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05671

Distr.
LIMITED

ID/WG.179/20
19 June 1974

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

In-Plant Training Workshop on
the Production of Refractories

Pilsen, Czechoslovakia

11-28 June 1974

REFRACTORY RAW MATERIALS AND REFRACTORY INDUSTRIES IN PAKISTAN[1/]

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id.74-4292

A country's industrial and economic strength depends greatly on mineral resources, power, technical know-how and skill. It is thus important to know the country's resources of minerals and how best they can be utilized.

By and large, ceramic raw materials are dependent on the natural rocks and minerals available in the lithosphere. These mineral raw materials are mainly inorganic crystalline solids formed by different geological processes. The ceramic properties of these materials are determined as much by the chemical composition of their essential constituents as by the nature and the amounts of accessory minerals present. On the other hand, the mineralogical characteristics of these materials also play a very decisive role in determining their ceramic properties and usage. These mineralogical characteristics, in their turn, are subject to wide variations among different occurances, depending on the geological environments in which the minerals deposit was formed and the physico-chemical modifications that have taken place during subsequent geological history. The present report summarizes some of the more important characteristics of the mineral and their availability in Pakistan.

Bauxite:

The bauxite is mainly bochmite with Fe_2O_3 0.5-3% and is mainly located in Punjab. The deposits are well over one million tons. This bauxite, the only one of its kind in the country, may prove to be best of the so far investigated bauxites and would be suitable for high alumina refractories, the manufacture of alum, alumina compounds, as well as the extraction of aluminium metal. Refractories and alum have already been developed from the above bauxite at our PCSIR Laboratories.

Kaolin or China Clay:

Out of a large number of samples of china clay acquired and evaluated, only one deposit has so far been proved to be kaolinitic. It comes from Swat. Exhaustive works were done by various laboratories before WPIDC took up the project and has since set up a beneficiation plant using hydrocyclones for the elutriation process with an annual capacity of 4,800 tons of washed

china clay. This kaolin is quite suitable for the use in white-ware ceramics, paper, leather and insecticides, etc. The deposits have been estimated to be over 1,700.000 tons. After beneficiation it will give 250,000 tons of pure china clay. China clay has also been found in Nagar Parker of Sind, and Dir of NWFP but the extent and quality has not yet been ascertained.

Chromite:

The only metallic mineral which is being exported is chromite from the Hindubagh area of Zhob district in Baluchistan. Ores containing over 48% Cr_2O_3 are termed high grade whereas those below 48% are termed low grade. The low grade ore in the area has been estimated to be over 250,000 tons. The PCSIR Laboratories have already developed refractories from these chromites.

Dolomite:

Dolomite is available in considerable quantities in Hazara, Jhelum and Mianwali districts. From amongst some two dozen samples tested in PCSIR laboratories three samples were found promising and were investigated in a comparatively more thorough fashion. One of these samples comes from a deposite spread over an area of about 5 to 6 sq. miles between the villages of Batt and Lillo in Haripur district; the second belongs to a deposit located near Monara in district Jhelum and the third to district Mianwali. Haripur dolomite contains 0.05-0.2% Fe_2O_3, Monara's 0.1-0.2% and Nammal Gorge's 0.55-0.99%. Another important deposit is that of Swabi in Mardan district. It contains Fe_2O_3 0.1-0.2%. All these could be used in metallurgical as well as in glass and ceramic industries.

Fire Clays:

We possess almost inexhaustable quantities of various grades of fire clay. These clay deposits are located in Hyderabad, Sargodha, Campbellpur, Jhelum and Mianwali districts. Of these, the Mianwali deposits deserve particular mention. The deposits fall in the Cis-Indus Western Salt Range and are being commercially exploited by a number of private agencies. Fire clay from these deposits fall under super quality, high quality, medium quality and low quality grades. A number of studies have been conducted in our PCSIR laboratories on various samples from these deposits. These clays contain,

on an average, 35-40% Al_2O_3, about 1% Fe_2O_3 and very little other fluxes. A recent report indicates the highest percentage of Al_2O_3 to be around 43% with less than 0.5% Fe_2O_3 and 1% of other fluxes.

In addition to these various types of fire clays, high alumina clays have also been discovered in the vicinity of Musa Khel and Sakesar Hills in the Mianwali area. Some samples of calcined Musa Khel clay have registered as high as 66.6% Al_2O_3 while representative samples of calcined Sakesar clay gave a product containing an average of 70-72% alumina with 23-25% silica. Musa Khel clay, however, is not truly a high alumina clay but an admixture of alunite, $K(AlOH)_3(SO_4)_2Al_2O_3$ alunite Al_2O_3, SO_3, H_2O and medium to high quality fire clay. Being so this clay can be incorporated in a fire brick mix only as a grog. Its use would accordingly be restricted to the manufacture of 45% and 50% alumina bricks. On the other hand, X-ray studies conducted on the Sakesar clay indicate the presence of 50-70% bohemite, 20-30% kaolinite and 3-5% anatase. It can, therefore, be used both in raw form as well as a grog in the manufacture of 70% alumina refractories.

