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A comparison of Florida, Georgia and G-1 kaolin as the chief clay ingredient for a sanitary ware casting body

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A COMPARISON OF FLORIDA, GEORGIA AND G-1 KAOLIN AS THE CHIEF CLAY INGREDIENT FOR A SANITARY WARE CASTING BODY

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INTRODUCTION

Purpose of the Investigation

The purpose of this investigation, originally, was to determine the suitability of substituting G-1 kaolin for Florida kaolin in a sanitary ware casting body. It was later extended to embrace a comparative study of Florida, Georgia and G-1 kaolin as the chief clay ingredient in a sanitary ware casting body.

G-1 white clay is mined by the Savannah Kaolin Co. at Gordon, Georgia and is therefore a Georgia kaolin. This Co. claims its use prevents excessive drying cracks when incorporated in a regular casting body. Two per cent G-1 kaolin is supposed to cause entire disappearance of drying cracks even in large pieces. The cast ware is also said to have uniform thickness due to lack of settling in wide portions of the mold owing to the use of G-1 kaolin.

This kaolin is an extremely fine, white clay with 2% free silica in the crude state and a low percentage of secondary minerals. It shows great plasticity upon tempering with water. Its P.C.E. value is cone 34.

Florida kaolin[1] is a white refractory ball clay which is sticky, short, and difficult to slip. It is most fre-

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1 - C. F. Binns, Nomenclature of Clays, Trans. Amer. Cer. Soc., (1912)

quently won by dredging and then refined by washing, filter-pressing, and drying. This results in a kaolin[1] which is noted for its workability and strength.

Georgia kaolin[1,2] is of two types: "hard clay" to flint clay on one hand to "soft clay" on the other. It is difficult to slake and filter-press, lacks uniformity, has excessive shrinkage and burns to a cream to white. Higher flint content improves the whitness. Georgia kaolin casts readily.

This investigation was to determine which of the above three kaolins alone or blended would produce the best body suitable for the casting of whiteware.

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1 - Stull & Bole, Sedimentary Kaolins of Georgia in Whiteware, Jour, Amer. Cer. Soc., VI, P 854, (1923)

2 - R. T. Stull, Distribution of Kaolin & Bauxite of the Coastal Plain of Georgia, Jour. Amer. Cer. Soc., VII, P 513, (1924)

METHOD OF INVESTIGATION

Preliminary Study

As a basis for this investigation it was necessary to find a whiteware body which would cast satisfactorily and which would be suitable for a varying of the kaolin content. H. L. Harrod, in his thesis, "Florida Kaolin as the Chief Clay Ingredient For a Sanitary Ware Casting Body," developed such a body:

Kaolin - - - 45%
Flint - - - - 25%
Feldspar - - 25%
Ball clay - - 5%

Three bodies were made up using Florida, Georgia, and G-1 kaolin. These bodies were used as end members of a thirty-six member triaxial. The feldspar was a Buckingham potash feldspar, and the ball clay was a #4 Kentucky ball clay. (Figure 1.)

It was decided not to use an electrolyte as a more accurate comparison of the bodies would result. A study of organic compounds as suitable electrolytes was contemplated if time permitted.

