# 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. 37 November 1991 No. 4


## BALCONY FALLS — "The key to the succession..."[1]


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The Cambrian and Ordovician outcrops in the vicinity of Balcony Falls on the James River played a key but almost forgotten role in resolving the basic stratigraphy of the Appalachian Mountains. To understand their significance, the historical development of the Cambrian system must be briefly reviewed. The Cambrian System, named by Sedwick from rocks in north Wales in 1835, nearly was swallowed up into the Silurian System, which was named by Murchison also in 1835, as the boundary of the Silurian was moved ever downward. Nevertheless, the Cambrian was eventually recognized as a distinct system of rocks (Secord, 1986). Arguments in England then turned to the issue of the boundary between the two; Lapworth in 1879 suggested the Ordovician System as a compromise for the disputed strata between these two systems.

By the mid-1880s, the concept of a Cambrian System was recognized by some American workers, foremost among them being Charles Doolittle Walcott of the U.S. Geological Survey. Not everyone, however, was willing to use this name in the sense of a system. In addition, in the Taconic Mountains at the New York-Massachusetts border, some geologists recognized a Taconic System. It was used by a few as equivalent to Cambrian, by others as older than Cambrian, and by still others in a variety of ways.

Yet another argument ensued as to the broad correlations within the Cambrian. In the east there was general agreement that the Potsdam Sandstone of New York was Cambrian. A number of geologists equated sandstone which cropped out in other places with the Potsdam, and the terms "upper" and "lower" Potsdam muddied the waters. In 1885, H. D. Campbell found Potsdam east of the Blue Ridge at Balcony Falls (Walcott, 1891a, p. 137). A section nearly half a mile thick of shales and sandstones occurred, but except for the tubular fossil *Scolithus* there were no organic remains reported (Walcott, 1891a, p. 292-298).

Elsewhere in the northeast and in the west, primarily in shales, several broad faunal zones were established in the Cambrian, including the zone of *Olenellus* and the zone of *Paradoxides*. Walcott had collected in fair detail in the Cambrian rocks of the Eureka Nevada District. Although the trilobite *Olenellus* was present in some abundance, no *Paradoxides* could be found in the west. G. F. Matthews working in New Brunswick had documented *Paradoxides* and had also confused some *Olenellus* with that genus. *Paradoxides* or its associated fauna and *Olenellus* were found at several places in New England and extreme eastern New York, but never in the same stratigraphic sequence.

After Walcott had completed his work in Nevada, he was sent east of the Hudson River to try to resolve the issue of the disputed Taconic System. By 1887, he had effectively destroyed the concept of the Taconic and had found a few Ordovician snails and Cambrian trilobites in the Taconic Mountains. One issue was resolved but others remained.

The available evidence suggested that *Paradoxides* was the oldest trilobite in the Cambrian and was succeeded by *Olenellus*. The Potsdam in New York contained few fossils, but correlative sandstones in Wisconsin and Minnesota had yet another trilobite fauna characterized by *Dikellocephalus*. However, although America had great sections of the Cambrian, it obviously was not the only place in the world where these rocks occurred. While Matthew and Walcott were investigating in North American, W. C. Brøgger was toiling away in Sweden where there is a flat lying relatively thin section of Cambrian rocks. In it, Brøgger found Olen*ellus* below *Paradoxides*, and he wasted no time in publishing his findings as to the error of the American view.

In 1888, Walcott married and convinced his young bride that they should honeymoon in Newfoundland. What could

[1] The National Park Service has recently instituted a program to mark sites important to the history of geology in the United States. The Division of Mineral Resources is proposing the Balcony Falls locality as a candidate for such designation.

be more romantic than collecting fossils? *Paradoxides* was known to occur there and if the *Olenellus* zone really was older, perhaps this trilobite could be found below the *Paradoxides*-bearing shale. Walcott searched several localities in vain. At Manuel's River, a massive conglomerate marks the base of the Cambrian. In a shallow depression in this conglomerate, through which a railway was fortuitously cut, Walcott found *Olenellus*; during the next century there has only been one other locality for this trilobite found in the general area. Walcott immediately set down to write a paper on this discovery, but after three days he decided to go to London (with bride) to the 1888 International Congress of Geologists. There he announced that Brøgger was correct and that American geologists, including Walcott, were wrong.

