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MINING AND PROCESSING BY-PRODUCT RESOURCES IN VIRGINIA

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INTRODUCTION

By-products from mining and processing plants, and coal-fired power plants are being utilized more as valuable resources in Virginia. Mining-related by-products are divided into two categories: those generated from mineral extraction and beneficiation and those generated from mineral processing or from industrial plants. Materials from both categories are produced in Virginia, where by-products have been exploited for various uses in the past and/or present. These materials include coal combustion products (fly ash and bottom ash), lime kiln dust, flue gas desulfurization residue, rock fines, magnetite, kaolin, lead-zinc mine tailings, soapstone rock, and calcium carbonate paste. Some of these by-products have never been utilized, although several ideas have been investigated over the years.

Determining factors in utilization of by-products include the location of the material with respect to potential markets, chemical suitability of prospective material, and consistent quality and quantity. Additional considerations include: production rates, processing and handling costs, availability of competing materials, seasonal adjustments, and the experience of design engineers, purchasing agents, contractors, legislatures, regulators, and other professionals. Following are some of the major mine, processing, and industrial plant by-products, listed, alphabetically in Virginia; their location, present use, and some potential uses are discussed (Figure 1).

AUSTINVILLE TAILINGS

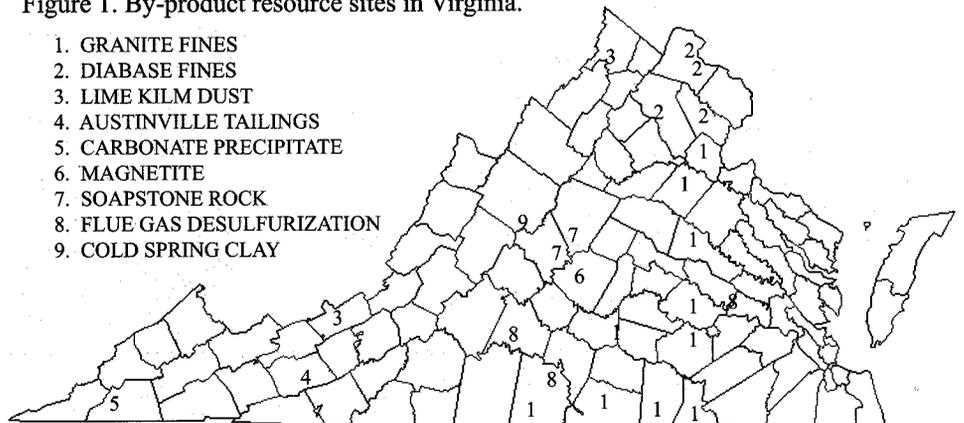
A tailings pile of approximately 6 million tons of carbonate material covering about 52-acres remained on the site of the former New Jersey Zinc Company property at Austinville in Wythe

County, when the company ceased operations at the end of 1981 (Figure 2). These tailings were the result of New Jersey Zinc Company processing lead and zinc ore for about 250 years at this site. Independent chemical analyses for borings in the tailings pile in the early 1980s indicated 27 percent CaO, 20 percent MgO, less than 4 percent Fe₂O₃, and just over 1 percent SiO₂.

In October, 1982, Austinville Limestone Co., Inc., a subsidiary of James River Limestone Co., began marketing the tailings

Figure 1. By-product resource sites in Virginia.

1. GRANITE FINES
2. DIABASE FINES
3. LIME KILN DUST
4. AUSTINVILLE TAILINGS
5. CARBONATE PRECIPITATE
6. MAGNETITE
7. SOAPSTONE ROCK
8. FLUE GAS DESULFURIZATION
9. COLD SPRING CLAY



for use as agricultural lime. The company has been marketing the tailings since late 1982 and by 1997, they had sold about 1.5 million tons; they expect at least another 30 years of reserves remain on site. Austinville Limestone also opened a quarry just north of the tailings pile in 1984, to produce aggregate.

CALCIUM CARBONATE PRECIPITATE PASTE

Until August, 1996, Cyprus Foote Mineral obtained lithium carbonate from brines in Nevada and also imported some lithium carbonate from Chile into the port of Charleston, South Carolina from where it was trucked in bulk bags to the plant at Sunbright,



Figure 2. Tailings at former New Jersey Zinc Company site, Austinville, Wythe County (circa 1992).

Scott County. Calcium hydroxide, obtained from an in-State producer, was mixed with the lithium carbonate to produce lithium hydroxide powder, used in many multipurpose grease applications. A by-product was calcium carbonate precipitate paste (half silt-size and half clay-size) which contains 43 to 50 percent CaCO_3 , 3 to 6 percent Ca(OH)_2 , 40 to 48 percent H_2O and some lithium. This material was disposed of in an on-site inactive, slope-entry, underground limestone mine at the rate of 225 tons per week (Figure 3). Because of its lithium content, the material may not have a use as a fertilizer; however, there may be some potential to utilize it to neutralize and stabilize coal refuse in the Southwest Virginia coalfields. Although production at the plant has ceased and a new plant is now operational in Silver Peak, Nevada, the calcium carbonate paste by-product remains on the site.

