MINERALOGICAL ABSTRACTS FROM SCIENTIFIC PAPERS PUBLISHED IN JAPAN,
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Age Determination 105038—105050;
Rock-Forming Minerals and Petrology 105051—104065

Age Determination 105038
Kawano, Y. & Yuhsara, M. Chronological and isotope
geological study of Cretaceous granitic rocks, upper reach
of the Nakagawa river, Fukuoka Prefecture. J. Geol. Soc.
Japan, 114, 218-230, 8 figs., 2 tables (in Japanese with

Cretaceous granitic rocks, consisting of Itohima granodiorite
and Sawara granite, are occurring at upper reach of the Nakagawa
River, Fukuoka Prefecture. The Sawara granite that is divided
lithologically into fine-grained facies and the main facies indi-
cates Rb-Sr whole rock isochron ages of 101.2 ± 10.9 and 96.6 ±
5.9 Ma, respectively. Both granites also suggest different initial Sr
isotopic ratios and geochemical features, indicating they have
been originated from different source magmas. Rb-Sr mineral
isochron ages using biotite of the main facies of the Sawara gran-
ite and the Itohima granodiorite are 88.3 ± 0.5 and 88.9 ± 0.2 Ma,
respectively. These ages represent the time when the rocks cooled
down to closure temperature of biotite. As a result, activity of the
Cretaceous granitic rocks in this area is estimated as follows. The
magnas of the Sawara granite (fine-grained and main facies)
have been intruded into the Itohima granodiorite during 101 to 97 Ma,
and temperature of the granodiorite have been heated to over the
closure temperature of biotite Rb-Sr system. After that, the rocks
in the area gradually cooled down to the closure temperature of bi-
otite around 88 Ma. (Authors' abstract)

105039
Takagi, H., Ishii, T., Tobe, E., Soda, Y., Suzuki, K.,
Iwano, H. & Danbara, T. Petrology and radiogenic age
of accidental clasts of granitic mylonite from the Aso-4
pyroclastic flow deposit and their correlation to the Nioki
Granite. J. Geol. Soc. Japan, 113, 1-14, 11 figs., 4 tables

The Aso-4 pyroclastic flow brought about accidental clasts of
granitic mylonite in the Aso-4 pyroclastic deposit in northern area
of the caldera formed at about 90,000 years b.p. These granitic
mylonite clasts were investigated petrologically and geochemo-
logically, and compared with the Nioki Granite in the Asaji area to
the east of the volcano. The Aso-4 granitic clasts are character-
ized by garnet-muscovite bearing adamelite-granite, and all of
them are moderately to strongly mylonitized and show porphyro-
clastic texture. Their SiO2 content ranges 71-74 wt.%. The range
of garnet composition of the Aso-4 granitic clasts is Al3(Fe2-3.3,4-
Sp4.2-2.8 Pyr2-3.1, Grs1-0.3) TiO2. These mineral and chemical compositions are
quite similar to those of the Nioki Granite. The K-Ar muscovite
age for Aso-4 granitic clasts was 98±2.1 Ma, whereas Nioki Granite
was 98±2.1 Ma. The heat of magma of the volcano did not affect the K-Ar
age system for muscovite when the pyro-
clastic flow took place, because heating has not fundamentally
shortened the fission tracks within zircon grains in the dated clast.
Accordingly, the Aso-4 granitic mylonite clasts are correlative
with the Nioki Granite, which was also weakly to moderately my-
lonitized. The intrusive age of the Nioki Granite was also deter-
mined to be 106±4 Ma using CHIME monazite dating. This sug-
gest that subsurface ductile mylonite zone initiated around 100
Ma of the major fault extends from Asaji area to the Aso volcano.
This fault coincides with the Oita-Kumamoto Tectonic Line,
along which the active fault segment has been known. The occur-
rence of EW extending mylonite zone is also significant evidence
in considering the western extension of the Median Tectonic Line
in Kyusyu. (R. Miyawaki)

105040
Uchino, T., Kawamura, M., Gouzu, C. & Hyodo, H.
Phengite 40Ar/39Ar age of garnet-bearing pelitic schist
pebble obtained from conglomerate in the Nedaomo Terrane,

