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BENEFICIATION OF KYANITE ORE FROM THE RADIUM HILL DISTRICT.

by

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BENEFICIATION OF KYANITE ORE FROM THE RADIUM HILL DISTRICT.

-Abstract-

This report covers preliminary investigations for determining suitable treatment methods to produce a kyanite of marketable grade for refractory purposes.

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1. SUMMARY.

Market grade specifications of kyanite for Australian consumers vary, but are approximately as follows:

Alumina.	Al_2O_3	62	percent	minimum.
Iron Oxide.	Fe_2O_3	2	"	maximum.
Titanium Oxide.	TiO_2	2	"	maximum.
Lime, Magnesia, Alkalies		0.5	"	maximum.

Although chemical analyses of experimental products were not made, it was obvious from the presence of chlorite and biotite that market grade material was not produced.

Heavy media treatment gave a sink product containing 58.2 percent of the kyanite in 14.4 percent weight of the original ore.

Electro-magnetic treatment of this sink product failed to produce a chlorite-free kyanite quartz fraction.

Gravity treatment on the ore as received, using shaking tables, failed to effect a satisfactory separation, probably due to the small specific gravity difference and the shape of the various minerals.

Electrostatic separation of the ore produced a fairly clean kyanite product but the recovery of kyanite in the concentrate was very low.

The results obtained from flotation were not encouraging since it was found difficult to prevent mica floating with the kyanite.

The results obtained were not very encouraging but the investigation was only of a preliminary nature. It is considered that further work is justified particularly with reference to magnetic and electrostatic separation and also in an investigation of the effect of grain shape.

2. INTRODUCTION.

A deposit of kyanite occurs a few miles from Radium Hill. Geological investigation of the deposit indicates the existence of a considerable tonnage of ore. The mineral occurs associated with large scattered masses of biotite schist, which are estimated to contain 20 percent kyanite.

A sample of approximately five tons received by the Metallurgical Section was used for the test work described in this report. The beneficiation programme was aimed at the production of a high grade kyanite concentrate suitable for use as a refractory.

3. MATERIAL EXAMINED.

Five tons of kyanite ore was received from the Radium Hill district. Mineralogical analysis showed that this sample contained 9 percent kyanite.

4. EQUIPMENT USED.

The following laboratory scale equipment was used.

(a) Cone type heavy media separation (20 inch diameter).
(b) Wilfley table.
(c) Pneumatic table.
(d) Induced roll magnetic separator.
(e) Electrostatic separator.
(d) Fagergren flotation cell.

5. EXPERIMENTAL PROCEDURE.

Portion of the ore was crushed to minus 1/2 inch and the plus 10 mesh fraction was subjected to heavy media treatment.

Magnetic separation tests were carried out on the original ore, the minus 10 mesh fraction of the ore, and on the heavy media sink product.

Wilfley tabling, pneumatic tabling, electrostatic separation and flotation tests were carried out on the original ore.

6. CONDITIONS and RESULTS.

6.1 Heavy Media Separation.

A sample of the ore was crushed to minus 1/2 inch, and the minus 10 mesh material screened out.

The minus 1/2 inch plus 10 mesh fraction was then subjected to heavy media separation in a ferrosilicon medium of specific gravity 2.7.

Mineralogical estimations and distributions of the products are given in Table 1.

TABLE 1.

Results of Heavy Media Separation.

Product.	Percent Weight of Original Ore.	Mineralogical Examination Percent Kyanite.	Percent Distribution Kyanite.
Sink fraction.	14.4	28.5	58.2
Float fraction.	50.1	3.9	27.6
-10 mesh material.	35.5	2.8	14.2
Original Ore.	100.0	7.1 (calc.) 9.0 (actual).	100.0

6.2 Gravity Table Concentration.

Although the difference in specific gravity between kyanite and the chlorite biotite gangue material is not great, gravity treatment on tables was tried to determine whether the difference in particle shape would aid the separation of the minerals. Kyanite occurs as long thin blade-like crystals, while the "black micas" occur as flat plates.

Samples of run-of-mine ore were treated at minus 10 mesh and minus 28 mesh (Tyler) on a laboratory size Wilfley table, and on a laboratory size pneumatic table.

In both instances poor recovery and little upgrading was achieved so further test work was abandoned.

6.3 Magnetic Separation.

6.3.1 Induced Roll Magnetic Treatment of Run-of-mine ore.

Due to the difficulty of assessing results by chemical analysis, and since the kyanite product must be low in iron content, the elimination of biotite and chlorite was taken as the criterion of separation efficiency.

Portions of the ore were crushed to varying degrees of fineness ranging from minus 14 mesh to minus 65 mesh (Tyler) and the minus 200 mesh material from each portion screened out.

Magnetic separation tests were carried out on the plus 200 mesh fractions.

The machine was adjusted to produce a first and a second magnetic fraction each containing as little kyanite as possible, a non-magnetic fraction free of magnetic material and a third magnetic fraction suitable for recycling as a middling product.

In no test was a kyanite-quartz product obtained free from chlorite biotite contamination.

6.3.2 Induced Roll Magnetic Treatment of Heavy Media sink Fraction.

Tests were carried out on samples of heavy media sink material crushed to varying degrees of fineness, the minus 200 mesh material being screen out in each case.

