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Rhodochrostone – A New Sedimentary Rock from the Janggun Mine, Korea

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Abstract

A new rock name, rhodochrostone is proposed for the sedimentary rock from the Janggun Mine, Korea, which consist mainly of rhodochrosite. Systematic classification of rhodochrositic rocks was made for the rocks of rhodochrosite-calcite-quartz and rhodochrosite-quartz-clay, respectively. According to the writer's new scheme of classification, the manganese carbonate beds of the Janggun Mine, Korea consist mainly of rhodochrostone and siliceous rhodochrostone, with minor clayey siliceous rhodochrostone. The underlying and overlying carbonate rocks consist of high-manganiferous dolostone, moderate-manganiferous dolostone and low-manganiferous dolostone. The same scheme of classification is applicable to the similar manganiferous rocks in other countries. Mineralogical, petrological and chemical studies were made.

Introduction

The classification and terminology of ordinary carbonate rocks which consist of calcite and/or dolomite are well established. However, the nomenclature of the rocks which are chiefly composed of rhodochrosite is not yet given, in spite of the necessity to have one. It is surprising that we do not have any suitable terms for such sedimentary rocks. Many authors have used the terms "rhodochrosite", "rhodochrosite-rich" or "manganiferous" to denote the sedimentary rocks which are mainly composed of rhodochrosite, with or without other carbonates or pelitic materials. The term "rhodochrosite" has been used by many workers as the mineral name as well as rock name as in the case of "dolomite". But nowadays, dolomite is a mineral name, and dolostone is a rock name for the rock which consists mainly of dolomite.

During the study of manganese carbonates from the Janggun Mine in the southeastern part of Korean peninsula, the present writer felt the need to have a certain name for the rocks which consist mainly of rhodochrosite with or without other carbonate minerals in order to define clearly the rocks of various mineralogical composition and to distinguish the rocks from minerals. He thinks that the unreasonable use of the term "rhodochrosite" as a rock name must be avoided, and the new rock name must be given to the rhodochrosite-rich sedimentary rocks. Genetic problems of the rhodochrostone will be published later.

Occurrence of Manganese Carbonate Rocks

The manganese carbonate rocks in sedimentary rocks are reported from many localities over the world. They generally occur as concordant continuous or lenticular intercalation in limestone, dolostone, shale, marl, chert, or sandstone. The manganiferous carbonate rocks at the Janggun

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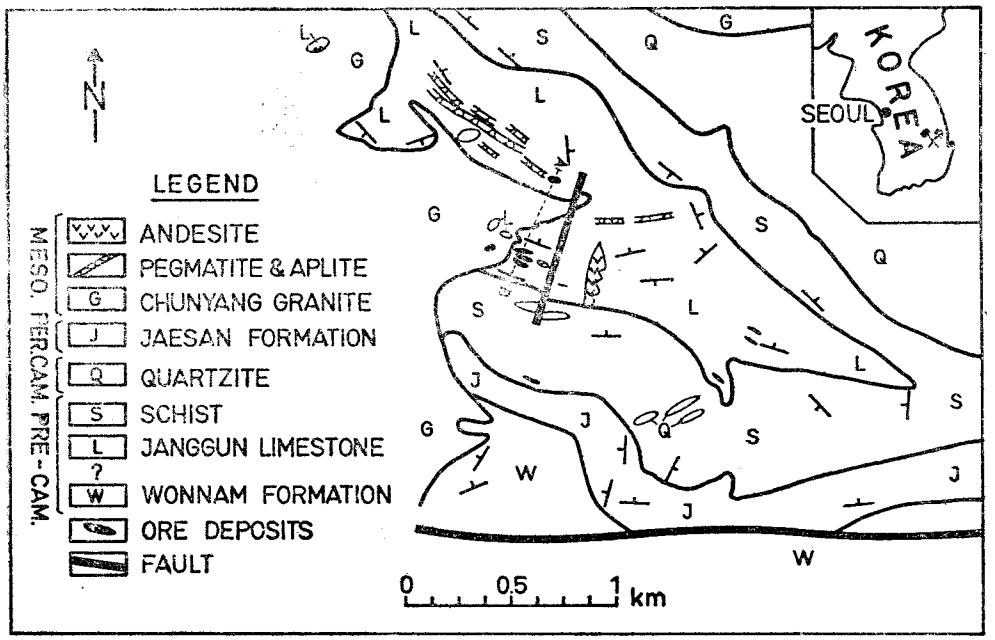

Fig. 1. Geological map of the Janggun Mine, Korea. (Kim, 1974).