Conglomerate containing garnet-bearing pelitic schist pebble
was obtained from the Nedaomo Terrane, an Early Carboniferous
accretionary prism of northeast Japan. Phengite in the schist peb-
ble is dated at 347-317 Ma based on the 40Ar/39Ar spot-heating
method. The schist in the pebble can be correlated with the Renge
Metamorphic Rocks of southwest Japan, and the Yamagami
Metamorphic Rocks in the Kitakami-Akubuma massif. The age
data suggest that high-P T metamorphism which produced the
garnet-bearing pelitic schist may have been in progress within
Early Carboniferous (359-318 Ma) and the schists were rapidly
exhumed to provide pebbles, or that the conglomerate containing
the pebbles may belong to a post–Early Carboniferous accretionary
unit which is not identified yet. In case that the age has been all re-
juvenated by secondary effects, the schist pebble may have been
derived from pre-Late Devonian high-P T metamorphics as the
Matsugadaira Metamorphic Rocks, probably 380 Ma.

(Authors' abstract)

105041
Jargalan, S., Fujimaki, H. & Ohba, T. Petrologic charac-
teristics and Rb-Sr age dating of lamprophyre dikes of
Tsagaan Tsahir Uul gold deposit, Mongolia. J. Mineral.

Geological, mineralogical and geochemical studies were car-
ried out on the lamprophyre dike. Representative analyses for ma-
jor and trace elements in the lamprophyre and in the minerals in-
cluded such as pyroxene, amphibole, biotite and feldspar are
given. The dike consists of phenocryst olivine amphibole and
clinopyroxene in the groundmass consisting of plagioclase, K-
feldspar, biotite and amphibole. The amphiboles are mostly parga-
site and some are rich in Ti (including kaersutite component). The
compositions of the olivines range Fo40-2~ Fo65 and distinct composi-
tional variation between core and rim is not observed. Plagioclase
are andesine (An14Ab2Or1) or oligoclase (An14-
Ab18Or13) TiO2, FeO, MgO, CaO, and MnO decrease, while Al2O3
and K2O increase with increasing SiO2. Trace elements are charac-
terized by high LILE (Ba,Rb,Sr) Cr and Ni. From the data ob-
tained the authors concluded that the lamprophyre belonging to
the calc alkaline series intruded at 248,61±18.5Ma and that the
lamprophyre may have been an active continental collision event
during the late Paleozoic in the region of the Bayankhonogor
metallogenic belt. (K. Onuma)

105042
Orihashi, Y., Iwano, H., Hirata, T., Danbara, T. & Shinhoe, H. U-Pb ages and trace element compositions of
reddish, colorless, and detrital zircons in the Kumano
Acidic Rocks in the Outer Zone of southwest Japan and
origin of the host magma. J. Geol. Soc. Japan, 113, 366-

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U-Pb ages and trace element compositions were measured using LA-ICPMS technique for colorless and reddish zircons in the Kumano Acidic Rocks in the Outer Zone of southwest Japan. Sorted U-Pb ages for these zircons range from 15.5 to 16.7 Ma and ca. 1 m.y. older than fission track ages, implying slightly longer time elapsed between generation and cooling of the felsic melt. The RREE patterns for both colorless and reddish zircons have a steep increase in LREE contents from La to Lu with significant positive Ce and negative Eu anomalies. The slopes of HREE region are gentler for the reddish zircons than colorless zircons. The RREE composition of coexisting felsic melt estimated from the colorless zircons is similar to the bulk rock composition of the evolved host rocks. Whereas the melt composition estimated from the reddish zircons has an adakitic signature. Two different felsic melts are suggested for the origin of the Kumano Acidic Rocks. Large amounts of plagioclase fractionation from the parental magma are required due to deep Eu troughs in the host melts. The low population of reddish zircon indicates a smaller production rate of the adakitic melts. This compositional variation may reflect variable degree of partial melting of accretionary prism sediments that comprise the basement of the Kumano area. The partial melting of the sediments would have been triggered either by underplating of tholeiitic basalt magma derived from Shikoku basin or felsic magma derived from slab melting of the subducted plate, or melting directly of the subducted sediment. (R. Miyawaki)

Fission track dating was carried out for 52 samples from the Otaki Group of the Cretaceous Mifune Group in Kyushu, southwest Japan, based on fission track ages and morphological characteristics of zircon. J. Geol. Soc. Japan, 113, 326-339, 6 figs., 3 tables (in Japanese with English abstract), 2007.

