Roper Bar Iron Ore: Stage 6 Post Mortem

Summary of Results

This brief report summarises the results of an investigation was undertaken with the aim of determining any underlying reasons for the disappointing results obtained in Stage 5 of this work. It was thought that possible problems could include the presence of coarse silica particles, iron-rich slime coatings on silica and silica-rich coatings on iron minerals.

The work was divided into two stages, using the same composite sample as previously. In the first stage the composite was ground for three different times (10, 15 and 20 minutes). In each case the ground product was sized and each fraction weighed and assayed. This enabled the distribution of iron, silica and carbonate (LOI) for the three grinds to be determined and compared. The second stage consisted of a series of flotation tests which were conducted on the ground products. Tests were conducted on deslimed and undeslimed material.

Size-by-Size Results

The mass distributions for the three grinds are compared in Table 1. Two things stand out. The first is that, as expected, the amount of material in the +106 μm fractions decreased significantly as the grinding time was increased. The second is that the amount of material reporting to the C7 fraction (precyclone overflow) increased significantly. This material is very fine (nominally less than 8 μm) and would be lost to the slime fraction during desliming.

Size (μm)	10 min	15 min	20 min
150	23.31	4.31	0.38
-150+106	18.55	12.82	4.31
-106+75	14.27	20.53	15.18
-75+53	8.00	11.00	13.01
-53+38	4.75	6.36	8.88
C1	1.35	1.90	1.53
C2	2.95	4.41	5.22
C3	4.85	6.87	8.93
C4	3.93	5.63	7.90
C5	2.62	4.27	6.48
C6	3.52	5.17	7.43
C7	11.91	16.72	20.75

Table 1. Mass distributions for different grinding times.

The effect of grinding on the iron, silica and carbonate assays and distributions is given in Tables 2 to 4. It should be noted that the cyclosizer, which was used to separate the -38 μm fractions also separates on the basis of density. As a result, heavier minerals tend to be over-represented in the C1 and C2 fractions, with the lighter minerals tending to be captured in the lower fractions. Hence, it is expected that C1 and C2 should have higher Fe contents than the subsequent size fractions.

Size (μm)	10 minute grind		15 minute grind		20 minute grind	
	Assay (%)	Distribution (%)	Assay (%)	Distribution (%)	Assay (%)	Distribution (%)
150	42.82	22.25	41.83	4.05	41.05	0.35
-150+106	42.29	17.49	42.42	12.23	43.2	4.17
-106+75	42.14	13.41	41.16	19.01	41	13.92
-75+53	43.84	7.82	41.86	10.35	42.22	12.28
-53+38	43.7	4.63	41.57	5.94	40.97	8.13
C1	58.1	1.75	58.33	2.49	58.2	1.99
C2	48.19	3.17	47.47	4.71	48.68	5.68
C3	43.78	4.73	41.49	6.41	40.58	8.11
C4	42.63	3.73	40.6	5.14	40.33	7.12
C5	42.92	2.51	41.83	4.02	38.97	5.65
C6	44.13	3.47	43.68	5.07	42.19	7.01
C7	56.67	15.04	54.69	20.56	55.11	25.58

Table 2. Fe assay and distribution for different grinding times.

Size (μm)	10 minute grind		15 minute grind		20 minute grind	
	Assay (%)	Distribution (%)	Assay (%)	Distribution (%)	Assay (%)	Distribution (%)
150	27.41	25.15	27.37	4.65	28.67	0.42
-150+106	29.63	21.63	27.27	13.79	26.87	4.52
-106+75	29.02	16.30	29.96	24.26	28.88	17.10
-75+53	27.12	8.54	29.11	12.62	29.6	15.02
-53+38	25.77	4.81	29.66	7.43	30.84	10.68
C1	6.57	0.35	6.23	0.47	5.92	0.35
C2	19.02	2.21	21.44	3.73	17.96	3.66
C3	26.52	5.06	28.99	7.86	31.86	11.10
C4	25.91	4.01	28.97	6.43	32.38	9.97
C5	26.65	2.75	28.52	4.81	31.91	8.07
C6	24.86	3.45	27.55	5.61	28.9	8.38
C7	12.27	5.75	12.67	8.35	13.26	10.73

Table 3. SiO_2 assay and distribution for different grinding times.

Size (μm)	10 minute grind		15 minute grind		20 minute grind	
	Assay (%)	Distribution (%)	Assay (%)	Distribution (%)	Assay (%)	Distribution (%)
150	6.05	23.00	6.31	4.45	6.82	0.42
-150+106	6.17	18.67	6.13	12.87	6.49	4.61
-106+75	6.74	15.69	6.41	21.55	6.52	16.29
-75+53	7.15	9.33	7	12.60	6.96	14.91
-53+38	7.2	5.57	7.02	7.31	7.01	10.25
C1	8.46	1.87	8.1	2.52	7.25	1.83
C2	7.9	3.80	7.87	5.69	8.57	7.37
C3	6.83	5.40	6.96	7.83	6.81	10.01
C4	6.74	4.32	6.75	6.22	6.6	8.58
C5	6.6	2.82	6.65	4.65	6.47	6.91
C6	5.98	3.44	6.06	5.13	6	7.34
C7	3.14	6.10	3.35	9.17	3.36	11.48

Table 4. LOI assay and distribution for different grinding times.