Walcott hastened to publish this new interpretation (Walcott, 1889), but could not immediately pursue all the implications in the field. He did rush to prepare a monograph on the fauna, in part rearranging some of the figures from his earlier papers and adding new data. On a quick trip south late in 1889, he found a few fossils in Tennessee on Chilhowee Mountain - though not trilobites - and took an accurate guess as to their age. "The Lower Cambrian horizon has been recognized in one place only in the Appalachian range south of New York." Walcott thought it reasonable that this age could be extended to other states, but "...there is not yet any positive paleontologic or stratigraphic evidence... (Walcott 1890, p. 536)."

The next international congress was scheduled for America, and, with other USGS geologists, Walcott set to work on one of a series of bulletins which would summarize knowledge of the American stratigraphic succession. His Bulletin 81 (Walcott, 1891a) is a treasure trove of stratigraphic and paleontologic information on all reports of Cambrian up to that time. In it, Lower, Middle, and Upper Cambrian are distinguished and generally correlated in terms of relative thickness somewhat more accurately than in his 1890 monograph. Once the congress left Washington, Walcott could again get out into the field.

"In company with Mr. Bailey Willis and Prof. H. D. Campbell an examination was made of the Balcony Falls section along the line of the James River. It failed to bring to light any traces of organic remains other than the *Scolithus* that occurs in the massive quartzite below the ferriferous shale at the western end of the gorge. On the following day [September 9, 1891] well preserved specimens of a species of *Ptychoparia* were discovered in the shale, by the roadside, about a mile south of Natural Bridge and one-fourth of a mile north of Gilmore, on the James River. Crossing the James on the south side and opposite Gilmore, in company with Mr. Willis, a search was made for fossils in the strata above the *Scolithus*-bearing quartzite of the Balcony Falls section. At a point on a small brook about three-fourths of a mile from the river a calcareous sandstone was found to contain the heads of a species of *Olenellus*, like *Olenellus thompsoni*, and *Hyolithus americanus* and *H. communis* (Walcott, 1892, p. 52-53)." In his field notes, Walcott mentioned "Follow up brook about 3/4 mile to sandstones passing over limestones. Exposure of vertical layers on east side in bank 20 feet high" (Smithsonian Institution Archives).

Put even more simply "In September, 1891, I discovered the *Olenellus* fauna at the summit of the Balcony Falls section, and the Upper? Cambrian in the shale east of Natural Bridge" (Walcott, 1891b, p. 534). What Walcott had done was to find the first *Olenellus* south of New York. As he wrote later (Walcott, 1896, p. 27), "The key to the succession of the lower sedimentary rocks of Maryland and Pennsylvania is contained in the Balcony Falls section of Virginia...."

It was that and a great deal more. Walcott had demonstrated that the so-called Potsdam Sandstone of the south was far older than was generally thought. From Balcony Falls he moved south, finding *Olenellus* in the rocks and clarified section after section. Later, he straightened out this part of the stratigraphic column in Pennsylvania and Maryland. Not incidentally, he had also positioned a great sequence of limestone within the Cambrian, differentiating it from the Late Cambrian-Early Ordovician limestones and further clarifying our understanding of historical geology and structural features of the mountain chain.

Walcott did not publish on his various finds of the *Olenellus* fauna. Many identifications of fossils were done in the field as Walcott visited various field parties and his efforts are reflected in the accuracy of the mapping in the "Atlas of Geology", the great folio series of the Geological Survey.

Although a century later there is still disagreement as to the assignment of some strata to the Precambrian or basal Cambrian, it is a minor problem compared to that of the past. Beginning with his discovery at the James River, Walcott had placed the base of the Cambrian firmly throughout the Appalachians.

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# THE CHARCOAL IRON INDUSTRY IN VIRGINIA

T. T. BRADY[1]

The history of iron production in Virginia starts in 1619, when the first charcoal iron furnace was built on Falling Creek (Figure 1) near the James River, about six miles south of Richmond. On Good Friday in March 1622, indians mounted an attack which resulted in the furnace being destroyed, workers killed, and tools thrown into the river. Three children were the only surviors of the massacre. Although attempts were made, during later years, to rebuild the facility they were unsuccessful.


