STATE OF OREGON
DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES

PORTLAND, OREGON

THE
ORE.-BIN

VOL. 7 NO. 10 PORTLAND, OREGON July, 1945

October 1945 Portland, Oregon

STATE DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES
Head Office: 702 Woodlark Bldg., Portland 5, Oregon

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ATOMIC PLANNING

Complete control of sources of supply of radio-active minerals by the Government will be effected by Congressional and Executive action. The recent order of the President as given below is one of the steps in the program. Many complex problems are involved and will continually arise in making the control of raw materials effective, as well as in supervision of all industrial and scientific applications of radio-active minerals, including research. As this program is without doubt the most critical and most important ever to confront this country, and as adequate planning must be based on expert knowledge, Congress and the President will need to rely on scientists more and more as time goes on. It would seem to be a wise move to set up a Federal department of science headed by a scientist with cabinet rank.

Editor

Executive Order 9613

Withdrawing and Reserving for the Use of the United States Lands Containing Radio-Active Mineral Substances

By virtue of the authority vested in me as President of the United States, it is hereby ordered as follows:

1. Subject to valid existing rights, all public lands of the United States, including Alaska, which contain deposits of radio-active mineral substances, and all deposits of such substances, are hereby withdrawn from sale and all other forms of disposal under the public-land laws, including the mining laws, and reserved for the use of the United States.

2. So far as not in conflict with existing law, all lands in the United States, its territories or possessions, heretofore acquired by the United States which contain deposits of radio-active mineral substances owned by the United States are hereby reserved from sale, and all leases, licenses, or other authorizations of whatever kind hereafter granted to occupy or use such lands, shall reserve to the United States the right, at any and all times, to enter upon such lands, and mine and remove such mineral substances; and all such lands hereafter acquired by the United States shall become subject to the provisions of this paragraph upon their acquisition; PROVIDED, That no reservation under this paragraph shall interfere with the use of the lands established or indicated by any act of Congress.

HARRY S. TRUMAN

The White House
September 13, 1945

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CERAMIC TESTING

Introduction

The ceramic industry is not only one of the oldest but also one of the largest industries in the country today. Its scope is wide, as it embraces nearly all of the silicate industries, such as those which make whitewares, refractories, abrasives, and glass. The fact that silicon is second only to oxygen as the most widely found element in the earth's crust is an indication of the far-reaching application of this industry. The art and science of ceramics have been instrumental in paving our roads, building our skyscrapers, smelting our metals, providing us with dinnerware, and offering us all sorts of ornamental forms to appease our aesthetic sense.

Clay originally was the foundation of ceramic enterprise, and although many other substances have come into auxiliary use, clay is still regarded as the most important of ceramic materials. The intrinsic property of clay, which allows it to be mixed with water to form a plastic mass and then to be fired to a hard durable body, is the basis for its wide use. A combination of both chemical and physical factors is involved in the use of clay and, on firing, any number of complex silicates can be formed, depending on the original material and its subsequent treatment. The knowledge and application of such branches of science as colloid chemistry, thermo-chemistry, mineralogy, mechanics, and phase rule studies are required to fashion our wide variety of ceramic articles on a twentieth century production scale.

Because of the many factors which, during the manufacturing process, have an effect on the final ceramic article, the testing of clays must follow the commercial practice as much as possible. It is important to know what happens to each clay as it is subjected to the processes used in ceramic enterprise. Thus it is the purpose of this paper to describe the more commonly known clays and some of their basic tests, and to show how these tests are important in the evolution of the final ceramic product.

Types of clay

One might say that there are as many types of clay as there are types of people. Numerous classifications of clay[1] (based on various factors) have been made. Ries, Buckley, Edward Orton, Jr., and Grimsley and Grout classify clays according to the manner in which they are geologically formed; Orton, Sr., classifies them according to low- and high-grade types; Wheeler and the U.S. Bureau of Mines according to uses. Each clay type has a number of names and the following are often referred to in ceramic circles.

Common clays burn to the darker colors. They are usually non-refractory, and are used to make heavy clay products such as sewerpipe, draintile, common and paving brick, etc., and in art pottery.