COLD SPRING CLAY DEPOSIT

The Cold Spring clay deposit, located near Big Levels in Augusta County, was last operated in 1951 (Upchurch, 1998). White kaolinitic clay was first mined at this site in 1912 for use as a paper filler. By the late 1940s, the better quality clay had been mined, and production was only for oil paints and for camouflage paint for wartime use. Over the years, as much as 175,000 tons of material may have been produced. An old chemical analyses of the material indicates 39+ percent Al_2O_3 . A sample collected in 1988 was analyzed by X-ray fluorescence (XRF), at the Division of Mineral Resources laboratory, and indicated 28.9 percent Al_2O_3 (Sweet and Giannini, 1990).

Today the site contains large spoil piles of kaolinitic material mixed with occasional bits of bauxite (Figure 4). The spoil piles can be seen from Interstate 81, four miles away. In the early to mid-1980s, a company utilized some of this by-product material as a component in a filler-extender use in a rug-backing product and also for use in the manufacture of white cement (Sweet, 1994).

FLUE GAS DESULFURIZATION (FGD)

Flue gas desulfurization (FGD) is a scrubber system, where finely ground limestone, wet or dry, is injected above the combustion zone and captures the sulfur from the burning coal. With the removal of sulfur, a FGD product is produced and collected at the base of the boiler. EPA has concluded that a flue gas desulfurization residue in the form of "synthetic gypsum" does not exhibit hazardous characteristics. There are about 12.3 million tons of FGD material produced each year in the United States, according to the American

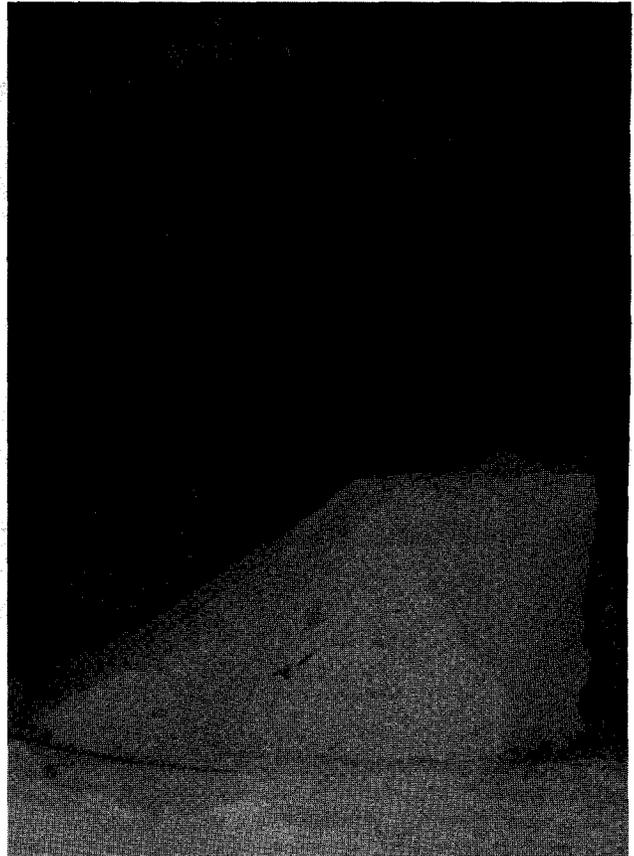


Figure 3. Calcium carbonate precipitate paste, inactive underground limestone mine, Cyprus Foote Mineral, Sunbright, Scott County.

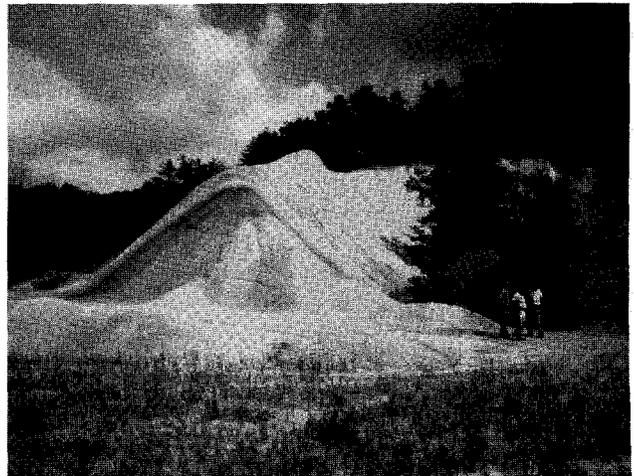


Figure 4. Large spoil piles of kaolinitic material, Cold Spring clay deposit, Augusta County.

Coal Ash Association (ACAA), which is a trade group made up of coal-burning electric utilities, coal-ash marketers, coal companies and suppliers of ash-related equipment (ACAA, 1997).