Fission track dating was carried out for 18 tuff samples from the Pliocene strata in the Shinjo Basin, Yamagata Prefecture. Ages were determined with examination to eliminate erroneous data owing to contamination of reworked zircon crystals. They are 4.3, 3.7 and 3 Ma for the boundaries of the Nakawatari, Sakakawa, Yamuke and Motoaikai Formations, respectively. (R. Miyawaki)

Fission-track (FT) dating was carried out on zircon crystals from four vitric tuff beds in the Mifune Group, middle Kyushu. FT ages of 93.1±4.4Ma, 89.8±4.0Ma for the lower part of the Lower formation, 83.6±3.1Ma for the lower part of the Upper formation and 82.1±1.1Ma for the upper part of the Upper formation were obtained. These data suggest that the data for tuff deposits in age from Late Cenomanian to Early Campanian, though the upper age limit remains uncertain. The age of the vertebrate fauna from the middle part of the Upper formation is assigned to Coniacian to Campanian. This age is younger than previously estimated age obtained from palentological studies. The Mifune Group is possibly correlated with the Onogawa Group on the basis of the present FT ages. (Authors' abstract)

Fission track dating was carried out for 52 samples from the Muro Pyroclastic Flow Deposit, the Sekibutsu Tuff and the Furudera Tuff in the northern region of the Kii Peninsula, and from fine-grained granitic bodies of the Omine Granitic Rocks (the Dorogawa, Shirakura, Kose, Asahi, Tenguyama, and Shira-tani bodies) and various rock facies of the Kumano Acidic Rocks (the Konogi Rhyolite, the Owase Complex, and the Kozagawa Dike) in the central to southeastern region of the Kii Peninsula. The resulting ages of all these samples and previously reported ages of the Tamateyama Tuff, the Nakaokau Tuff and the Shionomisaki Igneous Complex in the peninsula were clustering at 15 Ma. Most of the above igneous bodies contain a mixture of reddish and colorless zircons. Characteristic of the mixed zircons from the Muro Pyroclastic Flow Deposit, Sekibutsu Tuff and the north and south units of the Kumano Granite Porphyry is similar in terms of a ratio of reddish and colorless zircons being 2:3 and dominant crystal planes {100} for reddish and {110} for colorless. Based on the similarity and similarity of the mixed zircons, it is strongly suggested that the Muro Pyroclastic Flow Deposit and the adjacent tuffs in the northern Kii Peninsula are correlated with each other as a large-scale pyroclastic flow deposit at 15 Ma, and that its possible source is the Kumano Acidic Rocks in the southeastern Kii Peninsula. (Authors' abstract)

Fission track dating was carried out for 478 samples from the Shionomisaki Igneous Complex in the peninsula were clustering at 15 Ma. Most of the above igneous bodies contain a mixture of reddish and colorless zircons. Characteristic of the mixed zircons from the Muro Pyroclastic Flow Deposit, Sekibutsu Tuff and the north and south units of the Kumano Granite Porphyry is similar in terms of a ratio of reddish and colorless zircons being 2:3 and dominant crystal planes {100} for reddish and {110} for colorless. Based on the similarity and similarity of the mixed zircons, it is strongly suggested that the Muro Pyroclastic Flow Deposit and the adjacent tuffs in the northern Kii Peninsula are correlated with each other as a large-scale pyroclastic flow deposit at 15 Ma, and that its possible source is the Kumano Acidic Rocks in the southeastern Kii Peninsula. (Authors' abstract)
Luminescence dating method, single-aliquot regenerative-dose (SAR) protocol was employed for Toya pyroclastic flows using Red thermoluminescence (Red TL) of quartz grains. Red TL intensities were corrected by test-dose monitoring for sensitivity changes due to repeated heating and X-ray irradiations. The corrected Red TL ages of Toya pyroclastic flows using SAR protocol were well agreed with age estimation deduced from geological correlation.

