Importance of an Expanded Definition of Ocean Plate Stratigraphy For Evaluating Tectonic versus Sedimentary Mélanges

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The transfer of materials from a subducting oceanic plate to a subduction-accretionary complex has resulted in rock assemblages that record the history of the subducted oceanic plate from creation to arrival at the trench. These rock assemblages, which comprise the uppermost igneous part of the oceanic crust (commonly basalt) overlain by pelagic sedimentary rocks (chert and/or limestone) overlain by clastic sedimentary rocks (mostly sandstone, shale/mudstone), have been called Ocean Plate Stratigraphy (OPS). The original definition of OPS as a basalt-chert (with or without limestone)-clastic triad, was based on early recognized examples in ancient subduction complexes and the prevailing model for oceanic crust. Growing recognition of the variability of oceanic crust, including examples of serpentinite exposed on the sea floor, as well as observations of lithologic variability of oceanic imbricates in subduction complexes, suggests the need to expand the OPS definition. For example, at a structurally intermediate level in the Sierra City mélange of the Shoo Fly Complex of California, oceanic lithologies include zones of serpentinite, gabbro, diabase, basalt and chert up to 200 m thick, with internal structural style ranging from imbricate slabs to block-in-matrix with serpentinite, gabbro, and basalt locally forming matrix. Serpentinite-dominated OPS may also include slices of continental crust affinity where the subducted crust was apparently a hyper-extended continental margin. Examples of this type of OPS have been recently identified in high-pressure metamorphic rocks of the Western European Alps. The definition of OPS is important in interpreting “native” blocks, derived by progressive deformation from OPS, versus “exotic” blocks (may be introduced by sedimentary means) in mélanges. Prior to the defining of OPS, chert and basalt blocks in a clastic matrix were commonly considered exotic; a wider range of native lithologies needs to be considered and this requires corresponding care in evaluation of tectonic versus sedimentary origin of blocks-in-mélanges.

Keywords: Subduction Complexes, Ocean Plate Stratigraphy, Sedimentary and Tectonic Mélanges

ローソン石青色片岩の相平衡関係と吸水・脱水機構: 黒瀬川構造帯箱石サブユニットの例
Phase relation of lawsonite-blueschists and their role as a water budget: A case study from the Hakoishi sub-unit of the Kurosegawa belt, SW Japan

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This study investigated progressive changes in the mineral assemblage of a Palaeozoic lawsonite-blueschist (BS) unit of the Kurosegawa belt, Kyushu, Japan. The BS unit is mainly composed of intercalated metachert and metabasaltic rocks surrounded by serpentinite. Based on the spatial distribution of mineral assemblages in metabasaltic rocks, three mineral zones can be identified in a ca. 10 km-long east¬-west oriented unit: (1) a pumpellyite (Pmp) + Na-amphibole (Namp) assemblage dominated area (Zone 1); (2) an intermixture area of lawsonite (Lws) + Na-pyroxene (Napx) + Pmp and Lws + Namp + Pmp assemblages (transition zone); and (3) an area dominated by Lws + Namp + Napx assemblages (Zone 2), with excess chlorite (Chl), albite (Ab), quartz (Qz), titanite, and Fe oxides. Na-pyroxene varies its composition from jadeite(Jd)20-diopside(Di)25 of Zone 1 to Jd35Di15 in Zone 2 with a similar composition range of aegirine(Ac) content (from 40 to 55). Glaucophane component {XGln =Al/(Al+Fe3+)} of Na-amphibole associated with Lws and Pmp increases from XGln =0.2 in Zone 1 to XGln =0.8 in Zone 2. Jd contents and a lack of epidote and zeolite group minerals suggest that the pressure (P) conditions of the BS increase from Zone 1 (0.50 GPa) to Zone 2 (0.75 GPa) between 200-300 °C, suggesting that a low geothermal gradient (ca. 5-10 oC/km). Schreinemakers' analyses in a NaCaMgFe3+AlSiH (NCMF3ASH) system using mean mineral compositions of representative samples with excess of Chl, Ab, Qz and H2O suggest that 1) observed variations in mineral assemblages can be formed by a hydration reaction of Pmp + Napx + Chl + H2O = Lws + Namp, which was driven by a P increase from Zone 1 to Zone 2 and they represent the transition from the Pmp-BS to Lws-BS sub-facies; 2) the total H2O content stored in hydrous minerals increases from 3.6 wt % in the Pmp-Namp assemblage of Zone1 to 5.0-6.4 wt % in the Lws + Namp + Napx assemblages in Zone 2; and 3) along with the Lws-Namp and Pmp-Namp assemblages, the Napx + Chl assemblage can retain a significant volume of H2O and its stability field can expand to higher P conditions by decreasing the Di and increasing the Jd and Ac contents of Napx.

