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PETROLOGY AND INDUSTRIAL APPLICATION OF NIZAMPUR LIMESTONES, NWFP, PAKISTAN

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Nizampur limestone samples have been studied for their petrology and geochemistry. The results of these studies indicate that Nizampur limestones are suitable for cement, chemical, paper and other industries.

Key words : Limestone uses, Nizampur, Pakistan.

Introduction

Limestone and lime are among the most widely used natural substances because of their easy availability, low cost and abundant supply [1]. Limestone or lime is consumed by chemical, sanitation pulp and paper, ceramics, foods, petroleum, environmental, construction, pigment, leather rubber and many other industries [2].

At one time uses of limestones were confined to agriculture, building and cement purposes, now lime is the second largest heavy or basic chemical used after sulphuric acid [2]. In developed countries, calcium carbonate is the largest filler used in plastics representing about 50% of the market for mineral and reinforcing materials [2].

Limestone is widely distributed in Pakistan. Limestone reserves in the country are unlimited forming many ranges. It is exposed in the Indus Basin and Axial Belt, right from Karachi in the south to Khyber in the north [3]. In NWFP, limestones mostly occur in Peshawar and Hazara divisions. Pakistan produced more than 4.5 million tonnes of limestone in 1984-85 for use in cement, as a dimension stone and for chemicals. While North West Frontier Province contributed 512,121 tonnes to the total production of limestone in the country [4]. Limestones of high quality occur in Kohat-Nizampur and Attock-Cherat Ranges. The geological survey of Pakistan has carried out many valuable surveys of limestone deposits of Pakistan [5-9].

The detailed work on the geology of Attock-Cherat range was carried out by Tahirkheili [10]. Whereas, the high grade limestone in Kohat and Nizampur-Cherat ranges were studied by Siddiqui [7] and Hussain [11] respectively.

High grade limestone is a valuable mineral which should be exploited to its best applications in the industry. The uses of NWFP limestone are confined to construction and cement industry. Rarely they are being used in leather, rubber and chemical industries.

Extensive literature on the geology and structure of Nizampur limestone is existing but adequate data regarding their physico-chemical characteristics and industrial application are still lacking. The published data on the limestone deposits of Pakistan are confined to their suitability for cement manufacturing, the chemical application of limestone was not paid much attention. Whereas, on the basis of petro-chemical data of these limestone their genesis has also been discusse

Materials and Methods

Geologic setting. Major parts of Nizampur lie in Peshawar district, NWFP and the rest parts fall in Mardan and Attock Districts of NWFP and Punjab respectively. Nizampur is linked with a national highway and main railway line [11].

Tahirkheili [10] carried out detailed geological investigations of Attock-Cherat range. This work was followed by biostratigraphic studies of the Mesozoic Formation of Kohat Potwar Province [12]. Later Hussain [11] made extensive geological and structural studies of Nizampur-Attock-Cherat range. According to these workers two different types of lithologial assemblage with a tectonic contact are exposed in Nizampur. In the northern part of the quadrangle the stratigraphic sequence belong to the Attock Cherat range and mostly consist of metasediments of probably Late Precambrian to Paleozoic age. The lithological units in the southern parts of the quadrangle which include Nizampur and Kala Chitta range are entirely sedimentary in origin and range in age from Mesozoic to Tertiary.

The following rock sequence has been established in the Nizampur area:

Age	Formation	Lithology
Early to Middle Miocene	Alluvium	
Eocene	Patala Formation	Shale with interbedded limestone
Paleocene	Lockhart Limestone	Dark grey, medium to thick bedded hard nodular limestone, brecciated