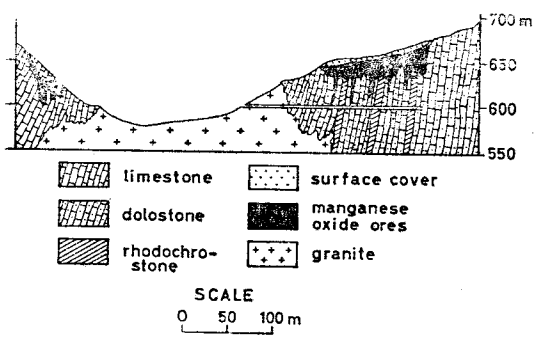

Fig. 2. Geoogical cross section of the manganiferous formations at the Janggun Mine, Korea.

Mine occur as three concordant lenses (6.5, 5.3 and 9.7m thick, respectively) in dolostone in Janggun Limestone (Fig. 1 and 2). They have characteristic sedimentary features such as bedding and fine lamination (Fig. 3 and 4). Some parts of the beds are brecciated after deposition. Occasionally, rhodochrostone alternates with thin beds of sulfide-quartz layers, showing well-developed lamination.

Scheme of Classification

The classification of the rocks that contain manganese carbonates is not simple, because they consist of various kinds of carbonates with or without silicates, oxides or sulfides. For simplification, only the manganese carbonate rocks with or without small amounts of manganes silicates, oxides or sulfides are treated here.

Manganiferous Carbonate Rocks

The classification of the rocks that contain manganoan calcite or manganoan dolomite as the unique carbonate must follow the same scheme of classification as those of non-manganiferous carbonate rocks. For instance, the scheme of classification of calcite-dolomite-clay rocks can be used for classification of manganiferous carbonate and allied rocks. In such cases, we need only to add the term "manganiferous" in naming the manganiferous sedimentary rocks. For instance, "manganiferous limestone", "manganiferous dolostone" or "manganiferous marl".

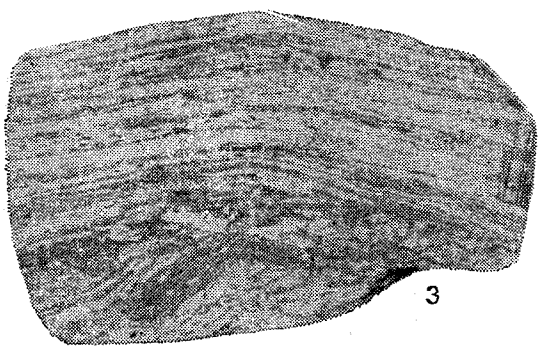

Fig. 3. Handspecimen of rhodochrostone. Note the folded lamination due to alternation of rhodochrosite and sulfides (black) and the slumping structure.

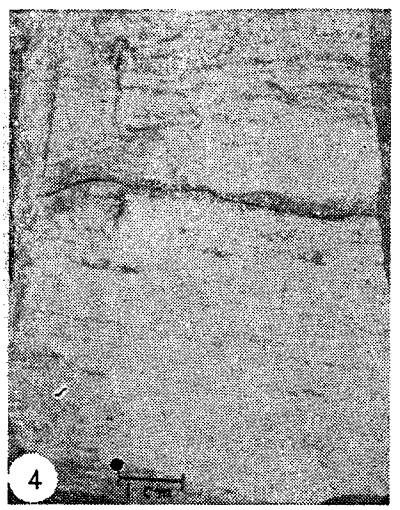

Fig. 4. Handspecimen of rhodochrostone.

Fig. 5. Rhodochrostone. Grey or dark grey parts are rhodochrosite, and white part is quartz. Thin sectin. Nicols not crossed. X46.

