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DETERMINATION OF MINERALS OF RARE EARTH ORES IN MONGOLIA AND THEIR PROCESSING

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ABSTRACT

Synchisite is one of the main economic minerals of rare earth ores deposit on the territory in Mongolia. Research data on the opening and dressing processes of Synchisite was poor. The Synchisite mineral contains Rare earth elements (REE) of cerium group. Taking into account the existing rare publication and research materials on production technology that uses current mineral at the REE production, the Lugiin Gol rare earth elements deposit of our country may be considered without analogue world-wide.

Therefore, despite that in our country former was not carried out technology research work for enrichment and processing of REE ore, in result of research work was proved that Synchisite could be a raw material of REE production like bastnasite, monazite, parisite, xenotime.

INTRODUCTION

The Synchisite mineral of rare earth elements was established through combination of X-ray phase, derivatography, mass spectrometric analysis methods and comparison of etalon samples.

A possibility of raising the Synchisite dressing by 20-25% is shown. It's REO being raised by 8-10% at the expense of its total dressing from the particles with size of - 0.05 mm fractions by using a method of flotation and subsequent separation of the sediments produced.

The choice of a chemical process for processing the concentrates is stipulated by the physical and chemical characteristics of the raw material, the composition of the minerals and its compounds.

EXPERIMENTAL

The essence of our processed and containing REE method for enrichment of fluorine carbonated ore consists in 3 stages of enrichment of pyrite, calcite, REE. During the enrichment of calcite, in order to enrich and separate calcite and REE minerals, through change of REE ore surface enrichment activation with support of metal gel gumine acid, completion of classic conditions to set flotole-7.9 collector reagent, was established the possibility to extract REE concentration with REE 27-32 percent specific content and 72-80 percent recovery metal sample.

For the determination of the Synchisite concentrate there have been applied the following methods as infrared spectroscopy, X-ray diffractometry, differential thermal analysis and mass-spectrometry.

The infrared absorption of the Synchisite concentrates was registered by a two-ray spectrometer UR-20 within the range of 400-1600cm.

The differential thermal analysis was carried out at the derivatigraph of a Paulic-Erdey system at heating speed of 10^0 /min to 1.000^0C.

The concentrate was heated in the furnace resistance at constant speed while the gases being educed analyzed with a statistical mass-spectrometer MX1307M. The X-ray analysis of the Synchisite concentrate was carried out with the diffractometry DRON-2.

RESULTS AND DISCUSSION

In spite that there are discovered deposits and occurrences of rare-earth elements (REE), niobium, zirconium, tantalum at the alkaline granite, carbonatite, fluorine carbonatite, apatite rocks in the territory of Khovd, Uvs, Dornogobi, Umnugobi and Bayan-Ulgii provinces of our country, and preliminary explorations of some deposits (Khalzan burged, Tsakhiurt, Ulaan and Shar tolgoi, Maikhan tolgoi , Mushgai hudag) were at starting point, the ore reserve of the Lugiin gol deposit, that represents REE deposit and where the technological research had been done, counted by 500000 tons and the average content of synthesis oxide of REE was 3.3%.

The oxidized ore of that area is enriched with minerals of metal and manganese /hematite, magnetite, limonite, psilomelane/. In addition, it was established that current ore is a synthesis ore that contains such minerals as calcite, magnesite, quartz, pyrite, sphalerite, fluoric spar, ilmenite, galenite.

The deposit Lugiin gol is studied full enough in the geological attitude. The tentative estimation of stocks on ore and on the sum rare earth elements is executed.

