

EMET KOLEMANİT CEVHERİ ÜZERİNDEKİ FLOTASYON ÇALIŞMALARI

FLOTATION STUDIES OF COLEMANITE ORES FROM THE EMET DEPOSITS OF TÜRKİYE

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ÖZET

Bu bildiriye ETİBANK Emet Kolemanit İşletmesine bağlı Hisarcik açık işletmesinin taban cevherinden alınan yüksek tenörlü kolemanit cevher numuneleri üzerinde yapılan cevher hazırlama ve buna bağlı olarak flotasyon çalışmalarının sonuçları özetlenmiştir. Çalışmalarda cevherin öğütülebilirliği, tane boyut dağılımı, çözünürlüğü ve pratik açıdan yüzdürülebilirliği saptanmıştır. Sonuç olarak pratik flotasyon çalışmalarının sonuçlarının daha önce yapılmış teorik çalışmaların bulgularıyla uyum içinde olduğu gözlemlenmiştir.

ABSTRACT

In this paper the results of material characterisation and flotation studies of high grade colemanite ores from the bottom section of the Hisarcik open pit mine of ETTBANK at the Emet deposits, Türkiye are reviewed. Grindability, particle size distribution and practical solubility of samples were determined prior to flotation tests. It has been observed that the results of the current studies are in general agreement with the findings of previous workers.

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1. INTRODUCTION : COLEMANITE FLOTATION

Although there has been only a limited number of reports of previous research on practical colemanite flotation, a wide range of flotation variables has been studied on the laboratory scale by several researchers over many years including measurement of theoretical solubility, pH values of the slurry, contact angle and zeta potential, and microflotation tests with the modified Hallimond tube, Partridge-Smith cell and other microflotation devices have been reported. (Yarar, 1985 ; Celik et al ,1992)

According to Yarar(1971), colemanite can be floated under certain conditions related to optimal particle size, natural pH value of the slurry, and usage of anionic type sulphonate collectors. When colemanite is put in water, it releases several species to the media, and the surface is charged to a certain electrokinetic potential, as well as pH value of the slurry is balanced. Altering acidity or basicity does not affect the natural pH value of the slurry during microflotation tests. Zeta potential of colemanite is decreased to the negative charge area with several anionic type of surfactants and this causes the flotability of this mineral.

Celik et al(1992) have reported that colemanite is floated efficiently when cationic (dodecyl amine hydrochloride) or anionic (sodium dodecyl benzene sulphonate) collectors are introduced into a slurry at the natural pH value. They also reported that theoretical solubility of colemanite in an aqueous system is 1.0 g/l, in broad agreement with Yarar's(1985) previous value of 0.8 g/l at ambient temperature.

The liberation particle size of colemanite ores from the Emet deposits is reported between 300 and 100 microns by several other investigators. (Kose et al ,1988)

The necessity of desliming the feed has also been discussed in several earlier studies. As colemanite is a very friable material, it forms fines readily during comminution processes. Previous researchers either cycloned the finely crushed sample or decanted the slurry after grinding prior to flotation. A suitable desliming particle size range was given as between 63 and 10 microns. (Yarar, 1971)

2. EXPERIMENTAL STUDIES

2.1. Source of the Samples

The samples used for flotation tests were taken from the bottom section of the Hisarcik open pit mine of ETIBANK at the Emet deposits by ETIBANK authorities and forwarded to the Mineral Processing Laboratory of the University of Birmingham.

A geological section map of the Hisarcik open pit mine is given in Figure 1 to illustrate the place where the current samples were obtained.

2.2. Sample Preparation and Particle Size Distribution Tests

All the main steps employed in the present studies on colemanite ore samples are illustrated as a flowsheet in Figure 2.

Raw colemanite ore samples sizing minus 200 mm were first crushed in a primary jaw crusher, then quartered once. While a quarter of the samples was stored for further purposes, the rest was crushed in a secondary jaw crusher, then crushed again in a tertiary roll crusher. Crushed colemanite samples were finally quartered four times in order to give an optimal amount of sample for dry grinding in a rod mill. The output of the rod mill was sampled by a spinning-riffler, and particle size distributions were measured on crushed and ground samples produced over different time periods. From the results, a 15 min grinding period was chosen as an optimum time for grinding, with 75-80 % of the material minus 210 micron. Under-over size graphs for the samples are given for comparison in Figure 3.

