

SCG008-01

会場:301A

時間:5月26日 08:30-08:45

高温変成帯における複変成作用を検知するためのツールとしてのCHIME モナズ石年代

CHIME monazite dating as a tool to detect polymetamorphism in high-temperature metamorphic terrane

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The chemical Th-U-total Pb isochron method (CHIME) monazite dating was carried out for pelitic-psammitic migmatites and the Ao granite (one of the Younger Ryoke granites) from the Aoyama area, Ryoke metamorphic belt, SW Japan. The Ao granite gives an unequivocal age of 79.8±3.9 Ma. The migmatites yield ca. 100 Ma monazite grains with younger domains of ca. 80 Ma. Some grains show ca. 80 Ma overgrowths on the older core of around ca. 100 Ma, and others show patchy rejuvenation of ca. 100 Ma grains.

Recent study on the Pb diffusion in monazite (Cherniak et al., 2004) concluded that Pb diffusivity in monazite is low and thus the closure temperature of monazite is high. However, reinterpretation of Cherniak et al. (2004) data by favoring the SIMS data rather than RBS data showed that results of Cherniak et al. (2004), Suzuki et al. (1994) and Smith & Giletti (1997) can define single array that gives the diffusivity similar to Suzuki et al. (1994). If this interpretation is accepted, the closure temperature of Pb diffusion in monazite becomes low, and about 600-750 °C provided that the cooling rate is ca.30 °C/Myr.

With this closure temperature, it is possible to reset monazite in the pelitic-psammitic migmatites from the Aoyama area by the thermal effect of the Ao granite intrusion alone. The patchy nature of the distribution of rejuvenated parts within monazite grains prefers, however, the rejuvenation mechanism other than volume diffusion, such as grain boundary diffusion along the microcracks developed in the monazite grains. Some of the monazite grains with young overgrowth rim are armored in biotite, supporting the possibility of the fluid activity affecting the rejuvenation of monazite grains. Therefore, ca. 80 Ma overprinting on migmatites over the Grt-Crd zone in the Aoyama area is probably caused by the combination of a thermal effect and a fluid activity caused by the Ao granite intrusion. Partial rejuvenation of the monazite grains implies that the thermal and fluidal effects were not too strong to completely reset the monazite grains.

Although the contact metamorphism by the Ao granite is hard to be detected through the field survey and petrographic examination, possibly because the migmatite already possessed the high-temperature mineral assemblage and was immune from the contact metamorphism in terms of major metamorphic mineral assemblage, the CHIME monazite dating reveals the presence of contact metamorphism clearly. The field mapping of the CHIME monazite age can be a powerful tool for recognition of polymetamorphism in high-temperature metamorphic terrains where later thermal effects cannot be easily detected by the growth of new metamorphic minerals.

キーワード: CHIME モナズ石年代, 複変成作用, 青山高原地域, 阿保花崗岩, 接触変成作用, 閉鎖温度

Keywords: CHIME monazite dating, polymetamorphism, Aoyama area, Ao granite, contact metamorphism, closure temperature

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Accretionary complex related to Paleo-Tethys subduction in northern Thailand Accretionary complex related to Paleo-Tethys subduction in northern Thailand

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The Paleo-Tethys, which opened in response to the Devonian separation of the North China, South China and Indochina blocks from Gondwana, occupied a large area around the equator from the Devonian to Triassic, where carbonates, chert, and basalt were deposited in a pelagic domain (e.g., Metcalfe, 1999). These Paleo-Tethyan rocks characterized by Ocean Plate Stratigraphy were subducted beneath the Indochina Block during the Permian to Triassic (Wakita and Metcalfe, 2005).

In the Inthanon Zone of northern Thailand, melanges occur in association with oceanic rocks of Paleo-Tethys origin. According to Hara et al. (2009), melange formation was characterized by hydrofracturing and cataclastic deformation, with mud injection under semi-lithified conditions followed by shear deformation and pressure solution. Illite crystallinity data suggest metamorphic temperatures below 250 degree during melange formation. The combined structural and metamorphic data indicate that during melange formation, the accretionary complex related to Paleo-Tethys subduction developed at shallow levels within an accretionary prism. Asymmetric shear fabrics in melange indicate top-to-south shear. After correction for rotation associated with collision between the Indian and Eurasian continents, the trend of the Paleo-Tethys subduction zone is estimated to have been N80E. We conclude that the Paleo-Tethys was subducted northward beneath the Indochina Block from the Permian to Triassic. Sandstones are dominant within melange, generally characterized by lithic greywacke. Based on the composition and geochemistry of sandstones collected from melange within the Inthanon Zone, provenance of sandstone is characterized by mostly continental arc, and slightly continental margin. We interpreted that the origins of sandstones are from both of continent (Indochina Block) and arc developed along the Indochina Block, which is possibly the Sukhothai Zone. Based on melange kinematics and sandstone provenance, we reconstruct island arc system by the Paleo-Tethys subduction during Permian to Triassic time.

キーワード: 付加体, パレオテチス, メランジュ, 砂岩化学組成, インタノン帯, タイ

Keywords: accretionary complex, Paleo-Tethys, melange, sandstone geochemistry, Inthanon Zone, Thailand

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タイ国中央部の地体構造区分：ペルム系および三畳系サクセションからの展望 Geotectonic subdivision of the Central Plain of Thailand: A perspective from Permian and Triassic successions

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In the last two decades, increasing geological evidence produced a number of substantial understandings on the geotectonic subdivision and evolution of mainland Thailand. Now, we have a consensus of opinion that the Sukhothai Zone (Permian-Triassic island arc system) to the east and the Sibumasu Block (fragment of the eastern Cimmerian continent) to the west are the two major geotectonic domains constituting Northern Thailand. However, their southward extensions to the Central Plain of Thailand are still less clear due to the poor information of basement rocks.

We have investigated several basement rock units distributed in Uthai Thani and Nakhon Sawan provinces of the central part of the Central Plain. Quaternary deposits widely cover the major parts of these provinces, but there are a number of monadnocks consisting of older rocks. In eastern Nakhon Sawan Province, the basements are composed mostly of Permian platform-type carbonates. They are interpreted as parts of the Saraburi Limestone of the Indochina margin.