Table 1. Inter plane distances of some minerals and ores of Lugiin gol deposites

Literatura				Ore of Lugiin gol	
Bastnesite		Synchisite			
d(A^0)	I	d(A^0)	I	d(A^0)	I
4.88	40	9.1	60	9.17	9
		4.53	50	4.58	10
				3.85	6
3.564	70	3.55	100	3.56	8
		3.32	40	3.34	2
				3.24	4
		3.97	30	3.04	100

				2.892	28
2.879	100			2.839	3
		2.80	100	2.802	9.5
2.610	1				
2.445	9			2.492	5
				2.4068	6
		2.30	20		
		2.28	20	2.283	13
2.273	3	2.06	50	2.0612	5
2.057	40	2.01	20	2.0179	6.5
				1.9244	3
		1.934	50	1.9209	16
		1.873	40	1.8732	17
		1.821	5		
1.783	9	1.777	10	1.7786	5
1.674	21			1.6234	5

Table 2. The maintenance of the basic components in investigated test of ore Lugiin gol deposite, %

1	**Component**	**Content**	1	**Component**	**Content**
1	SiO_2	4.0	9	CO_2	33.9
2	$Al_2 O_3$	1.0	10	Na_2O	0.15
3	$Fe_2 O_3$	5.3	11	K_2O	0.1
4	TR	8.6	12	$Nb_2 O_5$	0.01
5	CaO	33.6	13	$Ta_2 O_5$	0.02
6	MgO	5.3	14	$P_2 O_5$	0.12
7	MnO	4.5	15	TiO_2	0.07
8	PbO	0.3	16	ThO_2	0.14

The technology research work for ore enrichment of Lugiin gol REE deposit through the method of flotation was done in Poland. Regarding the technology, it was evident that there was used the technology of bastnasite ore enrichment of Mountain-Pass.

The method of drifting enrichment technology has such shortcomings in terms of technology as too much complex operation, number of stages, requiring much heating, as well as regarding the Polish technology has insufficient metal sampling and the application volume of vapor and water is high..

In order to carry out enrichment experiment through the gravitation method we have established newly the chemical and ore mineral content of present deposit.

Whereas the content of ore mineral were /%/: calcite-43.6, dolomite-25.9, Synchisite -11.05, monazite-0.36, parisite -0.71, pyrolysite-2.68, hematite-4.01, fluoric spar-6.05, nepheline-1.35, quartz-1.81, they were through chemical content /% oxide/: calcium-35.5, magnium-5.77,

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alluminium-1.69, iron-3.55, carbon-33.92, kalium-0.9, natrium-0.25, silicium-6.29, phosphor-0.14, titanium-0.08, sulphur-0.1, REE - 6.54.

Because the ore enrichment depends upon the amount of ore powdering, through the research to determine powdering kinetic regime was established the accumulation of REE Synchisite mineral in a fraction less than 0.4 mm, as well as in order to separate fully the Synchisite mineral at -0.05 mm from other minerals is effective the use of pivotal mill.

The main purpose of research work for enrichment of Lugiin gol REE ore consists in extracting 20-20% concentrate required for chemical-metallurgical processing and for this purpose about 2.0 ton ore of present deposit was enriched and tested in 2 versions on the semi production experimental equipment of Mining Institute by the Kola Scientific Center at the Russian Academy of Sciences.

The extracted REE concentrate was processed by the chemical-metallurgical method, at the technological research for extracting their synthesis acid was carried our the experiment of method for processing with nitrogen acid and sulphur acid, as well as at research of extrcated prodsucts were used X-ray phase, derivatography, IK and mass-spectrometry methods.

Considering the publication materials, it would be widely used the technology process at which the REE would be melted by sulphur acid and sodium, the melt dissolved in water /in case, if the content of fluorine is high/ and REE transferred into water. But because in our country's Synchisite concentrate has less fluorine concentrate, in results of experiment was proved the possibility to extract REE synthesis oxides with 89-95% content and 97% metal by burning the concentrate and dissolving in 50% nitrogen acid.

The infrared spectroscopy analysis of the Synchisite was performed for the samples of gravity (1), flotation (2) concentrate and the concentrate being at a temperature of 800^0C (3) (fig.1).

