VIRGINIA MINERALS

SESQUICENTENNIAL VIRGINIA DIVISION OF MINERAL RESOURCES 1835-1985

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF MINES, MINERALS AND ENERGY
Richmond, Virginia

Published quarterly by the DIVISION OF MINERAL RESOURCES
Natural Resources Building, McCormick Road, Charlottesville, VA 22903

Vol. 32 | August 1986 | No. 3

COAL-IN-WATER: Fuel of the Future?

S.O. Bird[1]

. . .*"Unless there is a significant technology breakthrough, synthetic fuels will not be produced in any significant quantity this century. They still cost twice as much as conventional liquid and gaseous hydrocarbons."*[2]

Success is of the present, promise is of the future. Recent events in the world of energy have postponed the success of a new coal-based fuel and have put some limitations on its promise. The recent plunge of oil prices has taken away the price advantage of the fuel, and cancellation of federal monies for synfuel development, especially those that would guarantee prices for initial commercial contracts, has so increased the risk of production that further development is stalled. Two of the leaders in development of the new fuel have their corporate headquarters and development plants in Virginia.

It is generally thought that coal and water, like oil and water, don't mix, but recent research at two corporations with headquarters in Virginia is doing much to nullify this view. Some 20 years ago a utility company in New Jersey used a coal-water mixture to generate steam for producing electricity. In the last ten years research by a number of firms working independently has led to the development of a coal-water mix that will burn efficiently in today's furnaces, be easy to handle, and retain its properties throughout storage and use. The level of this development is so high and expectations so great that today free communication between fuel developers has ceased—in its place is substantial optimism and a good measure of secrecy.

There are problems to be sure, but Dr. Richard Wolfe, Executive Vice-President of the Research and Development branch of United Coal Company, Bristol, Virginia and Mr. Neil Rossmeissl, Plant Manager of the ARC-COAL Corporation's pilot plant at Fredericksburg, Virginia think that commercial development is certain but now likely to be a few years longer in production. The fuel has been undergoing extensive testing at a number of sites for more than three years, and reportedly no serious technical problems remain in producing or burning the paint-like substance. One of the great assets of the mixture is that it is liquid and it can be transported and handled like a liquid. It burns with an oil-like flame and burns efficiently.

The general formula for the fuel is 70 (to 80) parts coal to 29 (to 19) parts water plus 1 part "additives." Variations in overall content reflect differences in feedstock coals and in manufacturers' preferences. The coal is pulverized to the

[1]Virginia Division of Energy

[2]Quote from Steffes, 1986. The "new" technology discussed here runs counter to Steffes's view, though this new fuel may never be of use in small self-powered vehicles.

fineness of talcum powder so that it can be atomized for burning—the water goes off as superheated steam. The ingredients making up the additives are a tightly held secret. Some information is generally available on the size distribution of the coal particles, but not on the process of grinding, except to say that it is done in a ball mill as a water and coal mixture. The additives and the sizes of the particles control the storage, flow, and burning properties of the fuel. The tiny particles are held in the water suspension by a particular arrangement of their opposite electric charges to produce a gel—a semi-solid like thick paint. Some mixing or stirring is required to keep the material in a homogeneous state for extended periods of time. The additives aid suspension by dispersing the particles, as do detergents aid in suspending dirt in the household wash. The size distribution determines the packing array of the particles. During pumping and atomization for burning, the fluid-flow properties of the mix are critical to its successful use.

The fuel mixture is a colloidal suspension. It pours and looks like chocolate syrup, a medium grade oil or black, latex paint. It feels oddly dry on the fingers, especially when it is warm, and it will soil them. A black ball, or at least a black wad, can be made of the powdered coal as the water is squeezed out between the fingers. It is not greasy, and it is easily removed from the skin with soap and water (dispersing agents). A subaerial spill of the material is all but immobile, for it quickly dries in air and forms a crumbly material which can be shoveled up for resuspension.

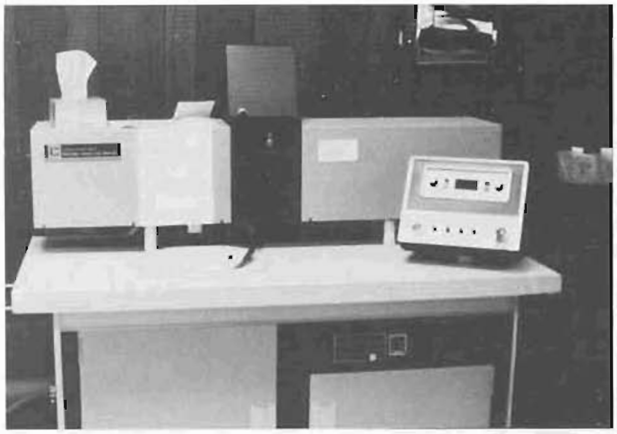
At ARC-COAL, continuous batches of the fuel are made from any one of a variety of coals. Some 85 different coals have been used, especially high-volatile bituminous stocks from Virginia and other states. Lignite and anthracite, at either of the far ends of the fixed carbon/volatile ratio spectrum for coal, have also been successfully tested. Tests have been run on coals from Virginia, West Virginia, Kentucky, and Pennsylvania. All experiments have been successful so far. The coal arrives at the ARC-COAL'S pilot plant by railcar or truck; it is screened and mixed with water and then passed repeatedly to ball mills for pulverizing the coal. Samples are taken from the mill for testing, and when the batch is done, it is stored in two 150,000 gallon tanks for distribution to testing sites as far away as Japan and Europe and as close by as Fredericksburg.