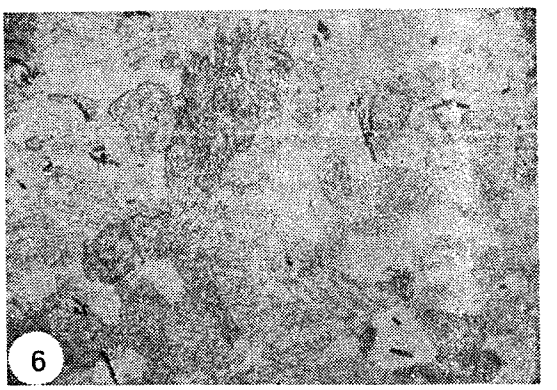

Fig. 6. Siliceous rhodochrosone. Note the rhodochrosite crystals (grey), interstitial quartz (white) and sulfides (black). This fabric was formed by deep-burial diagenesis or metamorphism of original rhodochrostone. Thin section. Nicols not crossed. X46.

The present writer proposes the following classification of the manganiferous carbonate rocks. The same scheme is applicable to manganiferous marl, shale, sandstone and chert.

A) Manganiferous limestone

High-manganiferous limestone

$MnCO_3 > 5\%$

Moderate-manganiferous limestone

$MnCO_3 = 1-5\%$

Low-manganiferous limestone

$MnCO_3 < 1\%$

B) Manganiferous dolostone

High-manganiferous dolostone

$MnCO_3 > 5\%$

Moderate-manganiferous dolostone

$MnCO_3 = 1-5\%$

Low-manganiferous dolostone

$MnCO_3 < 1\%$

Carbonate Rocks Containing Rhodochrosite

For the manganese carbonate rocks which consist of rhodochrosite only or with some other

minerals, the present writer proposes new classifications. In the similar way as with the name, dolostone, he proposes the new rock name "rhodochrostone" ("Jangmiam" in Korean) for the ntary sedime rock which consists mainly of rhodochrosite. The rhodochrostone at the Janggun Mine is more or less metamorphosed.

The following associations of rhodochrosite with other minerals are possible in the sedimentary rocks.

a) rhodochrosite-calcite-clay,
b) rhodochrosite-quartz-clay,
c) rhodochrosite-dolomite-clay, and
d) rhodochrosite-dolomite-quartz.

Among these four types of mineral association, the first two are significant for the practical application to classification. The last two are not important, because they are not distinct as rock types. The classification of only the first two associations is considered here.

The mineral associations in the rhodochrosite-calcite-quartz rocks is similar to those in calcite-dolomite-clay rocks. Therefore, the classification of rhodochrosite-calcite-clay (Fig. 7) was made after the scheme by Ruchin (1958) for calcite-dolomite-clay rocks.

The classification of the rhodochrosite-quartz-clay rocks is slightly different from that of rhodochrosite-calcite-clay rocks, because the ratio of the carbonate to other components, as a whole,