PROCEDURE

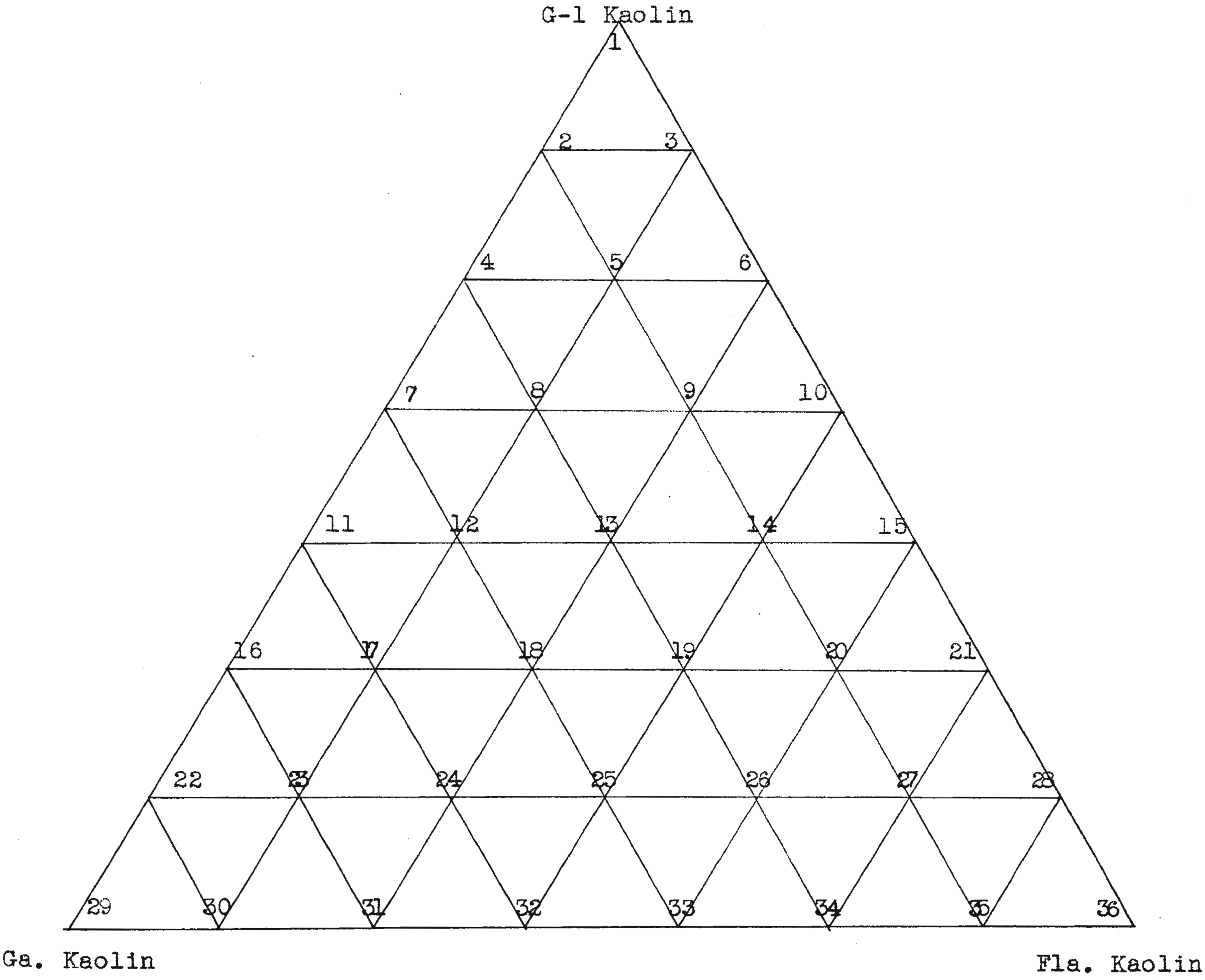

Figure 1.

Figure I shows the manner in which thee three bodies were arranged as end members of the triaxial. It was decided to compound the bodies on a basis of 80 pounds as the total weight. This gave the following weights:

Kaolin - - - 36 lbs.

Flint - - - - 20 lbs.

Feldspar - - 20 lbs.

Ball clay - - 4 lbs.

The kaolin and ball clay were crushed in a jaw crusher and then passed through rolls to bring them to a size which permitted ready slaking. Proper amounts of the materials were weighed into a porcelain lined, pebble mill where they were dry ground for thirty minutes to insure proper mixing. At the end of this time water was added in such an amount as to produce a very thin slip and the grinding and mixing was agin resumed for a three hour period. Screening was the next operation, being accomplished by means of a 100-mesh vibrating screen.

Because of the excess water added in blunging this operation was easily and effectively accomplished. The excess water was then removed by evaporation over steam coils. When sufficient water was removed to produce specific gravity of 1.8, the clay slip was removed to a humidor until needed.

The specific gravity was found by weighing a graduate filled first with water, then with slip, and then empty.

The actual weight of the slip divided by the weight of an equal volume of water gave the specific gravity of the slip. A 1.8 consistency is about the same as a soft mud.

The blending of the intermediate triaxial members was by volume since the specific gravities of the end members were the same. The constitutents were thoroughly mixed and cast into the plaster molds which were jarred so as to fill properly. After setting one half hour the excess clay on top was struck off and the bar allowed to dry another half hour. At the end of this time, the bars were removed from the molds, trimmed, weighed, labeled, and marked for shrinkage.

