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BASEMENT ROCKS OF THE JAPANESE ISLANDS: INFERENCE FROM CHROMIUM IN THE SEDIMENTARY ROCKS

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Abstract The trace element chromium in clastic sedimentary rocks was used as an indicator of the ratio of basaltic to granitic rocks in their provenance. The Cr abundance in the upper continental crust is estimated to be about 40 ppm. The Cr content of abyssal basalt clusters around 300 ppm. Early Precambrian sediments are enriched in Cr compared with later ones. The continental sialic crust may have developed from the oceanic simatic crust with time. The Izu-Mariana island arc built on thin oceanic crust has a Cr abundance intermediate between the continent and the oceanic region. The unmetamorphosed Paleozoic, Mesozoic and Tertiary sedimentary rocks from the Japanese Islands all have relatively low Cr contents similar to the Cr abundance in the upper continental crust, suggesting that they were derived from the dominant granite terrain. On the one hand, pelitic and psammitic rocks from the main metamorphic terrains such as Hida, Ryoke, Sanbagawa and Sangun show low Cr contents equivalent to the unmetamorphosed sedimentary rocks in Japan; especially biotite gneisses in the Hida metamorphic rocks are remarkably low in Cr. On the other hand, rocks from the Hidaka zone, metamorphic rocks in the Kitakami and Abukuma Mountains, the Terano, the Renge and the Komori metamorphic rocks, most of which are associated with abundant mafic and ultramafic rocks, have high Cr contents different from the Japanese sedimentary rocks; some of them may have originated from oceanic island arc.

Introduction

Chromium is most sensitive to magmatic fractionation and incorporated most effectively in early formed minerals with octahedral site such as spinel and pyroxene, because it has the largest octahedral site preference energy of trivalent ions (BURNS, 1970). The abundance of Cr in igneous rocks shows a wide variation ranging from 2000-3000 ppm Cr in ultramafic rocks to less than 10 ppm Cr in felsic rocks (SHIRAKI, 1978).

On the other hand, during weathering and transport Cr is relatively enriched in the detrital Al- and Fe-rich clay fractions and depleted in sandstones rich in quartz and feldspar grains, but there are no sedimentary rocks accumulating Cr to a great extent. Therefore, the ratio of mafic (and ultramafic) to felsic rocks in the source area is most important in controlling the Cr content in sedimentary rocks (SHIRAKI, 1966). Chromite in the heavy mineral fractions has often been used as an indicator of the presence of ultramafic rocks in provenance (*e.g.*, IIJIMA, 1964a, b). The use of bulk Cr content has the advantage of offering information on metamorphosed rocks in which detrital minerals have been recrystallized completely.

The purpose of this paper is to briefly review the crustal abundance of Cr, to present Cr data in the older, mainly metamorphosed sedimentary rocks from the Japanese Islands and to discuss the nature of the basement rocks of the Japanese Islands based on the Cr data. Many of the data have been given in the previous papers and briefly discussed (SHIRAKI, 1966; 1981). I have here more detailed discussions on each of the metamorphic terrains, but existing data are too insufficient for full discussions and the conclusions cannot be considered absolute.

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Crustal abundance of chromium

Table 1 summarizes Cr abundances in various geological units.

POLDERVAART (1955) estimated the upper continental crust to consist approximately of 4 parts quartzofeldspathic gneiss (granite) and 1 part amphibolite (basalt). From this figure the Cr abundance in the upper continental crust is calculated to be 37 ppm, assuming that the average Cr values for granite and basalt are 4 ppm (CARR & TUREKIAN, 1962) and 170 ppm (PRINZ, 1967), respectively. This value is in good agreement with Cr abundance data of the Canadian Precambrian shield (SHAW *et al.*, 1976; EADE & FAHRIG, 1973), the Precambrian crystalline basement rocks of Northwest Scotland (BOWES, 1972; TARNEY *et al.*, 1972) and soils of the United States (SHACKLETTE *et al.*, 1971). The Cr abundance of the upper continental crust may be estimated to be about 40 ppm.

Abyssal basalt shows exceptionally a uniform Cr distribution clustered to 300 ppm (SHIRAKI, 1978), although primary melt of the abyssal basalt in equilibrium with mantle peridotite appears to have 600 ppm Cr (BOUGAULT, 1977). The value, 300 ppm, is considered to represent the Cr abundance of the oceanic crust.

