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PETROGENESIS OF HAZARA DOLOMITES OF NWFP, PAKISTAN AND THEIR INDUSTRIAL USES

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Hazara dolomites are sedimentary rocks of Cambrian age and belong to Sirban formation of Abbottabad Group. These dolomites are formed by the alteration of limestones. There are huge resources of dolomite in the Sirban formation of Abbottabad area. Two textural varieties are found in these dolomites, one is coarse grained and the other is fine grained. Chemical analysis shows that these dolomites have many industrial applications. These are suitable for using as soil neutralizer, in the preparation of dolomite clinker, as an accelerator in the cement industry, in the preparation of chemicals like MgO, $Mg(OH)_2$ and in the steel industry.

Key words: Dolomites, Petrogenesis, Hazara.

Introduction

Huge deposits of dolomite, an important industrial mineral, are found as sedimentary rock from Paleozoic to Tertiary age throughout the world. Hazara dolomites are of Cambrian age and belong to the Sirban formation of Abbottabad Group (Fig. 1). These deposite were formed by the secondary alteration of previously formed limestones by Mg-rich fluids. Several million tons of dolomite occur at latitude 34° 30' N and longitude 73° 30' E in the study area and are exposed at many localities like Sirban, Kakul and Lambidogi. All these localities occur within 5-15 km of Abbottabad city in Hazara, NWFP (Fig. 1). The area is very complex due to tectonic disturbances.

Work on the Hazara area started when Waagen and Wynne [1] mapped the Sirban area situated in the south of Abbottabad. Later, Middlemiss [2] published a 1:120720 scale map. After this, various workers including Wadia [3], Marks and Ali [4,5], Latif [6a,b], Davies and Gardezi [7], Calkins and Matin [8] Bhatti *et al.* [9], studied different lithounits particularly the phosphates exposed in the area but no work has been carried out on these dolomites. Keeping in view the importance of this industrial mineral, studies on these dolomites were undertaken.

Materials and Methods

Geologic setting. The Hazara area has a very complex structure as it is highly folded and faulted. Predominantly sedimentary rocks are exposed in the area. Many workers, e.g. Latif (6a,b), Hasan and Ghaznavi [10], Bhatti *et al.,* [9] have described the stratigraphy.

The stratigraphic succession of dolomite bearing area is given in Table 1.

Dolomite occurs in the folded and faulted succession of Cambrian to Jurassic age occurring at various localities, it is mainly found in the Sirban formation of Abbottabad Group. At the base of the section in the Kakul mine, dolomite is a few centimeters to about three meters in thickness and these units are interbedded with chert. The indivi-dual beds of dolomite are white to bluish grey having thickness of 2 to 6 meters interbedded with chert. At about 6 meters height, the thickness of these dolomites increases with interbedded micritic limestone layers and chert nodules. The dolomite at Kakul section occurs up to 17-20 meters in thickness, afterwards it passes into banded chert [17].

Dolomite is of sucrosic texture at some places in Kakul which may be due to relatively loose fitting together of the dolomite rhombohedra. In Lambidogi area dolomite occurs as

Table 1. Stratigraphic Succession of Dolomite Bearing Area (After Latif, 1974).

Group	Formation	Member	Age
Thandiani	Maira		Lower Jurassic
	------- Conformity --------		
	Tarnawai	Hazira	
		Galdanian	
	------ Disconformity ------		
	Sirban		
		Mirpur	Cambrian
Abbottabad	Kakul	Mahamdagali	
		Sangargali	
		Tanakki	
	------ Unconformity ------		
	Tanol		
Hazara	Upper Langrial Limestone		
	Middle Miranjani Limestone		