Authors' abstract


Parts of the basement Tertiary strata around the Mutsu-Hisuchida volcano and of pyroclastic deposits of the volcano itself were suffered from alteration by hydrothermal activities related to the volcanoism. The study was carried out to clarify a progress history of the alteration by using geological mapping, thermoluminescence (TL) dating, XRD, and IR reflection absorption analyses and fluid inclusion study. The alteration areas were divided into the smectite, kaolinite, alunite, and pyrophyllite zones. The TL ages suggest that the hydrothermal activity end at 70-90 ka. The occurrence of pyrophyllite also suggests that hydrothermal Ts were 200 to 250°C in this area, being supported by the homogenization T of fluid inclusion in calcite, 242°C av. (K. Onuma)

Rock-Forming Minerals and Petrology


Recent advances in petrologic studies on kelyphite and symplectite, the reaction textures in metamorphic rocks, are reviewed. Kelyphitization of garnet is a phase transformation phenomenon accompanied by a 'long-range' material transfer between garnet and olivine crystals. The microstructure of kelyphite is mostly constructed at the reaction front via 'short-range' material transfer along the garnet crystal surfaces and by the topotaxial crystal growth of pyroxenes and spinel. The 'law of normality' and the 'principle of constant volume' of the kelyphitization are proposed. Structural similarities among the kelyphites, symplectites, pearlite (of Fe-C alloy) and columnar joints, developed in basaltic lavas, are pointed out and discussed. In general discussions, I re-define ‘petrography’ as the science of rock texture and discuss in a more general context its relation to ‘tectonics’ in solid earth sciences.

Authors' abstract


Petrological studies were carried out on the peridotite xenolith in an alkali basalt dredged from the Takeshima seamount (tectonic setting, ca. 230 km to the north of Oki islands, with major chemical compositions of rock forming minerals in the peridotite such as olivine, spinel, orthopyroxene, and clinopyroxene and 14 trace elements, to clarify the petrological feature of the Japanese Sea mantle. The xenolith (spinel-bearing herzolite to harzburgite) is classified into two types (Type 1 and Type 2) in terms of REE patterns of clinopyroxene. The Type 1 (Cr2+ of spinel, 0.4-0.5) is similar to abyssal peridotite in terms of major element chemistry and middle- to heavy REE concentrations of clinopyroxene. The Type 2 has high REE clinopyroxene with flat to slightly LREE-enriched patterns, and is quite similar to subcontinental peridotite obtained as xenolith from China. The southern part of the Sea of Japan was formed by mainly thinning and rifting of the continental lithosphere. The Type 2 peridotite is a remnant of the continental lithosphere. Chemical characteristics of BAB basalt and the Type 1 peridotite indicates that open-system melting of peridotite affected by flux from the downwelling slab was involved in the Japan-Sea opening.

Authors' abstract


Studied were geological setting and petrological characteristics of the ophiolite complex consisting of harzburgite, dunite, websterite, clinopyroxenite and gabbrro with volcanic rocks. Highly altered harzburgite is dominant ultramafic rock. Representative analyses for major elements in harzburgite, dunite, websterite and gabbrro are given as well as the trace elements of whole rock analyses. On the basis of the mineral chemistries and REE patterns the author concludes that the ultramafic body of the ophiolite could be formed in the mantle below the plate collision zone and that the ophiolite complex originated near plate margin.

Authors' abstract


Seven samples (four metabasaltic rocks and three meta sheeted-dike samples) and two samples of later metadolerite dikes of the Poroshiri ophiolite were analysed by ICP-MS. Chondrite normalized REE values of the metabasaltic rocks exhibit N-MORB pattern. Multi-element spider diagram shows a N-MORB signature except for variable concentrations in LIL elements that are ascribed to secondary modification. These metabasaltic rocks plot in N-MORB fields in discrimination diagrams using immobile elements and are distinct from such as IAT, BAB and E-MORB. Later dolerite dikes, which intruded after considerable cooling of the ophiolite, have also N-MORB signatures. However, the later dikes are slightly depleted in HREE and enriched in LREE concentrations, suggesting more fertile source than the Poroshiri ophiolite. These geochemical signatures and wide compositional range of the metabasaltic rocks with evolved rocks (e.g., ~3 wt% in TiO2 and ~30 in FeO/MgO) suggest that the Poroshiri ophiolite was generated at fast-speding ridge. Zr/Y and Zr/TiO2 ratios from the EPR basalt tend to decrease with increasing spreading rates. The Zr/Y and Zr/TiO2 ratios of the metabasaltic rocks are as low as those from the ODP Hole 1256D basalts generated at the EPR with an ultra-fast spreading rate. Assuming that the mantle source of the ophiolite was similar to that of the East Pacific Rise (EPR), this fact suggests that the spreading ridge produced the Poroshiri ophiolite spread at an ultra-fast rate more than 20 cm/year.