The largest test to date of ARC-COAL'S product is by Jones and Laughlin Steel Corporation, which is using 1 million gallons of it—more than a three month's output of the pilot plant. E. I. duPont de Nemours and Co., Inc. burned more than 2000 tons (400,000 gallons) of the synthetic fuel at its Memphis, Tennessee plant during a 35-day trial carried out in the fall of 1983. These and other industrial tests have proven highly successful and more tests are planned; utilities in the Great Lakes states are prospective testers.

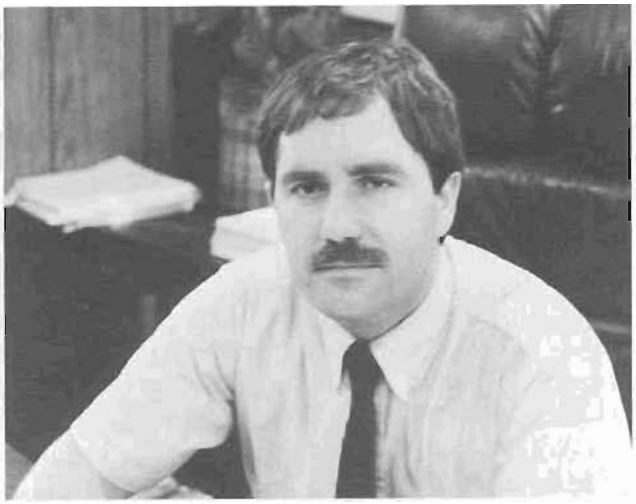
ARC-COAL can now make 600 barrels of fuel (25,200 gallons) per day at its pilot plant in Fredericksburg. The company has produced about two million gallons of coal-in-water fuel, which is better known as CWS (coal water slurry). Because of the current low interest in the fuel, ARC-COAL is scheduling a short-term shut down of its Fredericksburg plant this summer.

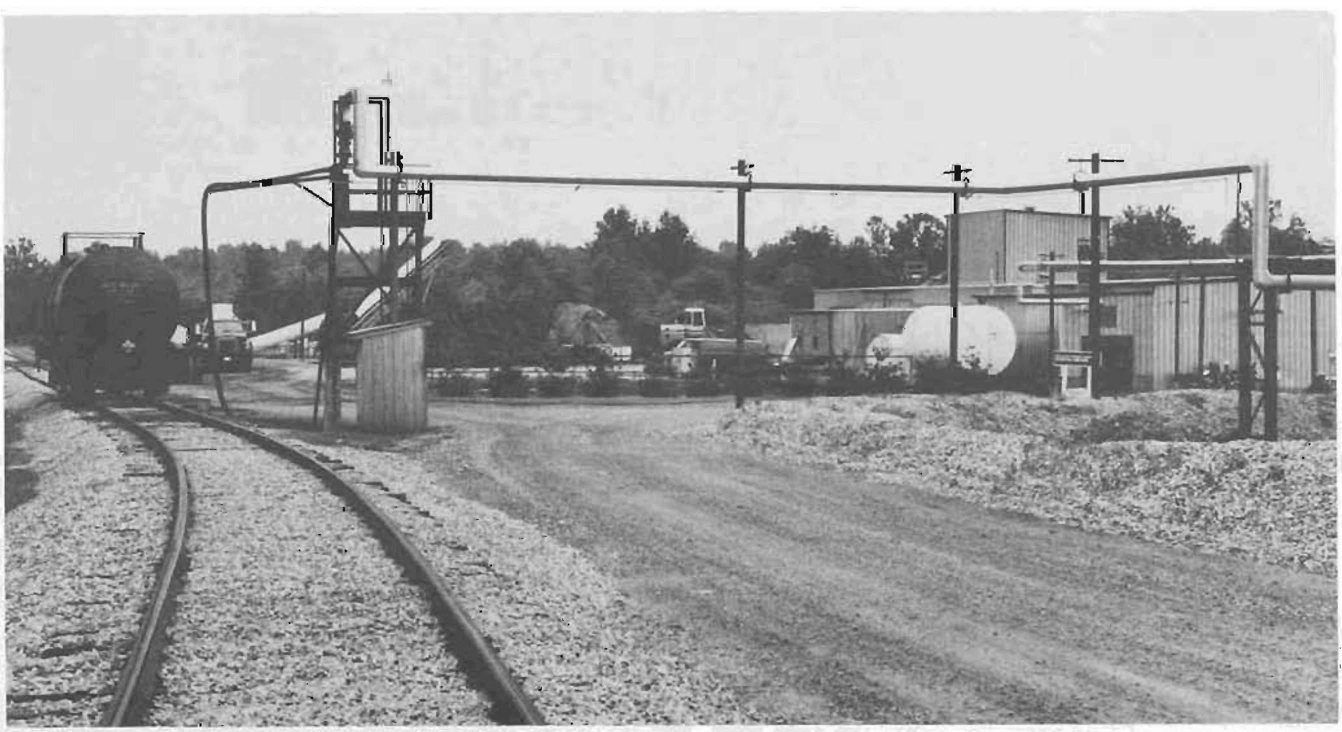
Coal/water fuel production at United Coal is on a smaller scale than at ARC-COAL, and because they supply their own coal for testing, fewer types of coal have been used at their recently opened, one-million-dollar research laboratory at Bristol. Surprisingly, fuel research is not a common activity with coal companies, but at United, a special company has been formed specifically for that purpose. Dr. Wolfe is head of research, and his group is involved in a number of promising projects, including, especially, methods of coal beneficiation and synfuel production. Ash and sulfur content can be reduced now to small quantities: ash can be removed by differential flotation of finely ground coal to values as low as 0.7 percent from initial values in coal as high as 5 percent. Chemical processing can further reduce the ash content, but each purifying step adds to the cost of the product. Mineral sulfur (pyrite) can be largely removed by two stages of flotation; the first floats the coal, the second floats the pyrite and sinks the coal. This second-stage flotation is a new process now being tested at United Coal. A further reduction of mineral sulfur is accomplished by heating the coal in air and then magnetically separating the partially oxidized iron and the associated sulfur. New methods of removal of organic sulfur bound to the coal include mixing in certain bacteria which feed on it. Atlantic Research has used genetic engineering to make bacteria which can accomplish this process of removing sulfur from coal, and the corporation has recently applied for a grant under the U. S. Department of Energy's Clean Coal Technology grant program to further its progress in removing sulfur from coal.