Continue on page 2

Continued

		in places, with intercalations of marl and shale.
		---- Unconformity ----
Late Cretaceous	Kawagarh Formation	Dark mal and cleaved calcareous shale
Early Cretaceous	Lumshiwal Formation	Quartzose, glanconitic and calcareous sandstone, silty phosphatic sandstone, argillaceous shelly limestone and nodular marl.
Late Jurassic to Early Cretaceous	Chichali Formation	Greenish, rusty brown, glauconitic sandstone with nodular silty calcareous phosphatic base or pyritic shale.
Jurassic	Samana Suk Formation	Grey to dark grey thick bedded oolitic limestone with subordinate calcareous shale intercalations.
		----Unconformity----

The good quality limestone deposits in Nizampur belong to Samana Suk and Lockhart Formations. They are hard, massive, medium to thick bedded in nature. The intercalations of marl and shales with these limestones are also common. Samanasuk Limestone varies in thickness from 190 to 350 metres, whereas the thickness of Lockhart Limestone is about 200 metres in Nizampur-Kalachitta Range [3].

Khairabad and Cherat thrust faults dominate the structural set-up of the area. Besides there are several strike-slip, normal and reverse faults. The area has been deformed into several anti clines, synclines and tight folds [10,11].

Experimental

About 20 samples were collected from different stratigraphic horizons both vertically and laterally along the

