, 2003.

Keywords: zircon U-Pb dating, disequilibrium, Quaternary zircon, precise isotopic analysis, laser ablation, ICPMS

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

SGL40-P14 Room:Convention Hall Time:May 19 18:15-19:30

SHRIMP geochronology of the Hida gneiss in the Wada-gawa area, Toyama Prefecture

Mami Takehara[1*], Kenji Horie[3], Tomokazu Hokada[3], Shoichi Kiyokawa[2]

[1]Department of Eart and Planetary Sciences, Graduate School of Sciences, Kyushu University, [2]National Institute of Polar Research, [3]Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University

The Hida belt, situated at the northern part of southwestern Japan, consists of low P/T metamorphic rocks such as paragneisses, orthogneisses, amphibolite and marble with multiple episodes of metamorphism evident, and Permo-Triassic granitoids. Previous works suggested that an earlier metamorphism occurred at ca. 350Ma under the granulite-facies conditions, and was overprinted by the amphibolite-facies metamorphism at 240-220 Ma (e. g., Arakawa et al., 2000) but these data were probably distributed by the Funatsu-type granites intrusion at about 180 Ma.

In regard to protolith, Sano et al. (2000) reported U-Pb zircon ages peaked at about 3420 Ma, 2560 Ma, 1840 Ma, 1130 Ma, 580 Ma, 400 Ma, 360 Ma, 285 Ma, and 250 Ma from the Hida gneiss at Amo area. Asano et al. (1990) also reported protolith ages of 415 +/- 189 Ma (Sm-Nd whole rock isochron) and 413 +/- 60 Ma (Sm-Nd mineral isochron) from basic metamorphic rocks and amphibolite at the Wada-gawa area, respectively. However, there is no precise geochronological data for protolith and the timing of the metamorphism. In this study, the Hida gneisses collected from the Wada-gawa area were analyzed by SHRIMP (Sensitive High-Resolution Ion Microprobe) to discuss about the protolith and the timing of the metamorphism of the Hida belt.

The Hida gneiss sample, WD090810-3, is composed of biotite, orthopyroxene, plagioclase, quartz and other minor mineral, such as prehnite, titanite, zircon, apatite and opaque minerals. Some biotite is chloritized. Most of plagioclase is also altered and fresh ones were partly observed. Zircon grains of the sample are rounded to well-rounded morphologies. Cathodoluminescence images reveal existence of overgrowth rim.

U-Pb dating of the zircon core yielded five age peaks centered at about 2526 Ma, 1864 Ma, 760 Ma, 553 Ma and 316 Ma, which indicates that the protolith is probably a sedimentary rock. Some age peaks are consistent with those reported by Sano et al. (2000). The youngest age peak suggests that the protolith was formed after 316 Ma. The overgrowth rim yielded weighted mean of ^{206}Pb-^{238}U ages of 247.7 +/- 0.5 Ma (MSWD = 1.18), which indicates the timing of metamorphism in the Hida belt. This age is first report of precise age of the Hida metamorphism and we will discuss about thermal history of the Hida belt with U-Pb titanite ages of the Hida gneiss.

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

SGL40-P15 Room:Convention Hall Time:May 19 18:15-19:30

U-Pb dating of Eoarchaean zircon using a NanoSIMS

Akizumi Ishida[1*], Naoto Takahata[1], Daniele Pinti[2], Jean David[2], Yuji Sano[1]

[1]AORI, the University of Tokyo, [2]Universite du Quebec a Montreal

Volatile compositions, such as hydrogen and/or sulfur which are included in the Eoarchaean igneous rock, have crucial information to reveal the evolution of interior of the early Earth. Apatite and/or glass inclusions, found in the zircon crystal, are expected to preserve a ”primitive” information of such volatile elements, though a high sensitive and high resolution analytical method are required for it. NanoSIMS is one of the most powerful tools to analyze such volatile compositions in micro-scale inclusions in zircon crystals with precise in situ U-Pb dating.

For the first step of this purpose, we performed ^{238}U-^{206}Pb and ^{207}Pb-^{206}Pb zircon dating using a NanoSIMS 50 ion microprobe, with the method developed by our group [1]. A 5 nA O^- primary beam, with 20 micrometers in diameter spot size, was used for ionization of sample surface, and secondary positive ions were collected in multicollector for mass analyses. The detector system was modified to measure $^{30}Si^+$, $^{90}Zr_2\ ^{16}O^+$, $^{204}Pb^+$, $^{206}Pb^+$, $^{238}U^{16}O^+$, and $^{238}U^{16}O_2{}^+$ ions simultaneously in ^{238}U-^{206}Pb dating session. In ^{207}Pb-^{206}Pb dating session, $^{204}Pb^+$, $^{206}Pb^+$, and $^{207}Pb^+$ ions were collected in one detector by scanning the magnetic field. A multicrystal zircon, QGNG (zircon extracted from Quartz-Gabbro-Norite-Gneiss from South Africa) with a U-Pb age of 1842 Ma, was used for standard of U-Pb dating [2].

The targeted zircons were separated from tonalite which was from Eoarchaean Nuvvuagittuq supracrustal belt, Surerior Craton, Canada. The reported U-Pb age of this tonalite is 3661+/- 4 Ma by using LA-MC-ICP-MS [3]. Euhedral to subeuhedral zircons were picked up to measure. The size distribution of zircons was from approximately 50 micrometers to 200 micrometers as the long axis of each crystal. Some of them have inclusions of glass or apatite whose size were 10 to 30 micrometers in diameter. Dating measurements were done avoiding such inclusions. Also, some of measured zircons have zonal structure. In such case, spot measurements were done by zone by zone for each zoning crystal.

