Suitability Assessment of Pab Sandstone for Industrial Applications, Southern Pab Range Pakistan

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Abstract: This study aims to evaluate the Physio-chemical characteristics of Pab sandstone of the Cretaceous age for its value-added uses and industrial applications. For this purpose, sandstone samples (n = 25) were collected from Southern Pab Range in Kirthar fold belt for petrography and chemical analysis. Petrography shows that the sandstone is mainly composed of coarse to fine, sub rounded to angular, and moderately sorted quartz. Chemical analysis shows that the mean content of SiO_2 is about 93.57% and Al_2O_3 is only about 1.65% suggesting the dominance of quartz. On the other hand, the mean concentration of Fe_2O_3, Na_2O and K_2O, CaO and MgO are found to be 1.54%, 0.11% and 0.05%, 2.26% and 0.45% respectively while SO_3 content is found to be 0.02% as an average. Chemical analysis and petrography suggest that Pab sandstone is suitable for the production of glass products such as Egyptian glass, glass fiber, soda lime silica container glass, and Roman glass as it contains more than 90% silica. The silica content can be further enhanced up to 99% by the removal of impurities (CaO and Fe_2O_3), making it suitable for foundries, ceramics, and silica gel. Beneficiation is required for the production of other types of glass, as well as for other industrial applications.

Keywords: Pab Sandstone, Pab Range, physic-chemical properties, Industrial application.

1. Introduction

Silica sand is one of the most plentiful and second-most prevalent minerals in the earth's crust (Edem et al., 2014). Silica solidifies at the final stage of Bowen's reaction sequence (Ketner, 1973). Silica is commonly found in a variety of rocks, including sedimentary, igneous, and metamorphic rocks (Bourne, 1994). The utilization of silica sand relies upon its mineralogy, chemistry and textural properties (Sundararajan et al., 2009). The major source of silica sand includes sandstone, quartzite, and deposits of loosely-cement or unconsolidated sand (Wilkinson, 2005). It exists in different crystalline forms such as the fibrous silica including chalcedony and semi-precious stones like agate, onyx, and carnelian. Jasper and flint are examples of granular variants (Malu et al., 2015), whereas diatomite and opal are examples of anhydrous kinds (Tsoar et al., 2004). Industrial sand and gravel, commonly known as "silica," "silica sand," and "quartz sand," contains sands and gravels with a high SiO_2 content (Bolen, 1996). The term "silica sand" refers to quartz sand that contains more than 99% SiO_2 and small amounts of the contaminating oxides like Al_2O_3, Fe_2O_3, CaO, MgO, TiO_2, and less than 0.1% heavy minerals (Mansour, 2015).

Silica is widely used in the production of glass and glass fiber, ceramic and refractory materials, silicon carbide, sodium silicate, Portland cement, silicon alloys and metals, filter media for water treatment, sandpaper, and a variety of other products (Sundararajan et al, 2009). Its specialized applications include products such as piezoelectric crystals, optical products, and vitreous silica. Due to its hardness, chemical inertness, heat resistance, resistance to weathering, and high melting point, which is caused by the strength of the atomic bonds, it is used in a variety of applications.

Silica sand has been used since ancient times and it was being used in the manufacturing of glass (Raghavan et al., 2006). Color, clarity, strength, and other physical characteristics of glass products are all influenced by silica sand's purity. For glass manufacturing, sandstone should be very low in iron and high in silica content (Kuzvart, 1984). Quartz is the fundamental glass-forming compound in a glass batch if sandstone has a very high content of quartz, it might be crushed and used as a source of silica for glass manufacturing. During the creation of ceramics, silica serves as the skeleton structure to which clays and fluxes are affixed. This is because silica improves the integrity, drying, shrinkage, and thermal expansion that control heat transfer (Gupta et al., 1986). With the exception of bone china, silica sand is widely used in white ware ceramic formulations, making up about 40% of the ceramic body. In foundries, silica sand is essential for constructing the molds into which metal is poured to produce metal casting, as well as for metallurgical processing (Mansour, 2015).

