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Liberation studies of low grade copper ore from Kallur, Raichur district, Karnataka, India

R.Purushottam Reddy[1], R.N.Raghavendra[2]*, R.Nijagunappa[2]

[1]Department of Studies & Research in Earth Science, P.G. Centre, Nandihalli, Sandur, Karnataka, (INDIA)

[2]Department of Studies & Research in Environmental Science, Gulbarga University, Gulbarga - 585 106, Karnataka, (INDIA)

E-mail : raghavendra_nr@hotmail.com

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ABSTRACT

Copper, an important non-ferrous metal, is in great demand in India, resulting in a continuous import of large quantities. The development and exploitation of new reserves assumes importance in order to meet the increasing demand from internal production rather than through imports of the metal. Minerographic study indicates the presence Chalcopyrite, Pyrite and Specularite are the chief ore minerals associated with Quartz, Feldspar, Calcite and Hornblende as gangue minerals. For ore beneficiation, it is necessary to know the mesh size at which the ore minerals are liberated from the gangue minerals thereby controlling the grinding limit for good separation. The liberation studies of different sieve fractions indicating the extent of free and locked mineral particle in each fraction. The experimental results show a total liberation of 86.32% of all mineral at -150+200 mesh. In this paper, the liberation of Chalcopyrite at -150+200 mesh is 73.42% and average cumulative liberation for those minerals at -150 meshes can be theoretically expected to be 81.50%. Hence -150 meshes is chosen as the theoretical mesh of grind for the ore at which size the smallest grain of chalcopyrite would have been reduced 10 times for good liberation of the mineral.

KEYWORDS

Liberation;
Minerals;
Mesh;
Sieve fractions;
Grinding.

INTRODUCTION

Copper, an important non-ferrous metal, is in great demand in India, resulting in a continuous import of large quantities. The total Copper ore reserves in India[1] have been estimated to be 497 Million Tons of which an average of 2 Million tons is being processed at present. In this context the development and exploitation of new reserves assumes importance in order to meet the increasing demand from internal production rather than through imports of the metal. The total estimated reserves of the state us 19.4 MT. 4.5 MT are at present commercially exploited at Ingaldhal of Chitradurga and Kalyadi in Hassan district respectively. New ore reserves have been found at Tinthani, Kallur, Machnur and Aladahalli and exploratory drilling for copper in these areas started by the Dept. of Mines and Geology.

In this paper, a detailed account of the liberation

TABLE 1 : Approximate mineralogical composition of low grade copper ores of study area

Sl. No	Mineral group	Mineral constituents	Approximate percentage
1	Sulphides	Pyrite	8-20
		Chalcopyrite	9-10
		Covellte, Cubanite Bornite, Chalcocite	Traces
2	Oxides	Specularite	2-3
		Magnetite	Traces
3	Native metal	Copper	Traces
4	Silicate and salt type	Quartz	60-70
		Feldspar	15-17
		Calcite	2-3
		Hornblende	2-3
		Chlorite, Epidote Zoisite, Clinozosite Sphene	Traces

studies carried out on the low grade copper ore from Kallur, Raichur district Karnatak are described for commercial exploitation in future.

MINEROGRAPHY

Polished and thin sections of the Granitic rock samples have been collected from different depths in various bore holes have been studied under reflected light and petro logical microscope for identification of minerals. Chalcopyrite, Pyrite and Specularite are the chief ores minerals associated with Quartz, Feldspar, Calcite and Hornblende as gangue minerals. The Chalcopyrite mineral grains vary in size from 25 mm to 1 mm and about 5% of the mineral occurs as minute inclusions with the gangue minerals. The copper mineralization at Kallur area has been extensively studied by Phene et.al.[2].The mineralization belt is traceable over a strike length of 575 metres with an average width of 15 metres. The ore reserves have been estimated at about 2.47 million tones. Mineralogical composition is shown in TABLE 1.

LIBERATION

To beneficiate the ore successfully, it is necessary to know the mesh size at which the ore minerals are liberated from the gangue minerals thereby controlling the grinding limit for good separation. The extent of liberation at any size was obtained by microscopic examination of the representative samples of different sieve fractions indicating the extent of free and locked mineral particles present in each fractions. The results in following TABLE 2 show a total liberation of 86.32% of all the minerals at -150+200 mesh. 97.5% of liberation at -200+ 240 mesh and increasing to over 99 5 at sizes below 240 mesh. The average cumulative liberation assuming equal proportion of particles viewed in each size fraction can be calculated and works out to be 95.82% for all minerals at -150mesh. The liberation of Chalcopyrite at -150+200 mesh is 73.42% and the average cumulative liberation for that mineral at -150 mesh can theoretically expected to be at 81.50%. Hence -150 mesh is chosen as the theoretical mesh of grind for the ore at which size the smallest grain of chalcopyrite would have been reduced 10 times for good liberation of the mineral.

TABLE 2 : Liberation at each size and cumulative liberation of all minerals and chalcopyrite in the ore

Sl. No.	Mesh size (B.S.S)	Total liberation of all minerals at each size	Average cumulative liberation of all minerals	Chalcopyrite liberation	Average cumulative liberation of chalcopyrite
1	-150	86.32	86.32	73.42	-
2	+200				
3	-200	97.50	91.91	-	-
4	+240				
5	-240	99.46	94.43	-	-
6	+300				
7	-300	100.00	95.82	-	81.50 (theoretical)

Selectivity index

Selectivity Index[3] was used as measure of the effectiveness of separation of copper from the major gangue which in the present case was SiO_2 + acid insolubles.

Crushing and grinding

Drill core samples of the ore size 2'-5' picked at random was reduced in a jaw crusher set at ½', and further fed to a roll crusher. The overall crushed product was sieved at 150 meshes. The oversize was dry ground in a porcelain ball mill using porcelain balls with 500 gm of feed and 3 kg of ball load for 30 minutes.

The ground was sieved on 150 mesh and the oversize transferred back into the ball mill for further grinding. Necessary amount of -150 mesh products was collected and each batch of flotation feed was chemically analyzed for Cu and SiO_2+ acid insoluble.

SUMMARY AND CONCLUSIONS

- The low grade copper from Kallur assaying 0.84% Cu and 78.36 5 SiO_2 has been found to contain Chalcopyrite, Pyrite and Specularite as the chief ore minerals with Quartz, Feldspar, Calcite and Hornblende as gangue minerals.
- The theoretical mesh of grind at 80% liberation of Chalcopyrite has been found to be 150 meshes (B.S.S).
- Lime is not suitable as a depressant for pyrite in comparison to potassium cyanide.
- Wet grinding the ore using sodium silicate and potassium cyanide followed by flotation and three stage cleaning is necessary for good results.
- Distribution of potassium cyanide between the grinding circuit and flotation cell is essential to control recovery, selectivity index and grade.
- From a feed containing 0.278% Cu and 78.25% SiO_2+acid insolubles, it is possible to get the best results at 27.29% Cu with a recovery of 97.35% Cu at a selectivity index of 158.67 under the optimized flotation condition.
- Extensive pilot studies are required before commercially exploiting the low grade ore.

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