Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SGL40-01 Room:102B Time:May 27 15:15-15:30

Geochronology and geochemistry of the early Paleozoic metamorphics-igneous complexes of Japan

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Early Paleozoic igneous – metamorphics complexes are sporadically distributed over the Japan Arc. These complexes are important to describe beginning of the Japan Island. Each complex has been studied in detail, however, chronological relationship and whole view of them clarified insufficiently.

The metagabbro – amphibolite complex in the Nomo Peninsula is located on the western end of the early Paleozoic igneous – metamorphics complexes. Isozaki et al (2010) pointed out this complex is one of the oldest igneous rocks in Japan. The zircon U – Pb ages of the metagabbo show 491 – 458 Ma. Re-examined amphibole K – Ar ages of the amphibolite are 534 Ma and 468 Ma.

The Kiroko amphibolite (Takeuchi and Makimoto, 1995) is located Yorii-machi, Saitama Prefecture, and situated in the middle part of the early Paleozoic igneous – metamorphics distribution, this rock has 420 Ma amphibole ^{39}Ar – ^{40}Ar age, and 555 – 463 Ma zircon U – Pb ages.

The Miyamori ophioltie complex and the Motai metamorphic rocks are north-eastern end of the distribution of early Paleozoic complex in Japan (Ozawa, 1984). The zircon U – Pb ages of gabbro of Miyamori ophiolite are 544 – 420 Ma. The Miyamori ophiolite complex often includes metamorphic rocks that correlate to the Motai metamorphic rocks. The amphibole K – Ar ages of the Ohachimori amphibolites in the Motai metamorphic rocks are 431 – 392 Ma. The amphibole ^{40}Ar – ^{39}Ar spectra has not good plateau, however the total ^{40}Ar – ^{39}Ar ages show 508 – 432 Ma.

The zircon U – Pb ages and amphibole K – Ar ages have good agreement with these complexes. An important note is that these amphibolites of early Paleozoic age were not suffered H*P* metamorphism, suggesting that their geochemical characteristics will be used to estimate tectonic setting.

The bulk rock chemistry of amphiboles belongs to basalt or basaltic andesite. The chemical feature of metagabbos and amphibolites belongs to calc-alkaline series, and is supposed to have an intra-oceanic arc/remnant arc characteristics.

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Keywords: early Paleozoic, metamorphics-igneous complex, zircon U-Pb age, K-Ar age, bulk rock chemistry

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SGL40-02 Room:102B Time:May 27 15:30-15:45

Study of brecciated process of iron and carbon-bearing veins of the Akiyoshi-dai drilled samples

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1. Characteristics of the Japanese islands: The present Japanese Islands has less young volcanic rocks compared with much sedimentary rocks (ca.60% in volume). This is mainly because the Paleozoic basement rocks (including the Akiyoshi limestone) are remained from ocean-floor aggregates before formation of the Japanese island-arc (ca.15Ma) characteristically.

2. Characteristics of the Akiyoshi-dai limestone: Japan Islands are geologically recently emerged from the ocean floor and situated North-South arc, though vast and old Akiyoshi sedimentary limestone is remained now on the plateau. This indicates that Main-land (West) mixed with different formation-time and locations is moved though ocean-floor movements before formation of the Sea of Japan.

3. Research results of Akiyoshi-dai drilling limestone samples (powder): The Akiyoshi underground samples (up to 250m in depth from the Kaerimizu site) drilled by the Akiyoshi Science Museum (at Kaerimizu, 250 m) show significant changes of 1) physical properties (structure and ESR signals) of powdered calcite minerals along the fossil reversal distributions [1-5], 2) elemental abundances of siderophiles from bulk XRF data analysis at the bottom of 243m in depth, and 3) re-crystallized calcite and minor contents of feldspars and quartz of the samples of the bottom (243m) and surface colored marble with iron contents [4].

4. FE-SEM study of the thin and massive drilled samples: The brecciated drilled thin-section samples prepared in the United States show the following the FE-ASEM and Raman data:
1) Shallow sample (50 m in depth) with small calcite decomposition and few carbon-grains. 2) Medium sample (160 m) to deep (217 m and 243 m) with nano-crystals of separated carbon grains, re-crystallized calcite and halite. 3) Massive deep samples with nano-carbon (the Raman peaks of high-pressure carbon) and shocked nano-calcites (related with artificial products) [3-5].

5. Comparison with overseas Paleozoic limestone: Four overseas Paleozoic samples are investigated in this study as follows [5]: 1) Carlsbad limestone of 300Ma (New Mexico) of coral reef origins with deep underground cave. 2) Sierra Madera Permian limestone (Texas) of impacted shuttered cone with significant siderophiles elements. 3) Alamo breccias 367Ma(Nevada) of shocked quartz and fine calcite without clear impact crater. 4) Santa-Fe breccias 350Ma(New Mexico) of shocked quartz and limestone with fluid-tube texture and separated nano-carbon grains.