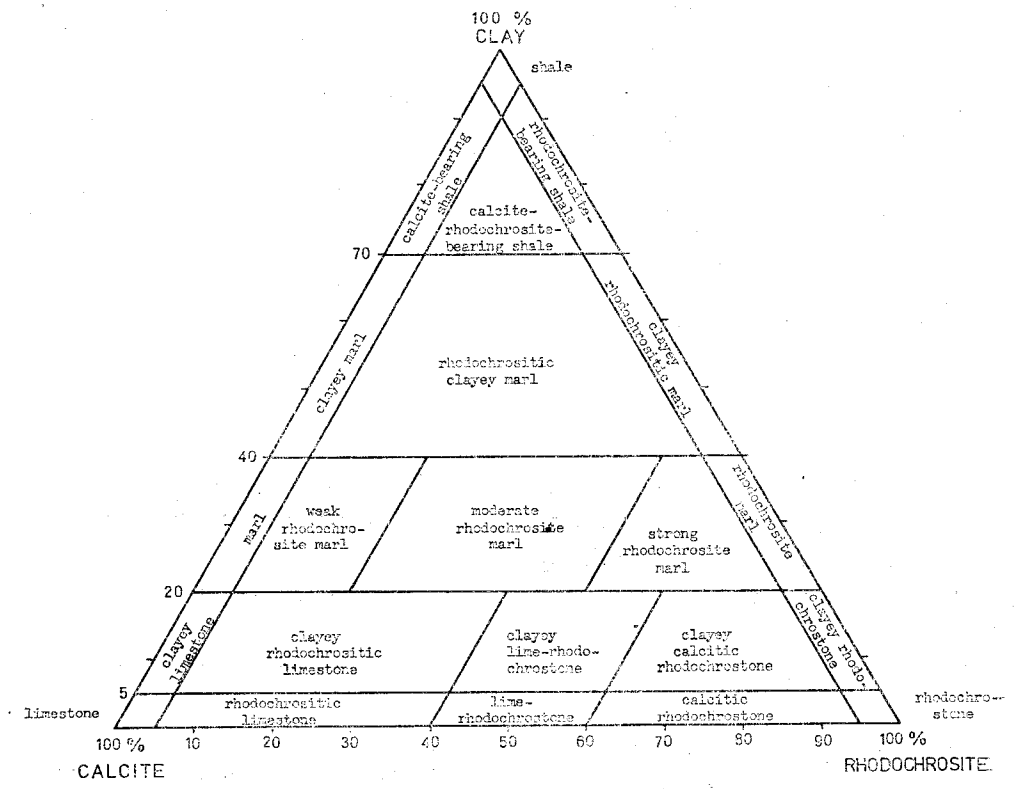

Fig. 7. Classification of rhodochrosite-calcite-clay rocks.

decreases from 2:1 to 1:2. The classification of the rhodochrosite-quartz-clay rocks is shown in Fig. 8.

The rhodochrostone containing significant amounts of sulfides or oxides must have the modifyingword "sulfide-bearing" or "oxide-bearing", forexample, sulfide-bearing rhodochrostone.

Practical Application

According to the new classification of the sedimentary rhodochrositic rocks, the manganese carbonate beds of the Janggun Mine, Korea consist mostly of rhodochrostone and siliceous rhodochrostone, with minor clayey siliceous rhodochrostone. The underlying and overlying carbonate rocks consist of high-manganiferous, moderate-manganiferous and low-manganiferous dolostones. For the applicability of above classification, the present writer gives further examples of naming the manganese carbonate rocks from other localities in Table 1.

Description of Rhodochrostone

Rhodochrostone and siliceous rhodochrostone are fine- to coarse-grained. They are light grey, pinkish or pinkish grey in color. Lamination is often found in the rocks. It is caused by the fine alternation of rhodochrosite and sulfide-quartz aggregates. Some parts of rhodochrostones are veined with later mobilized rhodochrosite.

Rhodochrostone consists chiefly of rhodochrosite, with minor quartz, sulfides and sericite (Fig. 5).