In central Nakhon Sawan and eastern Uthai Thani provinces, there are some, N-S trending monadnock ranges. Of them, we newly studied a carbonate unit composed of several limestone mountains. It consists of massive, shallow-marine limestone, and bioclastic grainstone and packstone are the major microfacies. In places, boundstone made by skeletal metazoans is observed. Late Triassic foraminifers occur from it. Based on the foraminiferal contents and lithology, it can be correlated to a limestone member of the Lampang Group in the Sukhothai Zone of Northern Thailand. In the same area, intermediate-acidic volcanic/volcaniclastic rocks of possibly Permian age are distributed. In Northern Thailand, a similar rock unit widely underlies the Sukhothai Zone.

Slightly to the east of the Late Triassic limestone, there are ranges of small mountains consisting mainly of fine-grained siliciclastics. Characteristically this unit contains chert successions in some parts; one of which distributed around Nakhon Sawan city is called the Khao Gob Chert. Permian radiolarians are found from some of the chert successions. Their lithological characters and age suggest that they can be correlated to the Permian Khanu Chert exposed to the north in the Sukhothai Zone. Moreover, granitoids in the same mountain ranges are of I-type characterizing the Eastern Granitoid Belt, which corresponds in Northern Thailand to the Sukhothai Zone.

In western Uthai Thani Province, there is a remarkable range consisting of karstified limestone, which is called the Uthai Thani Limestone. It is generally weakly metamorphosed and deformed, but Permian age is evident based on the occurrence of rare and poorly preserved fusulines from some localities. The Uthai Thani Limestone can be distinguished from the Late Triassic limestone just to the east by its distinctive NNW-SSE extension and by having different deformation and metamorphic records. It is more reasonable to correlate it with the Sai Yok and the Ratburi limestones widely distributed in the Sibumasu Block of Western and Peninsular Thailand. Moreover, granite in western Uthai Thani Province exhibits an S-type affinity of the Central Granitoid Belt, which corresponds to the eastern part of the Sibumasu Block.

All these lines of evidence suggest that central Nakhon Sawan and eastern Uthai Thani provinces belong to the southern extension of the Sukhothai Zone of Northern Thailand. In contrast, western Uthai Thani Province where the Uthai Thani Limestone and the S-Type granitoids crop out can be labeled as a part of the Sibumasu Block. Thus, we conclude that, in the Nakhon Sawan-Uthai Thani area there is a remarkable gap in terms of geotectonic properties of basement rocks between the Late Triassic limestone and the Uthai Thani Limestone. It corresponds to the southern extension of the Chiang Rai Tectonic Line in Northern Thailand, which separates the Sukhothai Zone to the east and the Sibumasu Block to the west.

キーワード: タイ国中央部, 地体構造区分, スコタイ帯, シブマス地塊, ペルム系, 三畳系

Keywords: Central Thailand, geotectonic subdivision, Sukhothai Zone, Sibumasu Block, Permian, Triassic

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Evolution of Magmatism and Metallogeny along the Western Edge of the Indochina Terrane Evolution of Magmatism and Metallogeny along the Western Edge of the Indochina Terrane

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Igneous rocks and their associated mineral deposits form north-south trending belt with the dimension of about 1700 x 100 km² along the edge of the Khorat Plateau from central Lao PDR to southeastern Thailand. These igneous rocks are predominantly felsic to intermediate plutonic and volcanic rocks with minority of mafic and ultramafic exposures. The latter which are usually Late Paleozoic in ages are regarded as to be temporally and spatially associated with the Loei suture which subdivided Indochina terrane from the Paleotethys Ocean. Based on U-Pb zircon, Rb-Sr whole rock, and ⁴⁰Ar-³⁹Ar dating, magmatism and associated mineralization are inferred to have a prolong history of tectonism from compression to extension and ranging in ages from Middle Paleozoic to Miocene. The first stage of tectono-magmatic episode includes calc-alkaline magmatism during Middle Paleozoic (ca. 405 ? 399 Ma) ages and associated with their mild Kuroko type mineralization of Fe, Cu, Pb, Zn, Ba and Mn minerals. They are mainly in the northern part of the belt and may have been part of Caledonian Orogeny. This igneous activity was formed as a result of calc-alkaline magmatism due to subduction of paleothethystic oceanic slab beneath the western edge of Indochina terrane. The second stage of magmatism took place within the early Indosinian Orogeny (ca. 260 ? 240 Ma). The igneous rocks are of calc-alkaline I-type affinity and thought to have been responsible for the late stage mineralization including porphyry copper, volcanogenic sulfide, skarn type, and hydrothermal Au-Ag vein styles which are mainly occurred in the northern belt. Such the strongly mineralized magmatism is believed to have formed in response to the continuous oceanic subduction beneath the Indochina terrane. Though associated unexplained Sn mineralization was reported in Lao PDR, it was virtually absent in Thailand. Associated accretionary complex and weak Cyprus type Cr and Ni mineralization may also have formed at this stage. The third stage of magmatism may have occurred in the very late stage of Indosinian Orogeny (ca. 190-210 Ma), and it was thought to have occurred in the extension environment giving rise to mainly alkaline magmatism, particularly along the suture zone. Stitching plutons with weak poly metallic vein-style mineralization may have formed due to the relaxation of the crust after intense compression. The fourth stage of magmatism may have formed in association with reactivation of major strike ? slip northwest ? trending faulting in response to early Himalaya Orogeny. Mylonitization of earlier granitoid rocks may have been occurred at this stage along with the post tectonic minor intrusions of water poor pegmatites and aplites with weak vein-style mineralization of Sb + Au-Ag hydrothermal ores. The fifth stage of magmatism is found in the central belt, and it was formed as a result of crustal relaxation during Miocene time (18-25 Ma). This rift related alkaline magmatism may have formed due to crustal thinning, and mantle upwelling by high heat flow activity may be responsible for partial melting of the lower crustal materials. Poly-metallic mineralization and Au-Ag veins of high sulfidation systems may have took place along the north-south ? trending open fractures, particularly in the central to eastern Thailand. Continental rifting event may have been continued to the last episode of magmatism during ca. 0.5 to 7 Ma along the Loei suture in response to high heat flow by upwelling mantle materials. Tectonic activity is geomorphologically and geochronologically evident to continue to the present time and gives rise to the presence of reactivated northwest ? trending active faults in the central belt. Only non-mineralized hydrothermal veins are encountered along these faults.