Refractory clays may be heated to a high temperature without deformation; cone 19 (1515° C.) is considered the lowest softening point for refractory clays. They usually fire to a buff color and are used for making firebrick, refractory shapes and forms, and some stoneware products.

Stoneware clays fire to a fairly dense, gray-colored body at approximately cone 8 (1225° C.). Some buff-burning refractory clays are considered stoneware clays, however. Stoneware clays are used in the making of earthenware, chemical stoneware, and art pottery.

Whiteware clays are light-colored, fine-grained clays and are used for making fine dinnerware, porcelain, and electrical insulators. The two principal types

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[1] Ries, H., pp. 32-37

of whiteware clays are china clay or kaolin and ball clay. China clays or kaolins tend to be light-colored in both the raw and fired state and are not as fine-grained and plastic as the ball clays. Ball clays are highly plastic, fine-grained, and refractory. They fire to a white or cream color and have a high bonding strength. Mixtures of china and ball clays are usually used in whiteware bodies.

Making ceramic ware

A biographical sketch of the life of a clay from the time that it is prepared for mixing to the stage of final firing emphasizes those critical points and peculiarities which must be controlled for any successful ceramic enterprise. These critical points and changes are the foundation for the procedures which have been developed for ceramic testing of clays. Only those operations which are common to all ceramic products will be considered.

Four processes must be carried out in the making of any ceramic ware. These are: (1) preparation of the clay-water mix, (2) forming of the ware, (3) drying of the ware, and (4) firing of the ware.

As water is added to the clay, the mixture first becomes crumbly and the particles do not hold together well except under great pressures such as are used in the dry-press method for forming ceramic ware. As more water is added, the clay reaches a stage where it can be deformed and the mass will hold its shape. This is its maximum plasticity and the amount of water required to bring the clay to this stage is known as its water of plasticity. This clay mixture is ideal for the stiff-mud or extrusion processes. Further addition of water causes the clay to become sticky and soft. This consistency is used in the soft-mud process. When sufficient water has been added, the clay becomes fluid and is well adapted to the casting process.

A plastic mass of clay contains a series of capillaries of varying size and because of these capillaries, which have a force more than three thousand times as great as the force of gravity, water is retained in the plastic mass.

During the drying process the water evaporates from the surface of the clay and water is replaced at the surface from the center of the clay piece by this capillary action. As water is removed from the clay, the particles come closer together and the clay shrinks. The amount of this shrinkage is known as the drying shrinkage and if it is excessive, distortion, warping, and cracking may occur.

When the clay has been dried, it is ready to be fired. As the ware enters the kiln, it is partly shrunk, very fragile, and porous. It is in the form and shape of the finished product and is composed of the same minerals with which it started. It has a definite specific gravity and color, which depend on the character of the original material. When the ware leaves the kiln, its shrinkage has increased and it is hard and strong, but not very porous. It has the same shape as before firing, but its mineral composition, color, and specific gravity have changed.

In the early stages of the firing any uncombined water is removed and continues to vaporize until a temperature of approximately 600° C. is reached. This is called the dehydration period. Before all the water is removed oxidation begins to take place and continues until the temperature is about 950° C. Sulfur and carbon are oxidized and volatilized in this period, while iron is oxidized to ferric oxide. At 900° C. vitrification begins. At this point eutectics* and solid solutions are formed with a rearrangement of the molecular structure of the clay and its associated minerals. There is no limit to the vitrification period and the amount of vitrification in any product depends on the final properties desired in the ware.

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*Refers to that particular mixture of a definite composition of two or more given substances which has the lowest point of solidification.

The firing behavior of any clay is similar to that of kaolinite, but it is affected by any other minerals which may be present. All ceramic clays contain kaolinite and the critical temperatures of kaolinite are as follows:

Less than 450° C.	Remaining uncombined water is removed.
500 - 600° C.	Combined water is removed leaving $Al_2O_3 \cdot 2SiO_2$ (aluminum silicate).
850 - 1000° C.	Amorphous mullite ($3Al_2O_3 \cdot 2SiO_2$) and tridymite (SiO_2 unstable at room temperature) are formed.
1350° C.	The crystallization of mullite takes place.
1470° C.	The conversion of tridymite to cristoballite (stable form of SiO_2 at 1470° C.) occurs and the specific gravity increases.
1545° C.	The eutectic melting of alumina and silica occurs. This eutectic consists of 5.5% alumina and 94.5% silica.
1745° - 1790° C.	The entire material melts.
2000° C.	The silica is reduced to SiO and the remainder of the material is nearly pure mullite.