Feldspar:

Both potash and soda spars are available in Hazara district; the most extensive deposits of potash spar being located in Rajdawari and Dadar areas while good quality soda spar deposits are spreading over a large area along the Khairabad road. Detailed investigations have been made on a number of representative samples from these various areas. The results indicate that Rajdawari and Dadar potash spars are of excellent quality and compare favourably with the foreign feldspar. Rajdawari spar registered as low as 0.026% Fe_2O_3 with 8.67% K_2O and 2.25% Na_2O. Dadar spar, on the other hand, gave as high as 13% alkalies (11% K_2O+2.5% Na_2O) with 0.05% Fe_2O_3. Ahl clay deposits of Hazara district in fact contain over 90% weathered soda feldspar and may, therefore, be used as such as feldspar.

Limestone:

Large deposits of limestone are found in Pakistan in the well-exposed mountains of Chidru, Marwandi, Okesar, Mammal, Daudkhel and other area of Salt Range. The outcrops extend for a distance of more than one hundred miles from Kattha in the East and beyond Kalabagh in the West. There are also available huge deposits of limestones at Surghund Hills near Hindubagh.

More than 100 samples representing some 30 sq. miles area of the Salt Range and 10 sq. miles of the Surghund Hills, have been collected and studied for their geochemical properties. In general, the Salt Range limestone samples recorded higher percentages of iron oxide as compared to the samples from Surghund Hills. Typical analyses of the two types being as follows:

	Salt Range	Surghund Hills
CaO	50.9-55.1%	55.4%
MgO	Traces	0.1%
Fe_2O_3	0.127-0.43%	0.08%
Al_2O_3	0.198-0.921%	0.03%
SiO_2	0.46-3.64%	0.64%

Magnesite:

Magnesite is found abundantly in the Hindubagh area; most of the deposits being of the cryptocrystalline variety, found in association with ultrabasic rocks. Some crystalline magnesite deposits also exist in the vicinity of Sra Salawat. Amongst the various deposits discovered so far, those found in Zhob district of Quetta Division are good. Chemical analysis, differential thermal analysis, X-ray diffraction and hydration studies have been conducted on a representative sample from this area. The sample appeared to be very pure, containing only 0.52% SiO_2, 0.60% CaO and 0.21% Fe_2O_3. It may accordingly be utilized in the manufacture of chrome-magnesite, and magnesite refractories as well as for the extraction of magnesium metal and for the preparation of its various salts. The magnesite deposits of Baluchistan are not more than 50,000 tons whereas those recently discovered in Hazara are well over 5 million tons; quality being the same as that of Baluchistan magnesite.

Quartz:

Quartz is found in the pegmatite rocks of Hazara district with feldspar, mica and beryl as well as in the mono-mineralic veins. Studies conducted in our PCSIR laboratories on various samples from this area indicate the presence of 0.035-0.05% Fe_2O_3 with SiO_2 ranging between 97-99%. This quartz may be used in the manufacture of good quality white-wares, glazes, and in the production of colourless glasses.

Talc or Soapstone:

Deposits of soapstone are found in Jamrud of Peshawar district, Ragha in Zhob district, Pruchinar in Kurram Agency and Illega Sherwan in the Hazara district. The results of tests on various samples indicate that Jamrud deposit is of higher quality than other deposits. At present, the soapstone of Sherwan area near Shottiand is being exploited commercially. The soapstones of Sherwan area contain iron oxide ranging from 0.5% to 1.3% whereas those from Jamrud contain 0.1% to 0.1%. Thus these talcs may be used successfully for various ceramic purposes.

Quartzite and Ganister:

Large deposits of quartzite and ganister occur abundantly in Peshawar, Mardan, Hazara, Campbellpur and Mianwali areas in the North-Western part of Pakistan. Evaluation studies of these potential resources have already been started in the Glass and Ceramic Division of PCSIR Laboratories Lahore and pilot plant investigations have also been initiated for the development of silica refractories and the results are very much encouraging.

In addition to the minerals mentioned above, a number of other ceramic minerals also exist in various parts of the country. These minerals include asbestos, beryl, calcite, kyanite, marble, mica, vermiculite. Preliminary investigations have been done on most of them and detailed work on these materials are already in the programme of our PCSIR Laboratories.
In Pakistan, commercially exploitable deposits of bauxites are available. Some bauxitic clays containing 60-70% alumina are also reported. Preliminary work has already been completed and a number of high alumina clays and hydrated aluminas (bauxites) have been tested in our PCSIR Laboratories. Promising samples have also been used in the formulation of bricks and blocks of alumina compositions ranging from 50% to 80% Al_2O_3. Laboratory results match favourably with those of the imported brick and are well in accord with the international specifications.

With the establishment and expansion of iron and steel, glass and other related industries, the demand of these refractories have increased accordingly. Moreover, self-reliant economy support can be extended by producing the refractories in Pakistan. At present, there is no commercial

production of high alumina refractories. The import of high alumina glass tank blocks is to the tune of about 12-14 lakhs/annum. This amount of foreign exchange could be saved if these refractories are developed in the country. General Refractories Ltd.'s factory in Karachi is planning to take up commercial production of high alumina refractories.