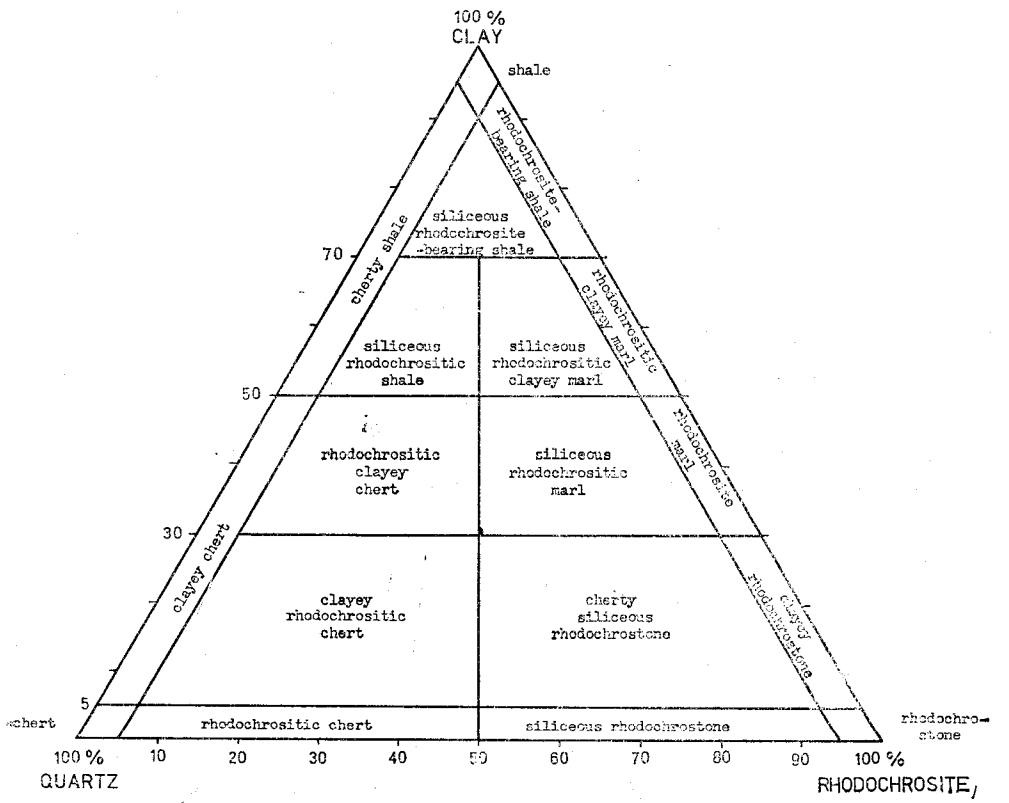

Fig. 8. Classification of rhodochrosite-quartz-clay rocks.

Table 1. Naming of carbonate rocks that contain rhodochrosite as major or minor constituent.

Minerals / New Rock Names	orhodochrosite	clay	calcite	silica (quartz)	thers (sulfides)	Locality and author	original rock name
Rhodochrostone	96.5	0.1	—	3.2	0.2	Janggun Mine, Korea (this work)	
Siliceous rhodochrostone	72.3	0.5	—	27.6	0.5	Janggun Mine, Korea (this work)	
Clayey siliceous rhodochrostone	83.5	6.1	—	10.4	—	Janggun Mine, Korea (this work)	
	68	16	—	15	1	Wales, England (Mohr, 1964)	nanganese ore
	70	10	—	20	—	Berchtesgaden, Germany (Gruss, 1958)	rhodochrosite bed
Clayey rhodochrostone	81.6	14.2	2.4	—	1.8	Usinsk, USSR (Varentsov, 1964)	calcian rhodochrosite
Siliceous rhodochrosiic marl	56.9	27.13	—	7.96	8.01	Usinsk, USSR (Varentsov, 1964)	ferroan rhodochrosite
Rhodochrosite-bearing shale	10.7	89.3	—	—	—	Allgäu and Lechtaler Alps (Germann, 1971)	manganese-rich shale
Rhodochrositebearing shale to rhodochrositic clayey marl	15-40	65-75	—	—	—	Allgäu and Lechtaler Alps (Germann, 1971)	manganese-rich marl

Siliceous rhodochrostone consists chiefly of rhodochrosite and quartz, with minor sulfides and sericite (Fig. 6). The modal compositions of rhodochrostone and siliceous rhodochrostone are rhodochrosite 70–97%, quartz 2–28%, muscovite 0–6% and sulfides 0–5%. Kutnahorite is occasionally included in the rocks.

The present textures of rhodochrostone and siliceous rhodochrostone are the result of diagenesis and metamorphism. The original textures are nearly completely destroyed by metamorphism. However, relict fabrics of the original rocks are discernible in rare cases. Rhodochrosite grains are generally more or less aligned subparallel to the bedding.

Rhodochrosite grains are commonly anhedral in the pure rhodochrostone, but subhedral to euhedral in siliceous rhodochrostone. The present shapes of rhodochrosite grains are also resulted from the diagenesis and metamorphism. In some cases, colloform banding is preserved in rhodochrosite grains.

Quartz is microcrystalline. It fills the interstices of rhodochrosite rhombs, but partly intergrown with rhodochrosite graphically. Quartz veinlets crossing the rhodochrosite grains are due to metamorphism. The relict fabric of colloform bands in recrystallized quartz aggregates suggest that they deposited originally as colloidal amorphous silica, and then crystallized to the fine-grained quartz aggregates. Chert-like small lenses are also found in the rhodochrostone.

Sericite was formed from clay particles of original sediments by diagenesis and metamorphism. It occurs as fine-grained flakes in quartz, along the contact of quartz and rhodochrosite, or together with sulfides.