Presently the major use (815,000 short tons) of FGD is in wallboard. An important consideration with the use of gypsum in wallboard is the percentage of chloride present as it may cause deterioration of nails and screws that secure the wallboard. Other uses, in descending tonnage, are in agriculture as "land plaster" to improve soil conditions for the peanut industry; rolled in balls for

use as a crushed stone substitute for roadbase and subbase material; for water stabilization; and as a retarder in cement.

ReUse Technology, Inc., R. T. Soil Sciences Division, at their location in Rocky Mount, North Carolina, has patented BUCKSHOT, which is a pelletized FGD residue that makes a spreadable calcium and sulfur-rich soil amendment (GYP SYN) or "land plaster" that enhances the production of peanuts, sweet potatoes, Christmas trees, ornamental shrubs, and grasses. The company began investigating the use of FGD residue for production of "land plaster" after discovering that over 200,000 acres of Virginia Style Peanuts were harvested annually in North Carolina and southern Virginia. The FGD residue, that the company obtains from the local Cogentrix Energy, Inc. power plant (Battleboro), and from LG Electric power plant in Altavista, Virginia, is a fine powder consisting of calcium sulfite, calcium hydroxide, calcium sulfate, and fly ash. The FGD residue is transported to the Rocky Mount plant in bulk tankers, and along with wetting ingredients is fed in precise amounts into a pin mixer for agglomeration; the BB-size granules are dried to a moisture content below 20 percent, screened, and stockpiled. Product is shipped in bags, mainly to retail outlets, also in one-ton bulk bags and also in bulk, by truck to market. The use of the high intensity, pin type mixers allows for agglomeration with the least amount of wetting, other types of agglomeration devices on this material were proven uneconomical. The major calcium and sulfur supplement product (GYP SYN), supplies the essential nutrients of calcium (20%) and sulfur (8%) to the peanut plants without changing the pH of surrounding soils. Successful field testing has given ReUse product acceptance into the marketplace and BUCKSHOT is currently registered in North Carolina as a by-product "land plaster" and as a registered fertilizer in Virginia. The company is currently investigating FGD residue from power plants in the Richmond, Virginia area for suitable material to make BUCKSHOT.

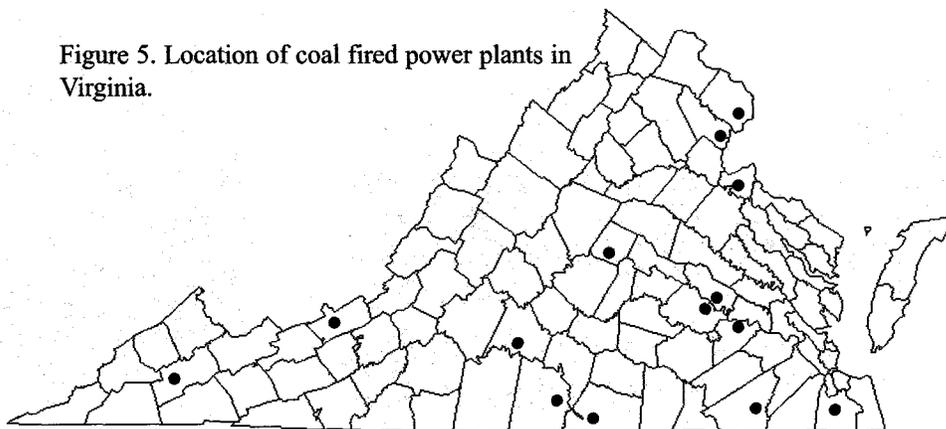
ReUse Technology, Inc. utilizes a large amount of FGD residue to produce their product; the patented process generates a pelletized product that has excellent spreading and distribution characteristics and turns a potential disposal cost into revenue producing product. The cost for power plants to place FGD in landfills is \$6 to \$10 per ton and estimates for the cost of disposing of this material in the future could range from \$20 to \$25 per ton (Sweet, 1994).

FLY ASH

Fly ash is a finely divided residue resulting from the combustion of pulverized coal that is blown into a burning chamber. Heavier ash particles (slag or bottom ash) fall to the bottom of the boiler while the lighter fly ash remains suspended in the exhaust gases; fly ash particles are removed by a filtration, electrostatic precipitator, or other method.

The American Coal Ash Association promotes the use of coal combustion by-products in applications that are commercially effective, technically proven, and environmentally sound (Industry Newswatch, 1994). ACAA notes the total production of all coal combustion products in 1996, in the United States, as 101,838,447 short tons (ACAA, 1997). This figure includes fly ash, bottom

Figure 5. Location of coal fired power plants in Virginia.



ash, boiler slag and FGD material. The total of fly ash (dry and ponded) was 59.4 million tons; about 16.2 million tons were utilized primarily in flowable fill, structural fill, waste stabilization, and mining applications. Bottom ash is utilized in all these applications, as well as for snow and ice control, blasting grit, and roofing granules. Almost ninety-one percent of boiler slag is used for blasting grit and roofing granules and more than half of FGD by-product is utilized in wallboard (ACAA, 1997). All of these uses are described in detail in the publication by the Office of Technology Applications (1995).

