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STUDIES ON NUNDYDROOG GOLD ORE WITH A VIEW TO IMPROVING GOLD RECOVERY(*)

P.V. Raman and
P.I.A. Narayanan,
National Metallurgical
Laboratory, Jamshedpur.

Gold is distributed widely in India though occurences in workable quantities are not many. The most important gold mines are found in Kolar Gold Field situated in Mysore State. Although some 26 quartz lodes, more or less parallel are known to occur, only one reef namely, the Champion, is being exploited and all the four mines viz. Mysore, Champion, Coregaum and Nundydroog have been developed along its strike. During the last few years the ore from the Western reef of Nundydroog is being mined in large tonnages. Nearly 21000 tons per month are milled and the ore as an average carried a gold content of 5.6 dwt/ton gold. Since the ore body is highly mineralised, several metallurgical problems, such as greater wear and tear of machineries, difficulties during cyanidation due to the presence of sulphides, increased consumption of chemicals and higher tailing values are experienced at Kolar.

At the instance of Ministry of Finance, Government of India, detailed discussions were held at Nundydroog between Officer-in-Charge(Ore Dressing), National Metallurgical Laboratory and the Chief Metallurgist, Kolar Gold Fields, about the gold extraction problems at Nundydroog. During the discussions, it was pointed by the latter that the gold loss in the final cyanide residue was gradually increasing during the past few years. Consequently, detailed laboratory investigations were undertaken at Nundydroog to determine the causes for the declining gold recovery and to improve the plant efficiency. One of the principal causes attributed to the increasing gold losses, as a result of their studies, was the presence of graphite which caused premature precipitation of gold during cyanidation. Presence of tellurides in the sample was also suspected

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as this also results in increased gold losses in the tailing. It was agreed that, keeping these observations in view, NML should undertake detailed studies on their problems and suggest suitable modifications to the existing plant to improve the gold recovery, which at present is only about 90%.

As desired by N.M.L., three samples namely (1) Run-of-mine ore after tertiary crushing, (2) Feed to cyanidation plant and (3) Final cyanidation tailing were received from Nundydroog for studies. The results obtained from each of these samples are briefly presented below:-

Sample No. 1 Run-of-mine-ore.

One of the problems confronted at Nundydroog is the frequent change in the characteristics of the ore body and its highly mineralised nature. Little published information is available on the mineralogy of the ore deposit at Nundydroog. Hence a detailed mineralogical examination of the run-of-mine ore was undertaken at National Metallurgical Laboratory. The ore was a complex one and contained a wide variety of minerals but was mainly composed of sulphides and silicious minerals. Hornblends, chlorite, Biotite and Quartz constituted the silicious minerals. The metallic minerals identified under ore microscope in order of abundance were pyrrhoitite, Arsenopyrite, chalcopyrite and Magnetite with traces of Marcasite and Pyrite. Gold was present in the silicious gangue as comparative coarse veins as well as in particles of 4 to 20 microns in size. It was also found to be finely disseminated in Arsenopyrite usually less than 4 microns in size. No tellurides were detected but traces of graphite were present in the finer sieve fractions. Spectrographic analysis also indicated the absence of Tellurium. These findings ruled out the possibility of Tellurides being responsible for gold losses in the cyanidation tailing. The run-of-mine ore assayed 5.6 dwt gold/ton.

Sample No. 2 - Feed to the Cyanidation Plant.

The sample, which was mostly in form of fines, assayed 2.3 dwt gold/ton and represented a gold distribution of 41% with respect to run-of-mine ore. Detailed cyanidation studies were made on representative samples, without further grinding, for different lengths of time to determine the optimum time of Agitation for maximum gold recovery. The tests were carried out by the

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bottle agitation method, keeping the NaCN and CaO concentrations at .018 and .008% respectively. The results showed that the gold recovery, which stood at 59% before the commencement of cyanidation increased gradually with increase in cyanidation time reaching 87.5% after 12 hours and the maximum value of 94.6% after 27 hours beyond which no further increase was observed. The results clearly indicated that an agitation time of 27 hours was the optimum to effect maximum gold recovery. The present practice at Nundydroog is to cyanide the sample for 12 hours only. Evidently due to incomplete cyanidation only 90% gold recovery was obtained and the cyanidation residue carried as high as 0.5 to .6 dwt gold/ton. It is thus clear, on the basis of studies at N.M.L., that by increasing the cyanidation time by another 15 hours at Nundydroog (viz from 12 to 27 hours), an extra recovery of 5% can be easily obtained. The cyanidation residue after 27 hours agitation assayed .3 dwt/ton gold and represented a gold loss of 5.4% gold in it.

