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RESEARCHES ON CHEMICAL, MINERALOGICAL AND BACTERIAL ANALYSIS OF BHOLARI SAND

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Bholari is a small village situated near Kotri, in province Sindh of Pakistan. It contains huge deposits of SiO_2 sand which are extensively utilized in sand moulding, both for ferrous and non-ferrous castings (specially at T & T Foundry, Kotri). Earlier no proper work is carried out on moulding properties of Bholari sands. Authors have collected the samples from the site and have studied the moulding properties, analysis and bacterial hazards, both alone and mixture with molasses, a common binder of moulding sands. It is concluded that although this sand can not be recommended as natural bonded sand because it contains very little amount of clay (< 0.5%) but it can be used as moulding material after addition of 5-8% clay, 1.5% water and an adequate quantity of additives e.g. molasses. The bacteria - culture investigation carried out at Veterinary Research Institute, Lahore shows no growth in the sand and its mixture with molasses, hence, the foundrymen working with this sand remain free pollution created by gases and SiO_2 dust evolved during moulding, from any bacterial hazard.

Key words: General moulding sand, Bholari sand, Bacterial hazards.

Introduction

Bholari, a small Village of Kotri, is situated near Hyderabad in Sindh province at the right bank of river Indus. It is particularly famous for its sand dunes which have been commercially utilized for moulding, casting, construction purposes and making glass bangles [1]. Now investigations are being carried out by the Zeal Pak. Cement Factory, Hyderabad for its utilization in the manufacturing of cement.

Experimental

Chemical Analysis. Samples of sand were analysed in Zeal Pak. Cement Factory. As per results it contains SiO_2 82.70%, Al_2O_3 1.86%, Fe_2O_3 0.70%, lime 7.55%, MgO 0.29% and SO_3 Traces. Table 1 gives the analysis of Bholari sand and its comparison with other types of SiO_2 based molding sands (Fig.1).

Sand grains. Sand grains are generally of different shapes e.g. rounded, angular & subangular and compounded. (Macrographic studies given in Fig. 2).

Minerals in SiO_2 sand. Table 1. shows chemical composition of typical sands and its comparison with Bholari sand. Some of the minerals present in SiO_2 sand are given in Table 2.

Clay minerals. Clay minerals present in SiO_2 sand are given in Table 3. Their photo micro structures at very high magnification are given in Fig. 3 (a to c).

Bacterial hazards. The atmosphere of foundries is not free from pollution. Most of the researchers have conducted their investigations on pollution created by gases and SiO_2 dust evolved during moulding, melting, casting and fettling. Noise (dB) pollution is also higher than admissible limits. This has been investigated extensively by the foundrymen.

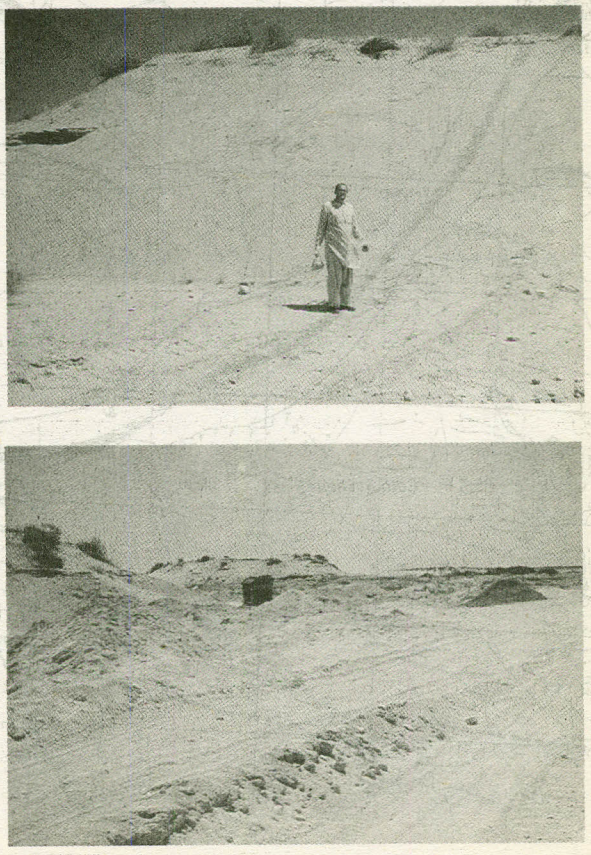

Fig. 1. Bholari sand dunes.