Nitrogen oxides (NO_x) are not released in large quantities during the burning of CWS because



Center, United Coal Company headquarters at Bristol, Virginia: Upper right and clockwise, part of the apparatus for making CWS; the research lab; Dr. Dick Wolfe and the "Man of coal;" a machine for determining distribution of particle sizes in CWS. This normally onerous task of hours is reduced to one of minutes by using laser refraction to replace measurement of gravity setting rate.





Mr. Rossmeissl; ARC-COAL's storage tanks, plant (background) and fuel lines to railcars.

of the relatively low temperatures of the flame. CWS burns at about 2500°F, a temperature 200-400°F less than the parent coal. Some ash is left when CWS is burned—it accumulates in popcorn-like aggregates below the burner heads, and it is easily collected and removed.

United Coal Research and Development is producing a smaller amount of CWS than ARC-COAL. United too is having its product tested by industry, and the Company is seeking new potential testers and users.

When the new fuel is fully developed, its cost will probably be considerably less than its chief rival, No. 6 fuel oil. The predicted cost of a commercial product is a function of the size of the manufacturing plant. The more fuel produced, the cheaper it will be. Estimates for a 20,000-barrels/day-sized plant (about 7 million barrels/yr.) are about $3 to $3.5/per million Btu's for CWS as opposed to $4.5 to $5 per million Btu's (1984-85 rates) for No. 6 oil.[3] CWS can be as free of noxious emissions as the oil. Far more important than the cost difference is the difference in availability. U. S. coal reserves are nearly limitless. Virginia's demonstrated reserve base is estimated at about 3.3 billion short tons, enough to keep the State's industry going for more than 80 years at the current production rate of 42 million short tons per year. In addition, the fuel may be conveniently shipped by rail, barge, or truck, or even slurry pipelines and easily and cleanly transported at the user's facility. Furthermore, the process of making the fuel is energy conserving—more energy is available in the fuel than was used in making it. This is not true for some synfuels.

What then is the prospect of commercial production of CWS? Following the Clean Air Act of 1970, many coal-burning industrial and power-generating plants converted to oil by modifying their coal-burning boilers. These facilities could rather easily and relatively cheaply reconvert to coal as CWS. Other oil burners cannot be so conveniently or economically converted to CWS, but both types of plants could use their oil tanks, pipes, and pumps for the CWS fuel. The coal-water fuel does abrade burner heads, but those of tungsten-carbide steel are not much affected. In one major test, CWS did not burn as efficiently as natural gas (about 76 percent for CWS, versus nearly 79 percent for gas), but the report (Perkins and others, 1984) suggested that higher efficiencies were attainable with the new fuel. CWS is about 2 percentage points less efficient than fuel oil. No burners specifically designed for CWS are now on the market, but several firms, including the Babcock and Wilcox Company, which has been a leader in inventing and manufacturing industrial boilers for many years, have worked on their development.

The biggest hurdle is selling the fuel. One large contract is probably all that is needed to bring the fuel into full commercial development and production. The needed conditions will include a running time of several years in order to insure a worthwhile investment for the CWS producer, which will have to invest tens of millions of dollars for a full-scale plant. If coal and residual oil for Virginia's utilities were replaced by CWS, it would take about 46 million barrels of the mix to supply the annual needs at the 1985 rate. This is about seven, 20,000-barrels/day plants. The current low price of oil does not bode well for CWS, but large demonstration projects are still underway in several countries in western Europe and in Japan and Korea. Canada has one commercial operation using CWS as fuel. It is used to turn iron ore into pellets at a plant in Sept Iles, Quebec.

Early commercial use will most likely be in industries and utilities, but tests are also underway in diesel locomotives. American diesel motors are mostly high-speed types, and they are not now suitable for CWS, so the tests are being run on low-speed engines in Europe through a U. S. Department of Energy project. United Coal has used its product in a demonstration diesel truck suitably modified to burn CWS. Recently, news was released of an automobile test at General Motors using pulverized coal as a fuel. Acceleration of the vehicle was disappointing, but other applications hold much promise.

