Studies on the Chromites and their Country Rocks from the Tari District, Tottori Prefccture, Japan

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北原順一：鳥取県多里地方のクローム鉄鉱並に母岩に関する研究

Introduction

The Tari district, Tottori Prefecture, is situated about 43 km. SSE of Matsue city, Shimane Prefecture.

The mines in this district are situated about 800 m. above the sea-level, and are about 400 m. above than the Tari environs.

Serpentinites or serpentinized peridotites occur near the ridge among the boundary line of Shimane, Tottori, Okayama and Hiroshima Prefectures, and occupy a moderately large area.

The characteristic geology in the Tari district is that these ulta-basic rocks intrude in Palaeozoic sediments and some serpentinites associate with chromites.

In this paper, the writer summarized the results of studies on the chromites and their country rocks in this district, including the description of two kinds of leuchtenbergite found by the author.

The author wishes to express his gratitude to President S. Yamane and Assistant Professor S. Nishiyama of Shimane University for their encouragemements.

The expences of this study was partly defrayed by the Sientific Reserches provided from the Ministry Education of Japan, to which the writer wishes to express his thanks.

General geology

The geologic map of the Tari district surveyed by the author is as shown in Fig. I.

There are principally sedimentary rocks, granitic rocks and serpentinites in this region.

The sedimentary rocks of the older series are chiefly composed of clay-slate, chert, sandstone and rarely limestone which are believed to be of Palaeozoic age. The series show generally strike of N50°-70°W and southward dip 30°-40°. The some chert and clay-slate by granitic rocks were metamorphosed and as the result, the quartzite-like rocks and hornfelses are found at several places in the region.

The younger series of rocks are Tertiary sedimentary rocks composed of alternations of shale, sandstone and conglomerate. The strike is as a rule N20°-30°W with dip 10°-20°

W, but the wavy undulation are frequently observed in the series.

Biotite granite widely develops to southeastward of the Hinokami serpentinite mass and eastward of the Hirose-Wakamatsu serpentinite mass.

Granite porphyry is exposed mainly in the environ of Tari. Granite porphyry at near Hagihara between Tari and Kawakami intruded in chert and as the result metamorphosed the chert and the chert altered into quartzite contained biotite particles (Fig. 2).

Quartz porphyry occurs at westward of the Hirose-Wakamatsu serpentinite mass. The rock is overlain unconformably by Tertiary sedimentary rocks at the roadside of Nogumi (Fig. 3).

Actual relations among granite, granite porphyry and quartz porphyry are not clear. The writer cannot ascertain whether these rocks are originated from same magma or not.

The relation between granitic rocks and serpentinites has not cleared.

Diorites which are found only in serpentinites and chromite bodies occur as differantial dykes of ultra-basic rocks.

The contact between serpentinites and the other rocks is mapped from scattered exposures and was not actually observed.

