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## Work of the Ceramic Experiment Station of the U. S. Bureau of Mines\*

By R. T. STULL

Under an Act of Congress approved March 3, 1915, provision was made for the establishment of 10 mining experiment stations and 7 mine safety stations in additions to those which were already established, providing that not more than 3 mining experiment station and 9 safety stations be established in any one year.

Up to the present time there are 12 experiment stations, 5 of which have been established under the above named act. Stations are now located at Pittsburgh, Pa.; Minneapolis, Minn.; Golden, Colo.; Seattle, Wash.; Bartlesville, Okla.; Berkeley, Calif.; Fairbanks, Alaska; Salt Lake City, Utah; Tucson, Ariz.; Urbana, Ill.; San Francisco, Calif., and Columbus, Ohio.

The problems of these different stations are largely those which are of greatest economic importance to the mining and metallurgical localities in which they are located. Some stations are necessarily doing work parallel or similar in nature though quite different in detail.

The Columbus Station was established July 1, 1917, and was located at Columbus for the following reasons: Ohio is the leading clay products state in the Union, its annual output being more than 22% of the entire valuation of the nation's annual output. Columbus is the approximate center of the ceramic industry. Ohio State University established the first ceramic engineering school in the United States. It has its ceramic traditions and is broadly known. The University entered into an agreement whereby it proposed to supply the Bureau of Mines with adequate rooms for offices and laboratories, to supply light, heat, power and janitor service fee and to provide laboratory furniture and other fixtures and to loan to the Ceramic Experiment Station the use of equipment consisting of kilns, machinery and other apparatus.

The Columbus Station is the only Experiment Station of the Bureau of Mines, devoted to investigations of clays and other ceramic materials, therefore its work is not confined entirely to the problems of greatest interest to the locality, but it has to do with all ceramic problems common to the United States and its foreign possessions.

The Station has twelve employees, consisting of a superintendent, chief clerk, stenographer, ceramic engineer, ceramic chemist, five ceramic assistants, a potter and an unskilled laborer.

The Station's problems are those pertaining to the mining, refining and utilization of ceramic

raw materials, the investigation of industrial problems with a view to reducing the cost of manufacture and to improve the quality of products. It has also to do with the elimination of waste and the safeguarding of the health of ceramic workmen.

The Station is authorized to do co-operative work with the different governmental bureaus, with the different states and with the industries. Clays are being tested for the Government Land Office, for the Indian Schools and the U. S. Geological Survey. A co-operative agreement has been made with the Geological Survey of Ohio for investigating the clays of the state.

Ohio's most valuable clays are the high grade fire clays and their investigation has been undertaken as the first step in a general survey of the different clays of the state. The geological and field work has been practically completed and samples taken by Mr. Wilbur Stout of the State Survey and the testing of these clays is to be done by the Ceramic Station.

The U. S. Public Health Service is investigating conditions in the potteries as regards the effect of dust upon the health of the workmen and the conditions causing lead poisoning. The assistance of the Ceramic Station has been requested and its services have been offered in conducting these investigations.

During the progress of the war, the work which was undertaken consisted principally of investigations of war minerals. The problem of producing large quantities of chemicals for explosives, poisonous gases and dye stuffs made a great demand upon the chemical stoneware industries. The first problem investigated was to determine the properties of some Ohio and Pennsylvania stoneware clays. Methods were studied to improve the quality of the ware and to bring to the attention of the chemical stoneware manufacturers, valuable clays not being used.

The second problem undertaken was that of American graphites and bond clays for the manufacture of graphite crucibles which are of importance in the melting of brasses, alloys and special grades of crucible steel. Before the war the graphite crucibles produced in this country were made from practically all imported graphite and German bond clays. Over 90% of the graphite used for this purpose came from the Island of Ceylon. The importation of German bond clay was shut off in 1914 and the supply on hand was soon exhausted. It was therefore necessary for the American crucible manufacturers to look to

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the American clays for use with their graphite in the production of crucibles. This condition at first created not only a hardship on the crucible manufacturers but upon the users as well, since the crucible manufacturers in general had not learned how to use American clays which were quite different from the imported German clays.

Crucible manufacturers had large stocks of Ceylon graphite on hand but after the United States entered the war it was necessary to conserve ocean shipping in order to carry men and material to France. The importation of Ceylon graphite was therefore restricted and it was found necessary to restrict the crucible manufacturers to the use of as much domestic graphite as possible. The Ceramic Station therefore took up the study of American graphites and bond clays for crucible making purposes. Over 200 crucibles made from foreign and domestic graphites and bond clays have been made and tested and it has been found that by proper blending and preparation, our domestic materials will make crucibles equally as good as those made from imported materials.

