Enrichment of Barite Deposits of NWFP for Commercial Utilization

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Summary: Three barite deposits of economic importance occur near Haripur, Havelian and Kohala in Hazara division. Beneficiation studies of eighteen representative samples from these deposits were undertaken by chemical method. The objective of this study was to upgrade the quality of barite to acceptable limit for utilizing in various industries. Simple treatment for 15 minutes with commercial hydrochloric acid has been suggested to obtain the required specification for 80% barite utilizing industries.

Introduction

Pakistan is rich in mineral resources particularly industrial minerals like gypsum, rock salt, silica sand, limestone, dolomite, barite, phosphate rock, soapstone and nepheline syenite [1].

Heavyspar or barite ($BaSO_4$) which is 65.7% barium oxide and 34.3% sulphur trioxide is an important industrial mineral. It has many fold uses. It is used in oil and water well drilling muds, in pharmaceutical industry for the preparation of several barium chemicals, manufacture of paint, lithophone, glass, artificial ivory and insecticides. Paper, rubber and plastic industries use barite as filler [2, 3].

Large stratiform barite deposits occur in Khuzdar and Lasbela districts of Balochistan along the axial belt. Barite deposits of Khuzdar are being mined at the rate of 30.000 tons per annum by Bolan mining company. Barite deposits also occur in various localities of NWFP the regional and local geological aspects of some of which have been studied earlier [4-7]. Studies related to petrographic and geochemical characteristics of barite deposits of Haripur and Havelian were later on carried out by various workers [1,8, 9]. Three principal occurrences i.e., Haripur, Havelian and Kohala barite deposits have been reported in Hazara. Presence of small deposits have also been reported in Swabi, Swat and Salt Range [10,11].

The present paper deals with the upgradation of the barite samples from Hazara deposits using hydrochloric acid to improve their characteristics for utilization in various industries in the light of international standard specification.

Results and Discussion

Table 1, 3 and 5 show that $BaSO_4$ varies from 89.6 % to 93.71%, iron from 0.11 to 0.36% and aluminium from 0.14 to 2.2 % in Haripur barite samples $BaSO_4$ ranges from 84.55 to 93.02 % iron from 0.08 to 0.16 % and aluminium from O.4 to 2.11 % in Havelian barite while $BaSO_4$ varies from 88.92 to 92.68 % iron from 0.12 to 0.26 % and aluminium from 0.28 % to 0.82 % in Kohala barite.

$BaSO_4$. is upgraded from 92.42 to 95.46 % in Haripur barite from 92.08 to 96.52 % in Havelian barite, while in Kohala barite from 94.32 to 95.90 % after hydrochloric acid treatment of the samples. The quantity of iron, aluminium, calcium and magnesium has been decreased and silica contents increased in all samples after the crude mineral is treated with the acid (Table 2, 4, &. 6).

Barite contains calcium, magnesium, iron and aluminium as impurities. From the above results it is obvious tjat some iron, aluminium and me part of the calcium and magnesium that is present as carbonates reacts with the hydrocloric acid to form soluble chlorides that causes the reduction of these elements.

This upgradation of barite has shown that unwanted impurities go along with washings and only minor impurities remain with the acid treated barite. Thus chemical composition of all samples except sample from Kachi, sample No. Chandumera 2 and Batagram 1 & 2 reaches the recommended limit of international standard specification (Table 7) for most of industries. If this beneficiation procedure is undertaken with increasing temperature, or other beneficiating methods are used, the highest quality of barite could be obtained which can be used for pharmaceutical purposes but that may be uneconomical. By this simple 15 minutes acid treatment Hazara barite can be made suitable for 80% industrial applications according to the world standard specification [12].

Table-1: Chemical composition of Haripur Barite in raw state

Sample	SiO_2	BaO	CaO	MgO	Fe_2O_3	Al_2O_3	SO_3	LOI	Total	$BaSO_4$	Sp.Gr.
Kag	2.62	61,37	1.15	0.80	0.18	0.26	32.34	0.71	99.43	93.71	4.238
Aluli	2.44	59.99	3.65	0.52	0.14	0.51	31.48	1.55	100.28	91.47	4.121
Darwaza	2.87	59.28	1.70	0.86	0.25	0.62	31.26	2.63	99.47	90.54	4.072
Kachi	2.26	58.70	1.68	1.61	0.36	2.19	30.90	1.75	99.45	89.60	4.029
Bir	0.98	60.77	1.48	0.56	0.18	2.20	32.03	1.20	99.40	92.80	4.182
Hil	2.61	60.78	1.26	0.85	0.11	0.14	32.06	1.40	99.21	92.84	4.179
Mean	2.29	60.14	1.82	0.86	0.20	0.98	31.68	1.54	99.51	91.82	4.139