6. Proposed formation of the Akiyoshi-dai limestone: Breccias of the Akiyoshi-dai Kaerimizu (243m in depth) are not simple sediments, but impact-related materials contains complicated activities of significant siderophiles, nano-carbon separated from limestone and two types of calcite (re-crystallization and nano-calcites), which cannot be explained only by simple volcanic and earthquake events, but also impact processes of remained sea-floor and weathering after uplift ground) [4, 5] .

7. Summary: The Paleozoic Akiyoshi-dai limestone-breccias which are remained in the Japanese islands with different time-location blocks show clear example of various colors, minerals and compositions with different eras and places on ocean-floor process, where they are difficult to explain by general shock-wave processes (earthquakes and volcanoes). In this study, oversea Paleozoic limestone investigations are compared with old limestone of the Akiyoshi-dai drilled samples.

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Keywords: Akiyodhi-dai limestone, Drilled samples, Iron-carbon grains, High-pressure carbon, Shiderophiles, Re-crystallized calcite

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Emplacement process of oceanic seamount origin limestone in the Northern Chichibu Belt

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Limestone blocks in the accretionary complex can be regarded as accreted fragments of seamount capping atoll carbonate in origin. To discuss emplacement process of such limestone blocks into the accretionary complex is significant for understanding subduction zone tectonics, but it has not been fully discussed except for some works. This study examines Kano-yama limestone in the Jurassic accretionary complex, the Kanto Mountains, central Japan and documents imbricate structure developed in the gigantic limestone block.

Kano-yama limestone and other adjacent limestone blocks such as Tatoro-yama, Futago-yama, and Hakuseki-san are embedded in the strongly sheared zone along the boundary of the Northern Chichibu Belt and the Sanchu “Graben” . This sheared zone comprises two formations: the Sumaizuku in the north and Hebiki formations in the south. The Sumaizuku Formation contains mainly chert and greenstone blocks whereas Hebiki Formation contains mainly sandstone blocks. Matsuoka et al. (1998) estimated accretion ages of the two formations to be Early to Middle Jurassic. Kano-yama limestone is accompanied by greenstones and volcanoclastic rocks. They are hyaloclastite and pillow lava, and according to chemical composition and petrology, they are N-MORB type basalt, except for one E-MORB. Thus, these greenstones are interpreted to have co-occurred tectonically with limestone, and almost all parts of volcanic body of a seamount seems to have subducted deeper.

Kano-yama limestone trends from WNW to ESE and is a limestone block 1 km $\times$ 200 m in size. The SW dipping bedding planes are observed in Kano-yama limestone, and on the basis of geopetal fabrics in boundstones, they represent normal sequence. Depositional facies of Kano-yama limestone are interpreted to be sand shoal and lagoon environment. Late Carboniferous to middle Permian fusulinacean genera are identified in Kano-yama limestone. Based on the fusulinacean age and lithology, Kano-yama limestone is divided into at least three units: Units 1, 2, and 3 in the seemingly descending order. Unit 1 contains components of sand shoal facies, and on the other hand, Units 2 and 3 contain both back reef and lagoon facies components. Fusulinacean age is younging upward within a single unit, but the older limestone overlies the younger limestone in a fault contact. They show totally imbricate structure. Limestone breccia is generally absent in Kano-yama limestone.

A lack of limestone breccia suggests that Kano-yama limestone is not an aggregate of redeposited collisional collapse products of oceanic reef complex at trench. Compared with sandbox experiment by Dominguez et al. (2000), a formative process of imbricate structure in the capping carbonate is rather explained by off-scrape of superficial part of a seamount. In conclusion, Kano-yama limestone was probably formed by off-scraping of back reef to lagoon deposits of cap carbonate, forming imbricate structure.

Keywords: seamount accretion, the Northern Chichibu belt, the Kanto Mountains, limestone, greenstone

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SGL40-04 Room:102B Time:May 27 16:15-16:30

Duplexes and other structures in the Misaki Formation of Shonan-Ubajima and their significance

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The Hirajima and Ubajima Islands in Sagami Bay off the Chigasaki fishly port are part of ridges arranged in a WNW-ESE line from the Hayama district in the Miura Peninsula. Although llithostratigraphic and nannofossil biostratigraphic analyses have been studied in the Ubajima Islands, geologic structures of the Ubajima and Hirajima Islands remain incompletely understood. Our stratigraphic and structural study revealed that Ubajima Islands have distinctive structures characteristic in an accretionary complex, represented by a decollement zone with duplexes, thrust-anticlines and bedding-parallel shortening structures.