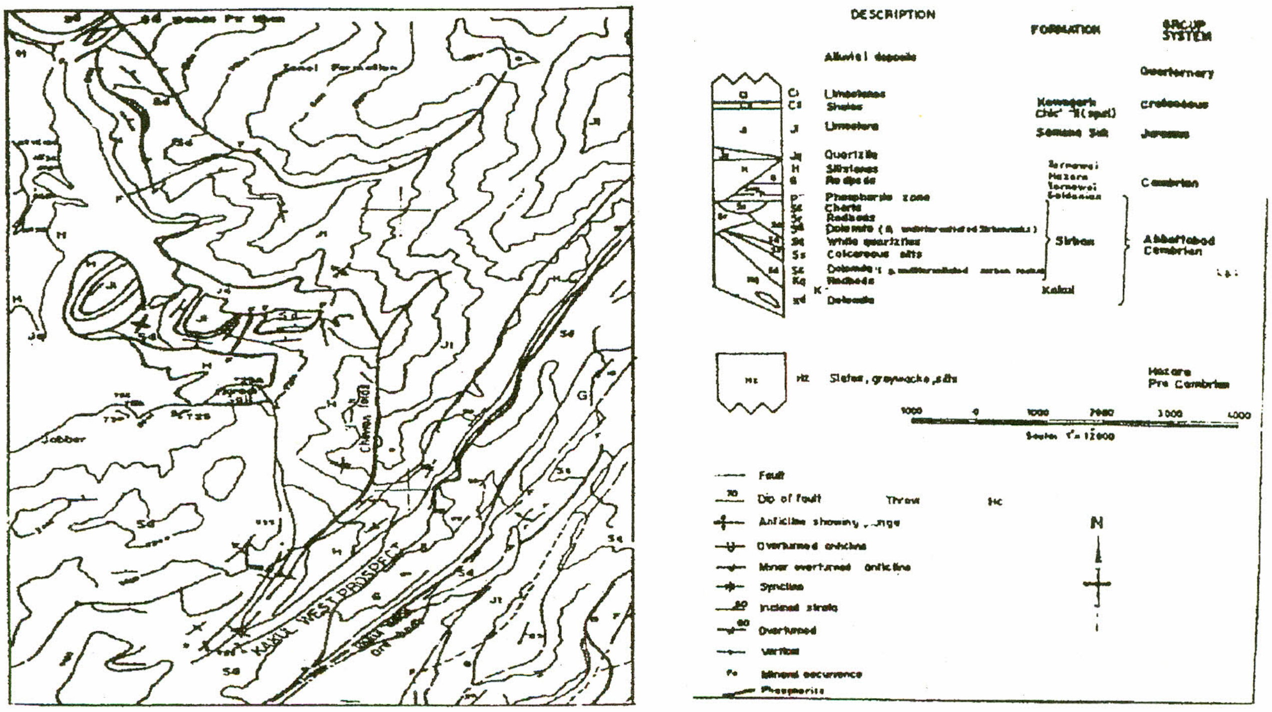

Fig. 1. Geological map of Kakul, Lambidogi area, Hazara Division, NWFP (After British Mining Consultants and Sarhad Development Authority, 1977).

interbedded and has sharp contact with massive phosphorites (Fig. 2).

Exprimental. About 20 samples were collected from different stratigraphic horizons of Kakul and Lambidogi deposits. Thin sections of these dolomite samples were prepared for their microscopic study. The petrographic study shows that the only other mineral present is calcite. Hence, X-ray studies were not carried out. The samples were also analysed for their chemical composition (Table 2).

Results and Discussion

Two textural types of the dolomite are recognized in this area (i) fine grained and (ii) coarse grained, the fine grained variety being dominant.

Most of the rock is composed of dolomite with rare calcite. Mostly, the dolomites are fine grained and inequigranular. The grains are anhedral to subhedral presenting the sucrosic mosaic with interlocking grain boundries (Fig. 3). Silt size quartz is present through the rock. The relic grains of calcite (Fig. 4) occur and opaque ore is present as small grains throughout the rock and as inclusions in the dolomite grains [18].

The rock exhibits a patchy structure, composed of coarse grained dolomite within fine grained dolomite (Fig. 3). Further, fine grains of dolomite are a few microns in size and peloidal in texture.

In plane polarized light, dark coloured patches are seen, which are ghost structures of skeletal material, which was more susceptible to dolomitization such as earlier aragonite shells or more resistant in the calcite shells (Fig. 5). These ghost structures show different degrees of dolomitization.

Coarse grains of dolomite are subhedral to anhedral and sometimes, show twining at the cleavage sets. Some of the dolomite grains show rhombic structures and zoning is also seen (Fig. 6).

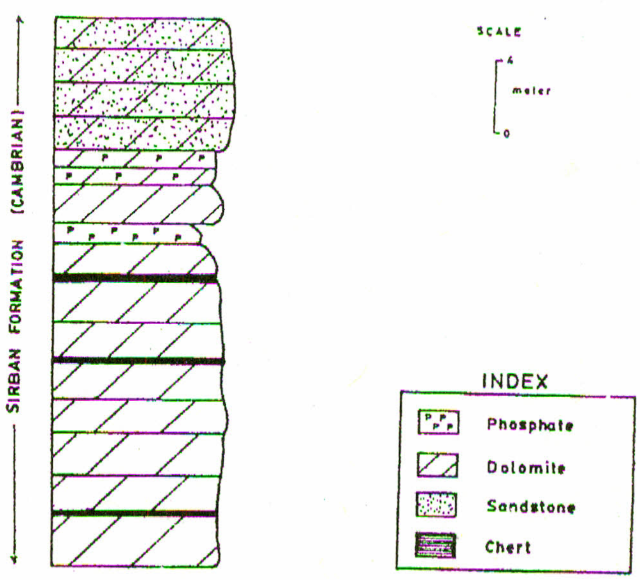

Fig. 2. Sirban formation of dolomite..