キーワード：ローソン石青色片岩、相平衡、沈み込み帯流体、黒瀬川構造帯
Keywords: lawsonite blueschist, phase relation, H2O budget in subduction zone, Kurosegawa belt.

The promise and pitfalls of microsampling Lu-Hf garnet geochronology

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The technique of microsampling, such as micro-drills and micro-saws, is an intriguing approach for unraveling the growth pace of garnet as well as the dynamics of tectonic and petrologic processes. Microsampling method so far has been successfully used for Sm-Nd and Rb-Sr garnet geochronology, yet, the difficulties of this method for Lu-Hf garnet system remain unresolved. The micro-zircon inclusion in garnet and the relatively large amount of materials needed for Hf analysis, are the two barriers to applying microsampling for Lu-Hf garnet geochronology. Here, we present several Lu-Hf dates from distinct zones of a single large garnet by conventional microsampling method. Two large garnet porphyroblasts of several centimeters in diameter, comprised of dark cores and pale rims, were studied. Elemental compositions and mineral inclusions in the garnet indicate two garnet generations. Lu-Hf dates of ~400 to 264 Ma were obtained from twelve micro-sawed sections from the porphyroblasts. These Lu-Hf dates were interpreted to bracket the period of garnet growth. The spread from 400 to 264 Ma is interpreted by a protracted and episodic garnet growth, which suggests two subduction cycles for the host rocks. Microsampling Lu-Hf geochronology of consecutive garnet shells is a promising approach to deciphering the growth rates of individual porphyroblasts.

Keywords: Lu-Hf, Microsampling, Garnet

Ophiolite in the Western Ethiopia: A fossil mantle wedge of the East African Orogenic Belt

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East African Orogenic Belt (EAO) along eastern Africa and western Arabia is the world's largest Neoproterozoic to Cambrian orogenic belt (Fritz et al. 2013). This amalgamated belt with a ~6000 km length reflects collision of arcs or microcontinents against the Archean craton margins. Although ophiolites and their subducted equivalents are minor components, those rocks provide a clue to understand the petrotectonic evolution, particularly geodynamic process of Neoproterozoic arc-trench systems. In this contribution, we will present petrological features of the Arabian-Nubian Shield ophiolite of the western Ethiopia, and will introduce significance of metasomatism to form "listvenite" (Cr-muscovite-bearing silica-carbonate rock) by CO_2-rich hydrothermal fluids.
We have studied metamorphosed mafic-ultramafic bodies in Tulu Dimtu area (western Ethiopia) of the Arabian-Nubian Shield. The ophiolitic bodies exposed within a NNE-SSW trending metavolcanics and quartzite complex; they consist mainly of serpentinite (antigorite schist), serpentinized harzburgite with minor metagabbro/metadolerite. The ultramafic bodies bear abundant Cr-muscovite-bearing silica-carbonate rocks, so called "listvenite". The serpentinized harzburgite contains high-magnesian metamorphic olivine (forsterite [fo]93-96) with magnetite and rare relict primary mantle olivine (fo90-91). Both serpentinite schists and serpentinized harzburgite contain zoned chromite; the cores with the ferritchromite rims preserve a pristine Cr/(Cr+Al) atomic ratio (Cr#= 0.79-0.87), suggesting a highly-depleted residual peridotite likely formed a supra-subduction zone wedge mantle. Metagabbros have a MORB/OIB-like affinity; they contain epidote-amphibolite facies mineral assemblages but rich in carbonate minerals. Listvenites in Tulu Dimtu contain relict chromites that overlap with Cr# of those in serpentinite and serpentinized harzburgite, excepting one sample (Cr#=0.57). Noteworthy chromites in listvenite has a significantly higher Mg/(Mg+Fe) ratio. This indicates that a complete metasomatic replacement of serpentinized peridotite to form listvenite took place prior to re-equilibration between chromite and surrounding mafic minerals; in other words, listvenite-forming metasomatism have occurred before the serpentinization of harzburgite. The CO_2-rich hydrothermal fluids infiltration into wedge mantle might have occurred prior to regional metamorphism/deformation of the EAO.

