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SCG62-P01 Room:Convention Hall Time:May 22 17:15-18:15

Fluor-wagnerite as a petrogenetic indicator: first occurrence from the Eastern Ghats Granulite Belt, India

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Accessory mineral phases in deep-crustal granulites often preserve plethora of information regarding the pressure-temperature-fluid evolution of the crust undergoing orogenesis. Their presence in different bulk compositions in granulites offer significant inputs to reconcile the *P-T* histories, as minor components present in these accessory phases may play crucial effects on the topology of petrogenetic grids. One such minor component is fluorine which is accommodated within accessory minerals and hydrous minerals in metapelitic granulites of 'appropriate' bulk compositions. Apatite is one of the common minerals that contain fluorine. On the other hand, wagnerite is rare phosphate mineral reported from some metapelitic granulites in different regional granulite terranes of the world.

The Eastern Ghats Belt of India evolved in phases in response to Proterozoic orogeneses in the span of c. 1.80-0.50 Ga. The high-temperature to ultrahigh temperature (UHT) granulites of this belt were retrogressed after emplacement to mid-crustal level as deduced from *P-T* history. Metamorphic fluid played an important role throughout this journey and its presence is characterized from mineralogical, theoretical and fluid inclusion analyses. Although wagnerite was previously reported from this belt, its composition is hydrous as presence of vapor fluid was interpreted to be responsible for its stability at the retrogressive stage of evolution. We report for the first time, presence of fluor-wagnerite in peak metamorphic porphyroblastic assemblages as well as retrograde matrix assemblages from Eastern Ghats Belt and explore its implication for the different stages of evolution of the lower crust. Fluor-wagnerite crystals develop inside garnet porphyroblasts of aluminous granulites as well as in the quartzofeldspathic matrix. Based on EPMA data and Micro-laser Raman analyses, we document an unusual high-Mg-F-rich chemistry of the mineral. Abundance of F over H_2O implies brine-rich nature of the fluid which was earlier inferred from F-rich nature of phlogopite crystals from this belt. Apatite is characteristically absent in the primary assemblages containing wagnerite, except a very late occurrence decomposing the matrix wagnerite grains. We propose that, given the 'suitable bulk and fluid chemistry', fluor-wagnerite can occur as a common accessory mineral in lower-mid crustal rocks, and fluorine should be taken into consideration while reconciling the P-T grid in the higher temperature side of biotite-dehydration melting curve.

Keywords: Fluor-wagnerite, UHT granulites, EGB, India

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SCG62-P02 Room:Convention Hall Time:May 22 17:15-18:15

Petrology of eclogitic garnet-clinopyroxene rocks from Namakkal, southern India

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We report new petrological data of eclogitic garnet-clinopyroxene rocks from two new localities in Namakkal region within the Palghat-Cauvery suture zone, which corresponds to the Gondwana suture zone in southern India. The eclogitic rocks from Pavithram comprise garnet and clinopyroxene with accessory orthopyroxene, hornblende, plagioclase, and quartz. The garnet is often mantled by orthopyroxene + plagioclase corona, suggesting decompression from high-pressure stage possibly along a clockwise P-T path. This is a common reaction texture of magic granulites in this region. In contrast, clinopyroxene in garnet-clinopyroxene rocks from Vadugappatti is mantled by garnet + quartz corona, suggesting the progress of reaction: clinopyroxene + plagioclase => garnet + quartz probably due to near-isobaric cooling. The two contrasting textures in garnet-clinopyroxene rocks from this region might indicate the occurrence of discrete metamorphic blocks with different P-T history within the suture.

SCG62-P03 Room:Convention Hall Time:May 22 17:15-18:15

Magmatic process of synplutonic mafic dykes in Ryoke belt at Shodo Island, southwest Japan

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Various synplutonic mafic dykes in igneous rock complex are widely distributed throughout the Tanoura Peninsula of the southern part of Shodoshima Island, in the Ryoke belt, southwest Japan. The common mineral assemblages are plagioclase + amphibole + biotite, sometimes quartz. Plagioclase phenocrysts (˜ 3 mm) are observed in all dyke samples, these modes vary according to each samples (0.2 to 14 vol.%). Plagioclase phenocrysts have An-rich core ($>$ An$_{80}$) and Ab-rich rim, these cores show partial dissolution shape indicate the magma mixing. An-rich core often contain inclusions of amphibole and/or biotite. Therefore, it suggest that the mafic end member of magma mixing is a low temperature hydrous basaltic magma. Ab-rich rim of plagioclase groundmass show similar Anorthite content. This observation suggest that both assemblage might be crystallized from the mixed magma during end stage.

Ratageski et al. (2005) performed the experiment of partial melting of mafic intrusion in lower crust. On the major oxides variation diagrams for SiO$_2$ contents, the experimental melt composition area by Ratageski et al. (2005) are located on the extension line of whole rock compositions of this study trend. This observation suggests that the felsic end member of magma mixing have similar composition for this experimental melt. Kutsukake (2002) proposed that the origin of the Ryoke tonalities were formed by the magma which generated the partial melting of amphibolites. This results also consistant with this study.