In Pakistan, large deposits of silica sand are found near Thano Bula Khan, Abbottabad, Dera Ismail Khan, Nowshera, Dera Bugti and Dera Ghazi Khan. Silica sand is also reported in Toi and Kingri formations (Malkani et al, 2016). In Karachi, huge deposits of silica sand are reported in the Halkani sandstone member of Nari Formation (Khan et al., 2019). Besides all these deposits, Pab sandstone deposit of Late Cretaceous age is widely developed in the Kirthar-Sulaiman Province and the Axial Belt (Moghal, 2012). Despite the occurrence of such huge deposits of Pab sandstone in Pab Range, no work has been carried out so far on its suitability for the industrial applications. Therefore, the present study is aimed at the assessment of Pab sandstone exposed in Khuzdar area for its industrial applications with a special focus on the glass industry through textural, mineralogical, and geochemical parameters.

2. Geological Setting of Study Area

The study area is located in North-West of Windar, District Lasbela, Balochistan. It lies in the southern part of Pab Range, which is part of Kirthar-Suleiman fold belt. The area can be accessed from Karachi via N-25 up to Winder. Later, a metalled road from Windar-Duddar leads to AOI. It lies in the semi-arid to arid zone. Due to low rainfall, vegetation in the study area is rare. In study area, Cretaceous formations, i.e., Pab sandstone and Parh limestone are cropped out (Fig. 1). Tectonically, the study area lies in Kirthar Fold Belt. The Ornach-Nal Fault System (ONF) and the Chaman Fault, which make up the western strike-slip boundary of the Indian Plate, together with the Kirthar Fold Belt (KFB) make up the southern part of the Fold Belt west of Pakistan's Lower Indus Basin. The KFB passes into the LIB on the stable Indian foreland in the east. The southern KFB is bounded to the west by the Bela Ophiolite and to the west of the fold belt is the Porali Trough (Ahmad et al., 2015).