Coal-fired power plants in Virginia produced about 2 million tons of coal combustion products (ash) in 1996 (Figure 5). ReUse Technology, Inc., R. T. Construction Sciences Division, located in Chester, Virginia has several products that they are marketing. Their "Xtra Fill" is a blend of fly ash, a cementitious binder (lime kiln dust) and water that is combined in a pug mill; the amount of water added is controlled depending on the application. Cogentrix Energy, Inc., which operates power plants in nearby Richmond and Hopewell, daily truck fly ash to ReUse's plant site. The lime kiln dust is obtained from Chemstone Corporation in Strasburg, Virginia. An example of the use of "Xtra Fill" is the construction site of the Target Department Store on Midlothian Turnpike and Branchway Road near Midlothian, Virginia. The 25-acre Target site was very wet and grade design required an average of six feet of fill in January, 1997. Local stone contained too much moisture. Xtra Fill (about 2-5 inches) was disc'd into a wet, silty clay subsoil; the excess moisture was absorbed by the product and then the site was stabilized with additional "Xtra Fill". A total of 250,000 cubic yards of the product was utilized. The material was so effective that only 20 work days were lost during 15 days of rainfall.

Another ReUse site is the structural fill for the Warwick Road site in Richmond where the Virginia Department of Transportation widened and regraded the road. The structural fill contains about 200,000 cubic yards of "Xtra Fill", up to 40 feet thick (Figure 6). A construction site on Midlothian Turnpike, Chesterfield Marketplace, was a large, low, wet area that required a structural fill, or a subbase material – a thin layer to the south and about four feet towards the north to level the area with a total of about 80,000 cubic yards of fly ash (Figure 7).

ReUse Technology, Inc. also obtains fly ash from the wet and dry ponds of the Chesterfield plant of Virginia Power. They operate a pug mill on site at the dry pond, which is part of what is called "Walden Pond" (Figure 8) to produce structural fill material (Xtra Fill) and truck fly ash to their Chester plant to produce "EZ Fill". "EZ Fill" is another product produced by mixing fly ash with cement and water; this flowable fill is delivered in a

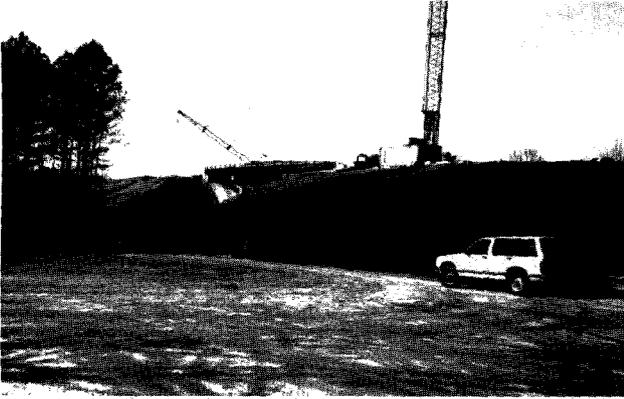


Figure 6. Grassed-over structural fill of "Xtra Fill" fly ash, Warwick Road, City of Richmond.



Figure 7. Four feet of fly ash, utilized as a structural fill for sub-base material, Chesterfield Marketplace, Chesterfield County.

cement truck. The product is a cost effective construction back fill which is delivered in a slurry state and hardens to provide superior load bearing characteristics. An example would be a private residence where the site soil is a plastic clay with shrink/swell potential. Ordinarily a contractor would undercut and back-fill with crushed stone or concrete. Accumulating water in voids between crushed stone particles and softening the underlying soil was a concern, as well as the additional weight using concrete. Sixty cubic yards of "EZ Fill" (flowable fill) were used instead and the foundation was ready for pouring concrete in three hours; cost was about half that of using concrete.

Agglite Corporation, on site at the Chesapeake plant of Virginia Power, mixes bottom ash with portland cement, surfactant foam, a dry catalyst and accelerators (Sweet, 1994). These ingre-

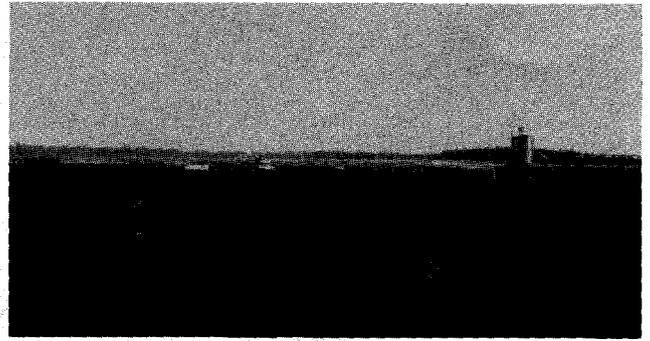


Figure 8. Dry pond of fly ash, with pug mill, Chesterfield Plant of Virginia Power, Chesterfield County.

dients are mixed with a screw auger, combined with water and the material is then pelletized. It is a cold-bonded process, with no external heat, as only the heat of hydration released by the combination of bottom ash and cement is utilized. The "manufactured aggregate" is spherical, is light (58 lbs./cubic foot), and has physical properties necessary to meet the three basic ASTM specifications for lightweight aggregate. The lightweight aggregate is stored in on-site silos. Markets for this product are for use in manufacturing concrete cinder block in Virginia and North Carolina. This company also has a small plant at the Chesterfield plant of Virginia Power where they process the bottom ash to produce a lightweight material that is also used in concrete cinder block. The material is marketed to Tarmac in the City of Richmond and to a block company in Charlottesville. Bottom ash from the Cogentrix Energy, Inc., in Richmond is marketed to the block plant of Betco in Manassas, Virginia.