Then what is the future for CWS? In spite of a great and almost certain promise of success of the fuel, there is now next to no interest in its commercial development by potential users, including utilities. If the recent plunge of oil prices results in a prolonged (one- to two-year) period of low prices, several energy crippling events are likely to follow. The already struggling coal industry, which now suffers from over-production, would be sorely hurt if electric utilities refired

[3]A barrel of oil contains 42 gallons, or about 6.3 million Btu's; 1 barrel CWS contains roughly 3.5 million Btu's. Virginia's electric utilities used about 1.60 x 10^8 million Btu's of coal and residual oil in 1985.

their oil-fueled generators and further conversions to coal were stalled. U. S. oil production would decline as companies waited for higher prices and exploration for new oil and gas hit new lows. Decline in production would likely result in increased imports of foreign oil, reversing the hard-won gains made over the last six years—a time interval during which foreign imports dropped by some 40 percentage points.

If imports rise again, the burden lifted from the U. S. economy by conservation and conversion to other fuels will be reimposed for a long while to come. Meanwhile work on development of alternate fuel resources seems destined to diminish or vanish, and the freedom from foreign domination of energy supply threatens to return with no immediate prospects for release from this stranglehold. Development of a coal-in-water fuel is slowing, and if shutdowns of days become shutdowns of months and years, inertia will replace momentum. That inertia will be difficult to overcome.

ACKNOWLEDGMENTS

I here gratefully thank Mr. Rossmeissl and Dr. Wolfe for their generous help in providing information, in allowing me to tour their facilities and in looking at parts of this report. Thanks also go to Dr. Don Shull, who helped supply references on CWS development.

SELECTED REFERENCES

Coal Outlook; 1986, Oil continues coal backout: vol. 10, no. 13, p. 1.

_________, 1986, Oil beats out coal in California: vol. 10, no. 12, p. 2.

_________, 1986, Bugs remove 50% sulfur from coal: vol. 10, no. 9, p. 8.

Energy Users News, 1984, Firm markets new coal-water slurry: vol. 8, no. 2, p. 16.

Funk, J. E. and others, 1981, Combustion tests of a high solids coal water fuel—Co-Al, Babcock and Wilcox Company report to the Governor's Conference on expanding the use of coal in New York State, Albany, N. Y., May 21, 22, 1981: Babcock and Wilcox Co., Alliance, Ohio, 9 p.

Inside Energy, 1986, Summary of proposals received by DOE for its clean coal solicitation: April 28 issue, p. 7-9.

Morris, Sheryl, 1986, Oil-industry leaders see harsh times ahead, but spoils for the survivors: Inside Energy, April 28 issue, p. 4a, 4b.

Oil and Gas Journal, 1983, Coal fines to compete with oil and gas: vol. 81, no. 44, p. 65

_________, 1983, Coal/water slurry set for production: vol. 81, no. 47, p. 40.

_________, 1984, Coal/water fuel slurry tests to be expanded: vol. 82, no. 25, p. 40.

Perkins, R. P., Smith, R. D., Manfred, R. K. and Taylor, B. E., 1984, Coal-water slurry test in an industrial boiler: In a paper presented at American Power Conference, Chicago, Ill. in April, 1984; 8 p.

Steffes, D. W., 1986, Energy industry leadership can eliminate world energy constraints: Strategic Planning and Energy Management, vol. 5, no. 3, p. 4-12.

U. S. News and World Report, 1986, Bushwhacking turns into a major sport: vol. 100, no. 15, p. 14.

_________, 1986, Texas takes a tumble: vol. 100, no. 15, p. 20-27.

Yeager, K. E. and Manfred, R. K., 1983, Coal-water mixtures: issues and opportunities for the electric utility industry: Electric Power Research Institute report, presented at 10th Energy Technology Conference, Washington, D. C., March 2, 1983: Palo Alto, California, 14 p.

Yoder, E. M., 1986, Flirting with statesmanship: U. S. News and World Report, vol. 100, no. 15, p. 14.

S.S. JOHNSON ELECTED

Stanley S. Johnson, a chief geologist at the Division of Mineral Resources, was elected second vice-president for the Tulsa-based international Society of Exploration Geophysicists (SEG). The term will be for SEG's 1986-87 year. SEG is the world's largest association of exploration geophysicists, with nearly 19,000 members in over 100 countries.

Johnson, active in SEG since 1971, served as general vice chairman of the society's 55th annual meeting in Washington, D.C., last year. He was membership chairman in 1982-83 and has been a member of the Professional Affairs committee since 1980. In 1980-81 he served as president of the Potomac Geophysical Society.

He earned his bachelor's degree in geology at the University of Virginia and has been with the Division for 23 years. He has authored and co-authored more than 37 publications, abstracts and maps, including the Gravity Map of Virginia and the Aeromagnetic Map of Virginia.

FREDERICKSBURG'S BATTLEFIELD GRANITE

Noel Harrison[1]

To the almost-forgotten past belongs the story of Fredericksburg's "Battlefield granite" quarries, once touted as being among "the most valuable granite properties in the United States".

The term, "Battlefield granite" is a trade name for a granitoid rock that was extracted from what today is called the Fredericksburg Complex, a group of geological rock units. Technically, the Fredericksburg Complex is a group of metamorphosed rocks, which include gneisses, schists, and granites (Pavlides, 1980). Blue-gray biotite granites with several joint sets (fractures) were extensively quarried for building and monumental stone (Watson, 1907). The color of the granite comes from the combination of minute flakes of black biotite mica scattered throughout a gray-white feldspar background. Exposed dikes and sills of granite are generally less than 200 feet thick. In some places they are transected by pegmatite dikes (feldspar) up to two inches thick (Steidtmann, 1945).

