Characteristics of Iron Ore Slime from Kiriburu, India

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Abstract

The mineralogical, size and chemical characteristics of slime vary from discharge point to the distal part of the Tailing pond of Kiriburu iron ore mines. They can be grouped as three end members of slime composition- (i) coarse grained dense martite microplaty hematite type, (ii) coarse to medium grained goethite and clay dominated martite hematite type, (iii) fine grained hematite-goethite-clay type, occurring systematically away from the discharge point. Any slime will have a bulk composition intermediate to these three end members. The study has significance in the planning for exploitation of slime.

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1. Introduction

Due to the raw material demand for lump type of ore in Indian iron making process, the mining operation of iron ore in the past was focused for the production of ore of -40+10mm size with the rejection of -10mm size. The crushed ore was either screened or was subjected to desliming as per the infrastructural facility in the respective mines. In the iron ore mines in Gua and Dalli, the dry screening is adopted due to which the fines produced are stockpiled as waste dump. The past operation has resulted in the present waste dump of fines of 12mT and 40mT in Dalli mines and Gua mines respectively (Pan et al., 2007), [1]. Presently, Kiriburu iron ore mines produces 5mT of ROM in a year out of which 30% is lost as slime [1]. Noamundi and Joda operation of Tata Steel treats ROM by Washing plant with screening, scrubbing and classification of 3mtpa capacity whereby 10-15% of slime is produced [2]. There is report of nanometer to micrometer thick microplaty hematite in blue dust and soft laminated ore which get released to fines of -150 micron size on washing [3] and has significance on slime mineralogy. Due to the future demand for beneficiated raw material for pelletisation, the slime and ore fines are of interest. Hence, the quality of raw material in a slime pond and its mineralogical characteristics are important to evaluate for future utility. The present work is a preliminary investigation on the quality of material in the Tailing pond of Kiriburu iron ore mines.

2. Kiriburu iron ore mines and the ore-types

Kiriburu iron ore mines in India was initially exploited for lump grade ore to be exported to Japan and was later a captive mines of Bokaro Steel Plant under Steel Authority of India Limited (SAIL). Presently, it is under the operation of Raw Material Division of SAIL to cater to the need of its iron and steel plants. It belongs to the Iron ore Group of Singhbhum craton of Precambrian age [4,5]. The deposit is indicated as supergene modified hydrothermal type with friable saprolitic ore derived from a precursor ‘hydrothermally altered iron ore formation’, successively enriched by supergene activity and subsequently altered to the present state [6]. It is comprised of dense martite, microplaty hematite, vitreous goethite, ochreous goethite and associated gangue minerals such as quartz, kaolinite, jasper. In a hematite-goethite mineral system four major ore-types are defined as (i) dense martitic ore (hard laminated ore), (ii) micro-platy hematitic ore (soft laminated ore, blue dust, biscuity ore), (iii) ochreous/vitreous goethitic ore (lateritic ore), (iv) banded hematite quartzite based on the dominant mineralogy the last being the part of mines waste.

In the Kiriburu iron ore mines, the lateritic capping occurs on the top with hard laminated ore, soft laminated ore and blue dust occurring successively in the lower part. The Hill-1 and Hill-2 are mined in the past and Hill-3 is under present mining operation. It is obvious that the ore type and quality varies over a time period as per the mining plan and so also the fines and quality of fines. Ring Rang slime pond has three discharge points, two of them are old and are abandoned, the third one in the other extreme end of the pond is active at present as per the plan. Hence, the fines of old production occur in the vicinity to the old discharge points. The slime stratification is of varied proportion of goethite and hematite. When dried, the layer of goethite peels off as sheets loosely supported by hematite interlayers.

3. Methodology

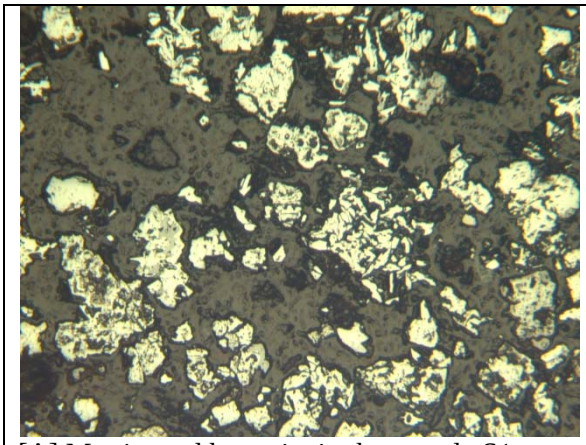
The abandoned discharge points are at higher relief and that portion of the slime pond is accessible for sampling. There is difference in the physical attributes of fines in the pond. There exists a stratification appearing as fines of different shades of grey and ochreous colour. There exists a colour variation spatially from discharge point to the periphery. The sampling was carried out about 30cm below the surface. Three representative samples of extreme characters were sampled as S1 from discharge point, S2 from a distance of about 200m and S3 at a distance of 400m. The collected samples were dried up, homogenized, cone and quartered and the representative sample was subjected to chemical analysis and mineralogical study. Particle size of the slime was determined by image analysis system with QWIN software, Leica make and laser diffraction particle size analyzer by Malvern, model Master sizer 2000 with wet dispersion system Hydro 2000 MU. The optical microscopy was carried out by petrological microscope, model-Orthoplan, Leica make.

