THE LINDSAY GREENBANK COLLECTION

CLASSIC MINERALS OF
NORTHERN ENGLAND

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EDITOR

Wendell E. Wilson

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FRONT COVER:
Top: Fluorite, 4.6 cm, from the Hilton mine, Westmoreland (see page 106); *Bottom, left to right:* Fluorite from the Blue Circle cement quarry, Weardale, Durham (see page 77); Calcite (cobalt-rich), 5 cm across, from the Tynebottom mine, Alston Moor, Cumbria (see page 69); Barite, 7.5 cm tall, from the Dalmellington mine, Frizington, Cumbria (see page 131); Quartz crystal, 4 cm, on hematite, from the Florence mine, Egremont, Cumbria (see page 128); Fluorite twin, 6 cm, from the Boltsburn mine, Weardale (see page 80).

BACK COVER
Calcite, 12.5 cm, from Egremont, Cumbria (see page 124).

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CONTENTS

The Stank mine in the South Cumbrian Iron Orefield in the late 1800s, source of many fine crystallized calcite crystal clusters which reached the mineral market through dealers such as Francis Butler, George L. English and A. E. Foote.

INTRODUCTION

by Michael P. Cooper

Mining and mineral collecting in northern England has a long and illustrious history. The production of important quantities of lead, silver, copper, iron, barite and fluorite extended over several centuries and almost every major deposit yielded specimen material for collectors and scientists alike. The output of these minerals and ores from the mines of Cumberland, Durham and Northumberland made a huge and crucial contribution to England's wealth and strength. The mines furnished raw materials for its rise to power during the 19th century when it was expanding its influence on every front at an unprecedented rate.

The sights and sounds of mining in the northern counties now linger only in the memories of a few, but not everyone was sad to see the mines go: tales of corruption, moral and ecological, have always dogged mines and miners and there will always be a divide between those who see the remaining shafts, dumps, and opencasts as unsightly scabs and those that esteem them as honorable scars. Nowadays, surface evidence of mining is mostly restricted to the barren heaps of waste rock and gangue discarded during mining—the mine buildings, shaft heads, and elaborate ore treatment and smelting plants have long since decayed into ruins or been swept away in a tide of environmental improvement. But, regardless of how the mines themselves and their environmental and social legacy may divide us, the mineral specimens from Northern England unite almost everyone in an appreciation of their beauty. In museum cabinets and private collections the world over, the names of these famous mines are still associated with the specimens as testimony to a once powerful and valuable industry and to ore deposits that were once at the forefront of social change and scientific and industrial development. Above all, these treasured specimens still fire the imagination and wonder of collectors and curators, and provide evidence of spectacular and unique mineral occurrences the like of which we will never see again.

The Romans are known to have mined mineral ores from the northern deposits, and documentary evidence of their work can be traced at least as far back as the 12th century. The collecting of minerals—at least in the scientific, social and aesthetic ways in which it is understood today (see Wilson, 1994)—is a much more recent development. With the rise, during the 17th century, of a scientific elite and a corresponding development of science as a gentlemanly pursuit, mineral specimens, along with all other productions of the natural world, came to be esteemed not only as tools with which to grasp the fundamental truths of nature, or as guides to hidden, exploitable wealth, but, increasingly, as objects desirable in their own right, worthy of a place in a gentleman's "cabinet of curiosities."

As collecting *per se* became more popular in England, especially following the establishment of the institutional museum culture driven by the founding of the British Museum in 1753, there developed a corresponding realization that commerce in these items could be a profitable occupation. Dealers in minerals and other natural curiosities began to appear in significant numbers during the 18th century and had become almost commonplace by the mid-19th century. The commercial pressure that these people exerted served to preserve many specimens that otherwise would have been crushed for ore or thrown away as useless waste. The largest concentrations of such men and women were, naturally, in the metropolitan centers near to their principal—and, at first, essentially aristocratic—clientele or in areas near the sources of desirable natural productions. As time went by, the collecting community became less exclusively aristocratic, and the collecting mentality shifted from that of the gentleman amateur to that of the educated professional or the successful entrepreneur.

As transport became easier, especially with the development of the railway network, travel to the mining areas became more practical for those interested in getting closer to the source. Increasing numbers of people traveled in search of the grandeur of nature, to shiver in awe or gasp in wonder, especially at the powerful scenery of the Cumbrian Lake District, the early home of the British tourist industry. To serve the visitors' needs for souvenirs, the nascent tourist industry was quick to exploit and celebrate local resources. Private museums were established in Keswick—at the heart of the tourist trade—in the late 18th century and sold, among other things, minerals from the northern mines. It took a few decades for dealers to establish themselves closer to the sources—the mines themselves—but by the 1820s the bleak and isolated mining village of Alston had become a center for mineral dealing and remained so until the decline of the local mines later in the 19th century.

Mines on Alston Moor and in the rich deposits to the east in Weardale and Allenheads produced some of the finest mineral specimens ever seen, and in such profusion that there can be no major public collection today without a representative suite of specimens. Not only was the specimen quality remarkable, but the deposits themselves were sometimes uniquely rich. Take, for instance, the mineral witherite, a barium carbonate uncommon elsewhere in the world: mines near Hexham produced hundreds of thousands of tons of this mineral alone.

The earliest documented northern metal mines centered on Alston Moor, and some of the earliest known northern mineral dealers (around 1800) made the town their base. As time went by the focus of mining and mineral specimen collecting broadened to include first the Caldbeck Fells, whose ancient copper and silver-lead mines were reworked to great effect between 1770 and 1870, and then the great iron deposits of west Cumberland, where the vast production of high-grade hematite ore was only matched by the equally spectacular production of mineral specimens, among them some of the finest calcite and barite specimens the world has ever known.

Although mining and specimen production continued well into the 20th century, competition from abroad forced metal prices down, causing many mines to close in the late 1800s. When the mines closed, the flow of specimens dwindled and eventually ceased. Nevertheless, the potential for fine mineral specimens remained: in abandoned galleries and quarries, pockets of crystals still awaited the collector. But collecting itself dwindled in popularity during the first half of the 1900s, and although the superb specimens that continued to be produced from the west Cumbrian mines still found a ready home in collections around the world, fewer collectors and even fewer dealers were active in England. It was not until the 1960s that a fervor for mineral collecting arose once again in England, and the old mines and dumps began to be searched for their remaining specimens.

Particularly active at the time was Tony Walshaw, who by the mid-1960s had become Lindsay Greenbank's principal mineral field-collecting partner. Greenbank and his later collecting partners (Mick and Brenda Sutcliffe, Ralph Sutcliffe, Richard Barstow, and his future wife Patricia) were all instrumental in this trend by the late 1960s. In a final flurry of activity in the 1970s and 1980s, some of the deposits were reworked for barite and fluorite, as well as iron ore at the Beckermet mine until its closure in 1982; and a new period of plenty visited the renewed mineral market. But this was short-lived and yet again the mines closed in the face of cheaper supplies from abroad. Collectors of even these recent productions must now await the recycling of old collections on the mineral market.

At one time it must have seemed that the supplies of mineral specimens from northern England were limitless. Hundreds of thousands of specimens came and went, collections blossomed, and serious sums of money changed hands. But whatever the beauty and the cost of the specimens, as the mines closed, as collectors died or lost interest, the fate of these collections and the continued preservation of the minerals within them was as much a matter of luck as judgment. Even their continued preservation in museums was not guaranteed, as shifting priorities and fashions usurped systematic mineralogy from its once prominent position, and tightened budgets made the purchase of new material impossible. For a time, the long-established mechanism of specimen exchange helped many natural history museums remain active in the marketplace. But their supply of classic old material was limited, and making beneficial exchanges became increasingly difficult.

Modern collectors have reopened many old specimen-rich sites, and much excellent material has been obtained. However, even this risky enterprise is under threat as increasing numbers of sites are being permanently filled in or blocked, and responsible authorities are restricting access or banning collecting altogether.

Arms of the Society of the Mines Royal, given in 1568. From John Pettus's *Fodinæ Regales* (1670).

THE LINDSAY GREENBANK COLLECTION

by Michael P. Cooper

Connoisseurs of mineral specimens regard many of the occurrences in northern England as classics. Ownership of fine examples is something that many aspire to or dream of, but it takes serious application, perspicacity, and perseverance to track down such specimens today, not to mention a good network of contacts, a talent for negotiation and the deep pockets necessary to pry them from the hands of their often-reluctant owners. As is typical of old classics, most of the connoisseur-quality specimens that have survived are now in museum collections; there is but a small proportion still in circulation among private collectors and fewer still are available by other means. Today's would-be collector of fine northern England minerals is thus faced with a difficult task.

It is doubly remarkable that the occurrences in northern England continue to feature in many lists of the best of species: not only has it been a long time since their heyday, but several of the minerals are very common and are known from hundreds of mines throughout the world in superlative specimens. Nevertheless, the old British classics remain a touchstone for other finds. The witherite, calcite, fluorite, barite, linarite, barytocalcite and plumbogummite have never been beaten, mimetite from Dry Gill (the variety known as *campylite*) is unique, and the recent finds of boracite from Boulby mine have set new standards for the species. Fine specimens of all of these minerals are to be found in the Greenbank collection.

The Lindsay Greenbank collection is remarkable not only for the fine quality of its specimens, its rich history and the detail of its documentation, but also for the fact that such a fine collection is in private hands at all. Although earlier collections have been assimilated into Lindsay's, it is today truly the collection of one man, since it is his careful research and documentation that have given these 500 or so specimens the conceptual coherence of a single unit. It would be almost impossible to build a collection like this today: the more recently collected specimens are the last gasp of old and dangerous mines or the final products of modern (and now abandoned) reworking of old sites, and many of the historic pieces are those acquired from museums whose reserve collections are now depleted or whose rewritten collection policies have eliminated curatorial freedom to exchange irreplaceable classic material for new acquisitions.

Any collector's first reaction to the Greenbank collection must focus on the beauty of many of the specimens. The informed viewer will appreciate that here is a remarkable set of old-time and modern classics, some among the finest of their kind. On closer examination, the mass of carefully collated supporting data would impress anyone: these data not only preserve the detailed provenance of each specimen, but also inspire the realization that so many other people, some famous, some not, have handled these pieces and by their choice of them have left something of their own personalities to travel with them from collector to collector. In some cases the acquisition of this information took more care and perseverance than the acquisition of the specimen itself. Scrupulous historical research and patience have been necessary to separate truth from rumor, to trace old collectors or to track down the specimen data in collection archives. For the modern specimens there are painstaking location details: maps, site photographs, and accounts of the occurrence. Many of these pieces were dug by Lindsay himself, or his close friends, and the accounts are thus supported by first-hand experience.

Table 1. **Species (and number of specimens) represented in the Greenbank collection (2003).**

Alstonite (14)	Chalcopyrite (2)	Pharmacosiderite (1)
Analcime (1)	Chrysocolla (1)	Philipsburgite (1)
Anglesite (1)	Cosalite (1)	Plumbogummite (8)
Ankerite (4)	Dolomite (2)	*Psilomelane* (1)
Annabergite (1)	Fluorite (122)	Pyrite (6)
Apatite (1)	Galena (21)	Pyromorphite (17)
Apophyllite (1)	Garnet (1)	Pyrrhotite (5)
Aragonite (3)	Gersdorffite (1)	Quartz (11)
Arsenopyrite (3)	Hematite (15)	Scheelite (3)
Azurite (1)	Hemimorphite (4)	Siderite (2)
Barite (43)	Hilgardite (3)	Smithsonite (1)
Barytocalcite (10)	Joseite (3)	Sphalerite (15)
Bayldonite (2)	Leadhillite (4)	Stolzite (1)
Beudantite (1)	Linarite (9)	Strontianite (1)
Bismuth (2)	Magnesite (1)	Susannite (1)
Boracite (4)	Malachite (1)	Tennantite (1)
Brochantite (1)	Marcasite (2)	Trembathite (2)
Calcite (72)	Mattheddleite (1)	Ullmannite (1)
Caledonite (3)	Millerite (1)	Witherite (28)
Carminite (2)	Mimetite (21)	
Cerussite (5)	Nickeline (1)	

November 1889

MEMORANDA OF INTEREST

ON MINERALS IN THE STOCK OF

GEO. L. ENGLISH & CO.

English Minerals.—We received during October one of the finest consignments of English minerals ever sent to America. The best and largest Egremont Twin Calcites ever offered for sale in the U. S. are now in stock; prices $2.50 to $17.50. Small and choice twins, 50c. to $2.00. Clear single crystals, 5c. to $2.00; groups of clear crystals, 25c. to $5.00. From the Bigrigg Mine, near Egremont, we have a number of very beautiful groups of clear crystals, an entirely new find; hand specimens, 25c. to $2.50; museum specimens, $3.50 to $7.50. From the Stank Mine, Lancashire, we have a superb lot of these ever popular Calcites, many of them delicately tinted by iron; hand specimens, 25c. to $2.50; museum specimens, $3.50 to $7.50. One of the most beautiful minerals ever in stock is the IRIDESCENT PYRITE ON CALCITE from Egremont, 25c. to $5.00. We have also a very fine stock of FLUORITES, including a large number of the rare tinted ones, such as blue, yellow, white, and green. Small green crystals, 10c. to 25c. each. Groups of purple crystals, 15c. to $2.00 hand size, $2.00 to $7.50 museum size. Blue crystals and groups, 75c. to $3.50; white crystal groups, 50c. to $2.50; yellow groups, 50c. to $2.00. ARAGONITE in radiated tufts of terminated crystals, two to four inches long, 25c. to $7.50. HEMATITE, brilliant crystals with quartz, 10c. to $3.50. KIDNEY ORE, very good, 25c. to $1.00. CASSITERITE, small crystal groups, 10c. to 50c. DOLOMITE, IRIDESCENT, choice specimens, 25c. to 50c. BARITE, a splendid stock of fine blue crystals, also green, red, and yellow tints, 10c. to $1.50; large museum specimens, $2.50 to $10.00. CHALCOSIDERITE, the new hydrous phosphate of iron, etc., in fine groupings of small green crystals, 25c. to $2.50. CHALCOTRICHITE, the needle-like crystals of the red oxide of copper, very beautiful, 25c. to $2.00. CELESTITE, from Yate, Gloucestershire, in fine groups of tabular crystals, 50c. to $2.50. CHALCOCITE in fine, distinct crystals, 25c. to $2.00. BOURNONITE, very large crystals and clusters, 25c. to $2.00. KAMPYLITE, the rare English variety of MIMETITE, 50c. to $2.50. OLIVENITE, PHARMACOSIDERITE, SCORODITE, LIROCONITE, CHALCOPHYLLITE, LIBETHENITE, and other rare arsenical minerals, in good specimens, 50c. to $2.50. GÖTHITE in slender crystals, 25c. to 75c. TORBERNITE, very beautiful little specimens, at 25c. to $1.50 each.

Philadelphia mineral dealer George L. English's ad offering minerals from England in *The Exchanger's Monthly* (November 1889). He had calcite twins from Egremont; calcite from the Bigrigg mine and the Stank mine; iridescent pyrite on calcite from Egremont; blue, yellow, purple, green and colorless fluorite; "a splendid stock" of blue barite crystals, as well as green, red and yellow barite; hematite "kidney ore"; and "campylite" mimetite, and many others, all considered rare and highly desirable by collectors today. A dollar in 1889 would be worth about $25 today.

PROVENANCE
OF SPECIMENS IN THE GREENBANK COLLECTION

by Wendell E. Wilson & Michael P. Cooper

It has taken nearly 50 years to assemble the Greenbank collection. It is an amalgamation of the personal collections of a number of contemporary collectors, active from the 1960s to the present day, each, in turn, incorporating the work of earlier collectors and mineral dealers. The earliest specimen in the collection is witherite LG-474 from the collection of Philip Rashleigh (1729–1811), and the most recent specimen was mined in 2003. Each piece has been photographed and has its own individual data sheet. The collection comes with a wealth of detail, not only regarding the persons involved and the historical passage of each specimen, but also of the location where each was found. There are site data for most of the contemporary pieces, including mine plans, photographs and other papers.

Some of the more important collectors and dealers represented in the Greenbank collection (in addition to Lindsay and Patricia Greenbank themselves) are sketched below; see the Mineralogical Record's online *Biographical Archive* for additional references.

Bernard G. Amend (1821–1911)

Bernard Gottwald Amend was born in Germany in 1821 and trained as a pharmacist. In 1847 he was working as an assistant to Baron Justus von Liebig (1803–1873), Professor of Chemistry at the University of Munich, while studying chemistry at the University of Giessen. There he met American chemist Eben Norton Horsford (1818–1893), and as a result of their discussions he decided to emigrate to America in 1848.

When a faculty position at Harvard didn't work out, he took a position as chemist in a small pharmacy owned by a physician in New York City. Amend was joined later by an old college friend, Carl Eimer. The company soon became the country's leading importer of drugs and chemicals. In 1874 they added chemical laboratory supplies to their stock, and also had a glass-blowing shop in New York. Eimer retired in 1882 (and had died by 1888), leaving Amend solely in charge. In 1886 Amend built a new seven-story brick building at the same location. In 1897 the company (originally a proprietorship) was formally incorporated. They advertised "collections of metals, minerals, rocks, crystals, crystal models, etc." The Eimer & Amend company was acquired by the Fisher Scientific Company in 1940.

Amend built a substantial mineral collection, and was involved in the establishment of the American Chemical Society. He was a member of the New York Mineralogical Club, and club meetings were sometimes held at his residence at 120 East 18th Street; Amend acted as Chairman and George F. Kunz as secretary (*The Exchangers' Monthly*, July 1888). As of 1923, twelve years after his death on April 6, 1911, his mineral collection had been preserved intact by his legatees, but in the 1930's it was sold to Oscar Bodelson.

Richard W. Barstow (1947–1982)

Richard William Barstow was one of the most talented, dedicated and accomplished British mineral dealers of recent times. He started out working in the sampling office of the South Crofty mine, where he no doubt came in contact with interesting specimens; he later worked in the same capacity at the Geevor mine. By the late 1960s he was already an experienced field collector, scouting over abandoned dumps and looking for old mine entrances. He met Ralph Sutcliffe while mining in the late 1960s and they became fast friends and collecting partners.

Barstow began his mineral business in January 1973 from his home in Tregeseal, near Botallack, Cornwall, then moved to Drakewalls House, Gunnislake in 1978. He collected at many classic and recent localities and was remarkably successful in recovering good specimens, some of which he sold and others he retained; his excellent personal collection of minerals from Great Britain and Ireland was one of the finest made in the last 50 years. In the Caldbeck Fells, Richard was particularly successful with opening a large pocket of pyromorphite in the Roughton Gill vein (now remembered fondly as "Barstow's Trench").

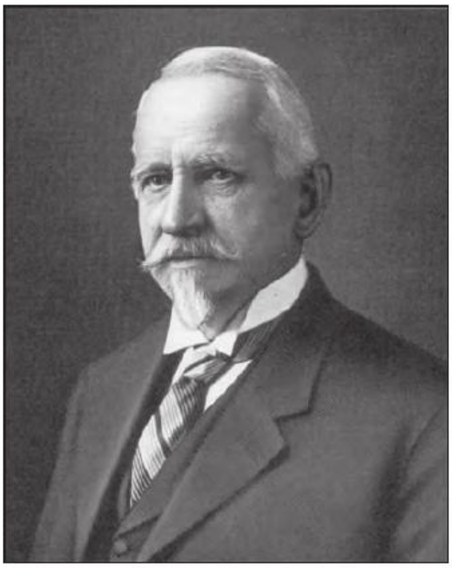
Barstow also dealt in worldwide minerals, and was instrumental in fostering the renewal of interest in mineral collecting in England which is still flourishing today. His monthly lists were very good, always containing something affordable and worth having, and his descriptions were very accurate. Unfortunately he died at the young age of 35, from liver cancer. In 1986 the Plymouth City Museum purchased a portion of his fine private collection of Cornish and Devonshire minerals for £70,000, and much of his finest northern England material was purchased from his widow, Yvonne, by Ralph Sutcliffe. Richard Barstow's name is honored in the new species *barstowite*, described in 1997.

Jean Behier (1903–1965)

Jean Behier was hired as a mineralogist with the Service Géologique, Madagascar in 1953; he helped develop the mining industry in that country. He wrote *Contribution à la minéralogie de Madagascar, deuxième partie, Service Géologique de Madagascar* (1958), *Contribution à la minéralogie de Madagascar* (1960), *Etude* *des minéralisations des plages de Madagascar* (1954), *Minerais de provincia de Moçambique* (1957), *Carte mineralogique de Madagascar* (1963), and other important works on the mineralogy of the region. The new Madagascar mineral species *behierite* was named in his honor in 1961.

Behier, in collaboration with analytical laboratories in Madagascar, France and Washington, discovered approximately 70 mineral species new to Madagascar, as well as the new mineral species hibonite. Until his death in 1965, he also worked at the organization and improvement of the Musée National de Géologie (National Museum of Geology) and the Laboratory of Mineralogy of the Service Géologique. He was responsible for the compilation of the list of mineral species forbidden for exportation, listed in the Mining Law. This list was officially compiled to "protect" the rare minerals of Madagascar, but in reality Behier probably intended to protect his own lucrative side-business in mineral dealing, so that he could remain the only person legally allowed to export minerals to museums and mineral collectors outside of Madagascar.

French dealer Alain Martaud, of Chamonix, purchased the Behier collection in 2001 and sold a number of specimens to Lindsay Greenbank.



Clarence S. Bement

Clarence S. Bement (1843–1923)

Clarence Sweet Bement was one of the greatest American mineral collectors of all time. He was born in Mishewaka, Indiana on April 11, 1843, and was an inveterate collector from an early age. He collected rare coins and books, but minerals were his abiding passion, and he always sought to obtain the very highest quality. His father, William Barnes Bement, had founded an extremely successful manufacturing firm in Philadelphia and made Clarence a partner in 1870, so money was always available for satisfying his high level of taste in specimens.

From around 1866 to 1900 Bement assembled one of the finest private collections of his or any other era, primarily by buying from the leading dealers of his day (including Bryce Wright, James Gregory and Samuel Henson in England, Emile Bertrand in Paris, August Krantz in Bonn, Bohm & Wiedemann in Munich, and A. E. Foote, Henry Ward, Lazard Cahn, George Kunz and George L. English in America). During the late 1800s he spent more than $100,000 on minerals.

In 1900 Bement sold this fabulous collection to the wealthy financier J. P. Morgan, who presented it to the American Museum of Natural History. The collection was so large, 12,500 specimens, that two railroad boxcars were needed to transport it from Philadelphia to New York. Bement died on January 27, 1923.

Maynard Bixby (1853–1935)

Maynard Bixby was born in Wyalusing, Pennsylvania June 28, 1853, the son of George Maynard Bixby and Jane "Jennie" Welles. Maynard's brother George worked as a "dry goods merchant, retail" and Maynard as "clerk in store," presumably their father's store. Maynard and his brother both graduated from Lafayette College in Easton, Pennsylvania in 1876. In 1880 Maynard worked as a bookkeeper and studied law in Wilkes-Barre, Pennsylvania, while his brother Charles worked as a bank teller, and their sister Ellen kept house for them. Maynard then traveled the country for a while, becoming involved in mining in Colorado and Arizona, and working for the Western Electric Company in Chicago. He spent a couple of years in Europe and also worked for Western Electric in New York.

Maynard Bixby took a trip to England in 1884, and enjoyed it so much that he took a similar trip five years later in 1889—perhaps these were mineral collecting trips, as he was traveling alone, was listed on the passenger manifest as a "miner," and on the return trip had five pieces of luggage! Sounds like it was a successful trip.

Bixby and his wife Katherine settled temporarily in Denver around 1890 and moved to Salt Lake City shortly thereafter. Maynard explored the Thomas Range in Utah for minerals and staked several claims for topaz. One, the Maynard claim, is still being mined for specimens. The mineral *bixbyite*, which he discovered there, was named in his honor by Penfield and Foote in 1897. The red beryl also found there was named *bixbite* in his honor, but was later discredited as a mere variety. Bixby also wrote numerous articles for *The Mineral Collector*, describing localities in Utah, Colorado, Montana and Idaho. Maynard Bixby and his wife Katherine died in San Diego, California, on February 18, 1935 and September 11, 1931, respectively.

Thomas Brown (1774–1853)

Thomas Brown of Lanfine, a Doctor of Medicine, was one of the great 19th-century Scottish mineral collectors. The son of a wealthy surgeon and banker (also named Thomas Brown) in Glasgow, he studied medicine at Edinburgh University and was appointed a Lecturer in Botany at Glasgow University in 1799, a post he held until 1815.

Brown succeeded his cousin to the Lanfine and Waterhoughs estates in 1829, and also inherited other valuable property. His written catalog of minerals was begun in 1832, but he had clearly been collecting since at least 1816, when he records finding "blende" (later shown to be greenockite) at Kilpatrick. He purchased or exchanged mineral specimens with many other collectors of his day, including Henry Heuland, James Sowerby, August Krantz, Sir William Hooker, William Nicol, Prof. William Buckland, Gideon Mantell, Archduke Maximilian, Alex Rose, and many others.

Brown eventually reached specimen number 5,473 in his catalog. Of the Lanfine mineral and fossil collection (also known as the Waterhaughs collection, after the name of his estates in Ayrshire) some 3,000 specimens were donated by his daughter to the Hunterian Museum, Glasgow University, and a further 600 minerals went to the Edinburgh University Museum. The exceptional pyromorphite from Roughton Gill, LG-30, is one of the finest Greenbank pieces from the Lanfine collection.

Francis H. Butler

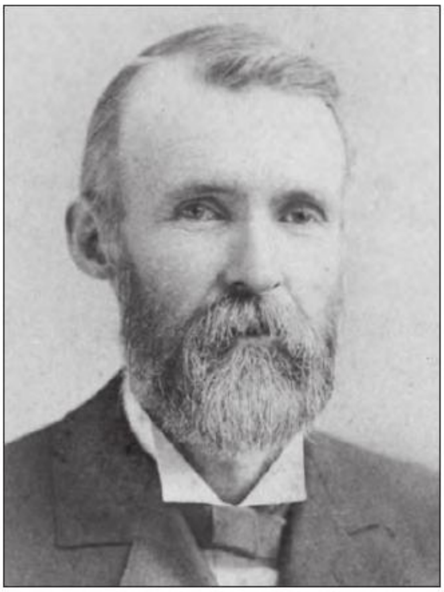
Francis H. Butler (1849–1935)

Francis Henry Butler, well-known British mineral dealer, was born on March 2, 1849 in the old Manor House where Sir Hans Sloane once had his collections (which were to form the foundation of the British Museum). He studied at the Royal School of Mines, London, 1866–69, taking the associateship in geology. After lecturing on science at Reading he matriculated at Worcester College, Oxford, in 1871, where he was an exhibitioner, and in 1874 he was placed in the first class in the natural science honor school. In 1877 he entered St. Mary's Hospital, London as a student, and became a fully qualified physician. However, it was while collecting minerals in Cornwall that he met and became friendly with the mineral dealer Richard Talling (1820–1883), and thus his future was decided.

On Talling's death Butler was nominated sole executor of his will. During the following year he gathered up Talling's stock, selling some to James Gregory, and established himself as a professional mineral dealer, first operating from his home in Paddington Green, but soon opening a business in Brompton Road, London, not far from the new British Museum. His first shop was at no. 180, where he called himself "successor to the late R. Talling, mineralogist." He then moved to no. 148 in 1887. The final move was to no. 158 in 1889.

Butler collected a great deal of material in the field, especially in Cornwall. The celebrated British collector Sir Arthur Russell was a close friend and the two would go on such trips together. Butler specialized in educational collections, but also dealt in the highest quality minerals and fossils, frequenting auction sales and regularly buying and selling whole collections including those of Thomas Wright (1809–1884), Thomas Henry Withers (1883–1953), and John Gray. The American collector Clarence S. Bement (1843–1923) visited Butler in 1888 and said of his acquisitions: "Though I thought I had good barites from Frizington, I bought about half a dozen from Butler which will quite build me up in that species."

From at least 1887 Butler expanded into natural history items in general, including osteological preparations, Recent shells and collector's equipment and cabinets, his store becoming "The Natural History Agency" in the late 1880's. He used a complex series of printed and hand-written labels, many of which are hard to date. In 1927 Butler retired from business, and his stock was bought by J. R. Gregory & Company. Butler died at his home at Sutton in Surrey on August 19, 1935.



A. E. Foote

A. E. Foote (1846–1895)

Albert Edward Foote, one of America's most famous early mineral dealers, was born on February 4, 1846, in Hamilton, Madison County, New York, the son of Edward Warren Foote and Phoebe Steere. He graduated from Courtland Academy in Homer, New York, where he first became interested in mineralogy through the influence of Dr. Caleb Green, and began collecting minerals in 1862. He was a student of Prof. Walcott Gibbs at Cambridge and Prof. Hoffmann in Berlin. Foote obtained his medical degree in 1867 from Michigan State University in Ann Arbor. In 1870, after teaching for three years at Ann Arbor, he took a position as Assistant Professor of Chemistry and Mineralogy at Iowa State Agricultural College, was promoted to Full Professor in 1871, and married Augusta Matthews in January of 1872, in Knoxville, Iowa. In December of that year they had a son, Warren Matthews Foote, who was destined, 23 years later, to take over his father's business.

Foote had developed an intense interest in mineral collecting, and had collected minerals from the Michigan copper mines (1868), from Magnet Cove in Arkansas (in 1875), and from the Minnesota iron range, ostensibly for teaching purposes, but building up a much larger stock than necessary. He displayed his fine personal collection in New York in 1873, and at the St. Louis Exposition in 1875, where he was awarded a medal. In 1875 he moved to Philadelphia and set up practice there as a physician, mineralogist, and seller of medical and other scientific books. He placed a handsome exhibit of minerals in the 1876 Centennial Exposition in Philadelphia, and had to rent cheap quarters nearby to store his surplus specimens; visitors to the exhibition wanted to purchase specimens, so he took them to his temporary quarters and thus his mineral business was born. He was eventually elected a Fellow of the American Association for the Advancement of Science, and was a Life Member of the Academy of Natural Sciences in Philadelphia and the American Museum of Natural History in New York.

Foote's famous mineral catalogs ran to 100 pages. He also published an illustrated 32-page monthly called *The Naturalist's Leisure Hour* (25 cents for 12 issues), containing much information on minerals; it began in 1877 and ran until A. E. Foote's death in 1895. Foote traveled the world regularly, sending back huge quantities of specimens to his headquarters in Philadelphia. He toured all of the important British localities on several occasions, purchasing large quantities of specimens which he had shipped back to the United States. Following the 1889 meeting of the British Association for the Advancement of Science, for example, he made the rounds in Cumberland with "a leading mineralogist," acquiring "butterfly" calcite, barite, fluorite, witherite, alstonite, barytocalcite, hematite, quartz, aragonite, siderite, linarite, caledonite and mimetite.

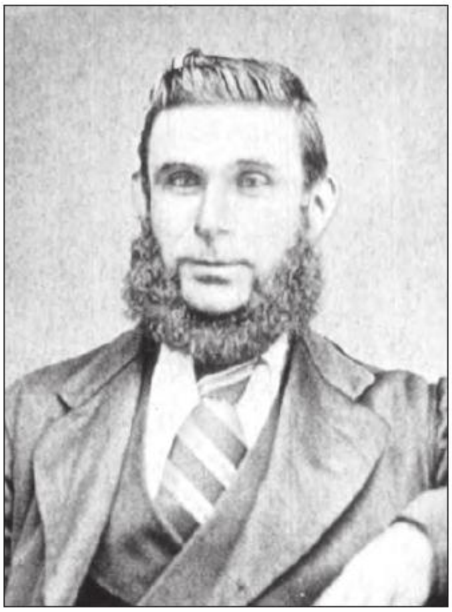
He also continued to place lavish, award-winning exhibits at the major international fairs including the New Orleans Exposition of 1884–1886, the Louisville Exposition in 1886, the American Exposition in London in 1887, and the Paris Exposition in 1889.

A. E. Foote died of a chronic tuberculosis infection on October 10, 1895, at the young age of 49, having built one of the largest and most successful mineral dealerships in history, and boasting "the largest stock of minerals in the world."

Patrick Gilmore (1833–1892)

Patrick Gilmore was born in Ballygar, Ireland around 1833, the son of Peter Gilmore, a shepherd. By 1861 he had moved to Alston where he appears as a "hawker" in the census records. His entries in trade directories for 1882–1884 list him as a "marine store dealer" or "metal broker" and mineral dealer of The Butts, Alston, but in 1883 and 1896 he was described solely as a mineral dealer on the marriage certificates of his daughters. The American mineral collector Charles Pennypacker (1845–1911) described him as "a junk dealer [who] had a warehouse full of specimens which he had bought from the miners of that region."

According to family legend Patrick once fled to America upon hearing that a bale of cloth he had bought was stolen property. The rumor of stolen goods was eventually shown to be false and Patrick returned home. Patrick supplied mineral specimens directly to institutions and private collectors, and also sold minerals wholesale to other dealers, such as Francis Butler, Bryce Wright and A. E. Foote of Philadelphia. Well-known private customers in America included Charles Pennypacker, William Jefferis (1820–1906) and William S. Vaux (1811–1882), with whom he began trading at least as early as 1875. Pennypacker had made a connection with Gilmore by sending a £10 draft to the postmaster at Alston, asking him "to hand it to some collector who would send me its equivalent in local minerals."