The Cr abundance, 40 ppm, in the upper continental crust is similar to that of the Recent shallow water sediments, but sligthly lower than the pelagic clay sediments (Table 1). A higher proportion of basaltic components in the pelagic sediments would cause a higher level than the average of the weathered continental crust (SHIRAKI, 1978).

Early Precambrian or Archean sediments are enriched in Cr compared with later ones, as shown in Table 1. This may reflect a higher

Table 1. Chromium abundances in common igneous rock types, continental crust, common sedimentary rock types and Early Precambrian sediments.

Geological unit	ppm Cr	Reference
Ultramafic rocks	2600	SHIRAKI (1978)
Abyssal basalts	300	SHIRAKI (1978)
Average basalt	170	PRINZ (1967)
Average granite	4	CARR & TUREKIAN (1962)
Canadian Precambrian shield	35	SHAW *et al.* (1976)
Canadian Precambrian shield	59	EADE & FAHRIG (1973)
Upper continental crust (NW Scotland)	30	BOWES (1972)
Soils (U.S.A.)	37	SHACKLETTE *et al.* (1971)
Average shale	80	SHIRAKI (1978)
Average sandstone	30	SHIRAKI (1978)
Pelagic clay sediments	80	SHIRAKI (1978)
Recent shallow water clays	60	SHIRAKI (1978)
Recent shallow water sands	26	SHIRAKI (1978)
Akilia metasediments (W Greenland)	285	MCGREGOR & MASON (1977)
Yellowknife metasediments (NW Canada)	155	JENNER *et al.* (1981)
Archean shales (Canada)	133	CAMERON & GARRELS (1980)
Fig Tree shales (S Africa)	860	DANCHIN (1967)
Dharwar metasediments (India)	268	NAQVI & HUSSAIN (1972)
Kambalda metasediments (W Australia)	133	BAVINTON & TAYLOR (1980)
Metapelites, Napier Complex (Antarctica)	431	SHERATON (1980)

proportion of mafic and ultramafic components in those early times and suggest that the continental sialic crust has developed from the oceanic simatic crust with time (*e.g.*, GLIKSON, 1972; CONDIE, 1980).

Chromium abundance in the Izu-Mariana arc

Chromium contents in the Izu-Mariana arc rocks were investigated to elucidate Cr abundance in the transitional area from oceanic to continental structure. The Izu-Mariana island arc, which forms the eastern boundary of the Philippine Sea, seems to have been built on thin oceanic crust far from continents. The oldest rocks in the Izu-Mariana arc are considered a metamorphosed mafic to ultramafic complex now exposed on the Yap Islands. It resembles the deep ocean-floor rocks in composition, on which volcanic rocks with island-arc tholeiitic and calc-alkalic affinities were erupted (SHIRAKI, 1971; HAWKINS & BATIZA, 1977). The outer or frontal arc, which emerges above sea level at Guam and Saipan in the southern Marianas and in the Bonins, comprises the dominant basalts and andesites with subordinate dacites and rhyolites of Eocene to early Miocene age (SHIRAKI *et al.*, 1978). To the west lies a chain of presently active volcanic islands which erupted lavas ranging in composition from basaltic to andesitic.

Histograms of the Cr contents in rocks from the Izu-Mariana arc: Yap, Guam, Haha-jima, Chichi-jima and presently active volcanic islands are shown in Fig. 1 and Cr contents in their sedimentary rocks are given in Table 2.

The gross average of the Yap rocks is 700 ppm Cr. The Yap rocks are enriched in Cr, compared with the average of abyssal basalt. The Yap basement metamorphics may have been derived largely from an olivine- and pyroxene-enriched picritic basalt. The overlying Miocene Map formation and Tomil volcanics include fragments of silicic to intermediate igneous rocks. However, the very high Cr contents in the Map formation sediments indicate negligible contributions of silicic to intermediate components. The sandy mudstone of the Map formation is predominantly composed of grains of amphiboles with a minor amount of feldspar and quartz.