Ten test bars were used to determine the properties of each triaxial member. Burning of the test pieces was accomplished in saggers placed in a direct oil-fired kiln. The burning temperature was 1206°C inside the saggers.

In securing the information contained in the tables of this report only standard methods were used.

TABLE I

Data

No.	H_2O of Plast.	Drying Shrink.	Firing Shrink.	Total Shrink.	Fired M. R.	Absorp. Fir. Bars
1	35.90	7.29	7.73	15.02	3,345	7.55
2	35.10	7.30	8.13	15.43	3,130	8.90
3	37.50	8.23	7.36	15.59	2,840	8.15
4	31.50	5.04	7.55	12.59	2,910	9.70
5	33.61	5.97	8.94	14.91	3,308	3.56
6	35.30	6.38	7.66	14.04	3,291	8.72
7	34.00	5.50	8.02	13.52	3,438	6.24
8	32.32	5.89	8.90	14.79	3,141	4.16
9	33.84	6.47	9.35	15.82	3,340	3.68
10	38.90	7.76	7.34	15.10	2,267	8.27
11	33.70	6.36	6.38	12.74	2,450	11.95
12	32.81	6.40	7.65	14.05	3,519	7.61
13	32.62	5.95	8.89	14.84	2,300	6.30
14	33.83	6.21	8.00	14.21	2,880	6.61
15	34.39	6.38	8.93	15.31	3,037	7.06
16	33.82	6.42	7.66	14.08	2,920	7.11
17	31.60	6.09	8.40	14.49	3,420	7.21
18	32.74	5.94	6.36	12.30	2,406	7.17
19	30.98	5.57	8.03	13.60	2,980	7.16
20	33.18	6.43	8.50	14.93	2,895	6.81
21	31.10	5.14	7.56	12.70	3,175	5.76
22	32.45	5.93	7.20	13.13	3,361	7.12
23	31.65	4.63	8.38	13.01	2,961	6.99
24	32.80	5.39	8.00	13.39	2,655	5.83
25	33.86	4.94	8.21	13.15	3,161	5.50
26	32,17	5.48	8.44	13.92	3,701	7.56
27	31.21	5.19	7.14	12.33	2,900	12.18
28	33.00	5.52	8.04	13.56	2,638	7.90
29	32.95	3.74	7.06	10.80	2,408	11.97
30	33.20	4.61	5.86	10.47	2,577	12.43
31	31.10	4.17	7.50	11.67	2,376	12.46
32	32.65	5.50	7.19	12.69	2,240	13.22
33	29.91	3.29	8.27	11.56	2,874	7.65
34	31.15	3.76	8.72	12.48	2,615	8.10
35	34.14	5.46	7.17	12.63	2,840	13.51
36	33.92	3.31	7.04	10.35	2,860	10.20

INTERPRETATION OF RESULTS

The three corner members of each corner were averaged with the following values:

High H_2O of plasticity	- Corner	1	Corner 1 -G-1 kaolin
Low " " "	- "	29	Corner 29-Ga. kaolin
High Drying Shrinkage	- "	1	Corner 36-Fla. kaolin
Low " "	- "	29	
High Firing Shrinkage	- "	1	
Low " "	- "	29	
High Total Shrinkage	- "	1	
Low " "	- "	29	
High M. R. Shrinkage	- "	1	
Low " " "	- "	36	
High Absorption	- "	36	
Low "	- "	1	

The G-1 kaolin body required more water to bring it to a plastic state indicating slaking down into finer particles which furnished more surface area to be wetted. The Georgia kaolin body required the least water. It is a plastic kaolin with an absence of non-plastic material which would give it shortness. The Florida kaolin was intermediate as regards plasticity.

As would be expected from the water of plasticity results, the G-1 kaolin had the greatest drying shrinkage. The removal of this water left a great number of voids to be closed on firing. Georgia kaolin required the least water and consequently had the least water to remove and, thus, the least drying shrinkage. This left a minimum amount of pores to be closed in firing. Florida kaolin was again intermediate.

G-1 kaolin had good vitrifying qualities, and the numberous voids were closed in the firing process. This, of course, gave it the high firing shrinkage. The Georgia kaolin had the least voids to close and so had least firing shrinkage. Florida kaolin was again intermediate.

Total shrinkage being an addition of the drying and firing shrinkage agrees with the above results; G-1 kaolin had the greater and Georgia kaholin had the least total shrinkage.

