MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT IDENTIFICATION AND USE

PRODUCT IDENTIFIER: Dry Clay
PRODUCT USE: Glaze Ingredient

PRODUCT IDENTIFICATION NUMBER (PIN): Alberta Slip
Supplier's Name: Archie Bray Foundation
Address: 2915 Country Club Avenue
City: Helena
Province: Montana, U.S.A.
Postal Code: 59601
Phone: (406) 442-2521

SECTION 2 - HAZARDOUS INGREDIENTS

<table>
<thead>
<tr>
<th>HAZARDOUS INGREDIENTS</th>
<th>%</th>
<th>CAS NUMBER</th>
<th>LD₅₀ OF INGREDIENT</th>
<th>LC₅₀ OF INGREDIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>*FREE SILICA (QUARTZ) (Respirable)</td>
<td>15-20</td>
<td>14808-60-7</td>
<td>NOT AVAILABLE</td>
<td>NOT AVAILABLE</td>
</tr>
</tbody>
</table>

SEE ATTACHED: None.

NOTES:

* FREE SILICA IS NOT HAZARD IN MOIST FORM, ONLY A HAZARD IF CLAY IS DRY AND DUST IS GENERATED.

SECTION 3 - PHYSICAL DATA

PHYSICAL STATE: SOLID
ODOUR AND APPEARANCE: Dark Grey Powder.

PHYSICAL PROPERTIES NOT APPLICABLE:
- Odour Threshold
- Vapour Pressure & Density
- Evaporation Rate
- Boiling Point
- Freezing Point
- pK
- Specific Gravity
- Coeff. Water/Oil Dist.

SECTION 4 - FIRE AND EXPLOSION DATA

FLAMMABILITY:
- NO
- CONSIDER DUST AS NON-FLAMMABLE AND NON-EXPLOSIVE

NON-APPLICABLE DATA:
- Means of Extinction
- Flashpoint and Method
- Autoignition Temperature
- Upper Flammable Limit
- Lower Flammable Limit
- Hazardous Combustion Products
- Sensitivity to Impact
- Sensitivity to Static Discharge

PRODUCTS OF DECOMPOSITION DURING KILN BURNING:
- Carbon Monoxide
- Carbon Dioxide
- Possible traces of sulfur dioxide
- Vent kiln during burning.

SECTION 5 - REACTIVITY DATA

CHEMICAL STABILITY:
- NO

CONDITIONS OF INSTABILITY:
- None.

INCOMPATIBILITY WITH OTHER SUBSTANCES:
- NO

INCOMPATIBLE SUBSTANCES:
- None.

REACTIVITY, AND UNDER WHAT CONDITIONS:
- Inert and Non-Reactive.

HAZARDOUS DECOMPOSITION PRODUCTS:
- WILL NOT OCCUR
SECTION 6 - TOXICOLOGICAL PROPERTIES

ROUTE OF ENTRY
- SKIN CONTACT
- SKIN ABSORPTION
- EYE CONTACT
- INHALATION
- INGESTION

EFFECTS OF ACUTE EXPOSURE TO PRODUCT
A NUISANCE DUST. SEE CHRONIC EFFECTS

EFFECTS OF CHRONIC EXPOSURE TO PRODUCT
LONG TERM EXPOSURE TO RESPIRABLE FREE SILICA IN CONCENTRATIONS HIGHER THAN RECOMMENDED TLV MAY CAUSE LUNG INJURY.

EXPOSURE LIMITS
TLV = 0.1 mg/m³ RESPIRABLE DUST

IRRITANT OF PRODUCT
MECHANICAL IRRITANT ONLY

SYNERGISTIC PRODUCTS
TOBACCO SMOKE MAY INCREASE LUNG DAMAGE

NON APPLICABLE PROPERTIES:
- Sensitization
- Carcinogenicity
- Teratogenicity
- Reproductive Toxicity
- Mutagenicity

SECTION 7 - PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT

GLOVES (Specify)
NOT REQ'D

FOOTWEAR (Specify)
NOT REQ'D

ENGINEERING CONTROLS (Specify)
LOCAL EXHAUST OR OTHER VENTILATION THAT WILL REDUCE DUST CONCENTRATION TO LESS THAN PERMISSABLE EXPOSURE LIMITS IS RECOMMENDED

LEAK AND SPILL PROCEDURE
IF CLAY IS MOIST, NO SPECIAL PRECAUTIONS REQUIRED. IF DRY, CLEAN UP AND COLLECT, MINIMIZING EXCESSIVE DUST GENERATION

WASTE DISPOSAL
BY APPROVED METHOD

HANDLING PROCEDURES AND EQUIPMENT
IF CLAY IS DRY, CONTROLS SHOULD BE USED TO MAINTAIN "FREE" SILICA DUST EXPOSURE LEVELS BELOW TLV.