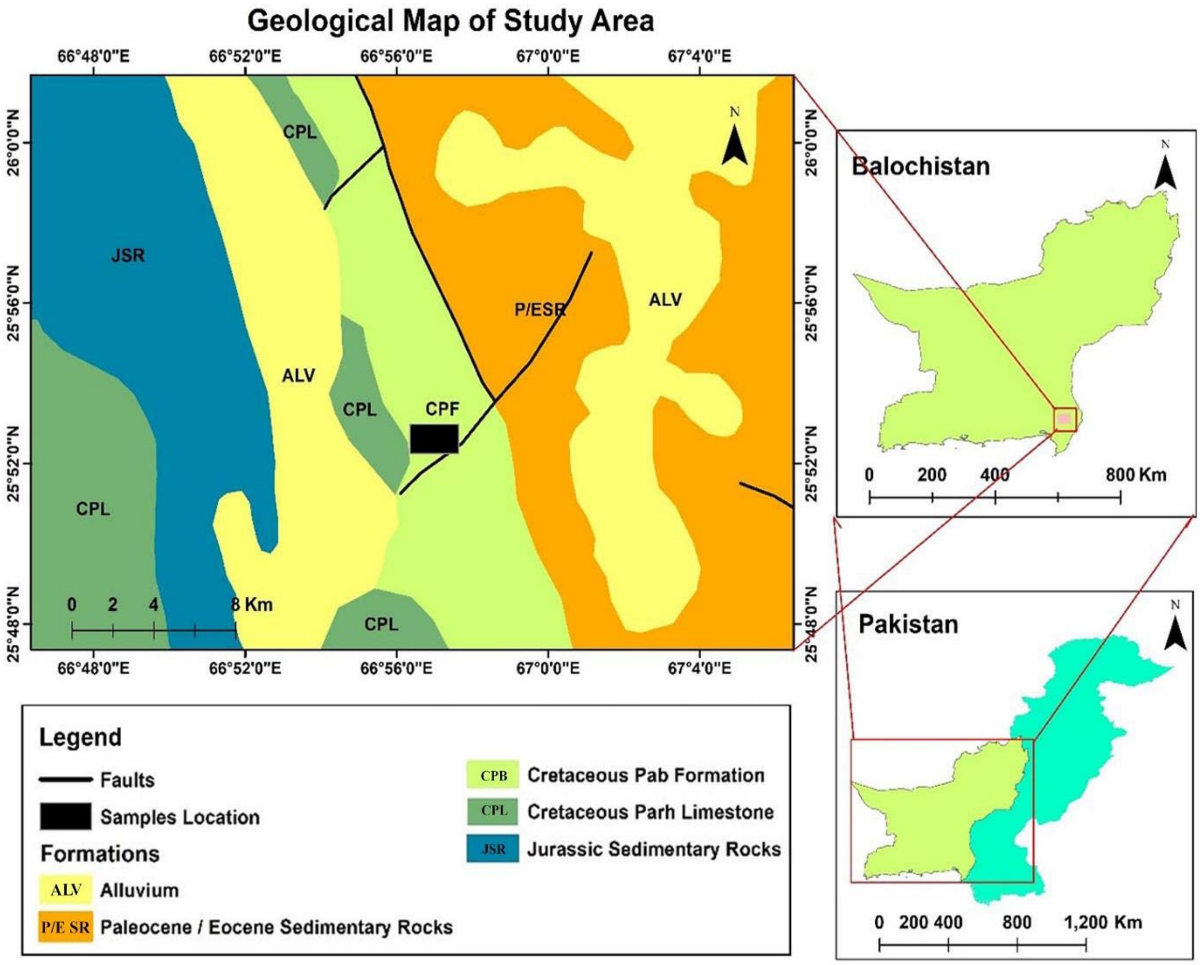

Fig. 1 Digitized geological map of the Pab Range, (Source: Geological Map of Pakistan 1964, by Geological Survey of Pakistan)

3. Methodology

Fieldwork was carried out to collect sandstone samples (n = 25) from southern Pab Range cropping out in Kirthar fold belt, Balochistan. Samples were randomly collected from the scarp slope across strike (Fig. 2). The samples were stored in cloth sample bags and labelled with the sample code and sample location (GPS coordinates). The collected samples were sent to the laboratory for chemical analysis and petrography. Three thin sections of sandstone samples were prepared to determine the mineral composition, and texture. Thin sections were studied under an optical microscope. Major oxides including SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O, and SO_3, were determined by using the

XRF technique in analytical laboratory of Kohat cement limited. The Specific gravity of all sandstone samples was determined by standard method. The aim of specific gravity determination was to support the occurrence of sandstone with its subtle variations and with minor heavy minerals. Firstly, all samples were weighed in air then thin veneer of wax was coated on the rock sample surface to take its weight in the water. The ratio between weights in the air to the weight in water was calculated to determine specific gravity.

Fig. 2 Sampling from Pab sandstone in Pab Range.

4. Results and Discussion

4.1. Color

Color is an important aesthetic property of rock. All the samples (n=25) of Pab sandstone were visually examined for their apparent colors. It is observed that sandstone is typically grey, greenish grey, or yellowish brown in color as described by Umar et al, (2011) and Moghal et al., (2012). Six samples are earthy brown in hue, nine are yellowish brown, two are grey, and eight are greenish grey (Table 1).

4.2 Specific Gravity

Specific gravities of Pab sandstone samples range from 2.2 to 2.43, with an average value of 2.32 (Table 1). Rock density is highly dependent on the minerals that make up a particular rock type. Sedimentary rocks and granite, which are rich in quartz and feldspar, tend to be less dense than volcanic rocks. Specific gravity is a very important property of rocks and minerals because it is used in reserve estimation.

Table 1 Physical characteristics of Pab sandstone and Geographic Coordinates.