Ground samples were sieved through a set of sieves into particle size fractions of + 1000, -1000+500, -500+420, -420+300, -300+210, -210+106 and -106 microns and were then analysed in order to determine the B_2O_3 % content of each fraction (Vogel, 1989).

The fine fraction, minus 106 micron was then wet-sieved through a different set of sieves at apertures of -106+90, -90+75, -75+63, -63+45, -45+20 and -20 microns and the B_2O_3 distribution was determined. From examination of this data, it was decided to deslime at 20 micron in order to restrict the loss to about 20 % of B_2O_3 contained in the fines fraction. Figure 4 and 5 shows the graphs of size distribution for coarse and fine colemanite samples respectively.

2.3. Solubility Tests

There have been a number of previous studies of solubility of colemanite and these have reported that the solubility value of colemanite in water at ambient temperature under atmospheric conditions is between 0.8-1.0 g/l. However, none of these have investigated the solubility of colemanite in terms of the conditions prevailing during flotation processes.

In this study, the solubility value of colemanite under flotation conditions was determined with respect to solid/liquid ratio of the slurry, impeller speed of the

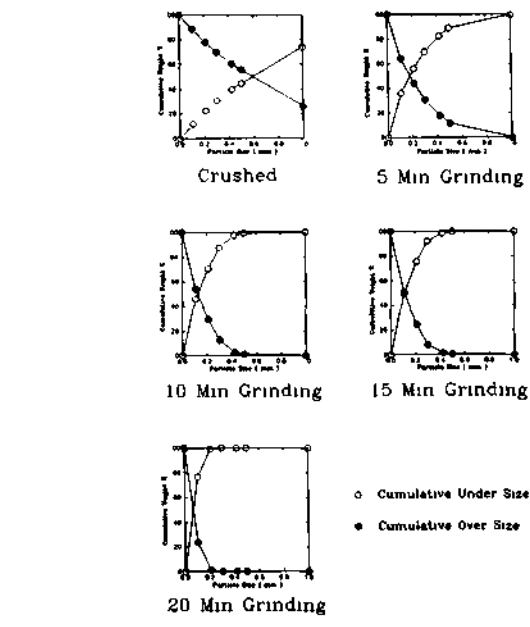
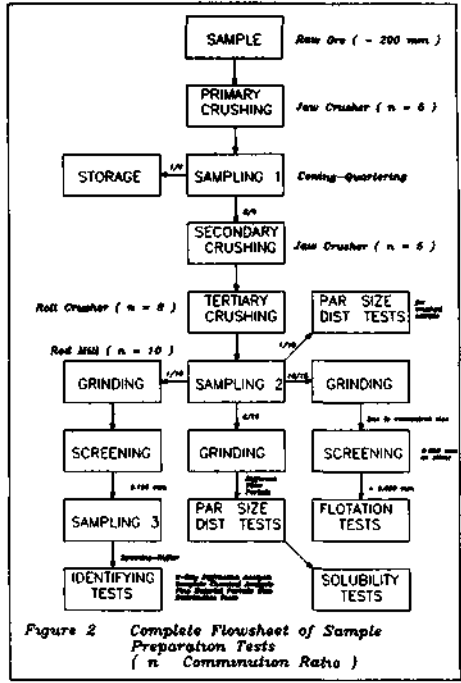
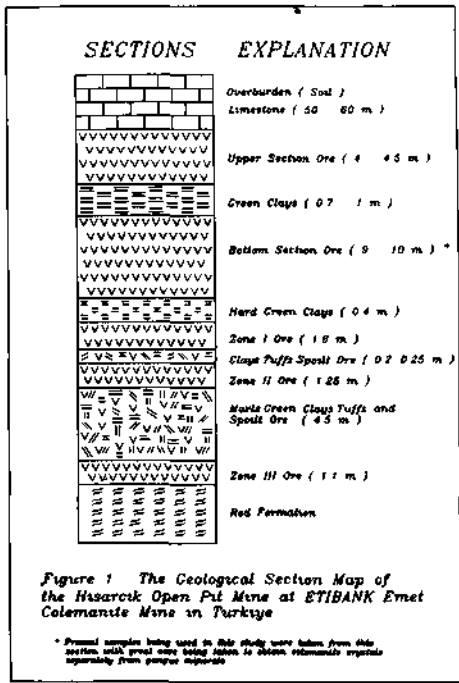


Figure 3 Under-over Size Graphs of Sample According To Different Grinding Time and Particle Size