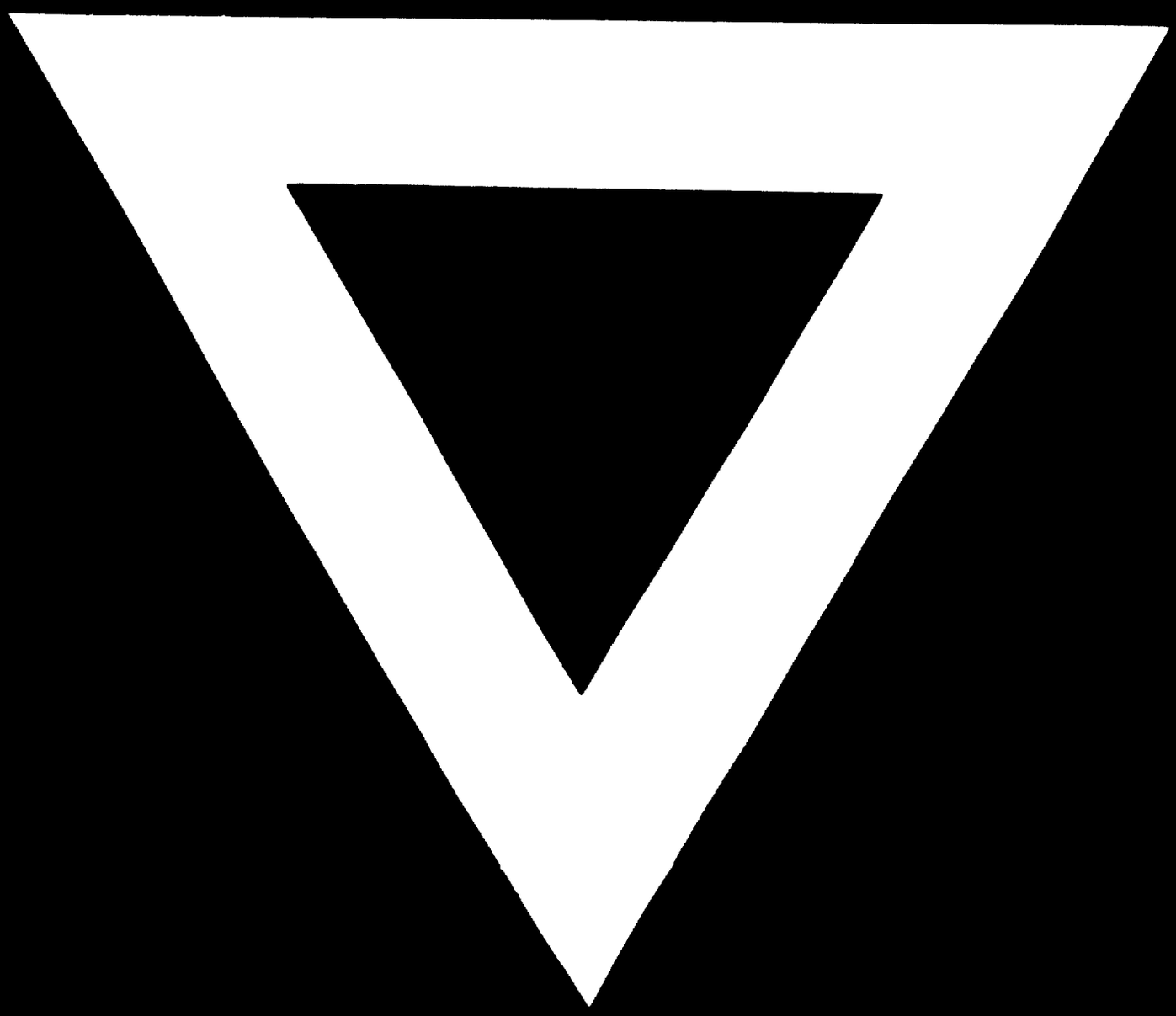
Basic refractories such as magnesite, chromite, magnesite chrome, chrome/magnesite, dolomite and forsterite, etc., are required in basic open-hearth steel furnace, blast furnace, electric arc furnace reverberatory and refining furnaces of nickel and copper, in the construction of forge and billet reheating furnace, in the burning zone of rotary cement kiln, glass tank regenerators, etc.

There is no factory producing basic refractories in Pakistan but WPIDC is planning to set up a factory for the production of magnesite bricks based on magnesite of Hazara.

List of some of the important refractories industries in Pakistan producing low and medium duty fire clay bricks

1.	General Refractories Ltd., Karachi (they are busy in extension and have a programme to produce 6,000 tons/year high alumina refractories)	15 tons/day
2.	Zak Brothers, Karachi	10 tons/day
3.	General Ceramic Industries, Gujranwala	10 tons/day
4.	Marshall Ceramics, Gujranwala	8 tons/day
5.	Refractories Industries, Jhelum	5 tons/day
6.	Westridge Fire Clay Co., Rawalpindi	3 tons/day

Besides, there are about six more small industries producing fire clay refractories and their total capacity amounts to about 20 tons/day.



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