Patrick Gilmore

In 1889 Pennypacker visited Gilmore in Alston and later published the story of his trip in *The Mineral Collector*. It required three days to review Gilmore's entire stock of minerals. Pennypacker gave William Jefferis a letter of introduction to Gilmore when Jefferis visited Europe around 1878–1882.

Patrick's son Peter Gilmore (born 1855) began helping him in the mineral business around 1886. The Gilmores supplied the British Museum with fine specimens of witherite, barite and fluorite which remain in the collection today. Green fluorite is among the most famous of North Pennine minerals, and the Gilmores supplied many fine specimens, especially favoring crystals containing liquid inclusions. The Gilmores' specimen acquisition problems were mentioned in an 1881 letter to the British Museum:

> Green Fluors is bad to get now as the Masters has closed up the old mine we got them from on account of so many people going & knocking the place to pieces & might have damages to pay for some of the men getting killed.

Peter died of heart disease and alcoholism on 19 September 1892, aged only 36 (his death certificate describes him as a "hawker of soft goods" so he was not a full-time mineral dealer), and his father, already a sick man, collapsed at his funeral two days later (21 September) and died "having only been ill three hours." After this double tragedy, the business was carried on by Peter's wife Elizabeth Gilmore. She moved to Carlisle (her home town) in late 1896 and seems to have given up mineral dealing in the following year. Patrick Gilmore's warehouse on the Butts in Alston is today an antique shop.

John More Gordon (1849–1922)

The Reverend John More Gordon (1849–1922) was the vicar of St. Johns, Redhill, Surrey. He was elected a Fellow of the Royal Microscopical Society in 1884, and for over 30 years, was also a member of the Swiss Alpine Club. He became an expert collector of Alpine minerals and built a particularly fine collection of Swiss minerals which he bequeathed to the British Museum in 1922. In 1906 he started building a mineral collection in memory of his grandfather, Harry Gordon. This collection was presented in 1922 to Aberdeen University Museum and was named the "Harry Gordon collection" at his request.

John Graves (1842–1928)

John Graves was born in Langdale, Westmorland, England on March 12, 1842. He worked as a miner in the west Cumbrian iron mines, and was so inspired by the beauty of the plentiful specimen-quality minerals there that he began dealing in them around 1873 (continuing to work as a miner at least through 1881). Based in Frizington, he was in close proximity to many rich specimen-producing mines that yielded superb examples of barite, hematite and calcite. He may have retired as a miner because of the decline in the price of iron which put many miners out of work in the early 1880s.

Graves was the principal buyer of the wonderful calcite crystals and twins first found in the mines around Egremont in 1888. He supplied fine mineral specimens to the British Museum, and to Oxford and Cambridge Universities. He also wholesaled large numbers of mineral specimens to other mineral dealers, especially George L. English, Ward's Natural Science Establishment, and British dealer Anthony Furnace of Keswick. English regularly advertised West Cumbrian specimens in *The Mineral Collector* beginning in 1894, and Graves himself took out a full page ad for "The beautiful, rare and choice minerals of England" in 1895. Some of the finest known British calcite and barite specimens passed through his hands. Graves may have been the unnamed Frizington dealer described by Pennypacker (1897) as having "his house lined and stuffed with calcites from garret to cellar . . . a keen pursuer of specimens . . . accumulating them against the days when the mines are abandoned and localities cease to be."

By 1898 Graves' health had deteriorated and he decided to offer his stock for sale in bulk, including his personal collection of twinned Cumbrian calcites, but had no takers. His health must then have improved, for he continued dealing in minerals for over 20 years thereafter, finally selling most of his remaining stock to Ward's in 1920. He died December 3, 1928 and was buried in St. Paul's churchyard, Frizington.

John Graves' son Frederick W. Graves carried on the business after his death. In 1942 or 1943 Gregory, Bottley & Co. bought the remains of the Graves collection, amounting to several hundred fine specimens, from the family. Several of the most beautiful calcite and barite specimens in the Greenbank collection (e.g. LG-114 , LG-54, and LG-57) were handled by John Graves.

E. Mitchell Gunnell (1903–1986)

Emory Mitchell Gunnell was born September 8, 1903 in Illinois, the son of Emory S. Gunnell, a department store Vice President.

E. Mitchell Gunnell

Gunnell, known to his friends as "Mike" and "Mitch," began collecting minerals in 1919, at the age of 16. He earned his Bachelor's Degree in Geology in 1928 at Knox College in Galesburg, Illinois. In 1931 he was awarded his MS Degree at Washington University in St. Louis, writing his thesis on mineral fluorescence. During the late 1930's he wrote several articles on fluorescence for *The Mineralogist*. In 1938 he married Kathryn Kidder and they honeymooned in the Southwest, traveling through Arizona, New Mexico and Colorado, and settled permanently in Colorado in 1940.

Properties he had inherited provided sufficient income so that Gunnell could work pretty much where and when he wished. He taught geology in Illinois, and worked for a time as Assistant Curator at the Buffalo Museum of Science. From 1940 to 1944 he worked in the mineral shop of August Pohndorf (q.v.) in Denver (Gunnell had previously acquired minerals for his personal collection from Pohndorf at least as early as 1930). Upon leaving Pohndorf's he decided to go into the mineral business for himself, and dealt on a part-time basis until 1976. His specialty (beginning in 1944) was single-crystal study sets, which he sold to collectors and universities across the country.

For the most part, however, Gunnell worked on building his own superb collection of (ultimately) about 4,000 mineral specimens. This collection was among the finest in the country, superior even to the collections of many museums, but it remained largely unknown because Gunnell was never interested in showing it all to anyone or exhibiting it publicly. Irascible and somewhat reclusive, especially in his later years, he collected solely for himself. Around 1977 he began selling off portions and sub-collections here and there; following his death in November 1986 the remainder of his collection was sold off.

Simon Harrison


MINERAL Collection for SALE in Two SPLENDIDLY made CABINETS.

MR. HENSON has for Sale a very large and fine Collection of Minerals and Fossils (mostly Minerals), contained in Two extremely well-made Cabinets, each Cabinet consisting of 27 drawers (19 × 17½ × 3¼).

The collection was made by an Irish Gentleman MANY YEARS AGO, and contains examples from a number of Irish and other localities not now to be obtained.

On View.

SAMUEL HENSON,
277 STRAND, LONDON,
Established 1840.] Opposite Norfolk Stree [Established 1840.

Samuel Henson ad in *Nature* (1888).

Simon Harrison

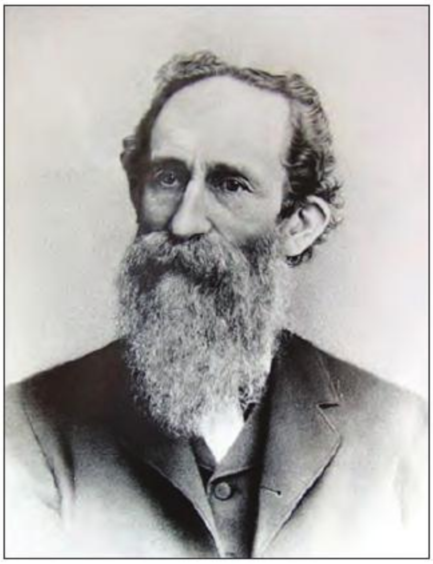
Simon Harrison is a mineral dealer in Cheltenham and Bath. Now retired from the mineral business, Simon was a highly successful full-time dealer in the 1970s, specializing in high-quality classic minerals. He retained for himself until recently a fine private collection of calcite and fluorite specimens from the northern fluorspar district. He engaged in several major exchanges with old collections (notably the Edinburgh University Museum), many of his acquisitions being purchased by Ralph Sutcliffe and other noted collectors. Several of the finest old-time specimens in the Greenbank collection passed through Simon's hands; the collection has been much enriched by his enterprise.

Samuel Henson (1848–1930)

Samuel Henson, prominent British mineral dealer, was born in London on September 22, 1848, the son of mineral dealers Eliza and Robert Henson (1814–1864). Samuel took over the family mineral business following his mother's death, moving it to 277 Strand in London in 1878–1888.

Henson and his sister gave private lessons and evening classes in mineralogy. He was elected a member of the Mineralogical Society in 1879 and of the Geologists' Association in 1880. Henson never kept a large stock of minerals on hand, preferring instead to concentrate on a limited number of showy, high-value specimens and semi-precious stones. The most important collections he acquired for resale were those of Dublin collector Sir Maziere Brady (1796–1871) (mostly Irish minerals), the Chilean mining engineer Theodor Hohmann (1843–1897), and the British collector Isaac Walker.

Samuel Henson's wife, Fanny (ca. 1838–1926), also had a good knowledge of minerals and assisted him in the business; she was also a member of the Mineralogical Society (1910–1917). Samuel Henson gave up the lease on his shop in 1915, but continued dealing privately in a small way thereafter. He had built a small private collection of his own, which was purchased from his trustees following his death on June 9, 1930, by Sir Arthur Russell. His business and remaining stock were acquired by Gregory, Bottley & Company.



William W. Jefferis

William W. Jefferis (1820–1906)

William Walter Jefferis was born in West Chester, Pennsylvania on January 12, 1820, and made his home in West Chester. He was educated in the West Chester Academy, and then took a position in the local bank while still in his teens. By 1857 he had worked his way up to the position of Cashier at the Bank of Chester County, second in command to the bank President, Dr. William Darlington. He held this position for the rest of his career, until 1883 when he retired for health reasons, and it must have paid quite well.

Jefferis had developed his first interest in minerals at the age of ten, and started collecting minerals seriously in 1837, probably while studying mineralogy at the Chester County Lyceum. For the next 60 years he worked tirelessly at enlarging his mineral collection; eventually it came to be regarded as one of the finest private collections in the country. It was rich in suites of minerals from eastern Pennsylvania and northern New York, many of the specimens self-collected. And he has one publication to his name: in 1864 he published *Minerals of Chester County*. Jefferis broadened his collection through exchanges and purchases from collectors and dealers in America and Europe, and accumulated countless specimens of calcite, barite and fluorite from classic British localities and significant suites from other European localities, mostly via the British dealer Bryce M. Wright.

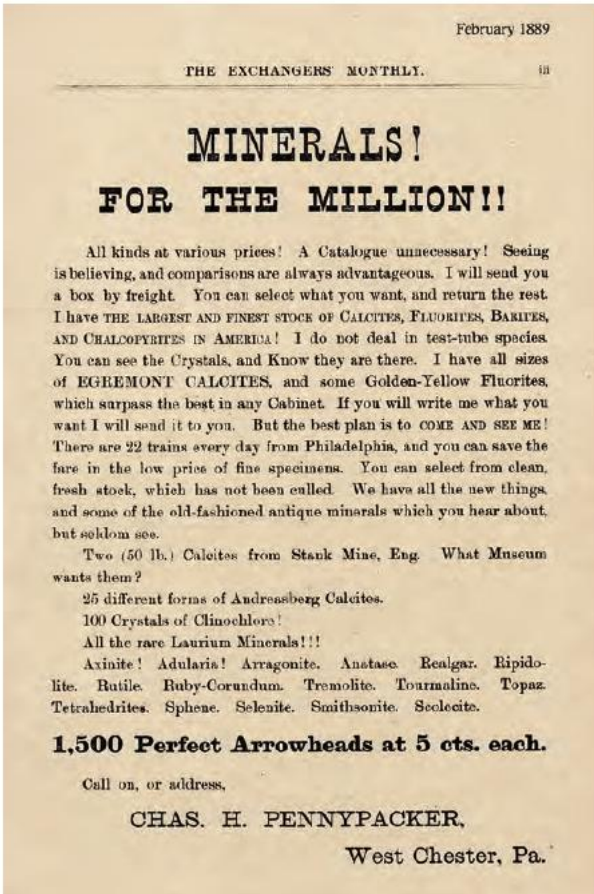
Jefferis corresponded regularly with important mineralogists of his day, including George Brush, James D. Dana and Benjamin Silliman, often loaning them specimens for study and illustration. Several of his specimens were illustrated in the 6th edition of Dana's *System of Mineralogy*—for example, phlogopite form Clark's Hill, St. Lawrence County, New York and clinochlore from West-town, Chester County, Pennsylvania. The mineral *jefferisite* was named in his honor by Prof. Brush, but was later discredited as a variety of vermiculite. From 1877 to 1878 he served as Professor of Mineralogy at the West Chester Normal School, in addition to his duties at the bank. In 1883, after retiring from the bank, he moved to Philadelphia and took the position of curator to the William S. Vaux collection, a position he held for 15 years until 1898.

In 1900 the word got out that Jefferis was thinking of selling his enormous collection, and numerous important collectors and museums made a play for it. In 1904, the industrialist Andrew Carnegie (himself a mineral collector) purchased Jefferis' entire collection, over 14,000 specimens, for $20,000, and in January of 1905 he donated it to the Carnegie Museum of Natural History. Two railroad boxcars were needed to transport the collection to Pittsburgh where much of it remains to this day. William Jefferis died in New York on February 23, 1906.

Charles H. Pennypacker (1845–1911)

Charles Henry Pennypacker, a mineral collector and part-time mineral and antique dealer, was born 16 April 1845 in West Chester, Pennsylvania, the son of Uriah Pennypacker, a Quaker of substantial means. He began mineral collecting at age 12, and was particularly fond of field-collecting his own specimens. He graduated from the West Chester Academy and the Phillips Exeter Academy (Exeter, New Hampshire). He studied law with his father and was admitted to the bar in 1870. A lawyer by profession, Pennypacker dealt in minerals for pleasure rather than profit. This brought him into contact with the great collectors of his day, including Charles Bement, George Vaux, William Jefferis, Theodore Rand, Frederic Canfield and Washington Roebling. He was also a frequent contributor to *The Mineral Collector* from 1894 to 1909, and placed many interesting (and amusing) advertisements in that journal, as well as in the earlier *Exchangers' Monthly*. He sold his collection to Henry Garrett, of Willistown, Pennsylvania, who had died by 1923 and dispersed his collection through a dealer. Some of his British specimens, obtained from Bryce Wright, Patrick Gilmore and others, eventually found their way back to England and into the Greenbank collection.

Charles H. Pennypacker



February 1889

THE EXCHANGERS' MONTHLY. iii

MINERALS!

FOR THE MILLION!!

All kinds at various prices! A Catalogue unnecessary! Seeing is believing, and comparisons are always advantageous. I will send you a box by freight. You can select what you want, and return the rest. I have THE LARGEST AND FINEST STOCK OF CALCITES, FLUORITES, BARITES, AND CHALCOPYRITES IN AMERICA! I do not deal in test-tube species. You can see the Crystals, and Know they are there. I have all sizes of EGREMONT CALCITES, and some Golden-Yellow Fluorites, which surpass the best in any Cabinet. If you will write me what you want I will send it to you. But the best plan is to COME AND SEE ME! There are 22 trains every day from Philadelphia, and you can save the fare in the low price of fine specimens. You can select from clean, fresh stock, which has not been culled. We have all the new things, and some of the old-fashioned antique minerals which you hear about, but seldom see.

Two (50 lb.) Calcites from Stank Mine, Eng. What Museum wants them?

25 different forms of Andreasberg Calcites.

100 Crystals of Clinochlore!

All the rare Laurium Minerals!!!

Axinite! Adularia! Arragonite. Anatase. Realgar. Ripidolite. Rutile. Ruby-Corundum. Tremolite. Tourmaline. Topaz. Tetrahedrites. Sphene. Selenite. Smithsonite. Scolecite.

1,500 Perfect Arrowheads at 5 cts. each.

Call on, or address,

CHAS. H. PENNYPACKER,

West Chester, Pa.

Pennypacker ad in *The Exchanger's Monthly* (1889).

Philip Rashleigh

H. E. Roscoe

Philip Rashleigh (1729–1811)

Philip Rashleigh, one of Britain's most famous early mineral collectors, was born in Aldermanbury, London on December 28, 1759, the eldest son of Jonathan Rashleigh, a Member of Parliament and a distinguished Cornish landowner. He entered Oxford in 1749 but left before obtaining his degree. His interest in natural history developed early, and he was among the subscribers to William Borlase's *Natural History of Cornwall* in 1758. After his father died he was elected a Member of Parliament himself and served until that body was dissolved in 1802.

Living in Cornwall, surrounded by a mining culture and many operating mines, he was well situated to collect minerals; he made the most of his opportunities, always working to obtain the finest specimens (and complaining about specimen prices!). As his collection grew, so did its reputation, and by 1794 it was being referred to as "rich and magnificent" in the travel guides and gazetteers of the day. At its peak it numbered over 4,000 specimens, and was arranged in his home in eight cabinets and a series of wall cases 10 meters long, with drawers underneath. In 1797 and 1802 he hired artists and published illustrated hand-colored descriptive catalogs showing many of his best specimens.

Rashleigh died on June 26, 1811. Amazingly, his superb collection of British (especially Cornish) minerals has remained largely intact in two institutions. It was initially willed to his nephew, William Rashleigh, who continued adding to it for 25 years; William gave a portion of the collection to his son Jonathan, and the rest was eventually sold by his descendants to the Royal Institution of Cornwall (County Museum) in Truro. Jonathan Rashleigh's portion was eventually acquired by Sir Arthur Russell, whose collection ultimately went to the Natural History Museum in London. Through sharing, trading, purchasing and publication combined with careful cataloging, Rashleigh played an important role in exposing and preserving the mineral wealth of Northern England.

H. E. Roscoe (1833–1915)

Henry Enfield Roscoe, prominent 19th-century British spectroscopist and chemist, was born in London on January 7, 1833, the son of Henry Roscoe (1800–1836), and the grandson of the historian William Roscoe (1753–1831). He studied at the Liverpool Institute for Boys and University College London, then went to the University of Heidelberg to work under Robert Bunsen, who became a lifelong friend. In 1857, Roscoe was appointed to the chair of chemistry at Owens College, Manchester, where he remained until 1886, by which time the Victoria University had been established. From 1885 to 1895 he was a Member of Parliament for Manchester South. He served on several royal commissions appointed to consider educational questions, in which he was keenly interested, and from 1896 to 1902 was vice-chancellor of the University of London. He was knighted in 1884.

Roscoe's scientific work includes a memorable series of researches carried out with Bunsen between 1855 and 1862, in which they laid the foundations of comparative photochemistry. In 1865 Roscoe was inspired to begin investigating vanadium when he visited the copper mines at Mottram (the type locality for the vanadium mineral mottramite, described by Domeyko in 1848), near Alderley Edge in Cheshire. Roscoe began an elaborate investigation of vanadium and its compounds, and devised a process for preparing it pure in the metallic state. He also carried out researches on niobium, tungsten, uranium, perchloric acid, and the solubility of ammonia.

Roscoe's *Treatise on Chemistry* (1877) went through numerous editions and was a standard college textbook for many years. The mineral Roscoelite was named after him, in recognition of its vanadium content and Roscoe's work on that element. He was also the uncle of the children's author Beatrix Potter.

Roscoe died December 18, 1915. Most of his mineral collection is held today by the Oxford University Museum, though a cabinet of specimens which he presented to the Chemistry Department of Victoria University in 1888 was obtained by the Manchester Museum in 1968.

Ralph A. Sutcliffe

Ralph Sutcliffe of Nelson, Lancashire, has been for many years one of the best known private collectors and dealers in England. Like his good friend and collecting partner, Richard Barstow, he did not restrict his collecting to the "silver pick," but pursued an active commitment to field collecting, particularly in the classic occurrences of northern England. Ralph, Richard and their associates reopened many old mines in search of minerals and, being among the first to do this on a significant scale, were often the first to tread the old galleries since the miners abandoned them in the last century (on one such trip, he met Lindsay Greenbank while underground). Apparently their explorations in those early days also spurred a sudden interest in collecting old mining antiques. Ralph is especially associated with campylite and plumbogummite from the Dry Gill mine, Caldbeck Fells, which was reopened in the 1970s after decades of neglect.

Ralph has assembled two fine collections. The first, a wide-ranging suite of minerals, was sold to a collector in the U.S. in the 1970s. The second, a much more focused collection concentrating on minerals from Derbyshire, northern England and Leadhills-Wanlockhead in Scotland, was sold in January 1991 to Lindsay and Patricia Greenbank. His exceptional suite of Scottish minerals was recently acquired by the Royal Museum of Scotland in Edinburgh; many of his specimens are superior to corresponding examples in the museum's long-established collection. Other pieces now reside in museums in Derby, Liverpool and elsewhere in England. Several Sutcliffe specimens were featured in Cooper and Stanley's ***Minerals of the English Lake District: Caldbeck Fells***, published by the Natural History Museum, London in 1990; and photographs of his Scottish material have appeared in ***Minerals of Scotland***, published by the National Museum of Scotland. The finest of the northern England specimens, however, were retained in the Greenbank collection.

Today, after a decade of hiatus, Ralph has taken up full-time mineral dealing once again with the purchase of the Raymond Clements collection, and attendance at worldwide mineral shows. He was also instrumental in brokering the recent sale of a large portion of the Greenbank collection to American dealer Rob Lavinsky.

Charles Otto Trechmann (1851–1917)

Charles Otto Trechmann was born in Hartlepool on March 19, 1851, the eldest son of Peter Otto Edward Trechmann, a Danish immigrant who established a cement factory in northern England in 1848. After a preliminary education at the Grammar School in Richmond, Yorkshire, he attended the Polytechnic School in Hanover, then entered the University of Heidelberg where he studied chemistry for two years under Bunsen and earned his PhD. Returning to England, he joined his father's business and managed it very successfully. He was also Managing Director of two other family businesses (Trechmann, Weeks & Co. Ltd. and the Purfleet Chalk Quarries in Essex), and served for many years as Justice of the Peace for the borough of Hartlepool.

While in Heidelberg he acquired an interest in mineralogy and crystallography, and began building a collection, working on it at every opportunity for the rest of his life. Despite his busy business and public schedule he also found time to publish 20 scientific papers, most of them dealing with crystallographic subjects, especially regarding the minerals of the Binn Valley in Switzerland. By the time of his death his mineral collection numbered about 5,000 choice, well-crystallized specimens housed in two well-made cabinets in his home, called Hudworth Tower, in Castle Eden.

He died on June 29, 1917, bequeathing part of his collection to the British Museum and part to his son, Dr. Charles Taylor Trechmann, who later donated more of the specimens to the same institution. The mineral trechmannite was named in his honor in 1905.

Mick Sutcliffe (*left*), Anthony Walshaw (*center*) and Ralph Sutcliffe.

Anthony Walshaw

Anthony (Tony) Walshaw was a field collector from Witherslack, Cumbria. He was Lindsay Greenbank's first field-collecting partner beginning around 1963; the two spent many weekends together inspecting old and abandoned mine dumps, with the guidance of their joint mentor, mineral dealer Bill Davidson of Penrith. They soon ran into Ralph Sutcliffe while field collecting underground in the Brandy Gill mine, and became lifelong friends.

Tony emigrated to Australia in 1967. His collection of worldwide minerals was purchased jointly by Ralph Sutcliffe and Lindsay Greenbank in 1989; specimens that initially went into the Sutcliffe collection later came to Lindsay Greenbank in 1991.

Bryce M. Wright, Jr.

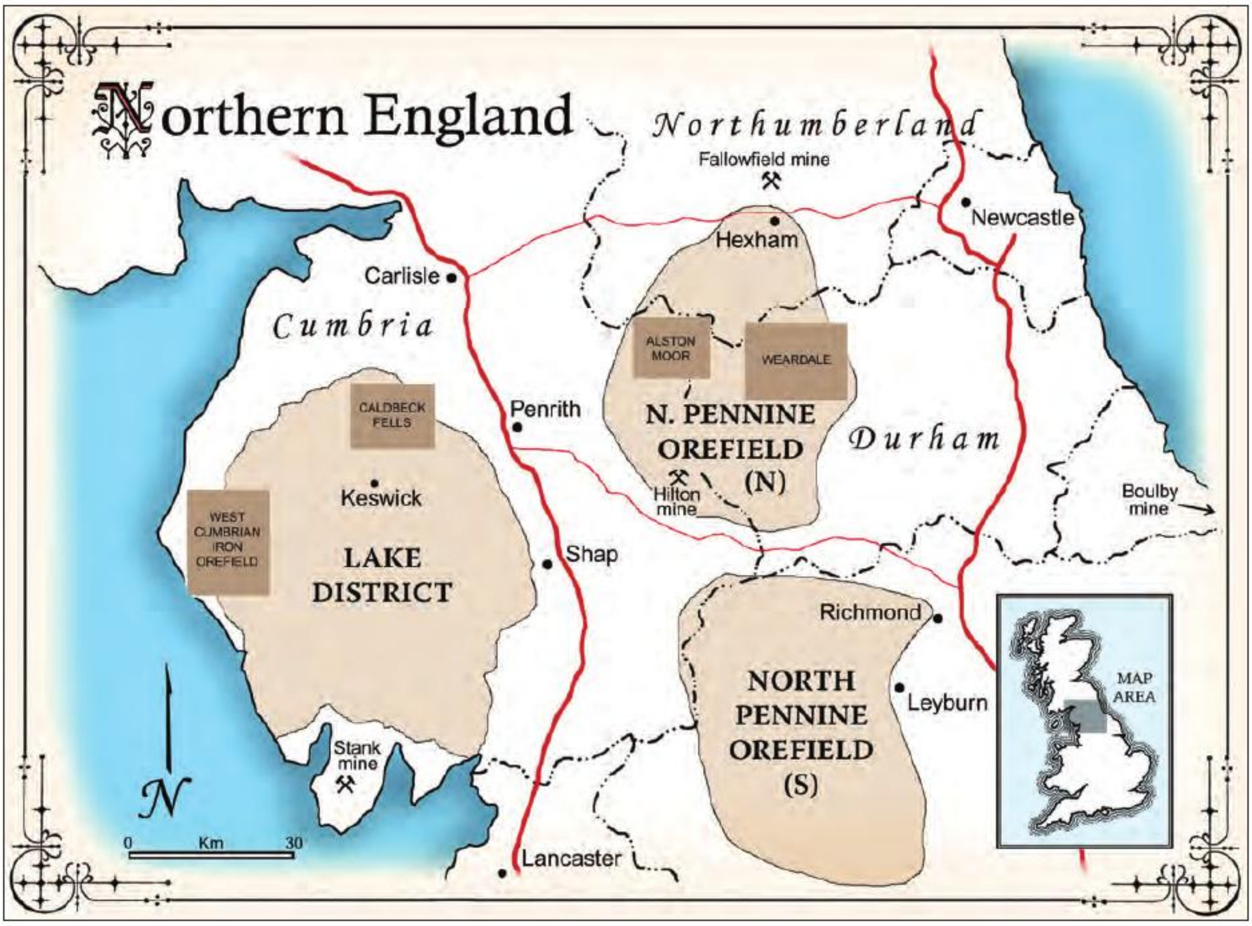
Bryce McMurdo Wright (1814–1875)

Bryce McMurdo Wright, Sr. (spelled "Brice" before 1860) was one of England's most prominent 19th-century mineral dealers. He and his son (Bryce McMurdo Wright, Jr., 1850–1895) dealt in minerals, fossils, shells, rocks, gems, corals, ethnological collectibles, and worked stones old and new for over 50 years. Despite their varied and worldwide stock in trade, it is for the minerals of northern England that their name is best remembered.

Wright, Sr. was born June 24, 1814 in Dumfries, Scotland and raised in Hesket Newmarket, Caldbeck, Cumberland, England. Little is known of his early decades, but according to Charles Pennypacker he worked as a miner in Cumberland, probably in the Caldbeck lead mines. His formal education was minimal, but more important to his success were his commercial acumen and tenacity, his capacity for learning and hard work, and above all his good fortune to be in the right place at the right time. In 1842 he married Jane Smith in Liverpool, where he was working as a painter, but he had probably already been mining and selling mineral specimens privately for a number of years before that. In 1843 he sold several fine self-collected Caldbeck Fells mineral specimens to the British Museum, one of which is present in the Greenbank collection: linarite LG-230. This linarite was sufficiently notable in its day to receive mention in Lazarus Fletcher's ***History of the Mineral Collections of the British Museum*** (1904). In the following years Wright made regular sales to the Museum of up to 100 specimens at a time. In 1845 he turned professional mineral dealer, and in 1849 he opened a shop in Liverpool. His advertising in 1854 mentioned his "extensive collection of minerals . . . of upwards of 3,000 specimens," including "many exceedingly rare substances."

In 1855 he moved from Liverpool to London; two years later he moved to No. 36 Great Russell Street, Bloomsbury, in the heart of London's "natural history district," just across the road from the British Museum. By 1857 he was claiming a stock of 7,000 mineral specimens, and by 1860, 10,000 specimens. He moved to No. 90 on the same street in 1866, where he remained until his death eight years later. The business flourished in that neighborhood, Wright becoming the most successful and the best-known London-based mineral and fossil dealer of the mid-nineteenth century. Some of the staff of the British Museum became personal friends and provided him with valuable professional scientific support. In 1868 he claimed to be in "direct communication with the most experienced miners in Cornwall and Cumberland, and also with Collecting Naturalists in Germany, Russia, India, and America." He even *rented* specimens out as temporary decorations for parties and lectures.

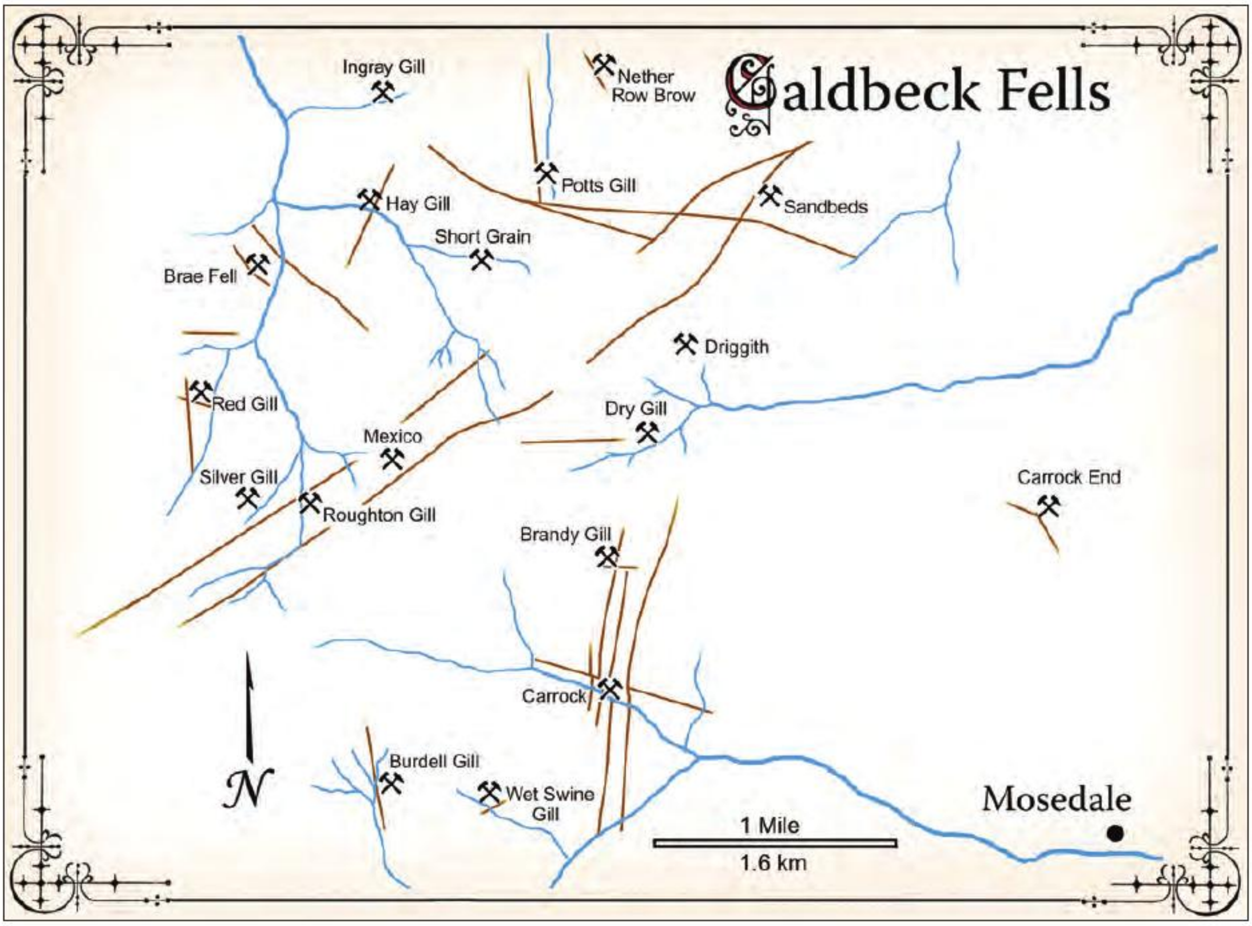
Wright traveled extensively throughout England five or six times a year, and occasionally on the continent, in search of minerals; one of his earliest trading contacts in America was William W. Jefferis (1820–1906), a mineral collector from West Chester, Pennsylvania. He sold specimens to the elite collectors of the day, including Clarence S. Bement (q.v.), and was an expert on the mines and localities of Cumberland. He died in London on October 10, 1874. Part of his excellent private mineral collection was auctioned in April 1875 by the J. C. Stevens auction house, amounting to about 1,500 fine specimens, and 3,000 more of his specimens were offered for sale in 1881. His well-known international mineral business was taken over by his son, Bryce Wright, Jr.



