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

SGL41-P01 Room:Convention Hall Time:May 23 18:15-19:30

Depositional environment of Miocene sedimentary basin distributed around Hitachiomiya area, northern Ibaraki, NE Japan

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Around the Tanakura Tectonic Line, northeast of Honshu Arc, lie Miocene terrigenous-subaqueous volcaniclastic sediments. These sediments are key in understanding the tectonics and the evolution of the northeast of Honshu arc during the Miocene, which corresponds to the opening of the Sea of Japan. Previous work conducted on the Mid Miocene succession around Hitachiomiya basin focus mainly on the paleontology or biostratigraphy of the succession. The past paleontological and paleoecological studies suggest a tropic-sub tropic environment for the deposition of the sediments based on the flora and fauna observed (e.g., Akutsu, 1952; Takahashi, 2001; Noda, 2001).

This investigation targeted the Tamagawa Formation within the Hitachiomiya basin deposits. The formation is up to 1000 m thick and is comprised of alternating tuffaceous fine sand stone and siltstone with several pyroclastic flow deposits. In this study, three characteristic facies are recognised. We interpret that two transgression-regression cycles occurred during the Mid Miocene based on detailed field observation and facies analysis on the deposits, and reconstruction of paleoenvironmental and paleoclimatic conditions. Our interpretation of two transgression-regression cycles is consistent with results from former studies focusing on other sedimentary basins around the Tanakura tectonic line.

Keywords: Tanakura basin, Miocene, facies analysis, pyroclastic flow deposits

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SGL41-P02 Room:Convention Hall Time:May 23 18:15-19:30

Geoenvironmental evolution from Pliocene to Pleistocene in and around Teshio Plain, Northern Hokkaido, Japan

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The Teshio plain is one of the largest Cenozoic sedimentary basin in Hokkaido. Post-Neogene thick sediments are distributed in both the Teshio plain and the surrounding area. Koetoi, Yuchi, and Sarabetsu Formations are Plio-Pleistocene sedimentary layers that show shallowing upward successions deposited on deep sea-terrestrial environments in the latest stage of the sedimentary basin. On the basis of micro-biostratigraphy and fission track ages, the geological age of these formations in the western part are younger than the strata in the eastern part, and these show contemporaneous heterotopic facies. However, the geological age and sedimentary environment of the strata in the Teshio plain is unclear because thick alluvium covers the surface. We conducted a deep drilling survey at a study site located in the coastal zone of the Teshio plain, then conducted a laboratory analysis of the core. The results of this comprehensive geological analysis confirm the fact that these strata are in a relationship of contemporaneous heterotopic facies until the Teshio plain, as is widely accepted (Koshigai et al., 2012). Yasue et al. (2005) estimated that the transition of space and time showed westward depositional migration caused in response to the movements of depositional centers. They also reconstructed the status of geoenvironmental evolution, which showed an open sea area gradually retreating with westward expansion of the land area. Conversely, the sedimentary environment of the Yuchi and Sarabetsu Formations clearly shows shallowing upward successions deposited on shallow-sea to lagoon environments from the results of sedimentary facies analysis and CNS elemental analysis of a core obtained from the borehole at the coastal zone of the Teshio plain. Moreover, Takashimizu (2009) analyzed the sedimentary facies of the Sarabetsu Formation at the eastern hilly area of Teshio plain and reconstructed two depositional systems composed of barrier-lagoon and beach-shoreface systems. Therefore, the geoenvironmental evolution from Pliocene to Pleistocene in and around the Teshio plain changed from an open sea to the unsociable sea environment that allowed for the spread lagoons in conjunction with the westward expansion of the land area.

Keywords: Yuchi Formation, Sarabetsu Formation, Pliocene, Pleistocene, Sedimentary facies analysis, CNS elemental analysis

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SGL41-P03 Room:Convention Hall Time:May 23 18:15-19:30

Mylonitization of granites in the central part of the Wariyama Uplift Zone

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Recently, granites of Upper Carboniferous age(300Ma) have been reported in the South Kitakami belt. One is granites of the GSJ B326 borehole samples of Tomioka town, in the southeast of Fukushima Prefecture (Ohtomo et al. ,2008, Tsutsumi et al., 2010) , the other is from the Wariyama Uplift Zone in the south of Miyagi Prefecture (Takeda et al., 2012). Both are located in the eastern part of the Futaba shear zone. The granites of the Tomioka borehole are composed of fine-grained tonalite and medium-grained tonalite associated with aplite, which have distinct foliation characterized by the elongation of quartz and an alignment of mafic minerals.

Fujita et al. (1988) named granite distributing in the Wariyama Uplift Zone (Oide and Fujita,1975) the Wariyama sheared granodiorite, and pointed out that it is the marginal facies of the Marumori Granitic Complex and belong to younger Abukuma granite. However, Takeda et al.(2012) found that there are granites of Upper Carboniferous (around 300Ma) and Upper Cretaceous, and called them the Wariyama granite and the Takase granite, each other. We report the distribution and mylonitization of both granites in the district between the Takase Pass and the Kosai Pass.

In the central part of the Wariyama Uplift Zone, the Wariyama sheared granodiorite(Fujita et al., 1988)is lithologically divided into the Wariyama granite and the Takase granite (Takeda et al., 2012). The former is composed mainly of fine to medium-grained tonalite, and latter is composed mainly of medium to coarse-grained tonalite, which is characterized by including porphyritic biotite (0.5-1.0cm in diameter). Both granites affected by strongly deformation are characterized by distinct foliation defined by the elongation of quartz pool and an alignment of mafic minerals. It is not clarified the geologic relations and mylonitization of both granite.

In E-W section along the Takase Pass, the boundary of both granite is located in east 300-500m of the pass. The Wariyama granite in the western side is composed of massive to weakly deformed granite. Around the boundary, both granites show the strongly mylonitic foliation and weekly lineation. In this section, the wide of mylonite zone is about 300m.The mylonite zone elongate to SW direction until Mt.Omori. In the extension area of the south side, the direction of the mylonite zone changes southeast from the southwest in the vicinity of western margin fault. The distribution of mylonitized granite is subparallel to the boundary of the granites. It is suggested that the mylonite zone was produced around the boundary of the Wariyama and Takase granite when the former contact tectonically with the latter.

Keywords: Wariyama Uplift Zone, granite, mylonitization, South Kitakami Belt

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SGL41-P04 Room:Convention Hall Time:May 23 18:15-19:30

Geology of the Atokura Nappe in the Yorii-Ogawa district, central Japan

Akira Ono[1]*

[1]None

The Atokura Nappe is distributed in the northeastern margin of the Kanto Mountains. The Atokura Nappe in the Yorii-Ogawa district consists with various kinds of geological bodies (Figure 1). Typical geological bodies are late Permian granitic bodies, mid-Cretaceous granitic and metamorphic rocks and early Paleogene high-pressure metamorphic rocks.

Geological structures of the Atokura Nappe are complex, but important facts are the following three points. (1) Various geological bodies are in contact with each other by high-angle faults. Low-angle faults have not been found anywhere. (2) Both of very small geological bodies and large geological bodies are widely distributed. Small elongated geological bodies are arranged along the boundaries of larger geological bodies. (3) The Atokura thrust, a low-angle fault between the Mikabo Greenstones and the Atokura Nappe, has been found at the locations of a, b, c, d and e.