Keywords: listvenite, metasomatism, serpentinization, East African orogeny, Ethiopia

東北日本，阿武隈高原の古殿オフィオライト中に産する著しく鉄に富む超苦鉄質集積岩の地質学的意義

Geological significance of unusually Fe-rich ultramafic cumulate of the Furudono ophiolite in Abukuma Mountains (NE Japan)

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Since Miyashiro (1961)'s concept of "paired metamorphic belts", the Abukuma LP-HT metamorphic belt of NE Japan has been thought as an eastern extension of the Ryoke belt that was paired with the Sambagawa HP-LT metamorphic belt. However as our recent study of the "Furudono ophiolite (FDO)" (Sato and Ishiwatari, 2015) showed the ophiolitic rocks provide new insights into a framework of pre-Jurassic geotectonic units of Japan. In this talk, we will introduce petrological characteristics of the FDO and will propose a few new ideas of correlation between the FDO and ophiolitic rocks not only in NE Japan but also in SW Japan.
Sato and Ishiwatari (2015) studied on small mafic-ultramafic bodies in the central part of the Abukuma Maintains; they proposed to distinguish the ophiolitic bodies from the Gosaisho-Takanuki metamorphic rocks as the "Furudono ophiolite". Key petrological features of the ophiolite includes: (1) highly-depleted residual peridotite, (2) unusually Fe-rich ultramafic, and (3) gabbroic rocks with arc-affinity. It is noteworthy that Fe-rich ultramafic cumulate is a rare rock-type in common ophiolites; it might have been produced by a partial melting at relatively great depths.
The recognition of a unique ophiolite in the Abukuma belt is significant in terms of the regional tectonic framework of Japan. What is the significance of the FDO? Sato and Ishiwatari (2015) agreed some similarities in highly-depleted residual peridotites between the FDO and the Hayachine-Miyamori ophiolite (HMO) of Kitakami Mountains (NE Japan). However here we also address a similarity between ultramafic rocks of FDO and these from the Higo belt in central Kyushu, in particular mineral assemblage and compositional similarity. Recently, Ichiyama (2015) reported unusually Fe-rich ultramafic cumulate (Mikame ultramafic body) from the Oshima metamorphic rocks of the westernmost Shikoku; he also pointed out the geological and petrological similarities between the Fe-rich ultramafic cumulate and ultramafic rocks from the Higo belt. Considering our study of the FDO together with recent finding of unusually Fe-rich ultramafic cumulates in the westernmost Shikoku, the FDO may correlate to ultramafic rocks of the Higo belt rather than HMO. It had been postulated a geological correlation between the Higo and Abukuma metamorphic rocks on the basis of protolith etc (e.g., Isozaki et al. 2010). Unusually Fe-rich ultramafic cumulates would be a new geological tracer to link between the Higo and Abukuma belts.

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