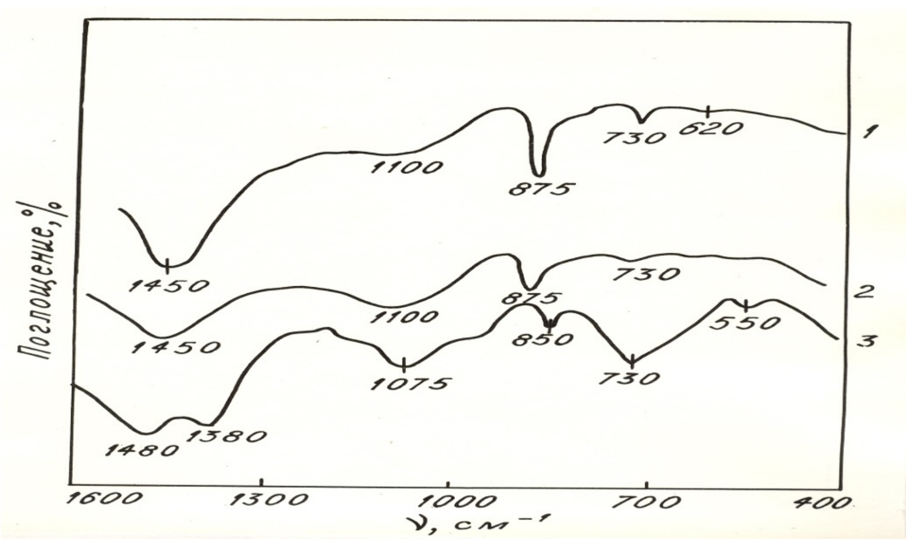

Figure 1. The infrared spectroscopy analysis

The absorption taken place at a 1480cm^{-1} might be apparently explained in connection with the fluctuations of a group pertaining to E (ν) (C-O). the absorption at a 1100cm^{-1}

Should be accounted for with the mixtures being contained in the samples studied. The absorptions at 630 and 550cm^{-1} are likely to be associated with M-O where M is REE or other components. The coincidence of the absorption range of the Synchisite concentrate with the standard samples of the Synchisite at 550 to 620.730. to 875. 1075 to 1100 and 1450 to1480 cm^{-1} evidences that the major carrier of the rare earths in ore is Synchisite.