The best results were obtained using minus 14 plus 200 mesh material.

Weight percentages of the products of this test with results of visual examination, are given in Table 2.

A screen analysis of the non-magnetic fractions, with results of visual examination of the screen fractions, is given in Table 3.

TABLE 2.

Results of Magnetic Separation of Heavy Media Sink. (minus 14 plus 200 mesh).

Product.	Percent Weight of Heavy Media Sink Product.	Percent Weight of Magnetic Separator Feed.	Observations.
1st Magnetics.	5.5	6.4	Predominantly chlorite and biotite, some fine kyanite.
2nd "	9.2	10.7	" " " " "
3rd "	13.0	15.1	Chlorite and biotite, some kyanite and quartz.
Non magnetics.	58.3	67.8	Mainly/quartz and kyanite, some coarse biotite and chlorite.
Minus 200 mesh.	14.0	-	Fine quartz, minor chlorite kyanite and biotite.
	100.0	100.0	

TABLE 3.

Screen Analysis of Non-Magnetic Fraction.

Mesh Tyler.	Percent Weight of Fraction.	Percent Weight of Heavy Media Sink Product.	Observations.
- 14 + 28.	31.6	18.4	Mainly kyanite, biotite and chlorite.
- 28 + 35.	22.8	13.3	Predominantly kyanite, some quartz.
- 35 + 48.	25.4	14.8	About equal parts kyanite and quartz.
- 48 + 65.	10.6	6.2	Mostly quartz, little kyanite.
- 65.	9.6	5.6	Almost pure quartz.
	100.0	100.0	

6.3.3 Induced Roll Magnetic Treatment of Minus 10 mesh Fraction.

The minus 10 mesh material screened off prior to heavy media treatment was subjected to magnetic separation without further size reduction but no satisfactory separation was obtained.

6.4 Electrostatic Separation.

A sample of run-of-mine ore was crushed to minus 10 mesh and fed to the electrostatic separator without any prior conditioning treatment. The results however were poor as very little separation occurred. A further sample was crushed to minus 20 mesh, and the minus 65 mesh fraction screened off. The minus 20 mesh plus 65 mesh fraction was then conditioned as a pulp with sulphuric acid, washed and dried and further conditioned with benzoic acid.

The acid conditioned sample was fed to the electrostatic separator in which a good separation of biotite and chlorite from quartz and kyanite was obtained. The non-conducting quartz kyanite fraction was repassed twice to give a clean product. However, the recovery of kyanite in this fraction was very low and no further electrostatic tests were carried out.

6.5 Flotation.

Flotation tests were carried out on 500 gram charges of run-of-mine ore which had been crushed to minus 10 mesh. All samples were ground to 60 percent solids in a laboratory ball mill prior to flotation in a Fagergren laboratory flotation cell.

6.5.1 Kyanite Flotation.

Three tests were carried out in alkaline circuit using oleic acid to float the kyanite and sodium silicate as a depressant for quartz.

A heavy voluminous froth, carrying most of the kyanite, was obtained in the preliminary test, and although starvation amounts of oleic acid gave better results, the concentrate could not be cleaned of mica.

Five tests were carried out in acid circuit using varying proportions of Cyanamid reagents 801 and 825. In four of these tests the pulp was conditioned with sodium fluoride and sulphuric acid prior to addition of the cyanamid collector. Pine oil was employed as the frother.

In all tests a sticky froth was obtained carrying appreciable amounts of kyanite, but contaminated with biotite and chlorite which were not removed in the cleaning stages.

6.5.2 Mica Flotation.

Several tests were carried out in which the micaceous minerals were removed in a preliminary flotation step using an amine type reagent in acid circuit after which a fatty acid type flotation was used to float the kyanite.

Results were fair although complete flotation of the mica was not achieved in the preliminary step, and the fatty acid float for kyanite was not very selective in acid circuit.

7. DISCUSSION OF RESULTS.

Preliminary investigations to determine possible methods ofrconcentration indicated that some methods may be eliminated as being unsatisfactory.

The methods investigated may be summarized as follows:

(a) Heavy media treatment gave poor results on the sample treated. On higher grade feed material a better grade and recovery could be expected.
Market grade product was not obtained.

(b) Magnetic treatment did not give complete removal of chlorite, and biotite, although market grade material was closely approximated. Recovery was poor.

The method appears feasible and further work is warranted.

(c) Gravity treatment on tables was not satisfactory due to the small difference in specific gravity between the minerals to be separated. The difference in particle shape did not aid the separation as was expected.

(d) Electrostatic separation appeared promising. Although recoveries were low, fairly complete separation of chlorite and biotite from kaynite was obtained. Further work is warranted in view of improvements made to the laboratory machine since the preliminary test work was carried out.

(e) Flotation shows promise, market grade was approximated though recoveries were low. Further work is warranted in view of improved fatty acid and amine type flotation reagents.

8. CONSLUSIONS.

An extension of the work on high intensity magnetic separation, electrostatic separation and flotation treatment, and on any method involving shape factor is warranted.

However, before this is done a more detailed appraisal of the deposit is desirable to determine the proportion and grade of the high grade ore in the deposit, as well as the tonnage of ore in the area as a whole.