Measured ^{206}Pb/^{238}U ratios range from 4.932E^{-1} to 7.644E^{-1}. These ratios get smaller toward the edge of zoning crystal. The ^{207}Pb/^{206}Pb ratios range from 3.052E^{-1} to 3.407E^{-1}. After the correction of common Pb, ^{238}U/^{206}Pb$*$ and ^{207}Pb$*$/^{206}Pb$*$ values were plotted on Terra-Wasserburg Concordia diagram. They showed a Discordia suggesting recent Pb loss. The intersection of Concordia and Discordia indicates that the age of this rock is 3633 +/- 35 Ma, which are agreed well with previous study. Now we are trying to measure the volatile compositions of inclusions in theses zircons. They could provide us primary information about the evolution of the Early Earth.

References

[1] Takahata et al., *Gondowana Res.*, 14, 587-596, 2008.
[2] Sano et al., *Geochem. J.*, 34, 135-153, 2000.
[3] David et al., *GSA Bulletin*, 121, 150-163, 2008.

Keywords: NanoSIMS, zircon, U-Pb age, Pb-Pb age

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

SGL40-P16 Room:Convention Hall Time:May 19 18:15-19:30

Chemically estimated depositional and zircon ages from metacarbonate rocks in the Sor Rondane Mountains, East Antarctica

Naho Otsuji[1*], Satish-Kumar Madhusoodhan[1], Tomokazu Hokada[2], Kenji Horie[2], Atsushi Kamei[3], G.H. Grantham[4], Noriyoshi Tsuchiya[5], Tetsuo Kawakami[6], Masahiro Ishikawa[7]

[1]Niigata University, [2]National Institute of Polar Research, [3]Shimane University, [4]Council for Geoscience, South Africa, [5]Tohoku University, [6]Kyouto University, [7]Yokohama National University

Estimation of timing of carbonate deposition implies the presence of platform environment for the accumulation of sediments from surrounding continents. As a consequence the determination of deposition ages in metasedimentary sequences is important in understanding the tectonic history of continental collisions and closure of oceans to form supercontinents. In general, radiometric dating, such as U-Th-Pb, of key horizons or the interval between youngest protolith age and metamorphic age in zircon from metasedimentary rocks helps us to determine the sedimentation age. However, zircons in metasedimentary rocks will provide information of provenance of source rocks in a wide interval between opening and closure of ocean. For this reason, other methods have to be employed for estimating exact depositional ages. In this study we have selected a typical continental collision zone of the Sor Rondane Mountains, located in the African-Antarctic orogenic belt formed during the Neoproterozoic to Cambrian time. This region is composed of medium- to high-grade metasedimentary, metaigneous and intrusive rocks of diverse composition. Shiraishi et al. (2008) and other studies reported wide range of depositional ages that were estimated by detrital and metamorphic ages of zircon from ortho- and paragneiss. Recently, Otsuji et al. (2013), estimated the depositional ages of 880-850 Ma and 820-790 Ma (late-Tonian and early-Cryogenian age) for the metacarbonate rocks by using strontium and carbon isotope chemostratigraphy. The metacarbonate rocks are considered to have deposited chemically in the so-called the ”Mozambique Ocean” that separated the continental blocks of Gondwana and possibly record geochemical signatures of contemporaneous seawater. However, according to the results by Otsuji et al. (2013), there are regional differences in their depositional timing. The determination of sedimentation ages may not be straight forward, and it has to be confirmed by the correlation with material derived from continental blocks. Here we present age information from zircon grains in impure metacarbonate rocks.

Petrographic observations of impure metacarbonate rocks, that contain relatively higher modal abundance of calc-silicate minerals, have shown that zircon is present in impure carbonate rocks from the Sor Rondane Mountains. Therefore it is possible that the zircons in impure metacarbonate rocks might be of detrital origin and record information about the provenance of pelitic components within the carbonate sediments. In contrast to the expected detrital ages, we obtained well-defined tight concordia U-Pb zircon ages of 545 +/- 1, 546 +/- 2 and 549 +/- 2 Ma, from three different layers in the Balchen region of the Sor Rondane Mountains. This age represent the latest phase of metamorphic age for this region, as reported in many recent studies. The zircons in metacarbonate rocks show hydrothermal re-equilibration texture on cathodoluminescence observations. Most of them have rounded shape, characterized by the absence of oscillatory growth texture, and shows dissolution-reprecipitation structures. Metacarbonate rocks are usually depleted in zirconium, however those in the Balchen region have abundant zircons. In general, zircon shows enriched heavy-REE pattern, whereas zircon in metacarbonate rocks from Balchen has flat REE pattern and low HREE concentrations, consistent with the rare earth pattern of zircons formed by hydrothermal activity. In addition to the high Cl-rich fluid activity around 600 Ma, our result shows that another important fluid activity was present in Balchen at around 545 Ma. Similar zircon age is reported from the matrix zircon in pelitic gneiss from Balchen (Higashino et al. 2013), implying that pelitic lithology also experienced the same fluid activity at around 545 Ma.

References; Shiraishi et al. 2008. GSL special publications, 308, 21-67; Otsuji et al. 2013. PR (in press); Higashino et al., 2013. JpGU abstract.

Keywords: depositional age, metacarbonate rocks, the Sor Rondane Mountains, zircon