Location map showing the principal mineral districts of northern England.

LOCALITIES

The localities discussed below are the northern England occurrences most commonly represented in private and institutional collections, and particularly in the Greenbank collection, but the geographical coverage is by no means exhaustive. For more information on the minerals and localities of northern England the reader is directed in particular to the comprehensive summary by Symes and Young (2008), the excellent review articles by Fisher (2004, 2009), the various scholarly works of the late Michael P. Cooper, and other references listed in the partial bibliography supplied here at the end. The *UK Journal of Mines and Minerals* and the *Journal of the Russell Society* are essential periodicals for the student of British mineralogy and mineral collecting, as is, of course, *The Mineralogical Record*, from which a number of sections here were summarized. The classic reference is Greg and Lettsom's *Manual of the Mineralogy of Great Britain and Ireland,* published in 1858 and still very useful. Just recently, however, the first major new work on British mineralogy since 1858 has appeared, A. G. Tindle's encyclopedic *Minerals of Britain and Ireland* (2008), a thorough and well-illustrated work which is the new standard reference.



Map of the Caldbeck Fells area showing the more important mines. Veins are shown in brown.

CALDBECK FELLS

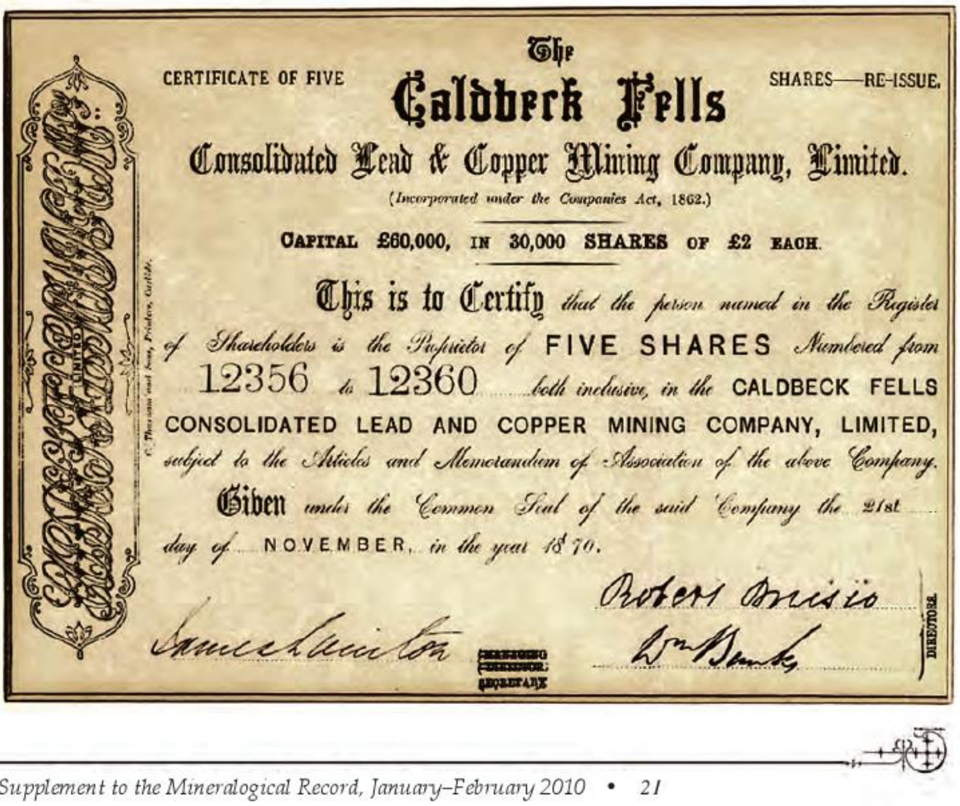
by Michael P. Cooper and Chris J. Stanley

INTRODUCTION

The Caldbeck Fells mining district is a loosely defined area covering some 25 square kilometers south of the village of Caldbeck in the northeastern corner of the English Lake District, about 12 km northeast of Keswick. Prior to changes in the county boundaries in 1974, the Caldbeck Fells were part of the ancient county of Cumberland, since absorbed into the new county of Cumbria (a change which accounts for old label and reference discrepancies).

For the most part, the Caldbeck Fells consist of rolling, treeless moors dissected by numerous watercourses running in steep-sided valleys (a "fell" is an upland pasture, moor or high plateau, and a "beck" is a creek; "Caldbeck" = "Cold Creek"). The valleys are known locally as "gills," and it was in these "gills" that most of the mineral veins worked by the early miners were found. The area is now part of the Lake District National Park, and both collecting and vehicular traffic are restricted there; however, it is a popular tourist area for hikers.

The pyromorphite, plumbogummite, hemimorphite and mimetite from the Caldbeck Fells were, and remain, among the finest the world has ever seen. They made the names of mines at Roughton Gill, Red Gill and Dry Gill synonymous with fine mineral specimens. The Caldbeck Fells district contains a greater variety of mineral species than any other area of comparable size in Great Britain. Approximately 175 valid mineral species have been recorded from the metalliferous veins; a further 40 are known from the country rocks. There are about a dozen species from various mines in the area that represent only the second or third world occurrence and over 30 that were, when first recorded, new to Great Britain. The Golden Hugh level of the Silver Gill vein is the type locality for redgillite.


CERTIFICATE OF FIVE SHARES—RE-ISSUE.

The Caldbeck Fells Consolidated Lead & Copper Mining Company, Limited.

(Incorporated under the Companies Act, 1862.)

CAPITAL £60,000, IN 30,000 SHARES OF £2 EACH.

This is to Certify that the person named in the Register of Shareholders is the Proprietor of FIVE SHARES Numbered from 12356 to 12360 both inclusive, in the CALDBECK FELLS CONSOLIDATED LEAD AND COPPER MINING COMPANY, LIMITED, subject to the Articles and Memorandum of Association of the above Company.

Given under the Common Seal of the said Company the 21st day of NOVEMBER, in the year 1870.

MANAGING DIRECTOR, SECRETARY

DIRECTORS

Early Caldbeck Fells mining stock certificate, issued in 1870 for the Caldbeck Fells Consolidated Lead & Copper Mining Company, Ltd. (founded in 1862). D. R. Hacker collection.

Members of the pyromorphite group that occur there include mattheddleite, mimetite, pyromorphite, hedyphane, phosphohedyphane and vanadinite. The first three occur in excellent specimens; vanadinite is found there very rarely, its occurrence only considered of importance because of the extreme scarcity of this species in Great Britain. Other species for which the area was a renowned source of collector specimens include plumbogummite, linarite, hemimorphite, caledonite, leadhillite, scheelite and apatite. The Greenbank collection is well known for its superb examples of linarite, plumbogummite and hemimorphite in particular.

HISTORY

The earliest record of mining in Caldbeck probably dates to 1331, when an order of King Edward III mentions one Robert de Barton, whom the king had appointed as keeper of a silver mine in "Minerdale and Silverbek" in Cumberland County. In 1537, a silver mine was reported to be operating in the parish by a Royal Commission sent to investigate the northern estates. In 1563, at the behest of the English Crown, copper deposits throughout England were investigated by mining experts from Germany. England turned to Germany not only for technical expertise—16th century German miners and smelters led the world—but also for capital. Shares in the new company were more or less equally divided between the Germans and the English, the latter including prominent government officials and members of the aristocracy. The situation looked very promising, both sides anticipating vigorous business and large returns. The result was a disaster. A vast investment program was initiated to open or reopen the Cumbrian mines and to set up a large administrative and processing complex near Keswick. Here the company built the biggest smelter in Europe and coordinated a large network of suppliers of fuel, food, transport and other necessities. In 1567 the first copper metal was produced, the process taking 18 weeks and 5 days from dressed ore to "perfect copper."

Most of the copper ore came from mines to the west of Keswick but the Caldbeck mines were also producing ore. Copper and argentiferous lead ores were raised; the latter, of value principally for its silver, was also used in the processing of copper ores from the other mines.

The smelting works were prodigiously expensive and much delay was caused by the complexity of the Cumbrian ores, which tested the Germans' expertise to the limits. Copper output never reached the first optimistic forecasts, and sales were disappointingly slow. The company also had to contend with many social and legal difficulties, but, although most of their problems were eventually resolved in the company's favor, the slow progress and continuing cash-flow problems eventually caused the English shareholders to reconsider their commitment. The huge operating deficit, compounded by serious economic problems at home, proved too much for the German shareholders, who withdrew completely in 1577, leaving the Company of Mines Royal in the hands of the English shareholders and those of the original German staff who chose to remain.

Chief among those Germans who remained with the company was Daniel Höchstetter, founder of a dynasty of master smelters and miners who worked the Cumberland mines for many years. From 1580 to 1597 the company leased the Cumberland mines to the Höchstetters and others, rather than bear the financial responsibilities of running the mines themselves. Improved methods and economies allowed the lessees to make a reasonable living after paying the company's rent. The position of the Caldbeck mines during this period is uncertain because complete records do not exist. The mines were reported as closed in 1581: "the rich lead mine at Caldbeck, w'ch holdeth good quality of silver, and hath cost the company great sommes of mony: Lieth now unwrought." In 1600 the mines were being cleaned out with a view to reopening, but the miners considered that they "have no hope of comfort in this work of Caudbeck, but think the cost. . . . bestowed there utterly lost." Other Cumbrian mines, however, were certainly worked. The Höchstetters and their colleagues made a profit in their first lease but went on to lose money in subsequent leases. Such patterns of profit and loss were to be typical of workings on the Caldbeck Fells veins right up to the closure of the last lead mine at the end of the 19th century.

For most of the 17th century the state of the Caldbeck mines is little known. It is certain that attempts were made to work them and that recommendations were made from time to time to drive new adits to dewater old levels, but little seems to have been done. Certainly, by the outbreak of the Civil War in 1642, all the Cumberland mines and the smelters at Keswick were at a standstill. Oliver Cromwell's army is usually blamed for the destruction of the mills and mines and the death or conscription of the miners, but there is little evidence to support this claim. It is likely that the mines were run down or even abandoned before this date and that financial or technical problems rather than violence were responsible for the collapse of the mining and smelting.

The Caldbeck mines were investigated by several people in the 1680's with a view to reopening them but nothing came of it. By this time technological improvements in mining and smelting were making many old prospects potentially economic and the repeal of the Mines Royal Act in 1693 (whereby the Crown lost its prerogative for mines yielding precious metals) stimulated private investment in metal mining. The newly formed Company of Royal Mines Copper leased the Caldbeck mines in 1692; ten years later this company merged with another Quaker-owned firm to form what was to become the London Lead Company. This company was still smelting lead from "Caudbeck" in 1702.

Records for the 18th century are fragmentary but suggest a substantial interest in the Caldbeck mines. In the early part of the century one Thomas Hillary was chief agent to lead mines throughout the district, and accounts for his workings from 1724 to 1726 survive. These workings may have continued at least until 1730, but thereafter nothing is known of workings in Caldbeck until 1785 when Joseph Scott was working a copper mine in Hay Gill (in the north of the district). Scott continued until at least 1792. By 1794 smelters had been built at Roughton Gill and Driggith, and by 1800 mining was probably in full swing throughout the district.

The period 1820 to 1860 saw the golden age of mining in the Caldbeck Fells. During these years almost all the metal deposits were tried, some with great success, and some mine owners made fortunes stripping rich ore from the deposits and then selling out. But, in general, those who lingered lived to regret it and the lives of most of the mines ended in recriminations and bankruptcy. Much expense was incurred in development work, something that had been ignored by previous owners intent on quick profits. These financial problems were compounded by the complexity of the ores (which even the most up-to-date and expensive milling equipment could not handle successfully), by difficulties with drainage, and by incompetent management. As the century wore on, ores became

The Brae Fell mine. Note the "hushes" running down the hillside, created by miners who used pent-up water, released suddenly, to erode exploration trenches. Gordon Akitt photo.

progressively leaner and more difficult to extract as the mines became deeper, and self-draining adits became uneconomic or impossible to sustain. The death blow came with the catastrophic slump in metal prices in the 1870s. The market was flooded with cheap ore, much of it from America, and the remaining Caldbeck mines were forced to close.

By 1876 the last lead mine had been abandoned, its owners bankrupt. From that time hardly any lead or copper has been raised, except as an occasional by-product of working the rich barite deposits in the north of the Fells. The last of these, at Potts Gill, closed in 1966. The Carrock tungsten mine has been the only commercial operation since then, and that only an intermittent operation during the 1970s and early 1980s. It is unlikely that Caldbeck will see the return of miners in the foreseeable future.

For references and fuller descriptions of these and other mines see *Minerals of the English Lake District: Caldbeck Fells* (M. P. Cooper and C. J. Stanley, 1990), and "Famous mineral localities: Pyromorphite group minerals from the Caldbeck Fells, Cumbria, England" by the same authors (*Mineralogical Record*, vol. 22, pages 105–121, 1991).

GEOLOGY

Many authors attribute the variety of minerals encountered in this area to the variety of host rocks, and to some extent this is true, for a number of quite distinct mineralizing events have occurred. Apart from a minor concentration of ilmenite in the basal gabbro of the Carrock Fell Igneous Complex, the earliest mineralization (Lower Devonian) is that which forms the north-south veins cutting the greisenized Skiddaw Granite, the hornfelsed slates, and the gabbros and granophyres of the Carrock Fell Igneous Complex. Predominantly this deposit is composed of quartz, wolframite, scheelite, apatite and arsenopyrite with minor amounts of bismuth, bismuth tellurides and sulfides, pyrrhotite, chalcopyrite and sphalerite; it formed from late-stage fluids derived from the granite.

The deposits of copper, lead and zinc are found almost entirely in veins formed along faults in the volcanic and plutonic rocks of the Eycott Group and the Carrock Fell Igneous Complex respectively. Most of the veins have a simple primary sulfide mineralogy dominated by galena, chalcopyrite and sphalerite with minor pyrite. Bournonite, native antimony and argentiferous tetrahedrite are common as microscopic inclusions in galena. The dominant gangue minerals are quartz and barite. Calcite is locally abundant in the Roughton Gill South vein and the Carrock tungsten veins but uncommon elsewhere in the Caldbeck Fells. Fluorite is very rare.

Isotopic evidence suggests that the main period of copper-lead-zinc mineralization occurred in Upper Devonian to Lower Carboniferous times (ca. 360–330 million years ago). The later barite mineralization of the area was assigned an Upper Carboniferous to Permian age (ca. 290–260 million years ago). The formation of the secondary minerals, for which the Caldbeck Fells are famous, resulted from a hydrothermal event 190–180 million years ago which altered the host rocks and the primary mineral assemblages.

MINES

Cooper and Stanley (1990) identify 15 mines in the Caldbeck Fells district, only the most important of which (from a collector standpoint) will be discussed here.

Brae Fell mine

The Brae Fell mine was worked from two short crosscuts (now caved) to an approximately north-northwest-trending vein, and the size of the associated dumps suggest, in local terms, a relatively extensive operation. The mine was last opened in the mid-1800s but this was merely a trial operation and nothing came of it.

Pyromorphite and cerussite are common in small amounts on

the dumps, but the Brae Fell mine is distinctive for being only the second known locality for the relatively new species mattheddleite. Mattheddleite occurs as etched prisms and pinkish masses on leadhillite and cerussite and as sharp prismatic crystals with pyramidal terminations encrusting lanarkite.

Brandy Gill mine

An east-west lead vein crosses Brandy Gill just over 500 meters upstream from the Carrock tungsten mine. Two levels in the west bank have been explored in this century and proved to be mostly barren, although the lower level does show some old stoping. The mine was operated sporadically until about 1873, but only a few tons of lead and copper ore were raised. J. G. Goodchild, of the Scottish Geological Survey, found wulfenite there in 1875 but the locality only really became of interest to collectors in the 1950s following the reporting of a suite of rare supergene minerals including bayldonite, duftite, beudantite, carminite, lindgrenite and stolzite (the first authenticated British occurrence). Duftite, bayldonite, beudantite, and carminite are occasionally seen as epimorphs after small mimetite crystals.

Carrock mine

The Carrock mine is the only British deposit outside of southwestern England that has been worked commercially for tungsten. Located in Grainsgill at the foot of Brandy Gill, it exploits three main structures: the Smith, Harding and Emerson veins. It was only intermittently economic, notably during World War I. Its last period of operation was in the 1970s. The north-south tungsten-

The Brandy Gill mine (*left*), upper level. Peter Briscoe photo.

Underground at the Carrock mine (*below*). Helen Wilkinson photo.

Arsenopyrite, 9 cm, from the Smith vein, Carrock mine, Caldbeck Fells, Lake District, Cumbria (LG-157). Collected late 1980s, ex. Sutcliffe collection; Joe Budd photo.

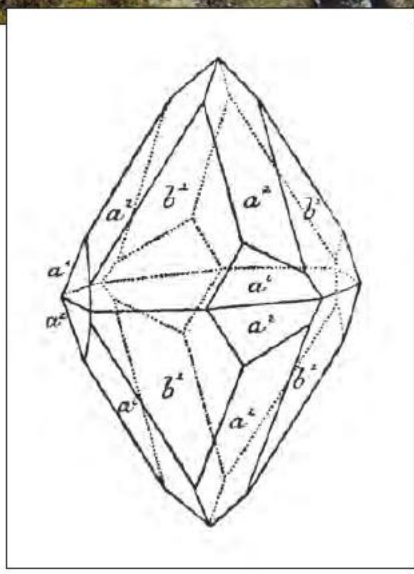
Carrock mine site. Gordon Akitt photo.

bearing veins, a well-known source of fine scheelite, apatite, rare crystallized bismuth, arsenopyrite and other minerals, are cut by east-west lead veins; interaction between the two mineralizations has resulted in the formation of some interesting supergene minerals. Vanadinite specimens attributed (probably incorrectly) to the Carrock mine in the Kingsbury collection at the Natural History Museum, London, show small short-prismatic crystals, zoned pale brown and cream.

Driggith mine

The Driggith mine is little known to mineral collectors outside the United Kingdom but has produced some interesting and characteristic pyromorphite-mimetite specimens as well as a suite of unusual rarities. It exploits a continuation of the Roughton Gill South lode from levels in the Driggith Valley and from lower levels over the fell at Sandbeds.

Ore minerals in the Driggith-Sandbeds vein were predominantly galena, sphalerite and chalcopyrite in a gangue of quartz and barite. The intimate association of galena, sphalerite and barite, especially in the deeper levels of the mine, caused insurmountable problems for the gravity separators used for ore-dressing in the Victorian workings and was a major cause of the failure of the mine.



Scheelite crystal drawing, Caldbeck Fells (from Levy, *Description d'une Collection de Minéraux formé par Henri Heuland*, 1837).

Scheelite crystals to 3 cm, from the Smith vein, Carrock mine, Caldbeck Fells, Lake District, Cumbria (LG-162). An old specimen ex. Richard Barstow; it passed to Ralph Sutcliffe in 1982 and then to Lindsay Greenbank in 1991. Joe Budd photo.

Bismuth, 2.5 cm, from the Harding vein, Carrock mine, Caldbeck Fells, Lake District, Cumbria (LG-172). An old specimen obtained by Richard Barstow; it passed to Ralph Sutcliffe in 1982 and then to Lindsay Greenbank in 1991. Joe Budd photo.

Scheelite crystal, 5 cm, from the Carrock mine, Caldbeck Fells, Lake District, Cumbria (LG-168). Probably collected in the early 1900s, it passed from A. G. Moss, Sr. to A. G. Moss, Jr., to Ralph Sutcliffe, and finally to Lindsay Greenbank in 1991. Joe Budd photo.

The earliest records of mining at Driggith are in documents from the early 18th century but information is scanty until the turn of the 19th century. The mine was profitably worked in the first decades of the century but thereafter, despite brief profitability in the 1850s, the mine was worked at a loss by successive operators, most of whom ended up bankrupt. The mine was effectively finished by 1874. Several attempts to rework it in this century for lead or barite were defeated by the dilapidated state of the workings or the problems of ore separation. The last operation was in 1948. Production statistics are incomplete but the mine produced at least 3,800 tons of lead ore from 1845 to 1907, yielding some 2,500 tons of lead and 40,000 ounces of silver. Small amounts of copper, zinc and barite were also raised.

Mimetite occurs at the Driggith mine in small, rounded, greenish to khaki-colored crystals encrusting quartz. The mineral frequently contains a high proportion of phosphate and forms a continuous series with pyromorphite; many specimens are of intermediate composition. Considerable quantities of pyromorphite are reputed to have been raised from the upper levels of the Driggith mine. The mineral is still common in the outcrops of the vein, generally forming small (<5 mm), opaque, rounded or seed-like, green to khaki-colored crystals encrusting quartz. Many specimens are near the midpoint in composition between mimetite and pyromorphite. A very characteristic form first recorded from the outcrop in the 1940s consists of masses of coarsely fibrous pyromorphite with pitted reniform surfaces, indistinctly color-zoned in shades of greenish yellow to yellowish green.

Dry Gill mine

Although of little commercial significance, the Dry Gill mine is one of the most famous mineral localities in the world. Lead minerals consisting predominantly of phosphate-rich mimetite in barrel-shaped crystals ("campylite") in a gangue of quartz, barite and manganese oxides were deposited in an east-west-trending vein. Other minerals occur rarely, the most well-known being plumbogummite.

Although mimetite specimens from Dry Gill are known to have been collected at least as early as 1830 there is no record of commercial ore mining there until a lease was taken by Hugh Lee Pattison, inventor of a cupellation process for the desilvering of lead. Pattison began work in 1846, driving an adit on the vein where it crosses Dry Gill Beck near the foot of the gill. He raised a few hundred tons of "coloured lead ore" but gave up the work in the 1850s. The property was subsequently tried by various operators, none of whom had much success. The mine was last worked in 1869.

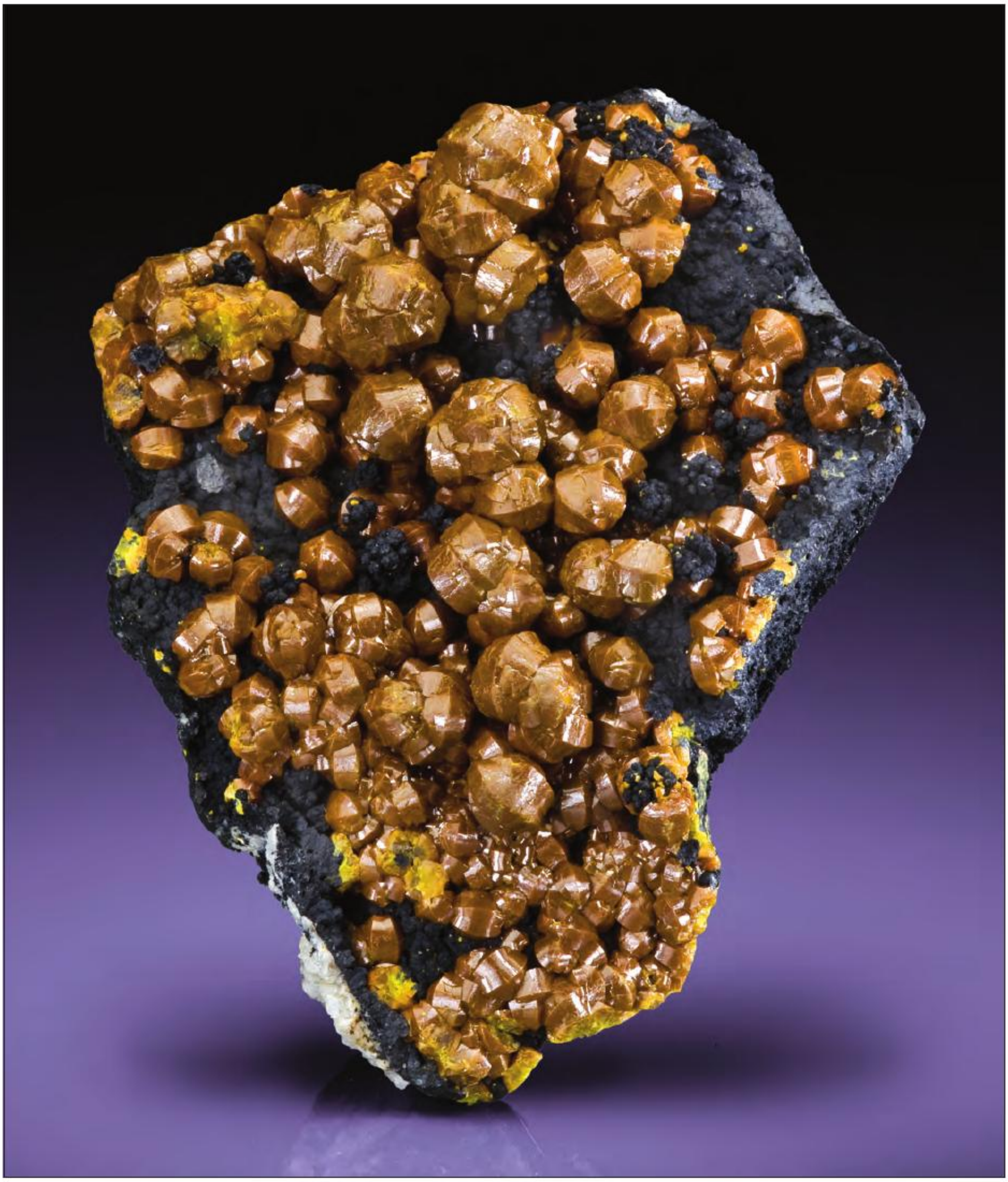
Ruins of the Driggith mine. Gordon Akitt photo..

Interior of an adit leading into the Dry Gill mine.

The finest mimetite specimens were collected in the 19th century but, although increasingly hard to find, some fine material has been obtained since, particularly in the 1970s through the efforts of the partnership of Ralph and Michael Sutcliffe, Lindsay and Patricia Greenbank, and Richard Barstow. In 1970, after years of searching, Lindsay and Mick finally found a means of entry through a collapsed shaft that led out to the top of the fell. They managed to keep this to themselves for some years by manufacturing a "lid" to cover the mine opening and changing the lock every weekend (to the frustration of rival collectors also wanting entry). Plans to mine on a larger scale had to be canceled when a formal licensing application to the mineral rights owners was turned down in 1973. However, the mine is notoriously unstable, cold and wet, and there have been a number of accidents involving collectors. No one has been critically injured but the incidents have highlighted the dangers of the old workings in the Caldbeck Fells.

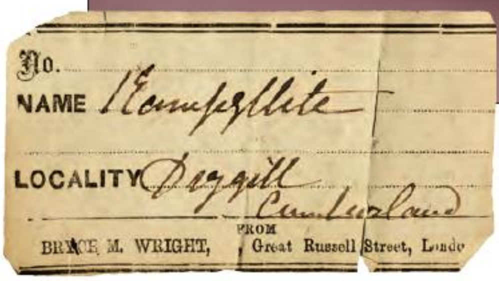
The deposit consists almost exclusively of mimetite and pyromorphite in a gangue of quartz, barite and manganese oxides. The quantity and quality of mimetite found at the Dry Gill mine makes the occurrence one of the most important in the world for this species. Specimens of mimetite from Dry Gill in the collections of the Natural History Museum, London, date from 1830, but the occurrence was not referred to in the literature until an "arseniate of lead" was described from Caldbeck in Allan's Phillips's ***Mineralogy*** (1837) as ". . . aggregated in opake, orange-yellow coloured individuals, which consist each of three hexagonal prisms curved towards their terminations in a manner often beautifully symmetrical." This material is undoubtedly identical to what Breithaupt formally described and named "campylite" (from the Greek *campylos*, "barrel") as a new species in 1841. Robert Allan's collection contains several specimens of typical Dry Gill mine mimetite.

Although campylite was later discredited as a species (= phos-



(*Above*) Mimetite (variety "campylite") with unusual, discrete, cream-colored crystals of plumbogummite, 9 cm, from the Dry Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-182). This is an old specimen from the 1800s, repatriated from the United States by Ralph Sutcliffe in 1983. Joe Budd photo.

(*Facing page*) Mimetite (variety "campylite") on psilomelane, 9 cm, from the Dry Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-180). This specimen was sold to the British Museum in 1893 by J. C. Williams, a member of a Cornish mining family who ran the Burncoose Essay Office in the late 1800s. It was traded in 1978 to Richard Barstow (1947–1982), and was acquired by Ralph Sutcliffe following his death; Sutcliffe's collection was purchased by Lindsay Greenbank in 1991. "Campylite" is a characteristic mimetite variety of the Caldbeck Fells, especially from the Dry Gill mine. The Greenbank collection contains a fine suite of specimens old and new. Other fine and historic campylite specimens that have passed through Lindsay's hands include the large Keates collection piece featured in Cooper and Stanley (1991), recently sold to the Liverpool Museum. Few modern collectors have had the opportunity to make such a difficult choice about which to keep! The Dry Gill mine today is renowned the world over for specimens of mimetite of this characteristic habit. It was dubbed "campylite" (from the Greek *campylos*—"barrel") because of the barrel-shaped habit of its rounded prismatic crystals. Joe Budd photo.



Mimetite (variety "campylite") with white barite and plumbogummite, 9 cm, from the Dry Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-192). A former Bryce M. Wright specimen, circa mid-1800s. This specimen is notable for its large dark green crystals, overgrown by a second generation of more typical tan-orange color. Joe Budd photo.

Mimetite (variety "campylite"), 9 cm, from the Middle level of the Dry Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-193). Unusual for its yellow-green appearance due to a thin second generation of rare green mimetite over the original orange crystals. Collected by Richard Barstow in 1972; it passed to Ralph Sutcliffe, and then to Lindsay Greenbank in 1991. Joe Budd photo.

phatian mimetite), the name lingers on among collectors as a useful descriptive term for the characteristic barrel-like habit of mimetite found at the Dry Gill mine. Pyromorphite crystals are generally in the range 5–10 mm but exceptionally have been found as large as 3 cm across and thickly coating matrix pieces to over 20 cm. Excellent stalactiform specimens (to over 5 cm long) were also found in the 19th century. The color varies from yellow to orange and, rarely, green. More recently collected campylite specimens are most commonly varying shades of brown. Color zoning and chemical zoning are common, brown campylite often being paler and sometimes yellow or orange within. Yellow acicular crystals, commonly found encrusting brown campylite or embedded in crusts of plumbogummite, are usually labeled mimetite but most, if not all, such crystals are actually pyromorphite. Mimetite also commonly occurs as tabular and short to long prismatic crystals and in globular masses.

Mexico mine

The Mexico mine is located adjacent to the Roughton Gill mine and exploits the eastward extension of the Roughton Gill South vein. It was begun in 1845, and three crosscuts were driven south to cut the vein. Promising shoots of pyromorphite and cerussite were found early on, in what the miners called "phosphate ground," regarded as an indicator of rich primary ore below. The crosscuts, a shaft and drifts parallel to the vein were all cut on the assumption that rich primary ores would be found when the vein was opened up. In fact the lode proved to be almost barren, and the heavy investment, largely made by the Caldbeck Fells Consolidated Lead and Copper Mining Company, was wasted. The mine was abandoned in 1868.

Pyromorphite is still the most abundant lead mineral to be found on the Mexico mine dumps. Characteristic of the locality are small

Mimetite (variety "campylite"), 6 cm, from the Middle level of the Dry Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-196). Mimetite crystals on manganese and massive mimetite from an open cut at the top of the fell, found during exploratory work by Anthony Walshaw and Lindsay Greenbank in 1963. Ex Walshaw collection, passing to Greenbank in the 1980s. Joe Budd photo.

bicolored (orange and green) crystals, most commonly found on the Low Level dumps in Todd Gill. Pyromorphite has also been found on these dumps, associated with pale smoke-brown plumbogummite or with small plates of wulfenite.

The finest pyromorphite to be found in the Caldbeck Fells in the last few decades was extracted in the 1970s from an outcrop of the Roughton Gill South vein just west of the Mexico mine High level. The original find was made by the late Richard Barstow; further material was dug by later collectors. This occurrence yielded many fine cabinet specimens displaying oil-green prismatic crystals to over 2.5 cm in solid masses and on quartz matrix. Later finds included pale yellow-green prisms to 2 cm or so and bright green botryoidal encrustations on matrix. On occasion several habits and colors were found in the same cavity. The locality is now worked out and backfilled.

Mimetite from the Mexico mine was first mentioned by Greg and Lettsom (1858). Brown, rounded crystals similar to, but distinct from, Dry Gill "campylite" have been found on the dumps from the High Level.

Old Potts Gill mine

Workings in the head of Potts Gill date from about 1870 when attempts were made to work the outcrop of the prominent east-west veins for lead. Very little lead ore was found in the predominantly barite-filled vein but the latter mineral was worked from the outbreak of World War I. The mine closed in 1947.