Stone from the south bank of the Rappahannock River was quarried at six sites west of Fredericksburg. These quarries were worked intermittently during the late 1800's and early 1900's.

The qualities of the "Battlefield granite" probably first became known with the establishment of a canal and navigation system (Callahan, 1969) along the Rappahannock River west of Fredericksburg. Beginning in 1829, a route was dug through what would later become the quarry vicinity, and the usefulness of the loose rock for building purposes was demonstrated during the subsequent construction of stone canal locks (Figure 1).

Figure 1. Stone canal lock on south bank Rappahannock River.

The first real attempt at quarrying came in 1871, when George Hazewell leased property along the Rappahannock River 2.5 miles northwest of the city with the intention of excavating granite for architectural stone. A quarry was apparently opened but later closed because of the difficulty of moving massive granite blocks over muddy roads to Fredericksburg's Rappahannock River wharves and to the Richmond, Fredericksburg, and Potomac Railroad depot.

In October 1893 Joseph York, an entrepreneur from New Jersey, announced that he would lease the quarry property for a period of 25 years. York was convinced that his preliminary survey of the area had revealed "one of the most valuable granite properties in the United States" (Free Lance, 1893). Shortly after signing the lease, York formed a quarrying partnership with Joseph Swift, a businessman from Delaware, as the Battlefield Granite Company (Fredericksburg b). The partners soon became engaged in the most extensive activity yet carried out at the quarry site. A rising demand for Virginia granite made hauling wagonloads of stone over muddy roads financially practical. The partners employed about 40 workmen, who extracted granite, transported it to a stone-cutting yard in the City of Fredericksburg, and there, crafted rough stone into finished products of various types. Their operation provided granite for buildings in Petersburg and Williamsburg, and cemeteries in Washington, D. C. and Fredericksburg.

Unfortunately, the operation began to experience a variety of problems. In 1894 York and Swift lost in their bid to obtain an important street-paving contract from the Fredericksburg City Council. Although the partners reported a business upswing in late 1896, their fortunes plummeted when a fire destroyed much of the stonecutting yard (Daily Star, 1896).

Between January 1897 and April 1899 the quarries underwent a change in management and eventually York and Swift transferred control of operations to the partnership of E. J. Cartright

[1]P. O. Box 3771, College Station, Fredericksburg, Virginia

and J. H. Davis, and the Battlefield Granite Company went out of existence.

The most important change made by Cartright and Davis alleviated the transportation problem. In May 1901 they acquired the right to float stone from the quarries to the stonecutting yard, using part of the old Fredericksburg canal system. In exchange, the partners pledged to repair any damage incurred to the canal's locks and banks and to pay rent based on the amount of stone they transported. In addition to being an alternative to moving tons of granite over bad roads, this arrangement would be the last regular use of the canal network for transportation purposes.

The Cartright and Davis years were indeed the heyday of Fredericksburg's granite industry. Elaborate processes were used to extract, transport, and process the granite. By 1906, there were six quarries operating at the same riverside site that had first attracted George Hazewell's attention back in 1871 (Watson, 1907).

A typical journey for a piece of Battlefield granite began at one of the quarries. Cartright and Davis employees used both hand and steam drills to bore holes into the granite (Figure 2).

Figure 2. Granite block with drilled holes.

Rough pieces of granite were subsequently broken off from a quarry face by placing round wedges or dynamite into the holes. A steam hoist was used in the loading of heavy stone blocks at the quarries. The loose rock was transported to the Rappahannock River and dumped into a canal scow. The documented presence of "hand cars" at the quarrying area in 1914 indicates that a miniature railway may also have been utilized to help move granite to the waiting scow (Fredericksburg c).

The scow was then floated down the river to a dam situated between the quarries and the city, where the boat was lowered into the Fredericksburg canal system by using a lock constructed with blocks of granite. After leaving the lock, the scow passed down the canal to a pier located at the edge of the stoneyard. Derricks were used to unload the granite, which was then taken to a barn-like finishing shed. A miniature "railway" enabled workmen to push heavy blocks of granite around the stoneyard and into the shed using dollies with flanged wheels (Raymond Decater, 1985; personal communication). In addition to providing shelter for workmen and their tools, the shed housed an office, a stable, and a blacksmith shop (Fredericksburg d).

The granite could now be fashioned into a variety of forms. If the stone was destined to become curbs, cobbles/spalls, or other "rough" materials, it was shaped using chisels, special hammers, and saws. If more delicate forms were desired, such as tombstones and monuments, granite cutters went to work with grinders, polishing machines, hand drills, and lettering tools. Waste granite and other types of "rubble" could be pulverized in a crusher for local use.

Like all craftsmen, the granite cutters had their own special vocabulary. A piece of granite arriving from the quarry was said to be in the form of a "pattern" which was the approximate size and shape of the stone needed for project construction. A "good pattern" required a minimal amount of additional labor to achieve a shape of the desired size. A "bad pattern" called for an extensive amount of labor. In processing, or "finishing," a rectilinear "pattern," the cutter would begin by preparing four smooth edges, or "drafts," around the periphery of one surface of the stone. This determined the plane to which the rough area remaining between the "drafts" was subsequently reduced. The cutter would "finish" each of the six surfaces of his "pattern" in this manner, utilizing a square to make sure the surface he was working on was perpendicular to those surfaces he had already completed (McKee, 1973).