The Florida kaolin body became the least vitrified at the temperature of firing. This was indicated by its having the maximum absorption and so more port space which was not closed due to a lack of vitrifying characteristics of the kaolin.. G-1 kaolin has very good vitrifying qualities, for, even with the most voids to be closed it developed the least absorption. The Georgia kaolin was intermediate.

The G-1 kaolin body, being the most vitrified, had the maximum strength. This was due to the melting of the smaller grains thereby filling the pores and developing a good bond between the larger grains. The Florida kaolin body lacked this and was porous giving a low strength. The Georgia kaolin body was intermediate in strength.

All colors were uniform light cream.

All absorptions ran much too high for this type body; a 2% absorption is allowable.

All fired M. R.'s are too low, being generally, about 3500 pounds per square inch, up.

These defects, no doubt, could be corrected materially if the study were fired to a higher cone. A state of under firing was evident on all trials.

CONCLUSIONS

The results indicated clearly that the body with the G-1 kaolin incorporated had the best vitrifying qualities and gives a maximum strength. It is, however, a disadvantage to have to add so much water for plasticity. This caused a maximum drying shrinkage but the water left the body readily without warping or cracking it. The firing shrinkage took place without warping and cracking even though it was the maximum of the three bodies.

If a strong body with low absorption were needed and an excessive shrinkage were allowable, the G-1 kaolin body would be the best.

If the shrinkage were objectionable, the Georgia kaolin body would be the best.

In all cases the Florida kaolin body did not come up to the standards of the other two bodies.

The claims of the Savannah Kaolin Company for their G-1 kaolin were substantiated.

RECOMMENDATIONS

As further work on this subject, a study of the proper proportions of electrolyte necessary for controlling the segregation of the materials in the body could be made. Many organic materials are plentiful and cheap and this would be a very fertile field for the development of a suitable electrolyte for casting use.

The determination of a suitable sanitary ware glaze for this type of body offers another interesting line of investigation.

APPLICATION TO THE INDUSTRY

Either the G-1 or the Georgia kaolin bodies would be suited for actual industrial use, depending on the shrinkage allowable. Their workability is good in that they would be easily prepared by blunging, screening, and filter-pressing and in that they would cast readily. Drying and firing would not be a difficult problem. The strengths obtained would be suitable.

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3 - R. T. Stull, Distribution of Kaolin & Bauxite of the Coastal Plain of Georgia, Jour. Amer. Cer. Soc, VII, P 513, (1924)

4 - W. Shearer, Control of Plasticities of Ceramic Slips, Jour. Amer. Cer. Soc., XV, P 622, (1932)

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ABSTRACTS

Notes on Casting Slip in Production. G. A. Wills, Jour. Amer. Cer. Soc.,XV, P 130, (1932).

Conclusions regarding eleven properties of a casting slip as to their influence on the loss record of shop and kiln are given.

Casting of Clay Ware. E. P. Hall, Jour. Amer. Cer. Soc.,XIII, P 751, (1930).

Survey of the literature is made, especially, that dealing with colloidal phenomena of clay suspension, which might be of assistance in solving some of the problems encountered in the use of the casting process.

Old and new methods of slip control are discussed.

Casting Control. A. C. Gerber, Jour. Amer. Cer. Soc., VIII, P 19, (1925).

Casting bodies can be toned to a point of success by a proper manipulation of carefully chosen clays. Qualifications of a good casting body are a balanced clay content and a correct ratio of clay content to non-plastic.

Vitreous Sanitary Ware. W. A. Darrah, Amer. Cer. Soc. Abst., IV, (1925)

A survey of the industry is given including manufacturing process, organization chart, detailed manufacturing costs, investment required, and a list of requirements.

The Effect of the Method of Preparation on the Viscosity of a Casting Slip. V. S. Schory, Jour. Amer. Cer. Soc., IV, (1921) In general, firmness of cast is a very desirable property in the casting process and this fact recommends certain methods of preparation above others. Discussion.

Distribution of Kaolin and Bauxite of the Coastal Plain of Georgia. R. T. Stull, Jour. Amer. Cer. Soc., VII, P 513, (1924).

Commercial deposits of sedimentary kaolin and bauxite occur in the lower Cretaceous of the Coastal Plain. Kaolins vary from "hard clay" to "flint clay on one hand to "soft clay" on the other. The hardness of the clays apparently depends on the free silicic acid content.