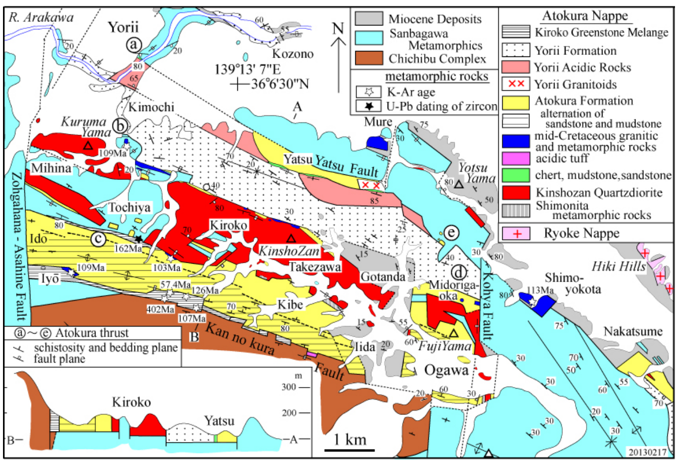
The small geological bodies of the Atokura Nappe are tectonic blocks which were formed when larger geological bodies integrated in the root zone of the Atokura Nappe. With respect to the formations of the small geological bodies, it is very important to understand geologies of the Tochiya and Yatsu regions.

In the Tochiya region, rocks of small elongated Kiroko greenstone melange are sandwhiched between sandstones and conglomerates of the Atokura Formation. As the Atokura thrust exists below the Atokura Formation, the same Atokura thrust is also assumed below the small elongated geologic body which is mainly composed of serpentinite. The small elongated Kiroko greenstone melange was formed in the root zone of the Atokura Nappe.

On the other hand, it is possible to consider that the small elongated greenstone melange was formed in the Sanbagawa belt. In this tectonic model the Kiroko greenstone melange which was situated far above the Atokura Formation fell down and was sandwiched between the rocks of the Atokura Formation. In this tectonic process geological bodies which were situated below the Kiroko greenstone melange were also significantly depressed. Nevertheless, the assumed geological structure is highly unnatural. Hence, the assumed tectonic model appears to be a mistake.

In the Yatsu region, the late Cretaceous Atokura Formation is distributed close to sandstones and conglomerates of the early Paleogene Yorii Formation. A small tectonic block of chert and mudstone is exposed in the west of the Yatsu region, but the Atokura Formation is directly in fault contact with the Yorii Formation in the east (Figure 1). As the Atokura thrust exists below the Yorii and Atokura Formations, the Mikabo greenstones also exist below the chert block. It is unreasonable to consider that the Atokura thrust below the chert has fallen into the deep.

Keywords: Atokura thrust, high-angle faults, tectonic blocks, root zone



SGL41-P05 Room:Convention Hall Time:May 23 18:15-19:30

Lithology and deformation of chert - clastic sequence in a long - core sample in Kochi - shi, Shikoku

Kaori Ohno[1*], Ken-ichiro Hisada[1], Katsumi Kimura[2]

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The Togano Unit of the southern Chichibu terrane, a part of the Jurassic accretional complex, is one of the representative rock units. The Togano Unit is characterized by a chert - clastic sequence. The site of borehole is situated at the northern end of the Kochi-shi eastern comprehensive sports ground. It is about 5 kilometers southwest of the Kochi JR Station. The whole length of the core is 601m. The interval between 0 to 127 m is an alluvium and 127 to 600 m corresponds to the Togano Unit. The boring core records obvious deformation structures, which is difficult to observe in the outcrop. As a result of the core observation, the core is characterized by the repetition of three chert - clastic sequences. The sequence is composed of cataclastic mixed rock, chert, siliceous mudstone and coarse clastic rock units, from the bottom to top. The cataclastic mixed rock unit consists of clasts of siliceous claystone, chert and volcanic rock in an argillaceous matrix associated with veins and scary cleavage. Bedded siliceous claystone and chert, 1 to 2 meters in thickness, are embedded in cataclastic zones. Cataclastic zones are cataclasite, breccia and gouge. Thus, the cataclastic zones are considered to have moved repeatedly. In contrast to the cataclastic mixed rock, its underlying clastic rocks record soft to semi solid sediment deformations. The deformations are concentrated in the uppermost part of the coarse clastic rock of the underlying chert - clastic sequence. The cataclastic mixed rock seems to represent the ancient decollement zone. At the same time, the hydro pressure increased remarkably and soft to semi solid deformation might be formed.

SGL41-P06 Room:Convention Hall Time:May 23 18:15-19:30

Middle Triassic chert-basalt succession in the Chanthaburi area, Southeast Thailand

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Paleozoic and Mesozoic rocks distributed in Southeast Thailand fundamentally comprise the basements of the Indochina continental Block to the east and the Sibumasu Continental Block to the west. Those distributed between the two continental blocks contain Permian?Triassic island-arc facies and back-arc basin facies, and have been discussed their geological significance and boundary. In the Sa Kaeo?Chanthaburi zone, the Triassic Pong Nam Ron and Noen Po formations are distributed in the Chanthaburi area of southeastern Thailand. Although Middle?Late Triassic radiolarians were reported from them (e.g., Hada et al., 1999), the lithologic features and sedimentary environments of fine-clastic and siliceous sediments have not been documented in detail. With respect to the depositional setting of these formations, moreover, there are two contrasted interpretations proposed up to now; one is that they are infilling sediments of the Nan?Sa Kaeo back-arc basin (Ueno and Charoentitirat, 2012) and the other is that they are arc-originated sequences associated with submarine volcanisms of the Sukhotahi arc (Sone et al., 2012).

At Ao Tan Khu, about 50 km southeast of Chanthaburi, we found an interesting exposure belonging to the Noen Po Formation. Reddish chert accompanied by basaltic rocks crop out along a seacoast of this area. We extracted radiolarians from the chert for age determination and also preliminarily examined petrographic and geochemical futures of the basalt to estimate its tectonic origin. Red and gray bedded chert and basaltic lava and tuff are exposed along coastal outcrops over the width of 250 m. The succession is divided into four parts as follows; basalt in the lower part, chert in the middle part, basaltic tuff in the upper part, and chert in the uppermost part in ascending order.

Chert in the middle part of this section is well bedded and recrystallized and is partly interbedded with tuffaceous shale layers, while in the uppermost part it is characterized by intercalations of black (manganese?) seams. Under the microscope, the chert in this section is free from volcanic fragments derived from the island-arc domain as well as coarse terrigenous grains, and contains a number of radiolarian tests within a cryptocrystalline quartz matrix. Poorly preserved but diagnostic Middle Triassic radiolarian species, Triassocampe sp., was obtained from a red-chert bed in the middle part of the section.

Basaltic rocks consist of lava showing pillow-like structure and alternations of thick lava and tuffaceous layer in the lower part of the section, and thick tuff and lava beds with minor intercalations of lens-shaped chert layers in the upper part. Under the microscope, the basalt shows an intersertal texture consisting of plagioclase and clinopyroxene phenocrysts within a fine-grained groundmass. We performed whole-rock geochemical analysis for two basaltic samples from the study section and plotted the result on some discrimination diagrams to estimate their tectonic origins. The plots mainly fall in the fields of tholeiitic basalt and MORB, suggesting that the basalt exposed at Ao Tan Khu should be derived from MORB.