Much of the company's work involved providing street improvements to the City of Fredericksburg. At the work site, Cartright and Davis employees would grade a street using plows and lay terra-cotta drainage pipes where necessary. Granite spalls, or cobblestones, and curbs were then installed on the levelled surface. Finally, bricks were laid and concrete sidewalks poured to give the street a "finished" appearance.

Additional income came from the crafting of "graveyard architecture." The engineering works included in this category range from a simple tombstone made for a Northumberland County family to a mausoleum that was built by Cartright and Davis in a cemetery near the Town of Orange (Figure 3). One businessman from Pennsylvania was so impressed by the qualities of "Battlefield granite," that he purchased an entire railroad-car load of blank tombstones and had it shipped to his home town.

Cartright and Davis provided veteran's groups with battlefield monuments commemorating various actions of the Civil War. One of the most ambitious projects undertaken involved the construction of a monument honoring General Alexander Hays who was killed during the battle of The Wilderness. Survivors of the war who had served under him wanted to mark the site of his fatal wounding by having a large cannon barrel erected. Cartright and Davis accordingly supplied a six-ton granite base to which the five-ton cannon was affixed (Figure 4). This was one of the largest single stones ever marketed by the quarrymen (Daily Star, 1905).

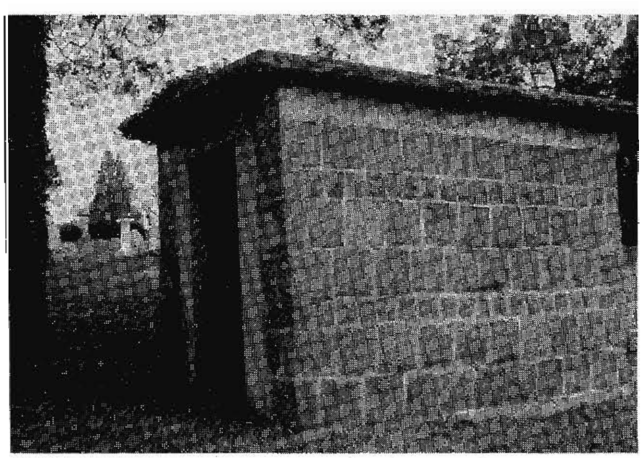


Figure 3. Granite mausoleum, Graham Cemetary, near Orange.

In 1904 Battlefield granite was used in the construction of a house for E. J. Cartright. This building, located on Fredericksburg's prestigious Washington Avenue, was finished in 1905 (Figure 5). The mansion's gray stone walls and "haunted

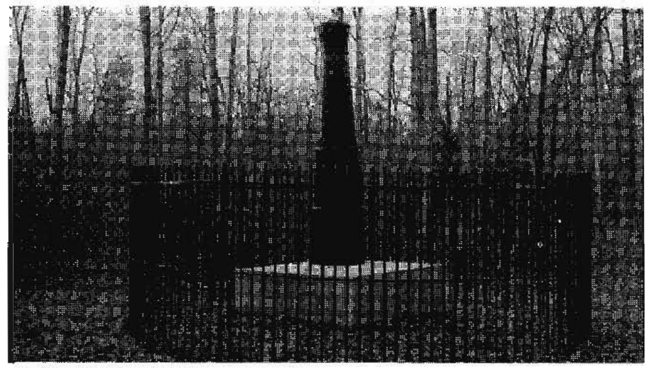


Figure 4. General Alexander Hays monument near Chancellorsville.

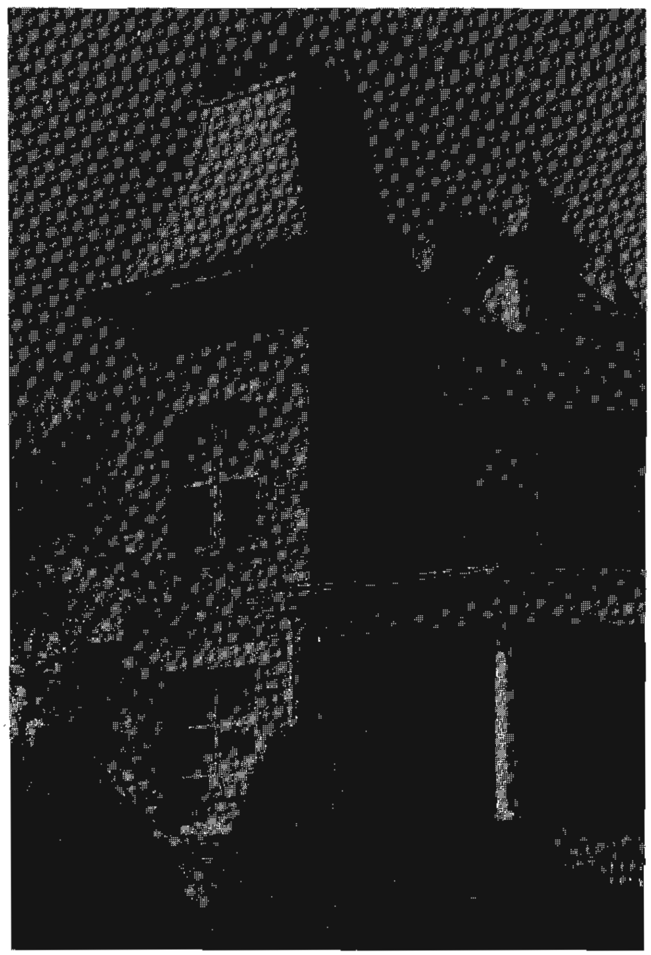


Figure 5. This Fredericksburg house was built for E. J. Cartright out of materials quarried from the "Battlefield Granite" properties.

house" design represented the most elaborate utilization of Cartright and Davis granite.