The most obvious thing that can be seen from the data presented above is the high iron grades (55-56% FE) of the C 7 fractions. The SiO_2 and LOI grades for the same fractions were much lower than those for the coarser fractions. The low LOI assays indicate that the predominant iron mineral in the slimes is hematite. This is not surprising given the oolitic nature of the hematite in the Roper Bar deposit. This preferential grinding of hematite resulted in mass distribution of iron in the C7 fraction being significantly greater than the mass distribution. In fact, for the 20 minute grind, around 25% of the iron in the feed reported to the C7 (slimes) fraction. This obviously has significant processing implications.

The distribution of silica in the coarser size fractions tended to be higher than the mass distribution. This is due in part to the soft nature of the oolitic hematite which is ground preferentially, thus leaving silica and other gangue minerals in the coarser fractions. For the 10 minute grind, which was used in the previous testwork, close to 50% of the silica was in the +106 μm size fractions. This would be expected to float more slowly, and is one possible explanation for the high silica values obtained in the final product from the earlier flotation tests.

The distribution of the LOI assay (which corresponds to siderite) in the coarse fractions was slightly higher than the mass fraction. As with silica, the increase is due to preferential grinding of hematite. The imbalance is not as great as that found for silica.

Flotation Results

Two sets of flotation tests were conducted on the products obtained from each of the grinding times used above. In one set the ground material was dried and tested without desliming. Similar conditions had been used in some of the previous work. In the other set, the ground material was deslimed using a 50 mm Mozely cyclone. The underflow, which was the flotation feed, was kept as a slurry until testing. It was then filtered and a sample equivalent to one quarter of the filter cake was used as flotation feed. All products were dried, weighed and prepared for assay.

It should be noted that the head grades for the different feed materials are given in Table 5.

	10 minute grind		15 minute grind		20 minute grind	
	Undeslimed	**Deslimed**	**Undeslimed**	**Deslimed**	**Undeslimed**	**Deslimed**
Fe	44.14	42.15	44.44	42.18	44.05	41.82
SiO_2	25.59	28.5	25.55	28.44	25.69	29.16
LOI	6.21	6.74	6.26	6.88	6.13	6.90

Table 5. Head grades for flotation feed.

The flotation results are given in Tables 6 and 7.

	10 minute grind		15 minute grind		20 minute grind	
	Assay (%)	**Recovery (%)**	**Assay (%)**	**Recovery (%)**	**Assay (%)**	**Recovery (%)**
Fe	45.58	65.93	47.92	59.59	48.65	52.61
SiO_2	22.25	55.34	19.11	41.41	16.94	31.42
LOI	7.16	73.96	7.55	66.76	7.88	60.45

Table 6. Flotation results for undeslimed feed.

	10 minute grind		15 minute grind		20 minute grind	
	Assay (%)	**Recovery (%)**	**Assay (%)**	**Recovery (%)**	**Assay (%)**	**Recovery (%)**
Fe	46.19	72.89	49.11	56.42	50.6	48.06
SiO_2	21.58	50.36	18.15	30.89	15.98	21.77
LOI	7.59	74.86	7.04	44.53	7.23	41.65

Table 7. Flotation results for deslimed feed.

The results show that increasing the grind time increased the final product grade in both sets of tests. They also show that the final Fe grade for the deslimed feed was higher than for the undeslimed feed. This is despite the reduction in head grade brought about by removing the high hematite containing fines. At the same time the SiO_2 grade of the final product decreased.

The logical explanation for these results is that increasing the grind time decreased the amount of coarse silica in the feed, which resulted in an increase in the amount of silica floating (decreased silica recovery).

As seen in previous work, desliming also results in improved final product grades. This is despite the lower head grade of the feed. In general, desliming also brings about a lower recovery. This is most likely due to the presence of slime coatings. In particular, hematite fines coating silica would result in silica not floating, thus decreasing the Fe grade of the final product. Similarly, silica attached to iron oxides may result in iron oxides floating, thus giving low recoveries.

During discussions with Kwan Wong, the deleterious effect of drying the solids prior to flotation was raised. This would result in increased slime coatings which would not be removed on repulping.

To investigate this, two deslimed samples were tested, with and without drying. The results are presented in Table 8. This shows a decrease in Fe grade and recovery and an increase in SiO_2 grade and recovery in the final product. This is consistent with the presence of fine iron coatings on silica particles.

	20 minute grind not dried		**20 minute grind dried**	
	Assay (%)	**Recovery (%)**	**Assay (%)**	**Recovery (%)**
Fe	50.6	48.06	49.50	41.48
SiO_2	15.98	21.77	16.82	29.50
LOI	7.23	41.65	6.28	46.37

Table 8. Effect of drying flotation feed.

Conclusion

The results show that increasing the grind time resulted in improved grades and recoveries. However, there was also a significant increase in the amount of iron present as slimes. These slimes may coat silica particles, thus preventing them from floating and hence decreasing final product grade.