Our stratigraphic observation revealed that the basalt and chert are essentially conformable, thus the radiolaria-bearing bedded chert was deposited directly on the Middle Triassic oceanic crust, forming a typical oceanic chert-basalt succession. Recently Sone et al. (2012) interpreted that the basalt in this locality originated in submarine arc volcanism, and the Noen Po Formation should belong to the Sukhothai Arc domain. However, our present data produce clear counterevidence to the explanation by Sone et al. (2012). The lithological features of chert and the occurrence of basalt with a geochemical signature of MORB both indicate that this basalt-chert sequence in the Noen Po Formation was formed in an oceanic area remote from the arc or continental domain rather than a basin where island-arc volcanism was active.

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New geochronological data from Mongolia: Implications for pre-Jurassic tectonic evolution of the CAOB

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INTRODUCTION The Central Asian Orogenic Belt (CAOB) is an east-trending collision belt between the Angara Craton and North China-Tarim blocks. The complex geology of the belt has prevented us from fully understanding its tectonic history. This study reports 1) age distribution of detrital zircons from some sandstone (ss.) samples in Mongolia, and 2) age-constraints of several shear zones.

GEOLOGY The northernmost Mongolia consists of continental elements of 0.7-3.1 Ga, and Neoproterozoic-Cambrian island-arc elements on the south. Further on the south are the following geologic elements. North-central Mongolia is occupied by Ordovician shallow marine beds (Haraa Belt) and Carboniferous accretionary complex (AC; Khangai-Khentei Belt) with a top-to-NNW Shear Zone alpha in between. In the Mongol Altai Mountains, NW-trending sinistral Shear Zone beta divides Ordovician shallow marine beds (Turgen Terrane) and Devonian island-arc elements (Tseel Terrane) on the north and an AC (Bidz Terrane) on the south. The South Gobi region on the east of Noyon is occupied mainly by Ordovician-Carboniferous arc volcanics, with some limestone bodies around Mandal Ovoo. Narrow zones of AC are detected near Shine Jinst and to the south of Janjin.

DETRITAL ZIRCONS The age-distribution of zircons from 12 ss. samples can be divided into three types from the shape of the probability density plot (peak ages; main peaks are in bold letters) and percentage of Precambrian zircons (%Pc) listed below.

Type A: Multimodal (**470-570 Ma**, **750-1000 Ma**, 1.7-2.0 Ga, **2.4-2.6 Ga**), %Pc $>$ 70. Ordovician ss. in the Haraa Belt belongs to this type.

Type B: Multimodal (maximum peak at **420-600 Ma**, 700-800 Ma, **0.9-1.05 Ga**, 1.25-1.5 Ga, 1.8 Ga, 2.5 Ga), with %Pc of around 35. Ordovician-Silurian shallow-marine beds in the Turgen Terrane, AC-forming ss. to the south of Janjin, and volcaniclastic ss. near Mandal Ovoo belong to this type.

Type C: Unimodal to quasi-unimodal (**300-450 Ma**, 800-1000 Ma), with %Pc between 0 and 20. The AC of the Khangai-Khentei Belt, and Devonian-Carboniferous AC and island-arc elements in the SW to S Mongolia belongs to this type.

AGE OF SHEAR ZONES From U-Pb dating results of sheared and post-tectonic igneous rocks, shear zones alpha and beta were dated to around 270 Ma and 280 Ma, respectively.

DISCUSSION

(1) Provenance of types A and B ss. The 750-1000 Ma igneous activity detected in both types has not been known from the North China Block and Angara Craton, but has been reported from ancient north Gondwana, such as India and Australia (e.g. Squire et al., 2006). Main age peaks from Cambrian ss. of India coincide with those from type A ss.. Peaks of 1.05-0.9 Ga and 0.82-0.74 Ga are likely the age of assembly (Tarim orogeny of Lu et al., 2008) and dispersion (Zhang et al., 2009a, b) of Rodinia, respectively. The 1.05-0.9 Ga age peak detected from type B ss. coincides with the age of the Tarim orogeny. Further, 1.25-1.5 Ga age peak only from type B ss. has also been known from Tarim ss., but has never reported from India and Australia (Rojas-Agramonte et al., 2011). Hence the provenance of type A and type B ss. was likely northern Gondwana (present-day India) and northwestern Gondwana (present-day Tarim), respectively.

(2) Tectonic setting of type C ss. Type C ss. shows unimodal age distribution with low %Pc values. It was likely deposited in an island-arc setting apart from a continental block with Precambrian basement rocks.

(3) Tectonic history

1) In Ordovician-Silurian times, type A and B ss. was deposited in continental arcs along northern and northwestern Gondwana, respectively. 2) The arcs were rifted from Gondwana and shifted northward. 3) In Devonian-Carboniferous times, type C ss. was deposited in an arc-trench setting apart from a continental block. 4) In Permian time (ca. 280 Ma), geologic elements of 2) and 3) were amalgamated, forming shear zones alpha and beta, and the main framework of the CAOB in Mongolia was constructed.

Keywords: U-Pb age, zircon, LA-ICP-MS, Mongolia, Central Asian Orogenic Belt, Gondwana

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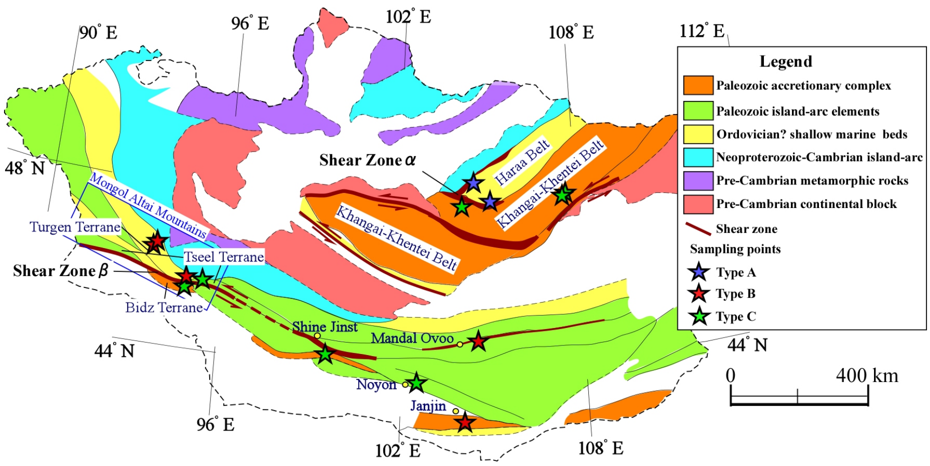

Japan Geoscience Union Meeting 2013
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Detrital zircon age distribution of Jurassic geologic units of Japan: New data and their implications

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U-Pb analyses of detrital zircons were carried out of major Middle-Late Jurassic geologic units of Japan to reconstruct the tectonic history.

RESULTS The results are listed in the following order: the shape of the probability density plot (peak ages +/- width (Ma); main peaks are in bold letters), percentage of Precambrian zircons (%Pc), the youngest concordia age with the 2SD error (YZ).

