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STUDIES ON QUARTZITE DEPOSITS OF NOWSHERA AND SWABI AREA, PESHAWAR DIVISION, PAKISTAN

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Geology, chemical composition, mineralogy, beneficiation and thermal studies of quartzite samples from Misribanda (Nowshera) and Naugram (Swabi) have been discussed. The results of these studies indicate that the Misribanda quartzite may be used in manufacture of semi-silica bricks while the Swabi quartzite is suitable for use as refractories in furnaces and manufacture of sodium silicate and colourless glass.

INTRODUCTION

Quartzites are the source of silica for metallurgical purposes. Silica bricks made from quartzite are extensively used in steel and glass industries. These bricks also find utility in electric furnace roofs, coke oven, open-hearth furnaces, copper refining furnaces, blast furnaces and glass melting furnaces. Pakistan Steel Mills require 25,000 tons of quartzite annually. Quartzite also constitute a basic raw material in fibre-glass and glass and ceramics industries. Quartzite of pure form is very useful in the manufacture of sodium silicate – an important industrial product having a variety of uses.

Extensive deposits of quartzite are found in various parts of North West Frontier Province. The notable occurrences of quartzite are found near Naugram, Misribanda, Charpani-Hisartang, Tarbela, Abbottabad and Sobra Gali areas.

Teichert and Stauffer [1] described the rocks of Misribanda area and Martin *et. al* [2] gave general description of the rocks around Naugram.

The present investigations have been undertaken to evaluate the quartzite deposits of Misribanda near Nowshera and Naugram near Swabi for their possible use in different industries.

Geology of the area

Misribanda deposit. The deposit is located near Misribanda village (lat.34° 1′00″N; long. 72°7′18″E) at a distance of 10 km to the northwest of Nowshera, district Peshawar. It can be approached by a metalled road of about 10 km from Risalpur which is located on the Nowshera-Mardan road.

The quartzite is light grey to brownish grey and contains dark brown and reddish brown ferruginous patches and encrustations. It is thin to medium bedded, compact and medium to coarse grained. The quartzite trends nearly eastwest and dips at 45-60° to the north. It is well sorted and contains poorly preserved cross beddings which indicate a normal sequence of strata. The quartzite is intercalated with sparsely distributed intercalation of argillites.

The quartzite is mainly composed of quartz grains which are well sorted and well rounded. Some of the grains show corroded margin and are replaced by dolomite.

The quartzite extends for 3000 metres with an average exposed width of 500 metres. Its reserves above the ground surface are estimated at 112 million tons.

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

Formation	Approximate thickness in metres	Lithology	Age
Surficial deposits	± 30	Gravel, sand silt and clayey material	Quaternary
Nowshera formation	75	Limestone and dolomite	Early Devonain
Misribanda quartzite	120	Quartzite with subordinate lenses of argillite and dolomite	Late Silurian
Mian Dheri formation	+ 40	Limestone, dolomite with subordinate argillite	Middle Silurian

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Naugram deposit. The quartzite is located at about 1 km to the southeast of Naugram village (lat.34°13′13″N; long.72°26′8″E), Tehsil Swabi, District Mardan. It can be approached by a fair weather road of about 7 km from Swabi on Mardan-Swabi road. The quartzite is the part of Tanawal formation which belongs to late Pre-Cambrian age.

The quartzite is white to light grey, hard and fine to medium grained. It is well sorted, compact and contains reddish brown to dark brown ferruginous encrustations along jointed and fractured spaces. The bedding is thin to medium and massive at places. Poorly preserved cross bedding is also found in a few beds. Irregular and cross cutting veinlets of quartz are common. The quartzite beds strike at N20°W and dip at 60-70°NE. It contains a few localized intercalations of phyllitic material. The quality of quartzite along these intercalations is poor due to the enrichment of muscovite, sericite and clay minerals along with the quartz grains.

The quartzite extends for 1000 metres in length with an average exposed width of 500 metres. Its reserves above the ground surface are estimated at 62 million tons.

The generalised stratigraphic sequence of the Naugram area is as follows:

Formation	Approximate thickness in metres	Lithology	Age
Surficial deposit	± 13	Gravel, sand, silt and clayey material	Quaternary
Abbottabad formation	75	Limestone, dolomite, argillite and quartzite	Late Pre-Cambrian
Tanawal formation	100	Quartzite with subordinate argillite	Late Pre-Cambrian
Hazara formation	± 120	Phyllite, slate and argillite	Late Pre-Cambrian

The locations of the samples are shown in Fig. 1.

EXPERIMENTAL

Chemical composition. Five representative samples from Misribanda and six from Swabi were analysed. The Misribanda quartzite contains on average 90.38% SiO_2; 0.38% Fe_2O_3 3.60% Al_2O_3, 0.17% TiO_2; 0.16% Na_2O and 3.7% K_2O. The average chemical composition of Swabi quartzite is 95.61% SiO_2; 0.12% Fe_2O_3: 3.50% Al_2O_3, 0.05% TiO_2; 0.00 Na_2O and 0.31% K_2O. Chemical analysis indicates that the Misribanda quartzite contains a high percentage of alkalis and iron which renders it soft on heating at high temperature. The percentage of alkalis and iron in Swabi quartzite are within permissible limits. In samples AH-9 and AH-10 the Fe_2O_3 content is 0.05% and 0.085% respectively. TiO_2 content in Swabi quartzite is less as compared to Misribanda.