Table-2: Chemical composition of Haripur Barite after HCI treatment

Sample	SIO_2	BaO	CaO	MgO	Fe_2O_3	Al_2O_3	SO_3	LOI	Total	$BaSO_4$	Sp.Gr.
Kag	2.96	62.40	0.63	0.42	0.07	0.12	32.82	0.16	99.58	95.22	4.279
Aluli	2.88	62.36	1.49	0.20	0.05	0.13	32.81	0.23	100.15	95.17	4.276
Dawaza	3.69	62.22	0.33	0.15	0.06	0.18	32,67	0.35	99.64	94.89	4.273
Kachi	3.88	60.55	0.83	0.84	0.09	1.03	31.87	0.32	99.41	92.42	4.162
Bir	2.40	62.37	0,57	0.22	0.06	1.00	32.88	0.20	99.70	95.25	4.290
Hil	2.88	62.52	0.40	0.32	0.04	0.05	33.94	0.28	99.43	95.46	4.298
Mean	3.11	62.07	0.71	0.36	0.06	0.41	32.66	0.36	99.75	94.74	4.263

Table-3: Chemical composition of Havelian Barite in raw state.

Sample No.	SiO_2	BaO	CaO	MgO	Fe_2O_3	Al_2O_3	SO_3	LOI	Total	$BaSO_4$	Sp.Gr
Chandomera 1	4.84	61.01	0.60	0.14	0.08	1.23	32.01	0.31	100.22	93.02	4.18
Chandomera 2	5.30	60.00	1.12	0.38	0.14	1.42	31.48	0.42	100.26	91.48	4.122
Faqir Mohd 1	0.88	55.52	5.56	1.26	0.16	2.11	29.03	5.88	100.40	84.55	3.812
Faqir Mohd 2	0.75	60.67	2.58	0.92	0.15	0.02	31.83	2.54	100.46	92.50	4.158
Datagram 1	6.82	59.04	0.82	0.52	0,09	0.40	30.83	1.66	100.17	89.87	4.048
Batagram 2	6.62	56.83	1.84	1.56	0.12	0.45	29.67	3.57	100.66	86.50	3.894
Mean	420	58.84	2.08	0.79	0.12	0.93	30.81	2.39	100.16	89.65	4.037

Table-4: Chemical compsitlon of Havelian barlte after HCI treatment

Sample	SiC_2	BaO	CaO	MgO	Fe	AO	SO_3	LOI	Total	$BaS0_4$	Sp.Gr.
Chandomera I	5.51	61.44	0.29	0.04	0.03	0.50	32.09	0.11	100.01	93.53	4.2K
Chandomexa 2	5.83	60.95	0.56	0.27	0.06	0.65	31.89	0.23	100.44	92.84	4.181
Faqir Mohd I	2.23	62.44	0.75	0.39	0.05	0.83	32.61	0.85	100.15	95,05	4.26S
FaqirMohd 2	1.43	63.34	1.08	0:25	0.04	0,43	33.18	0.58	100.33	96.52	4.345
Batagram 1	7.24	60.50	0.12	0.15	0.02	0.05	31.58	0.42	100,08	92.08	4.140
Batagram 2	6.92	60.65	0.34	0.28	0.03	0.06	31.66	0.65	100.60	92.31	4.148
Mean	4.86	61.55	0.52	0.21	0.04	0.42	32.16	0.47	100.24	93.72	4.215

Table-5: Chemical composition of Kohala Barite in raw state.

S.No.	Sample	SIO_2	BaO	CaO	MgO	Fe_2O_3	Al_2O_3	SO_3	LOI	Total	$BaSO_4$	Sp.Gr
I	Kohala 1	3.20	58.57	2.58	1.02	0.18	0.28	30,58	3.16	99.57	89.15	4.022
1	Kohala 2	2.65	58.32	3.23	0.86	0.16	0.45	30.60	2,96	99.23	88.92	4.002
3.	Kohala 3	3.32	60.49	1.48	0.62	0.12	0.32	31.61	1.50	99.46	92.10	4.146
4.	Kohala 4	2.08	59.16	1.95	1.32	0.26	0.82	30.89	3.22	99.70	90.05	4.045
5.	Kohala 5	1.88	60.62	1.83	0.84	0.13	0.63	31.70	2.16	99.79	92.32	4.163
6.	Kohala 6	2.02	60.88	1.47	0.56	0.15	0.52	31.80	1.87	99.27	92.68	4.172
	Mean	2.52	59.67	2.09	0.87	0.16	0.50	31.19	2.47	99.47	90.86	4.092