Hida Gaien Belt (1. Bathonian Tochimochiyama Formation (Fm.) of the Tetori Group)

1. bimodal (**213+66/-45 Ma**, **1776+220/-212 Ma**), %Pc = 39.5, YZ = 172 Ma

Mino Belt (2. Bathonian Kamiaso Unit)

2. quasi-bimodal (**179+17/-13 Ma**, 245+12/-17 Ma, **1826+637/-277 Ma**), %Pc = 53.8, YZ = 172 Ma

Northern Chichibu Belt (3. Bajocian-early Bathonian Nakaoi Unit)

3. quasi-bimodal (**183+88/-33 Ma**, 500 Ma, 1000 Ma, **1805+61/-108 Ma**), %Pc = 33.3, YZ = 163 Ma

Southern Chichibu Belt (Accretionary complex (AC) of 4. Bajocian Ogawa Belt, 5. Callovian Kobiura Belt, 6. Callovian Nishiyama I Belt, 8. Oxfordian Nishiyama II Belt, and 7. Oxfordian Naradani Fm., unconformably covering the AC of Kobiura and Nishiyama I belts)

4. bimodal (**250+86/-94 Ma**, **1848+304/-102 Ma**), %Pc = 47.4, YZ = 175 Ma
5. bimodal (**249+151/-95 Ma**, **1804+758/-316 Ma**), %Pc = 85.5, YZ = 166 Ma
6. quasi-bimodal (**176+129/-6 Ma**, 370 Ma, **1857+825/-190 Ma**), %Pc = 72.6, YZ = 175 Ma
7. quasi-bimodal (**173+79/-14 Ma**, 600 Ma, **1867+573/-127 Ma**), %Pc = 73.0, YZ = 171 Ma
8. quasi-unimodal (**170+40/-20 Ma**, 1790+276/-150 Ma), %Pc = 7.3-20.6, YZ = 157-160 Ma

South Kitakami Belt (9. Toarcian Hosoura Fm. of Shizugawa Gp., 10. Bajocian Aratozaki Fm. and 11. Oxfordian-Kimmeridgian Sodenohama Fm. of Hashiura Gp.)

9. quasi-unimodal (**255+/-30 Ma**, 373 Ma), %Pc = 0, YZ = 238 Ma
10. quasi-unimodal (**281+38/-191 Ma, 387 Ma**, 1929+146/-152 Ma), %Pc = 11.8, YZ = 166 Ma
11. quasi-unimodal (**180+101/-22 Ma**, 500 Ma, 1000 Ma, 1825+21/-100 Ma), %Pc = 10.8, YZ = 166 Ma

North Kitakami Belt (12. Oxfordian-Kimmeridgian Magisawa Fm.)

12. bimodal (**184+174/-26 Ma**, 1894+1141/-274 Ma), %Pc = 60.8, YZ = 168 Ma

JUNCTION OF OCEANIC ISLAND ARC AND CONTINENT The quasi-unimodal age distribution of the Hosoura Fm.[9)] with 0 %Pc strongly suggests its deposition on an oceanic island arc (OIA). The Middle-Upper Jurassic Aratozaki[10)] and Sodenohama[11)] Fms., on the other hand, show a contribution of ca. 2000 Ma zircons, most likely products of igneous activity during the amalgamation of the North China Block (NCB). The Early Jurassic OIA must have adjoined the NCB by Bajocian.

COMPARISON OF THE MIDDLE JURASSIC OF JAPAN Most of the Middle Jurassic sandstone in Japan[1),2),3),4),5),6),10)] shows bimodal to quasi-bimodal age distribution with a ca. 2000 Ma peak, indicating connection with the NCB, although the Aratozaki sandstone[10)] shows lower %Pc values. Moreover the Nakaoi sandstone[3)] of the Northern Chichibu Belt has slightly lower %Pc than the other sandstone in AC's and has received a supply of 500 Ma and 1000 Ma zircons.

WAS TOGANO UNIT FORMED THROUGH CONTINUAL OFF-SCRAPING? The Oxfordian Naradani Fm.[7)] and the underlying AC's of the Kobiura5) and Nishiyama I[6)] belts show a similar age distribution, characterized by a ca. 2000 Ma peak. They must have deposited along the margin of NCB. The Nishiyama II sandstone, on the other hand, shows a different age distribution with lower %Pc values, suggesting its deposition apart from the coeval Naradani sandstone. The Togano unit, proposed as a typical AC formed through continual off-scraping, can be subdivided into at least two subunits formed at different sites and later juxtaposed by faulting.

DIFFERENCE BETWEEN THE NORTH AND SOUTH KITAKAMI BELTS The Oxfordian Sodenohama Fm.[11)] and coeval Magisawa Fm.[12)] show significantly different age distribution. They must have deposited at different sites and have later juxtaposed. Wide ductile shear zones with prominent horizontal lineation run along the western margin of the North Kitakami Belt (Otoh and Sasaki, 2003). This is an item of evidence for the above post-depositional rearrangement.

Keywords: the shape of the probability density plot, South Kitakami Belt, North Kitakami Belt, Togano unit, Naradani Formation,

North China Block

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Displacement of geologic bodies induced from detrital-zircon stratigraphy of three geologic belts in SW Japan

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Stratigraphical change of age-distribution of detrital zircons from some pre-Permian to Jurassic geologic units of the Maizuru, Akiyoshi, and Renge belts in SW Japan revealed the displacements of geologic bodies.

GEOLOGIC SETTING

Maizuru Belt: The sedimentary units of the belt consist of the Permian Maizuru Group (Gp.), and unconformably covering Lower-Middle Triassic Yakuno and Upper Triassic Nabae Gps. (Hayasaka et al., 1996). We sampled the sandstone of the three groups.

Akiyoshi Belt: The belt consists mainly of Middle-Late Permian accretionary complex (AC), which has unconformably been covered by Late Triassic terrestrial to shallow marine beds such as the Mine Gp. (Hase, 1950). We collected a sandstone sample from the Ota Gp. (AC) and two sandstone samples from the Mine Gp.

Renge Belt: The belt consists mainly of high-P/T metamorphic rocks of 300 Ma (K-Ar age), which has unconformably been covered by Early Jurassic shallow marine beds with ammonoid horizons such as the Toyora Gp. (Kobayashi, 1931). We collected samples of the Renge psammitic schist, and the Early Jurassic Higuchi Gp. and Yamaoku Formation (Fm.).

RESULTS The results listed below are presented in the following order: the shape of the probability density plot (peak ages +/- width (Ma); main peaks are in bold letters), percentage of Precambrian zircons (%Pc), the youngest concordia age with the 2SD error (YZ).

Maizuru Belt (1. Maizuru Gp., 2. Yakuno Gp., 3. Nabae Gp.)

1. quasi-unimodal (**260 +190/-30 Ma**, 430 Ma, 2080 Ma), %Pc = 4.1, YZ = 254.0 +/- 6.9 Ma
2. quasi-bimodal (**260 +120/-20 Ma**, **500 +20/-70 Ma**, 910 Ma, 1855 Ma), %Pc = 8.3, YZ = 244.6 +/- 6.1 Ma
3. multimodal (**250 +120/-40 Ma**, **510 +90/-80 Ma**, **900 +70/-100 Ma**, 1090 Ma, 1260 Ma), %Pc = 14.5, YZ = 222.3 +/- 6.1 Ma

Akiyoshi Belt (4. Ota Gp., 5-6. Mine Gp.)

4. unimodal (**270 +/- 30 Ma**), %Pc = 0, YZ = 254.0 +/- 6.8 Ma
5. bimodal (**270 +45/-65 Ma**, **1855 +415/-145 Ma**), %Pc = 73.2, YZ = 213.1 +/- 5.3 Ma
6. bimodal (**230 +40/-20 Ma**, **1850 +730/-160 Ma**), %Pc = 93.5, YZ = 220.6 +/- 6.7 Ma

Renge Belt (7. psammitic schist, 8. Higuchi Gp., 9. Yamaoku Fm.)