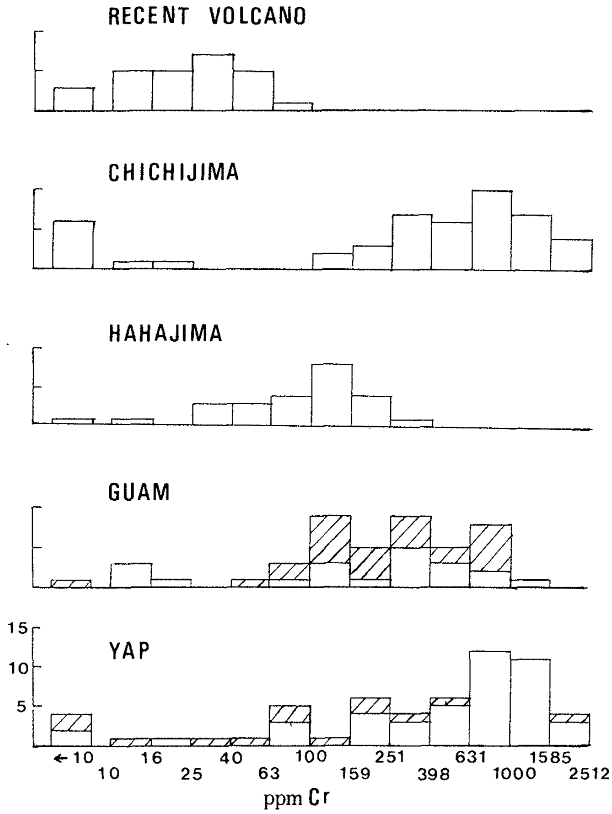

Fig. 1. Histogram of Cr contents of rocks from some islands in the Izu-Mariana arc. Hatched areas represent dredged samples (HAWKINS & BATIZA, 1977; DIETRICH *et al.*, 1978; BECCALUVA *et al.*, 1980). Data of Recent volcanic rocks are from IWASAKI *et al.* (1959), SHIRAKI (1966), DIXON & BATIZA (1979) & STERN (1979). Others are from SHIRAKI (unpublished) and NESBITT *et al.* (unpublished).

The volcanic rocks of Guam consist mainly of basalts and andesites belonging to both of the island-arc tholeiitic and the calc-alkalic series. The average of the Guam rocks is 290 ppm Cr, which suggests the preponderance of basalts over andesites.

Haha-jima is made up of lava flows, pyroclastic rocks and volcaniclastic sediments intercalating some fossiliferous beds containing middle Eocene foraminifera (UJIIE & MATSUMARU, 1977). In Fig. 2 is shown the distribution of Cr contents in the Haha-jima rocks. The average Cr value for all Haha-jima rocks is 110 ppm, reflect-

Table 2. Chromium contents in the Izu-Mariana sediments.

Rocks	ppm Cr
YAP	
Map formation, sandy mudstone	400
Map formation, sandy mudstone	443
Map formation, sandy mudstone	614
Map formation, mudstone	951
GUAM	
Alutom formation, mudstone	374
Umatac formation, mudstone	13.2
Umatac formation, tuff breccia	882
CHICHI–JIMA	
Tuffaceous mudstone, Mikazuki–yama	315
Mudstone, Miyano–hama	253
Tuffaceous mudstone, Ko–minato	248
Tuff breccia, Tatsumi–wan	538
HAHA–JIMA	
Mudstone, Iguma–wan	134
Mudstone, Coconut Beach	107
Calcareous mudstone, Oki–mura	10.8

ing the predominance of andesites.

Chichi-jima is composed of a sequence of lower boninite pillow lavas and upper andesite-dacite breccias. The thickness of the andesite-dacite breccias is thin, mostly less than 200m, while that of the boninite pillow lavas is more than 300m. Boninite shows exceptionally high Cr contents despite its high SiO_2. The Cr abundance in Chichi-jima is estimated to be 490 ppm and the high Cr contents in the Chichi-jima sediments suggest a high proportion of boninite.

Rocks from the presently active volcanic islands have generally low Cr contents; the average is 30 ppm Cr, which is close to the average values of island arc basalts and andesites given by JAKES & WHITE (1972). The Quaternary basalts and andesites of the Izu-Mariana arc seem to be differentiated relative to the Tertiary basalts and andesites.

In summary, the Izu-Mariana island arc has a Cr abundance intermediate between the continent and the oceanic region, and its sedimentary rocks show Cr contents proportional to the Cr abundances of respective islands.