Figure 1. Historical marker on U.S. Highway 1, Chesterfield County.

There was no successful iron venture for nearly 100 years following the catastrophe at Falling Creek. In 1714 Governor Alexander Spotswood began producing iron in his Spotswood (Tubal) furnace near the Rappahannock River west of Fredericksburg. This was the beginning of the successful iron industry in English America. The industry continued to expand in Virginia with furnaces and forges established primarily west of the Blue Ridge usually close to water transportation (Figure 2). The peak was reached in the period 1826 to 1850, with some 45 furnaces and forges being erected.

Many of the furnaces changed ownership several times and the name often changed with the new owner. For example "Glenwood" (Figure 3) was once known as "Cassandra", "White Rock" as "Panic", "Elizabeth" (in Augusta County) as "Ferrol" and there were others. Many furnaces were named for the wife or daughter of the ironmaster, that is, Rebecca, Jane, Grace, and Henrietta.

For more than 150 years, this industry was vital to the economy, and war efforts of the colonies, the state, and the nation, and thus many furnaces were the targets of military operations during the Revolutionary and Civil Wars. Some were attacked and destroyed as many as three times during the later conflict.

During the charcoal iron era many furnaces were eminent for awhile, then faded from the scene to be replaced by another. Some of the more prominent ones from 1714 to the end of the era were: Bristol Iron Works, Accokeek, Fredericksville, Spotswood, Marlboro Iron Works, Etna, Mossey Creek, Isabella (Redwell), Bear Garden, Cloverdale, Catawba, Lydia, Catherine(Page County), Glenwood, Lucy Selina, Arcadia, and Boom.

The critical importance of these furnaces was reached in 1862 during the Civil War when the Tredegar Iron Works, in Richmond, had to produce its own pig iron to reach a firm agreement with the Confederate government for supply. Charles Dew records in "Ironmaker to the Confedercy" that Joseph Anderson in July 1862, in a letter to General Branch, said: "Everything must stop unless we go into the mountains and purchase and operate blast furnaces to make pig iron." Dew further records that, "The Tredegar owners had to rebuild stacks and replace machinery at furnaces long out of blast, find competent managers, aquire teams and wagons for hauling ore, timber, and pig iron, and , most difficult of all, providing food and clothing for their hundreds of furnace laborers and obtain transportation for these items."

In this effort to insure an adequate supply of pig iron, Tredegar acquired 10 furnaces in the Alleghany and Blue Ridge Mountains and in the Shenandoah Valley. Of the 10 only four (Cloverdale, Grace, Glenwood, and Columbia) were in blast when acquired. Elizabeth Furnace, located in the northern Shenandoah Valley was exposed to the Union Army and was not put into operation. The remaining five (Australia, Caroline, Catawba, Jane, and Rebecca) required extensive repairs before being put into blast. Even with major effort, Tredegar, for the duration of the war, never received enough pig iron to operate much above one-third capacity. Some owners struggled on for a few years after the Civil War, but the loss of the almost free labor, the higher grade ores discovered in Minnesota, and the use of coal (coke) as a fuel made the charcoal iron furnace uneconomical and thus its demise.

To insure a successful iron operation, four primary factors were required. The first was an abundant supply of relatively high grade ore which was reasonably easy to mine. The second was an adequate supply of timber to make charcoal for fueling the furnace. The third a reliable water source to power the bellows to provide forced air to the furnace, and fourth, a supply of limestone used as the flux in the iron making process. There were, however, some departures from the limestone requirement. Spotswood used oyster shells in his furnace at Tubal, and Jordan used marl in the Westham Furnace in Richmond, which was hauled by canal boats from Buena Vista, as was the ore.

Surface or pit mines were made by trenching the iron deposit and recovering the ore. Spoil was shoveled to the side in flat-lying areas but in hilly areas it was either hauled to spoil piles, which created sinuous ridges, or used as valley fill. As this "surface ore" was depleted, shaft and slope mining was used to recover ore.

Iron deposits in Virginia are of four main types: limonite, hematite, magnetite, and carbonate (Gooch, 1954). The major production was from limonite deposits with Virginia

[1] Mr Brady's interest in the charcoal iron industry developed from surveying trips in the 1920s with his father in the Rockbridge County area.