Mantle origin mafic magmas were acted as the heat source of the Ryoke granitic magmatism. It is quite possible that felsic magma and mafic magma mixed at the lower crust.

Keywords: mafic dyke, magmatic process, geochemistry, mineral chemistry

SCG62-P04 Room:Convention Hall Time:May 22 17:15-18:15

Petrogenesis of olivine-clinopyroxene rocks: an example from the Takashima xenolith suite, northern Kyushu

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Olivine-clinopyroxene rocks (dunite, wehrlite, olivine clinopyroxenite and clinopyroxenite) very frequently occur as ultramafic xenoliths in volcanics and as plutonic rocks in ophiolites. Dunites and olivine-clinopyroxenites can be formed by cumulates during fractional crystallization, but wehrlites, intermediate in mode and very frequently observed, cannot be formed in the same work. Olivine-clinopyroxene rocks containing green clinopyroxene from the Takashima xenolith suite, northern Kyushu, show a gradual variation ratio of olivine to clinopyroxene from dunite to clinopyroxenite. The olivine-clinopyroxene rocks from Takashima are examined to understand their formation processes. They have recrystallization textures formed at subsolidus conditions, leading to change of Mg# (=Mg / (Mg + total Fe) atomic ratio) of olivine and clinopyroxene. Based on compositions and modal amounts of olivine and clinopyroxene from high temperature magmatic values, the igneous Mg# of olivine and clinopyroxene is recalculated to be 0.927-0.902 for dunites, 0.869-0.854 for wehrlites, and 0.886-0.876 for clinopyroxenites. Relationships between the Fo content and the NiO content of olivine and the Cr/(Al+Cr)atomic ratio of spinel suggest that these rocks were basically formed by crystal accumulation in fractional crystallization. The Takashima dunites and clinopyroxeneites are cumulates by fractional crystallization. Intermadiate wehrlites are a mixture of accumulated crystals of olivine with high Mg#s and olivine-clinopyroxene precipitated crystals with lower Mg#s from evolving intercumulus melt. These crystals were homogenized structurally and compositionally through subsolidus recrystallization.

Keywords: olivine-clinopyroxene rocks, wehrlite, fractional crystallization, intercumulus melt, Takashima xenolith suite

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SCG62-P05 Room:Convention Hall Time:May 22 17:15-18:15

Modification of continental lithosphere by the Miocene alkali basaltic activity recorded in gabbroic xenoliths in Shingu

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Miocene alkali basaltic dikes in the Shingu area, Ehime Prefecture, brought up abundant crustal and mantle fragments. They bear the information of the petrological structure beneath the region at the beginning of subduction of the Philippine Sea plate. We provide results of petrological examinations on the xenoliths and discuss the chemical diversities in magmas at the east Eurasian continental margin.

The gabbroic xenoliths in the Shingu can be classified into three groups: Amph-bearing gabbro (A type), brown Cpx-bearing gabbro-pyroxenite (B type) and gabbronorite (C type). The microtextures of the A-type gabbro are almost granoblastic with local subhedral Pl. The Hbl-Pl thermometry indicates the lowest equilibration temperature among the Shingu mafic and ultramafic xenoliths. Therefore, they probably formed a part of the lower crust beneath the Shingu. The B type gabbro-clinopyroxenite has petrographical features similar to the Group2 xenoliths that are considered as cumulates from an alkali basaltic magma. The C type gabbronorite contains granular Cpx with abundant exsolutions of Opx and brownish interstitial Cpx with no exsolution. High temperature crystallization (1250oC) and re-equilibration (1050-1100oC) are estimated for the gabbronorite, indicating that they were located at a mantle depth. Mineral chemistry of exsolution-rich Cpx in gabbronorite (C type) is richer in Cr and Mg and has a lower abundance of REE than Cpx in groundmass of the host alkaline basalt and the B-type gabbros whereas Pl is richer in alkaline elements. The major and trace element mineral chemistry of the interstitial Cpx is similar to the B type Cpx. These textural and chemical features indicate that the C type gabbronorite were modally metasomatised by an alkaline magma that have crystallized the B-type cumulates.

In order to explain the silica-saturated and Cr-rich but highly alkaline nature of the magma for the C type gabbronorite, we consider assimilation of Opx in lithospheric mantle by ascending alkali basaltic magma. Model calculation including Opx assimilation and subsequent fractionation of Cpx largely reproduces the chemical signatures of Cpx in gabbronorite. The significantly HFSE-enriched geochemical character implies a separation of carbonatite melt in the magmatic evolution. Considering the highly potassic nature of the C type, the original alkaline magma was formed by a low degree of partial melting of mantle probably at the earliest stage of the alkaline magma activity in the SW Japan. Such a silica-undersaturated magma modified the lithospheric structure beneath SW Japan by removing Opx from peridotite in mantle and by crystallizing gabbronorite at around the Moho.