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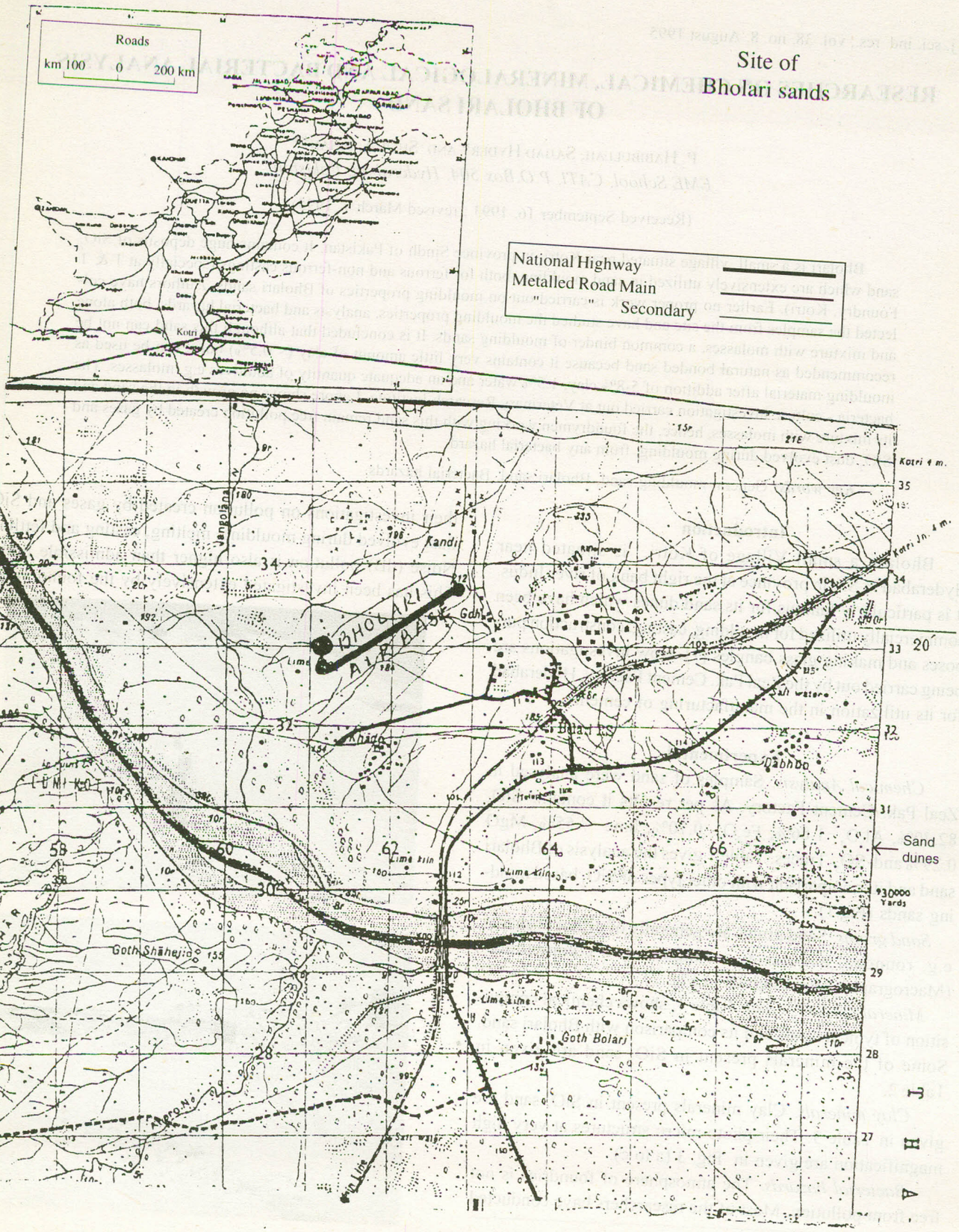