Petrography. The quartz grains are medium to fine grained. The minerals other than quartz are felspars, zircon, tourmaline, dolomite, calcite, magnetite, hematite and muscovite. Carbonates are also present as irregular interlocking crystals. Layering of quartz grains and carbonates are distinct in some thin sections.

Approximate percentage of various constituent minerals estimated by studying the thin sections are presented in Table 2.

Beneficiation. Powdered (–120 mesh) quartzite samples were subjected to water-washing and several chemical treatments [4] such as hydrochloric acid leaching, Adam's process and sulphite process in order to remove the iron which is undesirable constituent in the glass manufacturing raw materials.

The results are given in Table 3.

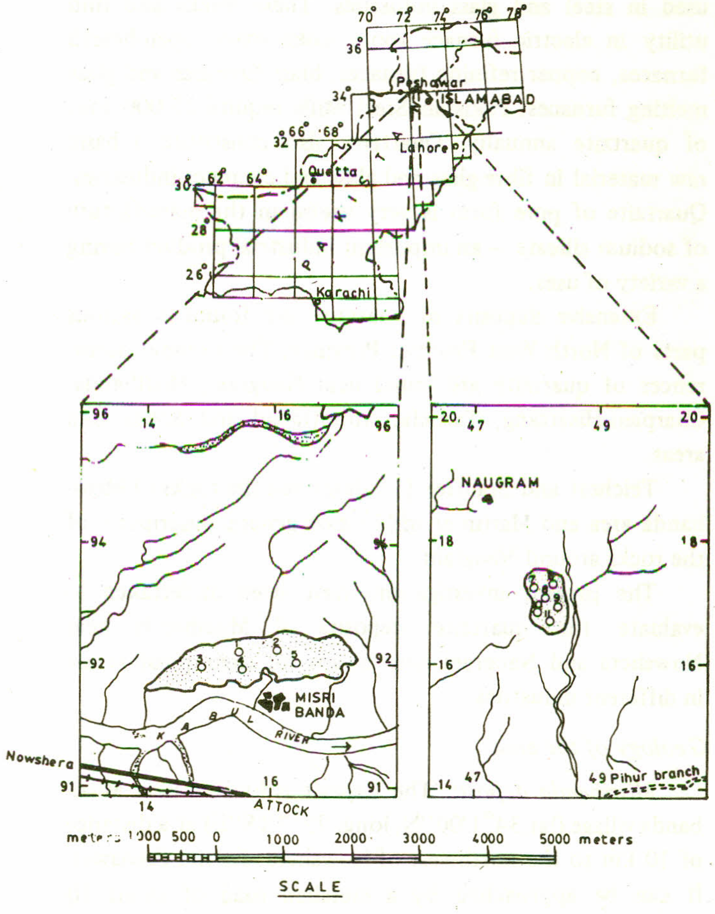

FIG. 1

Table 1. Chemical analysis of quartzite from Misribanda and Naugram

Chemical composition (%)	AH-1	AH-2	AH-3	AH-4	AH-5	AH-6	AH-7	AH-8	AH-9	AH-10	AH-11
SiO_2	90.10	90.30	89.51	89.70	92.30	97.20	94.86	97.68	95.01	94.20	94.76
Fe_2O_3	0.14	0.44	0.63	0.34	0.38	0.12	0.14	0.11	0.06	0.08	0.24
Al_2O_3	3.24	2.90	3.32	5.21	3.37	2.13	3.93	1.71	4.15	4.53	4.60
TiO_2	0.05	0.20	0.30	0.10	0.20	0.14	0.05	0.05	0.08	0.01	0.02
MnO	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
P_2O_5	NIL	0.09	0.05	0.05	0.10	Trace	Trace	Trace	Trace	Trace	Trace
CaO	1.23	0.89	1.10	1.45	0.72	Nil	Nil	Nil	Nil	0.39	Trace
MgO	Nil	Nil	Nil	Nil	Nil	Trace	Trace	Trece	Trace	Trace	Trace
Na_2O	0.17	0.15	0.17	0.15	0.17	Nil	Nil	Nil	Nil	Nil	Nil
K_2O	4.50	4.50	4.50	2.50	2.50	0.25	0.50	0.22	0.25	0.40	0.27
L.O.Ign:	0.20	0.50	0.50	0.50	0.20	0.19	0.45	0.23	0.10	0.29	0.20
Total:	99.63	99.97	100.08	100.00	99.94	100.03	99.93	99.98	99.65	99.90	100.09

*Samples 1-5: Misribanda.
Samples 6-11: Naugram.