Keywords: Indochina, Metallogeny, Tectonic, Magmatism, Thailand, Laos

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更新された北ベトナム地質；古期の付加体を突き破った中新世変成岩ドーム，デタッチメント正断層としての紅河断層 Renewed geology of northern Vietnam: Miocene metamorphic domes extruded the older accretionary complexes

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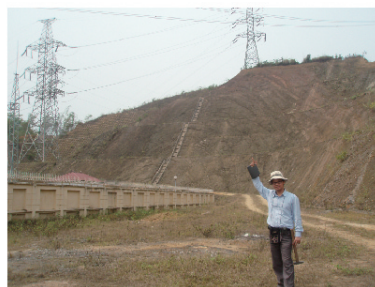
北ベトナムの基本地質構造は、背斜軸に変成岩や古期岩があり、それを取り巻いて、順次、整然とより新しい地層が分布するマップスケールの背斜として、地質図に図示されている。また、紅河断層など大小の横ずれ断層が多数、地層境界を含めて、図示されている。しかし、ここ数年の現地地質調査から、これらは空想であることが明らかになった。

紅河断層とソンチャイ断層に挟まれた変成岩ドームには、いくつかの、互いに見解が異なる研究があるが、筆者らはそれらとセンスが異なる右ずれ成分を伴うトランスプレッションの場での、軸面フォリエーションやそのセンスの伸長線構造を伴うD1ドーム（大規模背斜）と解析した。これのミニチュア褶曲が観察される大露頭を、カバー堆積物であるが、発見、記載している。D2は変成岩ドーム縁に観察される脆性断層で、結局、紅河断層とソンチャイ断層は変成岩エクシユージョンの最終段階を表すデタッチメント正断層として機能している。大規模横ずれ断層である根拠は、露頭観察からは得られていない。

ドームや正断層の上盤にあるカバー堆積物は、カンブリア紀から白亜紀まで順次重なる正常層ではない。基底不整合も保存されている白亜紀の赤色層を除いて、すべて付加体由来と考えられる。膨大な量の石灰岩や玄武岩の分布は例えば、三疊系として、マッピングされているが、遠洋性チャート、アンバー、半遠洋性多色泥岩など、付加体を特徴付ける岩石を、ベトナムで初めて発見した。例えばデボン系とされているタービダイトは海溝充填堆積物で、多くは海洋性岩石からなるブロックの基質をなすと考えられる。ただし、付加帯形成時の構造はほぼ消失していて、これらカバー堆積物の構造はドーム変成岩の構造と、大差ない。つまり、中新世の変形は、古期のカバー堆積物にも強く及んでいる。なお、化石産地は従来の地質図に多数記されているが、筆者らは1地点でペルム紀フズリナ化石を発見したに留まっていて、これは付加体であることに加えて、強烈な中新世変成作用を反映している。



Moetamorphic dome model



Miniture of metamorphic dome

Anticlinal fold accompanies axial planar cleavages, dextral stretching lineation, and parasitic folds

キーワード: 北ベトナム, 変成岩ドーム, D1 トランスプレッション, 右ずれ, D2 紅河断層, 付加体起源

Keywords: Northern Vietnam, metamorphic dome, D1 trans pression, dextral, D2 Red River normal fault, accretionary prism origin

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Insight into the tectonic deformation patterns along eastern Taiwan from seismological observations

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To decipher the seismotectonic structures in the Taiwan region, we have obtained more than 1,900 centroid moment tensor (CMT) solutions by inverting the broadband waveforms recorded at the BATS network. This dataset reveals the characteristics of faulting types along the eastern coast of Taiwan that is associated with the interaction between the continental margin and the NW moving Philippine Sea plate (PSP). In general, to the south of Hoping (24.3°N), the faulting type is dominated by thrusting and the sigma-1 direction is almost perpendicular to the strike of Coastal Range. However, between Hopin and Lanyang river, the strike-slip faulting type is prevailing along some EW trending geological boundaries in the crust with sigma-1 directed in NW-SE. Some low-angle dip-slip events at depth around 20 km were observed in the vicinity of Hopin. We infer that they may correspond to the interface earthquakes, where the underneath subducted slab moves westward. To the north of Lanyang river, the crust is dominated by normal faulting, which is believed to be caused by the spreading of the Okinawa Trough. On the other hand, for those intermediate depth earthquakes occurred beneath Ilan plain, the determined focal mechanisms show thrusting pattern with sigma-1 sub-parallel to the trench. Therefore, Kao and Jian(2001) suggested that the subducted PSP slab is colliding with the mantle lithosphere of EUP. Chou et al.(2006) also discovered the folding at the western edge of slab. Based on seismicity and 3-D velocity structures, Wu et al.(2009) proposed that the intersection of the Ryukyu Trench with Taiwan is placed at the latitude of 23.7°N, placing the northern part of the Coastal Range on EUP. This is consistent with the uplifting rate along the Coastal Range and the modeled deformation pattern. According to these observations, we concluded that the PSP starts subducting at 23.7°N and the upper plate boundary approaches the bottom of the brittle seismogenic layer at about 24.3°N, where very low-angle dip-slip events may occur. Once the slab subducts completely underneath the seismogenic layer, the faulting type in the crust would be dominated by pre-existed boundaries subjected to a torque that may be imposed by the trench retreat and the opening of back-arc basin. Behind the Lanyang river, the Okinawa Trough plays an important role for the occurrence of shallow normal faulting events.