Fly ash from the Chesapeake plant is also used by Agglite Corporation as a compacted sand substitute as well as a flowable fill. The flowable fill material is a combination of fly ash and cement, which are mixed with water in a concrete truck and applied on-site like concrete. A large quantity of flowable fill (approximately 9,000 cubic yards) was used as a base material under concrete slabs for vertical support beams at Harbor Park in Norfolk (Figure 9).

Presently, Virginia Power burns only coal at its Yorktown facility and in the early 1990s was storing both bottom ash and fly ash on a 45-acre site about two miles south of the power plant. The ash was transported by truck, compacted, and stored in 3-acre "cells" that are underlain by a 5-foot layer of bentonite clay (Figure 10). Each cell contains about 90,000 cubic yards of ash. After



Figure 9. View of Harbor Park, during construction, showing fly ash in a flowable fill, setting-up between vertical beams, City of Norfolk.



Figure 10. Fly ash "cell", with bottom 5-foot layer of bentonite clay, south of Yorktown Virginia Power plant, York County.

the ash is dumped and rolled, it sets up hard, and as the cell is filled, it is covered with a 2-foot layer of soil and is planted with grass. The final product is essentially a 20-foot high, long, flat plateau. Approximate cost of preparing a cell to store the ash was half a million dollars (L. Johnson, 1993, personal communication). By the end of 1997, four cells were complete and a fifth cell was being "mined" and utilized in the local area of York County. The fly ash is mainly used for structural fill, where the material (ash) is mixed, in a pug mill, with lime kiln dust; some is also mixed with cement and water in a concrete truck, to produce a flowable fill. ReUse Technology, Inc., Chester, Virginia is the main company that is presently using all the ash produced by the Yorktown plant (B. Easley, 1998, personal communication).

Other potential uses of fly ash include the filling of borrow pits and reclaiming surface coal mines. Borrow pits, in the Coastal Plain province of Virginia, can be lined with clay, filled with ash, covered with soil, seeded and brought back to their original contour level. Buchanan (1993) noted that consideration was being given to utilizing fly ash in reclaiming surface coal mines. The Virginia Department of Environmental Quality (Waste Management) began formulating regulations that would ban fly ash or only allow a percentage to be returned to the Southwest Virginia coalfields, according to the volume of coal mined in the county. In 1995, new State guidelines were passed by the Virginia General Assembly that allowed by-product fly ash to be only placed on permitted land sites and only to aid reclamation.

Another potential use of fly ash was initiated in the Chesapeake Bay area of eastern Virginia, in late 1994. This study involved the combining of fly ash, bottom ash, and portland cement into pellets (pin pong ball to grapefruit size) and their subsequent use as an environmentally acceptable substitute for natural shell in oyster-reef restoration (Industry Insight, 1994). The results of the study, in the laboratory, indicated that the pellets made from a mixture of about 88 percent fly and bottom ash and 12 percent Type II Portland Cement are environmentally safe and facilitate the settlement, attachment and growth of oysters (Andrews and others, 1997). When a large volume of pellets (barge full) were produced, quality control of the pellet size became a problem and the stack of pellets did not provide the interstitial space necessary for oyster habitat. Presently, the accessibility of ash, the cost of portland cement, and the necessary quality control are concerns; future studies should focus on making fly ash pellet reefs more economically feasible by reducing the cost of production through substitution of alternate stabilizers for the portland cement.

In late 1996, Michigan Technological University's Institute of Materials Processing developed a new carbon recovery technol-

ogy that would transform coal ash, by removing the carbon, into a useful mineral filler that can be recycled into concrete and other products (Industry Newswatch, 1996). This is important because the Clean Air Act Amendments of 1991 required coal burning facilities to reduce carbon dioxide and other air emissions which, in turn, led to increased levels of carbon in the ash and made it unsuitable to cement and concrete manufacturers. Mineral Resources Technologies (MRT) in Georgia is attempting to transform coal ash into a higher value mineral filler product that can be recycled into concrete and other products. Their plans are to commercialize the technology by developing and operating facilities across the county. At the present time, this technology is not being used in Virginia (D. Bendein, 1998, personal communication).