TABLE 2. CHEMICAL COMPOSITION OF DOLOMITE SAMPLES FROM HAZARA, NWFP (IN %).

No.	SiO_2	CaO	MgO	Fe_2O_3	Al_2O_3	Na_2O	K_2O	L.O.I	Total
P-11	1.73	31.18	23.36	0.27	0.65	3.80	0.26	38.77	100.02
P-14	5.29	26.41	17.68	0.40	19.10	3.85	0.32	26.76	99.81
P-16	8.02	28.89	17.49	0.94	1.66	2.44	0.15	40.45	100.04
P-23	3.16	30.71	18.88	0.96	2.27	3.34	0.15	40.60	100.07
P-24	34.45	17.74	14.42	1.93	2.30	1.94	0.30	26.93	100.01
P-33	56.90	13.61	6.73	1.95	3.48	1.68	0.60	15.79	100.14
P-38	0.90	29.58	23.12	0.55	1.92	1.15	0.33	42.36	99.93
P-40	5.30	29.06	21.34	1.10	2.61	1.15	0.28	39.20	100.04
S-1	0.39	29.34	23.55	0.53	1.77	1.43	0.33	42.65	99.99
S-2	0.48	29.81	23.80	0.40	0.85	1.42	0.31	42.98	100.06
S-3	0.75	29.63	23.86	0.49	0.87	1.43	0.31	42.61	99.95

Groundmass is composed of cryptograined dolomite and calcite. Microstylolites are present parallel to the bedding (Fig. 7). Primary quartz grains are also seen in these dolomites (Fig 8).

Genesis. The petrographic features like (i) relict grains of calcite and ii) presence of microstylolites suggest that these dolomites are of replacement origin [18]. The presence of primary quartz grains also suggest that the dolomite is of secondary origin. As no evaporites can be noticed in these dolomites or in the overlying sediments, it seems that complete dolomitization of the entire Sirban formation took place without the deposition of evaporite minerals as in the shallow subsurface dolomitization of Hanson Creek Formation of Central Nevada [19]. Hence, the dolomitization of the Sirban formation might have occurred post depositionally and a hypersaline brine was unlikely to have been the agent responsible for the dolomitization. Possibly the formation of dolomite took place after deposition of carbonates in shallow marine shelf environments but before burial compaction could produce diagenetic features like stylolites. Therefore, the presence of stylolites in the Sirban dolomites suggests that diagenesis has taken place after the formation of dolomites.

Industrial application. Chemical analyses of eleven representative samples of dolomite from the study area (Table 2) show that these dolomites could be utilized in a number of industries. The samples with about 29.4% CaO and over 21% MgO (Sample No. P- 38, 43; S- 1, 2, 3) are suitable for neutralizing soil acidity [20]. Pakistan needs application of such dolomites for neutralizing acidic soils, where thousands of acres of cultivable land is rendered useless every year because of acidity. Dolomite samples having 30% CaO and about 20% MgO (Nos. P- 23, 40) could be used for the preparation of dolomite clinkers and accelerating the rate of hydration of cement [21, 22].

The samples having 20-30% CaO and 20-25% MgO (Nos. P. 38, 40, 51) could be utilized for treatment of cracks in plaster work and wood work (23). Calcined dolomite is used in steel industry where its principal function is a slag adjuster (24) or as a refractory material.

Further, they can be used in the construction industry as building and ornamental stones and as powder in construction, ceramics, glass and oil-gas industries. Their other modern

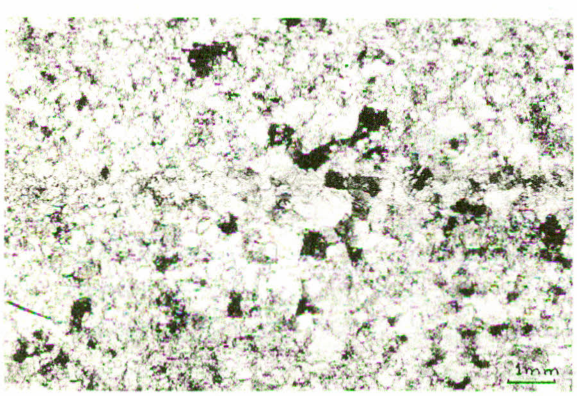

Fig. 3. Dolomite grains with interlocking grain boundaries (close packing) plane x 10.