キーワード: CMT, Focal Mechanism, Seismotectonics, Stress Tensor, Collision, Subduction

Keywords: CMT, Focal Mechanism, Seismotectonics, Stress Tensor, Collision, Subduction

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Petrology of eclogites from the Orobashy area, Aktyuz region, northern Kyrgyz Tien-Shan

Petrology of eclogites from the Orobashy area, Aktyuz region, northern Kyrgyz Tien-Shan

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The Aktyuz region is located in the Zaili Range of the Northern Kyrgyz Tien-Shan. Here, eclogites have been reported from two areas, i.e. Aktyuz area and Orobashy area (Orozbaev et al., 2010). Lens-shaped serpentinite bodies of varying size occur in the Orobashy area along NNE-SSW trending faults located within Kapchygai and Kokbulak migmatites. The largest serpentinite body contains 20 cm to 30 m across blocks of eclogites, garnet amphibolites, garnetites and gneisses. Eclogite, garnetite and garnet amphibolite blocks are massive, and range from 40 cm to 10 m in diameter. The marginal parts of the eclogite and garnetite blocks are amphibolitized. Both blocks and serpentinite matrix are intruded by granitic dykes.

Eclogites consist mainly of garnet, clinopyroxene, amphibole, clinozoisite and rutile with minor plagioclase, epidote, quartz, chlorite, biotite, paragonite, phengite, ilmenite, titanite, apatite and zircon. Garnets and clinopyroxene show coexisting texture and thus define the peak metamorphic assemblage. Garnets contain inclusions of amphibole (tschermakite, pargasite), quartz, epidote, rutile, ilmenite, apatite, plagioclase, biotite and rare paragonite and phengite. Garnets show a prograde zoning and they have compositions of 36.1-61.3 mol% of almandine, 13.3-21.9 mol% of grossular, 10.8-43.4 mol% of pyrope and 0.1-4.9 mol% of spessartine. Clinopyroxenes are Na-rich diopside in composition and their jadeite content varies from 0 to 19 mol%. The symplectite of Amp+Qtz and/or Amp+Pl is developed after clinopyroxene suggesting decompressional decomposition. Amphiboles occur as inclusions in garnet and clinopyroxene, and also in the matrix. Amphibole in the matrix is Mg-hornblende and contains inclusions of garnet, clinopyroxene (Jd9-12), rutile and quartz. Amphiboles in garnets are tschermakite and pargasite, whereas those in clinopyroxene are Mg-hornblende. Amphiboles in symplectites and in the veins are also classified as Mg-hornblende. Clinopyroxene, garnet and amphibole are cross cut by veins. Feldspars in the eclogites are plagioclase (An4-50) and K-feldspar. Paragonite occurs only as inclusions in garnets. Phengite occurs in the matrix and as rare inclusions in garnet. Epidote occurs as inclusions in garnets, clinopyroxenes and in the veins. Occasionally, clinozoisite develops in the matrix of some eclogites. Veins are mainly composed of plagioclase, epidote, amphibole and apatite.

The texture and the mineral chemistry of the Orobashy eclogites suggest three metamorphic stages i.e., prograde, peak and decompression stages. The mineral inclusions in garnet such as amphibole (tschermakite and pargasite), quartz, plagioclase (An13-50), epidote, biotite, paragonite, phengite, rutile, ilmenite and apatite may suggest mineral assemblage of the amphibolite facies conditions for the prograde stage. The coexistence of garnet and Na-rich diopside together with rutile and quartz in the matrix suggests the peak metamorphic assemblage. The garnet-clinopyroxene geothermometer of Ravna (2000) and Nakamura (2009) yielded $T = 590-710$ C at 13 kb, minimum pressure based on Jd=19 content in clinopyroxene. The symplectite of Amp+Qtz and Amp+Pl suggest decompression stage for the eclogites. Hbl-Pl geothermometer (Holland & Blundy, 1994) yielded 610-670 °C for this stage, and the minimum Jd content (>5) may suggest about 5 kbar for pressure conditions.

There are three different types of metamorphic events for the HP rocks of the Aktyuz Formation. Here, for the Orobashy eclogites single metamorphic event is recognized, which is HT metamorphism from amphibolite facies up to eclogite facies conditions and then decompression again to amphibolite facies conditions. Exhumation of the Orobashy eclogites to relatively shallow crustal levels was accompanied by re-equilibration under HT amphibolite facies conditions, probably during a period of continental collision, correlative to the third metamorphic event in the Aktyuz area.

キーワード: Orobashy, Aktyuz, eclogite, Tien-Shan, Kyrgyzstan

Keywords: Orobashy, Aktyuz, eclogite, Tien-Shan, Kyrgyzstan

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モンゴル中北部ハラホリン地域のペルム紀周氷河堆積物 Permian peri-glacial deposits in the Harahorin area, north-central Mongolia

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はじめに モンゴル中北部のハラホリン地域は、前期石炭紀付加体が分布するハンガイ - ヘンテイ帯 (Kurihara et al., 2009) に位置する。当地域で付加体を被覆するウルメグテイ層には、ドロップストーンを含む周氷河堆積物が含まれる。この度、この周氷河堆積物に関する地質学的・年代学的研究をしたので、ここにその成果を発表する。

地質概説 研究対象地域は、主に以下の地質単元からなる。

ヤシル層：ハンガイ - ヘンテイ帯の前期石炭紀付加体。

ウルメグテイ層：ヤシル層を被覆すると見られる地層。下位より礫岩層、砂岩層、花崗岩ドロップストーンを含むヴァーヴ状砂岩泥岩互層と、上方細粒化する。全体的に変形を受けており、下位ほど顕著な構造性面構造と伸長性線構造を有する。構造性面構造は北西走向・南西傾斜で、伸長性線構造は南北トレンドである。剪断センス指示物から、これらの変形構造は右横すべり成分をもつ北方への衝上性剪断により形成されたものと考えられる。