SAMPLE NO.	LATITUDE	LONGITUDE	COLOR	FORM	SPECIFIC GRAVITY
PB01	25°52'37.32"N	66°56'56.58"E	Yellowish brown	Granular	2.26
PB02	25°52'36.73"N	66°56'58.44"E	Yellowish brown	Granular	2.29
PB03	25°52'34.48"N	66°56'59.46"E	Yellowish brown	Granular	2.2
PB04	25°52'34.02"N	66°57'0.72"E	Yellowish brown	Granular	2.34
PB05	25°52'33.10"N	66°57'1.92"E	Yellowish brown	Granular	2.4
PB06	25°52'32.09"N	66°57'2.43"E	Yellowish brown	Granular	2.38
PB07	25°52'31.31"N	66°57'4.18"E	Yellowish brown	Granular	2.36
PB08	25°52'30.00"N	66°57'6.76"E	Yellowish brown	Granular	2.3
PB09	25°52'29.91"N	66°57'8.80"E	Greenish Grey	Granular	2.2
PB10	25°52'29.55"N	66°57'10.77"E	Yellowish brown	Granular	2.2
PB11	25°52'31.23"N	66°57'11.01"E	Greyish Green	Granular	2.34
PB12	25°52'32.69"N	66°57'12.11"E	Greyish Green	Granular	2.37
PB13	25°52'30.83"N	66°57'14.38"E	Grey	Granular	2.37
PB14	25°52'32.25"N	66°57'15.58"E	Greyish Green	Granular	2.4
PB15	25°52'33.25"N	66°57'16.33"E	Greyish Green	Granular	2.2
PB16	25°52'32.59"N	66°57'17.08"E	Earthy Brown	Granular	2.4
PB17	25°52'34.04"N	66°57'17.44"E	Earthy Brown	Granular	2.38
PB18	25°52'34.74"N	66°57'18.26"E	Earthy Brown	Granular	2.28
PB19	25°52'36.01"N	66°57'17.99"E	Earthy Brown	Granular	2.4
PB20	25°52'36.68"N	66°57'18.01"E	Earthy Brown	Granular	2.43
PB21	25°52'37.75"N	66°57'17.85"E	Greyish Green	Granular	2.3
PB22	25°52'36.93"N	66°57'20.52"E	Greenish Grey	Granular	2.37
PB23	25°52'36.12"N	66°57'22.57"E	Grey	Granular	2.34
PB24	25°52'35.71"N	66°57'24.51"E	Greenish Grey	Granular	2.35
PB25	25°52'35.36"N	66°57'26.10"E	Earthy Brown	Granular	2.2

4.3 Petrographic Examination

It is observed that sandstone is moderate to tightly packed, moderately to well sorted, sub angular to sub rounded, and has a range of grain sizes from coarse to fine. The petrographic images reveal the presence of ferruginous cementing material binding the sand grains together. Quartz constitutes the major portion of the samples i.e. > 90% (Figure 3 a-b). Approximately all the grains are of monocrystalline quartz. The higher percentage of mono-crystalline quartz over poly-crystalline quartz indicates that the Pab Formation sediments were derived primarily from an acidic plutonic source (Ahmed et al, 2021). According to the classification of Pettijhon and Folk's, Pab sandstone is quartz arenite and less commonly as a subarkose.