Chromium contents in Japanese sedimentary rocks

Previously SHIRAKI (1966) has shown that the unmetamorphosed Paleozoic*, Mesozoic and Tertiary sedimentary rocks from the Japanese Islands have almost the same average Cr values of 43.5 ppm, 44.5 ppm and 43.9 ppm, respectively. The values are close to the average Cr content of 44 ppm in the Recent Japanese and Korean coastal muds given by UEDA (1957) and the Cr abundance of 40 ppm in the upper continental crust. This may suggest that the ratio of basalt to granite (*sensu lato*) in the source area from which they were derived is the same as that of the present Japanese Islands and granitic rocks predominate. The dominance of granitic rocks in the provenance of the Japanese Paleozoic geosynclinal sediments has also been demonstrated from the studies of the constituents of conglomerates (*e. g.,* KANO, 1975; TOKUOKA & OKAMI, 1979) and of the composition of clastic plagioclase

* Rocks designated as Paleozoic by SHIRAKI (1966) may include early Mesozoic rocks as evidenced recently by Conodonts.

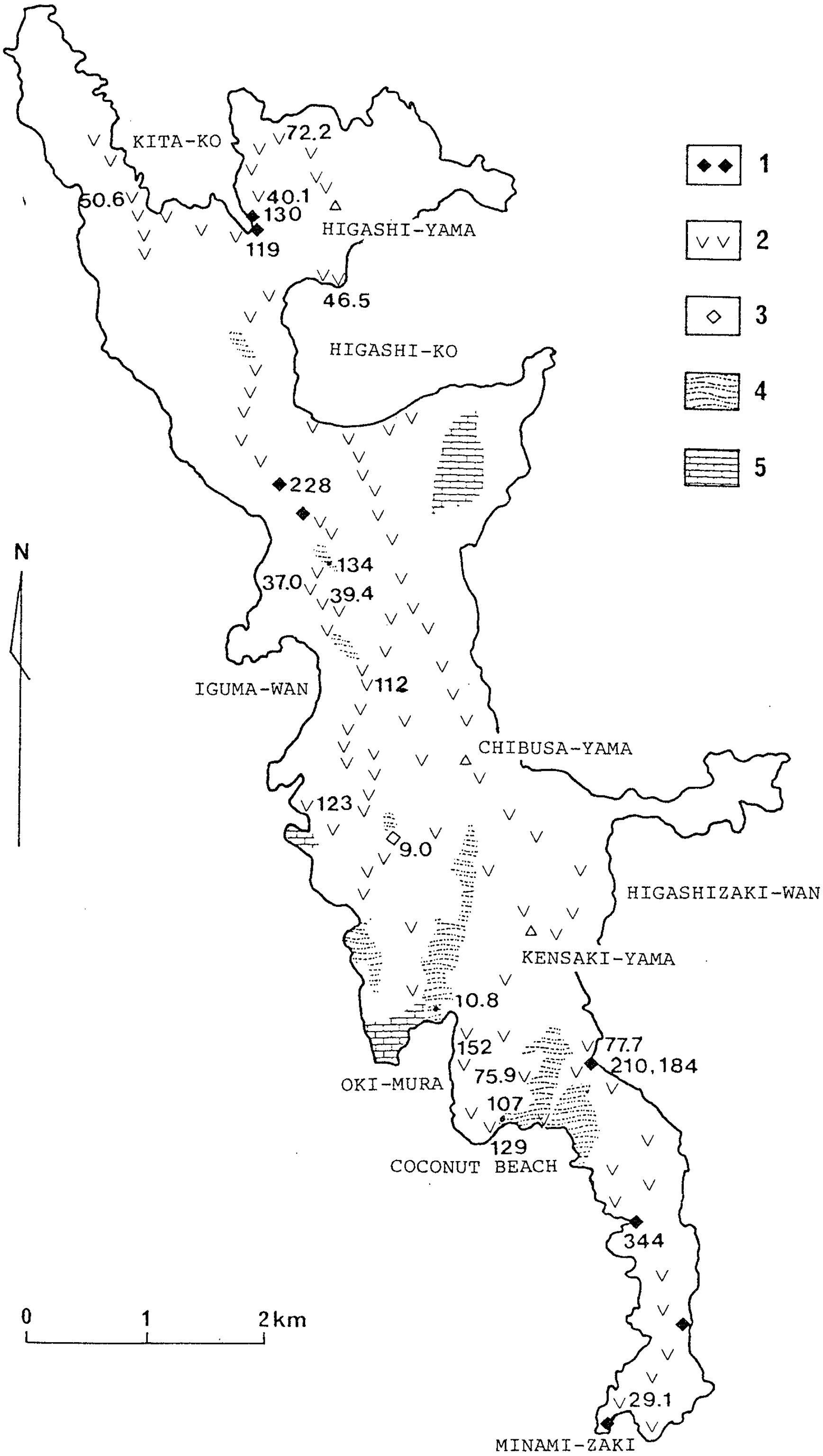

Fig. 2. Distribution of rock types and Cr contents in Haha-jima, Bonin Islands. 1. Basalt. 2. Andesite. 3. Dacite. 4. Shale and sandstone. 5. Limestone.
Numbers indicate ppm Cr.