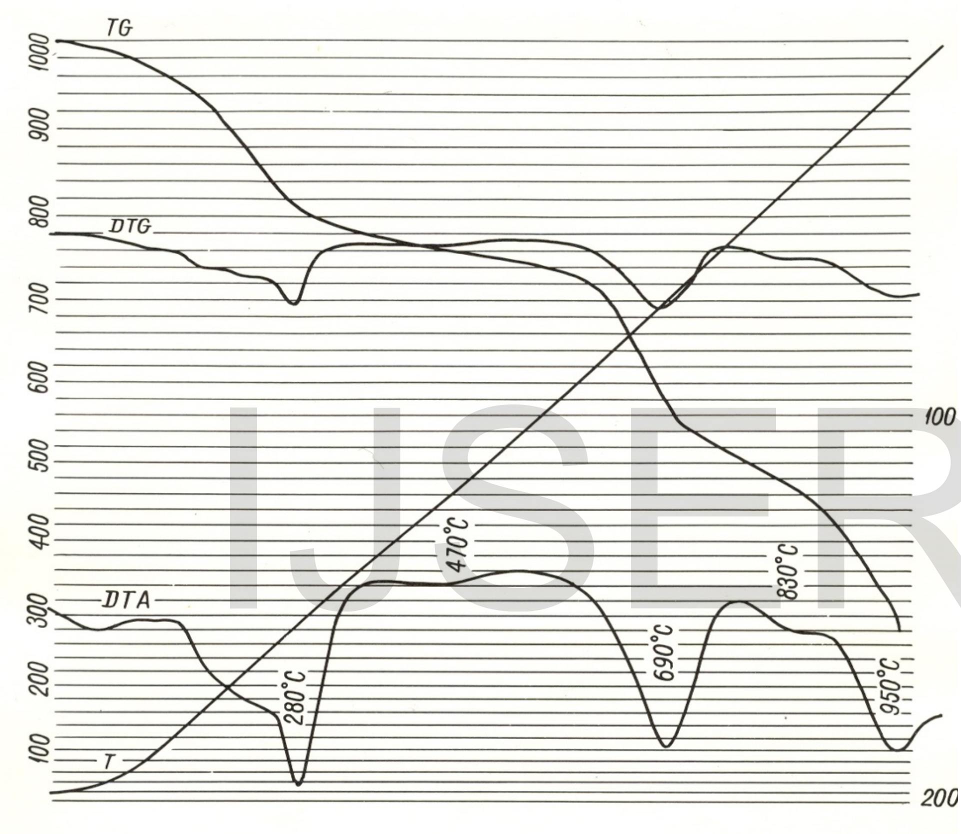

Figure 2. Differential Thermal analysis

Proceeding from the analysis of the derivatogramm the following conclusion is possible to be arrived at: the first effect in the range up to 280^{0}C is connected with a loss of the molecular water, the effect at a temperature of 470 to 600^{0}C signifies a decomposition of the Synchisite while the effect on temperature changes from 690 to 830^{0}C is to be characteristic the dissolution of carbonates of a bronerite (about 690^0) and calcite types together with dolomite (830^0). The step-by-step gradual character of the curves regarding the weight loss is much likely to evidence the hydration of the Synchisite and a partial substitute of CO_2 with hydroxyl groups. The total mass losses percentage under the heating accounts for 29.9 %.

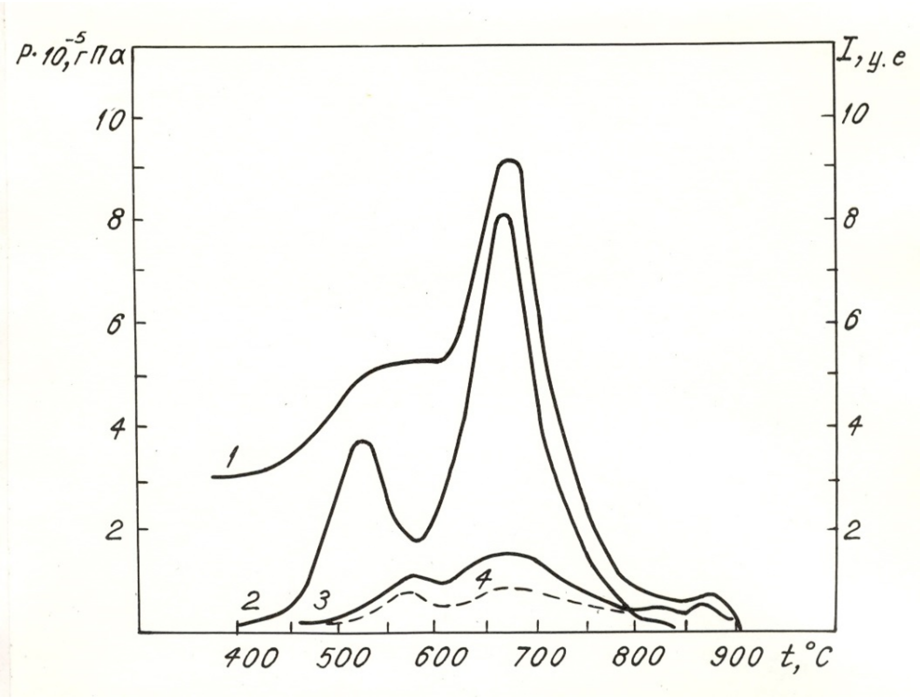

Figure 3. Mass specters

On Fig.3 there are presented poly terms of the general pressure and ionic currents of gaseous components (CO_2 and CO) produced on a thermal decomposition of a Synchisite concentrate.

It was to be expected that CO_2 is educed in two stages: around 500 to 530^{0}C and 670 to 700^{0}C.

In our opinion, the CO_2 an appear only due to the oxidation of cerium.

$Ce_2(CO)_3 \rightarrow 2\,CeO_2 + 2\,CO_2 + CO$

The fact of the cerium being subjected to oxidation is interesting in the respect that in the process of thermal treatment it is being transformed into a tetravalent form.