Table-6: Chemical composition of Kohala Barite after HCl treatment

Sample	SIO_2	BaO	CaO	MgO	Fe_2O_3	Al_2O_3	SO_3	Lol	Total	$BaSO_4$	Sp.Gr.
Kohala 1	3.54	62.10	0.54	0.32	0.06	0.16	32.43	0.52	99.67	94.53	4.249
Kohala 2	3.00	61.84	0.86	0.34	0.05	0.21	32.48	0.45	99:23	94.32	4.214
Kohala 3	3.57	62.10	0.38	0.29	0.03	0.17	32.58	0.26	99.38	94.68	4.258
Kohala 4	2.73	62.59	0.42	0.43	0.07	0.36	32.68	0.62	99.90	95.27	4.288
Kohala 5	2.34	63.00	0.39	0.30	0.04	0.28	32.90	0.36	99.61	95.90	4.320
Kohala 6	2.40	62.93	0.35	0.21	0.05	0.25	32.87	0.32	99.38	95.80	4.309
Mean	2.93	62.42	0.49	0.31	0.05	0.23	32.65	0.42	99.52	95.09	4.277

Table-7: General specification of barite 12

	1	2	3	4	5	
	drill mud barite	fillar application	glass grade barite	barite as heavy aggregate	barium chemicals manufacture	paint grade barite
Sp. gravity	4.2	-	-	-	-	-
$BaSO_4$	92%min	95% min	95% min	95% min	92-96% mim	95% min
SiO_2	-	-	1.5 max	-	-	-
Fe_2O_3	-	-	0.15 max	-	1% max	0.05% max
Al_2O_3	-	-	0.15 max	-	-	-
Colour	-	near white	white	-	-	white
Particle size	95% (45 μm)	95% .45μm	100%-8.50 μm	gravel size	-5.0 +0.5 mm	37 μm

The mean specific gravity of Haripur barite is 4.139, Havelian barite is 4.037 and Kohala barite is 4.092 in the crude form. In the beneficiated samples mean specific gravity changes to 4.263, 4.215 and 4.277 respectively. This increase in specific gravity confirms the increase in the purity of the mineral. The specific gravity of pure barite is 4.5 [13].

Experimental

Material and Methods

Brief description of barite deposits in Hazara is as follows.

Haripur barite deposits that lie around Haripur village have been recorded in 12 localities that are spread over an area of about 30-km^2. The promising barite deposits are Kag, Aluli, Darwaza, Chinjiala, Kachi Bir, etc. All the barite deposits are accessible through Haripur - Bir road. These barite occur in quartzite, quartz-mica and dolomite. In the Kag Aluli under ground mine up to 300 feet deep several feet thick barite veins occur.

Havelian barite deposits lie in the southern area of Hazara districts. In the thick sequence of limestone with subordinate shale, barite occurs in veins, varynig in thickness from few inches to several feet.

In this region Chandomera, Faqir Muhammad and Batagrain are three important barite deposits. In diandomera, reddish white barite veins occur in grey colour orgillaceous limestone and reddish shale [14]. The barite veins are irregular through out the region but have a sharp contact with the host rock.

Kohala deposit is the largest deposit of Hazara district. It is located at about 3 miles to the south west of the Kohala village, near Nathiagli. Barite occurs in large and small dilation veins and is the highest grade of all other barite deposits nearby in Hazara district, and reserves of all categories have been estimated up to 30 thousand tonnes [3].

Eighteen representative barite. samples were collected from Hazara deposits, selecting six each from Haripur, Havelian and Kohala respectively. For chemical analysis each sample was crushed to 150-180 μm after conning and quartering. Percentage composition of silica, iron, aluminium, calcium, magnesium, barium and loss on ignition was determined by conventional methods [15]. Iron was also determined by spectrophotometric method. Chemical analysis of raw samples is given in Table 1, 3 and 5.

Then 50 .gram of each sample was taken in 500-ml beaker, washed two times with distilled water by decantation and 50-ml commercial hydrochloric acid was added. Stirring was done with mechanical stirrer, After 15 minute's reaction, acid was decanted. Sample was washed with distilled water by decantation and then by filtration till the filtrate was free from chloride and iron. Washed sample was dried in oven at 110°C and chemical analysis was carried out, using the same procedures as were, used for the sample in crude form. .Results are tabulated in tables 2, 4 and 6 respectively. Specific gravity of all samples was also determined and reported (Table 1-6).

Conclusion

Though barite produced in Hazara is already utilised in petroleum drilling industry, manufacture of paint and chemical industry, this barite in original form is not suitable for high quality products. The present investigations were to improve the quality of the barite. The present study show that suitable quality of barite exists in Hazara which after simple acid treatment can be utilised for the international standard production of chemicals, paint and glass, and for application as heavy aggregate and as a filler in rubber, paper and plastic industries. It can also be used in petroleum drilling industry.

Commercial hydrochloric acid is abundantly available in Pakistan from the chemical industries.

This process can be fruitfully employed to reduce the unwanted constituents.

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