Sulfides in rhodochrostone and siliceous rhodochrostone consist of pyrite, arsenopyrite, galena, boulangerite, tetrahedrite, sphalerite, galena and chalcopyrite. Sulfides form thin continuous or discontinuous beds. Fine-grained sulfide particles are frequently diffusely disseminated through the rocks.

Chemistry of Manganese Carbonate Rocks

Manganese Carbonate Minerals

Chemical analyses of the manganese carbonate minerals (rhodochrosite, calcian rhodochrosite, kutnahorite, manganoan dolomite and manganoan calcite) are plotted into the $CaCO_3$-$MgCO_3$-$MnCO_3$ diagram (Fig. 9). Normative compositions of the typical manganiferous carbonate minerals from the Janggun Mine are given in Table 2.

Table 2. Normative composition of the typical manganiferous carbonate minerals from Janggun Mine, Korea. Recalculated from the chemical analyses.

	rhodo-chrosite	calcian rhodo-chrosite	kutna-horite	manganoan dolomite
$CaCO_3$	3.10	15.34	47.07	50.22
$MgCO_3$	0.55	4.16	5.94	40.57
$MnCO_3$	95.72	78.11	45.93	8.91
$FeCO_3$	0.63	2.40	1.06	0.30
total	100.00	100.00	100.00	100.00

Table 3. Chemical analyses of the manganese carbonate rocks (Calculated from the analysis by the Daehan Mineral Analysis Center).

	1	2	3	4	5
MnO	49.82	44.92	33.20	37.56	34.91
CaO	4.54	5.32	8.68	2.68	6.98
MgO	1.08	0.73	1.62	0.09	1.30
Fe_2O_3	5.86	8.77	14.64	8.95	16.21
PbO	0.41	0.32	0.89	0.14	0.82
ZnO	tr	0.30	0.63	0.15	1.01
CuO	tr	tr	0.04	tr	tr
SiO_2	1.06	2.24	2.32	12.80	11.42
As_2O_5	tr	5.96	10.96	tr	9.85
Al_2O_3	0.24	0.40	0.36	1.10	0.83
P_2O_5	0.018	0.009	0.014	0.005	0.23
S	0.58	1.21	3.27	1.15	2.39

1) Rhodochrostone
2) Sulfide-bearing rhodochrostone
3) Sulfide-bearing siliceous rhodochrostone
4) Siliceous rhodochrostone
5) Sulfide-bearing siliceous rhodochrostone

Rhodochrostone and Allied Rocks

The main metallic constituents of the manganese carbonate rocks are Mn, Si, Ca and Fe. The elements that are included less than one % are Mg, Pb, Zn, P and Al. Chemical analyses of rhodochrostone and allied rocks are given in Table 3. The main components of the rocks are plotted in $CaCO_3$-$MgCO_3$-($MnCO_3$+$FeCO_3$) diagram (Fig. 10). The average chemical composition of the rhodochrostone and allied rocks together is shown in Table 4.

Table 4. Average elemental composition of rhodochrostone and siliceous rhodochrostone at Janggun Mine, Korea

Si	Al	Fe	Mn	Mg	Ca
3.53	0.34	3.51	30.38	0.49	3.75
Pb	**Zn**	**Cu**	**As**	**S**	**P**
0.57	0.48	tr	1.53	1.84	0.016

The significant ratios of elements in rhodochrostone and allied rocks are Si/Al=11.31, Mn/Fe =8.34, Mg/Fe=0.14, Ca/Mg=7.70 and Mn/Ca=8.10.

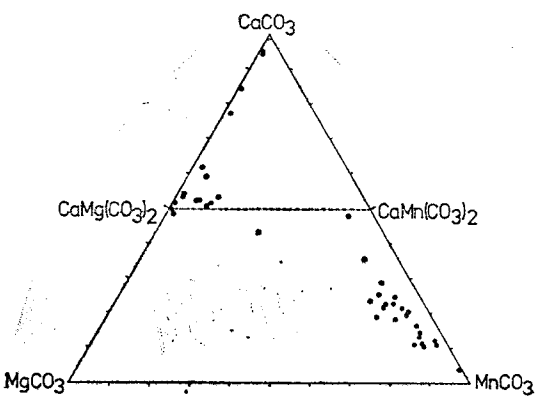

Fig. 9. Chemical variation of the manganese carbonate and associated minerals from Janggun Mine presented in terms of $CaCO_3$-$MgCO_3$-$MnCO_3$.