The Hirajima Islands located immediately on the south of the Chigasaki port is composed of tuffaceous fine sandstones correlated with the Oyama Formation of the Hayama Group. The Ubajima Islands located 2 km southeast from the Hirajima Islands is of tuffaceous muddy sandstones, more than 290 m in thickness, intercalating pumiceous and scoriaceous tuff beds. Middle to lower horizons of the Eboshi Honto and Odaira Island are dated at between 8.2-9.9 Ma based on co-occurrence of radiolarian species *Stichocorys delmontensis* and *S. peregrina* and no occurrence of *Cyrtocapsella japonica*, the combination of which is correlated with the Misaki Formation of the Miura Group. Geologic structure of the Ubajima Islands is divided largely into eastern part and western part. Eastern part strikes N-S with dips to west showing an anticline trending WNW-ESE and western part strikes E-W to ENE-WSW with dips to north. The thrust faults trending E-W at the central and south areas of western part bound its geologic structures and stratigraphy. At the southern area across the thrust fault in the Odaira Island in the western part of Ubajima Islands, decollement zone is identified, as consisting of the main share zone, fold and share zone, from the north to south, being accompanied with some duplex structures and layer parallel faults. On the other hand, the northern area of the thrust showing an anticline trending WNW-ESE that thrusts up onto southward, representing sinistral strike-slip fault in appearance. The decollement zone with thrust-anticlines observed in the Ubajima Islands is characteristic within accretionary margin in many toe areas of the Nankai Trough (Kawamura *et al*., 2009; Michiguchi and Ogawa, 2011). Normal fault trending NNW-SSE cut these duplexes and thrust trending E-W.

The structures observed at the Ubajima Islands should be formed in the following steps. Stage 1 (formation of multiple fault-bend folds (duplex structures)): The formation of the antiformal stack underneath resulted in development of multiple fault-bend folds for a series of duplexes during a period of N-S trend compression. Stage 2 (formation of fault-propagation fold): Fault related deformation induced by large scale folding and associated thrust was formed. Synclines of the Odaira Island in western area and the Ujima Island in eastern area and anticline in intermediate area were developed at this stage. Stage 3: Normal faults trending N-S were formed under an E-W compression after the changes of stress field, which is thought to stem from collision of Izu Arc, and is correlated with an E-W trending normal fault observed in Sagami Bay (Mori *et al*., 2010).

Maximum principal stress axis (σ1) inferred from the fold axis (average N36E) is oriented NE-SW, which is corrected N-S compressional stress field considering rotational angle of 55 degrees in a clockwise direction estimated at the Oiso Hills (Koyama *et al*. 1986). It corresponds with stress field in the South Fossa Magna before 1 Ma (Mori *et al*., 2010, 2012)

[Reference]

Kawamura K. *et al*., 2009, *Geol. Soc. Am. Bull*, **121**, 1629-1646; Koyama M. *et al*., 1986, *Monthly Earth*, **8**, 620-625; Mori S. *et al*., 2010, *Jour. Geogr. (Chigaku-Zasshi)*, **119**, 585-614; Michiguchi, Y. & Ogawa, Y., 2011, *Modern Approaches in Solid Earth Scienc* **8**, 229-246; Mori S. *et al*., 2012, *Jour. Min. Petr. Sci*, **41**, 67-86.

Keywords: Sagami Bay, Ubajima, Misaki Formation, duplex, thrust-anticline, accretionary prism

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Duplexes and other geologic structures in the Misaki Formation of the southernmost Miura Peninsula: Revisited

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The Jogashima Island in the southernmost Miura Peninsula, Miura City, Kanagawa Prefecture has been studied since Kodama (1968) and many others. We independently studied the geologic structures of the Misaki Formation for these 40 years (Ogawa & Taniguchi 1988; Hanamura & Ogawa, 1993; Stow et al., 1998; Yamamoto et al., 2009), and reached many interesting conclusions including duplex structures. They are summarized as follows; The Tsurugizaki anticline trends not westward but northwestward in an en echelon pattern, whose south wings dip steeply while north wings gently dip, similar to the Nankai prism toes (Kawamura et al., 2009; Anma et al., 2011). The Toriya anticline is overturned southward, displaying many thrust faults and duplex structures, as the western extension of the Sengen thrust as a fault-propagation fold (Yamamoto et al., 2005). Not all the thrust duplex structures have south-vergency but some north, also resembling the Nankai. Both thrust duplexes and conjugate thrust systems have northwest-trending P-axes in horizontal reference frame (Ogawa & Horiuchi, 1978). Those duplexes and thrust faults are either of tectonic origin or slump origin, the latter may relate to liquefaction and mud-diapirism. At Awazaki, easternmost tip of the Jogashima, the subsequent Misaki Formation is eroded more than 300 m with 30 degrees discordance, suggesting the anticline-syncline formation began during deposition of the superjacent Hatsuse Formation. N-S or N30E-trending left-lateral fault system that is overwhelmed in the peninsular and Tokyo Bay areas to the Sagami trough as discussed by Mori et al (2010). As a result both the Miura and Boso tectonics are characterized by the Izu forearc collision, but the internal structures are similar to those in the Nankai prism (Yamamoto, 2005; Yamamoto et al., 2009; Michiguchi and Ogawa, 201).

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Keywords: Jogashima Island, Misaki Formation, duplex, thrust system, fault-propagation fold