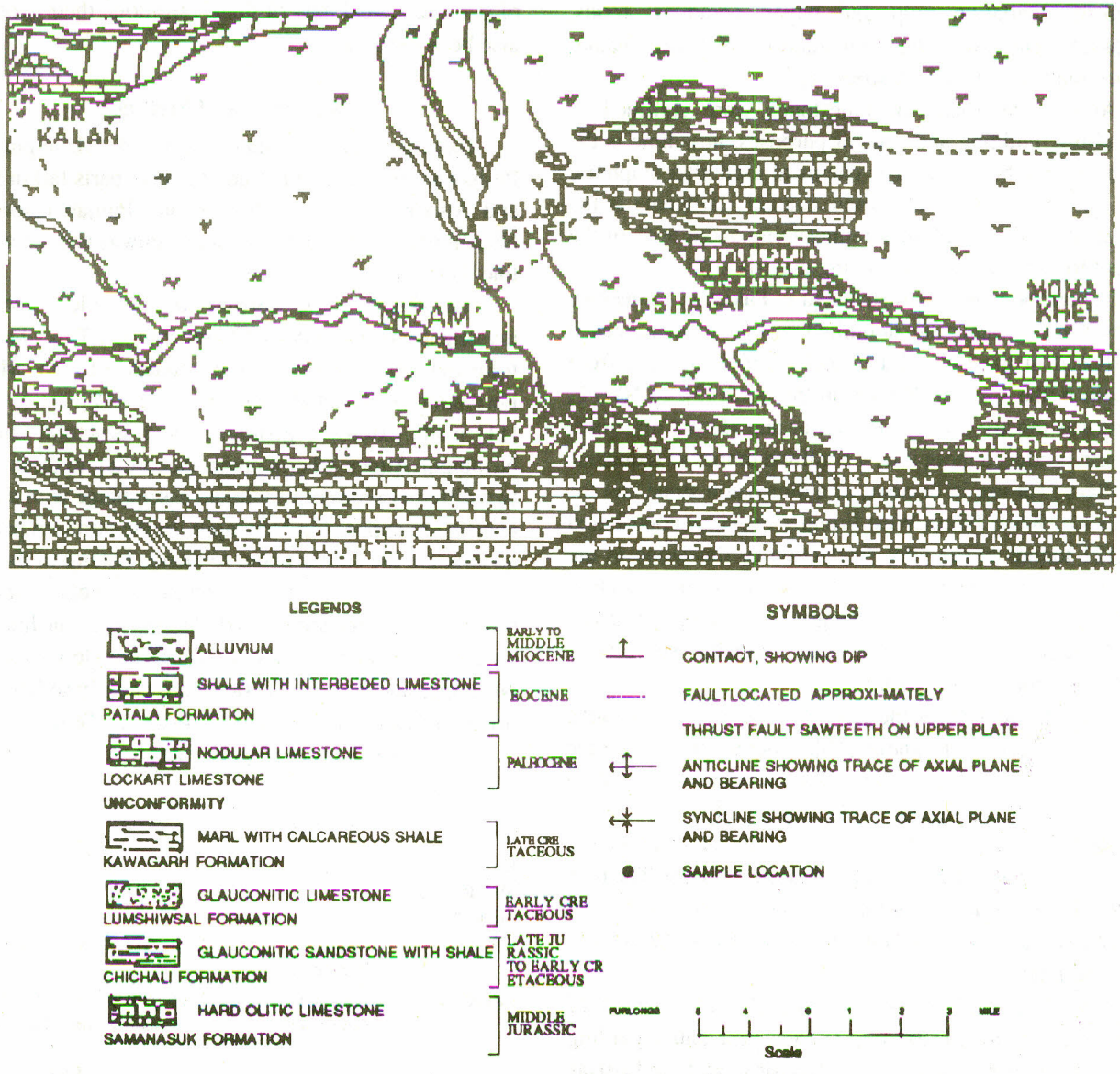

Figure 1. Geological map of Attock-Nizampur area. (After Ahmed Hussain 1978).

strike length of about 1 km from Wuch Khaur section of Nizampur.

The thin sections of limestone were subjected to staining test for doing microscopic studies.

A few limestone samples from the area were subjected to firing tests at 1000° in the laboratory of Frontier Ceramics, Ltd. Peshawar. These samples were also studied for their colour, hardness and specific gravity.

The carbonate samples were analysed for their major elements. The SiO_2 and $R2O_3$ were determined by conventional gravimetric method, whereas CaO and MgO were determined volumetrically. The volumetric results were checked by gravimetric method. Sodium and potassium oxides were determined by flame photometer, whereas the oxides of P, Fe, Ti and Mn were determined spectrophotometrically.

Results and Discussions

Petrology. In thin sections, limestone samples of Nizampur are dominantly composed of micrite, pellets, intraclastic calcite, microspar and cement. The major mineral components are calcite, dolomite and less commonly pyrite and iron oxide. The minor constituents are clays quartz phosphates and chalcedeny.

Micrite or microcrystalline mud is dark in colour occurring as coarser and finer patches. Fine to very fine crystalline micrite [13] appears to have been displaced by calcite cement which may form as vein or may create room for itself by pushing aside the surrounding allochemor carbonate mud through the active force of crystal growth [14,15].

According to Bathrust [16] the primary porosity is quite low in ancient limestones which is further reduced to its low value of about 3% due to introduction of cement (Fig. 2).

The ellipitical to ovoid shaped pellets of various sizes are important textural features of Nizampur limestones (Fig. 3). The pellets are mostly micritic in nature which are seen with their margins filled with calcite cement. Some times the cement appears to have replaced the whole body of micritic pellets (Fig. 3).

In some thin sections, dark interaclastic coarse grains of calcite with subhedral boundaries and perfect sets of cleavage are noticed (Fig. 4). The calcite grain boundaries are marked by droplets of iron oxide (Fig. 4).

In some cases microspars of calcite with fresh and clear surfaces and less prominent cleavages are seen in Fig. 5. These grains according to Folk [17] are the result of neomorphism of mud sized carbonate to 5-20 micron microspar and still further coarse neomorphic sparry calcite ranging upto the size of several lenths of millimeters (Fig. 5).

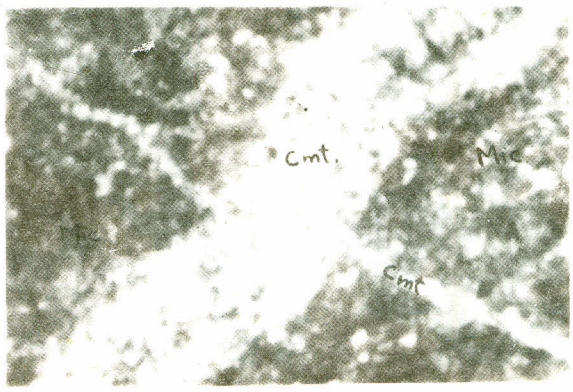

Fig 2. Micrite (Mic) and its replacement by cement (cmt.) (crossed polarized light x 6.3).