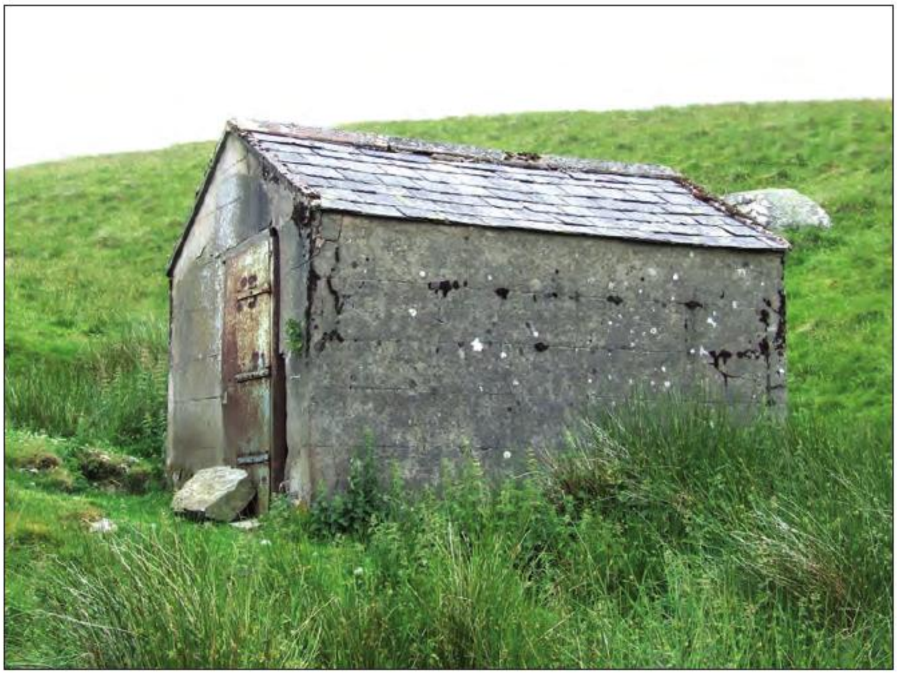
The barite mined was almost all massive and very little material of specimen quality was found. The deposit is of interest primarily for a suite of rare copper and lead minerals reported from the dumps of the "Old No. 1 level" by Arthur Kingsbury and J. Hartley.

Red Gill mine

The Elizabethans are supposed to have worked the Red Gill mine but no specific records have survived. Workings in Red Gill are mentioned in early 18th century documents but thereafter there is nothing known of the locality until the 19th century. The best-documented operations are those of the Red Gill Mining Company, which leased the property in 1861. The company extended the Red Gill mine and opened several other prospects nearby, but recorded

The Mexico mine.
Peter Briscoe photo.

Pyromorphite, 1.5 cm, from the Mexico mine, Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-234). A fine thumbnail of the style found by Richard Barstow in the mid-1970s in workings now referred to as "Barstow's Trench."
Joe Budd photo.



Potts Gill mine, an old stone or concrete shed with an iron door (possibly a powder magazine).

production was very small. The company went bankrupt in 1871, having raised no more than 28 tons of lead ore and 45 tons of copper ore. From that time there has been no commercial exploitation of the mine.

The Red Gill vein runs northwest-southeast and was worked from several levels in the spur between Swinburn Gill and Red Gill. Principal ore minerals were chalcopyrite and galena, closely associated in a gangue of quartz and barite. Intense oxidation resulted in a remarkable assemblage of supergene lead and copper sulfates including fine specimens of linarite, caledonite and leadhillite. The best specimens of these species were found while the mine was working; very few have been found in this century.

Specimens of such rarities as macphersonite, queitite and mattheddleite have been found recently on the otherwise almost barren dumps. In fact, the Red Gill mine has been the most productive locality in the district for recently collected specimens of mattheddleite. It has been found as microcrystals with caledonite, leadhillite and susannite on quartz, and in cavities in etched galena with minute sprays of pale blue lanarkite. Its occurrence seems restricted to the interior of cavities in the veinstone.

Roughton Gill mine

Roughton Gill is assumed to have been the site of the principal Elizabethan workings at Caldbeck Fells, although its present name does not appear in documents as a mining site before the end of the 18th century. Some workings are, however, undoubtedly ancient, as hand-cut levels can still be found in the higher workings.

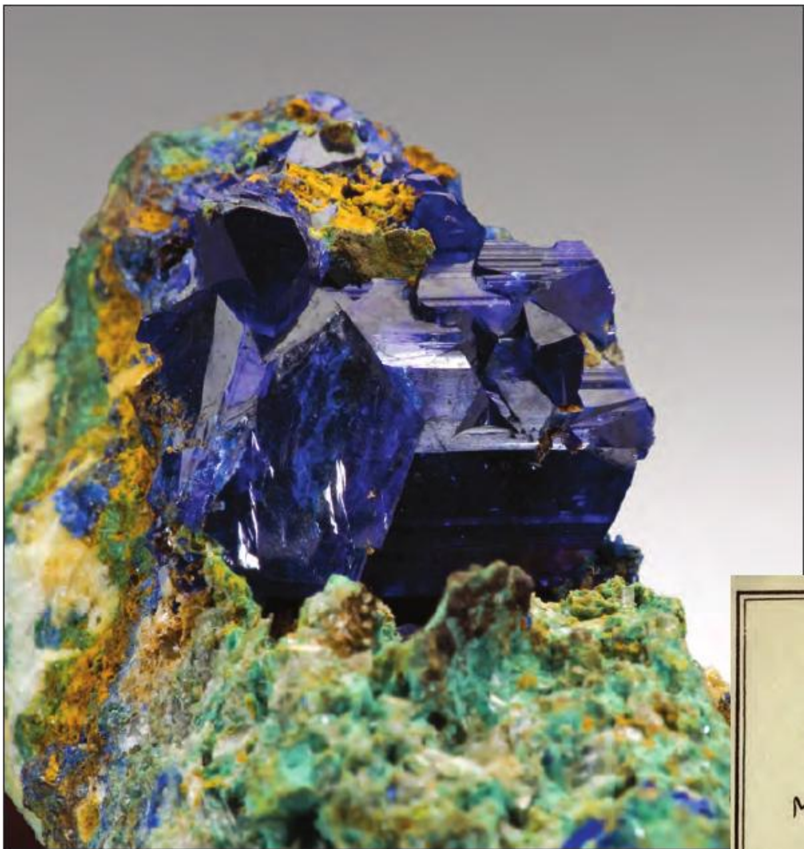
The mine exploited two large lodes known as the Silver Gill and the Roughton Gill lodes. The former was named after the valley to the west where it was once extensively and (legend has it) very profitably worked. These names have fallen somewhat into disuse, and the veins are now generally known to geologists and mineralogists as the Roughton Gill North and Roughton Gill South lodes respectively. This terminology leads to some confusion because these terms were used by the old miners to denote branches of the Roughton Gill vein proper.

The principal ore minerals at Roughton Gill were argentiferous galena and chalcopyrite with lesser, though occasionally valuable, amounts of pyromorphite, cerussite and malachite. The gangue was mostly hard quartz but, in an occurrence unusual in the Lake District, large quantities of calcite were associated with the richest shoot of ore in the Roughton Gill South vein. The ore deposits were apparently richest where gabbro formed one of the walls of the vein, this and other country rocks being intensively altered for a considerable distance from the lode.

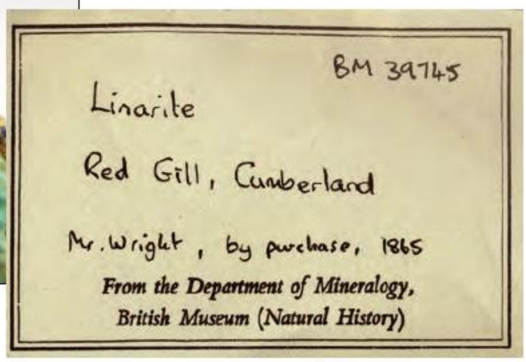
The earliest trials and levels are found in the higher reaches of Roughton Gill where the outcrop of the strong Roughton Gill South vein was worked from opencuts and short drives on the lode. In later years crosscuts were driven lower down the gill. There has been no access to the mine in living memory and this, along with the almost complete absence of any contemporary mine plans, means that the full extent of the workings is now unknown.

From about 1820, fortunes were made by a succession of owners but by 1865, when the mine was leased to the ill-fated Caldbeck Fells Consolidated Lead and Copper Mining Company, the richest ores were gone and the mine was in decline. The construction of the most up-to-date ore milling equipment and an expensive attempt to find ore below the 90-fathom level on the Cornish principle by the use of an engine shaft failed to improve the output or add to the known reserves. The market crash in the price of lead in the 1870s brought the company to bankruptcy in 1876. The mine closed and, apart from some interest shown by the Cleator Iron Ore Company,

Red Gill mine. Dennis Scott and Gordon Derry photo.



Linarite, from the Red Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-218). These 1.5-cm crystals are unusually large for the locality. The specimen was sold by Bryce M. Wright, Sr. to the British Museum in 1865, and carried the museum catalog number BM39745. It was traded by curator Peter Tandy to Simon Harrison, who sold it to Ralph Sutcliffe, whose collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.



BM 39745

Linarite

Red Gill, Cumberland

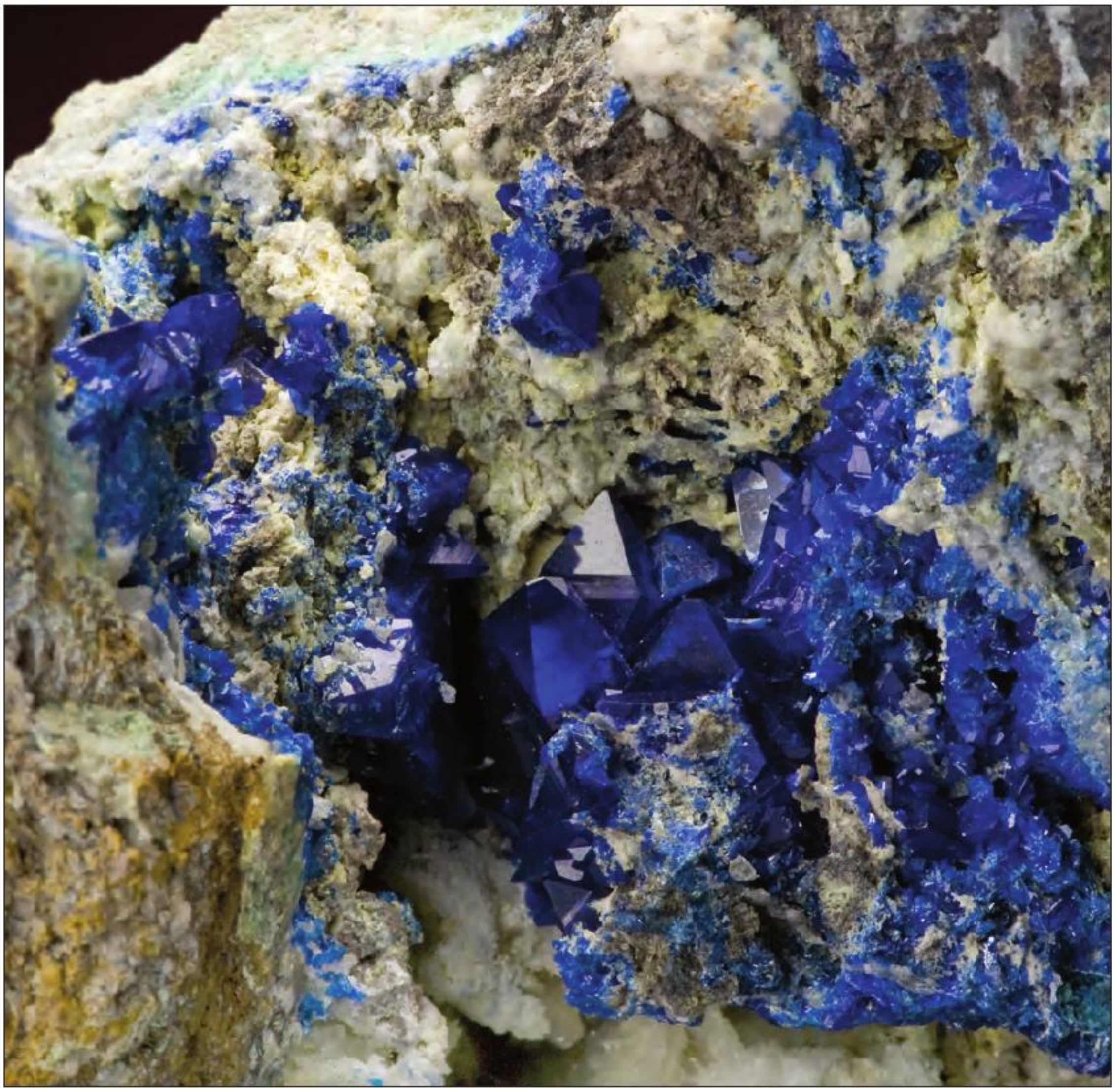
Mr. Wright, by purchase, 1865

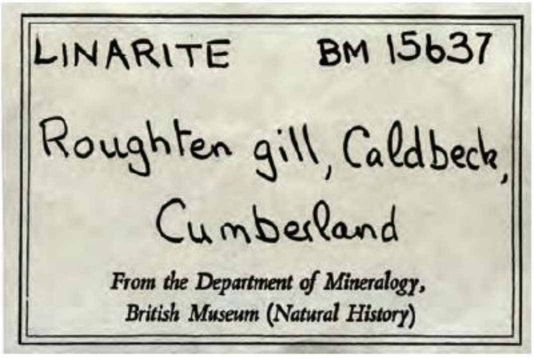
From the Department of Mineralogy,
British Museum (Natural History)

Roughton Gill mine entrance adit. Helen Wilkinson photo.

Roughton Gill mine surface workings known as "Barstow's Trench" (dug by Richard Barstow). Peter Briscoe photo.

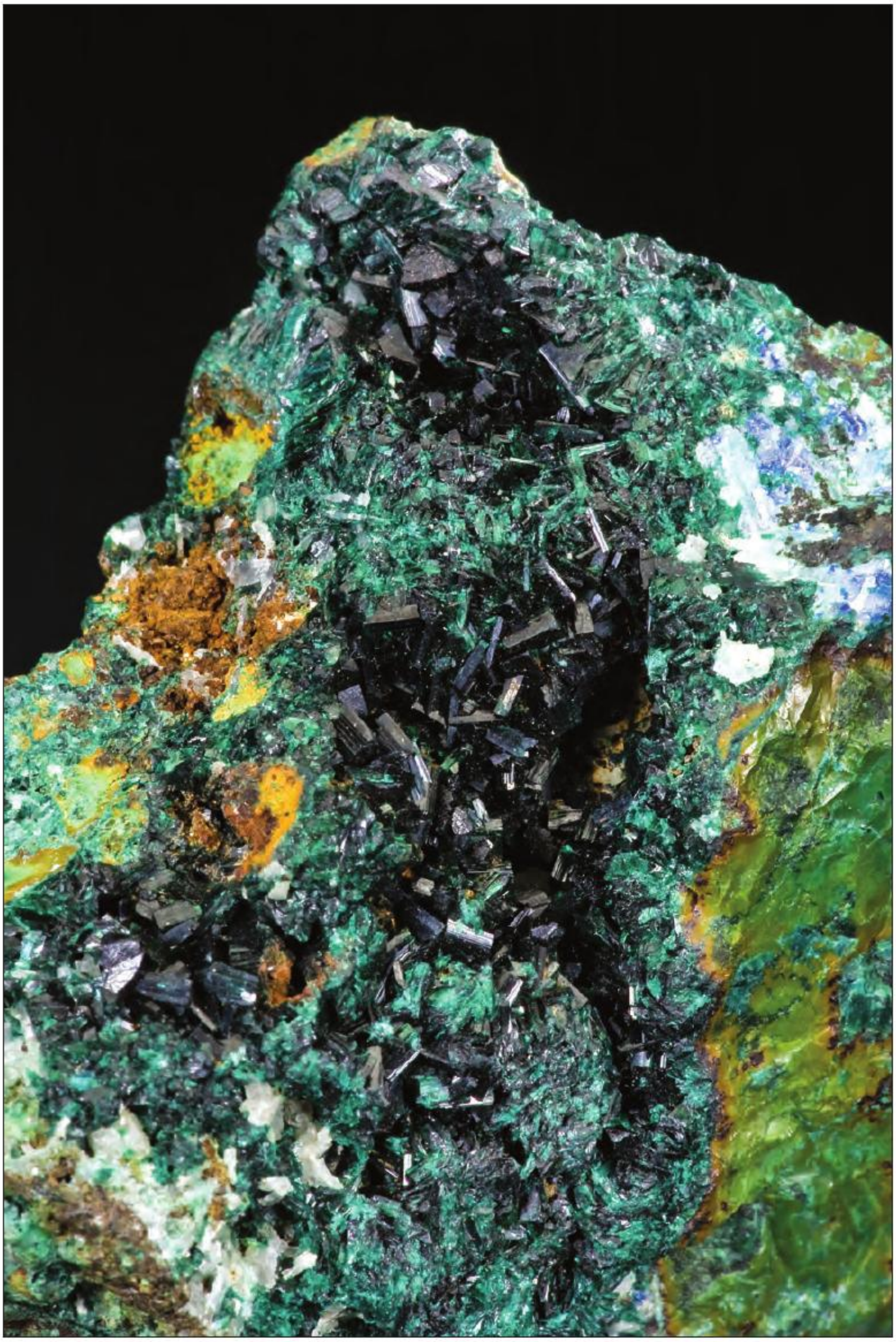
(*Facing page*) Linarite, 9 × 9 cm, from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-230). This was the first specimen to be acquired by the British Museum from mineral dealer Bryce M. Wright in 1843: a 9 × 9-cm veinstone matrix containing a cavity encrusted with small cerussite and anglesite crystals overgrown by two generations of deep blue linarite crystals to 6 mm, associated with minor leadhillite. This historic piece is the first linarite specimen acquired by the British Museum, the earliest authenticated linarite from Cumberland, and also the first specimen sold to the museum by Brice (later Bryce) Wright, Sr. Wright was to become one of the principal suppliers of Cumbrian specimens to the British national collection, though he was only a part-time dealer at the time, becoming a full-time professional a few years later. Lazarus Fletcher, Keeper of Minerals at the British Museum, mentions this piece in his chronological ***History of the Collections*** (1904) as one of the outstanding acquisitions of 1843. It was registered as BM15637. By exchange, Richard Barstow acquired the Wright specimen from the museum for his personal collection; it was purchased after his death by Ralph Sutcliffe. The historical significance of the piece was not appreciated until it was uncovered during research into Wright's life and business by the author in the late 1980s (see Cooper, 2006). Linarite specimens from Roughton Gill are very rare compared with the relatively prolific nearby locality of Red Gill. This specimen was considered by Mick Cooper (as well as by Sutcliffe and Greenbank) to be the finest known such specimen outside of one piece still held by the Natural History Museum, London, which they acquired from collector Robert Greg in an 1860 bequest. Joe Budd photo.

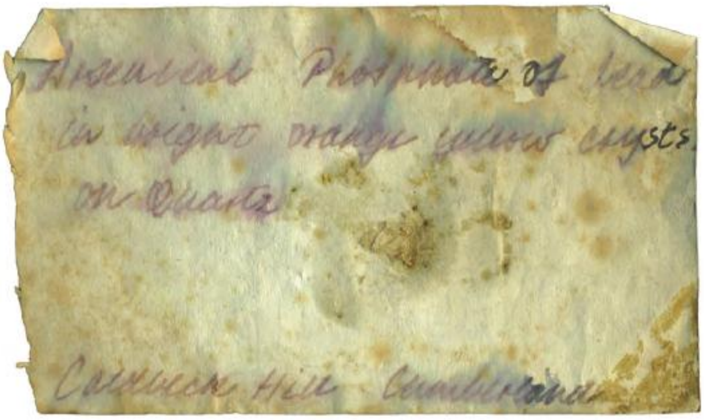




Transcription of a Bryce Wright letter to the curator of the British Museum mentioning the linarite; it is dated November 6, 1843:

Sir,
When I was at the British Museum last Spring, with some blue cupreous sulfate of lead [linarite], *you told me if I met with anything more I was to let you know. Beg leave to send you the following, if you have not already got them.*
—A beautiful brown specimen of sulfate of lead [cerussite], *size on opposite page.*
—4 beautiful arsenophosphates of lead [mimetite/pyromorphite], *about 2½ by 3½ inches, chrystals of which are in the box [of] pure red color.*
If you have them not, & will be kind enough to send me word, they shall be sent with the prices annexed.
I am, Sir, your ob't servant,
Brice Wright
56 Renshaw Street, Liverpool





Pyromorphite, 10 cm, from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-221). These unusual, yellow, globular crystals are one of the oldest specimens in the Greenbank collection; the early label dates it to the mining era of the 1700s because of the reference to "Caldbeck Hill," a place name which had fallen out of use by the turn of 1800. It was obtained from Gregory, Bottley in London by Richard Barstow in 1968, passed to Ralph Sutcliffe in the 1970s and then to Lindsay Greenbank in 1991. Joe Budd photo.

(*Facing page*) Brochantite, 5 cm, with dark green prismatic crystals to 3 mm, from the Roughton Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-615). The specimen is accompanied by a label written in the hand of Jean Behier (1903–1965), based on an old Bryce Wright label (now lost) that once accompanied this specimen, indicating that it came from "near Keswick." The locality was nevertheless incorrectly assumed by Behier to be Cornwall, where secondary copper species were more common. This specimen is one of the few known examples of brochantite from Wright's prime hunting grounds around Keswick in the county of Cumberland. It was sold by dealer Alain Martaud to Lindsay Greenbank when the Behier collection was dispersed in 2001. Joe Budd photo.

Hemimorphite, 7 cm, from the Roughton Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-499). The specimen passed at some point to the British Museum, and was later traded to American mineral dealer A. L. McGuinness (1926–1990), and carries his catalog number D.556; following McGuinness's death his son Mark sold it to Gene Schlepp of Western Minerals in Tucson, who sold it to Lindsay Greenbank in 1992. Since the early 19th century, hemimorphite specimens from Roughton Gill have been famous for their beauty. Very high prices were fetched even then. Bryce Wright once had a virtual monopoly on these pieces, and those that he sent to William Jefferis in America caused much excitement there. Specimens are still eagerly sought, the more so since none of significantly high quality has been found for over a century. Lindsay Greenbank always had a fondness for them, and kept two in his collection for many years. Joe Budd photo.

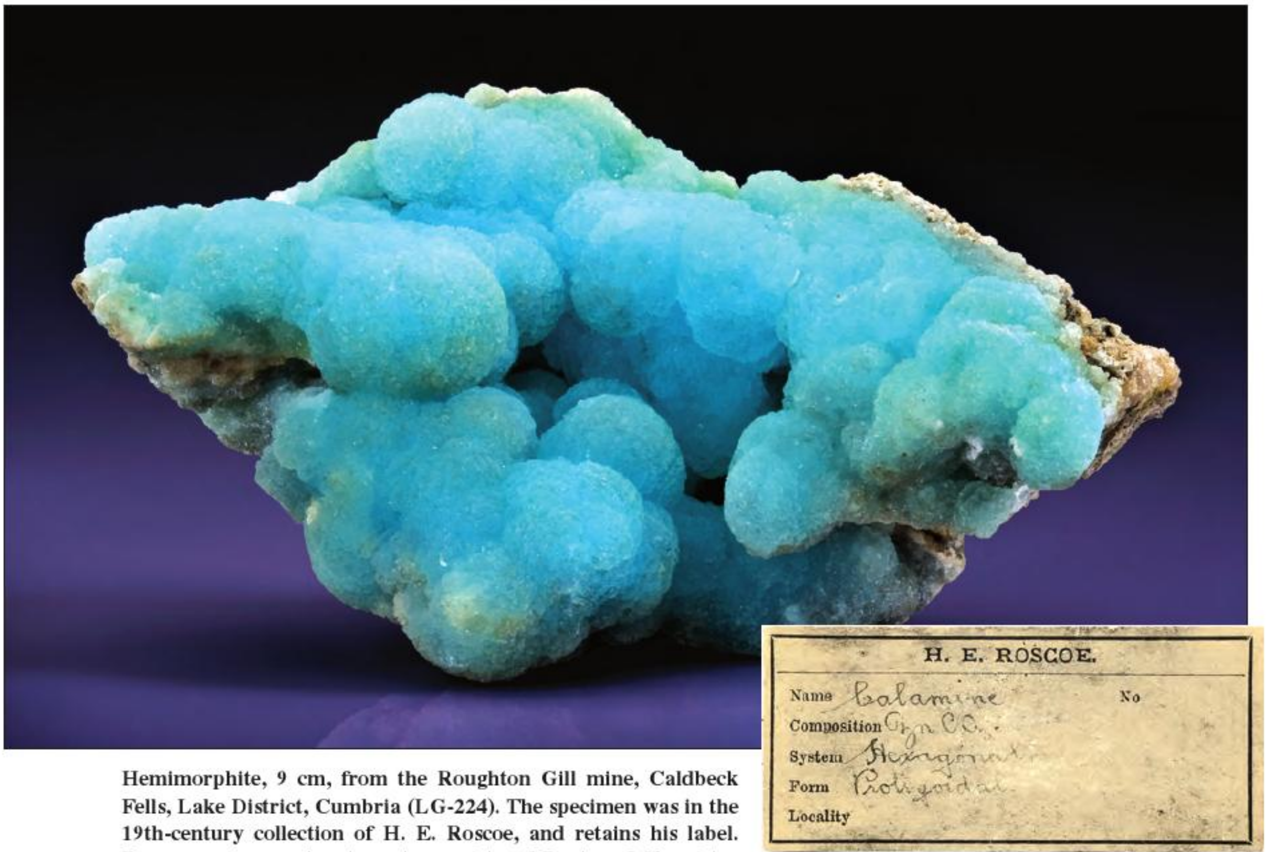
which worked barite and limonite in the Caldbeck Fells, Roughton Gill was effectively finished as a metal mine.

Records of production in the early period are vague. Output from the Roughton Gill workings alone are not recorded before the 19th century; the production figures are complicated by changes in ownership and were often given in combination with other mines worked by the same operator. Peak annual production of dressed lead ore was some 650 tons in 1851. From 1845 (the start of official production records) to the close of operations in 1876 some 10,500 tons of lead ore were raised, yielding over 6,000 tons of lead and about 13,000 ounces of silver. The mine also produced over 1,300 tons of copper ore in the same period; and 39 tons of zinc ore are recorded for 1873–74.

The Roughton Gill South vein contained one of the most remarkable deposits of pyromorphite on record; so much was collected from one area on the 60-fathom level that it became known as "the specimen stope." Unfortunately most specimens collected when the mine was working are accompanied by no details of their precise location within the mine.

The most characteristic Roughton Gill pyromorphite specimens exhibit tapering yellow-green to oil-green prisms (resembling spindles when doubly terminated), in solid masses and as encrustations on cavernous quartz; oil-green pyromorphite in association with smalt-blue plumbogummite is a hallmark of the locality. Prismatic crystals may reach over 2 cm long but are generally less than 1 cm. Solid masses to 20 cm across are known in collections but pyromorphite probably occurred in much larger masses in the vein. Stalactites are rare (only 19th-century specimens are known) and may be very attractive when coated with sparkling crystal faces. The full range of color encompasses shades of green (from oil-green to emerald-green), yellow, gray, white, brown and orange.

The most common associated species is quartz and the most char-



Hemimorphite, 9 cm, from the Roughton Gill mine, Caldbeck Fells, Lake District, Cumbria (LG-224). The specimen was in the 19th-century collection of H. E. Roscoe, and retains his label. Roscoe was a prominent spectroscopist and Doctor of Chemistry at Manchester University; most of his collection is held to this day by the Oxford University Museum, though a few specimens were obtained by the Manchester Museum in 1968. This specimen was traded by the Manchester Museum to Richard Barstow in 1978. Following Barstow's death in 1982 it passed to Ralph Sutcliffe, whose collection was purchased by Lindsay Greenbank in 1991. Joe Budd photo.

acteristic (and highly prized) is plumbogummite, particularly when the latter is of a deep blue shade. Rarely, small pyromorphite crystals are seen embedded in crusts of blue botryoidal hemimorphite and very rarely pyromorphite is found associated with small rounded mottramite crystals. Pseudomorphs of pyromorphite after cerussite have been found, and plumbogummite forms epimorphs after small prisms of pyromorphite. The latter were first described in 1843 by Johann Reinhard Blum as hemimorphite ("kiesel-zinc") pseudomorphs after pyromorphite—a very common 19th-century error.

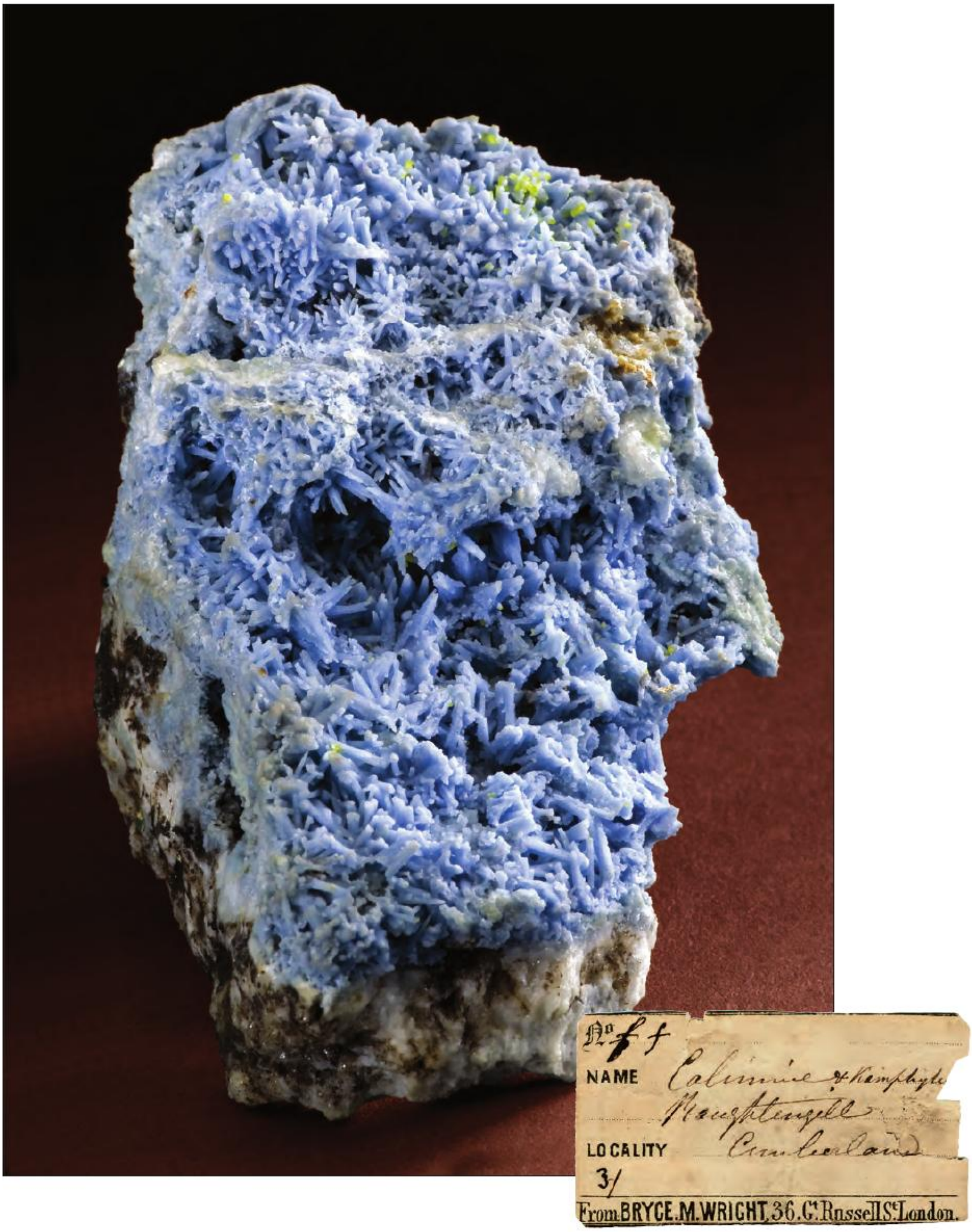
As with most occurrences of minerals in the Caldbeck Fells, the finest specimens of pyromorphite at Roughton Gill were found in the 19th century. When the mines declined, the supply of fine pyromorphite rapidly tailed off; as early as 1875 the dealer Bryce M. Wright, Jr. lamented that pyromorphite, once "the most common of Cumberland minerals [was] now very scarce." Nevertheless, even as recently as the 1940s and 1950s, fine specimens could still be collected from the dumps; one can only surmise the quantity of specimen-grade material available 100 years ago! In the last 50 years the thorough reworking of the sites by dealers and collectors has stripped away almost all of the cabinet-quality material to be found in the old dumps.

Mimetite is not as common at Roughton Gill as pyromorphite but there is little hard data on the distribution of the two species there, and mimetite may be more widespread than is supposed. "Wax-yellow crystals, well defined" were noted from Roughton Gill by Greg and Lettsom in 1858. Some fine specimens exist in old collections.

An outcrop of the Roughton Gill South vein in the higher reaches of the gill has recently yielded some good specimens of mattheddleite in minute needles with caledonite, lanarkite, leadhillite and hydrocerussite. An excellent example (since sold) was in the Greenbank collection. A very rare association is the sulfite scotlandite, this being only the third known locality.