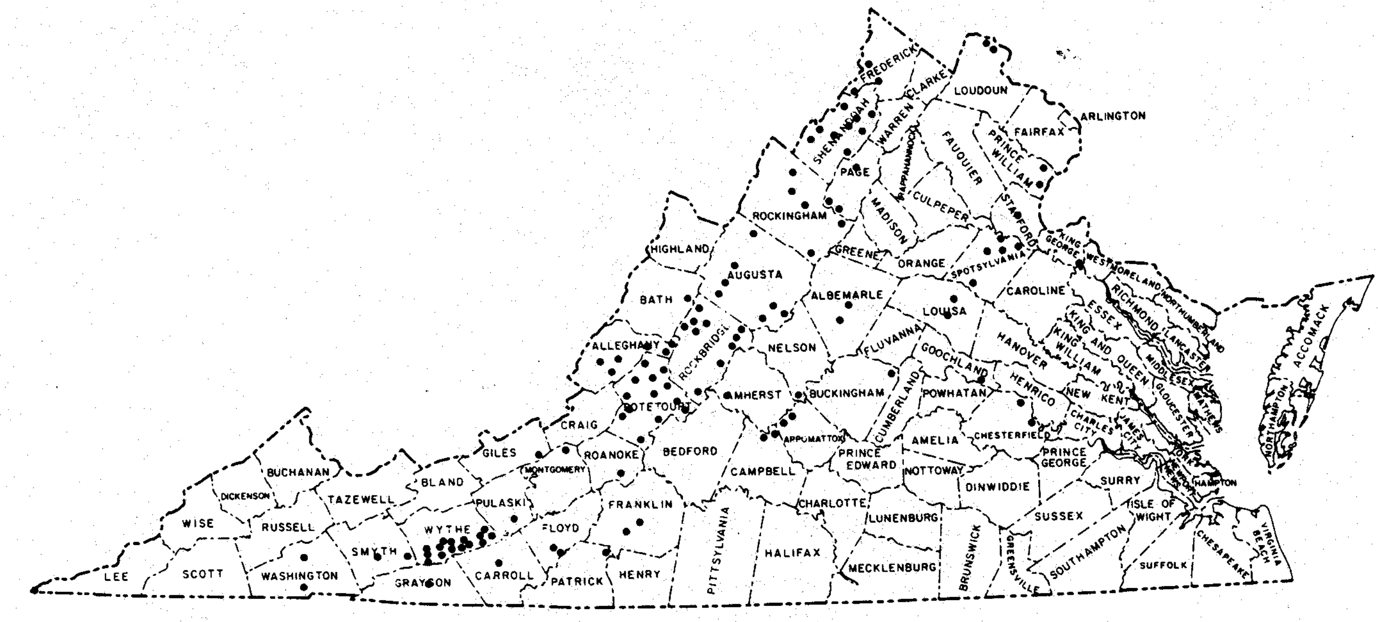


Figure 2. Map showing confirmed furnace sites, January 1987.

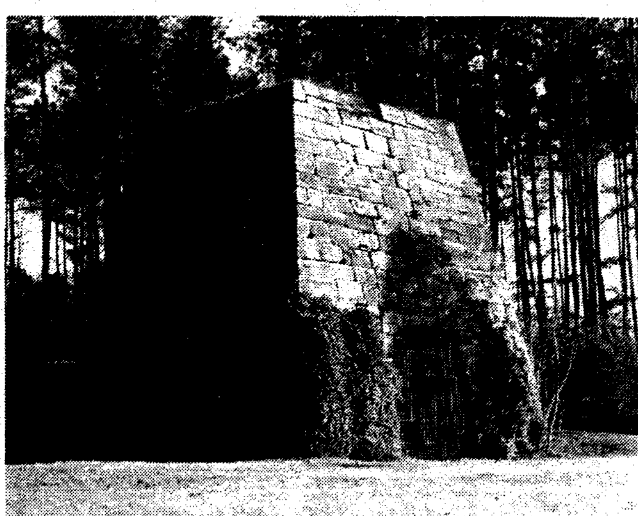

Figure 3. Glenwood furnace in Arnold Valley, Rockbridge County.

leading the nation from 1800 to 1901. Hematite deposits ranked second in production with magnetite deposits third; carbonate deposits were produced in small quantities that were incidental to limonite mining.