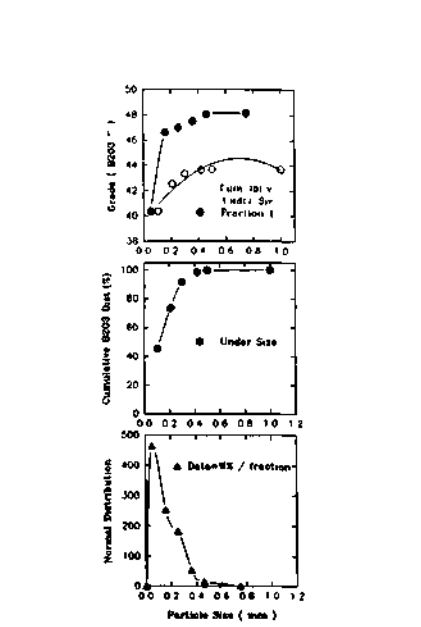


Figure 4 Size Distribution Graphs of Coarse Material

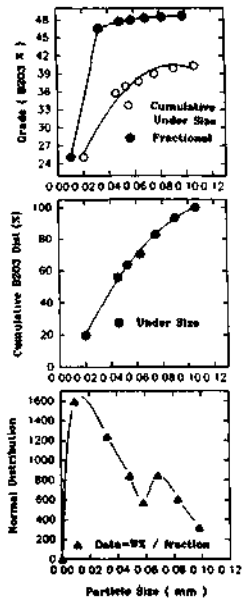


Figure 5 Size Distribution Graphs of Fine Material

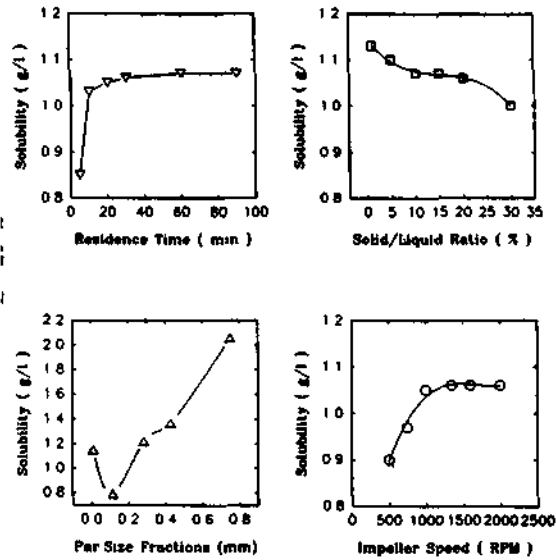


Figure 6 Solubility Graphs

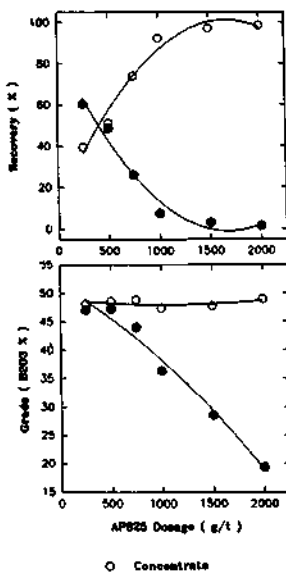


Figure 7 Graphs of Recovery and Grade Against AP25 Dosage

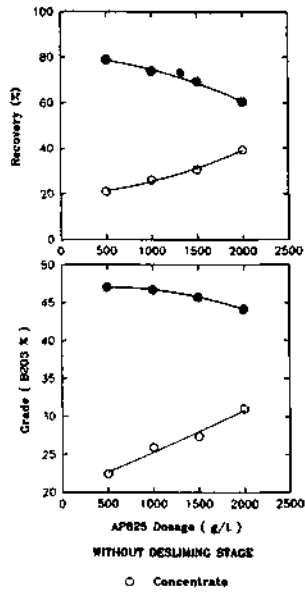


Figure 8 Graphs of Recovery and Grade Against AP25 Dosage Without Desliming Stage

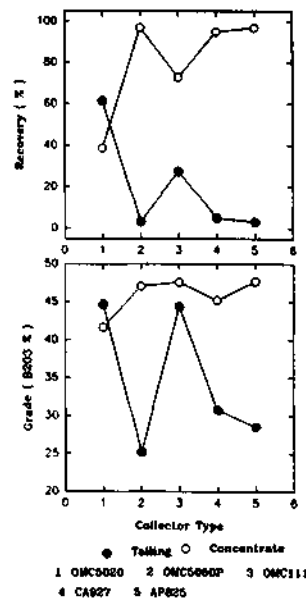


Figure 9 Comparison of Unconventional Collectors with AP25

flotation machine, residence time of the sample and particle size of the sample. Figure 6 shows the result of these findings together for comparison with each other.