Other Localities

Other workings in the area include the Hay Gill, Silver Gill, Burdell Gill, Wet Swine Gill, Sandbeds, and Nether Row Brow mines. Some smaller sites are mentioned in mineral descriptions: Short Grain and Ingray Gill are shallow valleys in the northwestern part of the Fells. Each contains several small prospects for lead or barite or both. These workings probably date from the mid-19th century and are of small extent and little economic consequence.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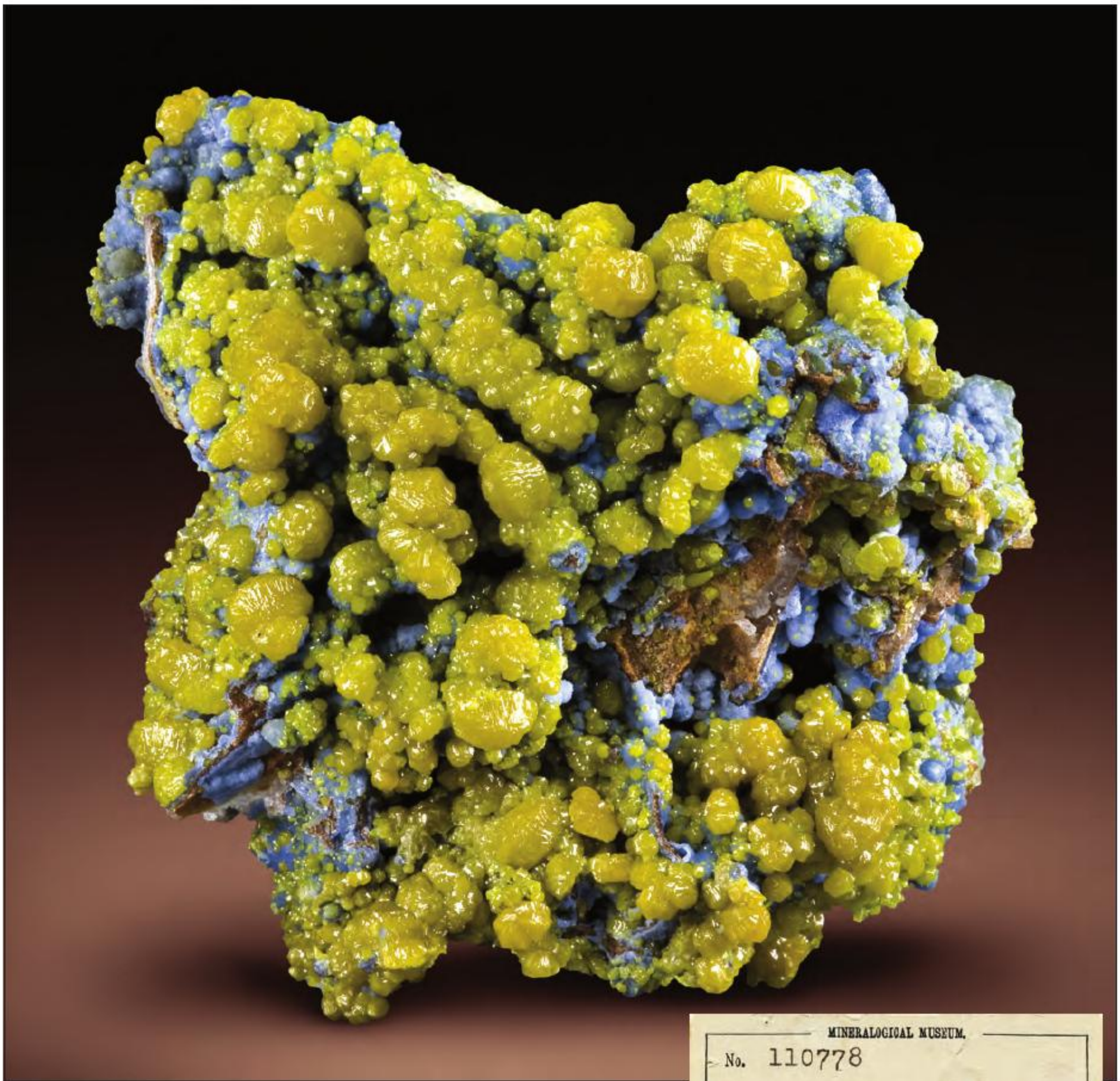
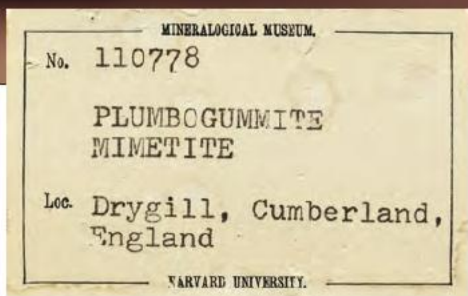



MINERALOGICAL MUSEUM.

No. 110778

PLUMBOGUMMITE
MIMETITE

Loc. Drygill, Cumberland,
England

HARVARD UNIVERSITY.

Pyromorphite with blue plumbogummite, 6 cm, from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-658)—a specimen dating from the late 1800s. It was deaccessioned from the Harvard Mineralogical Museum and acquired by Ed David, who held it until 1993 (his number remains on the backside). It was repatriated to England in the mid-1990s by Ralph Sutcliffe. Joe Budd photo.

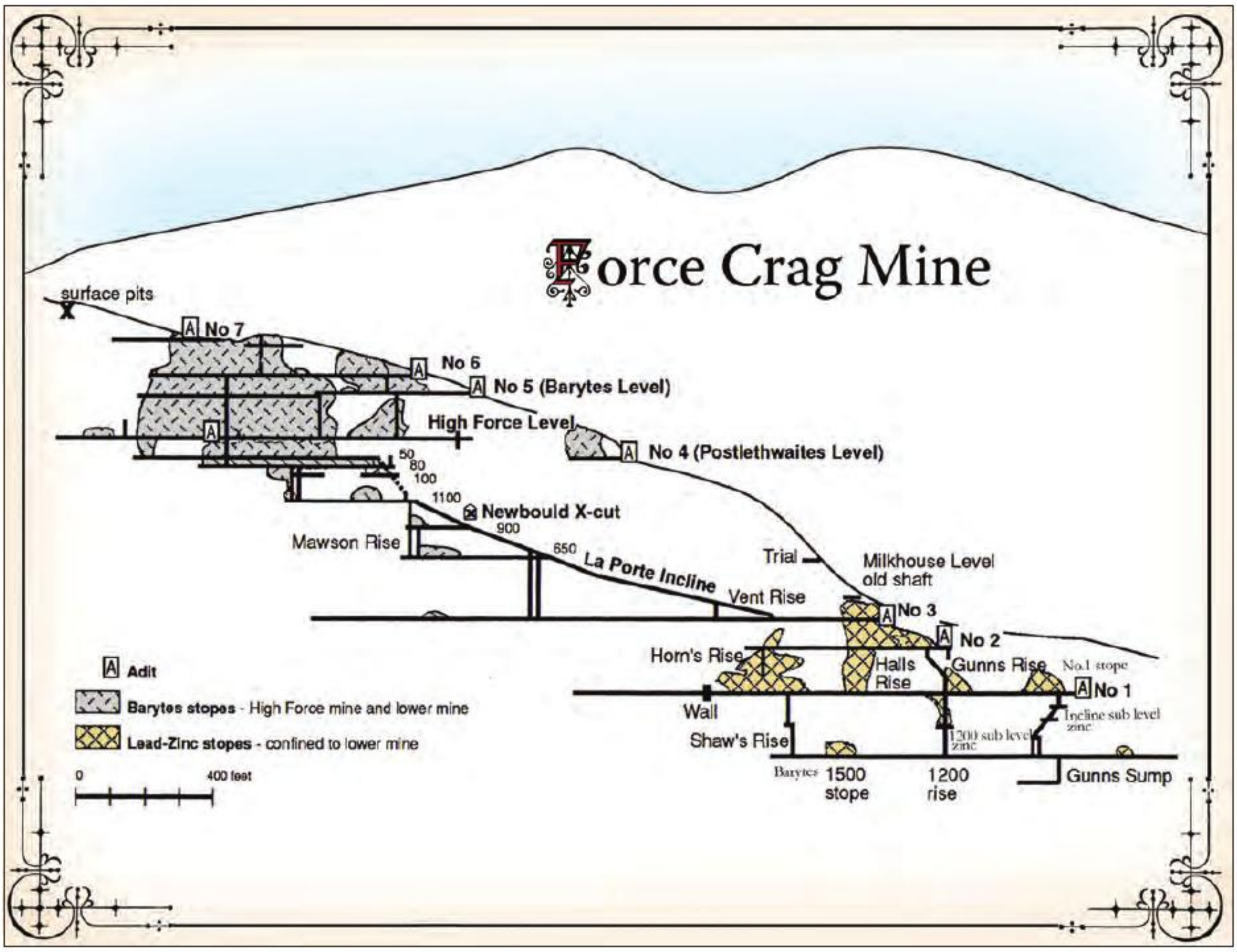
(*Facing page*) Plumbogummite pseudomorphs after pyromorphite in unusual pseudocrystals to 8 mm (overall size: 8 cm), from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-517). It was sold by Bryce M. Wright, probably to William Jefferis (of Pennsylvania), and eventually was acquired by the Museum of Geology and Mineralogy of the University of Pennsylvania. Joe Budd photo.

Pyromorphite, 6.5 cm, from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-222). It was purchased at a Sotheby's auction in London in the 1960s by Ralph Sutcliffe, who sold it to Texas collector Perkins Sams. The Sams collection was later acquired by the Houston Museum of Natural Science, but the specimen was eventually acquired by a California dealership in 1986, who sold it back to Sutcliffe at the 1987 Tucson Gem & Mineral Show; the Sutcliffe collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.

Pyromorphite, 8 cm, from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-219). This 19th-century specimen was sold by Bryce M. Wright, perhaps to the noted scientist and collector Hausmann whose name is noted on a German label that also records the supplier as Wright. Joe Budd photo.

Pyromorphite on plumbogummite, 8 cm, from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-27); collected in the late 1800s. Fine pyromorphite specimens from the Caldbeck Fells, with or without accompanying plumbogummite, are some of the most sought-after mineral specimens from the Lake District. Elsewhere in the world, plumbogummite is generally of unremarkable appearance (except for some specimens recently found in China). At Roughton Gill and Dry Gill it is characteristically powder-blue and occurs there in greater quantities than anywhere else: a truly unique occurrence. The colorful combination of green pyromorphite with blue plumbogummite is also unique to the Caldbeck Fells. Patricia Greenbank photo.

Pyromorphite, 14 cm, the finest known example from Roughton Gill, Caldbeck Fells, Lake District, Cumbria (LG-30). It was sold by the mineral dealer Bryce M. Wright in the 1860s to Thomas Brown; and was later donated by his estate to the Edinburgh University Museum in the 1870s. Once on prominent exhibit there until about 1910, the specimen was then put into storage where it remained out of sight and forgotten until it was exchanged to Simon Harrison in the 1980s; Harrison sold it to Ralph Sutcliffe, who sold it to Lindsay Greenbank, who then passed it to Ed David in 1995. Dr. David's collection was purchased by Rob Lavinsky in 2005, and this specimen was then acquired by Wallace Mann. Jeff Scovil photo.



The underground workings of the Force Crag mine in 1989, showing areas where minerals were collected by Lindsay Greenbank and his partners.

THE FORCE CRAG MINE

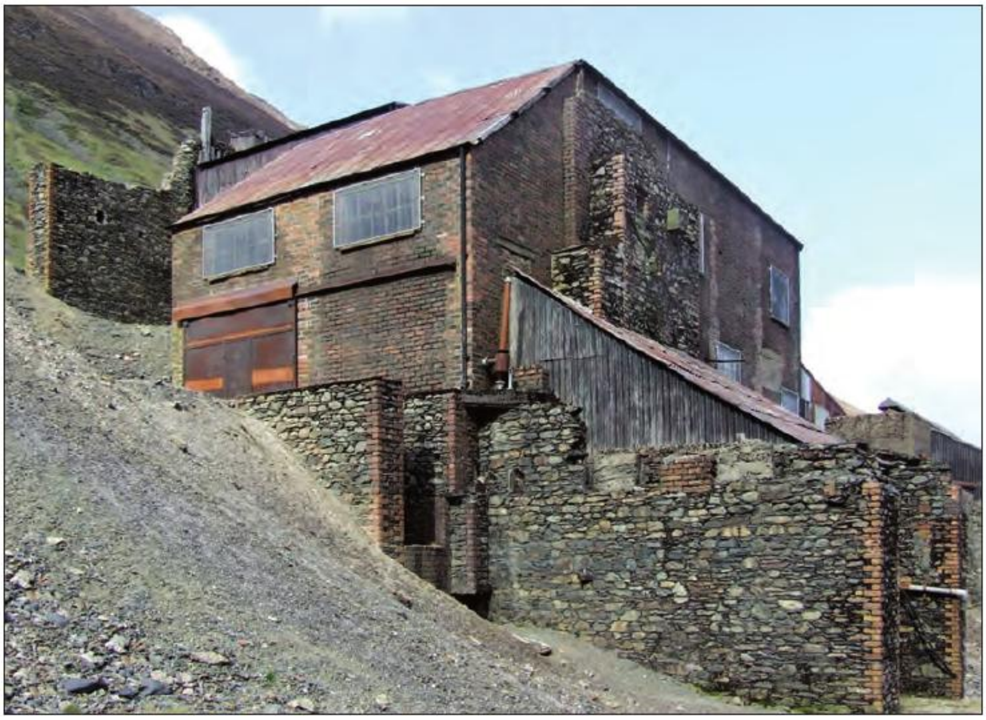
by Wendell E. Wilson & Michael P. Cooper

HISTORY

The Force Crag mine is located amid spectacular scenery at the head of Coledale Valley, 4 km southwest of Braithwaite and 7 km west of the town of Keswick in the Lake District, Cumbria. Although lead is known to have been mined from the head of Coledale in the 1500s, there are no records mentioning the Force Crag mine until about 1830 when a Keswick-based mining company began work there. The lead deposit proved to be rich in barite as well, and by 1860 it was being mined for that mineral, too. Mining of zinc and barite at Force Crag supplemented the sales of lead and helped keep the operation viable. The lower levels contained barite, sphalerite and argentiferous galena in a ratio of 30:10:1, but the upper part of the vein was mainly barite with manganese oxides.

The 19th century saw an increase in mining throughout the Lake District, facilitated by the construction of improved roads; the Force Crag mine was among the properties that benefitted. But a decline in world lead prices in the 1860s caused the Force Crag mine to close in 1865; it was reopened in 1867, and the upper levels were renovated for barite production, but the mine closed again in 1879. In the early 1900s an Elmore flotation plant was installed so that galena, sphalerite and barite could be separated. Production of all three minerals continued until the close of World War I.

The Force Crag mine was reopened in 1930, and produced barite intermittently under a succession of owners. Mining was initiated again in the 1970s by Force Crag Mines Ltd. of Toronto. The mine surveyor at that time, Bill Shaw of Keswick, allowed Lindsay and Patricia Greenbank into the mine in 1969 when a new level (the zero level) was being driven; they collected many groups of snow-white barite from a single large cavity exposed in the back. Since



Surface structures at the Force Crag mine. Gordon Akitt photo.

Barite crystal cluster, 7 cm, from the Force Crag mine, Braithwaite, Cumbria (LG-146). The fan of lustrous, white, tabular barite plates is perched on a mass of coarse sphalerite crystals. It was collected by Lindsay Greenbank in the 1200 manway sublevel of the Force Crag mine while he was operating it for the New Coledale Mining Company in 1989. Patricia Greenbank photo.

that time several different companies have attempted to reopen the mine, the most recent effort being that of Lindsay Greenbank's New Coledale Mining Ltd., which began working the deposit for both industrial barite and mineral specimens in 1984. Many excellent specimens of barite, sphalerite, galena, siderite and dolomite were collected, and some of the finest were retained in the Greenbank collection. It seemed for a while that commercial extraction of zinc and barite might actually be profitable for Greenbank's enterprise, but then the lowest entrance to the mine collapsed, blocking the outflow of water, and the mine flooded up to the next level. The effort was abandoned in 1990; it was the last metal mine in the Lake District to close. The National Trust now owns the property and has conserved the remaining mine buildings and machinery.

Today the adit entrances to the four levels that comprised the Low Force workings are easily found, along with the lowest of the High Force workings. Tramways, initially carrying ore cars pushed by hand or drawn by horses and later by diesel engines, were used to bring ore and waste rock to the surface, and traces of these can still be seen, though the steel rails have long since been taken away for scrap.

The rugged peak ("Force Crag") that towers over the mine made it difficult to transport the ore from the adits high up the valley sides down to the mills on the valley floor where the ore was crushed and washed. There are traces of tracks and tramways, and a channel for "hushing" the ore (that is, moving it by the force of water) and an aerial tow rope which worked like a ski-lift. The surviving crushing mill was built in 1908 and redesigned in 1939. The sites of two 19th-century mills were also identified: evidence remains from waterwheels, washing areas and settling tanks. Water was the primary source of power until the middle of the 20th century, so numerous cisterns, dams and water channels were built.

The Coledale Valley is open to the public (although there is no vehicular access), but unauthorized entry into the mill building and the mines themselves is illegal and potentially dangerous.

MINERALS

Minerals found at the Force Crag mine include sphalerite crystals (large, black to dark brown and lustrous) that are sometimes partially covered by honey-yellow drusy to botryoidal siderite. Fine specimens of sphalerite and of galena continued to be recovered right up to the time of the mine's closing. Beautiful, bladed white crystals of barite have also been collected. Small crystals of pale yellow fluorite were occasionally found as well, usually near the vein walls. In the upper levels of the mine psilomelane in a fine, black botryoidal habit was abundant. Greg and Lettsom (1858) cite the Force Crag mine as the first occurrence of stolzite ever found in England, though later writers believe that stolzite is unlikely there, given the mineralogical and geological setting of the vein.

THE BOULBY MINE

by David I. Green and Max D. Freier

INTRODUCTION

The Boulby mine is situated in the borough of Redcar and Cleveland, county of North Yorkshire, on the northeast coast of England in the North York Moors National Park. It is famous for producing the world's finest specimens of blue boracite, as well as trembathite and hilgardite. Operated by Cleveland Potash Ltd., it has some of the deepest workings (1,200 meters) in Britain. The primary product is potash (potassium chloride minerals), most of which is sold for agricultural use in fertilizers. In the early 1990s the mine was reported in mineralogical journals as a new locality for well-crystallized boracite and hilgardite. The fine, well-crystallized specimens, particularly of boracite, which reached the collector market were discovered during the development of a new area of the workings in late 1991. They represent the only significant discovery of fine-quality collector specimens at the mine to date. The majority of the fine specimens known were recovered by the mine geologists.

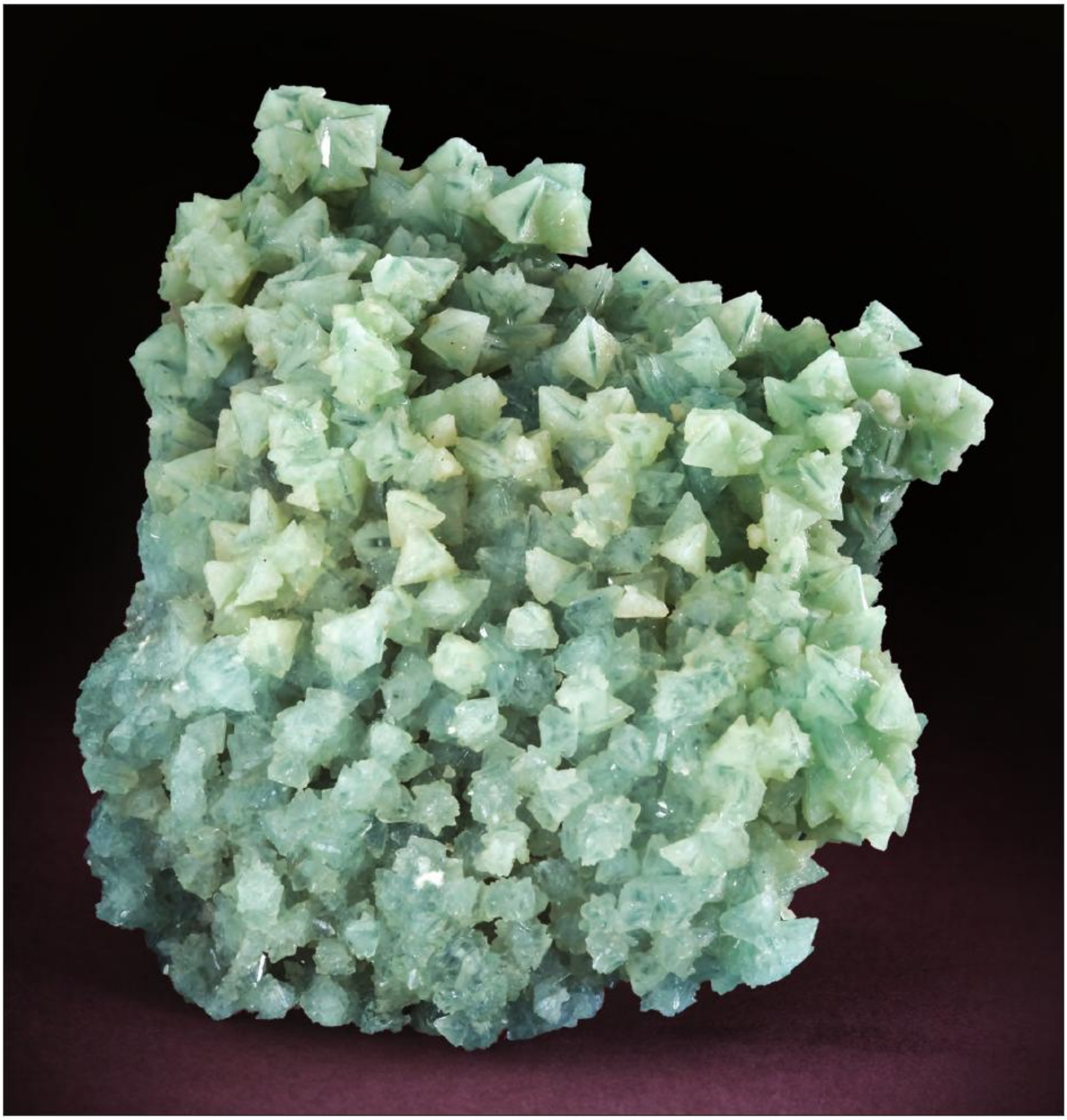
For references and further discussion regarding the Boulby mine and its minerals, see "The Boulby mine, Cleveland, England" by David I. Green and Max D. Freier (*Mineralogical Record*, vol. 27, page 163–170).

HISTORY

Evaporite salt and potash deposits of the Zechstein formation are the basis of major chemical industries in the United Kingdom, Germany and Poland. Potash was discovered in northeastern England in 1939 in a borehole drilled by the D'Arcy Exploration Company to test for oil and gas. Ten further boreholes drilled between 1948 and 1952 (by Imperial Chemical Industries and Fisons) proved the richness of the deposit, but because of its depth, mining was not considered possible.

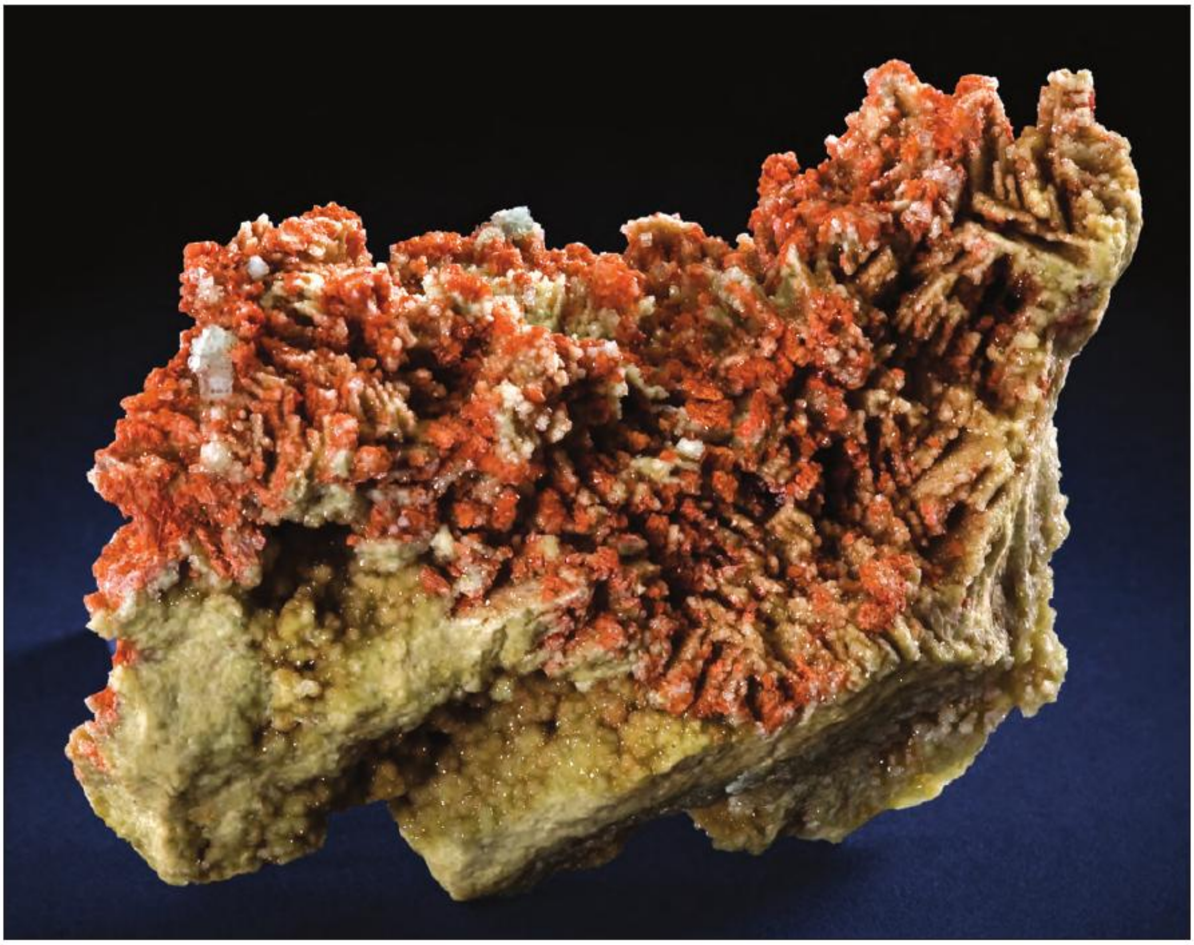
Developments in deep-mining technology in the Canadian potash fields led to a re-evaluation of the Boulby deposit, and further boreholes were drilled between 1962 and 1968. Three separate exploitation plans were submitted as a result, two for conventional mines and one for a solution mine. Planning consents were granted,

Modern ore processing facilities at the Boulby mine. David Eagle photo.



(*Above*) Boracite crystal cluster, 7 cm, showing sharp, tetragonal crystals to 5 mm, from the Boulby potash mine, Cleveland, North Yorkshire (LG-491). The hard, tough nodules of boracite in the Boulby deposit cause damage to mining machinery designed to process the compact but easily worked sylvite and halite. Miners and collectors were slow to realize the unique worth of these stony masses, but word eventually spread and the deposit is now recognized as the source of some of the finest specimens of boracite ever found. The specimen shown here was mined in 1993. Joe Budd photo.

(*Facing page*) Boracite crystal cluster with complex, lustrous crystals to 5 mm, from the Boulby potash mine, Cleveland, North Yorkshire (LG-496), collected in 1993 by the mine surveyor. Joe Budd photo.



Hilgardite after boracite, 5 cm, from the Boulby potash mine, Cleveland, North Yorkshire (LG-494); mined in 1993. Joe Budd photo.

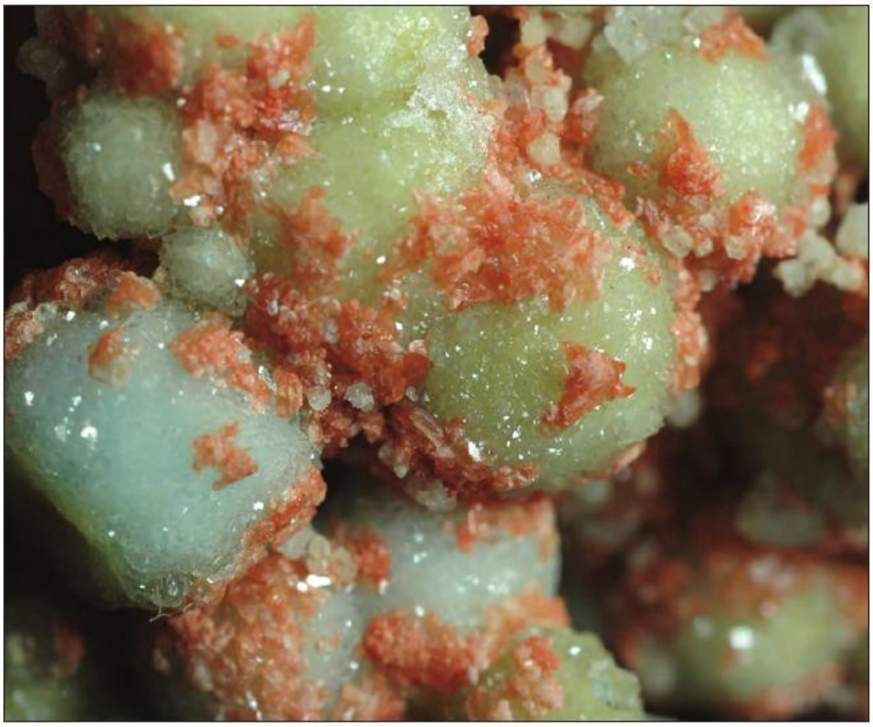
with the understanding that the developments would blend sympathetically with the environment, since the mines would be within the boundaries of the North York Moors National park.

Only one mine was developed beyond the planning stage. Cleveland Potash Ltd., a company jointly owned by Imperial Chemical Industries (ICI) and Charter Consolidated, began sinking two 5.5-meter-diameter shafts, one for ore and the other for men. This was a considerable engineering task since the shafts were deep, and passed through sandstone aquifers which had to be carefully sealed to stop water flow. Currently the mine is part of ICL Fertilizers Europe, which handles marketing and distribution of the products.

The Boulby potash deposit is worked using a variation of the mining technique known as the room-and-pillar method: this system, which is commonly used principally in coal mining, allows for areas to be extracted (rooms) leaving pillars to support the workings. At the Boulby mine, the voids (rooms) from which the ore is extracted are termed "panels." For a number of years potash was extracted from the panels using machines called "continuous miners," similar to those used in coal mining. These machines can extract up to 300 tons of ore per hour. To cope with greater lithostatic pressures in the ore at depths below 1,200 meters and to raise the production level above 3 million tons of ore per year by 2001, CPL converted its continuous miners to a remote-controlled operation, so they can be safely used in shaly sections without prior blasting. The mine now has a digital micro-seismic monitoring system. Remotely controlled continuous miners discharge ore into electric shuttle cars, which run to feeder crushers on the main conveyor belts to the hoisting shaft.

The ore is carried to the shaft system and hoisted out of the mine in 20-ton skips, at a rate of 600 tons per hour. Production since 1996 has been more than 3 million metric tons of ore annually, from which about 1 million tons of potash are extracted.

Development work is carried out in a thick, relatively stable halite bed some 30 meters below the potash. Ramps are driven upward from the development roadways into the potash, which is less stable structurally. Even the stable salt access roads are under high lithostatic pressure, because of the depth of the workings, and long horizontal slots are cut into the sides of the roadways to relieve stress. An aspect of the high rock pressure in the potash bed which initially made mining difficult was the existence of small, highly compressed pockets of gas (mainly nitrogen and methane). These



Hilgardite on boracite from the Boulby potash mine, Cleveland, North Yorkshire (LG-515); mined in 1993. Joe Budd photo.

were breached in the past, occasionally with adverse results. In one case a 60-ton continuous miner was turned on its side. Mine engineers have now developed a system in which the area to be mined is pre-drilled, thus neutralizing the gas pockets and eliminating the possibility of rock bursts. Over 1,000 km of tunnel have been excavated so far at the Boulby mine.

An interesting feature of the mine, although one that had little to do with either mining or minerals, is the Boulby Underground Laboratory, with over 1,000 m^2 of floor space, and its cold-dark-matter detector. Shielded from the effects of cosmic rays by 1,100 meters of rock, scientists have been performing experiments since 1993 intended to shed light on the so-called "dark matter", the missing mass predicted to be responsible for gravitational attractions observed in the universe, a problem which has puzzled cosmologists for decades.

GEOLOGY

The workings at the Boulby mine have been developed within a thick sedimentary sequence of late Permian age. In northeast England, the latter part of the Permian was characterized by episodic flooding of a large subsiding inland drainage basin, which led to the periodic formation of the shallow Zechstein Sea. Periodically this body of water was cut off from its oceanic source somewhere to the north and dried up, leaving behind evaporite deposits. Successive flooding and evaporation led to the cyclical formation of layers of carbonates, siliclastic rocks and evaporite rocks. At the Boulby mine these are overlain by about 1 km of mostly Jurassic and Triassic sandstones and shales.

The Boulby Potash, a distinct potassium-rich layer within the Boulby Halite formation, has an average thickness of about 7.5 meters. It is made up of an intimate mixture of sylvite, halite, some carnallite and various minor impurities. Also present are insoluble impurities—anhydrite, magnesite, hematite, borate minerals (including boracite) and clays—which can make up as much as 50% of the rock, but are typically present at a much lower concentration.