Table 3. Chromium contents in metamorphosed sedimentary rocks in Japan.

No.	Rock	Locality	Bulk rock ppm Cr	Biotite ppm Cr	Garnet ppm Cr
	HIDAKA METAMORPHIC ROCKS				
212	Sandy shale	Shirataki, Shirataki-mura	104		
219	Sandy shale	Erimo, Erimo-cho	136		
213	Garnet-biotite hornfels	Ikutora, Mmamifurano-mura	55.9		
N1	Massive hornfels	Saruru, Erimo-cho	110		
216	Massive hornfels	Saruru, Erimo-cho	60.3		
218	Schistose biotite hornfels	Chipira, Erimo-cho	67.9		
N2	Biotite gneiss	Chipira, Erimo-cho	82.8		
217	Biotite gneiss	Saruru, Erimo-cho	143	410	
N3	Biotite gneiss	Saruru, Erimo-cho	77.8		
214	Plagioclase porphyroblast-biotite gneiss	Horoman, Samani-cho	81.5		
215	Garnet-biotite gneiss	Horoman, Samani-cho	46.6	209	71.8
137	Cordierite migmatite	Saruru, Erimo-cho	83.9	307	
N4	Cordierite migmatite	Saruru, Erimo-cho	40.2	194	
N5	Cordierite migmatite	Saruru, Erimo-cho	49.1		
146	Granitic migmatite	Saruru, Erimo-cho	29.4	224	
N6	Granitic migmatite	Saruru, Erimo-cho	23.6		
N7	Granitic migmatite	Chipira, Erimo-cho	23.5		
	HIDA METAMORPHIC ROCKS				
197	Biotite gneiss (mafic part)	Tsunogawa, Kawai-mura	4.4	21.4	
198	Biotite gneiss (felsic part)	Tsunogawa, Kawai-mura	5.5	43.1	
N8	Biotite gneiss	Babadani, Unazuki-cho	5.4		
156	Granitic gneiss	Funatsu, Kamioka-cho	0.9		
157	Augen gneiss	Funatsu, Kamioka-cho	1.7		
31	Amphibolite	Raichozawa, Tate-yama	1.8		
199	Biotite gneiss	Araki, Saigo-cho, Oki	29.6		
200	Garnet-biotite gneiss	Araki, Saigo-cho, Oki	12.6	215	72.1
	RYOKE METAMORPHIC ROCKS				
202	Biotite schist (xenolith in granite)	Ichinose, Iida-shi	95.9		
203	Biotite gneiss	Taguchi, Shidara-cho	38.6	171	
204	Garnet-muscovite-sillimanite-biotite gneiss	Hongu-san, Nukada-cho	34.2	148	32.2
205	Garnet-biotite gneiss (xenolith in dacite)	Nijo-san, Taishi-cho	66.4	221	83.7
N9	Biotite gneiss	Obatake, Obatake-cho	49.6		
211	Muscovite-biotite schist	Kamiage, Kosa-cho	52.5		
	SANBAGAWA METAMORPHIC ROCKS				
206	Stilpnomelane-chlorite schist	Sadamine, Chichibu-shi	90.9		
207	Graphite-sericite phyllite	Sugashima, Toba-shi	53.3		
208	Psammitic phyllite	Takihara, Omiya-cho	49.3		
209	Graphite-sericite schist	Iwato, Yamashiro-cho	39.5		
210	Psammitic schist	Oboke, Yamashiro-cho	9.9		
	SANGUN METAMORPHIC ROCKS				
201	Graphite-sericite phyllite	Kawayama, Mikawa-cho	29.1		
	TERANO METAMORPHIC ROCKS				
187	Garnet-muscovite-biotite schist	Nishikata, Anan-shi	92.4		
N10	Muscovite-biotite schist	Nishikata, Anan-shi	89.3		
N11	Muscovite-biotite schist	Nishikata, Anan-shi	45.9		
188	Biotite-muscovite schist	Suberidani, Katsuura-cho	62.1		
N12	Muscovite-biotite schist	Sawadani, Kizawa-mura	85.1		
N13	Muscovite-biotite schist	Sawadani, Kizawa-mura	84.9		
N14	Muscovite-biotite schist	Sawadani, Kizawa-mura	42.5		
N15	Muscovite-biotite schist	Sawadani, Kizawa-mura	36.3		
189	Muscovite-biotite gneiss	Sakamoto, Sakamoto-mura	27.2		
	UNOKI METAMORPHIC ROCKS				
182	Biotite gneiss (xenolith in serpentinite)	Shoboji, Mizusawa-shi	279		
183	Muscovite-biotite gneiss	Motai, Maesawa-cho	111		
	MOTAI METAMORPHIC ROCKS				
190	Chlorite phyllite	Yamauchi, Mizusawa-shi	144		