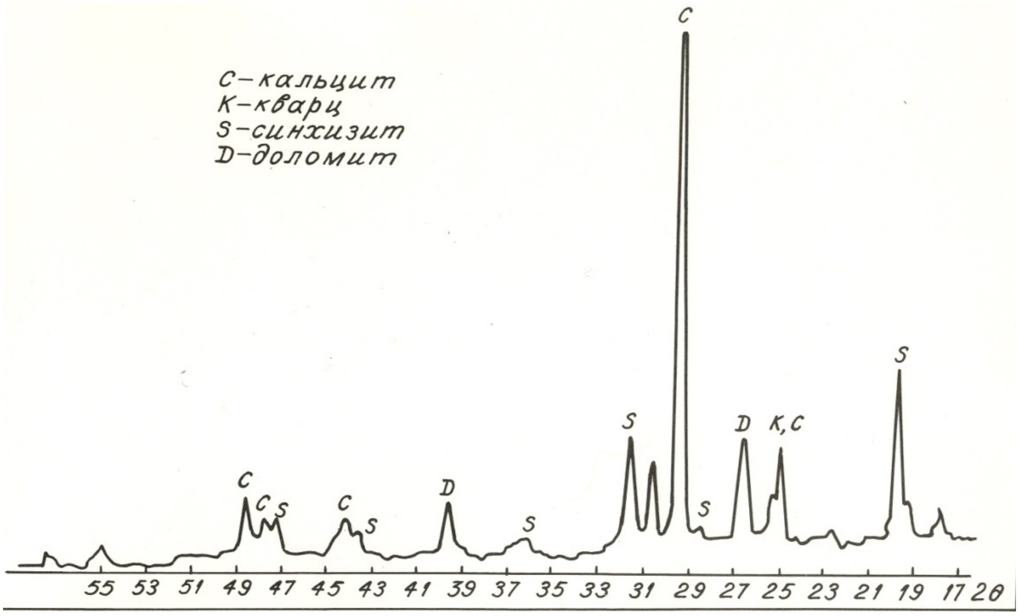

Figure 4. X - ray diffraction

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The results of the thermal analysis and infrared spectroscopy are in good agreement with the data of the X-ray phase analysis (Fig.4).

Taking into account the results of the thermal and mass spectrometric analysis the charring of the concentration was carried out in the range of temperatures from 400 to 800^0C, during which it was proved that the mass loss of the concentrate amounted to approximately 30% (Fig.5).

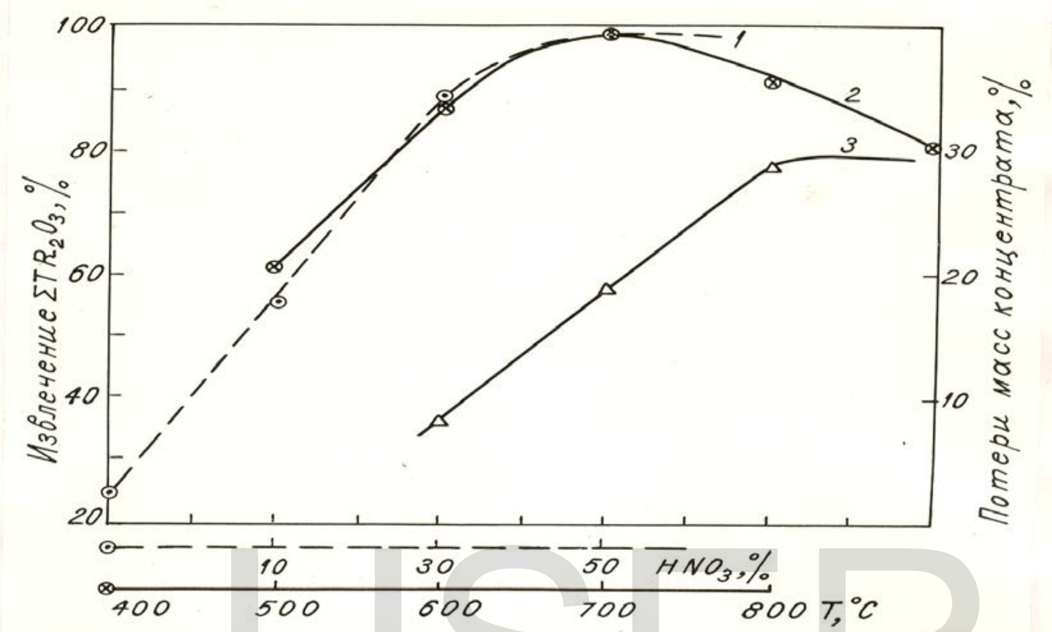

Figure 5. Concentration HNO_3 and anneal temperature dependence of the REO recovery (1,2) and temperature dependence of loss mass (3).