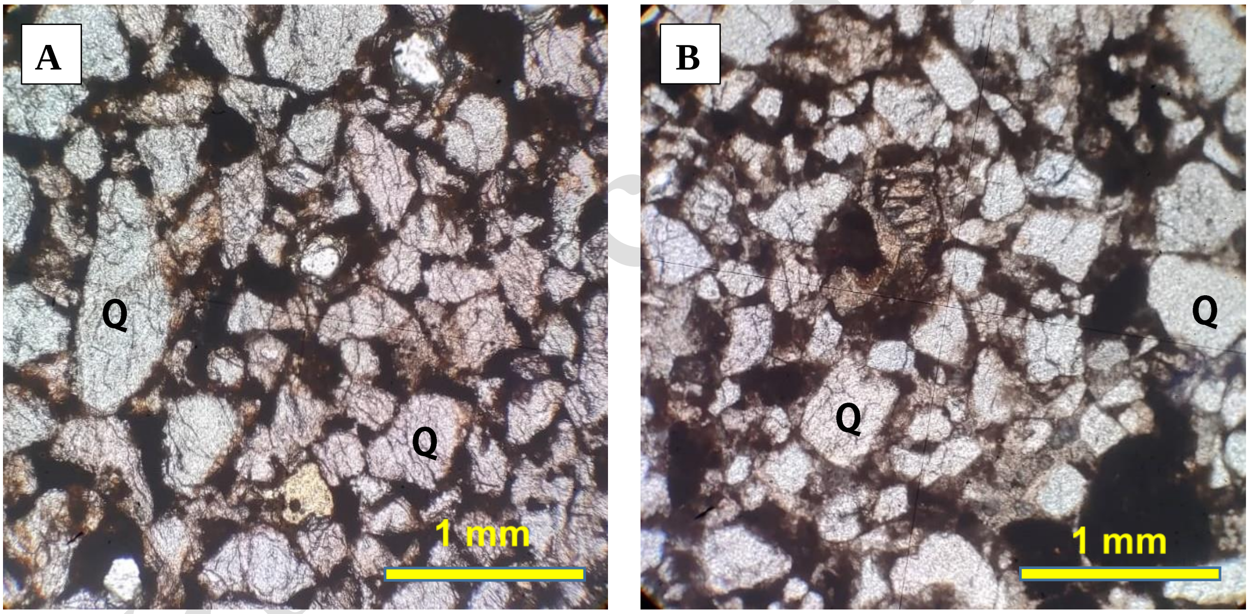

Fig. 3 (a-b) Petrographic images of Pab sandstone, Photos taken under Plain Polarized Light (PPL), Q=Quartz

~~4.4~~ Chemical Composition

The mean concentrations of corresponding metal oxide (wt. %) of representative samples have been listed in Table 3. Data reveals that SiO_2 is the dominant major oxide in all samples, which ranges from 89.09% to 97.62% with a mean concentration of 93.57%. It is dominant over the other oxides such as Al_2O_3, Fe_2O_3, SO_3, CaO, MgO, Na_2O, and K_2O. The high SiO_2 content in all the samples indicate occurrence of high silica mineral (Table 2). It is well established that silica sand generally consists of quartz with high SiO_2 contents. CaO is the second most oxide in sandstone, with a wide range of variation (0.33%- 6.9%; average 2.26%). The Fe_2O_3 content ranges from 0.37% to 3.53%, with an average value of 1.54%. On the other hand, Al_2O_3 ranges from 0.73% to 2.93% with a mean concentration of 1.65%. MgO content is slightly variable in range: 0.27-0.72%. The mean value of MgO is 0.45%. While Na2O concentrations range from 0.05% to 0.16% with an average value of 0.11%, K_2O concentrations are in the range of 0.03% to 0.09% with a mean concentration of 0.05%. The mean content of SO_3 is 0.02%. Thus, the geochemical data of the examined samples show the occurrence of high SiO_2 contents, which in turn suggests the abundance of quartz. This is consistent with the petrographic observation of corresponding samples where quartz mineral is reported frequently, which in turn is associated with the presence of high SiO_2 content.

Table 2 Major oxides in Pab sandstone samples.

Oxides %	**PB 01**	**PB 03**	**PB 05**	**PB 07**	**PB 09**	**PB 11**	**PB 13**	**PB 15**	**PB 17**	**PB 19**	**PB 21**	**PB 23**	**PB 25**
SiO_2	97.3	96.8	96.85	97.6	97.1	90.6	93.2	91.21	92.47	90.8	91.1	89.1	92.25
Al_2O_3	0.79	1.03	1.02	0.91	0.73	2.93	2.04	1.89	2.00	2.35	1.92	1.71	2.11
Fe_2O_3	0.75	0.51	0.51	0.40	0.37	3.53	2.95	1.58	1.89	2.36	1.61	1.23	2.28
CaO	0.42	0.62	0.58	0.33	1.00	1.62	0.88	4.25	2.71	3.61	4.30	6.90	2.21
MgO	0.29	0.49	0.47	0.27	0.29	0.72	0.45	0.50	0.38	0.39	0.51	0.48	0.55
SO_3	0.02	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.00
Na_2O	0.05	0.08	0.08	0.05	0.05	0.15	0.07	0.15	0.15	0.12	0.16	0.16	0.10
K_2O	0.03	0.09	0.09	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.09
Sum %	**99.6**	**99.60**	**99.60**	**99.6**	**99.6**	**99.7**	**99.6**	**99.64**	**99.66**	**99.6**	**99.7**	**99.6**	**99.59**

Table 3 Statistical Descriptive of Major Oxides of Pab Sandstone.