Topographical map 40 C/5

However Bacterial hazards found in the atmosphere of foundry have not been taken seriously and these pollutants are not investigated meticulously. Samples were collected from the Bholari site and cultured in different media e.g. nutrient agar (NA) maconkey agar (MA), selerod agar (SA) and nutrient broth (NB) and similarly the samples of molasses, which are extensively used both in ferrous and non - ferrous foundries, as an additive for developing better binding strength of moulding sand were cultured. In foundries, specially in small foundries sand, clay and molasses are mixed by hands. If some moulder having a cut on his hand, mixes these ingredients he may be affected by the bacteriae of sand, clay, molasses or other additives e.g. horse dung etc. Keeping in view, the seriousity of this phenomena, the bacterial hazards of Bholari sand have also been studied [2].

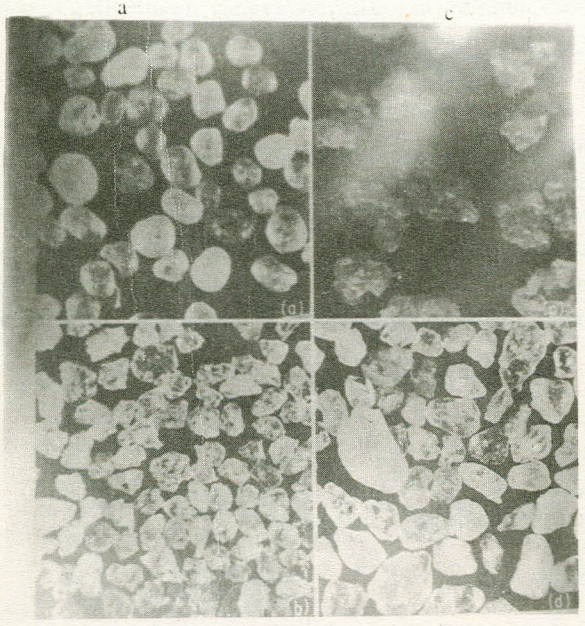

Fig. 2. Sand grain shapes. (a) Rounded sand grains (b) Angular sand grains (c) Compounded sand grains (d) subangular sand grains (from AFS).

Procedure for identification of micro organisms. The detailed technique for the staining process is as follows:

i. Stain the film for 2 min with Hucker's gentin violet prepared as follows:

1 ml saturated alcoholic solution gentin violet or crystal violet (4 gm dye in 20 ml of 95% ethyl alcohol). 10 ml of 1% ammonium oxalate.

ii. Wash with water and apply Gram's iodine 1 min. Gram's iodine is prepared as follows:

Iodine	1 gm
Potassium iodide	2 gms
Distilled water	300 ml

iii. Pour off excess fluid and wash with acetone (10 parts) and 95% alcohol (70 parts) until the smear ceases to lose colour.

iv. Wash with water.

v. Counter stain with 2% aqueous solution of ranin.

vi. Wash with water, blot, dry and examine.

Results

The results of culturing sand and molasses are given in Table 4. It is concluded that samples of both these materials

TABLE 1. CHEMICAL COMPOSITION OF TYPICAL SANDS AND ITS COMPARISON WITH BHOLARI SAND.

Constituents (%)	Washed silica sand*	Washed and dried silica+	Typical bank sand++	Bholari sand	Western bentonite bonded silica sand♦		Typical lake sand
					New	Used	
Loss on ignition	-	-	1.02	5.86	0.28	0.12	0.8
C	-	-	-	-	0.13	0.59	-
Free iron	-	-	-	-	-	0.97	-
Ferrous iron	-	-	-	-	0.44	0.68	-
Ferric iron	-	-	-	-	0.00	0.12	-
Total iron	0.10	-	-	-	0.44	1.77	-
Al_2O_3	0.39	-	-	1.86	1.32	0.63	-
SiO_2	99.08	99.80+	92.09	82.70	95.79	95.54	95.0+
Total Al_2O_3+Fe_2O_3	-	-	6.09	2.56	-	-	2.0
CaO	-	-	0.58	7.55	-	-	0.60
Alkali	-	-	0.22	-	-	-	0.20
MgO	-	-	0.22	0.29	-	-	0.40
SO_3	-	-	-	Traces	-	-	-