Authors' abstract


Ashihakide is the youngest composite cone in the Taisetsu volcanic group, with activity range of 20 ka to 250 years ago (stage 1 to stage 3). Presented are the representative compositions of minerals such as plagioclase, orthopyroxene, clinopyroxene and magnetite as well as 9 whole rock chemical and modal compositions. Disequilibrium features of plagioclase indicate the coexistence of An rich type (type A) and An poor type (type B). The magma mixing process of three end member magmas are discussed and it is estimated that in the Ashihakide most of the end member magmas were expanded in the stage-1, and relatively high ratio of mafic magma was mixed with a small amount of B-magma in the stage 2.

Authors' abstract

Geochemical and mineralogical studies were carried out on the juvenile materials of the Takedake volcano, known as the Nakao pyroclastic flow deposits (NPED), with 10 whole–magnetite composition and modal analyses and also some mineral compositions such as orthopyroxene, amphibole, biotite, and olivine. The 2300 years B.P eruption consisting of lava extrusion and dome growth in the summit area, and repeated gavitation collapse of the dome produced a series of block– and ash flow (NPED). On the basis of geochemistry and mineralogy the author suggests that mixing and hybridization of a mafic magma and a highly crystallized silicic magma is very effective, although the initial large contrasts in composition and viscosity. The petrographic evidence shows a model having 2 stages of interaction: hybridization during the basaltic replenishment and syneruptive mingling in a volcanic conduit. (K. Onuma)


Two compositionally different types were observed in the Tochinoki lava flow. One is silicic (SiO2 = 63-66 wt%) and phenocryst–rich (8-16 vol%) and the other mafic (SiO2 = 60-62 wt%) and phenocryst–poor (<7 vol%). Given are the 32 whole rock analyses for major and some trace elements and compositions of clinopyroxene, orthopyroxene, plagioclase, and magnetite. Mass balance calculation and trace element modeling show that the compositional variation in Tochinoki lava flow is explained in terms of fractional crystallization of plagio-oclase, orthopyroxene and magnetite from the most mafic lava. Simultaneous ascend of compositionally distinct magma may produce the Tochinoki composite lava flow. (K. Onuma)


Petrological study was carried out on the Bure volcanic rocks occurring in the northeastern Ethiopian plate, with the geochemical and isotopic data. Major and minor element compositions are given for 23 samples and also 31 trace elements for 21 samples. The rocks are mainly composed of flood basalts (30-25 Ma), ranging from transitional tholeiite to alkali basalts. In the transitional tholeiite the incompatible elements and isotopic ratios are variable (86Sr/86Sr = 0.70320-0.70429, 143Nd/144Nd = 0.51281-0.51304 and 206Pb/204Pb = 18.36-19.08). The alkali basalts show a homogeneous incompatible and Sr-Nd isotopic ratios (86Sr/86Sr = 0.70311-0.70363 and 143Nd/144Nd = 0.51279-0.51288) with a wide range of Pb isotopes (206Pb/204Pb = 18.91-10.83). The authors conclude that isotope and trace element variations within the Bure lavas reflect the involvement of: 1) an intrinsic isotopically depleted plume component, 2) a plume component having radiogenic Pb, Pb isotope and 3) enriched crustal component, and that the first and third component played a significant role in the initial stage of plume–induced continental flood basalt magmatism. (K. Onuma)


Whole rock compositions of the major and trace element were newly obtained for Miocene felsic igneous rocks in the Kii Peninsula to discuss the regional variation in the whole rock composition. The felsic igneous rocks include I- and S-type granitic rocks in the Outer Zone and felsic member of the Setouchi Volcanic Rocks. Granitic rocks in the Outer Zone are characterized by relatively constant chondrite–normalized middle to heavy REE abundance, whereas the felsic rocks of the Setouchi Volcanic Rocks show strongly HREE–fractionated patterns. Distribution of S- and I-type felsic rocks forms trench parallel zones and runs SW–NE direction, which is almost parallel to those of the high–Mg andesites in the Outer Zone. This direction coincides with the strikes of the contour lines of Wadati – Benioff Zone beneath eastern Kii peninsula. S-type felsic rocks at the Outer Zone and rhyolitic rocks of the Setouchi Volcanic Rocks are peraluminous with high SiO2 and K2O contents, which are expected to be produced by melting of sedimentary rocks. REE abundances of sediment melt were modeled based on the melt fractions and residual mineralogy in the melting experiments. Differences in the REE compositions between these two rock types are explained by simply the difference of the melting depth where S-type felsic rocks were formed at shallower level with plagioclase–rich residue, and rhyolitic rocks of the Setouchi Volcanic Rocks at deeper level with garnet–rich residue. The REE abundance model of basaltic rocks suggests that source rock of the I-type granitic magma should be enriched in light REE. (R. Miyawaki)