Limonite can be found within the Oriskany Sandstone as shallow residual deposits, as gossan deposits, and as deposits along faults. Limonite within the Devonian-age Oriskany Sandstone is the major source of the state's iron. It occurs in the western part of Virginia in the Valley and Ridge physiographic province. Limonite ore is also found in the Devonian-age Licking Creek Limestone and Millboro Shale. The iron is thought to be concentrated in the underlying sandstone and limestone from erosion of disseminated iron in the overlying shale. Continuous ore bodies can have a thickness of 8 to 25 feet and extend to 0.5 mile in length. Shallow residual deposits occur mainly in Pulaski, Wythe, and Smyth Counties, where the limonite is found in clays dervied from weathering of limestone. Gossan deposits are developed mainly from weathering of iron sulfides such as pyrite and pyrrhotite. Most of these deposits were mined in Carroll, Grayson, Louisa, and Spotsylvania Counties. Fault deposits, with either pyrite veins or iron-bearing limestone which have been altered to limonite, have been mined in Pulaski and Montgomery Counties.

Hematite has been mined in the Clifton Forge, Roanoke, Jonesville, and Lynchburg areas. Deposits from the Clifton Forge and Jonesville areas are found in the Silurian-age Rose Hill Formation. Roanoke area deposits are from Cambrian-age shale and quartzite. Near Lynchburg, hematite occurs in the Mount Athos quartzite.

Magnetite deposits occur mainly in Pittsylvania, Franklin, Patrick, Carroll, Grayson, Amherst, and Nelson Counties. A large magnetite occurrence in Pittsylvania County occurs as lenses in schist.

In selecting a furnace site it was necessary that the furnace stack be situated adjacent to a hill or ridge from which a bridge could be built to the top of the furnace for loading charcoal, limestone, and iron ore. Space had to also be provided in this high ground for the charcoal house and for the storage of limestone and ore. The site also had to have an adequate water supply to power the water wheel for the bellows. A reasonably level area adjacent to the furnace was needed to accommodate the casting floor.

Most furnaces in Virginia were truncated stone pyramids measuring generally about 30 feet square at the base and from 25 to 35 feet high. They were built with at least two arch openings and occasionally three. The main arch was the casting arch and the other one or two were for the induction of the forced air to increase the fire temperature. The reason that most furnaces were in the range of 25 to 35 feet in height was governed by the fact that with heights greater than 35 feet the sheer weight of the charge in the furnace would crush the charcoal at the bottom, thus sealing off the air blast to the fire. There are three known instances in Virginia where there was a departure from the standard truncated pyramid. Catawba Furnace in Botetourt County was built as a frustum of a cone, Boom Furnace in Pulaski County is a truncated pyramid of stone to a height of about 15 feet with a brick frustum of a cone on top of that, of about 15 feet. Speedwell Furnace (Figure 4) on Cripple Creek in Wythe County is a modified truncated pyramid with the exterior wall built in "steps", much like the Mayan monuments in Central America.