Table 2. Approximate mineral percentage

Minerals	AH-1	AH-2	AH-3	AH-4	AH-5	AH-6	AH-7	AH-8	AH-9	AH-10	AH-11
Quartz	90	89	90	87	91	92	91	92	91	90	91
Carbonates	3	2.5	4	5	2.5	3	4	3.5	4	5	3.5
Felspars	4	3.5	3	4	3	2.5	3	3	2	3	4
Muscovite	1.5	1.5	T	2	1	2	1	T	0.5	0.5	0.5
Biotite	T	–	1	1	–	T	–	–	–	–	T
Zircon	1	–	T	–	T	T	T	–	–	–	T
Tourmaline	T	1	T	T	1	1	T	–	1	–	0.5
Magnetite	1	1.5	1	1	0.5	T	0.5	1	1	1.5	0.5
Hematite	T	1	0.5	0.5	1	T	T	0.5	0.5	T	T

*Samples 1-5: Misribanda.
Samples 6-11: Naugram

RESULTS AND DISCUSSIONS

Misribanda quartzite contains silica ranging from 89.51 to 92.30%, alumina content varies from 2.90% to 5.21% and total alkali contents are in the range of 2.70 to 5.00%. Due to the presence of alkali and other impurities the quartzite develops cracks on heating to high temperature, the refractoriness is low and is not suitable for high class silica bricks. TiO_2 content in Misribanda quartzite ranges from 0.05 to .30%. According to Baron [6] about 2% TiO_2 lowers the refractoriness upto 0.5 cone as compared to 0.5-1.5% Al_2O_3 to 1-2 cones. The deformation temperature is not affected by the presence of TiO_2 even upto 3%. P_2O_5 content in Misribanda quartzite is negligible while the alumina content varies from 2.5 to 5.21%. The presence of alumina also has a lowering effect on the refractoriness of quartzite. The Misribanda quartzite is, therefore, not suitable for manufacturing quality silica bricks. However,

Table 3. Beneficiation of quartzite by chemical processes

Sample No.	Fe_2O_3 in raw sample (%)	Fe_2O_3 after Adam's process (%)	Fe_2O_3 after HCl leaching (%)	Fe_2O_3 after Sulphite process (%)
AH-1	0.14	0.014	0.25	0.057
AH-2	0.44	0.014	0.23	0.042
AH-3	0.63	0.110	0.28	0.140
AH-4	0.34	NIl	0.12	0.028
AH-5	0.38	0.040	0.19	0.055
AH-6	0.12	0.070	0.05	0.028
AH-7	0.14	0.012	0.04	0.028
AH-8	0.11	0.060	0.01	0.052
AH-9	0.06	Nil	Nil	0.022
AH-10	0.08	0.065	0.03	0.040
AH-11	0.24	0.085	0.02	0.014

* Samples 1-5: Misribanda.
Samples 6-11: Naugram.

it may be used for manufacturing semi-silica bricks or low-grade silica bricks.

Quartzite samples from Swabi contain as high as 97.68% silica. The lowest percentage of silica is 94.10%. The percentage of iron oxide is very low between 0.05 to 0.24%. The TiO_2 content is negligible while K_2O is also present in minor quantity.

Swabi quartzite which contains less amount of Na_2O, K_2O, TiO_2 and Al_2O_3 has excellent refractoriness and degeneration at high temperature is low and no deformation or cracks appear on heating at high temperature like 1750°. Swabi quartzite appears to be highly suitable for manufacturing different types of furnaces for metallurgical and glass melting purposes. As the quality of quartzite is very good it can be supplied to Pakistan Steel Mills but it may be uneconomical due to heavy transportation cost.

The water absorption capacity of the Swabi quartzite is below 0.7%. Quartzite having water absorption capacity less than 1.5% can be used for good quality silica bricks. Refractoriness is an important property of quartzite as it determines its suitability for making good bricks. For this purpose the Swabi Quartzite is very suitable.

Efforts were made to beneficiate the powdered quartzite samples for removing iron and other undesirable material keeping in view the requirements of glass industry. Though percentage of iron was appreciably reduced by water washing, the quantity of Fe_2O_3 retained by the samples was too high to be of any commercial value. HCl leaching, Adam's process and sulphite process were attempted to reduce the iron content. While hydrochloric acid leaching did not yield significant success, Adam's process and sulphite process showed varying degree of success for removing iron.

CONCLUSION AND RECOMMENDATION

The present investigations have spotlighted the presence of some good-quality quartzite deposits in N.W.F.P. The Swabi quartzite is suitable for use as refractories in furnace and the powdered and water-washed samples meet the requirements of glass industries for their low iron and high silica content. The cost will be on the higher side due to the process of heating, quenching and grinding involved, but the improved quality of raw material may have a balancing effect on the cost of production. The Swabi quartzite is also suitable for the manufacture of sodium silicate because of its purity which finds a variety of industrial uses. The Misribanda quartzite may be used as low quality silica bricks.

The Swabi quartzite is also suitable for use in steel mills where it is used as a raw material to control basicity in the blast furnace.

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