STORAGE REQUIREMENTS
NO SPECIAL REQUIREMENTS

SPECIAL SHIPPING INFORMATION
NOT REQUIRED

SECTION 8 - FIRST AID MEASURES

SPECIFIC MEASURES
SKIN - WASH WITH WATER
EYES - FLUSH WITH RUNNING WATER UNTIL MATERIAL IS REMOVED

SECTION 9 - PREPARATION DATA OF MSDS

PREPARED BY: Plainsman Clays Limited
PHONE NUMBER: (403) 527-8535
DATE: May 1, 1989

FURTHER PHYSICAL PROPERTIES AND DESCRIPTIVE LITERATURE AVAILABLE ON REQUEST.
Alberta Slip is one of the few materials that has the potential to be the only ingredient in a glaze. Used all by itself, with only iron added, it gives you a perfectly functional glossy dark brown glaze in both reduction and oxidation. It reaches natural maturity in the cone 8–10 range, however is still quite fused at cone 6. With an addition of 10% Ferro Frit 3134 or 3195, you can move its maturity range down by 4 cones or more.

Alberta Slip is almost guaranteed not to craze. This is because it has a very low natural thermal expansion. Crazing is normally caused by a glaze layer which contracts more than the clay on cooling, creating a "size 5 glaze on a size 6 pot situation"! If it contracts more on cooling, then it also expands more on heating. This is why a glaze of a lower expansion crazes less. Everyone knows how hard it is to fit glaze on porcelain bodies that have low expansion, and this is where Alberta Slip will really be appreciated for dark coloured glazes. Alberta Slip's expansion is low enough, however, that some clays might cause it to shiver. This is the opposite of crazing, and it is very easy to change a glaze formula to stop this problem. Please contact us for information about what to do in such situations.

We have used Alberta Slip on many types of ware, including medium temperature light and dark stoneware, porcelains and even china type translucent casting bodies. An interesting thing has happened in our studio also. Sceptical buyers of pottery, worried about lead, have been impressed by the fact that not only can a mug be made from natural native clays such as those available from Plainsman, but can be glazed with those same natural materials.

If you have any new ideas about how to use this material, or any questions, please contact us.

Alberta Slip is one of the few materials that works well when applied to both bisque ware or one-fire greenware! As a greenware glaze, you will find it also works well if applied at the leather hard state. This makes available a new range of decorating techniques, such as carving through the glaze to reveal the body under neath, or covering with another glaze after bisque to produce variegated effects.

The unique properties of Alberta Slip

- Alberta Slip has an extremely low thermal expansion

This means that it will not craze on just about anything, not even porcelain or casting china ware, not even if it is used at 100%!

- Alberta Slip is fusible

You can apply it 100%, (just add water) to any cone 10 (reduction or oxidation) piece made from any clay and it fires out to a beautiful satin gloss glaze ranging from a beadpot brown to a tenmoku, depending on the atmosphere and underlying clay. Albany slip performed in a similar manner. You can add 10% Frit 3134 and it behaves the same way at cone 6.

- Alberta Slip is plastic

Although you could pug and throw Alberta Slip nicely, it works best as a slip glaze. This means no bisque firing. As a clay, it glides onto the surface of a dried piece and leaves a very even layer, bonding with the underlying clay. Alberta Slip suspends very well, so you can make a very thin slurry of glaze, and it will not settle.

- Alberta Slip is flexible

Although it is plastic and works well as a slip glaze, you can still use the material on bisque ware even at 100% of the glaze recipe.

- Alberta Slip is fine

Most of the material will pass a 325 mesh screen, so it glides on evenly. It goes through a glaze sprayer with no problems. It paints on easily.

- Alberta Slip works with stains

To get a coal black porcelain glaze at cone 10R, just add 3–5% Mason 6600 black. For a stunning satin matte crystalline black at cone 6–7, use the same amount of stain and add 10% Frit 3134.

Alberta Slip is a highly fluxed, low temperature, dark firing clay material for use in earth tone and low expansion, craze resistant glazes for cone 2 to 10. Alberta slip can be used full strength on bisque, dry or leather hard pieces. At cone 6–10 in oxidation it yields a classic, beautiful glossy tenmoku glaze. At cone 8–10 reduction, it produces a glossy, saturated iron tenmoku glaze. It can also be mixed with fluxes like Gerstley Borate, Lithium, Dolomite, Frits etc. to give cone 4–6 glazes. The material has a very low expansion, and therefore will almost never craze, even on porcelain. Add 2–4% tin oxide and/or 2–5% rutile to varigate the color. This material is a close substitute (both chemically and physically) for the popular Albany Slip clay which has been used for many years by potters. It can be substituted on a one-to-one basis for standard Albany Slip clay.

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Usage Tips For Glazes With a High Alta Slip Content

- Leather ware glazes will work best if they are a little more viscous. This is because they must stay in place while wet.
- Bisque ware or dry ware glazes should be kept quite runny, so that the layer left on the ware is not too thick and crack prone.
- Cracking can occur as the slip layer dries and shrinks, especially with thick glaze layers or double thickness applications. If problems are encountered, calcine some of the Alberta Slip powder to cut shrinkage, or use a binder like CMC Gum. Cracking causes crawling.
- You can do wax resist decoration on dryware, and Alberta Slip will resist from it and go where you want, provided it is not too viscous.
- Alta Slip can be sprayed on to any thickness desired without cracking on dry or bisque ware.
Albany Slip has long been a "Standard" within the North American pottery community. It is extremely fine and fusible, and has proven invaluable in slips and for the production of non-crazing, earth tone glazes. Many potteries use it straight, or as an ingredient in many of their glaze formulas. Recently, the Hamill and Gillespie company have served notice that it has run out.