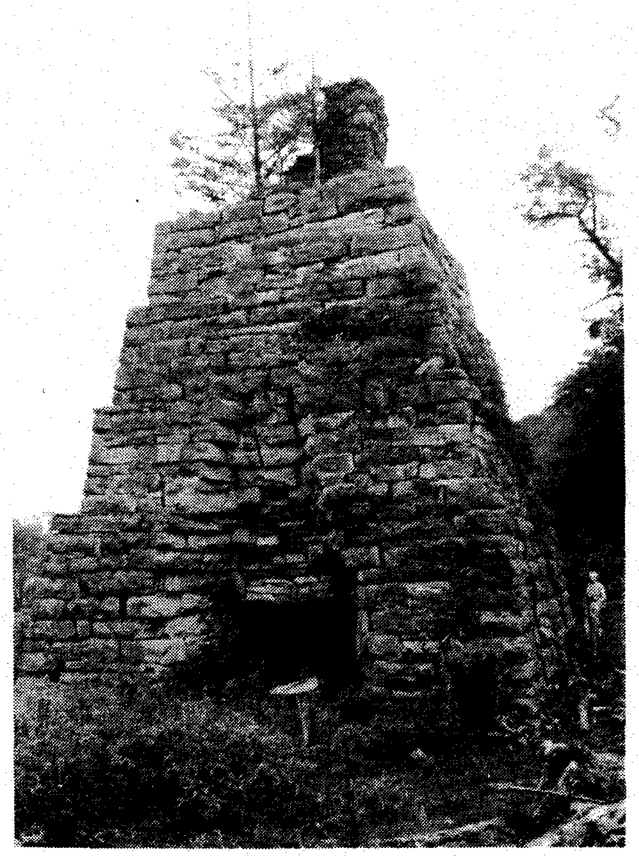

Figure 4. Speedwell furnace on Cripple Creek, Wythe County.

Diderot's Encyclopedia (1777-1779), a mid-eighteenth century French publication, contains detailed drawings of charcoal furnaces with very descriptive construction information. The extant furnace stacks in Virginia follow very closely these designs (Figure 5).

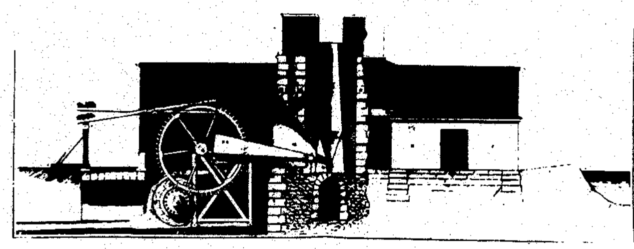

Figure 5. Cross section view of 18th century blast furnace.

To begin operations the furnace was loaded from the "bridge" with the proper proportions of charcoal, limestone, and ore. To produce one ton of pig iron at the Elizabeth (Ferrol) Furnace, in Augusta County, these proportions were recorded as : 4507 lbs of ore, 891 lbs of limestone, and 115 bushels of charcoal. When the stack was completely filled the charcoal was lighted at the top and allowed to "fire" all the way to the bottom. At that time, the bellows were put in operation to begin the forced-air blast required to bring the temperature to 2300° to 2500°F to melt the ore. As the ore melted and the charge began to settle, additional ore, limestone, and charcoal, in the proper proportion, were continually added to the furnace. In the smelting process, the limestone acted as a flux and produced a slag containing impurties which, being less dense, collected on the surface of the molten iron.

On an average of twice daily, the "Furnace Man" would use a long iron probe to break away the clay door in the crucible and allow the molten iron to run out onto the casting floor and into molds which formed the pig iron. The slag was extracted by a similar process, but through a clay door above the level of the molten iron. Once the process was completed, the clay door was replaced with fresh clay. The furnace was kept in continuous operation, generally for 12 to 15 weeks, stopping only when the crucible had to be rebuilt or for some failure in the air system. Most operated for 30 to 35 weeks during a year and produced from 900 to 1200 tons of pig iron.

Pig iron was by no means the only product produced at a furnace. At many furnaces casting were produced in the form of useful and necessary items for the community. Typical castings were: firebacks, andirons, gudgeons, stoves, ovens, skillets, pans, mortars and pestles, and pots. Annual tons produced at a furnace were much less when casting utensils than when making pig iron. Cast items sold for about $100 per ton while pig iron would bring $75 per ton.

This was a labor intensive industry. Weaver's records indicate that he employed 150 worker at his Bath Iron Works, which was situated at the western end of Goshen Pass, Rockbridge County.

The production of the charcoal required an extensive work force at each furnace. When the furnace was not in blast, those who normally operated the furnace cut wood. A cord of wood would generally produce 40 bushels of charcoal, and on average it required 200 bushels of charcoal (five cords of wood) to produce one ton of pig iron. The quarrying of limestone and digging of ore also required considerable manpower.

An ironworks, furnace or forge, was frequently known as an Iron Plantation. These were self-sustaining operations, often in remote locations, requiring growing food and fiber for men and beasts, making tools and equipment, building roads and providing for the necessities of life. Buffalo Forge had a forge, blacksmith shop, post office, owner and worker houses, stable, grist mill, leather shop and granery.