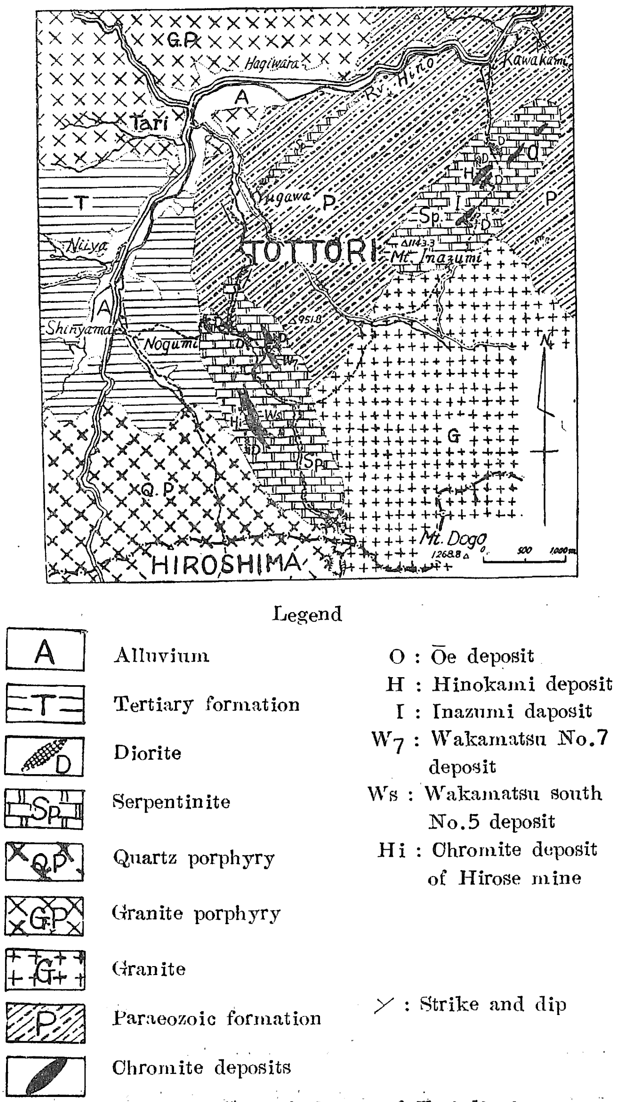


Fig.1 Geological map of Tari district (by J. Kitahara)

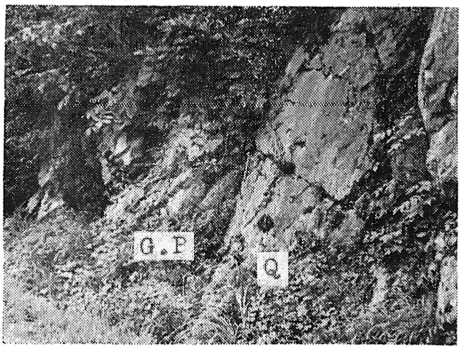


Fig.2 Chert is intruded by granite porphyry (G.P) and metamorphosed to quartzite (Q). Roadside between Tari and Kawami.

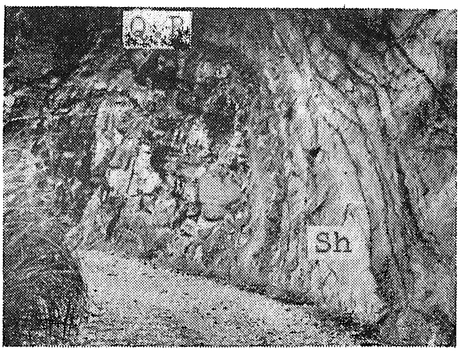


Fig.3 Unconformity between quartz porphyry (Q.P) and Tertiary shale (Sh) with intercalating lignite. Roadside of Nogumi.

Granite and related rocks

Granites and ganite porphyries develop to eastward of the serpentinite mass of the Wakamatsu-Hirose mines, southeastwards of the Hinokami serpentinite mass and the Tari environs.

The biotite granite exposured at about 1 km. south of Inazumi mountain, is megascopically a fine or medium granular rock with quartz, felspar and biotite. Under the microscope (Fig. 4), the minerals found in the rock are quartz, orthoclase, biotite (Nm=Np=I. 647 - I. 648), magnetite, and minor amounts of hornblende, apatite, zircon, chlorite (Nm = I. 574 -), epidote and calcite.

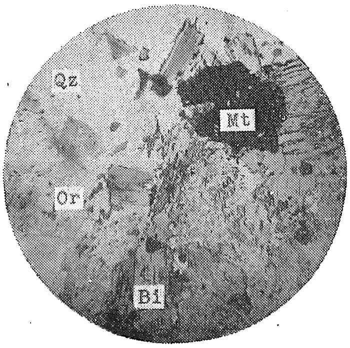


Fig.4 Biotite granite. (Qz) : Quartz, (Or) : Orthoclase, (Bi) : Biotite, (Mt) : Magnetite X27 About I km. south of Inazumi Mountain.

Serpentinites

Serpentinite masses showed in geological map (Fig. I) are mapped from scattered exposures of serpentinite. The author could not discovered the practical relation between serpentinites and Palaeozoic sedimentary rocks, but it seems probably that serpentinites intruded in Palaeozoic formation.

The long directional axis of the Hirose-Wakamatsu serpentinite mass of about 3 km. in length and 1.4 km. in width shows N10°W and that of the Hinokami serpentinite mass of about 3.1 km. in length and 1.3 km. in width shows N70°-80°E.