LIME KILN DUST

Lime kiln dust is a by-product of calcining lime in a rotary kiln. The gases and dust are directed to a baghouse, where the dust is collected and the gases are vented into the atmosphere. The dust particulate material consists of 15 to 18 percent CaO , and 70 to 75 percent CaCO_3 , which makes the dust highly alkaline (up to 12.4 pH), and the remainder is fly ash, high in SiO_2 and Al_2O_3 . When 2 percent by weight of lime kiln dust is added to acidic coal refuse generated at coal preparation plants, there is an increase in pH and alkalinity, bacterial growth is inhibited and the formation of acid water is drastically reduced (Rich and Hutchison, 1990).

At a locality in Nicholas County, West Virginia, lime kiln dust is trucked, from APG Lime Corporation in Giles County, Virginia, to the preparation plant and loaded into a dust bin. From the bin, the lime kiln dust is metered onto the coal refuse belt by means of a variable rate screw conveyor. The treated coal refuse is trucked to mined-out areas where a cell (disposal site) is created. The dust not only neutralizes the coal refuse, but also stabilizes the material, allowing dozers to easily push it up into piles. In a matter of a couple of days, the refuse will firm up enough to drive trucks on it. Some of the economic effects of utilizing lime kiln dust here includes requiring less equipment to maintain the refuse cell, elimination of rock bridges to support trucks while moving coal refuse around, and the extended life of the cell (Sweet, 1994).

In Virginia, lime kiln dust is trucked from Chemstone Corporation, near Strasburg, to Chester, Virginia, where it is utilized by ReUse Technology, Inc., R. T. Construction Sciences Division to stabilize fly ash in structural fills and embankments in the area. Some of the benefits are that the material (fly ash and lime kiln dust) is available in bulk quantities and is cost effective; low weight is ideal for placement over low bearing strength underlying soils. High shear strength make it ideal for placement under building foundations, and ease of handling and compaction reduce construction time and equipment costs.

There is also considerable interest in using lime kiln dust at sulfide metal-mining operations to neutralize tailings, waste rock, etc. On a trial basis, lime kiln dust has been utilized on tailings embankments at Kennecott's Ridgeway Gold Mine in Ridgeway, South Carolina. In Virginia, it may have a potential around some of the former sulfide metal-mining areas in Carroll or Louisa Counties.

MAGNETITE-COATED PYRITE

Kyanite Mining Corporation in Buckingham County quarries a kyanite-bearing quartzite, which contains some pyrite. After the material is crushed in a jaw crusher and a rod mill, froth flotation is used to remove the kyanite. It is then dewatered and dried. The

high temperature of the drier converts the sulfides (pyrite to oxides). Pyrite (FeS_2) or ferric sulfide is converted to magnetite (Fe_3O_4) or ferrous iron oxide. The material is removed with magnetic separators and stockpiled (Figure 11). The material was tested for use as the iron ingredient at a plant producing portland cement; it was discovered that since the magnetite was not "through the body", that it was introducing sulfur to the cement product. Presently the material is being marketed for use in synthetic heating briquettes (used in gas-fired grills), for use in exothermic compositions, and as a brick colorant. In briquettes, the magnetite fines (more than 75%) are mixed with some charcoal and a binder and then the material is extruded. The extruded briquettes are placed in an irregular pattern. For brick colorant, the magnetite fines are included in the mix to produce a black to bluish-black cast to the product.

Potential uses are still being investigated as an ingredient in cement, and as a heavy media for cleaning coal, and in other uses where the magnetic properties can be utilized.

ROCK FINES

Processing of rock materials, by crushing and screening to meet specifications for clean, uniformly sized aggregate, generates 5 to 15 percent dust-size fines (-200 mesh) as a by-product. These fines (classifier tailings) are presently calculated as a part of the production cost, which must be handled and disposed of. Fines are produced in both dry and wet processes, which are determined by the types of stone marketed. Wet-processed fines are usually collected in settling ponds (pond screenings). Major uses of dry and wet fines has been for general fill and reclamation.

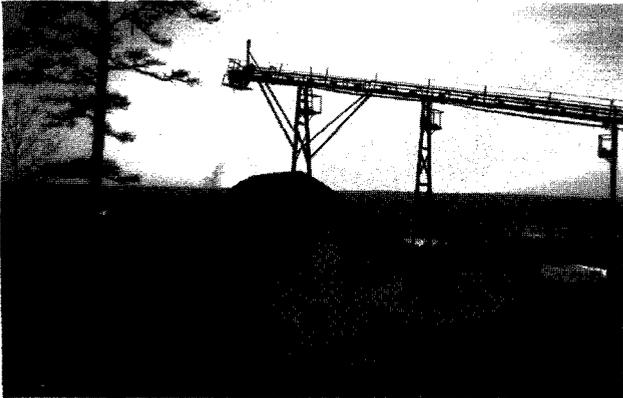


Figure 11. Stockpile of by-product magnetite at Kyanite Mining Corporation, Buckingham County.