The primary function of a furnace was to reduce iron ore to pig iron or castings. A forge, further refined the pig iron, through heating and hammering with a trip hammer producing bar iron, which was malleable (Figure 6) This bar iron became the source metal for the blacksmith to make wagon tires, horseshoes, hinges, nails and tools. A foundry was strictly a casting operation, in which pig iron, from a furnace was again melted and cast into the desired product.

Figure 6. Forge with trip hammer.

An ironmaster, such as William Weaver, was the entrepreneur - who put it all together, and risked it all, in a free-enterprize venture to make a profit for himself and provide an improved standard of living for those in his employ. Besides Weaver, some other prominent ironmasters during the charcoal-iron-era in various Virginia counties were David Ross in Campbell, Izaac Zane in Frederick, Direck Pennybacker in Page and Shenandoah, Miller in Augusta, and John Jordan in Rockbridge. There were of course many others who struggled to make a success of their ventures in iron.

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Table 1. Charcoal iron furnaces in Virginia.

| | |
|---|---|
| **Albemarle** | Albemarle Iron Co. |
| | Old's |
| **Alleghany** | Australia |
| | Blue Spring |
| | Clifton |
| | Dolly Ann |
| | Lucy Selina |
| | Rumsey |
| **Amherst** | Amherst |
| **Appomattox** | Le Grange |
| | Stonewall |
| **Augusta** | Cotopaxi |
| | Elizabeth (Ferrol) |
| | Estaline |
| | Kennedy |
| | Mossy Creek |
| | Mount Tory |
| | Siberton |
| **Bath** | Panther Gap #2 |
| **Botetourt** | Arcadia |
| | Callie |
| | Catawba |
| | Cloverdale #1 |
| | Cloverdale #2 |
| | Etna |
| | Grace |
| | Jane |
| | Martha |
| | Rebecca |
| | Retreat |
| | Roaring Run |
| | Salisbury |
| **Buckingham** | Bear Garden |
| **Campbell** | Calloway |
| | Oxford |
| **Carroll** | Cranberry |
| **Chesterfield** | Falling Creek |
| **City of Richmond** | Westham |
| **Floyd** | Shelor's |
| | West Fork |
| **Franklin** | Carron |
| | Washington |
| **Frederick** | Marlboro Iron Works |
| | Taylor |
| | Zane |
| **Giles** | Sinking Creek |
| **Goochland** | Manakin |
| **Grayson** | Point Hope |
| **Lee** | Cumberland Gap |
| **Loudoun** | Cocatin |
| | Potomac |
| **Louisa** | Rough & Ready |
| | Victoria |
| **Montgomery** | Broce's |
| **Nelson** | Elk Creek |
| **Page** | Catherine |
| | Isabella (Redwell) |
| | Shenandoah #1 |

Table 1. (continued)

| | |
|---|---|
| **Patrick** | Union |
| **Prince William** | Neabsco |
| | Occoquan |
| **Pulaski** | Boom |
| | Radford |
| **Roanoke** | Speedwell |
| **Rockbridge** | Buena Vista |
| | California |
| | Glenwood |
| | Grant's |
| | Jordan's |
| | Lydia (Bath Iron Works) |
| | Moore's |
| | Mt Hope |
| | Panther Gap #1 |
| | Vesuvius |
| **Rockingham** | Faussett |
| | Margaret Jane |
| | Marshall |
| | Oakland |
| | Shenandoah #2 |
| **Shenandoah** | Caroline |
| | Columbia |
| | Elizabeth (Fort) |
| | Henrietta |
| | Liberty |
| | Mine Run |
| | Paddy |
| | Van Buren #1 |
| | Van Buren #2 |
| **Smyth** | Thomas |
| | White Rock |
| **Spotsylvania** | Catherine |
| | Fredericksville |
| | Gryme's |
| | Massaponax |
| | Spotswood (Tubal) |
| **Stafford** | Accokeek |
| **Washington** | Paulina |
| | White's |
| **Westmoreland** | Bristol Iron works |
| **Wythe** | Barren Springs |
| | Beverly |
| | Brown Hill |
| | Cave Hill |
| | Cedar Run #2 |
| | Eagle |
| | Foster Falls |
| | Ivanhoe |
| | Noble |
| | Popular Camp |
| | Raven Cliff |
| | Speedwell |
| | Walton |
| | Wythe |