The ultramafic rocks in the region consist largely of dunite and harzburgite, more or less altered to serpentinite. The close association of pale yellowish green serpentinite and chromite are observed especially in the Wakamatsu mine. The yellowish green serpentinite grades rather abruptly into dark to black serpentinite of the wall rock.

Under the microscope, the olivine is colorless, transparent and has the typical optical properties of high refraction and high birefringence. Serpentinization begins first along grain boundaries, cleavage traces. Where serpentinization has progressed to a considerable development, the olivine grains become rounded and there is noticeable progress of dusty magnetites. The apparent difference between dark to black and yellowish green serpentinites is the abundance of dusty magnetite in the darker variety and the absence or scarcity of these in the yellowish green serpentinite. The dusty magnetite is abundant only in the darker serpentinite away from the chromite body. In the lighter coloured serpentinite fringing the chromite body, dusty magnetite is practically absent. Separation of magnetite in serpentine derived from olivine occurs at the time of serpentinization. Serpentinite rich in olivine particles is also dark to black in color. Some specimens of serpentinized peridotite collected from the chromite bodies of the region, generally contain scattered chromite grains and consist mainly of half altered serpentine with some specks of talc.

The refractive indices of olivine grains in serpentinite specimens from the region were measured by immersion method. The variation in the forsterite content for the specimens tested is Fo_{92-97} molecular percent for all the samples. Therefore the olivines remained in the serpentinite are rich in forsterite molecules.

The iron oxide ($FeO+Fe_2O_3$) content in serpentinite from the region is generally low, however the magnesia content usually high.

The type locality of serpentinized enstatite rock lies in the Hinokami serpentinite mass. It seems to the writer that the serpentinized enstatite rock is lenticular differentiations from serpentinized dunite.

Some specimens of chloritized pyroxenite collected from the Hinokami deposit of Hinokami mine consist mainly of fine grained leuchtenbergite with some specks of enstatite. These carry dissected grains of chromite surrounding by leuchtenbergite. The two kinds of leuchtenbergite were found by the present author from the deposit.

The writer omitted the results of the optical and chemical studies of the ultrabasic rocks in the paper.

Serpentinites from the No. 7 deposit and South No. 5 deposit of Wakamatsu mine

The iron oxide ($FeO+Fe_2O_3$) content in greenish serpentinites occured in contact with or near place of the chromite body is lower than those in blackish serpentinites occured at a distance or apart from the chromite body. In greenish serpentinite, dusty magnetite is scarcity and the forsterite molecule in olivine is high as in Fo_{96} (Mol%). When olivine rich in forsterite molecule get serpentintzation, it seems the author that the dusty magnetite is not almost separate from olivine and iron is contained in antigorite. When peridotite that forsterite molecule of olivine is comparatively low as in $Fo_{92\text{-}93}$(Mol%) get serpentinization, the dusty magnetite is separated from olivine. Serpentinite that is poor in ferrous oxide and rich in ferric oxide is brownish in color. It seems that the alumina content in brownish serpentinite is caused by enstatite and serpentinized enstatite.

Rocks from the Inazumi deposit of Hinokami mine

Since some of serpentinized harzburgite or serpentinite are poor in iron oxide content, the forsterite molecule of olivine in these rocks is high as in Fo_{96} (Mol%) and the rock is not black and yellowish gray in color. It dues to olivine remained in the rock, the iron oxide content in serpentinite, nevertheless, is comparatively low, the color of the rock is black.

Leuchtenbergite rock

Locality : At the Hinokami deposit of the Hinokami mine

The leuchtenbergite rock containing chromite grains was newly found by the present author in serpentinite mass, resulting from the hydrothermal alteration of aluminous enstatite rock. The leuchtenbergite is faint green, and the streak is white. It has a hardness of about 3 and specific gravity of 2.623 at 4°C. In thin section, the rock is composed of fine grained leuchtenbergite, enstatite as pretty flake and chromite grains. The leuchtenbergite is 0.05-0.2mm. in size, colorless, $(+)2V=2°$, $Np=1.5704$ and has weak birefringence. The enstatite as small flake is 0.1-0.2mm. in size and colorless showing parallel extinction. The chromite is entirely black, 0.5-1.5mm. in size and sheared.