After 1905 the firm of Cartright and Davis went into a decline. The quarries were closed down in 1907. Operations resumed in 1908, but business was not what it used to be. On October 4, 1912 Cartright turned over all his interests in the firm to Davis and the partnership was dissolved (Fredericksburg e). In August 1914, the two men joined forces again as "Cartright and Davis, Incorporated." Four months later this designation was discarded in favor of "Battlefield Granite Corporation" (Fredericksburg f).

Like the Battlefield Granite Company of 1895, the Battlefield Granite Corporation of 1914 had plenty of optimism but not enough business. On June 30, 1919, the property of the Battlefield Granite corporation was sold. The quarry was used by other businessmen until 1945 and the stoneyard to 1923.

In 1956 the Culpeper Stone Company leased the quarries area from its long-time owners, the Taylor family. This time, "Battlefield granite" was to be utilized as crushed stone for construction projects. During a flurry of activity in 1958-1959, one of the quarries yielded up to 150 tons of granite per hour (Gooch, 1960). The same company operates a quarry south of Fredericksburg in Spotsylvania County and a sand and gravel operation east of Fredericksburg.

REFERENCES

Callahan, Donald B., 1969, The Rappahannock canal: Fredericksburg, Virginia, Robert A. Hodge, p. 28-34.

Daily Star, 1896, December 5, Fredericksburg, Virginia.

________, 1905, April 1, Fredericksburg, Virginia.

Fredericksburg a, Deed Book AE, p. 387.

________b, Deed Book AF, p. 90.

________c, 1903, Land Book, p. 9.

________d, Deed Book 48, p. 357.

________e, Records of City Council, V. 16, p. 221, 251, 352, 369, 380.

________f, Records of City Council, v. 17, p. 51, 251, 443.

Free Lance, 1893, October 13, 31, Fredericksburg, Virginia.

Gooch, Edwin O., Parrott, W. T., and Wood, R. S., 1960, Sources of aggregate used in Virginia highway construction: Virginia Division of Mineral Resources, Mineral Resources Report 1, 65 p.

McKee, H. J., 1973, Introduction to early American masonry: stone, brick, mortar, and plaster: Washington, D. C., Columbia Univ., p. 21.

Pavlides, Louis, 1980, Revised nomemclature and stratigraphic relationships of the Fredericksburg Complex and Quantico Formation of the Virginia Piedmont: U.S. Geol. Survey Prof. Paper 1146, 29p.

Steidtmann, Edward, 1945, Commercial granites and other crystalline rocks of Virginia: Virginia Geol. Survey Bull. 64, p. 40-43.

Watson, T. L., 1907, Mineral resources of Virginia: Lynchburg, Virginia, Virginia Jamestown Exposition Commission, p. 27-28.

VIRGINIA FIELD CONFERENCE

This year's Virginia Field Conference will be held October 18 and 19 with overnight lodging in Keysville, Virginia. The field conference will be led by Dr. Bruce Goodwin (College of William and Mary), Kelvin Ramsey (University of Delaware), and Gerry Wilkes (VDMR). The field trips will include stops at select outcrops in the Richmond, Farmville, Briery Creek, and Roanoke Creek Triassic basins. The geology and mineral resources of these basins will be examined and discussed.

For more information contact Dr. Bruce Goodwin, Geology Department, College of William and Mary, Williamsburg, VA. 23185 (804-253-4204).

VAEE CONFERENCE

The Virginia Association for Environmental Education is planning a fall conference for October 17, 18, 1986. The conference will be held at the Wakefield 4-H Center in Wakefield, Virginia. The program will include a panel discussion on the safety of nuclear power and disposal of nuclear waste, a presentation of the environmental issues facing the Chesapake Bay, a representative from the National Wildlife Foundation to talk about a new environmental curriculum (CLASS Project), and wildlife walks.

If you need further information about this conference, please contact Mary Sutherland at Prospect Heights Middle School, 200 Caroline St., Orange, VA 22960, or call (703) 672-2296.

MINERAL UPDATE (Molybdenite and Pentlandite)

William F. Giannini and Richard S. Mitchell[1]

The mineral molybdenite (molybdenum sulfide), previously reported in Virginia only from Chesterfield (H. K. Freeland, personal communication, 1985), Floyd, and Greensville counties was recently discovered in Grayson County. Pentlandite (iron-nickel sulfide), reported earlier in Virginia in Floyd County, has also been found in Nelson County (W. F. Giannini). X-ray diffraction analyses were used to confirm the identity of both minerals, the associated minerals, and to disclose an uncommon crystal structure for one of the molybdenite specimens (R. S. Mitchell).

Crystals of molybdenite to 1 millimeter across were found in the feldspar of the Cranberry Gneiss Formation of Precambrian age 1 mile north of Rugby (Figure 1). Analyses of the mineral also indicated the presence of the rare 3R polytipic structure in one specimen and the more common 2H poly-type in two others. Pyrrhotite (magnetic iron sulfide), pyrite (iron sulfide), chalcopyrite (copper-iron sulfide), and marcasite (iron sulfide), an unreported mineral from Grayson County, were also identified in quartz veins cutting the Cranberry Gneiss at this location (R. S. Mitchell).