珪長質岩脈：ウルメグテイ層に貫入し、一部、ウルメグテイ層と共に上記の剪断変形を蒙っている。

花崗岩バソリス：ウルメグテイ層の変形構造を切って貫入する、非変形斑状花崗岩。

年代測定 京都大学平田研究室および東京大学地震研究所設置のレーザー照射型誘導結合プラズマ質量分析計 (LA-ICP-MS) を用いて、以下の試料より抽出したジルコンを分析し、ウラン - 鉛年代を求めた。

ウルメグテイ層中の花崗岩ドロップストーン：多くのジルコンは包有物を含み、細かい破断面をもち、分析に適さなかった。そこで、例外的にきれいなジルコン 3 粒子を分析し、²⁰⁶Pb/²³⁸U 年代の加重平均値をとった結果、273.0 ± 4.9 Ma という年代値が得られた。

ウルメグテイ層に貫入する変形した珪長質岩脈：ジルコン 17 粒子から 246.5 ± 4.0 Ma の ²⁰⁶Pb/²³⁸U 加重平均年代を得た。

花崗岩バソリス：ジルコン 10 粒子から、217.5 ± 8.7 Ma の ²⁰⁶Pb/²³⁸U 加重平均年代を得た。

考察

地史概要：ウルメグテイ層中の花崗岩ドロップストーンおよびウルメグテイ層を切る珪長質岩脈の年代から、ウルメグテイ層の堆積年代は 278-242 Ma (前期ペルム紀アーティンスク期～中期三疊紀アニサス期に相当；ICS, 2009) に拘束される。上記珪長質岩脈 (246.5 ± 4.0 Ma) は、ウルメグテイ層と共に剪断変形を受けている。従って、この剪断変形は 242 Ma より前に始まっており、251 Ma 以降まで継続したことがわかる。更に 217.5 ± 8.7 Ma の花崗岩バソリスが変形していないことから、ウルメグテイ層の剪断変形は、251 Ma (前期三疊紀インダス期；ICS, 2009) 以降まで継続し 208 Ma (後期三疊紀ノール期；ICS, 2009) には終わっていたと考えられる。

ウルメグテイ層周氷河堆積物の堆積年代と意義：後期石炭紀からペルム紀初頭にかけては、汎世界的な氷河時代で、南半球の Gondwana 大陸は広く氷河に覆われた。前期ペルム紀末には Gondwana の氷河も縮小し、以後は中生代に向けて地球は徐々に温暖化したとされる。アジアでも、278-242 Ma の氷河堆積物は、ベルホヤンスク、コリマ、オモロン地域など、シベリアの北東方でのみ知られている (Ustritskiy, 1973)。例えば、オモロン地域ルースカヤ川に分布する上部ペルム系ウーチャピン階の周氷河堆積物が分布し、その中のドロップストーンの産状および礫種構成 (Mikhaylov et al, 1969) は、ウルメグテイ層と類似する。また、主要な礫種は異なるが、類似する産状を示す周氷河堆積物は、ベルホヤンスク地域およびコリマ地域の中部ペルム系ワード階～上部ペルム系ウーチャピン階の中にも見られる。従って、今回得られた年代値およびアジアの周氷河堆積物の分布・年代から考えて、ウルメグテイ層は中期ペルム紀ワード期から後期ペルム紀ウーチャピン期 (268.0-253.8 Ma；ICS, 2009) に堆積したと判断される。ウルメグテイ層に覆われるハンガイ - ヘンテイ付加体は、これら中期～後期ペルム紀に氷河の発達した大陸または島弧と連続するシベリア東縁に付加し、中期ペルム紀ワード期から後期ペルム紀ウーチャピン期には現シベリア北東部のオモロン地域付近に位置していた可能性が大きくなる。ハラホリン地域とオモロン地域は現在約 2,000 km 離れているため、ハンガイ - ヘンテイ付加体とウルメグテイ層は、ワード期以降に再配列を受けて、後期三疊紀ノール期までに現在の位置に移動してきたと考えられる。ウルメグテイ層に見られる、前期三疊紀インダス期前後の右横すべり成分をもつ衝上性剪断運動は、この再配列の際にできた可能性がある。

キーワード: ペルム紀, 周氷河堆積物, ウラン - 鉛年代, テクトニクス, ハンガイ - ヘンテイ帯, モンゴル
Keywords: Permian, peri-glacial deposit, U-Pb age, tectonics, Khangai-Khentei belt, Mongolia

SCG008-09

会場:301A

時間:5月26日 10:45-11:00

Significance of metacarbonate rocks in unraveling the formation of Central Asian Orogenic Belt

Significance of metacarbonate rocks in unraveling the formation of Central Asian Orogenic Belt

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Metacarbonate rocks are key rock units in orogenic belts because they represent possible remnants of oceanic sediments. Furthermore, they provide important information regarding the fluid-rock history during metamorphism. Central Asian Orogenic Belt (CAOB) consists of several subduction-accretion complexes formed between 1000 Ma and 250 Ma. Metamorphic rocks in this region are important not only in understanding the tectonic evolution of the CAOB, but also can give important clues in understanding the formation of Asian continent. During the Japan-Mongolia Joint Geological Research we have collected several key rock units from the western and northwestern regions of Mongolia. Here we present carbon and oxygen stable isotope characteristics of metacarbonate rocks from the several localities of Central Asian Orogenic Belt of Mongolia. Metacarbonate rocks are common in the CAOB and occur as comparatively thin layers intercalated with pelitic and psammitic gneisses.

Carbon and oxygen isotope studies on metacarbonate rocks shows a large spread in isotope values among different belts within the CAOB. However, the coupled C-O isotope trend can be broadly grouped into two categories. (1) Metacarbonate rocks that preserve pre-metamorphic stable isotope signatures, and (2) those affected by fluid-rock interaction processes during metamorphism. In the first case, we were able to obtain carbon and oxygen isotopic composition that might be representative of sedimentary signatures, although isotopic shifts caused by the exchange of carbon isotopes with graphite derived from organic material is present in some samples. The equilibrium between calcite and graphite in such samples were used to understand the temperature of metamorphism in such samples. In the second case, we have got large coupled carbon and oxygen isotope shifts which are indicative of fluid-rock interaction during metamorphism. Such samples helped to understand the role of fluids during subduction-accretion processes during the formation of CAOB.

