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Study on the Mineral Composition of the Terra Albas from Taedong Area

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According to the preceding researches [1－3], terra alba can be classified as: kaolinite-type, illite-type, montmorillonite-type and special terra alba-type by mineralogical classification; felsite-type, felsite dyke-type, neutral-acid eruptive rocks-type and sedimentary rocks-type by petrological classification; hydrothermal-alteration weathering-type, weathering-type and sedimentation-type by original classification; Al(OH)-type, X-type and S-type by petrochemical classification. And practically according to the usage it can be classified as basic materials in making pottery and industrial art works, as fillers of paper, rubber, resin, soap etc, as materials for refining oil and drinking water and as paint, fireproof materials, toxicant-removing-carrier, binding materials, food additives and medical minerals.

The terra alba deposit in our research area has been newly discovered, and its geological and mineralogical features have not been fully uncovered.

Since terra alba is composed of several clay minerals, it is difficult to determine its mineral composition by conventional methods. Therefore, the mineral composition of the terra alba was analyzed through polarization microscope identification, differential thermal analysis (DTA), XRD and IR.

Polarization microscope identification Micro-sections were made from fragments which were separated from terra alba during its elutriating. According to the polarization microscope identification, clastic minerals are quartz and feldspar.

Quartz is white, relatively clear and round like the unworn original rocks. Feldspar is white or light grey, flat-shaped and keeps most of its original form, but it is a little worn along the edge, showing irregularly appearing kaolinized parts. Though kaolinized parts appear like spots or pieces of threads inside the fresh feldspar grains, most of its original shape remains as it was. Hence it is certain that feldspar is efflorescence not of the allochthonic sediments but severely kaolinized autochthonous sediments.

Differential thermal analysis (**DTA**) DTA patterns were recorded at the heating rate of 20℃/min at the temperatures ranging from the normal temperature to 900℃ with “DTA-5”. Analytical conditions were as follows: the time constant was 3s; the sensibility was 20mg; the crucible was made of alumina; and the sample was (clay powder removed fragments from terra alba) 10mgs.

Endothermic effects appeared at the temperatures of between 80℃ and 120℃ and between 560℃ and 680℃.

The first endothermic effect is due to the separation of the absorption water from clay mineral and the second is due to the separation of the bound water from clay mineral.

The crystal structure has two layers in which one Si-O tetrahedral sheet is bonded to one Al-O octahedral sheet, hence (OH) is placed at the surface of the crystal structure. The dehydration temperature of the two layers-type is about 600~800℃. In montmorillonite Si of the Si-O tetrahedral sheet is replaced with Al and the disomorphous replacement occur between cations such as Al and Mg of the Al-O octahedral sheet, while it is hydrated by inserting cations between crystal layers in order to compensate the lack of electric charge. The layer water resulted from this hydration dehydrates at the temperature of between 100 and 200℃. So it is clear that terra alba is composed of clay minerals with two layers.

Exothermic effects due to combustion of ferrous hydroxide or organic matter appeared at the temperature of 450~500℃ in DTA patterns in several terra alba including the *Taesong* one. Because exothermic effects did not appear at the temperature of 450~500℃ in DTA patterns in terra alba from the research area, it was not composed of ferrous hydroxide or organic matter.

XRD X-ray diffraction(XRD) patterns of samples were recorded at a scanning rate of 1°/min(2θ) using a Rigaku-MINIFLEX diffract meter (Cu Kα radiation, λ=0.154051nm, step 0.02°, measuring angles from 3 to 80°, measuring time 0.48s, CuKα radiation, voltage 40kV, current 12mA)