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SCG62-P06 Room:Convention Hall Time:May 22 17:15-18:15

Osmium isotopic and major element compositions of the fresh harzburgite from the Hayachine-Miyamori ophiolitic complex

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The Hayachine-Miyamori ophiolitic complex in the Kitakami Mountains, northeastern Japan is located in the Hayachine Tectonic Belt, which is one of the oldest geological terrane in Japan and consists of ultramafic tectonite and cumulate members correponding to the lower ultramafic sections of ophiolites (e.g. Ozawa, 1984; Ehiro, 2000). Peridotites in this complex are extensively serpentinized (most of them consists of $>$ 60 % serpentine; Ozawa, 1988). The tectonite member is divided into two suites on the basis of spinel Cr-number (Cr# = 100xCr/(Cr+Al)): aluminous spinel ultramafic suite (ASUS; Cr# $<$40) and chromite-bearing ultramafic suite (CSUS; Cr# $>$ 40; Ozawa, 1988). The Sm-Nd isotopic data with trace element compositions of clinopyroxenes of this complex suggest that the complex experienced partial melting events around 450 Ma ago with influx of three agents derived from the subducting slab (Ozawa and Shimizu, JGR, 1995; Ozawa, JGR, 2001; Yoshikawa & Ozawa, GR, 2007).

We found a least serpentinized boulder of spinel harzburgite (73003) belonging to CSUS and determined a bulk-rock major element compositions and ^{187}Re/^{188}Os - ^{187}Os/^{188}Os isotopic ratios. The sample 73003 is characterized by high CaO and low Al_2O_3 contents than other orogenic peridotites. Similar feature was observed from the Victoria peridotite xenoliths (Yaxley et al., 1991). Yaxely et al. (1991) proposed carbonatite metasomatism for the high CaO and low Al_2O_3 of the xenoliths from the following lines of evidence; (1) replacement of primary orthopyroxene by clinopyroxene and olivine, which may be attributed to the reaction between orthopyroxene and CO_2-rich melt to produce clinopyroxene and olivine, (2) presence of accessory apatite, which can be produced by reaction from primary olivine + diopside + cabonatite melt to secondary orthopyroxene + haloapatite, (3) high bulk-rock CaO/ Al_2O_3 value and extreme large ion lithophile element (LILE) enrichment without concomitant TiO2 enrichment. CSUS peridotites have petrological and geochemical features consistent with (2) and (3), although the replacement of orthopyroxene by clinopyroxene + olivine has not been observed in CSUS peridotites. The modal abundances of clinopyroxene in CSUS peridotites, however, are as high as or even higher than in ASUS peridotites which have lower Cr# ratios indicating less degree of melting than CSUS peridotite. It suggests addition of clinopyroxene by influx of a CaO-rich agent. On the basis of the above observations, we infer that CSUS peridotites underwent influx of a silicate-carbonatite melt most probably from subducted slab.

The ^{187}Os/^{188}Os isotopic ratio (0.1235) of sample 73003 is consistent with those of present average abyssal peridotite (0.1238, n=96; Rudnick & Waker, Lithos, 2009) and the Izu-Bonin fore-arc mantle peridotites (0.1193 - 0.1273; Parkinson et al., Science, 1998). The Re-depletion age of this sample is around 500Ma. This age is consistent with the K-Ar amphibole ages (480 - 520 Ma) of the Matsugadaira-Motai metamorphic rocks which have been interpreted as formed at the subduction zone (Kanisawa et al., GKK, 1992). The Os isotopic results thus strongly support open-system melting at subduction zone as presented by the previous studies.

Keywords: Os isotopic composition, Hayachine-Miyamori ophiolitic complex, whole rock comositions, metasomatism by silicate-carbonatite melt

SCG62-P07 Room:Convention Hall Time:May 22 17:15-18:15

Rare earth element composition of the Yakushima granitic body, Kagoshima Prefecture

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The Miocene Yakushima pluton intruded into Shimanto Super Group in Yakushima Island, Kagoshima Prefecture. The pluton consists of four members with granitic dike : Yakushima main granite (YMG), core granodiorite (CGD), core cordierite granite (CCG), marginal facies granite (MFG) and late granite dike (LGD). Anma et al.(1998) revealed geotectonic and petrological features of the pluton, and suggested that the YMG has different origin from other members. Furthermore, Kawano et al. (2007) discussed relationships between Sr initial isotopic ratios and origin of YMG.

In this study, rare earth elements of the Yakushima pluton are measured and REE characteristics for each rock facies are revealed. The rocks of the CGD and CCG have higher ratios of La/Lu and LREE/HREE than those of other rock facies. Negative Eu anomaly in the CGD and CCG is not recognized, it is suggested that fractionation of plagioclase was not performed. The rocks of the YMG have lower ratios of La/Lu and LREE/HREE than those of the CGD and CCG. Some samples from the YMG indicating remarkable negative Eu anomaly have lower Sr initial ratios of 0.702 to 0.704. Whereas samples having higher Sr initial ratios of 0.705 to 0.707 show no Eu negative anomaly. The former is exposed to the central part of the YMG, it is shown that fractionation of plagioclase is progressing in the central part. The MFG has no Eu negative anomaly, however, LGD is characterized by Eu negative anomaly and lowest ratios of La/Lu and LREE/HREE among the pluton.