キーワード: metacarbonate rocks, carbon isotopes, oxygen isotopes, Central Asian Orogenic Belt, Mongolia
Keywords: metacarbonate rocks, carbon isotopes, oxygen isotopes, Central Asian Orogenic Belt, Mongolia

SCG008-10

会場:301A

時間:5月26日 11:00-11:15

Geodynamics and ore mineralization in Bayankhongor metallogenic belt, Central Mongolia Geodynamics and ore mineralization in Bayankhongor metallogenic belt, Central Mongolia

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Bayankhongor metallogenic belt is one of the main gold producing area in Mongolia. In the regional geotectonic setting the Bayankhongor metallogenic belt is north-west trending tectonic zone, which consists of several tectonic units as Archean Baidrag terrane, Burd metamorphic unit, Bayankhongor ophiolite belt, Zag metamorphic belt and southern part of Hangai intra-continental basin. The tectonic zones of Bayankhongor belt has several episodes magmatic activity starting from Proterozoic continuing to Cambrian, Early Paleozoic, Late Paleozoic, and Mesozoic.

The Bayankhongor belt is known by its gold mineralization since ancient time, and there are remnants of old mining activity at the several places. Ore mineralization is closely associated with long history of geodynamic setting of the belt starting from old oceanic crust through accretion, collision and obduction as well as intra-continental magmatic activity.

Results of various stage geological stud, indicate that there are many deposits and occurrences of gold, copper, tungsten, iron, nickel and PGE etc. Copper, nickel and PGE mineralization thought to be related with mafic and ultramafic units of ophiolite belt, and formed during oceanic setting. Gold bearing quartz vein zones, and cold copper bearing scarn deposits, which must be primary source of placer deposits, are mainly distributed along the south and south west part of the belt.

Placer deposits mainly found along the along the mountain Jargalant, which is obducted ophiolite zone, and Burd passive continental margin terrane and Bombogor Proterozoic metamorph terrane. Age of placer deposits ranges from Mesozoic to Recent.

We study age and geochemistry of magmatic rocks which are distributed in and around the ore mineralization occurrences, in order to make clear its genetic relation and as well as reconstruction of tectonic evolution of Bayankhongor metallogenic belt. Result petrochemistry and of age dating analyses will be discussed and presented.

Keywords: Bayankhongor, ophiolite, gold, placer, PGE, magmatic rocks

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SCG008-11

会場:301A

時間:5月26日 11:15-11:30

伊豆弧衝突帯における大陸地殻形成 Formation of continental crust at the Izu-Honshu collision zone

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The tectonic setting of arc-arc collision and arc accretion in the Izu-collision zone is similar to that of Archean orogenic belts (e.g. Taira et al., 1992). Understanding the petrological processes of granite formation in the Izu-collision zone, where the geodynamic information is not modified by polyphase deformation and metamorphism, may contribute to understanding ancient orogenic belts, especially those related to collisional settings. The Pacific plate began subducting beneath the Philippine Sea plate about 50 million years ago to produce the currently active Izu-Bonin-Mariana (IBM) arc. The collision between the northern IBM arc system and the Honshu arc of the Eurasia plate has been occurring since the middle Miocene (c. 15 Ma) as a consequence of the northwestward migration of the Philippine Sea plate. The collision has led to the accretion of IBM arc crust to the Honshu arc, associated with a southward migration of the plate boundary and trench system. Neogene granite plutons are widely exhumed by tectonic uplift associated with arc collision. Tamura et al. (2010) integrated new geochemical results with recent geophysical imaging of the arc and concluded that Miocene plutonic rocks in the Izu collision zone were derived from the Eocene-Oligocene middle crust, which was partially melted, remobilized and rejuvenated during the collision. Similar rejuvenating processes may have operated in other collision zones. Moreover, (1) the mafic arc lower crust is missing at the collision zone (Kitamura et al., 2003) and (2) the aseismic Philippine Sea plate, which is subducting to depths of 130-140 km without evidence of a tear or other gap, has been detected even beneath areas 120 km NW of the collision zone (Nakajima et al., 2009). Thus, collisional coalescence accompanies delamination of arc mafic lower crust. Both processes are inevitable at the collision and necessary to yield continental crust.

キーワード: かこう岩, 中部地殻, 地殻構造, 島弧マグマ, 安山岩

Keywords: granites, middle crust, crustal structure, arc magmas, andesite

SCG008-12

会場:301A

時間:5月26日 11:30-11:45

西南日本白亜紀 古第三紀花崗岩に関する年代学的、岩石学的研究および数値計算 Chronology, Petrology and Numerical Simulation for Cretaceous to Paleogene Granitic Rocks, SW Japan

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Kazuya Iida^{1*}, Hikaru Iwamori², Park Taeho², Yuji Orihashi³, Yong-Joo Jwa⁴, Sung-Tack Kwon⁵, Tohru Danhara⁶, Hideki
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トラック

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of Yonsei, ⁶ Kyoto Fission-Track

Granitoid is one of the main components of the continental upper crust, and is thought to provide key information on evolution of the continental crust yet the origin of granitoid remains enigmatic. In order to address this important and unresolved problem, we have studied the origin of the Cretaceous to Paleogene granitic rocks in SW Japan. We especially focus on (1) spatial-temporal variation of granitoid, (2) temporal variation of petrological signature of granitoid, and (3) tectonic and dynamic setting that caused the observed spatial-temporal variation and provided heat for the melt generation, based on the U-Pb zircon age, whole rock chemistry, and numerical simulation for the thermal field of subduction zone. As a result, systematic spatial-temporal variations of magmatism and the spatial variations of petrological signatures in SW Japan have been observed. Numerical modeling suggests that ridge subduction model can explain spatio-temporal variation of granitic rocks in SW Japan. Based on these results, we discuss the origin of these variations.