Testing procedure

With this brief sketch in mind we are ready to step into the laboratory and see how the testing data is obtained and how it is related to the mass production of ceramic ware. At least 5 pounds of a representative sample of the clay is required for testing. When a clay arrives at the laboratory, its visible properties such as color, texture, hardness, and the presence of impurities are first noted. The sample is then air-dried and crushed to 20-mesh.

A screen test is carried out in which a weighed amount of the clay is mixed with water to form a slurry. This is passed through 60-, 100-, and 200-mesh screens. The results of the screen test and examination of the fractions on each screen show whether beneficiation of the clay will be necessary. The amount of purified clay per ton of raw material to be expected, the possible by-products to be obtained from the processing of the clay, and the type of beneficiation to be used are often indicated by this test.

A standard procedure for the testing of the ceramic properties of clays was developed by the American Ceramic Society in 1928. This procedure is in wide use and is accepted as standard throughout the country. In general, ceramic testing involves the preparation of bars of convenient size, and the determination of the weight and volume of the bars when they are dried and then fired to different temperatures. The clay is mixed with water until it reaches its maximum plasticity. Care must be taken to obtain uniform mixing of the clay and water. The test specimens are formed in a mold. They are then labeled and a reference line of given length may be marked on the bars to be used in determining the linear shrinkage. The specimens are weighed and their volumes are measured in a volumeter. Length of the reference line and weight and volume of each specimen are determined after the bars have been dried to constant weight. The specimens are divided into groups and each group is fired to a different temperature. Length of the reference lines and weights and volumes of the bars are determined after each firing. The fired specimens are then boiled in water for two hours and allowed to remain in the water until it has cooled to room temperature. The specimens are then weighed and this weight is called the saturated weight. Symbols for the measurements on the specimens are as follows:

W_p - Weight of the plastic specimen
V_p - Volume of the plastic specimen
L_p - Length of the reference line of the plastic specimen
W_d - Weight of the dry specimen
V_d - Volume of the dry specimen
L_d - Length of the reference line of the dry specimen
W_f - Weight of the fired specimen
V_f - Volume of the fired specimen
L_f - Length of the reference line of the fired specimen
S_f - Saturated weight of the fired specimen

From these measurements several properties may be determined and the results are reported as percentage values.

The water of plasticity is the amount of water required to bring the clay to its maximum plasticity. It is calculated according to the following formula:

$$\text{Percent Water of plasticity} = \frac{W_p - W_d}{W_d} \times 100$$

This indicates the amount of water to be added to the clay each time a mix is prepared and control of the water content is greatly increased.

The shrinkage water is the water given off up to the point where shrinkage ceases. It is calculated according to the following formula:

$$\text{Percent shrinkage water} = \frac{V_p - V_d}{W_d} \times 100$$

This information is of value in controlling the drying process.

The pore water is the water which is in the pores of the clay after shrinkage has ceased, but is driven off at 110° C. It is the difference between the water of plasticity and the shrinkage water.

The drying shrinkage is the change in size of the clay on drying. The linear drying shrinkage is determined by measuring the reference lines on the clay specimens and is calculated according to the formula below. The volume drying shrinkage is calculated as shown:

$$\text{Percent Linear drying shrinkage} = \frac{L_p - L_d}{L_p} \times 100 \qquad \text{Percent Volume drying shrinkage} = \frac{V_p - V_d}{V_d} \times 100$$

From this measurement the size of the dried ware can be calculated before it has even been made. Also, if the shrinkage is too large or too small, the ceramic body may be altered by the addition of other materials to produce a mixture of proper shrinkage.

As the clay is fired, progressive changes in color, texture, hardness, porosity, volume, absorption and strength occur. The color, texture, and hardness of the specimen at each temperature is noted. The other properties are determined by calculation.

