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BRUCITE DEPOSITS OF HINDUBAGH (WEST PAKISTAN)

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Brucite bearing serpentine rocks are located at an aerial distance of 5 miles north of Hindubagh and extend from the village Khazina to the west of the village Telri Muhammed Jan. Brucite is of fairly good quality and suitable for the production of the magnesium chemicals as well as for use in building materials.

It has been upward trend in Pakistan to substitute imported chemicals by manufacturing chemicals from indigenous raw materials. Magnesium salts are being imported in large quantities for use in rubber and pharmaceutical industries. Although good quality magnesite is available in Pakistan, which could serve as a raw material for the manufacture of these chemicals, yet the presently known deposits do not appear to be adequate to meet the growing demand of the magnesium chemicals within the country. In view of the fact that a sufficiently large deposit of brucite is available in the Hindubagh area, as is suggested from the geological investigation of these deposits undertaken as part of this study, it appeared worthwhile to investigate the use of brucite in the manufacture of these chemicals. The present investigation consists of: (a) the geology and the extent of the brucite deposits available in the Hindubagh area, and (b) the composition and the possible uses of brucite in the manufacture of magnesium chemicals.

General Geology

Brucite bearing serpentinite rocks are located at an aerial distance of 5 miles north of Hindubagh and extends from the village Khazina to the west of the village Telri Muhammed Jan. Sedimentary and ultrabasic intrusives are the common rocks of the area. The ultrabasic intrusions extend more than 4 miles in approximately ENE–WSW i.e. in the direction of the strike of the country rock. Apparently these deposits have not been properly studied so far; some earlier workers[1] have indeed worked on the identification of this mineral which apparently was referred to them by Geological Survey of Pakistan as an asbestos mineral. This work, however, is essentially an identification work and has been undertaken on perhaps random sample and as such is not very helpful in the evaluation of this mineral. For this reason it seemed desirable to study both the geology and chemistry of these mineral deposits and their possible utilization.

Fractures and fissures in the serpentinite rocks have developed irregularly and are scattered in the whole rock mass. In the fissures and fractures the fibrous variety of the brucite mineral has developed. The thickness of the brucite fillings (veins) varies from 1–4 in. It has been noted that the thickness of the brucite veins varies inversely with the distance between the fractures.

Mineralization of brucite has been controlled by the spacing in fracture system, when the spacing is closed then there is a maximum development of brucite is minimum.

The thickness of brucite in no case exceeds 4 in. In whole of the area the upper part of the serpentinite is weathered and covered with a layer of its own weathered materials.

Brucite found in serpentinite rock is mostly white but some brownish white varieties are also found. The brucite fibres are about 1–4 in long. The veins are comparatively short and discontinuous spreading in all directions and forming a network in the rock mass. It is estimated that the brucite constitutes about 6% of the serpentinite rock in central part of the depsit from where channel and bulk samples have been collected.

The fibrous nature and whiteness of brucite helps in distinguishing and separating it from the enclosing rock mass. Brucite closely resembles with amphibole asbestos in appearance. It has also been observed during the field work that at some places brucite disappears with the development of massive white magnesite.

The brucite occurs as small veins scattered in serpentinite rocks. The nature of deposits makes it difficult to calculate the reserves accurately. An attempt has been made to calculate the approximate reserves of the deposits in which volume tonnage factor has been taken as 18 ft^3/ton of the volume of serpentinite rocks.

Total of the serpentinite rock/ foot depth	10,151,360 ft^2

TABLE 1.—CHEMICAL ANALYSIS OF CHANNEL SAMPLES OF BRUCITE OF HINDUBAGH (WEST PAKISTAN). Weight Per Cent

S. No.	Sample No	SiO_2	R_2O_3	MgO	CaO	Loss on ignition	CO_2
1	White brucite	11.6	3.7	56.8	—	28.2	—
2	C-1	32.20	4.90	44.24	0.26	18.80	—
3	C-2	28.50	3.13	46.91	0.49	21.16	—
4	C-3	22.70	5.3	48.07	0.98	23.50	—
5	C-4	17.22	5.08	43.01	0.84	34.50	11.30
6	C-5	31.60	5.70	48.84	0.46	18.07	—
7	C-6	10.32	3.27	44.83	0.77	40.70	18.80
8	C-7	11.74	4.47	45.47	0.53	37.90	22.02
9	C-8	7.80	4.09	45.73	0.77	41.90	25.10
10	C-9	35.20	8.70	40.83	0.42	15.60	—
11	Bulk sample	25.6	7.1	45.45	0.35	22.1	—
12	Residue after hydrochloric acid treatment	97.2	2.2	1.05	—	—	

C=channel

Total volume of brucite	6,908.6 ft^3
Volume of the serpentinite rocks	
Sp. gravity of brucite	2.39
Volume tonnage factor	18 ft^3/tons
Approximate tonnage at per foot depth	33,837,8 tons
Approximate reserves at 100 ft depth	23,83,780 tons

Chemical Composition

In all eleven different samples have been analysed following the standard methods[2–4] of analysis for SiO_2, R_2O_3, MgO, CaO and CO_2 (Table 1) including nine samples from different channels C–1 and one bulk sample. Sample No. 1 (white brucite) is high in magnesium content i.e. it contains 56.8% MgO and the rest contain 40–45% MgO. It has been noticed during the chemical examination that at some places the brucite veins end with the development of white magnesite. This is clearly indicated by the analysis of the channel samples No. C–4, C–6, C–7 and C–8 (Table 1) which contain magnesium carbonate alongwith magnesium hydroxide.