The practical solubility value of the colemanite ore sample was determined as 1.05 ± 0.05 g/l under the conditions of subsequent batch flotation tests, i.e. 20 % solid/liquid ratio, -210+20 micron partical size range, 1350 RPM impeller speed and 10 min residence time.

2.4. Flotation Tests

In the current study a preliminary aim is to compare the use of unconventional reagents for colemanite flotation with conventional reagents. For this reason a number of flotation reagents was obtained from several mining chemical companies such as Cyanamid, Hoechst, Henkel and Allied Colloids. The reagents cover anionic type sulphonates, sulphates, sulposuccinates, sulposuccinamates and some fatty acids.

At first, AeroPromoter 825 (AP825) from Cyanamid was tried, since it has been shown to be an efficient collector for colemanite (Crozier, 1990 and 1992). AeroFrother 70 (AF70) from Cyanamid was employed at a constant dosage of 100 g/t. The feed particle size was -210 micron, solid/liquid ratio was 20 %, while the tests were conducted at the natural pH value of the slurry (8.5) and conditioning and flotation times of 5 min per stage were used. Fixed test parameters for each trial were ambient temperature at 20 ± 5 °C, impeller speed of 1350 RPM using a Denver SubA type flotation machine with 200 g sample and Birmingham tap water.

When tests were carried out without desliming the ore samples in advance, the consequent results were disappointing in terms of flotation yield, concentrate grade and recovery. However, an increase in AP825 dosage caused a slight increase in yield, grade and recovery of colemanite concentrate, although the values for tailings did not show a significant decrease and the feed grade was above the concentrate grade.

Similar dosages of AP825 collector were used in a second set of batch flotation tests with a desliming stage at -20 micron. In this case the results showed that when dosage was increased, the yield and grade of colemanite concentrates gave considerable increases in terms of B_2O_3 % content of the sample. While the concentrate grade was kept stable at about 48 % B_2O_3 , the tailing grade showed a sharp decline from about 40 % to 20 % B_2O_3 .

The effect of this desliming stage was that about 25 % of the feed sample by weight at about 20 % B_2O_3 content was discarded prior to flotation. Detailed results of batch

flotation tests with collector AP82S, with or without the desliming stage, are given in Figure 7 and 8 respectively.

The results show a flotation recovery of over 90 % and a final concentrate grade of 48 % B₂O₃ against the feed grade of about 40 % B₂O₃. However, feed grade was increased to about 45 % B₂O₃ after the desliming stage, and subsequently total recovery declined to about 75 % when the optimal AP825 dosage of 1500 g/t was employed.

Secondly, unconventional colemanite flotation reagents were tested under similar fixed test parameters with previous tests. Figure 9 illustrates the effect of optimal dosages of those collectors on colemanite flotation in terms of grades and recoveries of concentrates and tailings. Frother usage was found to be necessary at a dosage of 100 g/t, and the collectors were tried at different dosages for each experiment.

The collectors used were OMC5020(Partial sulphonated mixture of fatty material), OMC5050P(Petroleum sulphonate), OMCIII(Modified alkyl sulphosuccinate) from Henkel and CA927(sodium sulphosuccinamate) from Allied Colloids.

The results showed that while there was no significant improvement in recovery using OMC5020, the others affected the selective colemanite recovery. Determination of optimal dosages for these reagents are still under thorough investigation and only preliminary results are indicated in this paper.

3. DISCUSSION AND CONCLUSIONS

The current studies on colemanite flotation which are still being carried out reveal that colemanite from the Emet deposits are floatable when anionic type collectors covering sulphonates and sulphosuccinates are used in selective single stage batch flotation tests after a desliming process.

The feed particle size range used was minus 210 plus 20 micron material, obtained by 15 min dry grinding in a rod mill. The weight of slimes removed (i.e. minus 20 micron material), is about 20 % of input and this affects the total recovery to a level of 15 % in terms of B₂O₃ distribution.

Although the test samples consisted of high grade material after the desliming stage i.e. about 45 % B₂O₃, batch flotation tests were conducted in order to evaluate the efficiency of the flotation process under 'ideal' conditions and then the flotability of colemanite with unconventional collectors was tested.

Further investigations are currently being made to determine the nature of the slime coatings, their influence on flotation, and also to examine in detail the effect of unconventional flotation reagents for colemanite separation.

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