From these REE features, it can be considered that the YMG and MFG, the CGD and CCG, and the LGD were derived from the different origin, respectively. Moreover, REE pattern of the YMG is complicated and possibly was formed by mixture of the magma presumed from SrI.

Keywords: Yakushima, Granite, Rare earth element

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Magma process of the granitic rocks around the Chichibu mine, Saitama Prefecture

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Chichibu granitic body in the western Saitama Prefecture is composed of quartz diorite and tonalite (Ishihara et al., 1987). The body is divided into two main bodies, namely Chichibu south body and Chichibu north body, accompanied with some small body (Hara et al., 2010). Radiometric ages of the Chichibu granitic body were dated 6.3 to 5.9 Ma (Ueno and Shibata, 1986;Saito et al., 1996). In this study, modal and chemical compositions and mineral chemical compositions of the granitoids from the north and south bodies, and the magma process of the Chichibu south body is examined.

The marginal part of the Chichibu south body has large amount of biotite, whereas the central part shows large amount of amphibole. With the increase in SiO_2 value, an A.S.I value increases in the less than 0.80 to 1.1 range, and the Chichibu south body has feature of I-type granites. The A.S.I value becomes low in the central part of the Chichibu south body, and the value becomes higher in marginal part. The rocks of the Chichibu south body are rich in a LIL element and deficient in a HFS element. From these features of trace elements, it can be considered that the Chichibu south body was formed by Island arc magma activity.

In conclusion, the following magma processes can be considered. The magma crystallizing plagioclase and amphibole was intruded into sedimentary layers of the Chichibu area. Then, it reacted to the surrounding sedimentary rocks at marginal of the Chichibu south body. A marginal part becomes locally peraluminous magma and it crystallized biotite. As a result, crystallizing of amphibole continues in the central part. It can be considered that amphibole increased in the central part of the Chichibu south body, and biotite increased relatively in the marginal part of the body.

Keywords: Chichibu body, granitic rocks, magma process

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SCG62-P09 Room:Convention Hall Time:May 22 17:15-18:15

Alkali rhyolite found in Mt. Haguro, Tochigi Prefecture, central Japan

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Rhyolite occurred in Mt. Haguro, Tochigi Prefecture, is reported K-Ar whole rock age of 14.2+/-0.4 Ma (Yoshikawa, 1998). Yoshikawa (1998) shows phenocrysts of the Haguro rhyolite are comprised of quartz, plagioclase and biotite.

In this study, bulk and mineral chemical compositions of the Haguro rhyolite is revealed. Chemical compositions of the rocks were ranged 77 to 79 wt% of SiO_2 and 7 to 9 wt% of Na_2O+K_2O, and alkali feldspars are found in the phenocrysts of the rhyolite. Therefore the Haguro rhyolite is alkali rhyolite.

In N-MORB normarized incompatible element patterns, Sr is dominantly depletion. Furthermore, in chondrite normarized REE patterns, negative Eu anomaly is shown. Additionally in bulk major chemical compositions, Ca is poor. These behaviors of chemical elements suggest that plagioclase was fractionated from original magma.

Keywords: Utsunomiya city, Miocene, Alkali rhyolite

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Exsolution textures in alkali feldspar from the Ohgi tonalite

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Electron petrographic study of exsolution textures is performed on alkali feldspar in porphyritic granitic rocks from the Ohgi tonalite, which is one of the Late Cretaceous-Paleogene granitoids in the San' yo zone, Southwest Japan, distributed between Kyoto and Shiga Prefecture. Alkali feldspar occurs as subhedral to anhedral prismatic crystals (ca. 200 um in long) in matrix of the orthopyroxene-bearing porphyritic granitic rocks described by Takaya et al. (2009). Most of the crystals are partially or wholly altered. The unaltered alkali feldspar whose the chemical composition is $\mathrm{Or}_{57-71}\mathrm{Ab}_{24-38}\mathrm{An}_{1.8-3.1}\mathrm{Cn}_{0.4-3.4}$ containing up to 1.8 wt % in BaO displays the chemical zoning in Cn component; the composition in core is high, toward the margin Cn content decreases and rim is almost free in Cn. Various exsolution textures can be observed in the crystals in accordance with the chemical zoning in Cn component.