Table 1. The XRD analysis results of the terra alba

No.	$2\theta/(^\circ)$	$d/(\times10^{-10}\mathrm{m})$	R－I	A－I	mineral	No.	$2\theta/(^\circ)$	$d/(\times10^{-10}\mathrm{m})$	R－I	A－I	mineral
1	8.60	10.30	40	177	halloysite	14	42.20	2.14	18	78	feldspar
2	12.10	7.31	52	230	kaolinite	15	45.10	2.01	20	90	kaolinite
3	17.50	5.06	16	69	－	16	49.87	1.83	25	110	quartz
4	20.60	4.31	39	172	kaolinite	17	54.77	1.67	14	63	quartz
5	24.57	3.62	44	193	halloysite	18	59.77	1.55	20	86	quartz
6	26.40	3.37	100	441	quartz	19	62.07	1.49	13	56	kaolinite
7	29.57	3.02	15	68	feldspar	20	67.60	1.38	15	67	quartz
8	34.70	2.58	14	79	illite	21	68.03	1.38	20	87	quartz
9	35.77	2.51	14	61	－	22	69.17	1.36	10	44	quartz
10	36.33	2.47	22	95	kaolinite	23	70.00	1.34	10	43	feldspar
11	39.27	2.29	15	68	quartz	24	73.17	1.29	11	39	illite
12	40.07	2.25	12	52	illite	25	75.50	1.26	10	44	feldspar
13	40.93	2.20	8	34	illite						

As you can see in the Table 1, the terra alba from the research area is composed of clay minerals (kaolinite, halloysite and illite) and clastic minerals (feldspar and quartz).

FTIR The result of FTIR analysis is as follows: "FTIR-8101", resolving power 4.0mm^{-1}, summation frequency 40, recording speed 2.8mm/s, transmission.

The violent absorption curve near 3 580cm^{-1} is due to the OH^{-1} type of bound water and the other curve near 1 000cm^{-1} is due to the vibration of Si－O－Si, Si－O－Al and Al－OH^{-}. This property complies with the infrared absorption character of kaolinite.

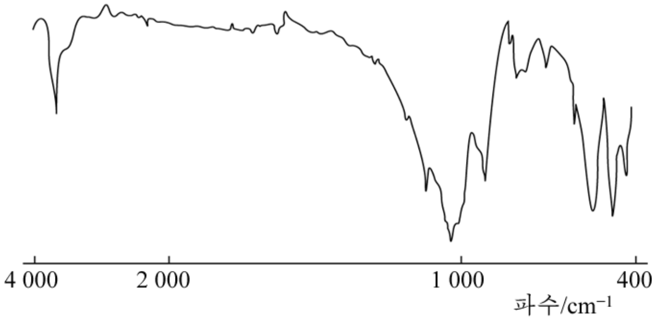

Fig. The FTIR of terra alba from the research area

To summarize the analysis results, the terra alba is composed of clay minerals (kaolinite, halloysite and illite) and clastic minerals (feldspar and quartz), and does not contain ferrous hydroxides (magnetite and limonite etc), iron sulfides and organic matters.

We made Micro-sections from fragments of the terra alba of our research area and examined how the mineral compositions of terra alba differ depending on ore bodies and wells using the polarization microscope identification method (Table 2).

Table 2. The mineral composition of terra albas according to the ore bodies and wells

Ore body	Well number	Clay mineral	feldspar	quartz	Ore body	Well number	Clay mineral	feldspar	quartz
Kosan	3－ㄴ	77.36	5.21	17.36	Kosan	6－ㄷ	82.50	2.50	15.00
〃	9－ㄱ	77.00	5.37	17.63	〃	6－ㅁ	78.00	5.00	17.00
〃	10－ㄴ	76.25	5.75	18.0	〃	6－ㄹ	76.50	5.50	18.00
〃	3－ㄱ	72.25	8.50	19.25	Ogum	3－ㄴ	72.90	7.70	19.40
〃	4－ㄴ	76.00	6.00	18.00	〃	3－ㄷ	76.25	6.00	17.75
〃	1－ㄱ	72.10	8.50	19.36	〃	4	73.00	8.20	18.70
〃	2	74.80	7.00	18.30	〃	6	77.25	6.00	16.75
〃	2－ㄱ	69.25	9.75	21.00	〃	20－ㄱ	70.33	10.17	19.50

Though the mineral compositions differ a little according to the ore bodies and wells, it is remarkable that its range of content change is very small. From this, it is clear that the terra alba has been formed as a result of the even efflorescence of the feldspathic rocks, the original rocks.

Conclusions

Terra alba from the research area is composed of clay minerals of 70~82%, feldspar of 4~11% and quartz of 15~20%, and was formed by efflorescence of feldspathic rocks. Though the mineral composition differs a little from one ore body to the other and from well to well, the range of its content change is very small.

References

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