Taking into account the results of the thermal and mass spectrometric analysis the charring of the concentration was carried out in the range of temperatures from 400 to 800^0C, during which it was proved that the mass loss of the concentrate amounted to approximately 30% (Fig.5).

For the lixiviation of the Synchisite concentration charred there were utilized 10 to 50% solutions of HNO_3 prepared from 67% nitrogen acid.

At a temperature of the charring not exceeding 400^0C recovery of the rare earth elements to the solution is not to be above 62% (Fig.5).

Which might be caused by the fact that a thin dissemination of Synchisite in minerals of the barren rocks is not being revealed due to a lack of its contact with acid.

The further raise of temperature leads to the opening of even those particles of the Synchisite and a temperature risen up to 600^0C the recovery of ERT to the solution reaches its highest values (97.1%).

The reduction in the REO recovery while temperature being raised further is associated with the formation of heavily soluble substances in particular cerium oxide in tetravalent form (CeO_2) and associates on a calcium basis. In order to dissolute them and thereby to increase the rate of recovery it is necessary to increase the time of dissolution or raise the acid concentration.

However an application of to much acid is not advisable for a following extraction of the REE.

As we have done an experiment to dissolve current concentrate by sulphur acid, we have extracted REE synthesis oxide with 76% content through dissolving sulphatized rests with water and sedimentation of solution with natrium alkaline. The following recovery of individual REE from nitrogen acid solution is executed as per a familiar technique by means of a liquid extraction with the utilization of different organic extra gents in the cascades of a few stage number.

Taking into account the preliminary geological exploration carried out in the Khalzan burged deposit located in the territory of Khovd province and containing rare metal, the content of rare metals and their preliminary established reserves, main minerals of present deposit are: zirconium silicate, pyrochlore, eudialyte, xenotime and REE fluorine carbonates.

The content of present deposit's rare metals as follows /%/: oxides of niobium 0.14, RE Elements -0.35, zirconium oxide-3.35.

We have carried out experiments to research possibilities for enrichment of present deposit's ore. In results of research work we have established that the ore of present deposit has much amount of radioactive substances, made conclusion that it is required to pay attention during the next technological experiments and put continual control over technological process.

CONSLUSION

Through the technology research of Lugiin gol ore enrichment, that represents REE deposit of our country was developed the technology for enrichment of present deposit's ore.

During the enrichment process of magnetite-apatite kind ore of the waved well was developed a version of technology for also possible enrichment of REE contained in it.

There were performed initial works to establish mineral and chemical content of ore of rare metals containing niobium, REE and zirconium of the Khalzan burged, as well as to research enrichment properties. It is required to establish geological and geochemical structure of present deposit, carry out large scale of technological research for ore enrichment and concentrate deep processing.

Through the research work was developed the technology for processing the concentrate by which was extracted the ore of the Lugiin gol by the chemical-metallurgical method and extraction of their synthesis oxide.

REFERENCES

Khaumdas Ashim. *“ The technological features of dressing and processing of the rare earth ores of Mongolia”* (in Russian). Ulaanbaatar. “Sorkhon tsagaan” Publishing house. 2006, 127 pp.

Khaumdas Ashim. “*Study of technological specific characteristic of the rare earth elements of Mongolia difficult of dressing”*. Dissertation for a degree of CANDIDATE of Technical Sciences., Almaty, 1995. 206pp

Khaumdas Ashim, Tuguldor N. “*Method of concentrating Fluor carbonate ores of Mongolia”*. Copyright N673, Ulaanbaatar. The first publication 4-7-1992.

Khaumdas Ashim, Rakaev A.I. and others. “*The developing of the rational technology of the Synchisite ore concentration”*. Proceedings of the 2 nd International Conference on Rare Earth Development and Application. Beijing, China. May 27-31. 1991. Vol.1.p.484-486.

Mihailichenko and others. “*Rare earth metals*”. Moscow.’ Metallurgy’ Publishing house. 1987, 232 pp.