	TSUBONOSAWA METAMORPHIC ROCKS				
185	Biotite gneiss (mafic part)	Tsubonosawa, Rikuzentakada-shi	97.3		
184	Biotite gneiss (felsic part)	Tsubonosawa, Rikuzentakada-shi	70.5	405	
	NON-METAMORPHIC ROCKS IN KITAKAMI MOUNTAINS				
223	Kawauchi formation shale (Silurian)	Higuchizawa, Ofunato-shi	32.3		
224	Kawauchi formation tuffaceous shale (Silurian)	Higuchizawa, Ofunato-shi	18.1		
225	Oono formation shale (Devonian)	Higuchizawa, Ofunato-shi	82.5		
226	Oono formation sandstone (Devonian)	Higuchizawa, Ofunato-shi	46.9		
227	Tobigamori formation shale (Devonian)	Iwai, Higashiyama-cho	47.5		
228	Sakamotozawa group sandy shale (Permian)	Shishiori, Kesennuma-shi	35.8		
229	Sakamotozawa group tuffaceous shale (Permian)	Shishiori, Kesennuma-shi	14.7		
	MATSUGADAIRA METAMORPHIC ROCKS				
191	Phyllite	Tateishi, Kashima-cho	78.5		
	GOSAISHO METAMORPHIC ROCKS				
195	Biotite phyllite	Negishi, Iwaki-shi	472		
194	Muscovite-biotite schist	Kaiya, Iwaki-shi	105	244	
193	Biotite schist	Usuki, Furudono-cho	86.1		
	TAKANUKI METAMORPHIC ROCKS				
192	Garnet-biotite gneiss	Kamada, Furudono-cho	16.0	363	127
	RENGE METAMORPHIC ROCKS				
196	Muscovite schist	Shiroumajiri, Hakuba-mura	80.1		
	KOMORI METAMORPHIC ROCKS				
186	Hornblende-biotite gneiss	Komori, Ooe-cho	96.1		

Numbers correspond to those of Tables 3 and 7 in SHIRAKI (1966).
N indicates new analyses.

feldspar (MIZUTANI, 1959).

For the metamorphosed sedimentary rocks, however, SHIRAKI (1966) has obtained a high average Cr value of 81.0 ppm. Because during progressive metamorphism Cr content remains unchanged or rather decreases up to amphibolite facies (SHIRAKI, 1978), the high Cr content in the metamorphic rocks is attributed to the higher proportions of components derived from mafic or ultramafic rocks.

The Cr contents in each of the metamorphic terrains are presented in Table 3 and discussed in more details.

Hidaka metamorphic rocks The Hidaka metamorphic belt is distributed in the southern part of the axial zone of Hokkaido. The central part of this metamorphic belt is occupied by migmatites which are always surrounded by gneisses grading into hornfelses at the outer part and then to unmetamorphosed sedimentary rocks, Hidaka group. Most of the migmatites contain cordierite as a subordinate mineral and are described as cordierite migmatites. Within the cordierite migmatite occur coarser-grained and more homogeneous rocks without cordierite, described as granitic migmatites (FUNAHASHI *et al.,* 1956).