Oxides %	MEAN	MAX	MIN	ST. DEV.
SiO_2	93.57	97.62	89.09	8.53
Al_2O_3	1.65	2.93	0.73	2.2
Fe_2O_3	1.54	3.53	0.37	3.16
CaO	2.26	6.9	0.33	6.57
MgO	0.45	0.72	0.27	0.45
SO_3	0.02	0.02	0	0.02
Na_2O	0.11	0.16	0.05	0.11
K_2O	0.05	0.09	0.03	0.06

5. Industrial Applications

There are numerous requirements that quartz sand must meet in order to be used as a potential source for various industrial applications. The primary component of glass, pavers, abrasives, paints, water treatment, and refractories metallurgy are all made of silica sand (Carr, 1971). The chemical and physical properties of silica sand play a very important role in above discussed applications. Grain shape plays an important role during melting. Round grains take longer to melt than angular grains (Lamar, 1928).

5.1 Glass Industry

5.1.1 *Chemical Specification*

The size and shape of the silica sand content accompanied by impurities are important factors for glass making. In general, the specifications of the raw materials depend on the purity of the quartz sand and necessary products (Fatima, 2021). The glass industry has established different standard specifications for the silica sand intended for different types of glass. Glass sand generally should have a high silica content of 95 to 99.85% (Kuzvart, 1984). According to the British Standard (BS2975), silica content is required to be approximately 97% for colored containers, 99.7% for optical glass, 99.6% for tableware glass, and 98.8% for colorless containers.

The mean concentration of silica in Pab sandstone samples is found to be 93.57%. It is found to be feasible in terms of its silica content for Soda lime silica container glass, Roman glass, Egyptian glass, and glass fiber which is required 72.0%, 69.4%, 67.8%, and 55% SiO_2 respectively (Austin, 1984). On the other hand, the mean percentage of aluminum oxide, magnesium oxide, and calcium oxide are about 1.65%, 0.45% and 2.26% respectively, Pab sandstone is marginally meeting the specifications prescribed by Austin, (1984) for glass fiber (Al_2O_3 14%, MgO 5% and CaO 13%) and Egyptian glass, (Al_2O_3 4.4%, MgO 2.3% and CaO 4.0%). Whereas soda lime silica container glass contains 10.2% and 2.1% CaO, and Al_2O_3 respectively. On the other hand, Roman glass contains about 3.5% Al_2O_3 and 7.2% CaO. Alumina, magnesium oxide, and calcium oxide are added to glass to give it stability and chemical durability (Mclaws, 1970). However, glass melting properties are impacted when the concentration of these three oxides exceeds the corresponding limits (Platias et al., 2014).

Mean Fe_2O_3 content in Pab sandstone samples is found to be 1.54%. The colored glass contains metal compounds to give color. If iron is present, the resulting glass will be green or brown. Conversely, the iron oxide can be used as a coloring agent in colored glass (Platias et al., 2014). Iron content is therefore the most important parameter in determining if a particular sand can be used to make clear glass. Fe_2O_3 is unwanted and shouldn't be allowed to exceed 0.013% for colorless glass, 0.04% for ordinary glass, and 0.008% for optical glass (Srivastava, 1978). The specification of iron oxide in silica sand reported for amber glass, chemical glass-ware, clear container glass, high-grade domestic, and decorative glass-ware is 0.25%, 0.02%, 0.06%, 0.013% respectively (Faruqui et al., 1967). The iron content of silica sand samples can also be reduced using electromagnetic separation techniques.

Iron can be beneficiated in significant amounts using processes such as chemical and biological methods (Faruqui and Hanif, 1970).

Sodium oxide is added in glass as fluxing agent (Silvestri et al., 2006). Generally, glass making sand contains 0.02% Na_2O whereas soda lime silica container glass, Egyptian glass, Roman glass, and glass fiber contains sodium oxide content which is about 14.9%, 13.7%, 17.3% and 0.5% respectively. The mean content of Na_2O in analyzed samples is found to be 0.11%. Mean K_2O content reported in Pab sandstone is about 0.05% which is greater than the specified value 0.03% of companies' specification (1969). High level of K_2O affects the melting property of glass (Platias et al., 2014). Hence, Pab sandstone is considered unfit for glass making in terms of K_2O. However, removing such marginally high K2O content will make Pab sandstone suitable for glass making in terms of K_2O. In contrast, the average sulfur trioxide concentration is 0.02% in sand samples which is below the allowable limit and is not suitable for making glass. Egyptian silica glass and lime glass must contain about 1.0% and 0.8% SO_3, respectively (Austin, 1984).