Apparent porosity is the volume of all the pores in the material that can be filled by saturating the specimen with water. This is calculated according to the following formula:

$$\text{Percent apparent porosity} = \frac{S_f - W_f}{V_f} \times 100$$

Volume change is the change in the volume of the specimen from the dried to the fired condition. This calculated as follows:

$$\text{Percent volume change} = \frac{V_d - V_f}{V_f} \times 100$$

When a product of given size is required, this information is used to calculate the size of the forming mold to be used. In the case of some products, such as electrical porcelain, the size specifications are very rigid.

By plotting the apparent porosity and volume change against the firing temperature, the firing range of the clay is indicated. A wide firing range allows greater variation in the firing without disastrous results, whereas with a narrow firing range the firing schedule must be very accurately controlled.

The mechanical strength of a clay can be determined by the weight required to break a test specimen. This determination is often beyond the scope of the small laboratory because of the large and costly equipment required. Nevertheless this is a very important property.

The pyrometric cone equivalent, usually expressed as PCE, is a measure of the softening point of the clay. It is of importance in classifying refractory clays. Small cones are prepared of the clay being tested and are placed in a plaque with similar cones of known softening temperatures or pyrometric cone equivalent values. The plaque is heated up according to a standard schedule and the standard cone, whose time of bending is the same as that of the clay cone, indicates the pyrometric cone equivalent of the clay.

When the testing is completed, much is known about the value of the clay. It has been classified and "finger-printed". The first step between the laboratory and the plant has been made. But this is just the beginning, for it is the constant cooperation between plant and laboratory which has made possible the utilization of materials heretofore considered of little value. It is this cooperation that has developed new and improved products at lower costs and increased plant efficiency and production scales to formerly unheard-of heights.

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Esther W. Miller

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COOS BAY MINE ACCIDENT RATE

As reported in the press October 5, 1945, a U.S. Bureau of Mines coal mine inspector stated that the accident rate at the Southport mine of the Coast Fuel Corporation, Coos Bay, was high compared to the average rate for the country's bituminous mines as a whole. The basis of the comparison was the number of tons mined for each disabling injury during the six months ending June 20, 1945.

Such a comparison gives a distorted picture wholly unfair to the Coos Bay mine. During this period the Southport mine was engaged in development work underground and construction work on the surface; therefore, of necessity, production of coal was secondary to this "dead work" which is always required before mining may be undertaken along engineering lines. The accident rate for the nation's mines as a whole would be determined from a large number of producers whose predominant activity was mining coal already developed.

It is difficult to understand why such a grossly unfair comparison was given to the press.

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PROSPECTOR'S COURSE

The University of Washington announces the opening of a Prospector's Course at the College of Mines on November 1, 1945. This course will be open without examination to all men past high-school age. The instruction will cover prospecting as commonly understood and the elements of geology, mineralogy, chemistry, and metallurgy. Operations in the mineral industry on which a prospector should be informed will be described with the aid of mine maps, motion pictures, and views of current practice.

The prime object of the course is to give each man familiarity with ores and minerals by means of study and tests in the laboratories. Practice will be given with standard mining and milling machinery, microscopes, furnaces, and the other extensive equipment in Mines Laboratory. Field trips will be made to mining operations, to geological features, the Tacoma Smelter, and other metallurgical plants.

The course continues from November 1 to February 23. A regular schedule of laboratory and class work is followed daily from Monday to Friday, with field trips at intervals. For those that can remain longer, the course will be continued from March 1 to June 15. Application may be made now in writing or in person to Dean Milnor Roberts, Mines Laboratory, Seattle 5, Washington. Registration will take place October 22 to 31.

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SURPLUS MINERALS

A recent list of surplus property issued by the Reconstruction Finance Corporation shows an amazing variety of materials for sale by the Government. The surplus mineral products as listed below (not including metals and alloys) is a nearly complete coverage of the mineral production of the country.

Incidentally anyone wishing to buy some "marine animals" should contact R.F.C., and as a further note, there appears to have been a brisk demand for them, whatever this classification includes.