The Cr contents in the migmatites together with the metamorphosed and unmetamorphosed rocks were investigated to elucidate the behavior of Cr during granitization and metamorphism. The granitic migmatite, which is more leucocratic, is lower in Cr content than the cordierite migmatite, but the biotite from the granitic migmatite shows almost the same Cr concentration as that from the cordierite migmatite and metamorphosed rocks. The decrease of Cr content in the granitic migmatite seems to be due to the introduction of felsic components. There is no systematic change in Cr content from the unmetamorphosed rocks to the cordierite migmatite.

The average Cr content of 11 rocks from the Hidaka group including the metamorphosed rocks is 87.8 ppm. This value is considerably higher than the average of the Japanese sedimentary rocks. The Hidaka group, constituting the basement of the axial zone of Hokkaido, may contain a considerable amount of mafic and ultramafic components.

Hida metamorphic rocks The Hida metamorphic rocks, considered the basement on which the Paleozoic sedimentary rocks in the Inner Zone of Southwest Japan were deposited, show generally low Cr contents. Especially biotite gneisses from the Hida terrain proper, Nos. 197, 198 and N8, have very low Cr values of 4.4-5.5 ppm. This is one of the lowest Cr values in the clastic sedimentary rocks analysed. The lowest Cr value in the unmetamorphosed sedimentary rocks was 4.4 ppm in an arkose sandstone from the Tomizawa formation of the Jurassic Somanakamura group in the Abukuma Mountains (SHIRAKI, 1966), which includes clasts of orthoquartzite, granite and dacite (OKAMI *et al.*, 1976).

The very low Cr contents and small amounts of mafic minerals in two gneiss samples Nos. 156 and 157 indicate that the gneisses are of granitic origin.

Because the biotites from biotite gneisses (Nos. 197 and 198) and amphibolite or metagabbro (No. 31) in the Hida terrain proper show very low Cr contents, Cr in the Hida metamorphic rocks may have been decreased by some metasomatic processes, although no Cr decrease is recognized in the Hidaka and Ryoke metamorphic rocks. AOKI (1964) also found that a biotite gneiss and two amphibolites from the Ioridani-Otani area have very low Cr contents of 7 ppm and 3-10 ppm, respectively.

Unless Cr in the Hida metamorphic rocks was decreased by metasomatism, it is possible to say that the Hida metamorphic rocks have been derived from a terrain exceptionally rich in granite.

Ryoke metamorphic rocks The average of 6 biotite schists and gneisses from the Ryoke metamorphic rocks is 56.7 ppm and that of 4 samples excluding 2 xenoliths in the granite and volcanic rock is 43.7 ppm, which is very close to the average of the unmetamorphosed Paleozoic rocks. The relatively low Cr contents of the Ryoke metamorphic rocks are in harmony with the view that Ryoke rocks represent the Upper Paleozoic to Lower Mesozoic rocks that have suffered regional metamorphism belonging to the low pressure facies series.

Sanbagawa metamorphic rocks The Sanbagawa metamorphic rocks, which are considered the Upper Paleozoic to Mesozoic rocks affected by high pressure metamorphism, also show a similar Cr value to the unmetamorphosed rocks; the average of 6 samples is 48.6 ppm Cr. A high Cr value of 90.9 ppm in stilpnomelane-chlorite schist (No. 206) suggests that it is mixed with basaltic components. Sandstone schist (No. 210), collected near the conglomerate schist containing a large amount of pebbles of felsic igneous rocks (KOJIMA & MITSUNO, 1966), is rich in quartz grains and has a very low Cr content of 9.9 ppm.

Sangun metamorphic rocks Only one analysis of the Sangun metamorphic rocks reveals a relatively low Cr value of 29.1 ppm, similar to the values of the Paleozoic sandstones.

Terano metamorphic rocks The Terano metamorphic rocks occur in the Kurosegawa tectonic zone in the Outer Zone of Southwest Japan, accompanying serpentinites together with Silurian volcanic and sedimentary rocks and 400 Ma granites (ICHIKAWA *et al.*, 1956; YAMASHITA, 1979; MARUYAMA, 1981). The average of 9 samples is 62.9 ppm Cr. The value is slightly higher than the average of the Japanese sedimentary rocks, but considerably lower than the Cr values in the Izu-Mariana sediments. The detritus of the Terano metamorphic rocks may have been derived mainly from well-developed island arc or continent, but mixed with basaltic components to some extent.