Hydroxyl water of chlorites is generally driven off in two stages. The leuchtenbergite specimen exhibits a first distinct endothermic reaction between 600° and 700°C, and a second endothermic reaction is not shown. As it seems that the two stages of dehydration occur within a narrow temperature interval, the endothermic curve would be expected to show an overlap of thermal reactions. An exoththermic peak is denoted at about 830°C.

The chemical composition of the leuchtenbergite is as follows.

	Wt%	Mol.props		Atom. ratios	Ditto when O(OH)=1800
SiO_2	31.15	519	Si	519	293.8
Al_2O_3	17.12	168	Al	336	190.2
Fe_2O_3	2.90	18	Fe'''	36	20.4
Cr_2O_3	tr				
FeO	0.56	8	Fe''	8	4.5
MnO	0.00				
MgO	34.57	864	Mg	864	489.1
CaO	tr				
Alk	n.d				
H_2O+	12.82	712	H	1424	OH 806.0
H_2O-	0.50		O	3180	O 994.0
Total	99.62				

The chemical formula calculated on the basis of chemical analysis is $(Mg_{4.89}Fe''_{0.05}Fe'''_{0.20}Al_{0.84})_{5.98}(Si_{2.94}Al_{1.06})_{4.00}O_{9.94}(OH)_{8.06}$

The end members of the specimen are as follows.

	Mol%
Antigorite ($H_4Mg_3Si_2O_7$)	48.7
Amesite ($H_4Mg_2Al_2SiO_7$)	50.4
Ferroantigorite ($H_4Fe_3Si_2O_7$)	0.4
Daphnite ($H_4Fe_2Al_2SiO_7$)	0.5

Leuchtenbergite rock

Locality: At the Hinokami deposit of the Hinokami mine

The leuchtenbergite that composed this rock (Fig. 5) is pale green, the luster is somewhat vitreous, and the streak is white. The hardness is about 3 and specific gravity is 2.648 at 4°C. In thin section, the rock is formed only by leuchtenbergite with chromite grains. The leuchtenbergite is 0.1mm. in size, colorless, (+)2V=small and N_P= 1.5727. The chromite is yellowish green (hercinite molecule, FeO.

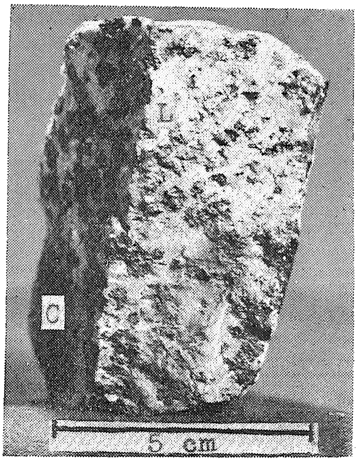


Fig.5 New leuchtenbergite (L) and its associated chromite (C) (NO.18) Hinokami deposit of Hinokami mine.

Fe_2O_3) with thick black border, 1-2mm. in size and fractured.

The chemical composition of the specimen is as follows.

	Wt%	Mol.props		Atom.ratios	Ditto when O(OH)=1800
SiO_2	30.44	507	Si	507	286.7
Al_2O_3	18.13	178	Al	356	201.3
Fe_2O_3	3.38	21	Fe''	42	23.7
Cr_2O_3	tr				
FeO	0.57	8	Fe''	8	4.5
MnO	0.00				
MgO	34.22	856	Mg	856	483.0
CaO	0.17	3	Ca	3	1.6
Alk	n.d				
H_2O+	12.70	705	H	1410	OH 797.4
H_2O-	0.30		O	3183	O 1002.6
Total	99.91				

The analysis indicates that the formula is $(Mg_{4.83}Ca_{0.02}Fe''_{0.05}Fe'''_{0.24}Al_{0.88})_{6.02}(Si_{2.87}Al_{1.13})_{4.00}O_{10.03}(OH)_{7.97}$.

Antigorite : 47.4, Amesite : 51.7, Ferroantigorite: 0.4, Daphnite: 0.5 (Mol%).

Gabbro

Gabbroic rocks occurred as lens or orbicular shapes are frequently found as xenolith within the chromite bodies and serpentinites in the region.