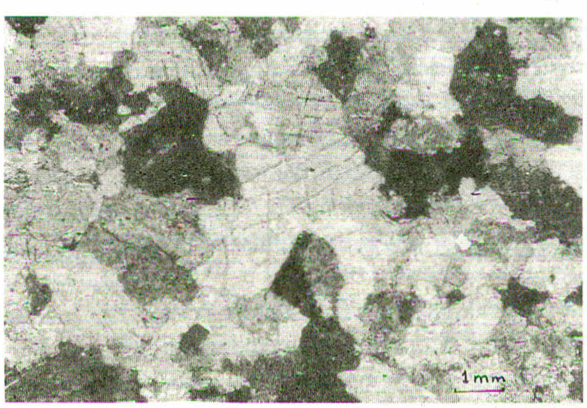

Fig. 4. Dolomite grains showing rhombs and rolic grains of calcito.

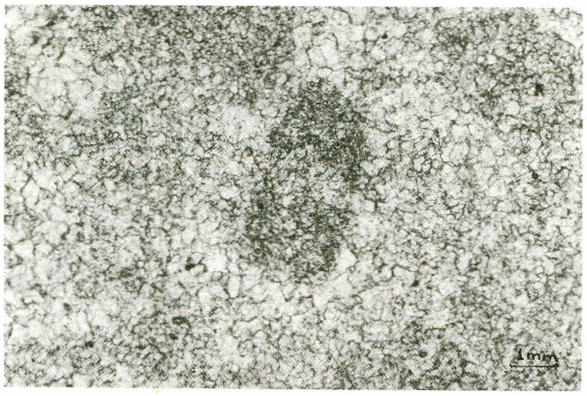

Fig. 5. Ghost structures in dolomite plane x 10.

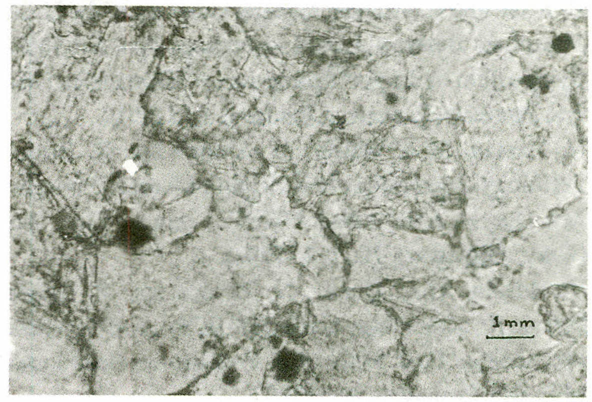

Fig. 6. Dolomite grains showing zoning plane x 10.

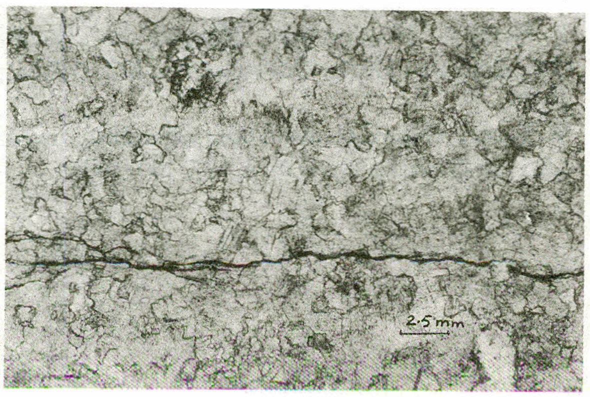

Fig. 7. Microstylolites in dolomite plane x 4.

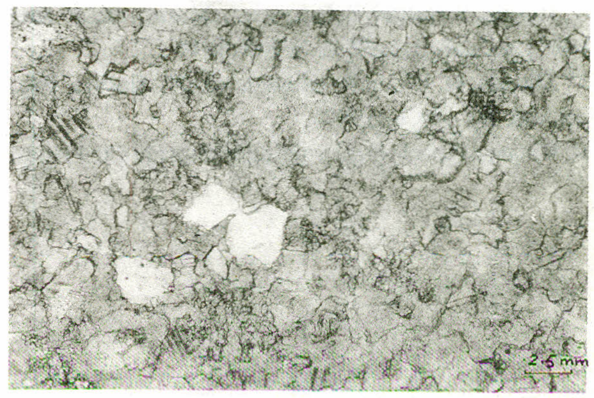

Fig. 8. Primary quartz grains in dolomite plane x 4.

industrial uses as fillers or in other forms are in plastic, rubber, paper, medicine, electric, electronic and optical industries (25).

Conclusion

There are huge reserves of dolomite in the district Hazara of Pakistan. Present study shows that dolomites of this area are suitable for use in various modern and value added industries. These dolomites are of secondary origin, formed by replacement mechanism. In view of the rich economic potential of these deposits, detailed studies are required in order to fully exploit them.

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