4. Result and discussion

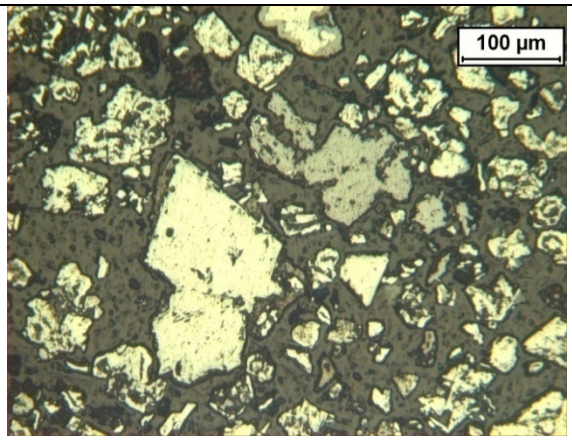
The microscopic study of the slime suggests that the sample S1 is dominated by martite, micro-platy hematite with minor amount of goethite (Fig.1A,B). There are grains of hematite goethite interlocking. The sample S2 contains martite, hematite and goethite (Fig.1C). There are some grains with interlocked goethite-hematite-clay goethite. In S3, the grains are characteristically of very fine size 1-3micron in dimension consisting of martite, micro-platy hematite, goethite and clay (Fig.1D). The particle size of S1, S2 and S3 are of the size range 0.4-2187 micron, 0.2-1259 micron, and 0.27-363 micron respectively. The chemical data as presented in Table-1 suggests that Fe content is the highest (67 wt%) in S1 with decreasing trend towards S2 to S3. S3 has hardly 42 wt% of Fe. The data suggests that the slime pond has a distinct pattern of mineralogy and chemistry. The minerals of high specific gravity and larger size get concentrated in the proximity to the discharge point. The chemistry of the bulk sample collected for processing is of intermediate composition with 57.73wt% of Fe.

Table 1: The composition of slime from different parts of Tailing pond in Kiriburu iron ore mines

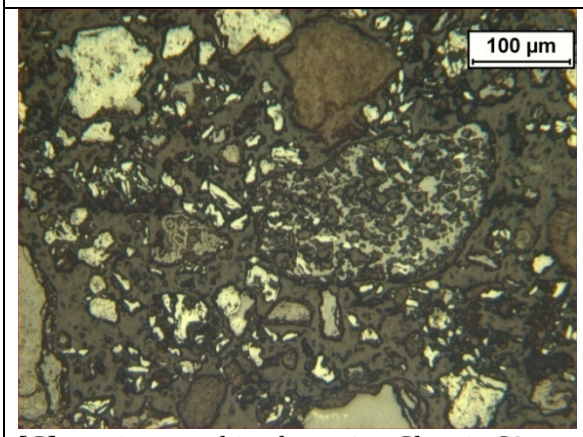
Location	Discharge point	200m away from discharge point	400m away from discharge point	Bulk slime sample
Sample No.	S1	S2	S3	S4
Fe%	67.0	60.16	42.71	57.73
SiO_2 %	1.10	4.87	14.72	5.62
Al_2O_3 %	0.82	4.38	15.5	4.53
LOI	4.17	4.51	8.56	5.61



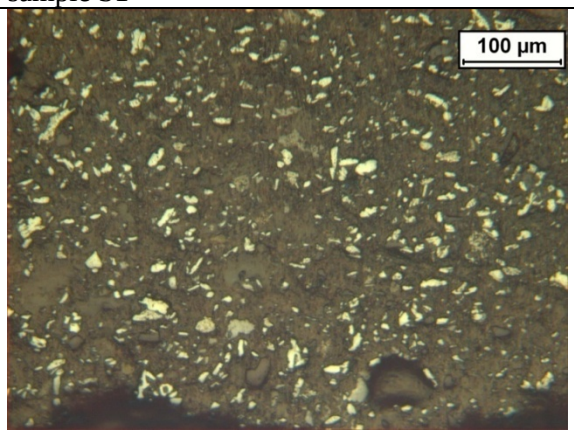
[A] Martite and hematite in the sample S1



[B] Martite, hematite and goethite in the sample S1



[C] martite , goethite, hematite, Clay in S2



[D] microplaty hematite, goethite and clay in S3

Fig 1: Photomicrograph of slime sample from Tailing pond. The S1 and S2 have coarse (>10 micron) grains of martite, microplaty hematite, goethite, clay whereas S2 has microplaty hematite, goethite, clay of <5 micron size

5. Conclusion

The study reveals that the minerals get classified in the slime pond broadly from discharge point to distal part. There exists a good concentration of dense martite and microplaty hematite in the proximity to the discharge point. The three samples analysed may be considered as the three extreme type of slime- (i) coarse grained dense martite microplaty hematite type, (ii) coarse to medium grained goethite and clay dominated martite hematite type, (iii) fine grained hematite-goethite-clay type. If they are considered as the end members of slime types, their relative proportion may represent a slime variant in different part of the slime pond. It may be clarified that the data on high content of hematite in the sample S-1 should not be misconstrued as the bulk slime characteristic, rather composition in sample S-4 is representative of a slime variant. It is important while planning for slime utilization and exploitation.

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