Megascopically, these rocks are dark black in color with fine grained felspar and coloured mineral.

Under the microscope, thin sections show typical granular texture with plagioclase felspars having polygonal outlines. The minerals found in these rocks are plagioclase, hornblende, sometimes pargasite, magnetite, ilmenite, leucoxene and minor amounts of clinopyroxene, apatite, and epidote.

Plagioclase felspar. —— The felspars are free from turbidity and large proportion of crystal are untwinned. This type is interpreted as a much older gabbro, metamorphosed and recrystallized. The composition of the plagioclases in these rocks are An_{57-77}. The composition which were determined by measuring on cleavage fragment (010), have been read from the curve presented by S. Tsuboi. These values ranged from 1.560 to 1.569, but generally in most rocks they were found to be $n_1=1.560$.

Hornblende. —— Hornblende is the most abundant mafic mineral of these gabbroic rocks. It appears to have been derived from the primary clinopyroxes, by thermal metamorphism. In some thin sections the hornblende carry a core of primary pyroxene. The following optical properties are shown by these hornblendes, which indicate them to be calciferous amphiboles. $Ng = 1.669\text{-}1.680$, $c \wedge Z' = 14\text{-}22^\circ$, $2V(-) = 54\text{-}76^\circ$. $X' =$ light green, pale yellow, $Z' =$ yellow green, green.

Pyroxene. —— Most of the clinopyroxene in the gabbro have been altered to amphibole. The clinopyroxene grains show peripherial alteration to hornblende and much of the hornblendes present in the rocks appear to have been derived by paramorphic alteration of pyroxenes.

Fair amounts of magnetites and ilmenites are found near the aggregates of hornblende. Leucoxenes are found as alteration product of ilmenite or titanium magnetite. The leucoxenes are opaque whitish aggregate.

Occasionally, apatite, biotite, epidote, and chlorite are seen in minor amounts in these rocks.

Diorite

Many irregular differential rocks of diorites ranging from 0.5m. to 2 m. in width are intrudrd into serpentinites, chromite bodies and have never been seen in any other rock mass in this region.

These rocks are megascopically dark gray or blue in color with felspar and colored mineral.

Under the microscope, the mineral constituents of these diorites are commonly plagioclase, hornblende and magnetite or ilmenite, occasionally pargasite, spinel and apatite, and as secondary minerals, chlorite, leucoxene and calcite.

The indices of plagioclase in these diorites are generally $n_l = 1.54$ to 1.55 on cleavage fragments (OOl) and (OlO), and corresponding contents are An_{34-44}.

The optical properties of hornblendes are as follows. $Ng = 1.673\text{-}1.689$, $c \wedge Z' = 16\text{-}22^\circ$, $2V(-) = 67\text{-}75^\circ$, and $X' =$ pale yellow, yellowish green, $Z' =$ green, bluish green.

Chromites and their occurrences

The chromite deposits of the region are in elliptical serpentinite masses mapped from scattered outcrops of serpentinite. The chromite constitutes a small proportion of the whole magma. The chromite deposits of the Hirose mine and the South No. 5 deposit of the Wakamatsu mine are situated nearly in the central part of the Hirose-wakamatsu serpentinite mass, and the No. 7 deposit of the Wakamatsu mine are lain eccentrically to right anterior border apart from central part of the serpentinite mass. Each of the chromite deposits of the Inazumi, Hinokami and Ōe of the Hinokami mine are stood eccentrically to NEE parts along the midline of the Hinokami serpentinite mass. It seems that the chromite deposits occur at some particular zone in the intrusion. The chromite deposits in the Hinokami mine are principally composed of disseminated chromite, and are 1 m. to 10 m. in width and 200m. long. The chromite bodies of the mine generally show N70°-80°E strike as the Hinokami serpentinite mass and have steep dip. The chromite deposits of the Hirose mine and the South No. 5 deposit of the Wakamatsu mine are continuous each other, and these deposits are generally constituted of massive chromite. The chromite layers of these deposits in the Hirose and Wakamatsu mines are from 1m. to 10m. in width, 300m. long and have westward dip or sometimes lie almost horizontally.