*New Jersey Silica Sand Co. + Ottawa silica sand. ++ Great Lakes Sand Co. Juniata. ♦A moulding sand from F.L. Orell, Jr., The Constitution of Discarded Moulding Sand Steel Founders Society of America, Report 23, 1950

are free from bacterial hazards.

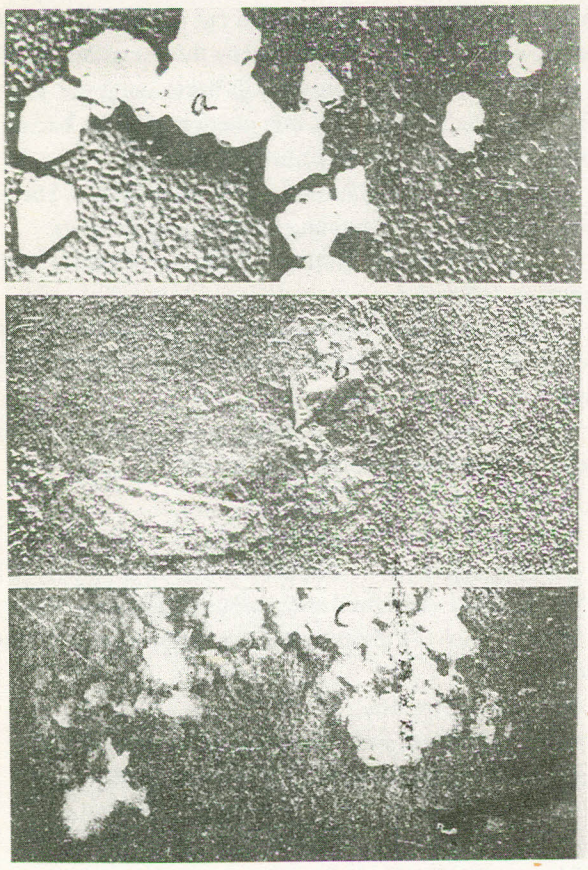

Fig. 3. (a) Kaolinite 30000 x. (b) Mont morillonite 38000x. (c) Illite 45000x.

Conclusion

The summary of investigation on Bholari sand, concludes that:

1. Although analyses of Bholari sand have shown that it contains very little quantity of clay but it can be used forcasting different ferrous & non-ferrous alloys by making mixture with an adequate quantity of clay bentonite and other additives. Table 5 summarizes the different types of sand mixture which can be used for casting different ferrous & non-ferrous alloys.

2. Bholari sand is free from any bacterial hazards. In small foundries the foundrymen mixes the sand with other ingredients and additives e.g. molasses by mulling with hand. Cultural report of molasses and Bholari sand has shown that in cultured samples small, opaque or yellow colonies have appeared but they were considered harmless and sand was declared free from any bacterial hazards for use in foundries.

TABLE 2. SOME OF THE COMMON MINERALS PRESENT IN SILICA SAND.

Mineral	Chemical formula
Mica Muscovit	$K_2O_3H_2O.6SiO_2x2H_2O$
Magnesium carbonate	$MgCO_3.3H_2O$
Calcite	$CaCO_3$
Dolomite	$CaCO_3.MgCO_3$
Siderite	$FeCO_3$
Glauconite	$K_2Mg(Fe,Al)_3SiO_4 \times 3H_2O$
Iron ore (hydrate)	$n\ Fe_2O_3.mH_2O$
Aluminium hydrates	$n\ Al_2O.mH_2O$

TABLE 3. CLAY MINERALS USED FOR BONDING MOULDING SANDS*.