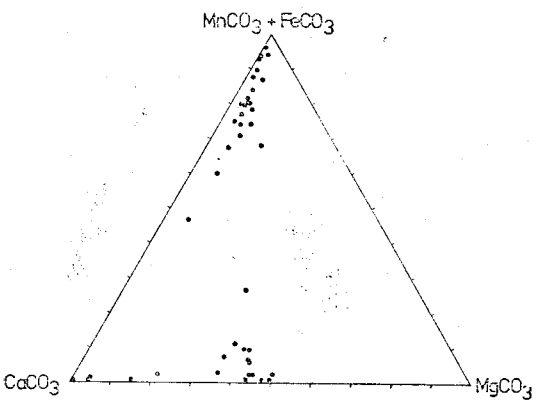

Fig. 10. Chemical variation of the manganese carbonate and associated rocks from Janggun Mine presented in terms of $CaCO_3$-$MgCO_3$-($MnCO_3$+$FeCO_3$)

Summary and Conclusion

The mineralogical, petrological and chemical studies of the new rock type, rhodochrostone from Janggun Mine, Korea, which is named by the present writer can be summarized as follows:

1) A new rock name, rhodochrostone, is proposed for the sedimentary rock which consists mainly of rhodochrosite.

2) From the systematic classifications of the rocks of rhodochrosite-calcite-clay and rhodochrosite-quartz-clay, respectively, the various new rock types are established.

3) The manganese carbonate beds at the Janggun Mine, Korea consist mainly of rhodochrostone and siliceous rhodochrostone with minor clayey siliceous rhodochrostone.

4) The average chemical composition of the manganese carbonate rocks at Janggun Mine is Si 3.58, Al 0.34, Fe 3.51, Mn 30.38, Mg 0.49, Ca 3.75, Pb 0.57, Zn 0.48, As 1.53, S 1.84 and P 0.016% The significant ratios of the elements are Si/Al=11.31, Mn/Fe=8.34, Mg/Fe=0.14, Ca/Mg=7.70 and Mn/Ca=8.10.

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薔薇岩 — 將軍鑛山產 新種 堆積岩

金 洙 鎭

將軍鑛山에서 産出되는 岩石으로서 菱망간石이 主構成鑛物인 炭酸鹽岩에 對하여 薔薇岩(Rhodochrostone)이라는 新岩石名을 命名하는 바이다. 이 薔薇岩은 石灰岩과 마찬가지로 海底에서 堆積作用에 依하여 生成된 堆積岩의 一種임에도 不拘하고 이 岩石에 對하여 지금까지 合理的이고 體系的인 岩石名이 世界에 걸쳐 없었다. 筆者가 薔薇岩 및 이와 關聯있는 各種岩石에 對한 鑛物學的, 岩石學的 및 化學的인 硏究로서 이들에 對하여 새로운 岩石名을 命名함으로서 망간을 含有하는 炭酸鹽岩의 體系的인 硏究가 容易하게 되었다. 世界各地에서 産出되는 類似한 炭酸망간岩에 對해서도 筆者의 分類法과 命名法이 適用된다. 筆者의 分類法에 따르면 將軍鑛山의 炭酸망간層은 主로 薔薇岩, 珪質薔薇岩으로 構成되어 있다. 炭酸망간層의 上盤과 下盤의 岩石은 含망간돌로마이트로 構成되어 있다. 將軍鑛山産 炭酸망간岩의 平均化學分析値는 Si 3.58, Al 0.34, Fe 3.51, Mn 30.38, Mg 0.49, Ca 3.75, Pb 0.57, Zn 0.48, As 1.53, S 1.84 및 P 0.016%이다. 含有元素들間의 相互關係는 Si/Al=11.31, Mn/Fe=8.34, Mg/Fe=0.14, Ca/Mg=7.70 및 Mn/Ca=8.10이다.

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