The most of the chromite of the parent magma separated from the olivine constituents, remained until the body of the rock was solid enough to fracture, and deposited along well defined fissures in ultrabasic rock. Some chromite was entangled between the grains of olivine to form the disseminated chromites. The formation of the massive or plate-like chromite bodies is evident by wall rock alteration of the chromite serpentinite contacts. There is evidence of discontinuity, such as intrusive contact at the margins of platy chromite bodies. The deposits may be interpreted as a melted fluid containing water.

The possibility that these massive chromites in this region were hydrothermal liquid are rejected, because in thin section, the chromites somewhat associate with serpentine characterized by igneous origine. The constant association of chromite and serpentinized dunite or serpentinite implies that most of the chromite was concentrated during the magmatic stage of the basic intrusion. The conclusion is further confermed by the occurrence of much chromite in disseminated form, in matrix of serpentine which presumably was originally olivine.

After all of the chromite and ultrabasic rock was consolidated, the final liquid magma flowed into cracks to form the diorite dykes. The diorite dykes were intuded after the serpentinization. The fact that diorite dykes cut the chromite bodies is additional evidence of the position of chromite in the magmatic cycle.

The size of the disseminated chromite is averages from 0.5mm. to 1.5mm. in diameter. In thin section, the disseminated or scattered chromite has generally black margins with yellowish brown center, cracks crossing the grains commonly have similar black margins and is sometimes crossed by black material, presumably ferrian chromite or chromian magnetite, but the massive chromites are usually brownish yellow in color and accompanied with compatively little magnetic substance (Figs. 6, 7, 8 and 9). The black ferrian chromites show sometimes chain or vein-like structure.

Fig.6 Disseminated chromite with black margin and cross cutting black line. X23 South No.5 deposit of Wakamatsu mine.

Fig.7 Disseminated chromite with thick black border. X23 Hinokami deposit of Hinokami mine.

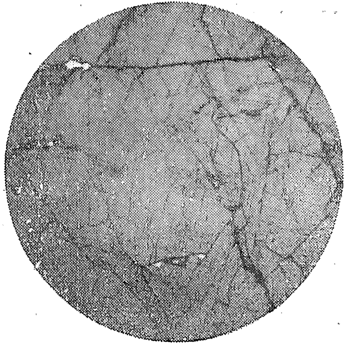


Fig.8 Massive chromite with inclusion of sepentine. X23 No.7 deposit of Wakamatsu mine.

Fig.9 Massive chromite with fractures filled by serpentine. X23 South No.5 deposit of Wakamatsu mine.

Serpentine-filled fractures are present in most chromite specimens examined. The fractures cut across chromite grains. The chromite sometimes carry inclusion of serpentine or serpentitzed olivine. This fact indicates that some of the olivine crystallized before or contemporaneously with the chromite. It seems that serpentinizing solution could have originated within the ultramafic rocks themselves. The chromite is fractured, even the smallest grains. This suggests that fracturing occurred prior to serpentinization. The serpentine filled fracture in chromite is to be ascribed to cooling resulted from emplacement of the chromite.

Specific gravity of chromite

The calculated specific gravities of spinel($MgO. Al_2O_3$), magnesio-chromite($MgO. Cr_2O_3$), ferrochromite($FeO. Cr_2O_3$), and magnetite($FeO. Fe_2O_3$) are 3.55, 4.43, 5.09, and 5.20 respectively.

The specific gravities of the disseminated chromites are commonly higher than those of massive chromites at the Wakamatsu and Hirose mines, but the chromites from the Hinokami mine show irregular value. Since the content of Cr_2O_3 in chromite from the Wakamatsu and Hirose mines principally shows lower value than those in chromite from the Hinokami mine, the densities of chromite samples from the Wakamatsu and Hirose mines are generally lower than those of chromite samples from the Hinokami mine. The writer omitted the results of the theoretical and measured specific gravities of the chromites in the paper.