As luck would have it, we have a similar quarry blend called "Redearth", on which a compatible material could be based. We approached the formulation task by first calculating what materials could be added to Redearth in order to duplicate Albany Slip chemically. Realistically, of course, you can't just "calculate" a substitute, because clay materials exhibit behavior which is a product of the mineralogy and particle size as well as the chemical makeup. However, we felt that the best starting point would be a formula duplicate, and then further trials could be made to fine tune the physical properties, (like plasticity, smoothness, dry strength, shrinkage, fired shrinkage, absorption, strength, fusibility, suspension behavior, glaze application characteristics etc.) still but stay as close as possible to the Albany formula. We used INSIGHT*, a computer program, for all calculations.

A reliable, representative analysis of the Redearth was calculated from analysis records of each of its ingredients. The formula was then added to an INSIGHT Materials Definition Table, so it could be referenced by recipes entered into the system. Figure A shows a printout generated by the program where Redearth is being calculated alone. Unity is set with the fluxes, since the material will be used in glazes, and will be compared to Albany, which is a flux-dominated material. The LOI figure was derived by weighing a bone dry sample, firing to cone 02, and weighing again.

Since Albany Slip has a reputation for varying somewhat in physical properties and chemical analysis, getting a representative analysis of it proved elusive. We finally decided on an arbitrary textbook analysis. This source did not include a Loss on Ignition, so it was necessary to fire a sample in the kiln to get it. (It turned out to be 8.4%) The Albany formula, with Unity set to the fluxes, was then added to the Materials Definition Table in INSIGHT and a Standard Formula printout is shown in Figure B. Although this formula does not appear very similar to Redearth, it may be surprising to find out how little material had to be added to make Redearth a duplicate of Albany (from a calculation point of view only, of course). It is important to note that we did not know whether the sample of Albany Slip clay we had matched this formula, nor did we know whether this formula could be considered "representative" of "normal" Albany clay.

Figure C shows the first calculated mix for Albany Slip in Detailed Formula format, showing how the calculation was done. Notice from the "UNITY FORMULA" totals line that we have duplicated the formula of Albany almost exactly.

Next, we mixed up a batch of this (and straight Albany), and fired them as a glaze on some test tiles at a variety of thicknesses and temperatures. The substitute had a rougher surface than the smooth and silky Albany.

It became evident that achieving a sufficiently fine particle size was going to be a key to properly duplicating the material, so the mix was ball milled for 2 hours in the lab and test tiles were redone. The substitute fired incredibly close to Albany slip in character, but about 1-2 cones less mature and it was a little lighter in fired colour.

The next step was to change the recipe of the substitute in such a way that we did not diverge much from the Albany formula, and still get closer to the physical firing characteristics of Albany. We decided to drop dolomite from the recipes and source magnesia from talc instead. This would allow the use of more magnesia, both to get better fluxing and retain Albany's low expansion. Had we continued to use dolomite as the source for magnesia, increasing it would have resulted in more calcium as well. We also decided to drop the alumina slightly to improve maturity and increase the iron oxide to give slightly more grey colour to the material.

The results of the above, when calculated, produced the printout shown in Figure D. It diverges slightly from the Albany formula we used as a pattern, however it is fired out, in most cases, identical to Albany slip. We did some simple fusibility tests by breaking off a chunk of dry pressed bar and firing it on a tile. At cone 9, the two are identical, but at cone 7, the Albany was very slightly more fused, probably because of a finer particle size. It appeared that we had met with success on this. The final test of compatibility was to put the two materials into a glaze and compare. A recipe with a high percentage of Albany was chosen, namely Albany 85, Lithium Carbonate 11 and Tin Oxide 4.

In general, True Albany seems to fuse a little better at lower temperatures than the current version of Albany Slip, so its glazes are flowing a little more at cone 5. We attribute this to the fact that we did not have a representative chemical analysis of Albany, or, that Albany is finer. At cone 9 the Albany Slip glaze is actually more fluid, and at cone 7 the difference is small. Certainly, it is possible to flux Albany Slip to a material of lower temperature. The True Alien Slip glaze has a tendency to de-vitrify more than the Albany Slip material. One real advantage of Albany Slip is that Redearth deposits of raw clay are consistent... And best of all, from a purely "visual appeal" point of view, Albany Slip makes a more vibrant and appealing glaze in our tests.

We failed to appreciate the versatility of Albany Slip until it was gone. But, now that's no problem. Now Micro Pulverized Albany Slip is available in any quantity you want. Like Albany, it can be applied full strength to greenware, or (even leatherware) to give a glossy basalt brown in cone 6-10 oxidizing and a crystal temmoku at cone 7-10R, all with crazing, even on porcelain!

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* Information is available from IMC, 134 Upland Drive, MEDICINE HAT, Alberta T1A 3N7 Canada.