7. quasi-unimodal (**473 +200/-85 Ma**, small peaks >700), %Pc = 31.3, YZ = 417.1 +/- 10.7 Ma
8. bimodal (**250 +45/-60 Ma**, **1940 +940/-400 Ma**), %Pc = 85.6, YZ = 199.2 +/- 4.9 Ma
9. bimodal (**190 +85/-30 Ma**, **1845 +600/-160 Ma**), %Pc = 26.9, YZ = 170.5 +/- 5.5 Ma

DISPLACEMENT OF THE MAIZURU ISLAND ARC The quasi-unimodal age distribution and low %Pc (4.1) of the Upper Permian Maizuru Gp. indicate that is was deposited in an island-arc environment with little Precambrian basement rock. The Triassic cover, however, shows multimodal age distributions having common peaks with those of the Paleozoic sandstone on or near Gondwana-derived blocks in East Asia (e.g. Tarim block; Rojas-Agramonte et al., 2011), suggesting that the Maizuru island arc was amalgamated with such a block.

FORMATION AND DISPLACEMENT OF THE AKIYOSHI AC The Ota sandstone of the Akiyoshi AC shows a unimodal age distribution with %Pc=0, indicating its deposition along an oceanic island arc. The overlying Mine Gp., on the other hand, shows bimodal age distribution with a prominent peak at ca. 1900 Ma. 1900 Ma is the age of suture zones in the North China Block (NCB) (Zhao et al., 2005), and the zircons of this age have abundantly been supplied to the Permian Pyeongan Supergroup on the NCB in South Korea (Lee et al., 2012). The Akiyoshi AC, accreted to a Middle-Late Permian oceanic island arc, must have shifted in Early-Middle Triassic to the margin of the NCB.

FORMATION AND DISPLACEMENT OF THE RENGE METAMORPHIC ROCKS The psammitic schist in the Renge Belt shows similar age distribution with Paleozoic sandstone on and near Gondwana-derived blocks (Kouchi et al, 2013). The Early Jurassic cover, on the other hand, shows similar bimodal age distributions with the Mine Gp. The protoliths of the Renge metamorphic rocks were likely accreted to the Gondwana margin before Permian, and the rifted margin may have been amalgamated with the NCB.

Keywords: U-Pb age, detrital zircon, LA-ICP-MS, Maizuru Belt, Akiyoshi Belt, Renge Belt

SGL41-P10 Room:Convention Hall Time:May 23 18:15-19:30

Tectonic environment of Triassic sandstones in NE Japan: Constraints from detrital zircon geochronology

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INTRODUCTION U-Pb LA-ICP-MS dating of detrital zircons was carried out of the South Kitakami, Nedamo, and North Kitakami belts, NE Japan. The analyzed samples were taken from (1) the Osawa, Fukkoshi and Isatomae formations of the Lower-Middle Triassic Inai Group, and the Chonomori Formation of the Upper Triassic Saragai Group in the South Kitakami Belt (SKB), (2) age-unknown Takinosawa Unit in the Nedamo Belt (NB), and (3) age-unknown Kamatsuda calcareous sandstone in the North Kitakami Belt (NKB). All of the sandstone samples are of lithic sandstone with abundant volcanic-rock fragments. We aim to constrain, from the dating, the age of Takinosawa and Kamatsuda sandstones, and evaluate the tectonic environment of Triassic sandstones in Northeast Japan.

OUTLINE OF GEOLOGY The **SKB** retains Ordovician to Early Cretaceous continual succession of shallow-marine strata (e.g., Kawamura et al., 1990), and is very important in analyzing the long-term tectonic and environmental history of the Japanese Islands. The **NB** lies in northwest direction between the SKB and NKB on the northeast (Ehiro and Suzuki, 2003). The Nedamo Complex, the main constituent of the NB, has been lithologically subdivided into the Tsunatori and Takinosawa units. The Tsunatori Unit occupies the southwestern, apparently upper half of the Nedamo Complex, and contains Late Devonian chert (Hamano et al., 2002) and probably Early Carboniferous siltstone (Uchino et al., 2005). The **NKB** lies on the northeast of the SKB and NB, and consists mainly of Jurassic to earliest Cretaceous accretionary prism. Nakae and Kurihara (2011), however, recently reported the Kirainai Unit with Late Permian mudstone along the southwestern margin of the NKB. The Kamatsuda sandstone is lithologically very similar with Kirinai sandstone.

RESULTS (1) **Triassic sandstone samples of the SKB**: All of the zircon ages clustered at 320-195 Ma. The concordant age of the youngest zircons in each sample ranged from 248 Ma to 195 Ma, and had upward-younging polarity. (2) **Takinosawa sandstone**: All of the zircon ages clustered at 330-240 Ma, and the concordant age of the youngest zircons was 241.2 +/- 6.5 Ma. (3) **Kamatsuda sandstone**: 58 zircon ages out of 65 clustered at 290-240 Ma, with smaller clusters or age distributions at 320 Ma, 360 Ma, 460-415 Ma, 1405 Ma, and 2475 Ma. Only two Precambrian zircons were detected, and the concordant age of the youngest zircons was 240.4 +/- 6.4 Ma.

DISCUSSION The age of most zircons analyzed in this study fell between 330 Ma and 195 Ma, except for 6 zircon ages from the Kamatsuda sandstone. The age distribution of detrital zircons from the Kamatsuda sandstone was also close to that of other sandstone samples. The unimodal (330-195 Ma) age distribution pattern emerged from the present study is quite different from that of Permo-Triassic sandstone in South Korea with 80% of Paleoproterozoic zircons (Lee et al., 2012). The Ordovician-Devonian and Middle Jurassic-Early Cretaceous sandstone samples of the SKB do not show a unimodal pattern, either (Shimojo et al., 2010; Okawa et al., 2012). Since all the studied samples are those of lithic sandstone with abundant volcanic-rock fragments, the Triassic sandstone of the SKB and the Takinosawa sandstone of the NB were most likely deposited in an island arc-trench system apart from a continent with Precambrian rocks. Although the Nedamo Complex was considered to be an Early Carboniferous accretionary prism, the Takinosawa Unit, having the youngest detrital zircon age of 241 +/- 6.5 Ma, must have formed in Middle Triassic or later. We further interpret that the Takinosawa Unit was accreted to an island arc that accumulated the Triassic sandstone of the SKB, in Middle to Late Triassic times, because of the close resemblance of the age distribution pattern between the Triassic sandstone of the SKB and the Takinosawa sandstone, both with abundant volcanic-rock fragments.

Keywords: U-Pb age, LA-ICP-MS, South Kitakami Belt, Nedamo Belt, North Kitakami Belt, oceanic island arc

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Detrital zircon geochrolology of the Sangun metamorphic rocks: Implications to the evolution of an arc-trench system

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INTRODUCTION High P/T type metamorphic rocks in the Inner Zone of SW Japan have collectively been called the Sangun metamorphic rocks. Their protolith age and tectonic development, however, have not fully been understood. In this study, we carried out U-Pb analyses of detrital zircons from the Sangun schists to constrain the protolith age and provenance.

OUTLINE OF GEOLOGY The Sangun metamorphic rocks have been subdivided from K-Ar cooling ages and tectonostratigraphy as follows: the Renge (RMR; ca. 300 Ma), Suo (SMR; ca. 220 Ma), and Chizu (CMR; ca. 180 Ma) metamorphic rocks (Shibata and Nishimura, 1989) in apparently descending order. The protoliths of the metamorphic rocks are sandstone, mudstone, chert, and mafic rocks, suggesting that they are originated from accretionary complexes.