Chemical composition of chromite

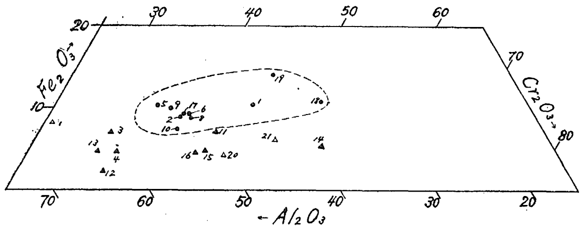
An effort was made to separate the black chromite from serpentine for chemical analysis. The quantity of gangue impurities was almost reduced by means of binocular microsope or heavy solution separations. This was not entirely succcssiful as the chromite contains some serpentine which was impossible to separate even by fine crushing, but these samples are considerably free from serpentine or other silicates. The samples selected for analysis were ground to powder. In the analyses of the chromite concentrates five major constituents such as Cr_2O_3, Al_2O_3, Fe_2O_3, FeO, and MgO were determined. FeO in chromite was determined using phosphoric acids as solvent in the absence of air. Three minor constituents such as MnO, CaO and SiO_2 were also determined. Trace or minor elements such as TiO_2, NiO and H_2O were not determined. The analyses show impurity of SiO_2. Assuming that the SiO_2 content is all in the form of serpentine or chlorite, this mineral was subtracted from the chromite analysis.

The major constituetnts of chromite are bivalent iron and magnesium and trivalent chromium, aluminium and iron. Chromite is a member of the spinel group and forms an isomorphous series expressed by the formula (Mg, Fe) $(Cr, Al, Fe)_2O_4$. The end members are ferrochromite, magnesiochromite, spinel, hercynite, magnesioferrite, and magnetite. Since chromites have a wide range in composition as the result of substiution of magnesium for ferrous iron and of aluminium and ferric iron for chromium, the composition of chromite is variable.

R. E. Stevens classified chromium bearing spinels according to composition. Since the chromites from the region are compartively rich in alumina and magnesia, these chromites belong to aluminian chromite (Mg,Fe)O(Cr,Al,Fe)$_2$O$_3$ and chromian spinel (Mg,Fe)O (Al,Cr,Fe)$_2$O$_3$. The elements in aluminian chromite and chromian spinel are written in order of abundance.

The results of the analyses made by the present author were plotted on the three diagrams, as (1)-ratios of R_2O_3 constituents, (2)-norms of M9O. Al_2O_3, (M9,Fe)O. Cr_2O_3, FeO. Fe_2O_3 and (3)-ground constructions of MgO, $Cr_2O_3+Al_2O_3$, Fe_2O_3 in composition, respectively (Figs. 10, 11 and 12).

Fig. 10



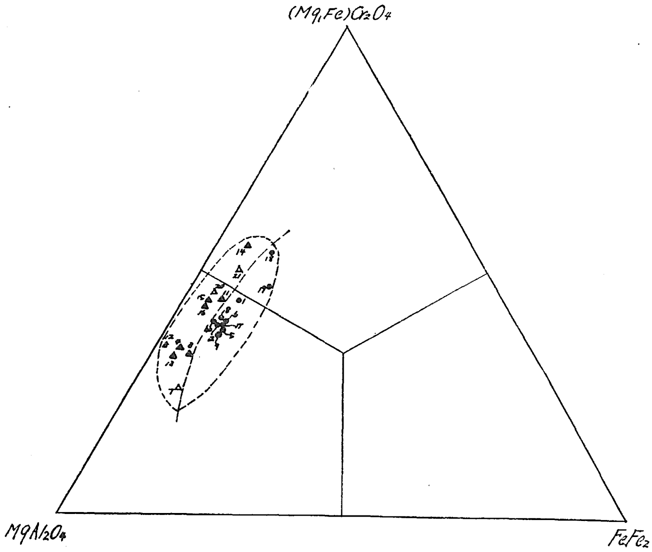
● : Disseminated chromite

▲ : Massive chromite

△ : Densely disseminated or nearly massive chromite

The content of FeO plus Fe_2O_3 in the disseminated chromite, which closely related to the serpentinite in the region, is generally higher than that of the massive chromite, but the content of Al_2O_3 plus Cr_2O_3 is reverse. The content of FeO plus Fe_2O_3 in the disseminated chromite is reverse of that in the green to yellow serpentinite that disseminated