Metamorphic rocks in the Kitakami Mountains Metamorphic complexes called the Unoki, Motai and Tsubonosawa metamorphic rocks underlie the unmetamorphosed Upper Paleozoic rocks in the Kitakami Mountains of Northeast Japan. All these metamorphic rocks have high Cr contents relative to the unmetamorphosed Paleozoic rocks in the same region, although shale No. 225 and sandstone No. 226 from the Devonian Oono formation, which are rich in andesite fragments, show somewhat high Cr contents. Because both the Unoki and the Motai metamorphic rocks are closely associated with mafic and ultramafic rocks (KANISAWA, 1964; MAEKAWA, 1981), they may have originated from island arc developed on oceanic crust.

Metamorphic rocks in the Abukuma Mountains Phyllite No. 191 from the Matsugadaira metamorphic rocks, which are correlated to the Motai metamorphics in the Kitakami Mountains, has a relatively high Cr content of 78.5 ppm. The Gosaisho metamorphic rocks considered to belong to low pressure facies series similar to the Ryoke metamorphics, are very rich in Cr; especially 472 ppm Cr of biotite phyllite No. 195 was the highest value in the sedimentary rocks analysed by SHIRAKI (1966). The Gosaisho metamorphic rocks seem to contain abundant mafic components. MIYASHIRO & HARAMURA (1962) also found high Mg and Fe contents in the pelitic rocks of this metamorphic suite.

However, garnet-biotite gneiss No. 192 from the Takanuki metamorphic rocks, regarded by some authors to represent the higher grade part of the Gosaisho metamorphic rocks, has a very low Cr content of 16.0 ppm. This may be attributed to a high proportion of quartz and feldspar grains, because the biotite and the garnet separated from the gneiss are rather high in Cr.

Renge metamorphic rocks A muscovite schist from the Renge metamorphic rocks shows a relatively high Cr content of 80.1 ppm. The Renge metamorphic rocks occurring in the Hida marginal zone, are associated with abundant mafic and ultramafic rocks (ITO, 1975; CHIHARA & KOMATSU, 1981).

Komori metamorphic rocks Hornblende-biotite gneiss No. 186 from the Komori metamorphic rocks, which are associated with mafic to felsic rocks of the Yakuno intrusives (KANO *et al.*, 1959), also has a high Cr content of 96.1 ppm. The rock contains a considerable amount of hornblende, suggesting that mafic rock fragments were mingled with argillaceous materials.

Conclusion and summary

Pelitic and psammitic schists and gneisses from the main metamorphic terrains in the Japanese Islands such as Hida, Ryoke, Sanbagawa and Sangun, have relatively all low Cr contents equivalent to the unmetamorphosed sedimentary rocks in Japan, suggesting that they were derived most likely from the dominant granite terrain similar to the present Japanese Islands. However, the Hidaka metamorphic rocks and rocks exposed in small areas associated with abundant mafic and ultramafic rocks show high Cr contents compared with the unmetamorphosed sedimentary rocks; some of them may have originated from oceanic island arc.

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日本列島の基盤：堆積岩のクロムからの推定

白 木 敬 一

（要 旨）

砕屑性堆積岩中の微量元素クロムを，その供給源地における塩基性岩と酸性岩の割合を推定するのに使った．おもに花こう岩からなる大陸地殻上部のクロム存在度は 40 ppm と見積られる．深海玄武岩の平均クロム含有量は 300 ppm である．先カンブリア時代初期の地層はクロム含有量が高く，塩基性岩の比率が現在より高かったことを示すのかもしれない．主として玄武岩と安山岩でつくられる伊豆マリアナ島弧は，大陸と海洋地域のあいだに入るクロム存在度をもつ．日本の非変成古生層，中生層，第三紀層それぞれの平均クロム含有量は，いずれも約 40 ppm と大陸地殻の存在度に等しく，酸性岩を主体とする後背地から供給されたことを示唆する．日本の主要変成帯：飛驒・領家・三波川・三郡各帯の泥質および砂質岩は，非変成堆積岩とほぼ同様な比較的低いクロム含有量をもつ．特に，飛驒変成岩は著しくクロムに乏しい．一方，日高・鵜ノ木・母体・壺ノ沢・松ヶ平・御斎所・蓮華・河守・寺野各変成岩は，堆積岩平均値より高いクロム含有量を示す．これらは塩基性・超塩基性岩と伴なうことが多く，その一部は海洋地殻上の島弧を含むかもしれない．