Broadly, the brucite samples could be divided under two categories, viz. white brucite sample and greenish-grey samples, the white brucite appears to be pure containing 56.8% MgO while the greenish-grey samples contain 40.3%.

Brucite from Hindubag is different from the Canadian brucite,[5] which is associated with limestone (Table 2). But this brucite contain insoluble matter to the extent of 10–11%. This crystalline insoluble matter on analysis was found to be magnesium silicate (Table 1, analysis No. 12). This mineral may be favourably compared with the U.S.A.[5] and Japan[6] brucite which contain very little quantity of limestone (Table 2).

TABLE 2.—COMPARATIVE CHEMICAL COMPOSITIONS OF BRUCITE OF DIFFERENT COUNTRIES. (Weight %)

	Pakistan	U.S.A.	Canada	Japan
SiO_2	11.6	0.7–4	1.26	0.33
R_2O_3	3.7	0.7	0.50	1.77
MgO	56.8	61.65	31.86	64.81
CaO	—	1.4	22.66	—
Loss on ignition	28.2	31.32	42.9	31.38
MnO_2	—	1.2	—	1.10

X-ray Analysis

The X-ray powder pattern of the sample was taken using CUK α radiation, the observed data are given in Table 3. A search through the A.S.T.M. cards showed that the majority of the observed lines corresponded to the standard data of brucite. After accounting for the lines due to brucite, over half-a-dozen other lines, mostly of faint and weak intensities, remained to be accounted for. A further search through the A.S.T.M. cards showed that these lines could arise due to two phases, namely dolomite and asbestos. The powder data alone could not however conclusively establish their presence in the sample. The chemical analysis (Table 1) however indicated that the same samples showed a substantial loss on ignition, of which a fair proportion appeared as carbon dioxide. This evidence supported the conclusion that the sample contained dolomite as

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TABLE 3.—X-RAY ANALYSIS OF BRUCITE FROM HINDUBAGH (WEST PAKISTAN).

Intensity	*d*-values	$MgO.H_2O=Mg(OH)_2$ *d*-values (*I/I*)	Dolomite $MgCO_3CaCO_3$ *d*-values (*I/Io*)	Asbestos $3MgO.2SiO_22H_2O$ *d*-values (*I/Io*)
W	7.4	—	—	7.4(100)
MS	4.8	476(80)	—	4.53(100)
FW	4.25	—	—	4.11(4)
W	3.67	—	—	3.66(60)
W	2.9	—	2.89(100)	—
FW	2.76	—	—	2.72(4)
VF	2.63	—	—	2.61(8)
VF	2.54	—	—	—
S	2.39	2.37(100)	2.40(13)	—
W	2.20	—	2.19(40)	—
F	2.03	—	2.02(20)	—
MS	1.79	1.79(80)	1.80(40)	—
M	1.58	1.57(70)	—	—
F	1.54	—	1.55(10)	—
MW	1.49	1.49(60)	—	—
M	1.37	1.37(6)	—	—
MW	1.31	1.31(60)	—	—
MW	1.18	1.18(50)	—	—
FW	1.09	1.09(20)	—	—
FW	1.05	1.03(40)	—	—
FW	1.01	1.00(60)	—	—
W	0.955	0.95(40)	—	—
W	0.946	0.94(40)	—	—
F	0.91	0.91(40)	—	—
F	0.902	—	—	—
F	0.897	—	—	—
W	0.866	—	—	—
W	0.817	—	—	—
F	0.815	—	—	—

Note: For dolomite, only those lines have been given, the intensity of which are greater than or equal to 10.

well. Further, the fact that the sample also contained some amounts of SiO_2 lended support to the view that small amounts of asbestos is also contained in the sample. The appearance of this mineral is fibre like but the X-ray analysis does not show any resemblance to asbestos (Table 3). The standard data of brucite, dolomite and asbestos are also reproduced in Table 3 from the A.S.T.M. cards for comparison.

Utilization

It would appear from the chemical and X-ray analysis results that the white brucite samples consist essentially of $Mg(OH)_2$, whereas the bulk sample comprises of the three phases, brucite, dolomite and asbestos. On an average the sample contain 45.5% MgO, whereas the richest samples contain as much as 56.8% MgO. Thus these brucite samples appeared to hold promise for the manufacture of magnesium chemicals. Efforts were, therefore, directed to prepare these chemicals, namely magnesium sulphate, magnesium trisilicate, heavy and light magnesium carbonate, magnesium chloride, magnesium citrate using these brucite samples as the starting raw material. It has been found that these chemicals can be economically prepared from these brucite samples and the processes of manufacture are now available for commercial exploitation. Further uses of these samples, such as, in the manufacture of inorganic insulating tapes and sprayable paints may also be investigated.

In view of the potential uses of brucite, it needs hardly be stressed that the brucite deposits of Hindubag area deserve to be given more importance and that it would certainly be possible to undertake a more extensive survey of these deposits.

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