Fig. 11

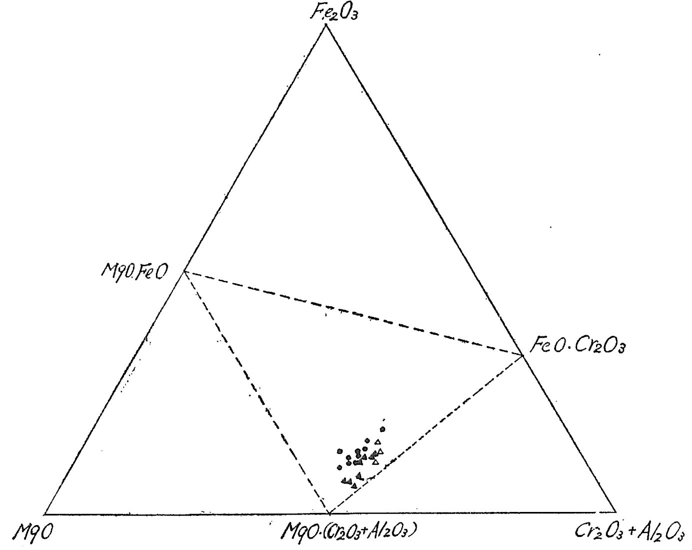


the chromite. The serpentinite containing the disseminated chromite is principally low in content of FeO plus Fe_2O_3. The disseminated chromite in the leuchtenbergite rocks, which rich in Al_2O_3 content, is low in Al_2O_3 content. The proportion of MgO, FeO, Cr_2O_3, Al_2O_3 and Fe_2O_3 in the chromite appears to be determined by the relative proportions of composition in the magma.

The ratios of the R_2O_3 constituents in chromite may be controlled by a number of factors, including the relative amounts of Cr_2O_3 and Al_2O_3 available for chromite and oxidizing condition of the iron. The chemical relation of the massive and disseminated chromitses in the region is obvious from Fig. 10.

Each of the molecular ratio of $Cr_2O_3+Al_2O_3$ in the disseminated chromites is generally lower than that of the massive chromites in the region. The plotted position of the molecular ratios of MgO, $Cr_2O_3+Al_2O_3$ and Fe_2O_3 are grouped near $MgO(Cr_2O_3+Al_2O_3)$ — FeO. Cr_2O_3 line as shown in Fig. 12.

Fig. 12



The Cr_2O_3 ranges of the chromite specimens obtained from the Hirose, Wakamatsu and Hinokami mines 29-39 %, 22-40 % and 32-45% respectively. The chromites from the Hinokami mine are compatively higher in Cr_2O_3 content than those from the Hirose and Wakamatsu mines.

There is reason to believe that massive chromites may not differ greatly in composition from chromites disseminated in serpentinites. Variation in chromite composition implies a history of crystalization. The disseminated chromite in all these deposits in this district is generally higher content in Fe_2O_3 than the massive chromite. As most massive chromites in the region are consistently low in Fe_2O_3, it is believed to have been formed in some reducing enviroment. This principal difference in composition between the massive and disseminated chromits brought in Figs. 10 and 11.

Some presence of serpentinized enstatite rock in the vicinity of the Hinokami mine and almost absence of that in the neighborhood of the other mines in the region suggest difference in the ratios of SiO_2, CaO, and Al_2O_3 in the magmas which should be reflected in the composition of the chromites. The composition of the chromite that the matrix of the chromite is leuchtenbergite varies erratically (Nos. 18 and 19 in each of Figs. 10 and 11).

The writer omitted the results of the chemical analyses of the chromites in the paper.

Veinlets in serpentinite and chromite

The xenocrysts of chromite and serpentinite are rarely found in magnesite veinlet filled the fissures of the serpentinite mass. Besides the main magnesite veins, there are numerous irregular paches of magnesite or calcite in the serpentinite. It is clear that the vein forming solutions penetrated the serpentinite along various cracks or opening and replaced it readily.

Small amounts of uvarovite are rarely found in the fissures of the chromite bodies in the region. The mineral is emerald green in color and presumably alteration product from complex of chromite-silicate mineral.

The saponite veinlets are frequently observed in the serpentinite and chromite bodies in the region. It seems probably that these veins were formed through alteration of serpentinite. The saponite is soft and grayish white.

References

The author omitted the references of literatures in the paper.