Fig 3. Elliptical to oovide-shaped Micritic Pellets (Mic. Pell.) Showing replacement by cement (Cmt.) (Crossed polarised light x 6.3).

Fig 4. Coarse grains of calcite (ct) showing perfect cleavages. (Crossed polarised light x 6.3).

Earlier workers have reported fossils of forminifers and mollusks from Nizampur limestones and assigned Paleocene age. [11] In thin sections under study, fossils have not been identified. However some skeletal fragments surrounded by micrite and cement are seen rarely (Fig. 6).

The lime mud which is later lithified into micrite or pelmicrite is formed possibly from physico-chemical precipitation [18,19]. The other components of Nizampur limestones like microspare or spary calcite are the result of

Fig 5. Sparry calcite (Sp. ct) (Crossed polarised light x 6.3).

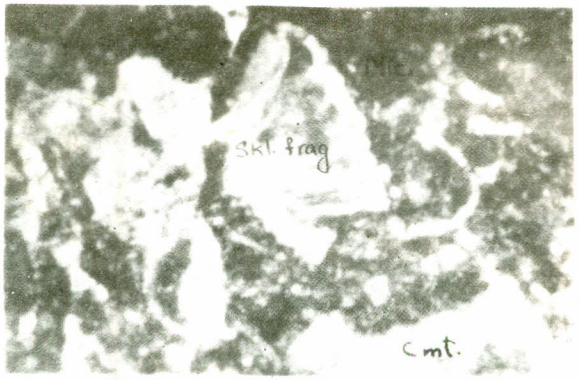

Fig 6. Possibly Skeletal fragments (Skl. Frag.) (Crossed polarised light x 6.3).

neomorphism of micrite [13]. Moreover, the dominant micritic pelletal nature of Nizampur limestones reflect moderately agitated marine environment of deposition [20].

Industrial applications. The chemical analysis of Nizampur limestones (Table 1) show that they are suitable for sugar and paper industries. They are also good cement limestones [1,7].

Nizampur limestones are grey coloured, uniformly fine grained and crystalline massive. Physical characteristics (Table 2) show that limestones are compact, hard, with high specific gravities, which indicate their homogeneity, low

TABLE 2. PHYSICAL PROPERTIES OF NIZAMPUR LIMESTONE

Formation	Crystalline Form	Colour	Hardness	Sq. Grave.	Fired Coloui
1. Lockhart limestone	Calcite	Dark grey	2-3	2.48	While
2. Samanasuk Limestone	Calcite	Dark grey	2-3	2/54	White

porosity, mechanical strength and low calcination rates [1]. When some limestone samples were fired at 1000°, the loss on ignition was 35-40% and the fired colour was white. These physical characteristics make them suitable for ceramic industry. Graded limestones from Nizampur with $CaCO_3$: 97, SiO_2: 2 and Fe_2O_3: 0.3% [7] can be used for ceramics.

Nizampur limestones with an average content of $CaCO_3$: 93, SiO_2: 2.72 and R_2O_3: 1.54% (Table 1) are suitable for manufacturing alkalis. Some fractions of Nizampur limestone which are impure to be used in chemical industries, due to their high silica content, can be used as blast furnace and open hearth fluxing stone. The average content of silica of these limestone is below 3% which make them useful to the steel industry [1].

Highly graded limestones of Nizampur which have $CaCO_3$: 92, SiO_2: 2 and Al_2O_3: 3% [1, 7, 21] can be used in chemical industry and as a carbonate filler in paper, rubber, plastics and other industries [6,8].