Fire brick and other refractories are of vital importance to the metallurgical industries. Without proper refractories for furnace linings, the majority of the modern metallurgical processes would be impossible. The bulk of refractories are made from fire clay, silica, magnesite, bauxite and chromite. Refractories made from zirconia, silicon carbide and spinel have come into prominence more recently and are being used in limited quantities.

Furnaces used in the production of copper and certain grades of steel require magnesite refractory lining and large quantities of magnesite brick are used annually. Prior to the war, over 80% of the magnesite used for refractory purposes in the United States came from Austria, although vast deposits of magnesite occur in the states of California and Washington. Most of the magnesite refractories find use east of the Mississippi River, but the cost of mining, preparation and delivery of the magnesite from the Pacific Coast was so great that the foreign magnesite could be secured in normal times, much cheaper. Since the foreign supply became unavaliable, the manufacturers of magnesite refractories have drawn largely upon the magnesite from the Pacific Coast and to a smaller extent upon the Candian deposits.

The necessity of using a more expensive raw material together with the increase of prices due to abnormal conditions, has brought the market price of magnesite brick up to nearly three times that of normal times.

Enormous deposits of the double carbonate of calcium and magnesium, commonly known as dolomite, occur widely distributed throughout the eastern states. The State of Ohio contains thousands of acres of dolomite. At present its principal uses

are for crushed stone in concrete and for surfacing roads. Perhaps the best known deposits are those of the Cedarville, Ohio, district, some of which are so pure that they correspond very closely to the theoretical dolomite formula.

During the past four years, numerous attempts have been made by various investigators to devise methods of preparing dolomite so that it could be used as a substitute for magnesite refractories. About a baker's dozen patents have been issued on methods of treating dolomite for refractory purposes. The material is being treated under a few of these patent processes and sold in the loose or granular form under different trade names. The material has found a limited application in steel furnaces where it is used for making temporary patches in the magnesite lining and is also mixed with a suitable binder and tamped in the bottom of open hearth furnaces. However, in so far as the writer can learn, the production of a practical dolomite fire brick that will withstand a long period of storage without slaking or disintegrating under atmospheric conditions, is yet to be attained.

About a year ago the Ceramic Station undertook the study of the preparation of dolomite for the manufacture of refractories. The different patent processes for dead burning dolomite have been tested and a number of other methods are being investigated. The work has not progressed far enough at the present time to draw definite conclusions, but it can be said that "the results are promising."

Over 50% of the white clays used in the better grades of pottery comes from England, it being the general opinion that the imported clay produces ware of a better color and texture. In order that we may be independent of importations, it will be necessary to develop new deposits and to improve the present refining processes.

In June last year, the Ceramic Experiment Station undertook a survey of the china clay and kaolin deposits east of the Mississippi river. One hundred and five samples of white clays were collected in the field and shipped to the Ceramic Station for tests. Sixty of these samples were collected by Prof. A. S. Watts representing the U. S. Bureau of Mines and the remainder by Dr. Ries and Dr. W. S. Bayley representing the U. S. Geological Survey.

These clays are being tested in order to determine their physical properties and methods applicable to their purification are being studied. A new type of clay washer has been developed on a laboratory scale which removes the finer impurities not removable by the present clay washing process. Before the new method of washing clay

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### CERAMIC ENGINEERING STATION

(Continued from page 15)

can be recommended, it must first be tested under practical working conditions.

Although the work of the Ceramic Station is national in scope, it perhaps means more to the State of Ohio than any other state because of the state's high rank in the production of ceramic wares. To illustrate the economic importance of the work of the Bureau of Mines' Ceramic Experiment Station, we might mention the fact that the development of a practical dolomite fire brick would develop a new industry and add to the state's wealth by utilizing a raw material low in value and abundant in quantity.

The main object of the white clay investigation is to improve our domestic clays by refining and blending in order to produce materials at least equal to the imported pottery clays. If this can be done it will mean much in economy and independence nationally and especially will Ohio be a benefactor since the state produces over 42% of the value of the nation's pottery output. Ceramics as a field for investigation is so new, it has often been said that "the surface has not been scratched." The problems crying for investigation are so numerous that it is difficult to determine which is most in need of the nursing bottle.

Space will not permit of a more detailed account of all activities of the Station, but it is hoped that the above brief description of a few problems undertaken will give the reader an idea of the kind of work the Ceramic Experiment Station is doing and the kind of service it is trying to render the public.