The core part is clearly composed of several parts on the basis of the textural feature; one characterized by the presence of the relatively-coarse exsolution lamellar intergrowth and the other by the fine exsolution lamellar intergrowth with no coarse lamellae. TEM observation of the coarse intergrowth (bulk composition: $\mathrm{Or}_{58-61}\mathrm{Ab}_{34-37}\mathrm{An}_{2.1-2.5}\mathrm{Cn}_{2.9-3.3}$) reveals that the interface between lamellae is linear and sharp, and the periodicity of the intergrowth is irregular, the fact of which implies that the coarse intergrowth was formed due to nucleation and growth mechanism. In the fine lamellar intergrowth (bulk composition: $\mathrm{Or}_{57}\mathrm{Ab}_{38}\mathrm{An}_{2.2}\mathrm{Cn}_{2.6}$), in contrast, the interface between lamellae is sharp and wavy, and the periodicity of the intergrowth is regular, suggesting that the fine intergrowth was formed by proceeding with spinodal decomposition mechanism. In the rim, on the other hand, the apparently-homogeneous regions can be occasionally observed in addition to the coarse lamellar intergrowth. TEM observation in this region (bulk composition: $\mathrm{Or}_{62}\mathrm{Ab}_{36}\mathrm{An}_{1.9}\mathrm{Cn}_{0.5}$) was clarified to be a presence of the fine lamellar intergrowth whose texture is similar to that of the fine lamellae in the core, that is, the fine lamellar intergrowth in the Cn-poor rim suggests to be formed by spinodal decomposition.

These electron petrographic observations reveal that two distinct exsolution textures, each of which was formed by the different mechanisms (nucleation and growth and spinodal decomposition), are coexisting in a single crystal of alkali feldspar, which can be explained by a small difference in the Or component (almost same Cn) even by a simple cooling process. Furthermore, it is suggested that Or-rich limb in spinodal curve shifts to Or-poor side by increasing with Cn content because the bulk composition of the lamellar intergrowth formed by spinodal decomposition is Or-richer at low Cn content in comparison with high Cn content. This present tendency is concordant with that suggested by Lagache and Catel (1992) and Viswanathan (1992).

Keywords: alkali feldspar, exsolution texture, spinodal decomposition, nucleation and growth, celsian, Ohgi tonalite

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Mineralogy of anorthite megacrysts from Take-shima, Kagoshima Prefecture, Japan

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Anorthite megacrysts of about about 1 cm in maximum diameter are found as phenocrysts in the basaltic lavas from Take-shima, Kagoshima Prefecture, Japan. Take-shima is an island located about 40 km SSW of the southern tip of Satsuma peninsula. The island lies at the northeast edge of Kikai caldera, which measures 17 x 20 km^2, and is one of the large calderas in southern Kyushu (Matsumoto, 1943). Most of the caldera except for three islands, Take-shima, Satsuma-Iou-jima and Shin-Iou-jima, lies below the sea level. The anorthite megacrysts occur in the basalt which is supposed to erupt from Magomeyama, pre-caldera volcano in Take-shima. Similar anorthite megacrysts have been found in the basalt from Satsuma-Iou-jima (Ono et al., 1981). The purpose of this work is to understand the mineralogical significances of anorthite megacrysts from Take-shima, and reveal the genetic mechanism behind these megacrysts.

Thin section were made from fragments with anorthite megacrysts, and observed under a high-magnification polarizing microscope, Nikon ECLIPSE E600 POL. A polarizing stereoscope, MEIJI TECHNO EMZ-5POL-2 was also employed to study microstructure and optical property throughout the megacryst in the same view. For mineral identification, X-ray powder patterns were obtained using a RIGAKU Ultima IV Protectus, X-ray diffractometer with monochromated CuKa radiation (40 kV, 40 mA) at Faculyty of education, Kagoshima University. Software PDXL was used for mineral identification. Refinement of cell parameters was carried out using a single-crystal diffractometer, Rigaku R-AXIS RAPID at the Chemical Analysis Center, University of Tsukuba. Chemical analyses were carried out using a JEOL JXA-8530F EPMA (20 kV, 1.0 x 10^{-7} A for qualitative analyses; 20 kV, 1.0 x 10^{-8} A for quantitative analyses and BSE image observation) at the Chemical Analysis Center, University of Tsukuba. ZAF online full matrix corrections were used for quantitative analyses (Reed, 1996). Compositional maps were obtained using a HORIBA XGT-5000 X-ray analytical microscope (50 kV, 1.00 mA) at the Chemical Analysis Center, Kagoshima University.

The megacryst, reaching a maximum size of about 1 cm in diameter, are mainly found as phenocryst in augite-bearing olivine basalt. The anorthite megacrysts show slight optical zoning. Zonal arrangement of opaque minerals and micro-bubble inclusions are common in the specimens. Moreover they often contain several corroded inclusions of olivine, and albite twins occur in every specimen. Though powder X-ray diffraction pattern of the megacryst shows that an ordered P-1 anorthite is the most likely candidate, single-crystal X-ray diffraction data suggests the structure with c = 0.7 nm cell. X-ray analytical microscope and electron microprobe studies reveals that the megacryst is chemically homogeneous, whereas BSE image shows a slight oscillatory zoning. It indicates Anorthite content of the megacryst is about 94 mol%. Because a trifling amount of Fe and excess Si are detected by EPMA, minor end-members of $FeAl_2Si_2O_8$, $CaFeSi_3O_8$ and $[\ ]Si_4O_8$ are incorporated into the present megacryst.