White carbonate fillers are precipitated calcium carbonate, obtained mainly by grinding the limestones. In North America and Europe the plastic industry is the largest consumer of white carbonate fillers. The automobile industry is already a considerable user of plastics including many that

TABLE 1. CHEMICAL ANALYSIS OF NIZAMPUR LIMESTONE

Elements	NL-1	NL-2	NL-3	NL-4	NL-5	KL-1	KL-2	KW-1	KW-2	SM-1	SM-2	LK-5	LK-6	CH-1	Mini. value	Maxi. value	Ave-rage
SiO_2	0.53	2.37	0.64	1.46	4.44	2.24	2.16	6.28	11.84	1.20	2.44	0.94	1.30	1.34	0.53	11.84	2.79
CaO	53.34	52.03	54.01	53.14	50.43	50.83	52.01	47.28	44.92	53.19	52.01	53.19	53.19	54.37	44.92	54.37	51.71
MgO	3.05	1.64	0.25	0.78	1.56	1.95	0.51	2.75	0.92	1.65	1.84	0.92	Trace	Nil	Nil	3.05	1.27
$CaCo_3$	96.52	96.27	96.98	98.20	90.07	90.77	92.87	84.43	80.21	94.98	92.87	94.98	94.98	97.09	80.21	98.20	92.89
P_2O_5	0.06	0.09	0.10	0.11	0.09	Nil	Nil	0.07	0.08	Nil	Nil	Nil	Nil	Nil	Nil	0.11	0.42
AL_2O_3	0.46	0.28	0.42	0.40	0.15	1.31	2.35	2.99	3.04	0.88	0.66	0.83	1.50	0.5	0.15	3.04	1.13
Fe_2O_3	0.04	0.47	0.20	0.13	0.59	0.31	0.31	1.17	1.88	0.04	0.18	0.11	0.10	0.04	0.04	1.88	0.39
TiO_2	0.12	0.02	0.02	0.02	0.02	Nil	Nil	0.35	0.44	Nil	Nil	Nil	Trace	Nil	Nil	0.44	0.06
MnO_2	—	0.01	0.02	—	0.04	Traces	Traces	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.04	0.05
K_2O	0.13	0.68	0.18	0.20	0.66	0.42	0.33	0.30	0.35	0.32	0.40	0.23	0.20	0.19	0.13	0.68	0.32
Na_2O	0.46	0.75	0.68	0.65	0.04	0.64	0.57	0.30	0.31	0.35	0.35	0.66	0.76	0.77	0.30	0.77	0.56
LOI	41.81	42.13	42.94	42.97	41.25	41.84	41.59	38.18	35.79	42.44	41.79	42.80	42.92	42.74	35.79	42.97	41.51
MgCO	3.34	3.44	3.36	3.40	3.28	4.09	1.07	5.77	1.93	3.46	3.86	1.93	Traces	Nil	Nil	5.77	2.78
Total	99.98	100.47	99.46	99.86	99.87	99.54	99.67	99.57	100.07	99.69	99.68	99.97	99.99				

may use calcium carbonate as a filler. Besides, it is being largely used in paint, paper, rubber and leather tanning and other industries [22].

The demand for carbonate fillers is constantly growing in local market. It is being used by plastics, rubber and paper industries, mostly concentrated in Punjab and Sind. There are few units manufacturing carbonate fillers and some more are coming up in various parts of the country. These industrial units are facing a tough competition with imported calcium carbonate. It was imported for Rs. 3.1 millions in January, 1989 [23].

Calcium Limited, Hayatabad, Peshawar is only carbonate filler manufacturing unit in NWFP. Its product is being supplied to Bata and Service Shoe Companies in Karachi. There is a scope of a few more such units in the Province including one based on Nizampur limestone if import of carbonate fillers from China and Belgium is banned totally [21].

High accessibility of Nizampur, availability of water, electricity and cheap labour are other factors which favour the calcium carbonate filler industry in Nizampur.

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