U-Pb zircon age determinations using LA-ICPMS was performed on total 91 rock samples. The obtained age range from 95 Ma to 30 Ma, with a possible temporal gap between 60 Ma and 50 Ma. During 95-60 Ma, the systematic migration of granitoid magmatism from the south to the north occurred. Temporal variation of petrological signatures is also observed: with time, (1) initial ratio of Sr isotopes ($^{87}\text{Sr}/^{86}\text{Sr}$) decreased from enriched characters (0.7090-0.7065) to depleted ones (0.7065-0.7050), and (2) rock types of granitoid changed from ilmenite-series to magnetite-series.

In order to investigate the mechanism of temporal changes observed, ridge subduction model has been tested with numerical simulation, especially in terms of thermal impact of the subducted ridge as a function of subduction velocity and angle with or without slab window. The numerical results suggest the following points: (1) thermal impact of ridge subduction is potentially large especially when subduction velocity changes from high to low (i.e., the leading plate subducts faster), creating a slab window, (2) after the ridge subduction, melting region, mainly of slab melting, shrinks from the trench side to the rear arc side, and (3) subduction angle together with subduction velocity is important to control the overall duration and spatial range of magmatism, required to explain the observed wide horizontal range of the magmatism.

Finally, the numerical results have been compared with the observed spatio-temporal variation of the granitoid magmatism in SW Japan. The comparison suggests that the observed features (e.g., long duration (greater than 35 m.y.), a wide across-arc distance (~150 km) of the magmatism, and northward (toward backarc side) migration of the magmatism) require a shallow subduction angle (~10 degrees) with velocity change of the plates from high to low is required. With these specific conditions, it is inferred that the ridge subduction could have been the primary cause of Cretaceous to Paleogene granitoid magmatism in SW Japan.

SCG008-13

会場:301A

時間:5月26日 11:45-12:00

Correlations of the blueschist facies metamorphism from the Heilongjiang Complex, NE China and the Suo belt, SW Japan Correlations of the blueschist facies metamorphism from the Heilongjiang Complex, NE China and the Suo belt, SW Japan

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The Jurassic accretionary terranes, which are characterized by high-P/T blueschist facies metamorphism, have been documented from the eastern margin of the Asian continent. Such high-P/T metamorphic evidence occurs from northeastern Russia via northeastern China to southwestern Japanese islands (Sengor et al., 1993; Isozaki, 1997; Taira, 2001; Wu et al., 2007).

High-P/T blueschists of the Heilongjiang Complex are exposed in northeastern China, and they consist mainly of epidote-glaucophane schists with minor amounts of garnet-barroisite schists and glaucophane aegirine-augite schists. The peak metamorphic conditions obtained for the Heilongjiang high-P/T metamorphic rocks vary from the epidote blueschist facies (320-550 C, 6-15 kbar; e.g. Bai et al., 1988; Zhou et al., 2009; Li et al., 2010a) to the epidote amphibolite facies (500-540 C, 10-12 kbar; Li et al., 2010b). U-Pb ages of 190-255 Ma for detrital zircons suggest that the protoliths of the Heilongjiang Complex are the early Mesozoic granitic batholiths (e.g. Zhou et al., 2009; Li et al., 2010c). Furthermore, the high-P/T Heilongjiang metamorphic rocks were developed by the subduction and collision of the Jiamusi Massif to the eastern border of Central Asian Orogenic Belt at the time of Jurassic period (145-190 Ma; Wu et al., 2007; Li et al., 2010c).

In the Japanese islands, Jurassic accretionary terranes occur as large-scale nappes that are tectonically sandwiched between overlying pre-Jurassic and underlying post-Jurassic sequences (e.g. Isozaki, 1997). The Suo metamorphic belt in southwestern Japan is characterized by blueschist facies metamorphism of 160-230 Ma in metamorphic age (Nishimura, 1998). The blueschists are predominantly made up of epidote-glaucophane schists with subordinate epidote-barroisite schists and sodic clinopyroxene-bearing phengite-epidote schists in the Suo belt, especially in the Gotsu and Masuda areas (e.g. Sengan, 1985). The peak metamorphic conditions preserved in the epidote-glaucophane schists are defined by the crystallization of porphyroblastic epidote, Na-amphibole (glaucophane and Mg-riebeckite), phengite (Si = 6.6-7.0 pfu), chlorite, hematite and titanites, suggesting the epidote-blueschist facies metamorphic conditions (430-530 C, 12-15.5 kbar). Additionally, the metamorphic facies series of the Suo schists of pumpellyite-actinolite facies through glaucophane schist facies to epidote amphibolite facies has been described by previous studies (e.g. Nishimura et al., 1998).

These facts suggest the similarities of both high-P/T blueschists from the Heilongjiang Complex, NE China and the Suo metamorphic belt, SW Japan, not only in the timing of metamorphism, but also in the metamorphic conditions. In this study, we therefore propose that the Heilongjiang high-P/T metamorphic rocks continued to the south, and the Suo metamorphic belt in southwest Japan is thus possible southern extension of the Heilongjiang Complex. The results reported here will contribute toward a better understanding of the Mesozoic tectono-metamorphic development of the eastern margin of the Eurasian continent.

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キーワード: high-P/T, blueschist, Heilongjiang Complex, Suo metamorphic belt, NE China, SW Japan

Keywords: high-P/T, blueschist, Heilongjiang Complex, Suo metamorphic belt, NE China, SW Japan

SCG008-14

会場:301A

時間:5月26日 12:00-12:15

アジア大陸成長期の大陸衝突変成作用と黒瀬川帯の形成

Multiple collision metamorphism during Asian continental growth with relation to the formation of Kurosegawa tectonic zone

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¹Kyushu University, ²Yamaguchi University, ³Shizuoka University, ⁴Kyoto University, ⁵Fukuoka University

In E- and SE-Asia, there are at least seven micro-continental blocks of Mongolia, North China, South China, Indochina, Shanthai, Sibumasu and West Burma from N-NE to SW. Geological Research program to realize the tectono-metamorphic processes during continental collision orogen of E- and SE-Asia has been done for the last decade.