Though further investigation is required for completely understanding the formation of the anorthite megacryst from Take-shima, this new work provides fundamental information about the history of magmatic system related to anorthite megacryst formation under island arc. The presence of oscillatory zoned micro-bubble inclusions implies the oscillation in pressure, temperature or vapor pressure occurred at a certain narrow range around the melting point of anorthite. The textural feature seems to be consistent with limited chemical zonation observed in BSE image. Both the above implication and the presence of corroded olivine inclusions as a nucleus lead to the megacrystallization of chemically almost homogeneous anorthite in host magma, which offers a good example of Ostwald ripening in nature.

Keywords: anorthite, megacryst, Take-shima, oscillatory zoning, Ostwald ripening

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The stable region of sibirskite and parasibirskite

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1. Introduction

Many type of novel minerals from high temperature type of gehlenite-spurrite skarns were found in the Fuka area, Okayama prefecture, Japan. At the last stage of the formation of the skarn, many borate minerals were also formed. The minerals at the first stage of the borate minerals was takedite (Ca3B2O6) (Kusachi et al., 1995), and various secondary hydroborate minerals were formed after that. Sibirskite (CaHBO3) (Kusachi et al., 1997) and parasibirskite (Kusachi et al., 1998) was formed at this stage. These hydoroborate minerals were considered as a polymorph each other. The synthesis of sibirskite was reported by the Sun et al. (2011), and parasibirskite was reported by the Schafer (1968a) etc. In this study, we attempted to define the stable region of the sibirskite and parasibirskite by the synthetic experiments.

2. Sibirskite and parasibirskite

Sibirskite is hydroborate CaHBO3. It occurs in many places of Russia, and Fuka is the third place of occurrence. It is white with vitreous luster in hand specimen, and colorless in thin section. In Fuka mine, It occurs as aggregates of prismatic crystals up to 0.1 mm long and 0.02 mm wide, in association with takedaite, frolovite and calcite. The cell dimensions and the space group determined are P21/a, a=8.643(6), b=9.523(2), c=3.567(3) A, s=119.23(3)o and Z=4 (Kusachu et al., 1997).

Parasibirskite is a polymorph of sibirskite, and it is a new mineral found at Fuka mine. It is white with weak pearly luster in hand specimen, and colorless in thin section. In Fuka, it occurs subparallel aggregates of tabular crystals up to 40∗20∗3 um in size, in association with takedaite, olshanskyite, sibirskite, frolovite and calcite. The cell dimensions and the space group are P21/a, a=6.722(4), b=5.437(2), c=3.555(2)A, s=93.00(5)o (Kusachi et al., 1998).

3. Result

3-1 Synthesis from takedite

In Fuka mine, the sibirskite and parasibirskite were formed by hydrothermal alteration of takedite. So, these minerals were synthesized formed from natural takedite by boric acidic water alternation and changing the quantity, temperature, pressure and synthesis period. The reaction formula is Ca3B2O6+H3BO3 ?3CaHBO3

At 350oC and 400oC condition, calcibolite (CaB2O4) was synthesized or not identified because the XRD peak so low. Sibirskite and parasibirskite were formed when synthesizing it for 7 days at 1000kg/cm3 and 300oC, and only sibirskite was formed for 14 days.

3-2 Stable temperature and pressure region for sibirskite and parasibirskite

To examine the stable region of sibirskite and parasibirskite, the mixing samples of these minerals with water were synthesized under the hydrothermal condition. The temperature were changed from 200oC to 450oC by the step of 50oC, and the pressure were changed from 500kg/cm3 to 1500kg/cm3 every 500 kg/cm3.

Parasibirskite was decomposed to form the sibirskite by 14 days duration time with over 250oC of synthetic temperature. At 1500kg/cm3 and 400oC, and 450oC, sibirskite and parasibirskite were decomposed to form the Shimazakiite (Ca2B2O5) (Mastubara et al., 2011). Moreover, at below the 200oC of synthetic temperature, the XRD peaks of sibirskite and parasibirskite were nearly not changed.

4. Discussion

The sibirskite and parasibirskite that occurred in Fuka mine were considered as formed by the hydrothermal alteration of takedite. In this study, those minerals were also synthesized from takedite by the 500, 1000 and 1500kg/cm3 with 300oC. However, the parasibirskite were decomposed by 14 days of synthesis time. So, those were considered as the minerals of first stage and partially unstable one. From the result of 3-2 experiments, the stable region of sibirskite were limited with 350oC to 400oC with 1500kg/cm3, with 400oC to 450oC with 500kg/cm3. At the outer of stable region, the mineral is changed to the Shimazakiite. The lower limit of sibirskite and upper limit of parasibirskite were considered as 200oC.