## MINERAL UPDATE

# STRENGITE, A NEW MINERAL FROM THE MOREFIELD PEGMATITE MINE, AMELIA COUNTY, VIRGINIA

John R. Smerekanicz[1], Francis Ö. Dudás[1], and William D. Baltzely[2]

Strengite, a hydrous iron phosphate ($FePO_4 \cdot 2H_2O$), has been added to the list of mineral species recorded from the Morefield pegmatite mine. X-ray powder diffractometry was used to identify strengite, which occurs as 1 to 3 mm rosettes of bladed, deep-violet colored crystals. It also occurs in poorly crystalline masses that comprise a lavender, powdery crust on several samples. Data on the physical properties were not obtained since sample material is very limited.

The samples were collected by Baltzely, December 1990, during examination of material freshly extracted from the mine. Strengite occurs in association with triplite $(Fe,Mn)PO_4$. Glass (1935) reported that triplite at the Morefield mine occurs as translucent, salmon-colored, crystalline masses about 2 cm in diameter, usually surrounded by zones of brownish-black triplite embedded in a matrix of black, manganese-stained albite (variety cleavelandite) and quartz. The strengite-triplite samples, collected by Baltzely, show this same mode of occurrence with larger pods of triplite. The material analyzed was mined from the 50-foot level of the northeast mine drift.

Strengite has been reported in Virginia, but not from the Amelia County pegmatite provenance. It was initially reported associated with the mineral dufrenite (hydrated ferroan phosphate) in Rockbridge County (Dana and Ford, 1949) and later with rockbridgeite (hydrated ferroan-manganoan phosphate) from the same location (Barwood and Zelazny, 1982; Dietrich, 1970, 1990; and Kearns and Penick, 1989). Strengite also has been reported as occurring in areas of the western part of the Virginia Piedmont Province and in the Ridgeway-Sandy Ridge district of Virginia and North Carolina (Dietrich, 1990, and Jahns and others, 1952).

Strengite is commonly found as a secondary (or hydrothermal) mineral in pegmatites that have phosphate-rich phases, such as triplite. The primary and secondary phosphates found in pegmatites are among the most structurally complex in the mineral kingdom (Moore, 1982).

The Morefield pegmatite mine has a long history of ownership and development for various resources, such as feldspar, mica, and gemstones. The reader is referred to Sweet and Penick (1986) for a through description of the mine's history and general geology. The mine lies 3.8 miles east-northeast of Amelia, Amelia County, Virginia, 0.4 mile off the northeast side of State Road 628, just south of U.S. Highway 360 (see Figure). The mine, now a fee operation of Powhatan Mining Company (804/561-3399), is operated for the recovery of gemstones and for recreational mineral collecting.

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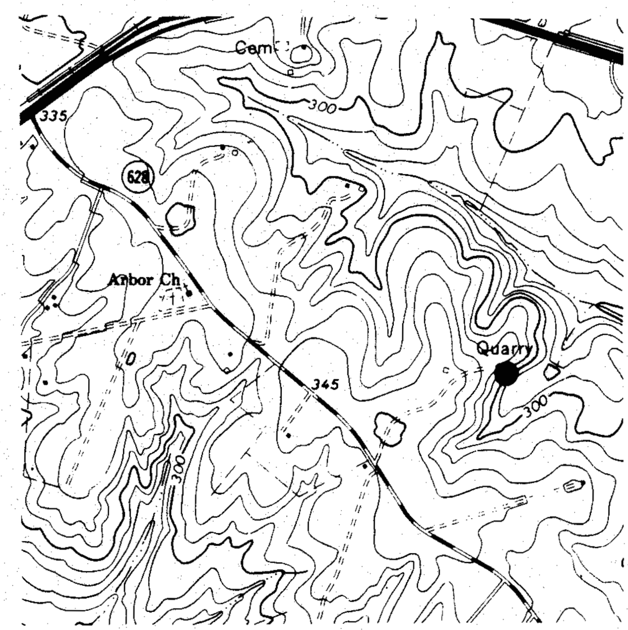


Figure. Location map for Morefield pegmatite, Amelia County, 3.8 miles east-northeast of Amelia Courthouse (Amelia Courthouse 7.5-minute quadrangle; scale - 1:24,000).