RESULTS We collected ten samples of pelitic and psammitic schist from the following areas. RMR: one sample each from the Kashii (RK), Wakamiya (RW), Saga (RS), and Iiba (RI) ; SMR: three samples from the Yame area (SY1 to 3), one sample from the Asakura area (SA) and one sample from the Hazumi-minami Formation (SH); CMR: one sample from the Maniwa area (CM). The results listed below are presented in the following order: the shape of the probability density plot (peak ages +/- width (Ma); main peaks are in bold letters), percentage of Precambrian zircons (%Pc), the youngest 206Pb/238U age with the 2SD error (YZ (Ma)).

RMR (K-Ar cooling age = 272 +/- 8 Ma (Shibata and Nishimura, 1989))

- RK: quasi-unimodal (**473 +200/-85**, small peaks >700), %Pc = 31.3%, YZ = 417.1 +/- 10.7
- RS: quasi-unimodal (**446 +95/-40**, small peaks >800), %Pc = 23.8%, YZ = 415.4 +/- 10.3
- RW: quasi-unimodal (**437 + 120/ - 90**, small peaks >600), %Pc = 37.5%, YZ = 361.7 +/- 11.9
- RI: quasi-unimodal (**460 +/- 160**, small peaks >900), %Pc = 13.3%, YZ = 299.5 +/- 5.5

The protolith age of the RMR is constrained between 428 Ma (Gorstian of Late Silurian) and 264 Ma (Wordian of Middle Permian).

SMR (K-Ar cooling age = 211 +/- 7 Ma (Shibata and Nishimura, 1989))

- SY1: quasi-unimodal (**273 +45/-33**, 1771 +/- 31), %Pc = 0.7%, YZ = 248.3 +/- 7.2
- SY2: quasi-unimodal (**259 +123/-32**, 1700 +/- 250, older 5 grains), %Pc = 14.6%, YZ = 236.6 +/- 4.1
- SY3: quasi-unimodal (**248 +97/-27**, 389 +/- 23, 1770 +/- 250), %Pc = 13.7%, YZ = 228.8 +/- 5.6
- SA: quasi-unimodal (**253 +50/-30**, 10 grains of 400-2700), %Pc = 7.1%, YZ = 231.5 +/- 7.2
- SH: quasi-unimodal (**254 +/- 45**, 1850 +/- 200, 2310 +/- 60), %Pc = 16.5%, YZ = 207.0 +/- 4.0

The protolith age of the SMR is constrained between 256 Ma (Wuchiapingian of Late Permian) and 204 Ma (Rhaetian of Late Triassic).

CMR (K-Ar cooling age = 178 +/- 6 Ma (Shibata and Nishimura, 1989))

- CM: multimodal (**176 +45/-8**, **245 +/- 35**, 1970 +140/-250), %Pc = 42.4%, YZ = 174.1 +/- 4.6

The protolith age is constrained between 184 Ma (Pliensbachian of Early Jurassic) and 170 Ma (Bajocian of Middle Jurassic).

DISCUSSION The original accretionary complex of the RMR was likely formed along the Gondwana continental margin in the Late Silrian-earliest Permian age; the quasi-unimodal age distribution with small peaks between 400 Ma and 3000 Ma is common with the coeval sandstone on or near Gondwana-derived continental blocks in East Asia (e.g. Tarim block; Rojas-Agramonte et al., 2011). On the other hand, the SMR and CMR have downward-younging polarity in the youngest zircon age. In addition, zircon age distribution pattern gradually changes downward from a quasi-unimodal pattern to a multimodal pattern with a 2,100-1,700 Ma peak. 2,100-1,700 Ma is the age of igneous activity related to the amalgamation of the North China Craton.

Assuming that these high-P/T type metamorphic rocks were formed intermittently in a single subduction zone, it is presumed that the tectonic setting changed from the Gondwana continental margin (Late Silurian-Early Permian), through the margin of an oceanic island-arc (Late Permian), to the margin of the North China Craton (Late Triassic-Early Jurassic).

Keywords: U-Pb age, detrital zircon, LA-ICP-MS, Sangun Metamorphic rocks, arc-trench system, eastern margin of continental Asia

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Provenance of pre-Aptian sandstones of Japan viewed from detrital zircon geochronology

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Age composition of detrital zircons from pre-Aptian sandstones (ss) is examined to clarify the tectonic development of the Japanese Islands. The results are as follows (%Pc: percentage of Precambrian zircons).

Hida Gaien Belt: Age-unknown Ashidani and Motodo ss show unimodal age distribution patterns at ca. 270 Ma. The Tetori group mostly shows bimodal distribution at 200 and 1900 Ma, with %Pc increasing upwards (40-84), with an exception of Oxfordian ss (%Pc = 8).

Sangun Belt: Ss of the **Renge Belt** shows multimodal (peaks up to 3000 Ma) patterns with the maximum peak at 450 Ma. The Lower Jurassic cover shows bimodal patterns at 230 and 1900 Ma. The **Suo Belt** has downward-younging polarity in the youngest zircon ages (270-160 Ma); %Pc (mainly of 2000 Ma zircons) gradually increases downwards.

Akiyoshi Belt: Permian ss of the accretionary complex (AC) shows a unimodal pattern at 270 Ma. The Upper Triassic cover shows bimodal patterns at 230 Ma and 1900 Ma (%Pc = 65-88).

Maizuru Belt: The Upper Permian shows a quasi-unimodal pattern at 270 Ma, with a very small peak at 2000 Ma. The Lower-Middle and Upper Triassic show multimodal patterns with the maximum peak at 250-270 Ma and older, and small peaks at 500 Ma, 900 Ma, etc.

Ultra-Tamba Belt: Ss of the belt shows quasi-unimodal patterns at 250 Ma. The Higashimata Formation in the eastern extension of the belt, however, shows a multimodal pattern with peaks at 450 Ma, 900 Ma, etc.

Tamba-Mino Belt: Upper Triassic AC shows a multimodal pattern with small peaks at 500 Ma, 800 Ma, 1500 Ma, etc. Lower-Middle Jurassic AC shows bimodal patterns at 170 Ma and 2000 Ma (%Pc = 54-62).

Northern Chichibu Belt: Upper Permian AC shows a unimodal pattern at 270 Ma. Lower-Middle Jurassic AC shows a bimodal pattern at 200 Ma and 2000 Ma, with %Pc increasing with the age of formation (18-33). Very few 1000 Ma zircons are also detected.

Kurosegawa Belt: Upper Permian shallow marine bed (Katsura ss) shows a unimodal pattern at 270 Ma. Upper Permian AC shows a quasi-unimodal pattern at 270 Ma, with a very small 1900 Ma peak.

Southern Chichibu Belt: Upper Permian AC, similar with that of the Kurosegawa Belt, was found to the north of Tokyo. Lower Jurassic AC shows a bimodal pattern at 200 Ma and 2000 Ma (%Pc = 18). Middle Jurassic AC and the Oxfordian cover show bimodal patterns at 200 Ma and 2000 Ma (%Pc = 47-86). Oxfordian AC, on the other hand, shows quasi-unimodal patterns with low %Pc values (4-16).

South Kitakami Belt: Silurian ss shows multimodal patterns with the maximum peak at 430 Ma, with smaller peaks up to 3000 Ma. Devonian ss also shows a similar pattern with the maximum peak at 410 Ma. Lower Carboniferous ss shows quasi-unimodal pattern with several 400+ Ma peaks (%Pc = 19). Lower-Middle Permian ss, by contrast, shows unimodal patterns at 275 Ma. Lower Triassic-Lower Jurassic ss also show unimodal patterns with %Pc = 0. Middle Jurassic-Lower Cretaceous ss shows bimodal patterns at 130-450 Ma and 2000 Ma (%Pc = 8-29).