Multiple collision boundaries in Asian continent are identified and they are subdivided into following six;

- 1) Siberian craton/Mongolian: 480 ? 500 Ma,
- 2) Mongolian/North China: 280 ? 300 Ma (so called Central Asian Orogenic Belt),
- 3) North China/South China: 240 ? 250 Ma,
- 4) South China/Indochina: 230 ? 250 Ma (Trans Vietnam Orogenic Belt),
- 5) Indochina-Shanthai/Sibumasu: ca. 210 Ma,
- 6) Sibumasu-West Burma/Indian subcontinent: ca. 45 Ma.

Characteristics of constituent rock types and metamorphic processes in each collision boundary were reported by many detailed works (e.g. Osanai et al., 2004, 2008; Nakano et al., 2008, 2009, 2010).

Especially in the collision boundary between the North and the South China blocks (e.g. north Dabie terrane, Imjingang belt), various kinds of Permo-Triassic collision zone metamorphic rocks are identified. The Higo metamorphic complex as well as the Hida-Oki terrane in Japan would also have belonged to this type of collision zone and which experienced a top-to-the-south displacement under extrusion tectonics with forming a regional nappe structure before the Cretaceous granitic activities. The basal portion of this regional nappe extrusion would be considered as a serpentinite diapir derived from relatively ductile mantle beneath the North China craton. The diapir intruded along the collision boundary and included various kinds of metamorphic rocks of HT granulite and amphibolite from the lower crustal portion of obducted North China craton and HP blueschist and eclogite from the shallower portion of subducted South China craton. The Kurosegawa tectonic zone as the serpentinite melange corresponds with this diapir.

In the presentation, we will make a detailed talk on this tectono-metamorphic evolution in eastern Asia.

SCG008-15

会場:301A

時間:5月26日 12:15-12:30

Permian sequences and faunas in the peri-Gondwanan region and their palaeogeographical and tectonic implications Permian sequences and faunas in the peri-Gondwanan region and their palaeogeographical and tectonic implications

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The rifting and drifting of different tectonic blocks in the peri-Gondwanan region has long been one of the most hotly-discussed issues among geoscientists. Extensive investigations during the past decade indicate that numerous sections with carbonate and clastic deposits containing abundant Permian faunas are distributed in the Himalayan region and the Indus-Tsangbo Suture Zone in southern Tibet. A detailed comparison of faunal affinities among different tectonic blocks in different stages in the Permian Period suggests that nearly all blocks in the peri-Gondwanan region including the Qiangtang, Baoshan, Tengchong, Lasha and the Himalaya Tethys Zone are characterized by containing diamictites and typical cold-water faunas in the pre-Artinskian time, therefore were probably in a relatively high-latitude area and attached to the northern margin of Gondwanaland. By the end of late Sakmarian or early Artinskian time, warm-water faunas first occur in the Baoshan and Tengchong blocks in western Yunnan, which probably implies that those blocks began to drift away from the peri-Gondwanan margin and they moved to a relatively warm temperate zone in the Late Guadalupian (Middle Permian), as indicated by widespread distribution of warm-water faunas and carbonate deposits. The earliest warm-water faunas occurred in the Midian in the Lasha Block, which suggest a slightly later rifting and/or climatic amelioration than the Tengchong and Baoshan blocks. Numerous exotic blocks between the Lhasa Block and the Himalaya Tethys Zone containing abundant Middle Permian fusuline faunas and compound rugose corals also indicate a different palaeontological contents and palaeobiogeographical affinities between the Lhasa Block in the north and the Himalaya Tethys Zone in the south. By the Late Permian (Lopingian) time, these palaeontological and palaeobiogeographical disparities became more evident, therefore strongly suggest that the Lhasa Block probably rifted away from the peri-Gondwanan region in the early Middle Permian, a much earlier open time of the Neotethys, not Triassic as previously suggested.

キーワード: Permian, tectonic blocks, peri-Gondwanan region, faunas, rifting, drifting
Keywords: Permian, tectonic blocks, peri-Gondwanan region, faunas, rifting, drifting

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東アジア地域の地震テクトニクス、火山の起源とマントルダイナミクス East Asia: Seismotectonics, Volcanism and Mantle Dynamics

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We introduce the significant recent results of geophysical studies and discuss their implications on seismotectonics, magmatism, and mantle dynamics in East Asia. High-resolution geophysical imaging revealed structural heterogeneities in the source areas of large crustal earthquakes, which may reflect magma and fluids that affected the rupture nucleation of large earthquakes. In subduction zone regions, the crustal fluids originate from the dehydration of the subducting slab. Magmatism in arc and back-arc areas is caused by the corner flow in the mantle wedge and dehydration of the subducting slab. The intraplate magmatism has different origins. The continental volcanoes in Northeast Asia (such as Changbai and Wudalianchi) seem to be caused by the corner flow in the big mantle wedge (BMW) above the stagnant slab in the mantle transition zone and the deep dehydration of the stagnant slab as well. The Tengchong volcano in Southwest China is possibly caused by a similar process in BMW above the subducting Burma microplate (or Indian plate). The Hainan volcano in southernmost China seems to be a hotspot fed by a lower-mantle plume associated with the Pacific and Philippine Sea slabs' deep subduction in the east and the Indian slab's deep subduction in the west down to the lower mantle. The occurrence of deep earthquakes under the Japan Sea and the East Asia margin may be related to a metastable olivine wedge in the subducting Pacific slab. The stagnant slab finally collapses down to the bottom of the mantle, which may trigger upwelling of hot mantle materials from the lower mantle to the shallow mantle beneath the subducting slabs and cause the slab-plume interactions. Some of these issues, such as the origin of intraplate magmatism, are still controversial, and so further detailed studies are needed from now.

キーワード: 東アジア, 地震テクトニクス, プレート内部火山, マントルダイナミクス, 沈み込むスラブ

Keywords: East Asia, seismotectonics, intraplate volcanism, mantle dynamics, subducting slab