Keywords: sibirskite, parasibirskite, synthesis

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SCG62-P13 Room:Convention Hall Time:May 22 17:15-18:15

Occurrence of the Komanakigawa Fault and hydrothermal alteration of rocks around the fault

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The Kokura-Higashi Fault constituting northern part of the Kokura-Tagawa Tectonic Line is considered as an active fault (The Research Group for Active Faults of Japan, 1980), and the timing of activity and its style in Quaternary were analyzed (Watanabe, 1989; Senda, 1990; Takatsu, 1996; Watanabe et al., 2002). However, presumption of timing of activity at the the Tagawa Fault constituting northern part of the Kokura-Tagawa Tectonic Line was performed only by the analysis of fracture system in the Neogene volcanic and sedimentary rocks (Hikosan Collaborative Research Group, 1992). Sako and Yuhara (2004) analyzed the fracture system, which develops in the Soeda Granodiorite around the Tagawa Fault in Hikosan River valley, southern area of Soeda Town, and clarified the formation history of fractures before the Neogene. However, the Tagawa fault could not be found. The fault continuous along the Komanaki River, which is regarded to branch from the Tagawa Fault, was found by subsequent geological survey. In this paper, we report the occurrence of fault rocks and the hydrothermal alteration of rocks around the fault.

This fault can be traced more than 3 km along the Komanaki River from Yakatabaru, Soeda Town. Yuhara and Miyazaki (2007) called it Komanakigawa Fault. The Komanakigawa Fault makes the boundary of the Soeda Granodiorite distributed in the east side and the Tagawa metamorphic rocks distributed in the west side. The politic schist of the Tagawa metamorphic rocks in maximum width of 11m and the Soeda Granodiorite in maximum width of 12.5m are whitened by hydrothermal alteration.

The Komanakigawa Fault strikes N14^o to 42^{o}E and dips 78^{o}W to 88^{o}E. This fault has fault gouge with maximum width of 90cm and cataclasite with maximum width of 200cm. The striations observed in cataclasite are almost horizontal. There are white and dark gray fault gouge and cataclasite. Andesitic dykes correlated to the Kitasakamoto Formation intruded along the fault. Considering occurrence in field and under microscope, white fault gouge and cataclasite were formed by destruction of whitened rocks. This suggests that the hydrothermal alteration took place at least two times before and behind faulting.

In the whitened granodiorite, most of biotite and hornblende are altered, and plagioclase is emplaced by small altered minerals. In the whitened pelitic schist, most of biotite and plagioclase are altered. Those altered minerals are illite, siderite, kaolinite, calcite and montmorillonite.

MgO, CaO and Sr contents of the Soeda Granodiorite decrease and As, Ni and S contents increase by hydrothermal alteration. In the whitened pelitic schist, there is decrease of MgO and CaO contents.

Keywords: Kokura-Tagawa Tectonic Line, Komanakigawa Fault, Soeda Granodiorite, Tagawa metamorphic rocks, Hydrothermal alteration

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Electrical and magnetical properties of the sea-floor hydrothermal deposits

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The newly discovered sea-floor hydrothermal deposits in the Japanese EEZ are growing concern as the crucial future mineral resources and to comprehend the reserved amount of the mineral ores are among the key issues for the developments. Electrical and Electromagnetic exploration technologies are prevailing for the onshore mineral deposits due to the significant differences of the electrical properties between the ores and host rocks, but newly improved technologies are demanded for the ocean bottom applications. The electrical and magnetic properties such as resistivities, chargeabilities and magnetic susceptibilities of the ocean bottom samples from Bayonnaise Knoll and Izena Cauldron are measured and combined with the analysis with X-ray Diffractometry(XRD), X-ray Fluorescence Analysis(XRF) and inductively-coupled plasma mass analysis(ICP-MS). Mineral compositions are determined also with visual and reflecting microscope observations. As comparison samples, the KUROKO black ores which are thought to be the same origin as the ocean bottom hydrothermal deposits are obtained from Koshiji and Kosaka mineral deposits and analyzed in the same way.

The resistivities and chargeabilities are measured with the samples saturated with 0.3 ohm-m water to get the ocean bottom properties. The resistivity values from the Izena samples range from 0.1 to several ohm-m, while those from Bayonnaise and Kuroko range from 1 to several 10s of ohm-m, while chargeability values are found to be high for those two areas. Also no practical differences are found for the IP-values between the above two areas. As the results of the XRF analysis, the average iron content of Izena samples is found to be about 28.8%, which is 6 time higher than that of Bayonnaise and KUROKO (average 4.7%). Bayonnaise samples also contain 35.6% of zinc. Crystalline minerals of Bayonnaise analyzed using XRD showed the same tendency as KUROKO, containing more sphaleraite(ZnS) than Izena samples. The mineral contents of Izena samples are distinct from Bayonnaise samples for containing much more pyrite and also containing marcasite and sphaleraite, the resistivity of which is usually higher than those of pyrite or other sulfide minerals. The general order of the resistivity values of the ore minerals are from low to high values of pyrite, chalcopyrite < galena < marcasite < sphalerite. The results of our resistivity measurements show good agreements with the mineral composition obtained from the XRD analysis and the differences between those 2 areas can be explained. From the results of ICP-MS analysis, Au and Ag contents are practically no differences between Bayonnaise Knoll and Izena Cauldron, but associate with the contents proportional to Zn and Pb. The magnetic susceptibilities of the ore samples from Izena Cauldron are higher and proportional relation to the Fe contents. The hexagonal pyrrhotite crystals are observed in the samples which show high permanent magnetism.