Clay mineral type	Composition type	Base exchange	Refractoriness (softening point)	Swelling due to water	Shrinkage due to loss of water	Particle size and shape
Montmorillonite class IA, western bentonite Source: Wyoming South Dakota, Utah	$(CH)_4Al_4Si_8O_{20}nH_2O$ Ex: 90% montmorillonite, 10% quartz, feldspar, mica etc.	High Na is adsorbed ion, pH=8-10	2100-2450F	Very high, gel-forming	Very high	Flake size of less than 0.00001 in.
Montmorillonite class IB, southern bentonite	$(CH)_4Al_4Si_8O_{20}nH_2O$ Ex:85% montmorillonite 15% quartz, limonite, etc.	High. Ca is adsorbed ion, pH = 4-6.50	1800 F+	Slight, little tendency to gel	Very high	Flake size of less than 0.00001 in.
Kaolinite class IV, fire clay source: Illinois, Ohio	$(CH)_4Al_4Si_4O_{10}$ Ex: 60% kaolinite, 30% illite, 10% quartz, etc.	Very low	3000-3100F	Very low, non-gel-forming	Low	Fire clays are often ground and therefore may be relatively coarse or may be ground to a flour
Illite class III, grundite	$(CH)_4K(Al_4Fe_4Mg_4Mg_6(Si_8\text{-}Vl)O_{20}$	Moderate	2500F±	Low non-gel-forming		

*Adapted from R.E. Grim and F.L. Cuthbert.

TABLE 4. CULTURAL REPORT OF MOLASSES & SAND.

Date	Culture	Seen on 26.4.93
25.4.93	Culture of Molasses on NA (nutrient agar)	3 bing colonies seen, opaque & yellow coloured
-do-	Culture of Molasses on MA (maconkey agar)	Sterile (no growth)
-do-	Culture of Molasses on SA (selerod agar)	Heavy fungus growth seen
-do-	Culture of molasses on NB (nutrient broth)	Heavy turbidity seen
25.4.93	Culture of sand on NA	Two types of colonies seen, big & small, opaque coloured
-do-	" " " MA	Sterile
-do-	" " " SA	Sterile
-do-	" " " NB	Little turbidity seen
	Re-culture	Seen on 27.4.93
26.4.93	Reculture on SA from NB of sand	Sterile
	Reculture on SA from NB of molasses	Fungus isolated
27.4.93	Morphological report of sand	Organisms were given negative, cocies. Cocied form observed, not dangerous for human health
28.4.93	T.B report of Sand	Negative

TABLE 5. EXAMPLES OF SAND MIXTURES.

Sand type	Sand green base	Clay binder	Other additives	Comments
Steel general facing	Silica sand, 40-60 AFS fineness	7% western bentonite	14% silica flour, molasses water	Temper heavy with water and use sufficient dextrin or molasses, bake at 600°F until dry
Steel	50% new silica sand, 40-60 AFS fineness, 50% reclaimed system sand	7-8% fire clay, 1-2% western bentonite	2-3% silica flour	Temper heavy with water, bake at 650°F until dry
Gray iron, general	40% new silica, 50-60 AFS, 60% old sand of same source	3-6% western bentonite	1.0-2.0% pitch 1.0-1.5% cereal	Temper to good workable moisture. Typical sand properties: 8.0-10 psi green strength, 90-120 permeability, 4-5% moisture Bake at 350-450°F
Steel, air-dry	New or reclaimed silica sand, fineness 40-60 AFS	3.5% western bentonite	5% silica flour, 1.25% cereal	3.5-4.5% moisture, air-dry open mould

3. However like any other SiO_2 sand, Bholari sand is a strong source of silicosis. Substitution of non-silica moulding aggregates e.g. olivine, zircon or chromite sand for silica in moulding material can reduce SiO_2 control by 80% because respirable particles are reduced greatly when olivine sand is used. It imparts greater resistance to thermal shock to casting. Its low thermal expansion can minimize the need of organic additives. The ratio of forsterite to fayalite is properly controlled because it determines the amount of mineralogical impurities. No kind of olivine dust gives rise to silicosis.

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