Small borate nodules a few centimeters in diameter are common in a distinct band near the base of the Boulby Potash, known locally as the Borate Nodule Bed. However, a series of larger nodules up to about 1 meter in diameter, found at or near the base of the Boulby Potash in the north and west of the mine, have furnished most of the fine boracite specimens collected in the 1990s. These large borate nodules are of no commercial interest, but present a particular hazard to mining equipment because of their exceptional hardness.

BORACITE

Boracite, $Mg_3B_7O_{13}Cl$, is well-known from the Permian evaporite deposits which formed across northern Europe as a result of the drying of the Zechstein Sea. It is commonly represented in museum collections by small, isolated, pseudo-tetrahedral, pseudo-cubic or pseudo-dodecahedral crystals from German localities. The first British record is from a borehole in Permian salt and anhydrite near Aislaby in North Yorkshire. A mineral described as "iron-boracite," was reported from the Boulby mine. This is not a distinct mineral species; analyses showed its composition to be borderline between boracite and trembathite.

At the Boulby mine, boracite occurs within massive sylvinite ore in a variety of habits ranging from isolated single crystals to large nodules. It is commonly white, but may be pale to aquamarine blue or green. The most sought-after specimens are those displaying transparent, euhedral, aquamarine-blue, pseudo-cubic to pseudo-tetrahedral crystals. Exceptional matrix specimens to 20 cm covered with crystals to 5 mm were discovered in late 1991 in an area of the mine around panel 281; this find furnished almost all of the material subsequently offered by mineral dealers.

Examination of the boracite nodules suggests that some are formed by aggregation of spherules a few millimeters in diameter. These spherules usually have a characteristic structure, displaying two concentric boracite shells surrounding a core of impure sylvite. The inner shell is typically compact to powdery, with no readily discernible structure. It is surrounded by a macroscopically crystalline shell, the outermost surface of which is composed of small interlocking crystals.

The spherules are found in varying stages of aggregation in different nodules. They occur within the rock as isolated groups of a few individuals, and as large spherulitic lattice-works; their presence can also be inferred in massive compact boracite which commonly has remnant spherulitic structure. Examination suggests that in the process of nodule formation the crystalline outer surfaces of the spherules have merged and the central cores of white, compact boracite have gradually diminished to produce a tough homogeneous mass. Those rare specimens which display groups of euhedral blue crystals appear to represent a further stage of nodule formation. The massive boracite on which the crystals are disposed shows traces of spherulitic structure, and the well-crystallized specimen surfaces seem to have formed by recrystallization at the boracite-sylvinite interface.

Boracite occurs in an intriguing variety of habits. In addition to the nodules, single crystals are common and make superb micromounts. Crystals commonly appear cubic (although they are in fact orthorhombic polysynthetic twins, since boracite only has full isometric symmetry at high temperatures). Small triangular tetrahedron faces are sometimes seen modifying alternate vertices of cubic crystals producing unusual asymmetrical habits. Occasionally, the rarer pseudo-tetrahedral habit is well developed. Unusual composite crystals made up of many pseudo-tetrahedral crystals, each slightly offset, have sometimes been found.

The blue specimens are an iron-rich variety of boracite. Quantitative analyses of specimens by atomic absorption spectroscopy (at Manchester University) and by electron probe microanalysis (on behalf of Cleveland Potash Ltd.) have shown Fe^{2+} to be substituting for Mg at levels up to about 30 mol%. Very pale or colorless boracite contains very little iron, but above about 5 mol% there seems to be no discernible relationship between color intensity and iron content. Manganese is the only other significant substituent in the lattice, typically at levels of a few mol%.

Boracite specimens are stable in storage, once the soluble halides have been removed. It is perhaps worth noting, however, that the aquamarine-blue color appears pale in daylight but much more intense under tungsten light; such variations in color are sometimes indicative of long-term instability and it is suggested that the blue specimens be treated as light-sensitive until proven otherwise.

OTHER MINERALS

Trembathite, $(Mg,Fe^{2+})_3B_7O_{13}Cl$, the trigonal dimorph of boracite, was originally identified at the Boulby mine as ericaite. It occurs as superb, isolated, euhedral, blocky crystals to 2 cm that are probably the finest known for the species. The dark brown, subtranslucent crystals occur on pinkish sylvinite rock matrix. The few specimens known were collected in the 1980s by mine geologists in a now-abandoned area of the workings in panel 14. The iron-dominant analog **congolite,** $(Fe^{2+},Mg,Mn)_3B_7O_{13}Cl$, is also present in domains within some of the trembathite crystals.

Hilgardite, $Ca_2B_5O_9Cl{\cdot}H_2O$, is relatively common at the Boulby mine as well-developed, transparent, colorless to pinkish crystals in boracite nodules and more rarely as nodules in which it is the main insoluble component. It occurs interstitially within spherulitic boracite lattice-works as colorless paper-thin crystals. Thicker but less perfect crystals are sometimes revealed when the central core of sylvite present in some of the hilgardite nodules is dissolved. The brick-red coloration of much of the hilgardite is due to finely divided hematite. Hilgardite is very rare on a worldwide basis, and the recent (mid-1990s) specimens from Boulby, which include crystalline nodules to more than 25 cm in diameter, with crystals to 1 cm, may possibly represent the finest development of the species.

Most of the other minerals found at the Boulby mine are of relatively little interest to collectors. They include carnallite, cuprite, dolomite, gypsum, halite, hematite, magnesite, pyrite, quartz, rectorite, rinneite, sylvite and syngenite.

ALSTON MOOR

by Wendell E. Wilson, Thomas P. Moore and Michael P. Cooper

HISTORY

The Romans were surely involved in mining in the Alston Moor area, but the oldest surviving records of mining in northern England tell us that silver and lead were being won from Alston Moor as early as the 12th century. Accounts for annual rent of £40 levied in 1130 A.D. suggest that the mines were already well-developed by that time. During the 13th century the king brought in miners and secured protection and liberties for them. By the 15th century the Crown is known to have developed the Fletcheras mine on Alston Moor, an operation which remained productive for over 400 years. By 1611 when the mines passed into the ownership of the Hylton family, they were thought to be more or less exhausted.

In 1629 the Alston Moor mines were purchased by the Earls of Derwentwater, but that family later supported the doomed Jacobite Rebellion and lost all their properties as a result. The mines were confiscated by the Crown and given to the Greenwich Hospital for Seamen; in 1735 the Commissioners of the Hospital decided to begin leasing the mines, most of which were taken by the London Lead Company (also known as the "Quaker Company," founded in 1692). The London Lead Company was responsible for most of the developments in mining and smelting that took place on Alston Moor from then until the crash in lead prices in the early 1880s.

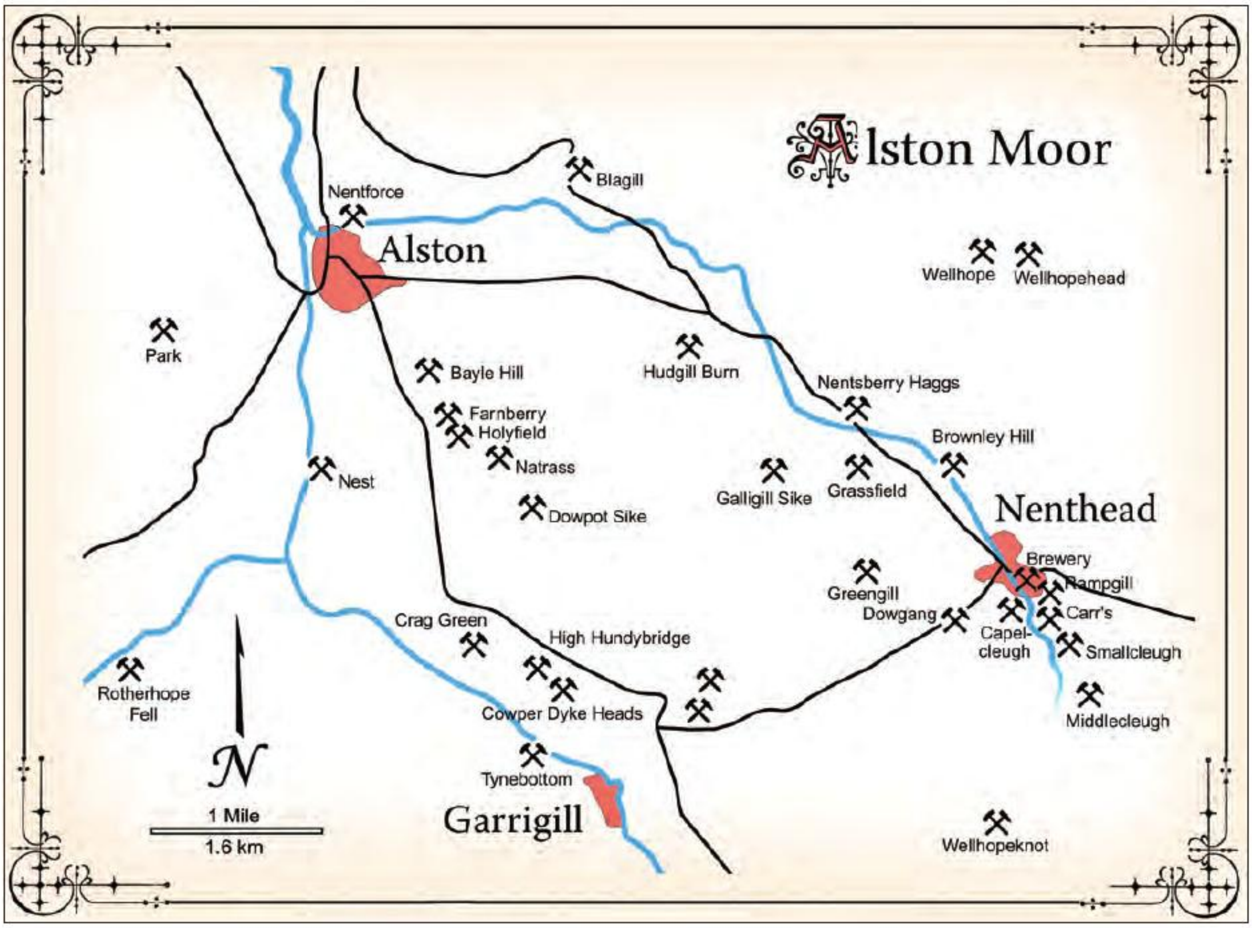
The rich deposits on Alston Moor were mined for centuries. The veins were riddled with large open pockets or vugs lined with crystals, the spectacular beauty of which was a bonanza for the miners, who would collect them to decorate their homes or sell to collectors. Many a miner's pocket benefited, but the practice was long frowned upon by the mine owners who would order the contents to be destroyed or the occurrence to be walled up to prevent time-wasting. It is unlikely that such closures remained in effect for long. In 1821, Westgarth Forster allowed his descriptive powers full rein when he was confronted with such a cavern:

> There is, commonly, a hard concreted stony crust, called *druse* or *rider*, by the Alston Moor and Allendale miners, adhering to the inside of the cavity, out of which, as out of a root, an innumerable multitude of short prismatic crystals are shot, which sparkle like a thousand diamonds, with the candle, or when brought up to the sun. Between these clusters of mock diamonds, and sticking to them promiscuously, there are often lead ore, black jack, pyrites, or sulfur, and spar, shot also into prismatic, cubic or other figures; and besides these clusters of grotesque figures, which grow out of one another, and are, as it were, piled upon one another, the whole inside of the cavern is, sometimes, most magnificently adorned with the most wildly grotesque figures which grow upon, and branch out of, one another, in a manner not to be described, and with all the gay and splendid colors of the polished gold, of the rainbow, and of the peacock's tail; and all these blended together, and the masses reflecting all the beauty of such an assemblage of gaudy colors.
>
> But, it may be remarked, that these caverns are never so magnificent and glorious, as when there is less or more of yellow copper ore, or of the pyrites, or black jack in them; as these ores are found to produce, in hard veins, the most beautiful colors in the world . . . seen at Allenheads, Coal-cleugh, in Northumberland and Nenthead in Cumberland.
>
> These mineral loughs, shakes, or caverns, are the great source of materials for grotto-work; and the specimens, collected from the miners, are, generally, the most showy and dazzling articles in the whole arrangement of the splendid grotto.

The grottoes to which Forster alludes were the large crystal and shell-lined imitation caverns popular in the landscape gardens of 17th and 18th-century British aristocrats, following a long-established European tradition. Miniature versions of these were often made by the northern miners who would line wooden boxes with crystals from local mines. Today these rustic "spar boxes" are much sought after by collectors, and appear to be unique to the northern lead and iron districts. The mineral alstonite was named for the locality. It was first found in the Brownley Hill mine. Other famous mines on the moor include the Nentsberry Haggs, Smallcleugh and Tynebottom mines.

GEOLOGY

The North Pennines are made up of a mostly horizontal series of carbonate and siliciclastic rocks of Carboniferous age lying unconformably over older clastic volcanic rocks that were intruded by the Weardale Granite. The sedimentary rocks have been intruded by the Whin Sill dolerite and other minor igneous bodies. Stratabound Mississippi Valley-type fissure veins (in the harder beds) and replacement orebodies (flats) have been emplaced within this geological framework (mostly in the unit called the Great Limestone) by low-temperature metal-rich brines. Gentle doming of the Alston Block produced many of the fractures that later served as conduits for ore-forming solutions. Deposits in the central part of the orefield (directly above the Weardale Granite body) tend



Locality map, Alston Moor district.

to have fluorite as the main gangue mineral and were deposited at a higher temperature, whereas lower-temperature deposits with barite and witherite gangue predominate toward the periphery of the orefield. Between the fluorite and the barium zones is a zinc-rich intermediate zone characterized by quartz, ankerite and calcite gangue. The Brownley Hill deposits span this intermediate zone, and consequently show greater mineralogical diversity than other deposits in the Alston Block.

MINES

Symes and Young (2008) identify 47 mines in the Alston Moor district, only the most important of which (from a collector standpoint) will be discussed here.

Blagill Mine

The Blagill mine is located at the small settlement of Blagill, about 2.5 km northeast of Alston. Mining of the deposits for lead goes back as far as the 14th century. The mine is the type locality for barytocalcite (Brooke, 1824), and has yielded some good specimens (lustrous, transparent, prismatic crystals to nearly 1 cm); in fact, it is the only locality in the world where that mineral has been commercially mined. However, when the higher barium-content witherite from nearby Nentsberry came onto the market, the demand for the lower-quality Blagill material disappeared and there are no production records after 1895.

The mine has been declared a Site of Special Scientific Interest under Section 28 of the Wildlife and Countryside Act of 1981, and is off-limits to collecting.

Brownley Hill Mine

The Brownley Hill mine was thought to be exhausted when it was acquired by the Greenwich Hospital for Seamen in 1715, and no one wanted the lease on it until Alderman Ridley worked the Slate Sills for a while. Ultimately, the Brownley Hill Company was formed in 1795 and took over the lease, benefitting from the high price of lead that prevailed during the Napoleonic Wars. But by 1816 the mine had become unprofitable as all of the major orebodies were running out. The lease was taken up by Jacob Walton and Thomas Shaw, who subcontracted to groups of independent miners, basing their pay on the amount of drifting accomplished, the amount of ore produced, or a combination of the two. This system worked well, and the Brownley Hill mine became one of the more

Dump of the Blagill mine. Lloyd Llewellyn photo.

Entrance to the Brownley Hill mine. Helen Wilkinson photo.

productive mines on Alston Moor during the middle 1800s. The new Brownley Hill Mining Company took over the lease in 1874 and switched the focus of mining to zinc production, the lead having been more or less exhausted. The Nenthead and Tynedale Lead and Zinc Company tried to operate the property between 1891 and 1894 but failed to turn a profit. During the final period of mining work was undertaken by the Vielle Montagne Zinc Company of Belgium, which operated a number of other mines in the district as well. A six-month trial in 1936 proved unprofitable, and the mine closed for the last time.

The Brownley Hill mine produced notable mineral specimens during its several centuries of operation, mostly from veins and replacement orebodies or "flats" in the Great Limestone, the most important lead-bearing horizon in the district. Professional mineral dealers such as John Cowper and Patrick Gilmore operated from the Alston area for most of the 19th century, providing the miners with a ready market for specimens. The mine is particularly well known for alstonite, for which it shares type locality status with the Fallowfield mine (which see for references). The mineral, at first thought to be a form of barytocalcite, is trimorphous with barytocalcite and paralstonite, and forms white to colorless or faintly

Barytocalcite crystals to 1 cm, from the Blagill mine, the type locality for the species (LG-508). Arkenstone photo.

pink acute pseudohexagonal pyramids or dipyramids up to 6 mm long. In some specimens the alstonite is intergrown with very thin hexagonal platy crystals of "nail-head" calcite. Alstonite commonly encrusts compact crystalline white to pale pink barite.

In the early years of the 1800s alstonite was marketed as "bromlite"; there is one such specimen in the Greenbank collection (LG-320), dated by the use of that discredited name on the label. In 1888 even a small specimen of alstonite could bring as much as £5, a month's wages for the lucky miner. Sir Arthur Russell, in particular, assembled a fine collection of Brownley Hill alstonite specimens later acquired by the British Museum.

During the 1970s, Lindsay Greenbank and Richard Barstow repeatedly tried to find access into the old underground workings so they could search for alstonite. Sadly, Barstow did not survive to see this search rewarded. But Lindsay Greenbank and partner Mick Sutcliffe finally succeeded in 1987, gaining entry through an old air shaft. Once in, they were able to collect some of the world's finest alstonite specimens. Good specimens of fluorite, galena and calcite also emerged from their work in the High Cross vein, and these were briefly common on the English mineral market.

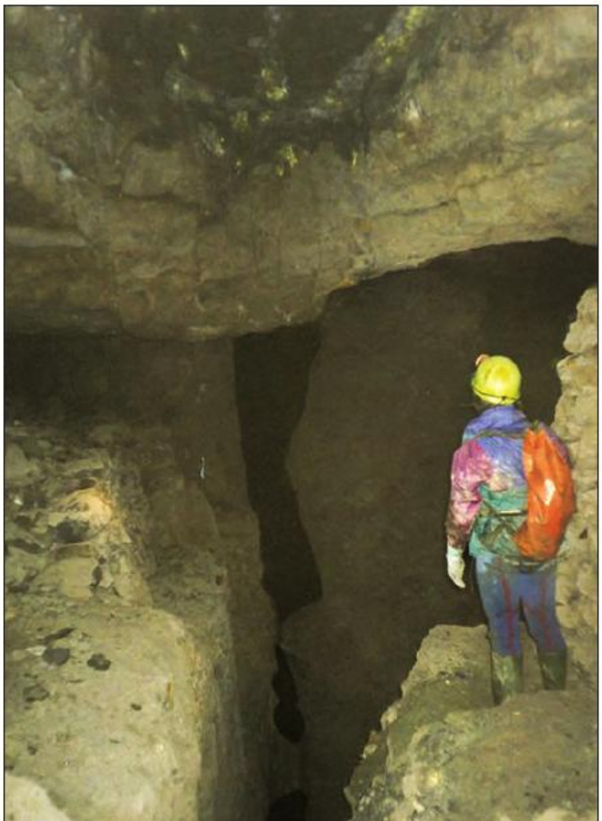
Calcite from the mine typically forms short-prismatic, colorless, white, yellow and brown crystals with low-angle rhombohedral ("nailhead") terminations, or thin platy crystals stacked along a common *c* axis; individuals seldom exceed 3 cm.

Witherite from the Brownley Hill mine was first described by Thomson (1835) as forming "very large, six-sided prisms terminated by low six-sided pyramids." Crystals to 3 cm are sometimes seen on old-time specimens from the High Cross vein, whereas more recently found crystals from a brecciated, sulfide-rich vein at the base of the Great Limestone formation are pseudo-bipyramidal and up to 1 cm in size.

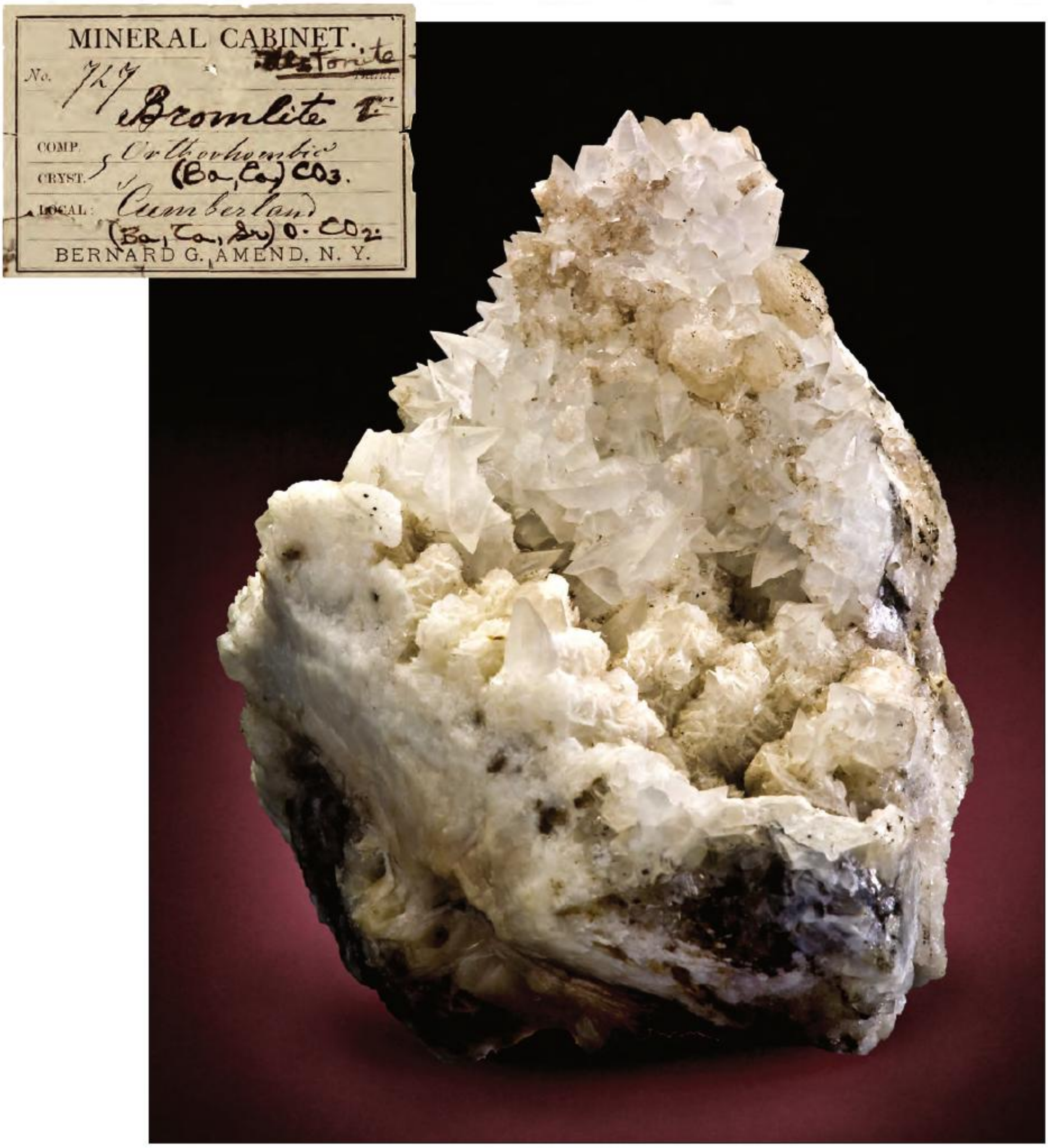
Good fluorite crystal specimens were first recorded from the Brownley Hill mine by Forster (1821), and have been found only in the Jug vein, where lustrous, translucent to transparent, pale yellow to amber-colored cubic crystals to 3 cm occur, commonly associated with ankerite. Like most other fluorite from the region, Brownley Hill fluorite fluoresces a bright blue-violet. "Old" specimens probably still outnumber "new" ones, but freshly collected material from Brownley Hill, including fluorite, was briefly common at mineral shows in Britain following Greenbank's work in the late 1980s.

Galena in good cuboctahedral crystal specimens was once relatively common at the Brownley Hill mine, both in the veins and in large cavities in the flats. Greg and Lettsom (1858) noted large cubic crystals. The best specimens probably came from large replacement bodies associated with the Middle vein, where cuboctahedral crystals to 10 cm were found with ankerite, quartz and sphalerite.

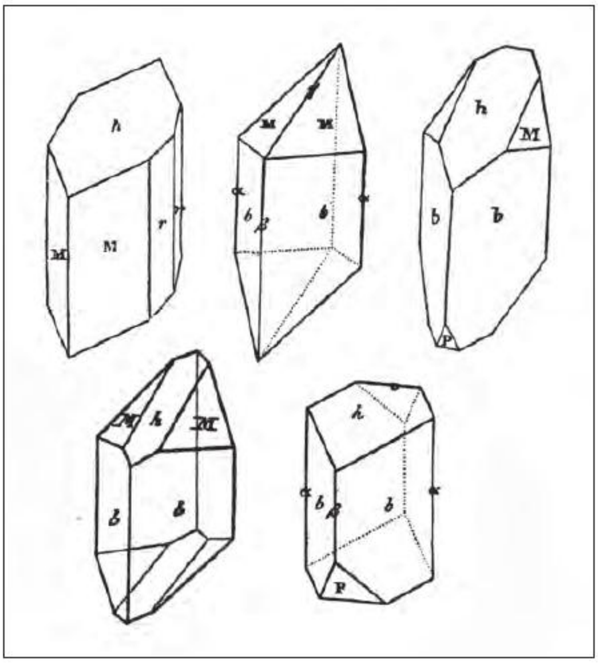
A number of other minerals have been found there as well, including the rare minerals bottinoite and brianyoungite (for which the mine is the type locality), and a suite of primary minerals (bournonite, millerite, strontianite, and ullmannite) which are not common in other Mississippi Valley-type deposits.



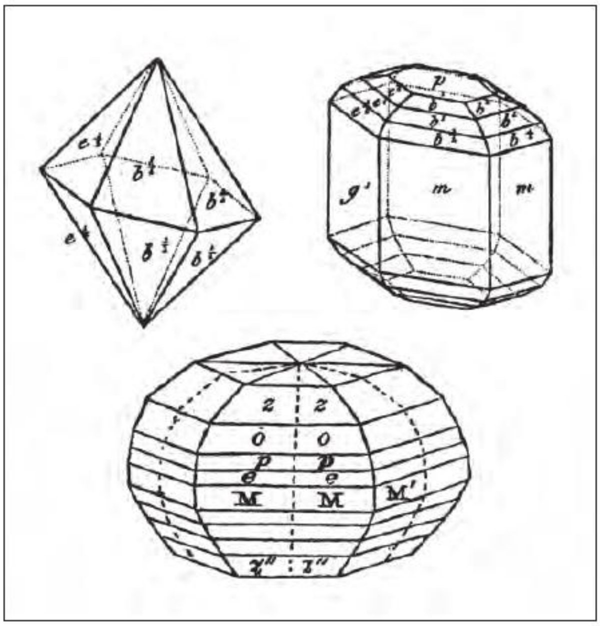
Dangerous stopes following a vein called Tatter's String in the Brownley Hill mine. Helen Wilkinson photo.



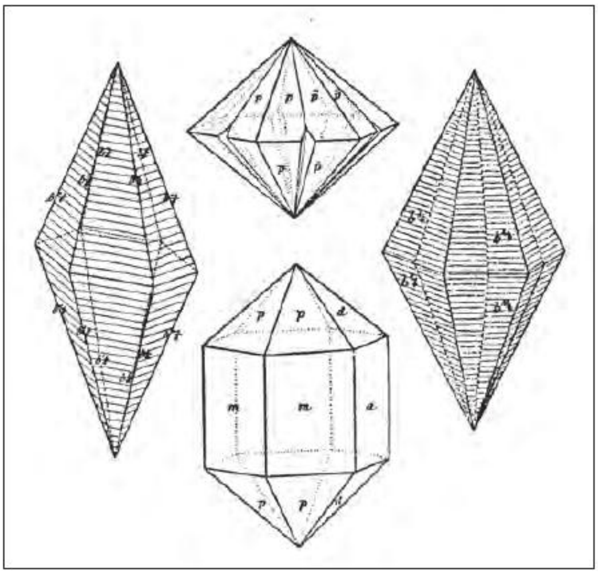
Alstonite crystals on barite matrix, 6 cm, from Brownley Hill mine, Nenthead, Alston Moor district, Cumbria (LG-320). The specimen was part of the collection of the New York pharmaceutical and chemical merchant Bernard G. Amend (1821–1911), and later was acquired by Massachusetts collector John Marshall (1931–2008) in the 1970s. Alstonite was first discovered in the Brownley Hill lead and silver mine at Alston Moor in the early 19th century and was subsequently found in Northumberland and Durham. The label dates this specimen to the early 1800s, when collectors called the mineral "bromlite" after a misspelling of the locality name as "Bromley Hill" (noted on the back of the label). The species remained unique to the North Pennine Orefield until it was identified at Cave-in-Rock, Illinois in 1974. Joe Budd photo.



Barytocalcite crystal drawings, Alston Moor (from Haidinger, *Edinburgh Journal of Science*, 1824; Mohs & Haidinger's *Treatise on Mineralogy*, 1825; Levy, *Description d'une Collection de Minéraux formé par Henri Heuland*, 1837).



Witherite crystal drawings, Alston Moor (from Levy, *Description d'une Collection de Minéraux formé par Henri Heuland*, 1837; Greg and Lettsom, 1858).



Alstonite crystal drawings, Alston Moor (from Miller, *Elementary Introduction to Mineralogy*, 1852; and Descloizeaux, *Manuel de Minéralogie*, 1874).

Nentsberry Haggs Mine

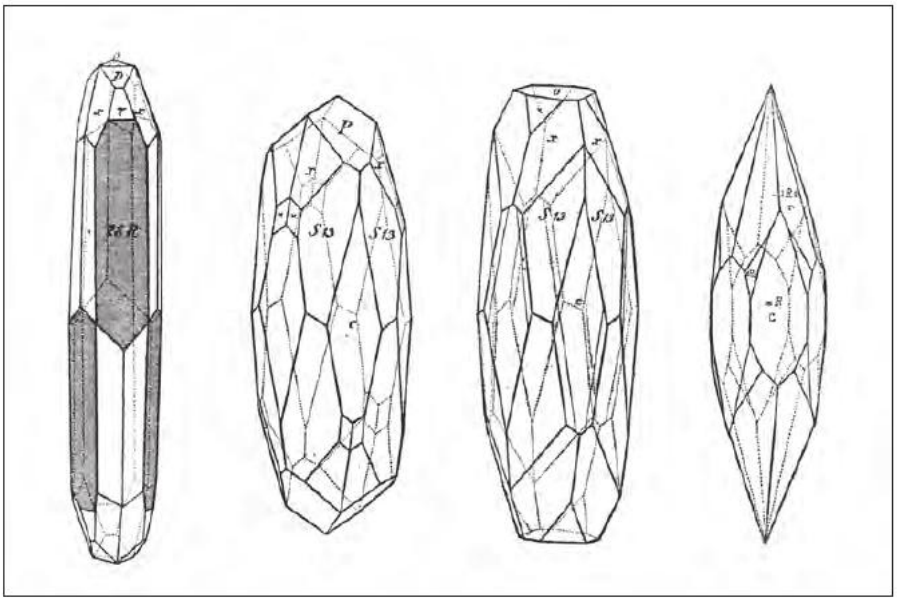
The earliest workings around what was then called the Haggs mine consisted of levels and exploratory drifts north of the horse level. Among the larger levels was the High Raise Low level, following the High Raise vein which was discovered in 1789 by the Brownley Hill Company. The Nentsberry Haggs vein was being worked in 1737, accessed via the main horse level.

In 1913 or 1914 the mine was taken over by the Vieille Montagne Zinc Company of Belgium, and over the next 16 or 17 years this company drove along the High Raise vein, discovering other veins in the process (the Cox, Dupoint, Sincay, First Sun, Second Sun and Treloar veins). Production from the Nentsberry Haggs mine peaked in 1938, after which it was worked only sporadically by a succession of companies including the Anglo-Austral Company, which ceased operations there in 1953 and abandoned the property at the end of 1958.

In 1983 new exploratory work was undertaken by Industrial Minerals, Ltd. from the Wellhope shaft. They discovered that the sublevels above the flooded horse level were accessible, and that high-grade lead ore was still present along with the zinc-witherite ores.

Specimens showing sharp, 2.5-cm calcite pseudomorphs after witherite were collected at the Nentsberry Haggs mine during the early 1990s in a crosscut between the High Raise and Treloar veins; when marketed in the U.S. these specimens were incorrectly labeled as having come from the "Higgs mine, Netsherry, Northumberland." At about the same time, the Admiralty Flats section of the mine yielded calcite pseudomorphs after alstonite to 1 cm, with barite.