Stokowski (1993) notes a long list of potential products from pond screenings that include agricultural, ceramic, chemical, cleansers, construction, industrial mineral and precious metal, mineral coatings, fillers, pigments, and pollution control and safety products. Numerous articles have suggested the value of powdered rock in replenishing essential minerals, improving existing soils, and creating new topsoil. Successful crop production has been carried on for years in regions of naturally fertile soils where geological processes provide a continuous supply of nutrients. The processes include a complex geochemical balance of all 92 elements present in minerals (Leonardos and others, 1987). Able (1992) notes the benefits of adding rock dust to soils: it can improve soil quality; reduce the need of soluble chemical fertilizers; improve resistance of plants to insects, disease, and fungus; im-

prove the nutrient density and flavor of food and feed; regenerate damaged forest ecosystem; and preserve air and water quality. As for application rates of rock dust for remineralization of soil, the consensus of opinion through numerous articles indicates the standard is about 10 tons per acre. As much as 20 tons per acre is recommended for very poor, nutrient depleted soils (Able, 1992).

In 1996, more than 40 million tons of aggregate were produced from basalt, diabase, granite, and greenstone (metabasalt) in the Commonwealth of Virginia. Using even median figure of 10 percent fines, this equals about 4 million tons of fines (rock dust) produced in one year.

Diabase

More than 11.2 million tons of diabase for aggregate were produced during 1996; all production was from northern Virginia. A large amount of fines resulted from these operations, especially from the production of "stone sand", mainly for use in asphalt. Minus 200-mesh material are the fines by-product looking for a market; some are used as an extender in asphalt and in roadbase material.

During the early 1990s, one quarry supplied more than 150,000 cubic yards of diabase fines for use as bedding around concrete pipes for a municipal water supply project in northern Virginia. Luck Stone Corporation has installed a gravitational inertial classifier at their Leesburg Plant, where they quarry and crush diabase. The classifier is a series of screens and fans in their sand plant, where the "stone sand" is produced in a dry process that requires less energy. A primary customer for the stone sand are asphalt companies, which require less than five percent passing 200 mesh. The company presently produces the product with less than three percent passing 200 mesh. Up to fifty percent of their -200 mesh fines are being marketed as a flowable stone fill (FSF), which is being utilized as a dry backfill around underground pipes and wiring. Very fine material is marketed as mineral filler in stone mastic asphalt (SMA), which gives the product various degrees of consistency required. With success at this plant, the company has installed the gravitational inertial classifier system at three of their other plants in Virginia.

Vulcan Materials Company utilizes much of their diabase fines at the Manassas Quarry to produce a Super Top Soil (STS), which they describe as a manufactured organic rich topsoil designed to optimize plant-growing conditions, by blending sand, silt, and clay constituents (rock fines) with specialty designed organic compost. One of their components (-400 mesh), is a 100 percent natural rock dust soil amendment material (Mineral Rite). "Mineral Rite" adds potassium, depleted soil minerals, and secondary and micro nutrient value including S, Ca, Mg, Cu, Zn, Cl, Fe, and Co; and increases cationic exchange capacity (soils' ability to retain minerals and prevent leaching and runoff). This weed free product combined with a finer clay material (-600 mesh), coarser sand, and compost allows for better root penetration; optimizes permeability, pH, water holding capacity, porosity, organic content, and texture; and is easily spreadable and mineral fortified.

Uses for remineralization are being investigated by several companies, however it seems that the most marketable products includes mixing the fines in a topsoil product or with other ingredients to make a soil amendment. Other possibilities are as a filler in charcoal briquettes, and as an ingredient in the manufacture of clay pigeons, and for use in warning tracks for ball fields (Figure 12).



Figure 12. Use of rock fines for a warning track at the baseball field of Longwood College, Farmville.

Granite

Many of the granite quarries in the southern Piedmont province produce "stone sand" utilizing a wet process. Their resulting fines from these operations are presently being stored in settling ponds on the property.

Potassium, one of the three main plant nutrients in fertilizer, is present in potassium silicate (orthoclase feldspar), common in igneous and metamorphic rocks. When these rocks weather, potassium is released not only from orthoclase feldspar but also from minerals such as sylvite, which contains about 63 percent K_2O , and kainite, which contains about 19 percent K_2O . Some whole-rock chemical analyses for granitic materials in Brunswick and Nottoway Counties in the southern Piedmont province of Virginia indicate that they contain up to 4.5 percent K_2O (Alex Glover, 1995, written communication). Granite fines may be suitable as a low-grade fertilizer or as a soil remineralization ingredient. This material needs to be dry in order to marketed, thus one of the main problems is that the fines are produced wet because of the more economical milling process and would have to be dried before they could be sent to market. Another potential environmentally driven market is the use of granite fines for remineralization of golf courses, leading to the reduced use of chemical fertilizers. The "Mineral Rite" that Vulcan Materials Company is presently evaluating, is available from quarries in granite/diabase rocks that offer minerals necessary for remineralization. Additional benefits offered by this 100 percent natural, non-polluting, soil amendment includes soil conditioning by improving the soil texture, structure, and porosity.