General specifications for glass sand in terms of chemical composition have been listed in Table 4. It demonstrates that manufacturing of green glass, amber glass, insulating fiber, clear/float glass, and borosilicate glass required 95% SiO_2 and 98.5% SiO_2, respectively. Although the mean silica content in Pab sandstone is about 93.57% but it can be improved by various beneficiation methods for industrial applications. Pab sandstone fulfills the requirements for high-grade glass set forth by numerous international agencies, such as the US Bureau Standard, American Ceramic Society, and their proposed detailed chemical specifications for silica sand for use in producing various types of glasses (Sundararajan et al., 2009), which are listed in Table 5.

Table 4 General Specifications of Chemical Composition of Glass Sand.

Major Oxides	Insulating fiber	Green glass	Clear/Float glass	Amber glass	Colorless container glass	Borosilicate glass	Optical glass	Pab sandstone Results
SiO_2%	95.00	95.00	95.00	95.00	98.50	98.50	99.8	93.57
Al_2O_3%	0.50	4.0	4.0	4.0	0.50	0.50	0.10	1.65
Fe_2O_3%	0.30	1.00	0.20	1.00	0.150	0.05	0.005	1.54
CaO/MgO %	0.50	0.50	0.50	0.50	0.50	0.20	0.10	5.02

Table 5 Comparison with Various Standards for High Grade Glass and GlassFiber (Austin, 1984).

Element Oxides	Austin (1984) Glass Fiber	US standard (1965)	British standard (1988)	Vycor high temperature scientific glassware Austin (1984)	Pab sandstone Results
SiO_2	55%	95 % (min)	98.5 % (min)	96.3	93.57
Al_2O_3	14	4 (max)	-	0.4	1.65
Fe_2O_3	-	1 (max)	0.30 (max)	-	1.54
MgO	5	0.5 (max)	0.5 (max)	-	0.45
CaO	13	0.5 (max)	0.5 (max)	-	2.26
Na_2O	0.5	-	-	-	0.11
K_2O	-	-	-	-	0.05

5.1.2. Physical Specifications

Pab sandstone is generally fine to medium grained with a significant proportion of coarse grains, sub-angular to sub rounded as also described by Moghal et al, 2012. Large grains melt slower than small grains (GWP consultants, 2010). Sand that falls between the fine and coarse grades is suitable for making glass (Lamar, 1928). Angular grains are beneficial for melting as these melt faster than rounded grains, it is due to the fact that angular grains expose more surface area to heat than rounded grains (Lamar, 1928). Pab sandstone would be appropriate for glass manufacture after being crushed to the desired size and shape.

5.2 Foundry Industry

In foundries, large amounts of quartz sand are used to make molds for metal casting. The key benefit of silica sand in foundry work is its low cost, abundant resources, and high (Temp = 1610 C) melting point (GWP Consultants, 2010). Foundry sand contains about 97.0% SiO_2, 1.63% Al_2O_3, 0.15% Fe_2O_3, 0.11% CaO, 0.14% Na_2O, and 0.74% K_2O. The concentrations of CaO and Fe_2O_3 in the Pab sandstone are significantly high, but the K_2O and SiO_2 contents are lower than the permissible limit for foundries. However, the content of Na_2O and Al_2O_3 is close to the permissible limits (Table 3).

5.3 Ceramic Industry

All ceramic products, including tableware, cleaning supplies, floor and wall tiles, depend on ground silica for the glaze's texture and composition (Moiola and Weiser (1968). Clay and fluids (flux) are attached into the skeletal structure of silica. The SiO_2 is used to modify thermal expansion, control drying and shrinkage, and improve the integrity and appearance of the structure (Gupta et al., 1986). For ceramics production, silica, alumina, and iron in sand should have about 97.5%, <0.55%, and <0.2%, respectively (GWP consultants, 2010). About 93.57% silica, 1.65% aluminum oxide, and 1.54% iron oxide are reported in the samples of the study area (Table 3). Silica is not significantly low but Al_2O_3 and Fe_2O_3 are significantly higher than permissible limits for ceramics. Thus, chemically, Pab sandstone is not suitable for ceramics, but after beneficiation, it can be made suitable for the ceramics industry.