Light bronze-yellow masses of pentlandite to 1.5 centimeters across in a 3-inch-thick dolomite vein and intimately associated with chalcopyrite, were located in the block-dump of an inactive soapstone quarry, approximately 0.4 mile southeast of Schuyler (Figure 2). Galena (lead sulfide) and ilmenite (iron-titanium oxide) were also present in the vein.

Molybdenite is the main ore of the metal molybdenum used in many special alloys and as a dry lubricant to resist high temperature. Pentlandite is a principal source of nickel. Commercial deposits of molybdenite or pentlandite are not known in Virginia.

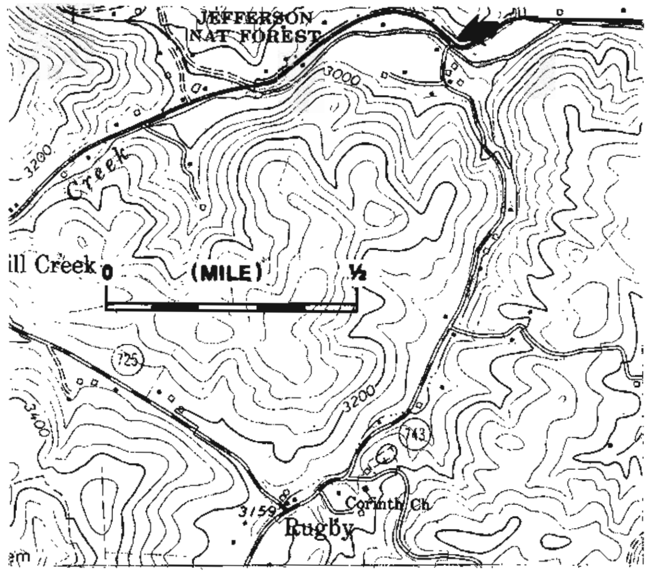


Figure 1. Discovery locality for crystals of molybdenite.

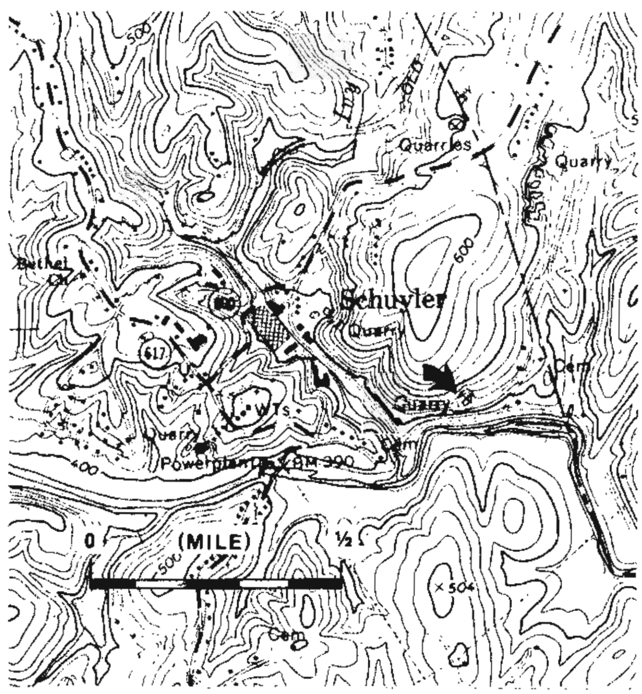


Figure 2. Discovery locality for masses of pentlandite.

[1]Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia.

Postmaster:
Send address corrections to —
Virginia Division of Mineral Resources
Box 3667
Charlottesville, VA 22903

Virginia Minerals
Second-class postage paid at
Charlottesville, Virginia
ISSN 0042-6652

NEW PUBLICATIONS

PUBLICATION 59

Geology of the Southwestern Virginia Piedmont, by James F. Conley; 33 p. with color geologic map, 1985.

$12.00

Publication 59 describes the geology of an area that covers much of Henry, Franklin, and Pittsylvania counties. The report divides the region into five areas, each of which is underlain by a distinctive sequence of rocks. The work is a compilation of much detailed geologic mapping, some of which has never been published. The text discusses the regional geology and presents a reinterpretation of the stratigraphy and structure. It contains a color plate, 12 illustrations, and several stratigraphic-nomenclature charts.

This publication can be purchased at the Division for $12.00 (plus 4 percent State sales tax).

PUBLICATION 60

Geology of the Harrisonburg and Bridgewater Quadrangles, Virginia, by Thomas M. Gathright, II and Peter S. Frischmann; 21 p. with color geologic map, 1986.

$12.00

This publication presents the geology of the Harrisonburg and Bridgewater 7.5-minute quadrangles (scale 1:24,000) on a color geologic map with an accompanying 21-page text. The text discusses the stratigraphy, structure, and economic geology of the two-quadrangles area. The appendix names the formational units of the report area and describes their geologic and economic factors affecting land modification. Publication 60 can be purchased from the Division for $12.00, plus 4 percent State sales tax for Virginia addresses.

PUBLICATION 61

Thomas Jefferson and American Vertebrate Paleontology, by Silvio A. Bedini; 26 p., 1985.

$4.00

This publication documents the importance of Jefferson's contributions to the promotion and development of the study of vertebrate paleontology in America. It tells of his pursuit and collecting of fossil specimens, some of which are pictured in this report. This historical documentation, with more than 60 references, can be purchased at the Division for $4.00 (plus $0.16 State sales tax).