From the inspection of the core samples, the width of the mineralization and altered zones is minimum of several cm, and the massive or conglomerate minerals ware obtained. From the observation under a reflective polarization microscope , the ores with the various crystal-grain sizes ware confirmed, it seem to be due to the difference process of the crystallization condition under the ocean bottom such as the concentration of elements, temperature, pressure and redox status. The depth of all the samples used are from shallower than 10m from the ocean bottom, and more samples from deeper layers are needed for the total understanding of the sea-floor hydrothermal deposits.

Keywords: sea-floor hydrothermal deposit, resistivity, chargeability, magnetic susceptibility, chemical composition, mineral composition

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Oxygen isotope study of vein type gold deposit at the Tsagaan Tsahir Uul in the Bayankhongor belt, Mongolia

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The Bayankhongor metallogenic belt, ˜700 km southwest of the capital city, Ulaanbaatar, is the second productive gold-field in Mongolia. Production of this gold-field is not well known, but is estimated at about 50 kg/yr. Most gold is recovered from alluvial deposits, however primary sources of alluvial gold in the district are not well understood. The Tsagaan Tsahir Uul (TTU) gold deposit is located at the southeastern part of the Bayankhongor metallogenic belt, and is possible source of alluvial gold. The geology of the TTU deposit consists of Proterozoic tonalitic gneisses and marble-bearing schists, Proterozoic granitoid (647 Ma) and Permian small dioritic stocks (250 Ma) and Permian lamprophyre dikes (352 Ma). Gold mineralization in the TTU deposit is accompanied by quartz veins hosted in migmatized schist and granite.

There are two types of quartz veins. First group is 15 gold-bearing quartz veins that have NNW to NS direction with length of 0.2 to 2.8 km. The width of these veins is between 0.2 and 0.5 m. Quartz veins consist mostly of crustified bandings of milky quartz, with associated silver-black bands. The other vein is barren quartz-carbonate vein with ˜4 km length and from 5 to 50 m width. This vein cuts quartz veins mentioned above. The veins composed of brecciated fragments of quartz and fracture filling carbonate-quartz matrix. Ore minerals in quartz vein are pyrite, chalcopyrite, galena, sphalerite, tetrahedrite, arsenopyrite and native gold. The fluid inclusions found in gold-bearing quartz veins were two-phase and some of them contain CO_2, with homogenization temperature range from 160-290^{o}C. Oxygen isotope of quartz veins were analyzed by CO_2-laser ablated BrF_5 fluorination technique. The delta^{18}O values of quartz vein range between 11.3 to 17.9 per mil, compared to -9.4 to -6.4 per mil for the quartz-carbonate vein. Calculated delta^{18}O values of fluid from the delta^{18}O of quartz using fractionation factor between quartz and water and homogenization temperatures (200 and 125^{o}C, respectively) of fluid inclusion are 1.3 to 6.2 per mil for gold-bearing quartz veins and -27.3 to -24.2 per mil for quartz-carbonate vein. These data suggest two veins were formed completely different processes. Oxygen isotopic values of fluid suggest, the origin of gold-bearing fluid is metamorphic fluid from deep crust and migrated along the big fault system. Fluid responsible for quartz-carbonate vein was dominated by meteoric water, and this vein was probably formed at shallow level.

Based on the tectonic setting of the deposit, the TTU deposit possibly belongs to orogenic type gold deposit (Groves. 1998). The geological, mineralogical and geochemical features of TTU deposit are similar to those of worldwide orogenic gold deposits.

Keywords: orogenic gold, oxygen isotope, Tsagaan Tsahir Uul

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Relationship between seismic velocity and permeability on granular rock model

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Fluid flow in a rock pore is of great importance in subsurface development, e.g., petroleum engineering and carbon dioxide capture and storage. Permeability, which shows how easily fluid can pass through rock mass, is one of the most important indicators to evaluate fluid flow in porous media. Since permeability can be measured by laboratory experiments and well logging, permeability in a large-scale reservoir must be predicted by other information. In this study, we focus on seismic velocity as information to predict permeability because it is the most trusted parameter in subsurface exploration. In order to predict permeability from seismic velocity, the relationship between permeability and seismic velocity must be revealed.

These two parameters are not directly connected to each other. Pore geometry of rock mass could be a bridge between them because it is mainly governing fluid flow and seismic velocity. However, the geometry is very complicated. For a general discussion, we adopted granular rock models including a lot of spherical grains whose size distribution is assumed to be Gaussian. The permeability and seismic velocity are numerically computed from these rock models. The permeability is calculated by lattice Boltzmann method, which is one of the computational fluid dynamic methods and well-suited for simulation under complicated fluid-solid boundary condition. The homogenization by finite element method is adopted for the calculation of seismic velocity.

It is demonstrated that the sorting parameter is governing the seismic velocity and permeability in this model. Sorting parameter is one of the most important parameters in the discussion of grain size distribution. This is an indicator which shows the standard deviation of grain-size. The result of this research shows the relationship between permeability and seismic velocity granular rock models by the bridge of grain sorting.

Keywords: granular model, permeability, seismic velocity, sorting