5.4 Silica Gel Industry

Silica Gel is prepared by reacting sodium silicate with an acid, the resulting gelatinous silica is dried and granulated to form an extremely porous, hard, absorbent solid. Pab sandstone does not meet the chemical requirements because the average silica content is found to be 93.57%, which is lower than the permissible limit (99%), and the mean concentrations of Al_2O_3, Fe_2O_3, and CaO+MgO are 1.65%, 1.54%, and 2.71%, respectively, which are higher than the desired limits. It is due to the fact that for the manufacturing of sodium silicate, silica sand or sandstone should contain approximately 99% SiO_2, less than 1% Al_2O_3, 0.5% CaO+MgO, and 0.1% iron (Mclaws 1970). Hence, in raw form Pab sandstone is unfit to be used for sodium silicate or silica gel preparation.

6. Conclusion

The present study has demonstrated the textural characteristics and chemical composition of Pab sandstone, as well as its suitability for various industries. Texturally Pab sandstone is coarse to fine grained, sub rounded to angular, and moderately sorted. Mineralogically it can be classified as quartz arenite to subarkose. Chemically, this sandstone is rich in silica, making it suitable for the manufacture of various types of glass. It is feasible for soda lime silica container glass, Roman glass, Egyptian glass, and glass fiber. However, Fe_2O_3 and CaO are anomalously high in studied rock samples. These deleterious materials make this sandstone unfit for other industries, including ceramics, foundries, and silica gel manufacturing, which can be removed by various beneficiation methods before glass making and other uses. Further studies are needed to find out the occurrence of deleterious materials (CaO and Fe_2O_3) in Pab sandstone exposed in other parts of Balochistan and their removal techniques.

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ارزیابی مناسب بودن ماسه سنگ پاب برای کاربردهای صنعتی، محدوده پاب جنوبی پاکستان

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چکیده

خصوصیات فیزیکوشیمیایی ماسه سنگ پاب سن کرتاسه برای کاربردهای صنعتی آن انجام شد. برای این منظور، نمونه های ماسه سنگی (n=25)برای آنالیز پتروگرافی و ژئوشیمیایی از محدوده پاب منطقه خوزدر جمع آوری شد. داده های پتروگرافی نشان می دهد که ماسه سنگ عمدتاً از کوارتز و به دنبال آن فلدسپات و کانی های سنگین به مقدار کم تشکیل شده است. تجزیه و تحلیل بافت نشان داد که دانه‌ها نیمه گرد تا زاویه‌ای، طبقه‌بندی متوسط و درشت تا ریز هستند. تجزیه و تحلیل ژئوشیمیایی نشان داد که میانگین محتوای SiO_2 حدود ۹۳.۵۷٪ و Al_2O_3 تنها حدود ۱.۶۵٪ است که نشان دهنده غالب بودن کوارتز است. از سوی دیگر، میانگین غلظتFe_2O_3 ، Na_2O

وK_2O ، CaOو MgO به ترتیب ۱.۵۴، ۰.۱۱ و ۰.۰۵، ۲.۲۶ درصد و ۰.۴۵ درصد است. از سوی دیگر، محتوای SO_3 به طور متوسط ۰.۰۲٪ است. نتیجه‌گیری می‌شود که ماسه‌سنگ پاب برای تولید محصولات شیشه‌ای مانند شیشه مصری، الیاف شیشه، شیشه ظرف سیلیکا سودا لیم و شیشه رومی مناسب است. ماسه سنگ پاب بیش از ۹۰٪ سیلیس دارد و CaO و Fe_2O_3 دو ناخالصی اصلی هستند که باید حذف شوند بنابراین محتوای سیلیس تا ۹۹٪ افزایش می یابد. از این رو، آن را برای ریخته گری، سرامیک و سیلیکاژل مناسب می کند. بهره گیری برای تولید انواع دیگر شیشه و همچنین برای سایر کاربردهای صنعتی مورد نیاز است

واژه‌های کلیدی: ماسه‌سنگ پاب، محدوده پاب، خواص فیزیکوشیمیایی، کاربرد صنعتی.