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RECOVERY OF MINERAL VALUES FROM ORE

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This invention relates to a process for the recovery of mineral values from ore. More particularly this invention relates to a leaching process for the recovery of mineral values which are not recoverable efficiently by the usual processes for the beneficiation of ore and which is especially well suited to the recovery of acid-soluble copper minerals such as oxide copper values associated with sulfide copper minerals in ores containing acid insoluble gangue minerals.

It has long been customary in the processing of mineral bearing ores to utilize a flotation process to concentrate and facilitate recovery of the desired minerals. When, as is often the case, the minerals are present in several forms, valuable mineral values are lost in the tailings unless, before the ore is subjected to the flotation process, the ore is treated to convert the otherwise unrecoverable mineral values to forms which respond to the flotation process. An alternate process involves reprocessing the tailings but the cost involved is usually excessive.

For example, in the case of copper bearing ores, most of the copper is usually present as a sulfide which is recovered by means of a flotation process but significant oxide copper values are lost because they do not respond to this flotation process directed to the concentration of sulfide copper.

Recovery of oxide copper values from the tailings has not proven to be economically feasible because of the expense involved. While the advantages to be gained from the conversion of the oxide copper values to the sulfide of copper before subjecting the ore to flotation are obvious, processes hitherto proposed and utilized for this purpose have left much to be desired.

For example, as proposed in U.S. Patent No. 1,333,688 and Patent No. 1,178,191, oxide copper values in the ore are dissolved by a solvent and by using a precipitant the sulfide of copper is precipitated and then recovered by flotation. This process as well as others hitherto known, involving using first leaching reagents then a precipitant followed by flotation, have required such expensive installations of equipment as well as excessively large quantities of the reagents and water as to be impractical from the economic point of view for most recovery operations.

Another serious disadvantage of conventional leaching processes, in which the ore is suspended by agitation during leaching and the leach solutions are subsequently separated from the solid ore particles prior to recovery of the dissolved values, is the high cost of the liquid-solid separation. Classification, thickening, and filtration have proven to be expensive and not always efficient for this purpose. The large amounts of slimes created during crushing and grinding of the ore to a size fine enough to allow suspension by agitation, and additional slimes created by attrition and chemical action during leaching, markedly increase the cost and inefficiency of this operation. The large amounts of liquid hitherto required for such leaching and washing operations, and the large equipment and space requirements, are further serious disadvantages.

In the case of the recovery of oxide copper values, the precipitants utilized to recover the dissolved copper values have left much to be desired. Metallic iron in a suitable form such as sponge iron has been utilized to precipitate the dissolved copper as metallic copper. The use of

sponge iron as a precipitant on a commercial basis requires a low cost source of metallic iron because of the relatively large amounts consumed in the process and, even when such a source of metallic iron is present, the process is nevertheless relatively expensive. The amount of iron required to effect the copper precipitation is ordinarily several times that required stoichiometrically and in addition prolonged agitation in spite of its attendant difficulties is necessary to insure efficient precipitation. Then too, recovery and recycling of unreacted sponge iron is often required. In practice, the copper bearing leach solutions of necessity are separated from the bulk of the ore before precipitation with sponge iron because the copper precipitate produced by that precipitant does not respond satisfactorily to the process conditions employed in the flotation recovery of naturally occurring copper sulfides. It must be recovered in a separate operation under different process conditions, which is a further disadvantage.

It has also long been proposed to utilize ferrous sulfide (FeS) to precipitate copper from its solutions as well as a precipitant which contains both ferrous sulfide and calcium sulfide prepared by heating pyrites with an equivalent of lime in the absence of air. The reactions involving ferrous sulfide as a precipitant are relatively slow and, in addition, the large quantities of free acid required, in turn, necessitate the use of large amounts of neutralizer in order to effect satisfactory recovery by means of flotation.

In accordance with an important feature of the present invention, the crushed ore mass is treated with a minimum of liquid leaching reagent. The amount of liquid reagent utilized during the leaching process is so small that the moistened ore can be carried by the usual conveying apparatus utilized in transporting dry ore to and from the storage bins which are customarily provided in continuously operated plants. This results in a marked savings in that considerably less leaching reagents are used per ton of ore and, also, the need for special equipment to handle the moistened ore as well as the large quantities of water hitherto considered to be necessary in the operation of such installations are avoided. Leaching of the crushed ore mass may be carried out in accordance with the present invention with little or no agitation other than that which occurs incident to the normal transportation of the ore. Thus, there is avoided the need for agitating equipment and the formation of slimes is minimized, slimes being particularly undesirable when the dissolved values are to be separated from the bulk of the ore solids before precipitation.

A further important feature of the present invention in the recovery of oxide copper values resides in the preparation and use of a precipitant the active ingredient of which is calcium sulfide (CaS) and which is effective to precipitate copper rapidly in the presence of an exceedingly low free acid concentration. The reaction time and the free acid concentration required are so low that the reaction is completed long before ferrous sulfide, if any is present, could be effective as a precipitant because of the greater free acid concentration and time required by the latter.

Further features as well as objects and advantages of the present invention will be apparent to those skilled in the art from the following detailed description. While the present invention will be described primarily with regard to the recovery of oxide copper values from copper ores, it is also applicable to the recovery of other metal values from their ores by solvent leaching and variations in the carrying out of the present invention will be apparent to those skilled in the art.

The present invention comprises a process in which the