Sir Arthur Russell collected specimens of witherite and calcite pseudomorphs after witherite in the mine during the 1930s, and



Calcite crystal drawings, Alston Moor (from Zippe, Wien Akad. Denkschr., 1852; vom Rath, *Poggendorff's Annalen*, 1867).

new specimens were found in 1993 and marketed a few years later. At about the same time in the early 1990s, barite was found as pseudomorphs after alstonite in the High Raise Second Sun vein in the Admiralty flats, in a deep cavity with jet-black sphalerite crystals, galena, and witherite. The very sharp, pseudomorphic crystals of barite after alstonite reach 2.5 cm, some with honey-yellow witherite on colorless, transparent barite crystals to 10 cm long. Unfortunately, when a few of the pseudomorph specimens were marketed in the U.S., their source was misidentified as the nearby Brownley Hill mine.

At a crosscut between the High Raise and Treloar veins, Sir Arthur Russell collected excellent specimens of witherite and calcite pseudomorphous after witherite in the 1930s, and in the early 1990s Lindsay and Patricia Greenbank also took out some good specimens (about 40) at Russell's old site, which had remained untouched in the intervening decades. In a handful of thumbnail and miniature specimens marketed in the U.S. a few years later, opaque and chalky white, sharp, slightly convex hexagonal prisms of witherite to 2.5 cm rest in greenish white matrix or form groups of lightly attached individuals. Most or all of the crystals are probably partial pseudomorphs of calcite after witherite. Well-formed crystals of barytocalcite were also found.

The gated portal of the Nentsberry Haggs mine is located on the north side of the Nenthead-Alston road about 450 feet west of Nentsberry Bridge. The Horse level had collapsed about 100 meters in from the portal, and the workings were only accessible via interconnections underground with the Wellgill Cross vein in the Brownley Hill mine workings or the Wellhope shaft. However, the rubble was cleared by mine explorers in 2009 and the adit entrance can now be used to access the workings all the way to the Brownley Hill mine.

Rotherhope Fell Mine

The Rotherhope Fell mine (also known as the Rodderup Fell mine), southwest of Alston, is the only mine in the Alston Moor area known to have produced really outstanding specimens of fluorite. Most of the fine fluorite specimens for which the North Pennines are famous have come from the Weardale district farther to the east.

Mining began there in the late 1700s, and Fairbairn (1993) lists a long succession of leaseholders over the years. Extensive workings in the Rotherhope Fell mine exist on a number of veins including the Smittergill Hill Sun, Rotherhope Fell, Rotherhope Cleugh Sun, Crag Green North and Dowpot Sike veins.

The property was acquired by the Vieille Montagne Lead and Zinc Company of Belgium in 1900, and operated until 1947 when it was sold and dismantled. Reprocessing of old dump material for fluorite continued into the 1970s. The most recent workings were accessed by an incline known as the Blackburn level, leading to a number of drifts and underground shafts.

Some excellent specimens of fluorite from the Rotherhope Fell mine can be found today in collections, most of them from flats in the Tyne Bottom Limestone below the horizon of the Blackburn level. For example, there is a superb suite of Rotherhope Fell specimens, most of them collected in the 1930s, in the Sir Arthur Russell collection in the Natural History Museum, London. Many of the old specimens from this era exhibit intense fluorescence and a sharp "phantom" zoning consisting of a core of intense purple fluorite within a thin outer layer of yellow fluorite. One of the best known specimens from Russell's bequest, a remarkable plate of fluorite crystals about 30 cm across, is on exhibit in the old mineral gallery at the Natural History Museum in London, in a large upright vertical case against the middle of the wall as one enters the room.

Nentsberry Haggs mine portal. Lloyd Llewellyn photo.

Underground in the Nentsberry Haggs mine. Helen Wilkinson photo.

(*Facing page*) Barytocalcite, 21 cm (shown about actual size), from the Second Sun vein, Nentsberry Haggs mine, Alston Moor district, Nenthead, Cumbria (LG-40). A large cavity in a 21 × 13-cm matrix of crystalline witherite lined with lustrous, deep honey-colored barytocalcite crystals to 2 cm: a remarkable specimen and probably the finest example of the species in existence. Barytocalcite was first described from Alston Moor. Many fine specimens have been found there, though it is a very rare mineral elsewhere in the world. This stunning specimen was collected *in situ* by Lindsay Greenbank and Michael Sutcliffe in 1972, during one of a series of long overnight collecting and exploration trips into the mine. It came from a cavity at the eastern end of the high flat in the Second Sun vein. It is remarkable for the exceptionally well-formed, translucent and lustrous crystals (this species is most often dull, white and opaque). The mine was not investigated by collectors until the late 1960s; generally barytocalcite is not an attractive mineral, and specimens from the nearby type locality of Blagill are of far lower quality. The mine is now in a ruinous state of deterioration, and the barytocalcite exposure can only be reached with great difficulty and danger. Joe Budd photo.

Barite pseudomorph after witherite, 4 cm, from the Liverick vein, Nentsberry Haggs mine, Northumberland (LG-303). Patricia Greenbank photo.

Smallcleugh Mine

The Smallcleugh mine was started round 1770 as an exploratory effort seeking the continuation of Hanginshaw's West of Nent vein, but was soon abandoned. In 1787 it was reopened by the London Lead Company on the Smallcleugh Cross vein, producing a very large quantity of ore. Over the following years the mine was operated by a succession of companies, but most of the work had come to an end around 1900. In 1901, a banquet was catered by the Miners Arms Inn and brought by mine wagons into a large Smallcleugh stope that became known as the Ballroom Flat.

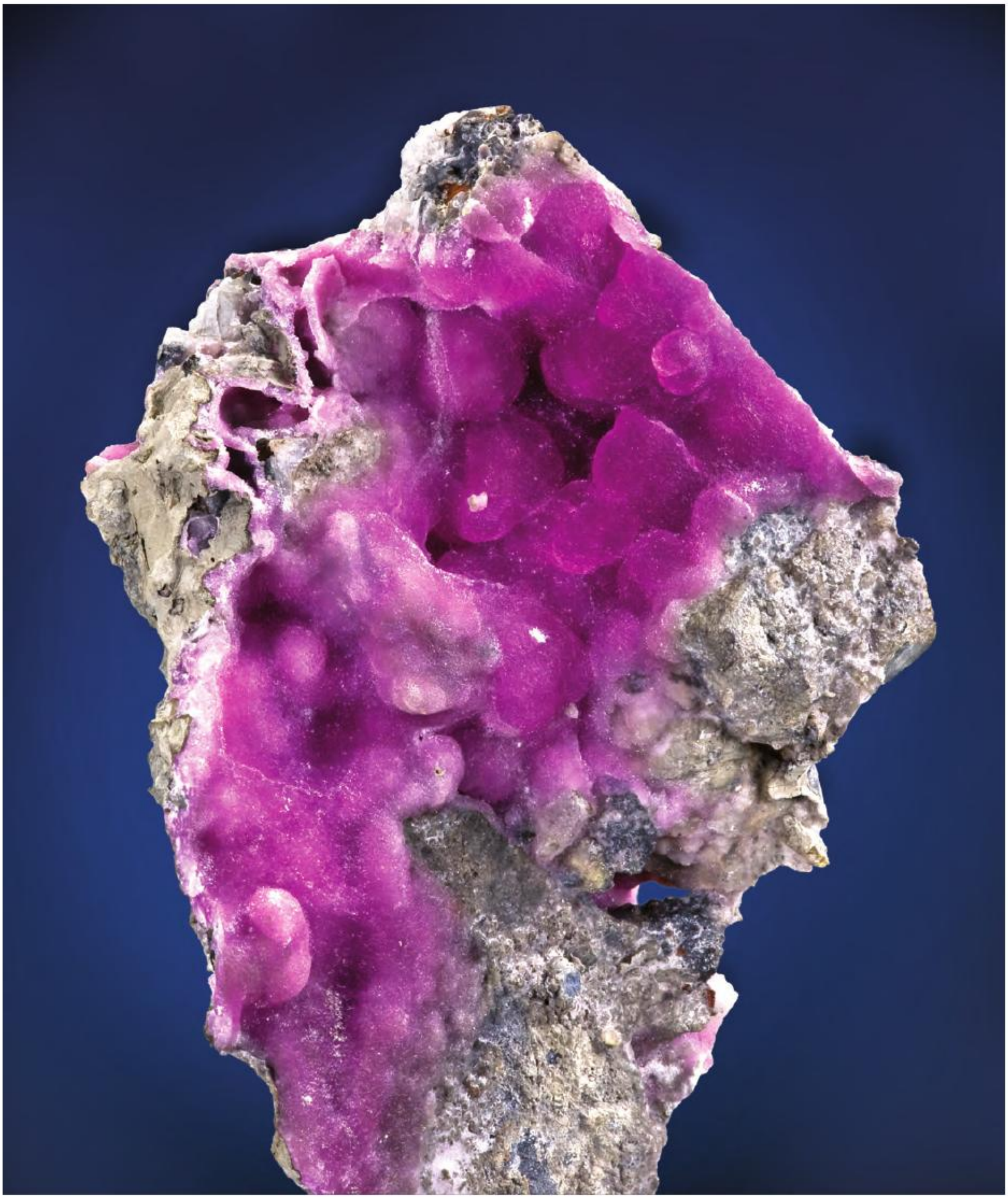
In the Smallcleugh mine the limestone was replaced by ankerite, sphalerite and galena; spectacular mineralized cavities can still be seen underground. Some of these cavities, large enough to walk into, are lined with cubic crystals of galena up to 30 cm on an edge. Interesting occurrences of secondary sulfates such as melanterite, gypsum and epsomite have also been reported. The Smallcleugh mine is well-known for producing well-crystallized cuboctahedral galena, glittering black clusters of sphalerite crystals, and large "nail-head" calcite crystals. The rare minerals schulenbergite and namuwite were reported from there by Livingstone *et al.* (1990).

The underground workings are accessible and beautifully constructed, with vaulted drifts, dry-stone arching and spectacular stopes that make the mine a popular destination for mine explorers. The mine has been declared a "Site of Special Scientific Interest" under Section 28 of the Wildlife and Countryside Act of 1981 and is now off-limits to collecting.

Tynebottom Mine

The Tynebottom mine has produced an interesting suite of nickel and cobalt-containing minerals including erythrite, safflorite, nickel-

Underground in the Blackburn level of the Rotherhope Fell mine. Helen Wilkinson photo.



Calcite (colored by cobalt), 5 × 7.5 cm, from the Tynebottom mine, Garrigill, Alston Moor district, Cumbria (LG-294). Collected in 1974 by Anthony Walshaw. Joe Budd photo.

Dumps of the Tynebottom mine. Lloyd Llewellyn photo.

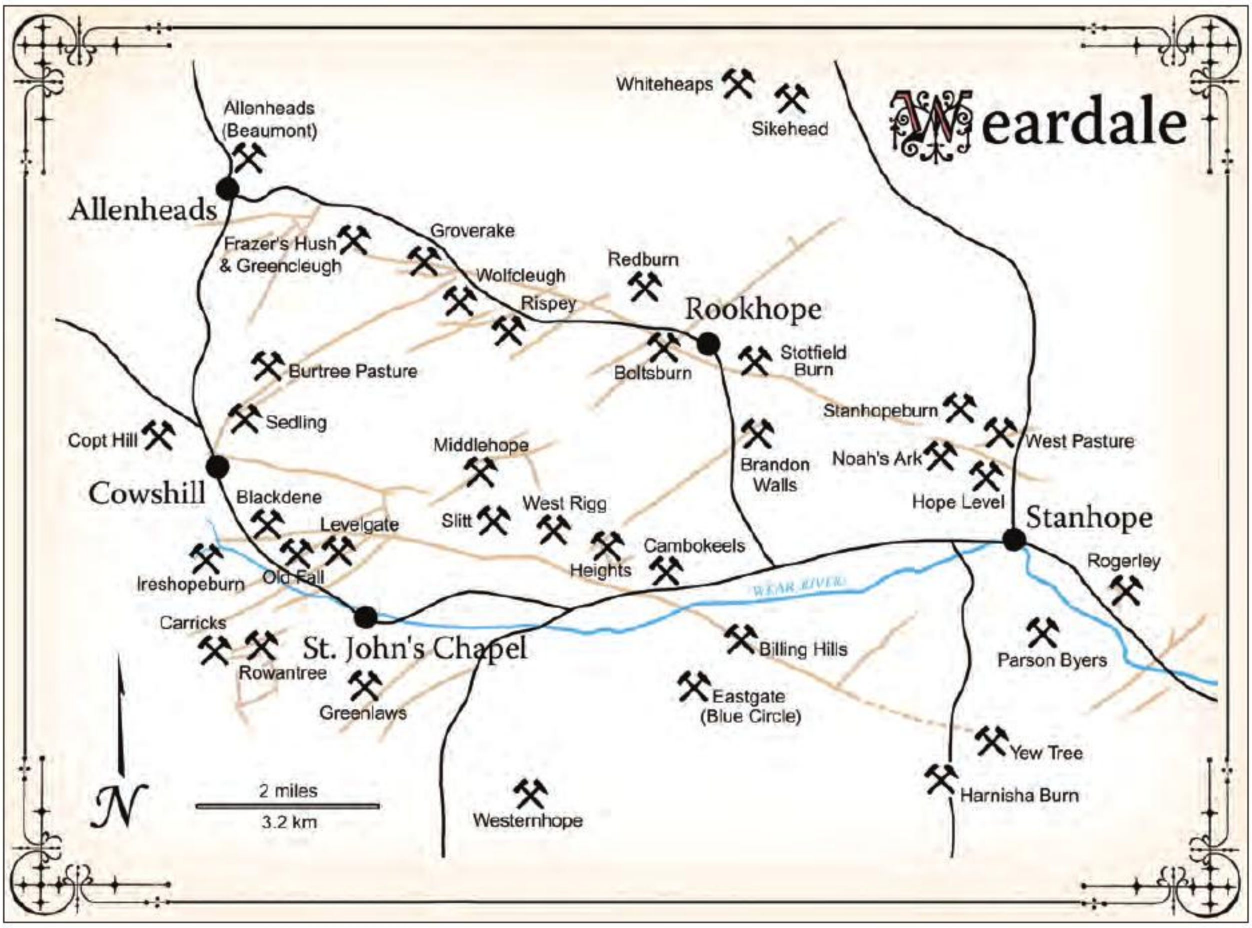
skutterudite, violarite, rammelsbergite, annabergite, and some very attractive specimens of drusy calcite and "flowstone" colored pink to deep magenta by micro-inclusions of erythrite, or blue by copper salts. Superb specimens of large dimensions were collected when the mine was operating during the 19th century. Other minerals found there include the sulfide minerals chalcopyrite, galena, glaucodot, marcasite, pyrite and sphalerite, as well as anglesite, barite, brochantite, "nail-head" calcite, devilline, dolomite, linarite, malachite, quartz, schulenbergite, serpierite, smolyaninovite and wroewolfeite. The mine has been declared a "Site of Special Scientific Interest" under Section 28 of the Wildlife and Countryside Act of 1981 and is now off-limits to collecting.

THE WEARDALE MINES

by Wendell E. Wilson and Thomas P. Moore

INTRODUCTION

Excellent fluorite specimens have come from a number of mines in the Weardale region since mining began there in the 12th century. Fortunately for the collecting community, there was generally a tolerant attitude on the part of mining companies toward the collecting of specimens by miners in their off hours. In fact, the miners considered it their right, and one of the few perks of the job. Selling the attractive specimens (referred to as "bonnie bits" by the miners) to collectors and mineral dealers provided the miners with additional, much-needed income. Thus today one can see superb examples of Weardale fluorite in museums and private collections around the world. Adding to this bounty is the renewed interest in recent years in mining specifically for specimens, providing the



Location map, Weardale mines.

Fluorite penetration twinned crystals, 2.2 cm, from the Blackdene mine, Ireshopeburn, Weardale, Durham (LG-345). Recovered in 1965 from the Slitt vein. Jesse Fisher photo.

modern collector with an opportunity to select from substantial lots of newly collected material.

The information on the district presented here is taken largely from Fisher (2004, 2006, 2009), Fisher and Greenbank (2000, 2003), Cooper (1996), Dunham (1948), Green and Briscoe (2002), Symes and Young (2008) and various mineral show reports.

HISTORY

Mining in the Northern Pennines probably goes back to Roman times, but most evidence of such activity was obliterated by later activities. Early methods of mining included the digging of round, shallow open pits (called "bell pits") along the vein, and hydraulic stripping of overburden through the sudden release of dammed up water (called "hushing). Two major lead-mining companies dominated the area during the 18th century: the London Lead Company (which obtained its first leases in 1692) and the Beaumont Company (which started about the same time). These two companies finally shut down in 1882 and 1884 respectively, in response to the worldwide crash in the market price of lead.

Iron oxide deposits in many of the replacement orebodies and veins throughout the Weardale district were also mined; the first record of iron production dates to the 12th century when the Bishop of Durham took a lease on a mine near Rookhope to produce iron for the manufacture of plow blades. Iron mining in the district, primarily by the Weardale Iron Company, peaked in the last half of the 1800s; smelting furnaces operated in the villages of Stanhope, Tow Law and Wolsingham. By the early 20th century, however, all iron mining in the district had ceased.

By the late 1800s the modern steel-making industry had developed a need for fluorite as a flux, and this new market rejuvenated the Weardale mines, where formerly fluorite had been discarded on the dumps as waste. Witherite and barite also proved profitable, and thus the local mines were supported well into the 20th century. Commercial production of fluorite in the Weardale district was initiated in 1882 by the Weardale Lead Company. Most mines shut down in the early 1980s when the British steel industry collapsed, but a few properties such as the Groverake and Frazer's Hush were still being operated at a reduced level as late as 1999. Environmental restrictions on the use of chlorinated fluorocarbons, coupled with competition from subsidized fluorite production in China, ultimately brought an end to fluorite mining in England, despite the fact that significant reserves surely remain in many of the mines.

For further information on the history of mining in the Weardale district see Fisher (2004), Fairburn (1996), Hunt (1970), Raistrick and Roberts (1984) and Dunham (1990).

Fluorite, 11 cm, from the Silver Dycks vein, Blackdene mine, Ireshopeburn, Weardale, Durham (LG-53). A superb, tapering, elongated floater crystal of purple fluorite 11 cm long. One face is coated with a very fine quartz druse with a sprinkling of small pyrite crystals. Weardale has long been known for complete "floaters" and unusual deformed or elongated crystals of fluorite. They have never been common, however, and are highly collectible specialties of the district. Few are as attractively colored or as lustrous as this beautiful piece, which was recovered by a miner in 1969 and sold directly to Lindsay Greenbank. Joe Budd photo.

Fluorite crystal, 35 cm, from the Blackdene mine, Ireshopeburn, Weardale, Durham. Joe Budd photo.

Fluorite with nailhead calcite crystals, 5 cm, from the Dib Incline, Blackdene mine, Ireshopeburn, Weardale, Durham (LG-352). It was collected in the late 1960s and acquired by Lindsay Greenbank in January 1991 with the purchase of the Sutcliffe collection. Joe Budd photo.

Calcite crystal on matrix, 9 cm, from the Blackdene mine, Ireshopeburn, Weardale, Durham (LG-353). Purchased from a miner, late 1960s. Joe Budd photo.

Fluorite, 10.2-cm "floater" crystal group, from the Slitt vein, Blackdene mine, Ireshopeburn, Weardale, Durham (LG-344). The crystals appear slightly curved along one axis. It was recovered by miner Kenny Stephenson of Frosterley, and sold to Richard Barstow in 1978; in 1982 it was sold by Richard's widow, Yvonne, to Ralph Sutcliffe, whose collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.

The Blue Circle (Eastgate) cement quarry. Helen Wilkinson photo.

Fluorite, 2.5 cm, Blue Circle cement quarry, Eastgate, Weardale, Durham (LG-612). Recovered in 1975 by Lindsay Greenbank. Jesse Fisher photo.

Fluorite crystals to 1.75 cm, Blue Circle cement quarry, Eastgate, Weardale, Durham (LG-378). Collected by Michael Sutcliffe; Joe Budd photo.

MINES

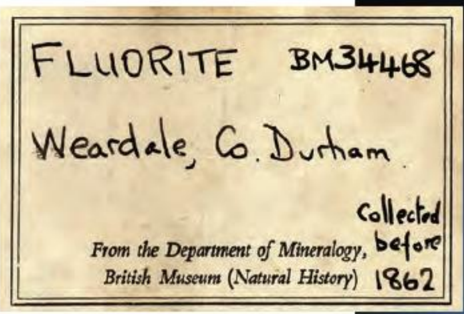
Blackdene Mine

The Blackdene mine began operating in 1401, and during the mid to late 20th century it became one of the most productive fluorite mines in the district. Originally mined for lead in the late 1800s by the Beaumont Company, it followed the Blackdene vein northeastward from the Wear River, producing over 14,000 tons of lead between 1818 and 1861. It was shut down in the 1870s or 1880s, but reopened in 1908 as a fluorite mine under a succession of owners who worked both the Blackdene vein and the Slitt vein. In 1973 a new incline driven to access unmined portions of the Slitt vein encountered many open crystal-lined vugs, and produced many of the finest specimens preserved in collections today. The mine finally closed in 1987.

Fluorite from the Blackdene mine most commonly occurs as cubic crystals in medium to dark shades of purple, but pale green and yellow crystals have also been found, typically in attractive association with dolomite, calcite, quartz or lustrous galena of complex habit. Bright microcrystals of pyrite and chalcopyrite are commonly found scattered over some surfaces of the fluorite crystals. Gemmy fluorite crystals from Blackdene reach 5 cm on edge, and opaque

Headframe of the Boltsburn mine, ca. 1910. Beamish Museum photo archives.

Miners working underground at the Boltsburn mine, ca. 1910. Beamish Museum photo archives.



Zoned fluorite crystal, 6 cm, from the Boltsburn mine, Rookhope, Weardale, Durham; this is a pre-1840 specimen (LG-403) acquired by the British Museum (Natural History) in 1862. It was traded by the Museum to Anthony Walshaw in the 1980s, who sold it to Lindsay Greenbank in 1989. Joe Budd photo.

crystals to 20 cm on edge are known; Lindsay Greenbank long kept a decorative piece in his home which features an astonishing 35-cm single crystal (shown on page 74, top).

Specimen supplies have always been spotty and, in the absence of documentation, the collecting date of specimens has typically been difficult or impossible to determine; it was always more common to see individual pieces, very likely from recycled, older collections, than to see lots of freshly collected specimens. In the late 1970s, Blackdene mine specimens with beautiful purple and dark green fluorite crystals to 15 cm associated with brilliant galena crystals appeared on the market, probably from the Slitt vein. In early 1986, just before the mine closed, a large pocket was discovered in a new drift, and about 40 good specimens were marketed soon afterwards; these measure from 2 to 10 cm.

Blue Circle Cement Quarry

The Blue Circle Cement quarry, where the Portland cement process was developed, lies very near the classic Heights mine and Cambokeels mine fluorite localities. Begun in the 1960s, the quarry closed in 2003, having sporadically yielded fine green fluorite specimens for almost 50 years. The fluorite crystals are simple cubes in classic penetration twins; they are a typical "English" sea-green, and transparent, but many have purple zones near their centers. They are generally a paler green than the crystals from the Rogerley mine and the Heights quarry. In the mid-2000s (after the quarry closed), a few Blue Circle specimens were recovered showing purple color or a deep golden yellow color resembling that of fluorite from the Hilton mine; commonly these have a thin zone of purple color just below the surface.

Blue Circle quarry fluorites are easy to confuse with fluorite specimens from other places in northern England, and probably are quite rare on the market, at least in the United States; a small lot was offered in California in the early 1990s. As of 2002, the quarry was closed, its plant and landmark chimney had been demolished, and the site was undergoing reclamation.

Boltsburn Mine

The Boltsburn mine workings, opened as a lead mine in the early 1800s, follow the northeast-trending Boltsburn vein. It was originally worked by the Beaumont Company, and was rich in fluorite but

Fluorite penetration twin, 6 cm, from the Boltsburn mine, Rookhope, Weardale, Durham (LG-63); shown in daylight (left) and in incandescent light (right). This is a pre-1860s specimen, though its history has been lost. Ex Ralph Sutcliffe collection; Joe Budd photo.

carried only modest levels of galena. Beaumont gave up its leases in the 1880s, after the crash in lead prices, and the mine was taken over by the Weardale Lead Company. In 1892 miners following galena stringers away from the vein encountered extremely rich, highly mineralized replacement bodies about 6 meters from the vein. Mining proceeded to gradually greater depths until 1932, when the mine was closed because of labor and transportation problems. Exploratory drilling in the 1970s revealed that much ore still remains in the unmined portion of the replacement body, but it would probably be too expensive to mine.

Mineralization was developed along three horizons (the High Flats, Middle Flats and Low Flats) which merge with each other; individual flats were up to 25 feet thick and extended up to 200 feet from the vein. Crystal-lined cavities several feet in height and up to 50 feet long were encountered. These cavities contained large amounts of crystallized galena and well-developed, highly transparent fluorite crystals to more than 20 cm. Watson (1904) described entering such a cavity, walking over 6-inch cubes of translucent, bluish violet fluorite, some of them studded with sparkling crystals of calcite or quartz, finding a perfect 12-inch cubic crystal of fluorite, and marveling at the solid coating of galena crystals across the roof of the pocket.

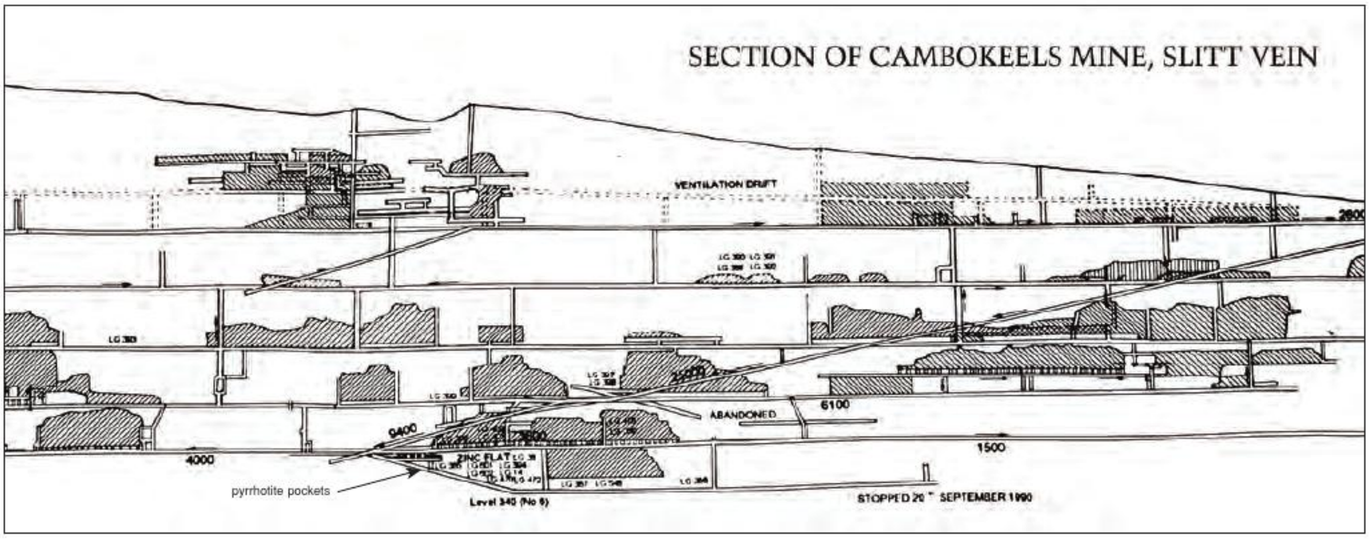
The Boltsburn mine is famous for particularly large and transparent crystals of lavender to purple, yellow and pale olive-green fluorite, lustrous cuboctahedral crystals of galena, and "nail-head" calcite, sometimes in association with siderite, drusy quartz, sphalerite, pyrite and rare chalcopyrite.

Cambokeels Mine

The Cambokeels mine, which exploited a section of the Slitt vein extending from the nearby Blackdene mine, was worked for lead by the Beaumont Company from 1868 to 1871; the relatively wide vein was nevertheless poor in lead values, and the mine was soon abandoned. It was reopened for fluorite in 1905 and was worked intermittently thereafter, closing in 1989. From the early 1970s until 1989 it was among the most prolific producers of fluorite in the Weardale district. Operators put in a new incline below the old Horse level, discovering high-grade fluorite below the 40-meter level; working levels were established at 200, 240, 280, 320 and 340 meters, making it the deepest mine in the district.

Hundreds of cavities lined by crystals of quartz, calcite, pyrite and fluorite (surprisingly, there were very few sphalerite crystals, even though the ore ran to as much as 20% ZnS) were encountered on the 320 level during the 1980s. Most of the cubic fluorite crystals are purple or colorless, but green to ice-blue crystals up to 5 cm on edge were found in the Zinc Flats on the 320 level; the crystals are lustrous, transparent and beautiful, occurring in large clusters dusted with microcrystals of pyrite. A single cavity opened in 1989 on the 340 level yielded fine specimens showing twinned, gemmy lavender to lilac-pink fluorite crystals on white quartz matrix. The miners were adamant that this fluorite had a deep red color underground, but changed color when brought to the surface. Pyrite crystals in quartz were found above the 320 level.

Notable specimens that have been found include superb purple, green, pale pink and blue fluorite. And Britain's best pyrrhotite specimens were collected from a few pockets found in the lower workings just before the mine closed in 1989. The lustrous crystals,



Cross-section through part of the Cambokeels mine, with LG specimen locations indicated.

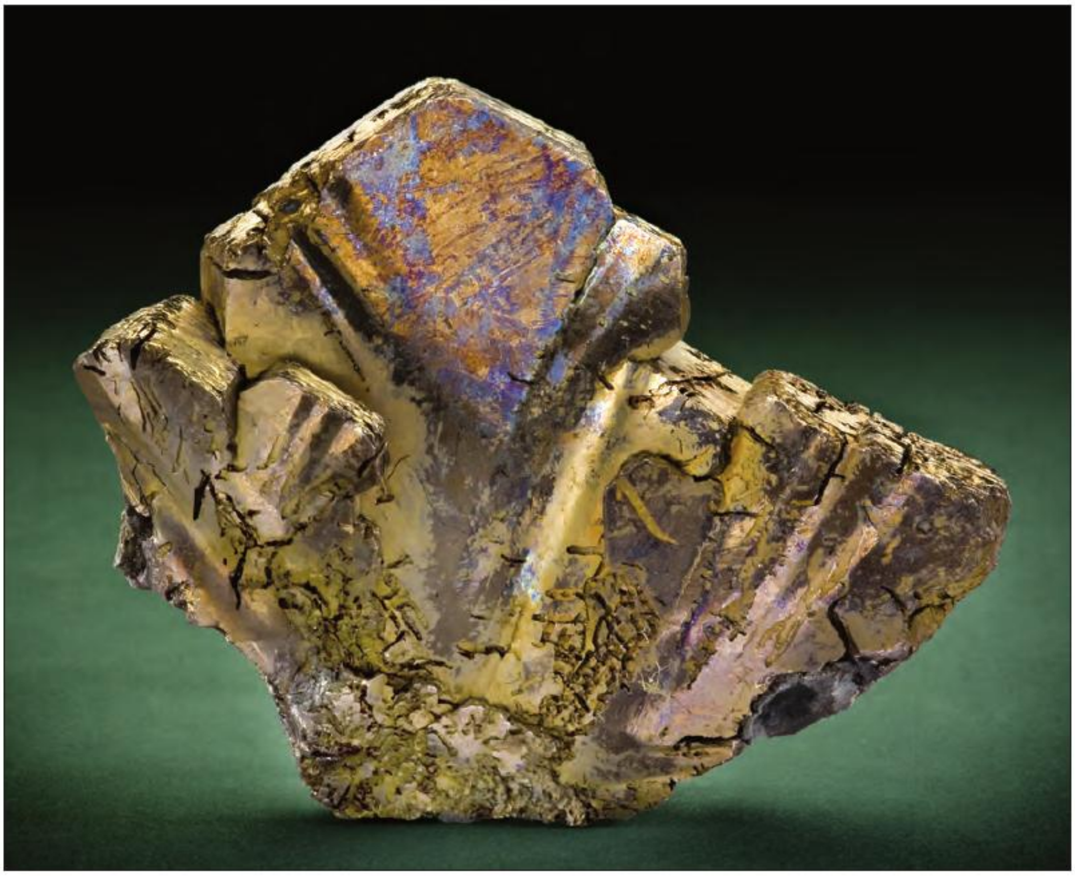
Portal to the Cambokeels mine on the Horse level. Above the portal, carved in stone, it says "TWB 1847" ("Thomas Wentworth Beaumont").

most of them loose individuals, are bronze-colored, sharp, and characteristically slightly curved and etched; they reach 10 cm across. Initially the miners discarded many specimens, taking them simply for an odd kind of pyrite.

Milky white calcite crystals were found in the Cambokeels workings in a wide variety of habits, including paper-thin hexagonal plates, hexagonal tablets, simple rhombohedrons, and pseudocubic and "nailhead" forms. Some of the analcime crystals found on the dump by government geologist Brian Young were acquired by Lindsay Greenbank.

Frazer's Hush Mine

The Frazer's Hush mine exploited the Greencleugh vein, a western extension of the Red vein near the Groverake mine. The underground mine workings date from the 1970s, but the mine is named for a nearby site that had been worked by "hushing" (hydraulic



(*Above*) Pyrrhotite, 9 cm, collected in 1989 in the Slitt vein, Cambokeels mine, Weardale, Durham (LG-601). Pyrrhotite is uncommon in northern England. Small crystals occur at the Carrock mine in the Caldbeck Fells, but the finest material came from the Cambokeels mine in 1989–1990. Most of the recovered specimens are crystals found loose in the vein and represent by far the finest crystallized specimens of the species ever found in the British Isles. The unusual crystal habit is distinctive. The Greenbank Collection contains three of the finest examples, including one of the largest crystals found. Joe Budd photo.