Alkali minerals, crude.
Aluminum ores, tailings and unrefined products.
Calcium and magnesium carbonate minerals, ground.
Clays and earths.
Coal.
Fertilizers - phosphatic.
Fluoride minerals and rocks, ground.
Iron ores, tailings, and concentrates.
Mica.
Mineral basic products, chiefly non-structural.
Mineral basic products chiefly structural.
Mineral products, ground.
Mineral wool, basic products.
Minerals, natural, inorganic, general grade.
Minerals non-metallic, crude.
Miscellaneous metallic ores, tailings, etc.
Natural asphalt and bituminous rock.
Ores, tailings, and concentrates - precious metal.
Peat.
Pottery basic products, chiefly structural.
Precious metal and precious metal-base alloy basic shapes and forms.
Refractories, clay.
Sand and gravel.
Silica minerals and rocks, ground.
Sticks and stones abrasive
Stone crushed and broken.
Stone products natural, structural.
Waxes, mineral, except paraffin.
Whiting.

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MERCURY IN AUGUST 1945

The U.S. Bureau of Mines issued the following release on October 20, 1945:

Imports and consumption of mercury in August fell well below the high record monthly rates established in July and May, respectively, but were higher than the average monthly rates for any year prior to 1945, according to the Bureau of Mines, U.S. Department of the Interior. The full effects of the cancellation of war contracts on consumption of mercury is not evident in the August figures. Production dropped 8 percent from July, but the August total was high in comparison with the other months of 1945. Stocks continued at the high level reached in July and prices continued their accelerating decline.

Salient statistics on mercury in the United States, October 1944 to August 1945, in flasks of 76 pounds

Period	Production	General imports	Exports	Consumption	Stocks at end of month 3/		Price per flask at New York
					Consumers and dealers 4/	Producers 5/	
1944:							
October	2,700	886	33	3,900	7,400	2,550	$109.20
November	2,300	1,270	42	3,900	7,800	2,094	116.30
December	2,500	935	20	3,900	10,400	2,714	128.88
Total 1944	1/ 37,688	19,819	748	42,900	----	---	$118.36 6/
1945:							
January	2,500	846	28	5,200	9,000	2,188	$156.85
February	2,700	2,835	9	5,100	13,000	1,946	165.55
March	3,000	2,263	25	6,100	12,200	1,584	162.00
April	3,000	10,963	30	7,500	15,800	2,148	156.84
May	3,300	7,242	70	8,900	15,600	2,760	153.69
June	3,000	3,677	22	8,500	16,100	1,377	147.73
July	3,600	19,504	23	6,600	7/ 33,600	3,179	140.72
August	3,300	4,417	(2/)	5,300	32,300	3,266	123.20

1/ Final annual total; monthly figures not adjusted. 2/ Data not yet available. 3/ Based on location rather than ownership. 4/ Largely excludes redistilled metal. Excludes metal afloat from Europe. 5/ Held by reporting companies. 6/ Average. 7/ Revised.

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Mercury imported into the United States in January-August 1945, by countries, in flasks (general imports)

	January	February	March	April	May	June	Total 6 months	July	August
Canada	20	1,700	---	---	---	----	1,720	----	----
Chile	----	---	300	---	---	200	500	100	150
Honduras	----	---	---	---	---	23	23	----	----
Mexico	826	1,055	1,963	1,909	1,390	1,452	8,595	1,170	1,233
Peru	----	80	---	51	---	----	131	----	32
Spain	----	---	---	9,003	5,852	2,002	16,857	18,234	3,002
	846	2,835	2,263	10,963	7,242	3,677	27,826	19,504	4,417

Exports of mercury averaged only 30 flasks a month in Jan.-July, 1945. Data for Aug. are not yet available.

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CLEARING HOUSE

CH-85: For sale or lease four and a fraction patented quartz claims in Virtue mining district, east of Baker, Oregon. Formerly known as Rachel Consolidated. Value of production reported as about $150,000. Considerable underground development, probably about 4000 ft., was done by former operators. High-grade assays have been obtained. Interested persons should get in touch with owner, H.H.Waggoner, 2690 Broadway, Baker, Oregon.

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