Hatsuhe plutonic complex in the Ryoke metamorphic belt, central Kinki Province, SW Japan, is composed mainly of the Cretaceous gneissose biotite granodiorite and hornblende gabbros. The biotite granodiorite is a syn–kinematic pluton during the deformation forming upright folds and the hornblende gabbros are syn–plutonic dykes intruded subparallel to the gneissosity of the surrounding granodiorite. The trends of the gneissose structure in the granodiorite and of the lithological boundaries between the granodiorite and gabbros exhibit basin structure possibly divided into major E-W trending synform and minor N-S trending synform. The gneissose structure in the granodiorite is defined mainly by the alignment of the long–axis of the biotite clots. The microstructural analyses suggested that the gneissose structure was formed by the magmatic to submagmatic flow during the emplacement of the granodiorite magma. Emplacement depth of the granodiorite magma was estimated to be 450-600 MPa corresponding to crustal depth of about 20 km based on the amphibole chemistry. High-T plastic deformation conditions were observed for the c-axis fabric of quartz grains (X–maximum and type II crossed girdle patterns) in the granodiorite. The maximum elongation directions between the magmatic/submagmatic flow and the high-T plastic deformation structures are consistent with each other. The deformation lasted just after the solidification of the magmas relating to the emplacement of the granodiorite magma. The basin axis of the major E-W trending synform is parallel to the regional upright folds observed in the Ryoke metamorphic belt. The emplacement of the plutonic complex may be governed by the regional stress fields to form the upright folds in the Ryoke metamorphic belt. (R. Miyawaki)


A systematic study of fluid inclusion was carried out and three categories were identified to the inclusions: (1) primary aqueous inclusions in porphyroblastic garnet, (2) primary to pseudosecondary carbonic inclusions in quartz, and (3) secondary aqueous inclusions in quartz. The inclusions (1) exhibit melting and homogenization T of 2.5 to 0.3°C and 162.2 to 360.0°C, respectively. The inclusions (2) shows melting T of ~64.2 to ~56.6°C, indicating a CO2–rich composition with minor amount of CH4 and/or N2. The inclusions (3) were divided into high–density (1.121–1.153 g/cm3) and medium density (0.683–1.111 g/cm3)
types. The latter fluid density indicated that CO₂ was entrapped at the peak of P, T conditions of the studied area (2.8 – 5.2 kbar at 770 – 850°C). The isochores are consistent with prograde high P condition of the Abukuma metamorphic rocks in some district (Takanuki) (8-10 kbar at 700-750°C). Isochores calculated for the inclusions (2) in granitic gneiss indicate the P-T path at 2-3 kbar at 650°C, suggesting that the fluids were trapped during the retrograde stage. It is inferred that H₂O was the dominant fluid species during the prograde stage of Abukuma metamorphic belt. The prograde H₂O-bearing fluid was probably derived from the break down of hydrous minerals. The presence of CO₂-rich fluid during peak metamorphism probably lowered the H₂O activity. The isochores calculated from the (3) inclusions give low P-T conditions (300°C and 1.7 – 3.5 kbar), that suggest retrograde origin of the fluid.

(2.3 kbar, 740 °C). The metamorphic facies phases. Therefore, P-T estimations of the eclogite facies stage in the Sanbagawa metamorphic belt should be re-examined carefully on the basis of textural and compositional heterogeneities of constituent minerals. (Authors' abstract)