Nedamo Belt: AC-forming Takinosawa ss is correlated in detrital zircon age pattern with the Lower Triassic of the South Kitakami Belt. They show a unimodal pattern at 250-300 Ma.

North Kitakami Belt: AC-forming Triassic Kamatsuda calcareous ss shows a quasi-unimodal pattern at 250 Ma (%Pc = 3). Upper Jurassic AC and Lower Cretaceous cover show bimodal patterns at 150-170 Ma and 2000 Ma, with %Pc of 60-90 and 40, respectively.

Keywords: U-Pb geochronology, zircon, LA-ICPMS, Japanese Islands, Gondwana, tectonics

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New U-Pb analyses of detrital zircons from Permo-Triassic sandstone in Japan

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INTRODUCTION This study adds new U-Pb analytical data of detrital zircons from Permo-Triassic sandstone in SW Japan, and outlines Permo-Triassic sedimentary environment. We studied the samples from the following units: Akiyoshi accretionary complex (AC), Ultra-Tamba AC, Tamba-Mino AC and Maizuru Terrane in the Inner Zone of SW Japan, and Northern Chichibu Belt (NCB), Kurosegawa Tectonic Belt (KTB) and Southern Chichibu Belt (SCB) of the Outer Zone of SW Japan.

OUTLINE OF GEOLOGY The Akiyoshi AC is a Middle to Late Permian AC, covered by Upper Triassic clastic rock unis (e.g. Mine Group (Gp.); Kanmera et al., 1990). The Ultra-Tamba AC is a Late Permian to Middle Triassic AC (e.g. Ishiga, 1990; Sugamori, 2008, 2011). The Maizuru Terrane is lithologically divided into three zones: Northern (Yakuno felsic rocks), Central (Permo-Triassic Gps.) and Southern (Yakuno mafic rocks) zones (Kano et al., 1959). The Permian Maizuru Gp. in the Central zone has been unconformably covered by the Lower-Middle Triassic Yakuno and Upper Triassic Nabae Gps. The KTB includes lenticular bodies of granitoids, metamorphic rocks, and Silurian to Early Cretaceous shallow marine beds. The Tamba-Mino Belt, NCB, and SCB consist mainly of Jurassic AC, with some Permian AC (Sawadani Unit) and Permo-Triassic clastic rocks.

RESULTS The results listed below are presented in the following order: the shape of the probability density plot (peak ages +/- width (Ma); main peaks are in bold letters), percentage of Precambrian zircons (%Pc), the youngest concordia age with the 2SD error (YZ).

Akiyoshi Belt (1. Shimomidani Formation (Fm.))

1. quasi-unimodal (**270 +50/-30 Ma**, 400 Ma), %Pc = 0, YZ = 250 +/- 14 Ma

Maizuru Belt (2. Maizuru Gp., 3. Yakuno Gp., 4. Nabae Gp.)

2. quasi-unimodal (**260 +190/-30 Ma**, 430 Ma, 2080 Ma), %Pc = 4.1, YZ = 254.0 +/- 6.9 Ma
3. quasi-bimodal (**260 +120/-20 Ma**, **500 +20/-70 Ma**, 910 Ma, 1855 Ma), %Pc = 8.3, YZ = 244.6 +/- 6.1 Ma
4. multimodal (**250 +120/-40 Ma**, **510 +90/-80 Ma**, **900 +70/-100 Ma**, 1090 Ma, 1260 Ma), %Pc = 14.5, YZ = 222.3 +/- 6.1 Ma

Ultra Tamba Belt (5. Ajima Fm., 6. Kamitaki Fm., 7. Higashimata Fm.)

5. quasi-unimodal (**260 +40/-20 Ma**, 1530 Ma), %Pc = 2.0, YZ = 248.5 +/- 5.1 Ma
6. quasi-unimodal (**245 +75/-15 Ma**, 395 Ma), %Pc = 0, YZ = 238.1 +/- 3.8 Ma
7. quasi-bimodal (**260 +280/-20 Ma**, **900 +1060/-140 Ma**, 2690 Ma), %Pc = 25.4, YZ = 246.2 +/- 6.9 Ma

Tamba-Mino Belt (8. Shimamoto Fm., 9. Otaki Unit)

8. quasi-bimodal (**265 +/- 25 Ma**, **470 +40/-100 Ma**, 1400 Ma), %Pc = 5.1, YZ = 246.6 +/- 5.1 Ma
9. multimodal (**253 +53/-88 Ma**, 370 Ma, **509 +52/-76 Ma**, 750 Ma, **942 +44/-168 Ma**), %Pc = 12.5, YZ = 184.2 +/- 5.8 Ma

Northern Chichibu Belt (10. Agekura Fm.)

10. quasi-unimodal (**265 +45/-25 Ma**, 375 Ma), %Pc = 0, YZ = 250.7 +/- 3.4 Ma

Kurosegawa Belt (11. Nariki Fm., 12. Katsura sandstone)

11. quasi-unimodal (**255 +25/-15 Ma**, 465 Ma, 1740 Ma), %Pc = 7.3, YZ = 250.4 +/- 5.8 Ma
12. unimodal (**280 +30/-40 Ma**), %Pc = 0, YZ = 249.9 +/- 6.8 Ma

Southern Chichibu Belt (13. Ryogami Unit)

13. quasi-unimodal (**260 +110/-30 Ma**, 490 Ma, 1860 Ma), %Pc = 2.4, YZ = 235.1 +/- 9.1 Ma

DISCUSSION

Middle-Upper Permian sandstone that shows unimodal age distribution with very low %Pc and was most likely deposited in an oceanic island-arc setting is scattered nationwide.

Triassic sandstone was differenciated from Permian into three age-distribution types: unimodal (South Kitakami Belt (Okawa et al., 2013) and Ultra-Tamba Belt except the Higashimata Fm.), bimodal (Mine Gp.), and multimodal (Maizuru Belt, Otaki Unit., Higashimata Fm. and Shimamoto Fm.). The unimodal type shows an oceanic island-arc environment. The bimodal Mine Gp. shows the supply of 1900 Ma zircons from the North China Block (Obara et al., 2013). The multimodal type shows the zircon supply from a Gondwana-derived continental block that presently lies in the Central Asian Orogenic Belt.

Keywords: U-Pb age, detrital zircon, LA-ICP-MS, oceanic island-arc, Central Asian Orogenic Belt, North China Block

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U-Pb geochronology of detrital zircons from the Magisawa and Omoto formations in the North Kitakami Belt (NKB), NE Japan

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INTRODUCTION U-Pb analyses of detrital zircons from sandstone samples of the Magisawa and Omoto formations in the eastern part of the NKB, NE Japan, were carried out to constrain the age of sedimentation and provenance. Moreover the degree of possible dispersion of some statistical values was estimated from the analyses of four sandstone samples of the Magisawa Formation.

GEOLOGIC SETTING The study area lies in the eastern marginal part of the Akka-Tanohata Subbelt in the NKB, and comprises, in younging order, (1) the Magisawa Formation, consisting of Triassic to Late Jurassic chert-clastics sequences, (2) the Omoto Formation, consisting of sandstone, mudstone, and pyroclastic rocks, (3) the Harachiyama Formation, consisting of andesitic to rhyolitic pyroclastic rocks, (4) Early Cretaceous granite cutting these geologic units, and (5) the Late Aptian-Albian Miyako Group, consisting of clastic rocks. Minoura and Tsushima (1984) further divided the Magisawa Formation into nappes I, II, and III, in ascending order, among which we collected 4 sandstone samples from the upper part of Nappe II. The Omoto Formation is assumed to be of earliest Cretaceous (Berriasian-Valanginian) age, from plant and molluscan fossils (Sugimoto, 1969). K-Ar ages of 114-121 Ma have been reported from the andesitic volcanic rocks in the NKB and SKB, correlative with the Harachiyama Formation (Shibata et al., 1978; Mikoshiba, 2002).

