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STUDIES ON THE EFFECT OF PARTICLE SIZE ON THE UPGRADING OF CHROMITE FROM DARGAI AREA (PAKISTAN). PART I

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Abstract. Studies have been made by physical methods to see the effect of particle-size reduction for upgrading the chromite of Dargai area. The physical analyses have shown that liberation of chromite from the gangue material occurs in the finer fraction. 114μ is the most suitable grain size for beneficiation of chromite of this area. All these results have been confirmed by chemical analysis.

Chromite ore of Dargai area is mainly composed of chrome spinel, picotite, with serpentine and olivine as gangue minerals. The serpentine is a later product and has been derived after the olivine of intermediate composition. The serpentine mineral is antigorite. The chrome-spinel has crystallised earlier than the olivine which has penetrated through the fractures of the ore mineral. Pull-apart texture has also been observed which confirms the early formation of the ore. The relict structure confirms that the original gangue mineral was olivine.

The chromite ore lumps from Dargai area were crushed to 1/4 in size and sample collected after quartering and coning. The sample thus obtained was then crushed in a pestle and mortar and sieve analysis was carried out. The fractions collected were of 60, 72, 120 and 150 mesh sizes(B.S.S).

Thin section of each fraction was made and studied. These studies revealed that in the coarser fractions retained on +60 the gangue has not been detached from the chromite grains. The fraction retained on +150 mesh size consisted of chromite grains which has been completely liberated from the gangue material.

Modal analysis of each fraction using swift point counter has been carried out and given in Table 1.

It is evident from Table 1 that the maximum gangue-free chrome-spinel grains were concentrated in the +150 mesh fraction with a minimum percentage of the compound grains. Sieve fraction finer than —150 may have even less percentage of compound grains and the chromite grains may be completely liberated from the ore. However, the concentration of gangue-free ore is reduced to a minimum. Therefore, the (—120+150) mesh size (B.S.S.) seems to be ideal for the beneficiation of the Dargai chromite by this methods.

Concentration of the Ore. The ore has been concentrated by passing different sieve fractions through an isodynamic magnetic separator. The side and front tilts of the magnetic separator were 5° and 10° respectively whereas the amperage was kept at 0.6. Each separated fraction was also examined under the binocular microscope to ensure complete removal of the gangue minerals. Results are given in Table 2.

The removal of gangue is maximum, as 8.13% (w/w) in —120+150 mesh (114μ) fraction. Similarly in the coarser fraction 273μ the percentage of free gangue grains is only 1.73% which shows that finer fractions contain more of liberated chromite grains. These results are in coincidence with the results stated in modal analyses. The separation of gangue and the ore was not successful in —150 mesh by this method due to the fineness of the gangue and chromite in this fraction.

Chemical Analyses of Different Fractions. Chemical analyses of different mesh sizes of uncleaned and cleaned chromite was done by the method described by Bilgrami and Ingamells.[1] Results of the analyses are presented in Table 3.

TABLE 1. MODAL ANALYSES OF SIEVE FRACTIONS.

Grain size (B.S.S.)	No. of chromite grains	Chromite (%)	No. of free gangue grains	Free gangue (%)	No. of compound grains	Compound grains (%)
+ 60	365	73	10	2	125	25
+ 72	386	77	27	5	91	18
+120	427	85	42	7	41	8
+150	451	90	40	8	9	2

TABLE 2. TREND OF GANGUE LIBERATION WITH RESPECT TO PARTICLE SIZE.

Mesh size (B.S.S)	Size (μ)	Gangue removed (w/w %)	Chromite* (w/w %)	Purity (%)
—52+60	273	1.73	98.27	93.6
—60+72	231	2.94	97.06	95.0
—72+120	167	5.59	94.41	97.5
—120+150	114	8.13	91.87	100.0

*Chromite grains including compound grains.

TABLE 3. CHEMICAL ANALYSES OF UNCLEANED AND CLEANED CHROMITE FRACTIONS.

Mesh size (B.S.S.)	Uncleaned			Cleaned		
	Cr_2O_3	Fe_2O_3	Cr:Fe	Cr_2O_3	Fe_2O_3	Cr:Fe
+ 60	35.55	17.42	1.98:1	35.95	17.58	1.99:1
+ 72	35.52	17.56	1.97:1	36.50	18.30	1.94:1
+120	35.50	17.59	1.96:1	39.55	19.30	2.04:1
+150	35.50	17.59	1.96:1	41.07	18.60	2.15:1
—150	35.47	17.59	1.95:1	—	—	—

The chemical analyses of uncleaned fractions of the ore show that there is negligible variation in the Cr_2O_3 content and in chromium–iron ratio whereas in the cleaned chromite fractions there is an increase of 5.12% in Cr_2O_3 content. The higher values of Cr_2O_3 content are present in finer mesh sizes. The maximum Cr_2O_3 percentage is 41.07 in +150 mesh fraction.

Discussion

Sastry *et al.*[2] have studied the effect of particle size and liberation trend of magnetite on the extraction of vanadium from Indian ores. The effect of particle size reduction to the low-grade chromite ore, for the beneficiation, have been found to be successful.

Modal analyses indicate that the gangue-free chromite ranges from 73 to 90%, gangue 2–8% and the compound grains 25–2% in +60 to +150 mesh size respectively. The maximum gangue free chromite has been obtained in −120+150 mesh (114μ) fraction. The results obtained by concentrating the ore through isodynamic magnetic separator are in agreement with modal analyses. The chemical analysis of different fractions shows that there is no significant increase of chromium–iron ratio in any fraction in uncleaned samples whereas in cleaned fractions marked increase has been noticed. There is an increase of 5.57% Cr_2O_3 and 1.05% Fe_2O_3 in −120+150 mesh fraction. The chromium-iron ratio has also increased from 1.96:1 to 2.15:1. The results of chemical analyses are also in confirmity with the physical and optical results. Thus from the above studies it may be concluded that the −120+150 mesh (114μ) is the optimum fraction at which the Dargai area chrome ore is almost completely free from gangue and most suitable for upgrading.

References

1. S.A. Bilgrami and C.O. Ingamells, Am. Mineralogist, **45,** 576 (1960).
2. A.R. Sastry, G.J.V. Jagannadha Raju and C.V. Rao, Indian J. Technol., **9,** 347 (1971).