Kyanite-bearing eclogite assemblages occur in the highest-grade zone of the Sanbagawa metamorphic belt, central Shikoku, Japan. The eclogites consist mainly of garnet, omphacite, phengite, kyanite, epidote, quartz and rutile. Compositionally variable amphibole (glauconaphene/barroisite/pargasite), phengite and paragonite occur as inclusions in garnet and other eclogite facies phases. Careful examination of garnet zoning in kyanite-eclogites suggests that (i) most garnet grains show complex zoning consisting of relatively Ca-rich/Mg-poor inner and Ca-poor/Mg-rich outer segments, (ii) the inner segment of the zoned garnet formed at the eclogite facies stage, and (iii) the Mg-rich outermost rim of garnet does not always represent a composition at peak eclogite stage but could form at lower pressure conditions of subsequent epidote-amphibolite facies. The assemblage of inner segment of garnet, omphacite, phengite, kyanite and quartz points to equilibrium conditions of 2.3–2.4 GPa/675–740 °C. The metamorphic P-T conditions of the eclogite facies stage reported in literature have been estimated assuming that the outermost rim of garnet with Mg-rich composition was in equilbrium with other eclogite facies phases. Therefore, P-T estimations of the eclogite facies stage in the Sanbagawa metamorphic belt should be re-examined carefully on the basis of textural and compositional heterogeneities of constituent minerals. (Authors' abstract)


Vitrinite reflectance was systematically measured on coalified phytoclasts in pelitic rock from metamorphosed to weakly metamorphosed accretionary complexes, the Sanbagawa Metamorphic belt. The source of granulite facies metamorphosed accretionary complexes in the Sanbagawa and Northern Chichibu belts, eastern Shikoku. Apparent maximum and minimum of reflectance were measured on polished particular specimens. The vitrinite is optically biaxial. The approximated maximum reflectance value increases toward the lower structural level in the Northern Chichibu Belt, although, it shows no systematic variation in the Sanbagawa Belt. The average of maximum reflectance values from the Northern Chichibu Belt (5.21%) is higher than that from the Sanbagawa Belt (4.79%). The flattening for maximum and minimum of reflectance ([(maximum - minimum) / maximum]) increases generally to the north, that is, to the lower structural level. This would imply an increase of burial depth or depth of accretion. (R. Miyawaki)


D detrital garnet provenance analysis was carried out on sandstones of the Cretaceous Yukawa Formation in the Shimanto belt of central Kii Peninsula, Southwest Japan. The Yukawa Formation is an upper continental slope deposit of late Albian to Turonian age. The sandstones of the Yukawa Formation in central Kii Peninsula are feldspathic-lithic sandstones. Spessartine-almandine garnets containing some pyrope and grossular contents and originating from low to intermediate grade metamorphic rocks and felsic igneous rocks are the main components of the Yukawa assemblage in the study area. Pyrope-rich almandine garnet derived from granulite-facies metamorphic rocks originating from psammitic or pelitic rocks also occur, along with granulite garnet derived from metamorphosed calcareous rocks, and minor amounts of high P/T garnet sourced from mafic gneiss and garnet-amphibolite. The source area for garnets derived from granitoids and low to intermediate grade metamorphic rocks, thermally metamorphosed noncalcareous and calcareous rocks is considered to be the Higo belt that may be a constituent of the Paleo-Ryoke belt. The source of granulite-facies metamorphic garnets was probably Precambrian continental basement in East Asia, possibly the Korean Peninsula or North China. Eclogite-origin and high P/T garnets may have been derived from the Kurosegawa belt. The presence or absence of eclogite-origin garnets, appearance and disappearance of granulite garnets and their different concentrations in coeval deposits indicate the detritus supplied to the Yukawa depocenter was heterogeneous, due to varying proportions of lithotypes in the individual source regions. (Authors' abstract)


XRD, SEM and petrographic studies were carried out for slaty cleavage and chlorite-mica stacks in the Tertiary Taisyu Group, Tushima Island, northwest of Kyushu. The intensity of cleavage development is classified into 3 classes; 0, I and II. In the 0-class, cleavage can not be observed. The I-class is characterized by non-penetrative cleavage domains and pencil structure, and the II-class by penetrative cleavage domains. Chlorite-mica stacks have generally tabular form with a long axis nearly parallel to bedding plane in the 0-class and show deformatinal features such as folding and kinking especially in the II-class. The thickness of the stacks increases from the 0- to II-class; 9.4, 12.7 and 21.5 μm in the 0-, I-, and II-classes, respectively. These data indicate that the shape change of the stacks accomplished by the chlorite and mica intergrowth during strain-controlled deformation and formation of slaty cleavage. Illite crystallinity values obtained were 0.39–0.43, 0.36–0.40 and 0.35–0.40 for the typical samples of 0-, I- and II-classes, respectively. The relatively higher geothermal gradient was suggested at the formation of slaty cleavage after considering about the extensional setting of the Japan Sea, 7 of lower anchozone and thickness of the Taisyu Group. (R. Miyawaki)