RESULTS The U-Pb dating of the zircons was carried out with the LA-ICP-MS equipped in the Graduate School of Environmental Studies of Nagoya University. The results are summarized as follows. (1) **Magisawa Formation**: Four data sets from the sandstone samples of the formation all clustered at 300-160 Ma and 2100-1700 Ma, with the youngest concordant age of 160.3 +/- 3.1 Ma. The proportion of Precambrian zircons in each sample (%Pc) ranges from 60% to 90%, with the average of 71.3% and standard deviation of 12.7% (17.8% of the average). The correlation coefficients of two of the four data sets range from 0.71 to 0.98. (2) **Omoto Formation**: The zircon ages also clustered at 300-160 Ma and 2100-1700 Ma, with the youngest concordant age of 132.3 +/- 3.5 Ma. %Pc of the Omoto zircons, 40%, was significantly lower than that of the Magisawa zircons.

DISCUSSION (1) **Age of sedimentation**: The age of Nappe II of the Magisawa Formation is assumed to be Oxfordian to Kimmeridgian, because (i) the siliceous mudstone Nappe III, overlying Nappe II, yields Late Jurassic (Oxfordian) radiolarians (Matsuoka and Oji, 1990), and (ii) the chert-clastics sequence in the accretionary prisms in Japan usually has downward-younging age polarity. The youngest zircon age from the Magisawa sandstone (160.3 +/- 3.1 Ma; Oxfordian), which marks the upper limit of the age of sedimentation, is concordant with the assumption. The youngest zircon age from the Omoto sandstone (132.3 +/- 3.5 Ma; Valanginian-Hauterivian), on the other hand, is most likely the age of sedimentation, because the volcanic activity that formed the pyroclastic rocks of the formation may have supplied coeval zircons in the sandstone. The age gap of 28 m.y. between the Magisawa and Omoto formations, together with the slight structural obliquity between the two formations (Minoura and Tsushima, 1984), suggests an unconformable relationship. (2) **Provenance**: The two sandstones presumably had the same continental provenance with abundant Paleoproterozoic rocks, because they have common zircon age clusters at 160-300 Ma and 1700-2100 Ma. The lower %Pc of the Omoto sandstone can be explained by the "dilution" of Paleoproterozoic zircons with coeval igneous zircons. (3) **Statistical dispersion**: The four data sets from the Magisawa Formation all show common major age-clusters, and encourage us that we can grasp major age clusters of a geologic unit with a single sample. However the %Pc values from the data sets warn us that %Pc can disperse some 18% of the average even in a single geologic unit.

Keywords: U-Pb age, detrital zircon, LA-ICP-MS, North Kitakami Belt, Akka-Tanohata Subbelt, Northeast Japan

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Geochronological study of the Motodo Formation in the Hida Gaien Belt, Fukui Prefecture, Central Japan

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We carried out a U-Pb geochronological study of the age-unknown Motodo Formation in the Hida Gaien Belt, central Japan.

PREVIOUS STUDIES The Motodo Formation is a southward-facing, red-bed-dominant formation, consisting of conformable three members: the Nakajima Tuff Breccia (NTB), Wasadani Conglomerate (WC), and Kumokawa Conglomerate (KC) members, in ascending order (Ono and Takeuchi, 2001). Kawai et al. (1957) correlated the Motodo Formation with the Lower Cretaceous Kanmon Group, which also consists mainly of red bed. Ono et al. (2003) constrained the age of the Motodo Formation between Early Jurassic and Early Cretaceous and supported the correlation of Kawai et al. (1957), because (1) they obtained zircon CHIME ages of 201 +/- 20 Ma and 202 +/- 30 Ma from granodiorite clasts in the WC Member, and (2) they found that the pre-Late Cretaceous faults of the Hida Gaien Belt arranged the distribution of the Motodo Formation. On the other hand, Omura (1968) considered that the Motodo Formation is a Late Permian to Triassic formation, because (i) limestone clasts in the Motodo Formation yield only Paleozoic fossils, such as *Codonofusiella* sp. and *Lepidolina toriyamai*, (ii) the geologic structure of the Motodo Formation is discordant with that of the Middle Jurassic-Early Cretaceous Tedori Group, and (iii) the paleomagnetic directions of the Motodo Formation and Kanmon Group are significantly different.

SAMPLE AND METHOD LA-ICP-MS, U-Pb analyses of zircons from the following four samples were carried out: (1) andesitic tuff breccia of the NTB Member, (2) a granodiorite clast and (3) matrix sandstone of the WC Member, and (4) felsic tuff breccia of unknown affiliation that was sampled from the distribution area of the Tetori Group in previous geologic maps, about 100 m to the north from the base of the Motodo Formation.

RESULTS (1) **Andesitic tuff breccia:** Analytical data of 14 zircon grains showed 2 clusters on concordia plots. We consider that the concordia age of the younger cluster (consisting of 3 zircon ages), 253.0 +/- 3.6 Ma (2 SD) is the age of deposition. (2) **Granodiorite clast of the WC Member:** The weighted mean of the $^{206}Pb/^{238}U$ age of 14 zircons was 252.8 +/- 3.1 Ma, which, we consider, is the age of formation the granodiorite. (3) **Matrix sandstone of the WC Member:** Age data from 77 zircons all clustered between 300 Ma and 250 Ma, with the concordia age of the youngest zircon of 248.7 +/- 8.8 Ma. (4) **Felsic tuff breccia:** The weighted mean of the $^{206}Pb/^{238}U$ age of 12 zircons was 254.2 +/- 2.5 Ma, which, we consider, is the age of deposition.

DISCUSSION The andestic tuff breccia of the NTB Member (253.0+/-3.6 Ma), granodiorite clast of the WC Member (252.8+/-3.1 Ma) and felsic tuff breccia (254.2+/-2.5 Ma) are all products of Late Permian (Changhsingian) igneous activity. The youngest zircon age of the sandstone of the WC Member (248.7+/-8.9 Ma) suggests that the sandstone was deposited in Early Triassic (Olenekian) or later. Considering the conformable relationship of the three members of the Motodo Formation, these age data strongly suggest that the age of deposition of the formation was Late Permian (Changhsingian)-Early Triassic (Olenekian). Although there still remains a possibility that there is a large age difference between the NTB Member and the other 2 members from the CHIME ages of Ono et al. (2003), it is unlikely that a 200-Ma granodiorite body was distributed in the hinterland, because no zircons younger than 248.7 +/- 8.9 Ma were detected in this study. A similar unimodal age distribution with the detrital zircons of the Wasadani sandstone is also detected from the sandstone of the Lower-Middle Triassic Inai Group in the South Kitakami Belt, NE Japan. The Inai Group includes red beds (Horikawa and Yoshida, 2006), a common feature with the Motodo Formation. The Inai Group and the Motodo Formation may have coevally deposited in a similar climatic environment.

Keywords: red bed, zircon U-Pb age, Kanmon Group, Nakajima Tuff Breccia Member, Wasadani Conglomerate Member, Inai Group