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NEPHELINE SYENITE. A holocrystalline, granular, igneous rock made up of nepheline (K_2O-$3Na_2O$-$4Al_2O_3$-$9SiO_2$), potash feldspar (microcline), soda feldspar (albite) and such minor accessory minerals as mica, hornblende and magnetite. It is found in Canada, India, Norway and the former USSR. It resembles granite in texture but contains no free quartz.

An analysis (in %) of commercial ceramic nepheline syenite from Blue Mountain, Ontario, is: 60.2 SiO_2, 23.6 Al_2O_3, 0.08 Fe_2O_3, 0.35 CaO, 0.02 MgO, 10.5 Na_2O, 4.8 K_2O, 0.42 LOI. Iron—~2% in the original rock—has been removed from this material.

For this composition, nepheline syenite has a mol. wt. of 447; sp. gr. of 2.61 in the crystalline form and 2.28 in the glassy state; and Mohs' hardness of ~6. It starts to sinter at cone 08 and has a PCE of about cone 7. There is a eutectic between soda feldspar and nepheline which is a factor in the wide sintering range of nepheline syenite.

In **sanitaryware** bodies, the substitution of nepheline syenite for potash feldspar makes possible a much lower firing temperature. A longer firing range with decreased warpage is noted when firing the ware in commercial tunnel kilns. Research in the development of low fired vitreous ware has demonstrated the fact that a cone 4 sanitaryware body can be made which will provide a very large reduction in the cost of fuel and refractories, plus the added advantage of a fast firing cycle.

In **floor and wall tile** bodies, the lower fusibility and increased fluxing action of nepheline syenite permit the formulation of bodies maturing at lower temperatures. Direct substitution of nepheline syenite for potash feldspar in wall tile bodies lowers the absorption and moisture expansion and increases the shrinkage and mechanical strength. Floor tile bodies show less variation in thermal expansion with differences in thermal treatment than the corresponding feldspar bodies. Thermal expansion of talc wall tile bodies is lowered by the direct substitution of nepheline syenite for feldspar, although bodies fluxed with nepheline syenite alone have a higher thermal expansion than those fluxed with potash feldspar only.

In **electrical porcelain,** the same general results as noted earlier may be expected: substitution of nepheline syenite for potash feldspar increases the firing range, increases strength, decreases absorption and increases shrinkage at the lower firing temperature.

In **semivitreous** bodies, nepheline syenite produces increased vitrification. There is a wide range which results in less warpage. In bodies fluxed with nepheline syenite, the thermal expansion is greater than in corresponding feldspar bodies. This tends to promote a state of compression in the glaze and reduce crazing tendencies.

Low-temperature **vitreous** bodies maturing at cone 3-5 can be formulated from clays and nepheline syenite without recourse to an auxiliary flux. Such bodies have a wide firing range and good strength. These bodies are highly translucent when prepared by wet milling, and by combining low temperature with a fast firing cycle a large savings is made in fuel, refractories and ware lost from warpage; furthermore, a wider color range in both body and glaze is made possible.

The higher the nepheline syenite content of the bodies, the higher the thermal expansion and the smaller the variation in expansion with differences in thermal history. The addition of 5-10% flint raises the thermal expansion of the bodies so that typical semivitreous dinnerware glazes are placed under adequate compression and can be used for one-fire ware. Also, special high compression glazes have been developed for this use. For two-fire ware, excellent glazes are available which have good service characteristics and which mature at cone 01.

A typical low temperature body formula (in %) is: 54 nepheline syenite; 6 flint; 24 kaolin; 16 ball clay.

Due to its high alumina content, nepheline syenite is a good material for introducing alumina into a **glass** batch. It contains considerable alkali, a desirable constituent of the batch, and melts at a relatively low temperature. These advantages, together with the fact that it is taken into the melt very readily, make it a desirable addition to tank glasses. Substitution of nepheline syenite for potash feldspar on a chemical analysis basis in a typical opal glass batch is said to permit melting at a lower temperature, thereby affording the possibility of fuel economy and longer life of refractories. The resultant glass will have the same thermal expansion as the comparable feldspar glass, but softens at about 50°C lower temperature. The iron-alumina ratio of this material makes it particularly useful in glasses where low iron oxide content is of primary importance.

Proposed Batch, lb[1]

Sand 1000
Nepheline syenite 153
Burned dolomite lime 169
Barium sulfate 12
Fused borax (pyrobor)[2] 27
Soda ash 339
Arsenic .... 2 lb
Decolorizer sufficient quantity
Cullet 35% of batch weight

[1]Not considering weight of cullet, the foregoing batch will produce ~1548 lb of glass.
[2]Fused borax or pyrobor preferred, but if ordinary borax, which contains waters of crystallization, is used, it will be necessary to use 54 lb instead of 27 lb.

(This is a typical container batch which is rather high in aluminum oxide and lime, but it has been found that this glass has great durability and strength, and the rate of production is increased due to the higher aluminum oxide content.)

Calculated to Glass, %

Silica	70.30
Iron and alumina	2.36
Calcium oxide	6.32
Magnesium oxide	4.54
Barium oxide	0.50
Sodium oxide	14.26
Potassium oxide	0.48
Boric oxide	1.20
Total	99.96

Glass-grade nepheline syenite is now refined by means of magnetic separation, making possible a granular concentrate with a constant low iron oxide content.

In **porcelain enamels,** the obvious advantage again is the decreased fusion temperature possible. However, when substituting directly for feldspar, increased viscosity due to increased alumina makes it necessary to fire at nearly normal temperature to get proper maturity. It also is possible, through the use of nepheline syenite, to incorporate considerably more alumina in an enamel without increasing the hardness of the enamel. This is desirable because increasing alumina generally reduces the solubility of the enamel.

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