Other uses for the granite fines has been at farms for use in "loafing" pens for dairy cows, in horse arenas, and on farm roads (Figure 13). Other investigated uses are as a binder with charcoal in making charcoal briquettes. The specifications required for this use are that the fines be dry, are a suitable color, and be restricted in size to no larger than a buckwheat grain.

Another use of the granite fines has been as a base material in landfills. Landfills are normally lined with clay. However, in a landfill in Chesterfield County, the clay is covered with a 1 to 2-foot layer of granite fines (acting as a bed), then a plastic liner is added and covered by another clay layer (Figure 14). This landfill is adjacent to a granite quarry, which allows for an accessible source of granite fines.



Figure 13. Granite fines used on a farm road at Horseshoe Hill Farm, northwest of Ashland, Hanover County.



Figure 14. Landfill in which the underclay is overlain by one foot of granite fines, west of Chester, Chesterfield County.

Slate

LeSueur-Richmond Slate Corporation produces almost 200,000 short tons of slate annually, which is mainly sold as roofing slate. In the production of roofing slate, 80 percent or more of the slate is unfit for roofing shingles and is utilized for floor tile, architectural slate, and flagging. The rejected material from manufacturing these products is sent to the aggregate plant, and local road aggregate is produced. The aggregate material ranges in size from 3/8" to fines, some of which is put to use around the plant as landcover or "hole filler" and is also sold for this same end use. Some fines can be put back in with the aggregate for crusher run, some can also be used as a filler in asphalt for paving.

SOAPSTONE ROCK

Soapstone has been quarried in central Virginia since the 1880s by many companies. During the processing of soapstone for laboratory tops, sills, stoves, etc., thousands of tons of waste soapstone blocks were piled up around the inactive quarries near Alberene, Albemarle County and at the Schuyler, Nelson County, Virginia plant site (Figure 15)

In the early 1980s, several Lynchburg businessmen had the idea of utilizing this by-product soapstone rock by crushing to 1-inch size and producing heat-retaining terrazzo panels with epoxy or high temperature cement. These decorative panels could be

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used in various ways in the house. This proposed operation never came to pass. During the early part of the 20th century, the waste soapstone was pulverized into dust for various uses.



Figure 15. Inactive, water-filled, soapstone quarry with dumps of blocks, south of Alberene, Albemarle County.

REFERENCES CITED

Able, R., 1992, Classifier tailings for soil remineralization: Presentation and proposal, *in* *Aggregates Industry and Topsoil*, 25 p.

American Coal Ash Association, 1997, 1996 Coal Combustion Product (CCP) – Production and Use, Alexandria, Virginia, 2 p.

Andrews, R. S., and others, 1997, The use of a coal combustion by-product as substrate for Oyster Reef Development, *in* *The Proceedings of the 22nd International Technical Conference on Coal Utilization & Fuel Systems*, Clearwater, Florida, 13 p.

Buchanan, J., 1993, Letter puts end to Wise fly ash ordinance debate: *Kingsport Times News*, Kingsport, Tennessee, February 5, 1993.

Industry Insight, 1994, Exploring alternative uses for Fly Ash, *in* *Virginia's Environment*, p. 8.

Industry Newswatch, 1994, Working for Ash, *in* *Mining Engineering, Society for Mining, Metallurgy, and Exploration, Inc.*, Littleton, Colorado, v. 46, n.8, p. 934 and 936.

Industry Newswatch, 1996, New technology transforms coal fly ash to Mineral Filler, *in* *Mining Engineering, Society for Mining, Metallurgy, and Exploration, Inc.*, Littleton, Colorado, v. 48, n. 10, p. 24-25.

Leonardos, O. H., and others, 1987, The use of ground rocks in laterite systems: An improvement to the use of conventional soluble fertilizers?, *in* *Chemical Geology*, 60: Elsevier Science Publishers B. V., Amsterdam, The Netherlands, p. 361-370.

Office of Technology Applications (OTA), 1995, Fly Ash facts for highway engineers, 70 p.

Rich, D. H., and Hutchison, K. R., 1990, Neutralization and stabilization of combined refuse using lime kiln dust at High Power Mountain: Presentation at the 1990 Mining and Reclamation Conference and Exhibition, Charleston, West Virginia.

Stokowski, S., Jr., 1993, The many uses of pond screenings, *in* *Rock Products*, January, p. 40-43.

Sweet, P. C., 1994, Waste material resources in Virginia, *in* *Tabilio, M., and Dupras, D. L., editors, 29th Forum on the Geology of Industrial Minerals: Proceedings: California Department of Conservation, Division of Mines and Geology, Special Publication 110*, p. 29-37.

Sweet, P. C., and Giannini, W. F., 1990, Non-bauxitic alumina resources in Virginia: *Virginia Division of Mineral Resources Virginia Minerals*, v. 36, n. 2, p. 9-16.

Upchurch, M. L., 1998, The Cold Spring and related clay deposits along the western slope of the central Blue Ridge in Virginia: *Virginia Division of Mineral Resources Virginia Minerals*, v. 44, p. 1-8.

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