It was reported during discussions at Nundydroog, that the presence of graphite in the sample caused premature precipitation of gold during cyanidation thereby increasing the gold losses in the residue. This aspect was studied next in detail. The graphite which was present in minor amounts was floated using **pine** oil, and the flotation tailing was subjected to cyanidation studies as before for 27 hours. The final residue assayed 0.3 dwt/ton thereby indicating that gold losses in the residue, was the same irrespective whether the feed contained minor amounts of graphite or not.

Since the cyanide residue obtained after 27 hrs cyanidation still contained 0.3 dwt gold per ton, attempts were next made, for recovery of the remaining gold from it by suitable methods. Wet magnetic separation studies on the residue showed that there was little concentration of gold in the magnetic fraction which was mostly pyrrhotite. Floation studies were then made for recovery of Arsenopyrite from the non-magnetic fraction. Optimum conditions for Arsenopyrite floatation were established. The Arsenopyrite float assayed 4.8 dwt gold/ton and represented an additional gold recovery of 3.3% gold with respect to run-of-mine ore. Since Arsenopyrite is refractory to cyanide treatment the same was left uncyanided and lost in the residue.

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Tabling method was also tried for recovery of Arsenopyrite from the non-magnetic residue obtained after wet magnetic separation. The heavy mineral table concentrate assayed 5.2 dwt gold/ton and represented a gold recovery of 3.3% with respect to run-of-mine ore. Recovery of arsenopyrite by flotation or tabling finally rejected a cyanidation residue assaying .1 to .14 dwt gold/ton. Thus, the overall gold recovery, if flotation or tabling is also adopted, will be of the order of 98%.

Sample No. 3. Final Cyanidation Tailing.

The sample No. 3 received in N.M.L. was a cyanidation residue obtained after12 hours agitation at Nundydroog. It assayed 0.54 dwt gold/ton and represented a gold loss of 9.6% gold in it. The objective in undertaking studies on this sample was to confirm some of the earlier findings that were already established with sample No. 2 and also to recover the gold lost in it by suitable methods.

Further cyanidation studies undertaken at N.M.L on the sample indicated that nearly 50% of the gold lost in it could be recovered if it is subjected to an extra 15 hours agitation. The residue assayed 0.25 dwt gold/ton and represented a gold distribution of 4.8% gold only. These findings confirm that 27 hours cyanidation time (including the 12 hours agitation at Nundydroog) is required to effect an overall recovery of 95% gold.

Straight tabling with the 12 hrs cyanided sample produced a heavy mineral concentrate assaying 3.6 dwt gold/ton with a distribution of 47.4% gold with respect to table feed and equivalent to an additional recovery of 3.8% gold with respect to run-of-mine ore giving an overall gold recovery of 94.3%. Evidently cyanidation for 27 hrs is to be prefered since the gold present in the table concentrate is finely associated with Arsenopyrite, the same should be roasted and then cyanided.

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CONCLUSION

The run-of-mine ore (Sample No.1) assayed 5.6 dwt gold/ton whereas the feed to cyanidation plant assayed 2.3 dwt/ton, showing that 3.3 dwt/ton had been recovered at Nundydroog by the blanket straking representing a recovery of 59% gold. The feed to the cyanidation plant at Nundydroog carried 41% of the total gold.

87% of the gold present in the feed (Sample No.2) to the cyanidation plant at Nundydroog or 35.6% with respect to run-of-mine ore could be extracted by subjecting the ore to cyanidation for 27 hours effecting an overall gold recovery of nearly 95%. This compares with the reported overall gold recovery at Nundydroog of only 90%, where cyanidation is done only for 12 hours. It is thus clear that by just increasing the cyanidation time by another 15 hours, an extra 5% gold recovery can be obtained.

To obtain still higher recoveries of gold, the cyanidation residue produced after 27 hours cyanidation, will need flotation or tabling when an arsenopyrite concentrate having a gold value of 4.8 to 5.2 dwt/ton and representing an additional recovery of 3.3% gold with respect to run-of-mine ore can be recovered. The final loss of gold in cyanidation residue after flotation ortabling treatments would be of the order of 1.6 to 2.2% when the values are calculated on the basis of run-of-mine ore. Thus there should be no difficulty in getting an overall recovery of 98% by producing an arsenopyrite concentrate by flotation or tabling from the residue after 27 hrs cyanidation and recovering the gold therefrom by roasting and cyanidation.

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