Pyrrhotite, 7 cm, from the Slitt vein, Cambokeels mine, between Eastgate and Westgate, Weardale, Durham (LG-396). It was collected from just above the zinc flats on the 320 level in 1989 by Robert Porter, a miner from Stanhope, and was sold to Patricia Greenbank. Joe Budd photo.

overburden removal) in medieval times. Although the mine was in decline commercially by the late 1980s, it still managed to produce many fine fluorite specimens from a series of cavities encountered between 1988 and 1999 when the mine closed. Patricia Greenbank made many collecting trips to the mines during those years, and acquired what is probably the finest large Frazer's Hush specimen from that era (LG-471).

Typical Frazer's Hush specimens display extremely glassy, transparent, twinned fluorite crystals showing purple to dark sea-green or indigo-blue color, some reaching 5 cm on edge. They are highly fluorescent, even in sunlight. Fluorite may be associated with galena, marcasite, sphalerite, calcite, siderite and ankerite; and fluorite crystal groups totally coated with glittering crusts of galena microcrystals have also been found.

In the late 1980s the mine yielded large specimens with transparent, gray-violet to purple cubic crystals, commonly penetration-twinned and displaying tetrahexahedron faces; in 1990 a cavity on

Pyrrhotite, 5 cm, from the Slitt vein, Cambokeels mine, between Eastgate and Westgate, Weardale, Durham (LG-38). Collected in 1989. Joe Budd photo.

Fluorite twin with drusy pyrite, 5 cm, from the Cambokeels mine, Weardale, Durham (LG-14). It was collected by Joe Forster, a miner from Stanhope, and was originally in his collection. Jeff Scovil photo.

Calcite, 7 cm, from the Cambokeels mine, Weardale, Durham (LG-390). Collected by Joe Forster, a miner from Stanhope who is said to have the finest collection of calcites from the mine. Jeff Scovil photo.

The Frazer's Hush mine area.

Fluorite with etched galena, 6 × 9 cm, from the Frazer's Hush mine, Weardale, Durham (LG-587). Collected in 1996. Joe Budd photo.

the 340 level gave up abundant specimens showing purple cubic crystals on matrix, some with good galena crystals. In the mid-1990s, a number of substantial pockets produced lustrous, purple, twinned fluorite crystals to 3 cm which rest on cavity-lining layers of smaller fluorite crystals (e.g. the one shown above). In 1998, on the 360 level, matrix plates as large as 10 × 20 cm were dug, these with transparent purple fluorite cubes to 1 cm on edge grown thickly over massive green, vein-lining fluorite, with 1-cm cuboctahedrons of galena. Cubic fluorite crystals to 30 cm on edge were found during the late 1980s in the Great Limestone workings, but these very large crystals are of poor quality. The Frazer's Hush mine finally closed in 1999, by which time its underground workings had been connected with those of the Groverake mine.

Greenlaws Mine

The Greenlaws mine, originally operated during medieval times, exploited two parallel veins. It was worked for lead by the Beaumont Company from 1850 to 1884, after which the lease was picked up by the Weardale Lead Company until 1897. The mine

Fluorite crystals to 1.5 cm (7 cm overall), from the 340 level, Frazer's Hush mine, Weardale, Durham (LG-414). Collected by Cliff Wilkie in 1990. Joe Budd photo.

was reopened briefly in the 1940s but has been idle since then, except for the activities of collectors. The mine was worked for specimens in the late 1990s, producing amber-yellow to dark purple cubic fluorite crystals to 10 cm on edge. The crystals, however, are not as lustrous or transparent as the best from other, better known Weardale localities.

Groverake Mine

The Groverake mine is located at the confluence of the Groverake vein, the Greencleugh vein and Red vein. Mining probably began there in the 1600s, but major mining by the Beaumont Company began in the late 18th century, initially for lead. The veins proved to be rich in fluorite but rather poor in lead, and yielded only about 6,500 tons of lead concentrate between 1818 and 1883 when the market price for lead crashed. During World War II, under the British Steel Company; the mine became one of the leading producers of fluorite in the district. Weardale Minerals and Mining came in when the steel industry was privatized, but went bankrupt in 1991, at which time the mine was acquired by Sherburn Minerals and worked until closing in the summer of 1999. It was the last commercially active fluorite mine in the North Pennines.

Fluorite specimens from the Groverake mine are rare, and not especially good by the region's general standards. They consist of groups of simple cubic crystals of a pastel green color unlike that of fluorite from any other Weardale mine. The mine apparently worked entirely within veins and did not encounter any major replacement bodies that would have included large cavities—a fact which probably accounts for the scarcity of specimens found there.

Heights Mine

The underground Heights mine, opened in 1847, operated on three different veins: the roughly parallel Heights North (a likely

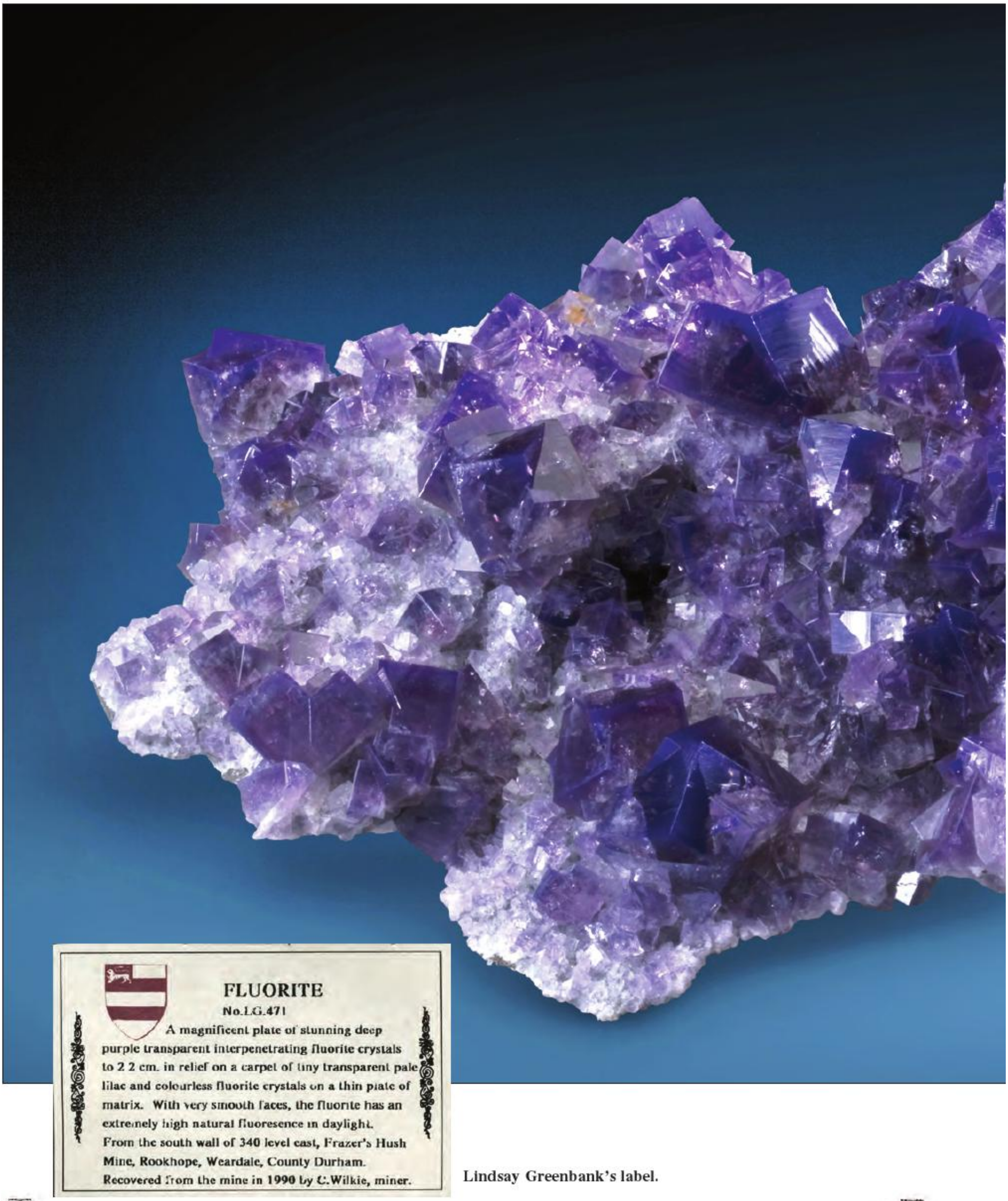
(*Above*) Ruins at the Middle level of the Greenlaws mine, Daddry Shield, Weardale, Durham. Jesse Fisher photo (2003).

(*Left*) Stone-arched portal to the Middle level of the Greenlaws mine. Jesse Fisher photo (2005).

continuation of the Greenlaws West vein) and Heights South veins and the intersecting West Cross vein. The Heights mine was worked briefly for lead in the 1860s by the Beaumont Company, but was operated principally for limonite by the Weardale Iron Company between 1850 and 1868. The replacement bodies proved to be very vuggy, yielding superb specimens of transparent, colorless to pale purple and deep green, penetration-twinned fluorite crystals to 10 cm. Many Heights mine fluorite crystals are dotted with tiny colorless calcite crystals.

Commercial activity finally ceased in the early 20th century, but the mine was popular with field collectors for many years. A major collecting effort at the Heights mine was undertaken in 1976 and 1977 by a party headed by Peter Briscoe, who, on one of these dangerous trips underground in the old workings, opened a 3 × 5-foot pocket (called "the Green Hole") which yielded about 35 superb fluorite specimens with lustrous green, transparent, penetration-twinned cubic fluorite crystals to 3 cm on edge. Access to the underground workings was still possible (with difficulty) in 1979, when Peter Bancroft accompanied Lester Jackson on a visit and found pale green penetration-twinned cubic crystals to 2 cm on edge, but a few weeks later the old tunnels were blasted shut.

In the early 1990s, after a change of management, the old South vein and the West Cross vein, once worked underground, were worked again in the Heights quarry, just to the east of the old



FLUORITE

No.LG.471

A magnificent plate of stunning deep purple transparent interpenetrating fluorite crystals to 2 2 cm. in relief on a carpet of tiny transparent pale lilac and colourless fluorite crystals on a thin plate of matrix. With very smooth faces, the fluorite has an extremely high natural fluoresence in daylight.
From the south wall of 340 level east, Frazer's Hush Mine, Rookhope, Weardale, County Durham.
Recovered from the mine in 1990 by C.Wilkie, miner.

Lindsay Greenbank's label.

Fluorite in penetration-twinned crystals to 2.2 cm, from the south wall of the 340 level, Frazer's Hush mine, Rookhope district, Weardale, Durham (LG-471). Within a week of being collected in 1990 it was acquired for the Greenbank collection. The specimen is shown actual size (28 cm). Joe Budd photo.

Under ultraviolet light.

Fluorite, a 2.5-cm penetration twin on a 5.5-cm ironstone matrix, from the Heights mine, Weardale, Durham (LG-18). Collected in July 1977 by Richard Barstow. Ex Barstow collection; Jesse Fisher photo.

mine, and collectors once again had access to this famous fluorite locality. Opaque, deep green cubic fluorite crystals to 12 cm were collected from mud-filled cavities on the West Cross vein, and more fine specimens were dug near the South vein: good milky purple to gray, blue-green and "classic" bottle-green fluorite crystals emerged and were marketed during the 1990s. However, as of the mid-2000s, illicit collecting has led to a ban on digging in the quarry.

Middlehope Shield Mine

The Middlehope Shield mine in Middlehope Burn north of Westgate, accessed by an adit called White's level, is the earliest of the Weardale mines known to produce collector-quality specimens of emerald-green, penetration-twinned fluorite (Fisher, 2006). Records indicate that the mine was active some time before 1809, and mineralogist Edward Daniel Clarke (1819) made special note of a large find of good specimens there. White's level penetrated several major ore-bearing veins (including what may be a continuation of the Heights West Cross vein) in the Quarry Hazle sandstone unit just below the Great Limestone formation, and consequently the fluorite specimens are distinctive for having a sandstone matrix. The mine was in operation at least through 1864.

Unlike some of the more famous Weardale mines, White's level was never reopened in the 20th century, and was never described in the mineralogical literature, so it has remained relatively unknown. The workings have since collapsed and the area is now a protected archeological site where collecting is forbidden.

Underground at the Heights mine. Helen Wilkinson photo.

The stone-arched portal of White's level, Middlehopeburn. White's level was the site of the first documented find of fluorite specimens in Weardale, in 1818. Jesse Fisher photo (2002).

Redburn Mine

The Redburn mine is a modern operation begun in 1964 by the Weardale Lead Company and soon taken over by Swiss Aluminium UK. A well-mineralized portion of the vein was worked for a distance of over 300 meters, and a second section discovered 1,200 meters away was worked for another 610 meters. The mine closed in 1981 when the economic reserves were exhausted.

Though not a major source of collector-quality fluorite specimens, the Redburn mine did produce some attractive specimens of a pale green to medium-green to purple color, showing both twinned and untwinned crystals associated with quartz, calcite and sulfides. Specimens of jackstraw cerussite were also recovered, unusual for this district and for the British Isles. The Greenbanks kept for their collection one of the largest specimens recovered (shown here, page 93) and one of the most aesthetic small cabinet pieces, as well.

Rogerley Mine

The Rogerley mine, driven into the side of an abandoned limestone quarry of the same name, has produced some of the very best of the variously styled fluorite specimens from the Weardale region. And, unlike most of the other famous Weardale localities, it has done so liberally in very recent times. The Rogerley limestone quarry began working in the mid-1800s; specimen-quality fluorite was first noticed and saved (as far as is known) by collector Raymond Blackburn in the early 1970s.

Fluorite, 10 cm, Middlehope Shield mine, White's level, Weardale, Durham (LG-299). Green, twinned fluorite crystals to 2 cm on sandy matrix, showing the "rounding" on edges typical of this occurrence. From a large find circa 1818. Jesse Fisher photo.

From 1972, Lindsay Greenbank and Mick Sutcliffe ran a specimen-mining operation here, producing gorgeous deep green (and highly fluorescent purple), transparent cubic fluorite crystals, as individuals and penetration-twins to 2 cm covering matrix. These specimens from the "Sutcliffe vein" trickled out sparsely onto the general market, sometimes misattributed to the Eastgate mine. Rarely, purest blackberry-purple crystals were also found in the same vein (an early piece is shown here, from the Michael Sutcliffe collection). Lindsay suffered an overwhelming illness in 1996, after which mining here was stopped and the rights sold to two of his friends in the United States, Jesse Fisher and Cal Graeber.

Beginning in 1999, the American consortium called UK Mining Ventures, led by Cal Graeber and Jesse Fisher, leased the mine and

(*Facing page, above*) Cerussite, 15 cm, from the Redburn mine, Rookhope district, Weardale, Durham (LG-47). This jackstraw cluster of crystals was purchased by Peter Blezard of Broughton Minerals in Ravenstonedale, in 1972, for Lindsay Greenbank. It is perhaps the largest fine Redburn cerussite known, though the Greenbank collection also contains small cabinet and miniature-size specimens. Joe Budd photo.

(*Facing page, below*) Rogerley quarry, showing the portal to the Rogerley mine in spring 1998, before being taken over by UK Mining Ventures.

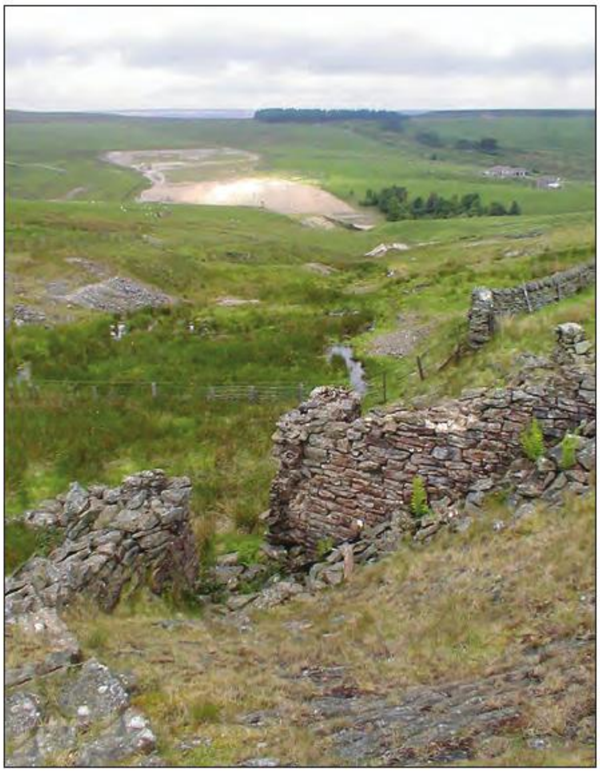
Portal to the recent workings in the Rogerley mine. Lloyd Llewellyn photo.

(*Facing page, above*) Fluorite, 7 cm, from the Rogerley mine, Frosterley, Weardale, Durham (LG-443); mined by Cumbria Mining and Mineral Company ca. 1975. Patricia Greenbank photo.

(*Facing page, below*) Fluorite, 10 cm, from the "Sutcliffe Vein," Rogerley mine, Weardale (LG-642); mined by Michael Sutcliffe around 1975 from the vein that his partners named after him. Joe Budd photo.

Fluorite crystal cluster, 11 cm, from the Rogerley mine (LG-647). Mined in 2003. Joe Budd photo.

Fluorite, 11.5 cm, from the West Pastures mine, Weardale, Durham (LG-438); a plate of sparkling limonite on quartz with yellow-green fluorite crystals to 1.5 cm. This color is typical of crystals collected in the West Pastures mine in the mid-1970s. Joe Budd photo.



The Whiteheaps mine, Weardale. Lloyd Llewellyn photo.

began rehabilitating the workings, also seeking specimens. The walls of a 35-meter adit driven into the wall of the old quarry were sprayed with pressurized water, and the UK Mining Ventures group almost at once found an interconnected series of pockets which began yielding great numbers of wonderful fluorite specimens. The crystals are penetration-twinned, and reach 3.5 cm; they are uniformly dark green, though some have purple zones in their cores or around their outsides. Their fluorescence is so intense that they glow blue or purple in ordinary sunlight. Associated species include drusy milky quartz and corroded, octahedral galena crystals.

In the summer of 1999, about 1,800 specimens came out, ranging from loose 3-cm twins to great matrix plates 60 cm across, in addition to profligate swarms of thumbnails, and this was the start of the near-flooding of the general market with beautiful Rogerley fluorite. In the summers of 2001 and 2003, gorgeously colored fluorite crystal groups were mined from the West Cross Cut in the Rogerley mine; superb specimens to 3 × 5 cm appeared at the Ste.-Marie-aux-Mines show of that year. The summer of 2007

Headframe and ore bins at the St. Peter's mine near Spartlea, East Allendale (early 1900s). Beamish Museum photo archives.

was also a very good collecting season, with clusters of gorgeous crystals to 4 cm individually, and crystal-blanketed matrix plates to 20 cm across, emerging from pockets the collectors named the "Jewel Box" and the "Rat Hole"; many of these specimens were marketed in Denver in the same year. For a thorough account of specimen-recovery work at the Rogerley mine during the early 2000's, see Fisher and Greenbank (2003).

The 2009 collecting season at the Rogerley mine was only modestly successful. Many fine specimens were recovered in June, but then the zone they had worked so successfully for the past couple years finally petered out. July and much of August were spent driving a new exploratory tunnel, during which a few smaller pockets were encountered. UK Mining Ventures is currently the only large operation devoted entirely to specimen recovery in the British Isles.

West Pastures Mine

The West Pastures mine operated on the West Pastures vein, near the Stanhopeburn mine, but its early history is unknown. Simple cubic crystals of pale apple-green fluorite to several centimeters on edge were collected at the West Pastures mine during the 1970s when it reopened briefly for the mining of large decorative pieces; unfortunately the color of fluorite from this mine is light-sensitive, and most specimens have by now faded from an attractive apple-green to a dull yellowish brown. The Greenbank collection retains one large specimen, kept in a drawer to avoid fading. Later collecting in the mine produced specimens showing yellow and dark purple fluorite crystals, as well as more of the apple-green crystals.

Whiteheaps Mine

The Whiteheaps mine operated on a series of interconnected veins (mainly the White, Ramshaw and Jefferson veins). The earliest workings for argentiferous galena probably date to the early 1700s, but after the mid-1880s, mining concentrated primarily on fluorite. Blanchard Fluor Mines, Ltd. took over the mining leases in 1940, but the mine was nationalized in 1967 and passed to the British Steel Company; in 1982 it was taken over by Weardale Mining and Processing, but mining ceased in 1987.

Whiteheaps mine fluorite is typically purple to lavender and occurs in crystals to several centimeters that are commonly found coated by small, blocky quartz crystals. Other minerals found there include galena, pyrite, sphalerite, marcasite and pyrrhotite.

St. Peter's Mine

The St. Peter's mine vein near Spartylea in East Allendale was discovered accidentally in 1902 in the course of finishing the Blackett Level. The St. Peter's vein consisted primarily of galena in a fluorite gangue. Lead values decreased with depth, eventually becoming subordinate to zinc (sphalerite). The vein was thought at the time to be the continuation of Swinhope vein. The St. Peter's mine closed in 1946 when the Great Limestone formation carrying the ore-bearing veins and flats was found to be truncated on the west by glacial sediments filling the East Allen Valley. All that remains aboveground today are some old concrete foundations of mine buildings.

Some of the finest apple-green fluorite specimens ever found in

Fluorite crystals on galena, 12 cm, from St. Peter's mine, East Allendale, Durham, Northumberland (LG-445). A group of lustrous galena cubes accompanied by pale green fluorite crystals to 1.5 cm, some faces lightly frosted with sparkling quartz. Specimens from the St. Peter's mine are rarely seen, though it is famous for producing some of the finest green fluorite ever found in northern England, almost all of which seems to have found its way into the collection of Sir Arthur Russell (and now in the Natural History Museum, London). This specimen was purchased as part of the Ralph Sutcliffe collection in 1991; its earlier history is unknown. Joe Budd photo.

Britain came from the St. Peter's mine in the 1930s, collected by Sir Arthur Russell, who later donated them to the British Museum. Attractive (though lesser) clusters of lustrous, untwinned purplish gray and amber-colored fluorite with siderite overgrowths were found in the mine and marketed in the U.K. in the mid-1990s, but Russell's original location for the legendary green fluorite has never been rediscovered. Groups reach large-cabinet size. Ankerite, calcite and quartz have also been reported. The St. Peter's mine has recently been worked for specimens by Dave Hacker and Northern Minerals.

THE FALLOWFIELD MINE

by Wendell E. Wilson

HISTORY

The Fallowfield mine is situated in St. John's Lee parish, about 2 miles north of the village of Hexham, Acomb, Tyne Valley, Northumberland. The workings extend for roughly 1.5 miles, following the narrow valley of the Acomb Burn and then westward across open fields. It was probably worked in Roman times, and is very near the line of Hadrian's Wall (built by the Romans in 122 A.D.), which some writers believe served as a boundary for the known mineral field of the North Pennines.

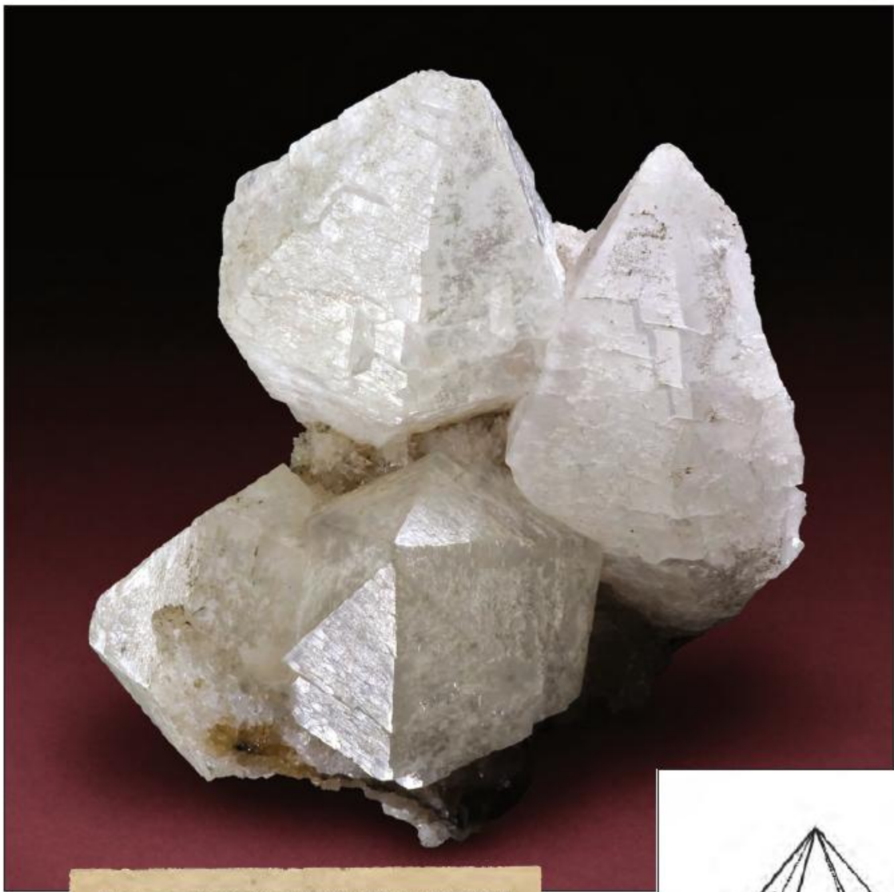
The Fallowfield mine is thought to have been worked during the Middle Ages by the monks of Hexham Abbey, who used the lead in the roofing of the Abbey. The remains of a medieval village abandoned in the 1400s can still be seen around the old village of Fallowfield. But the earliest documentation dates to 1611, when a petition was lodged against Sir John Fenwick by the owner of the Fallowfield mine, John Errington. Ownership remained unchanged until 1715 when the Errington family, having supported the abortive Jacobite rebellion, were dispossessed and their lands were turned over to the Blackett family.

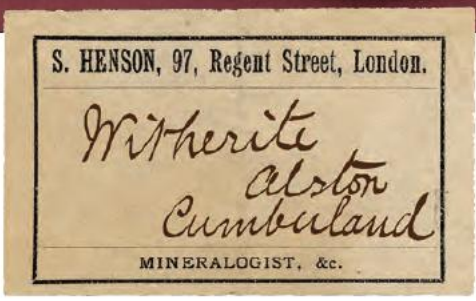
The mine was first worked for lead, which at one time was smelted on the site, as evidenced by accounts dated 1681 recording the purchase of a waterwheel, bellows and hearthstones. The St. John's Lee parish register makes frequent mention of miners towards the end of the 1600s. But as mining deepened and extended below sea level the problem of drainage became increasingly severe, and by 1734 the mine was listed as being "inundated and idle." The workings were eventually dewatered by new drainage levels, and a steam engine pump was installed in 1762 to pump water from the deepest workings on the 414-foot level. Lead ore was packed out on horses to the smelter at Acton, about 9 miles to the south, and sections of the horse path can still be traced. By 1765 there were 100 miners employed at the mine, producing 400 tonnes of lead ore that year at a cost of £5200.

For the next 20 years the mine prospered, and the Blacketts decided to extend the workings along the vein in both a westerly and an easterly direction. They also installed a second pumping engine around 1774. A plan of the mine dated 1777 shows that the vein had been worked over a distance of 2,245 feet, with four main levels at 120, 270, 366 and 414 feet in depth—sea level being at 420 feet. To the west of the Old Engine shaft a new shaft called the Nook Shaft was sunk, connecting with the Acomb Flank adit which provided gravity drainage for that part of the mine.

In 1788 the Blacketts leased the mines to Jacob Walton and John Cooper, and by the end of the 1700s the richest portion of the vein had been extracted in the search for lead. But the leases were continuously renewed throughout the 1800s. In 1845 declining lead production inspired Walton and Cooper to begin mining the Fallowfield vein for witherite and barite (hitherto discarded as waste) instead of galena. Initially witherite mining concentrated on backfill left by the early lead miners, but soon the workings were in full operation again. In

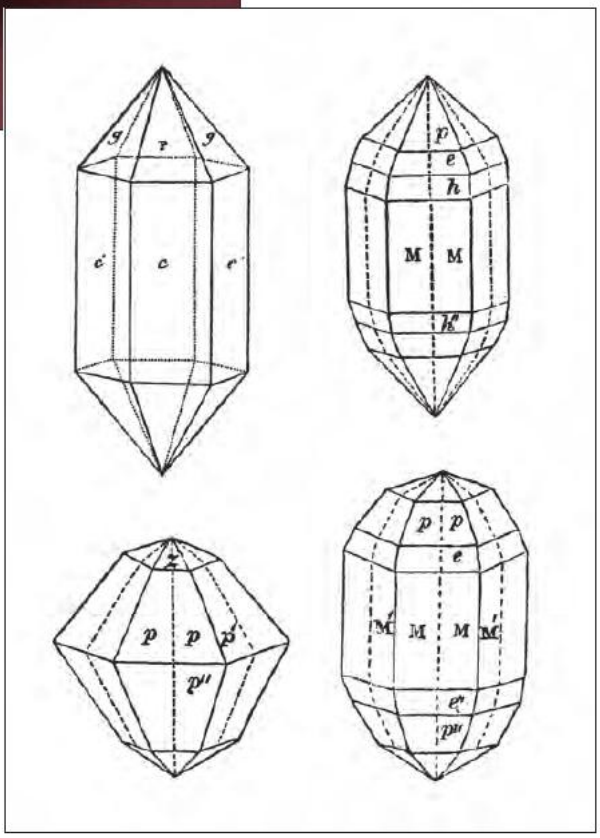
Large, translucent witherite crystal, 6.5 cm, with minor alstonite at its base, from the Fallowfield mine near Hexham, Northumberland (LG-459). An old specimen formerly in the collection of the Smithsonian Institution, de-accessioned and repatriated by Ralph Sutcliffe in the 1980s. Joe Budd photo.





Witherite crystal group on alstonite, 5 cm, from the Fallowfield mine, Hexham, Tyne Valley, Northumberland (LG-456). This aesthetic miniature specimen carries a label from the London mineral dealer Samuel Henson (1848–1930), and was later acquired by the prominent Philadelphia collector Clarence Sweet Bement (1843–1923), whose collection was purchased for the American Museum of Natural History by J. Pierpont Morgan in 1900. It was valued in 1888 at $8.75, a fairly large sum for the day. Ralph Sutcliffe acquired the specimen by exchange, and his collection was later acquired by Lindsay Greenbank in 1991. Witherite is the second most common barium mineral after barite, but is of infrequent, though widespread, occurrence. Joe Budd photo.

(*Below*) Witherite crystal drawings, Fallowfield mine (from Haüy, *Traité de Minéralogie*, 1823; Greg and Lettsom, 1858). The world's first and finest examples of the species came from northern England.



Witherite crystals to 4 cm, from the Fallowfield mine, Hexham, Tyne Valley, Northumberland (LG-458). The British Museum (Natural History) acquired this specimen from Patrick Gilmore's widow as part of a large purchase following his death in 1892. It was exchanged to Richard Barstow in the 1970s and passed to the Sutcliffe collection in 1982, then to Lindsay Greenbank in 1991. Joe Budd photo.

so doing they established the world's first commercial witherite mine, which until its closure remained one of only two main sources of witherite in the British Isles (the other being the Settlingstones mine a few miles to the west). Workings were extended between Thorntree and the Old Engine shaft by driving new levels at depths below the shaft collar of 26, 96, 151, 206 and 246 feet. The mining of witherite and barite rejuvenated Fallowfield, aided by the proximity of the Newcastle-Carlisle railway, which had opened in 1838, providing cheap and easy transportation of ores to Newcastle and Blaydon, from where it could be exported, particularly to Russia.

Although exploratory work revealed good witherite ore in the lower 90 feet of the old lead workings, witherite was never mined there. Furthermore, old records show that the mine owners at the end of the 1700s intended to open the vein between the Old and New Engines, but plans of the mine drawn up in the 1940s indicate that this was never done, so it is likely that potentially productive sections of the vein still remain in place today, especially those portions situated below sea level.

Toward the end of the 1800s the old problem of drainage was exacerbated as the mine workings became more extensive, and in 1908 serious flooding caused the underground workings to be permanently abandoned. The dumps and reserves were worked until 1913, when the mine finally closed after over three hundred years of operation. Total witherite production since 1846 is estimated at 105,000 tons, ranking Fallowfield as the second largest producer of witherite in the United Kingdom.

GEOLOGY

The northeast-trending Fallowfield vein is part of the Haydon Field group of deposits. The vein occupies a fault that has been traced over a distance of 2 miles, from the Wall-Acomb road to Coldlaw Dene; the northern section of the vein was the most productive. Exploratory workings extending southwest from the North Tyne Level, and to the northeast near the military road proved unsuccessful, as the vein split into numerous small, poorly mineralized faults. The thickness of the vein was variable over its length, but usually measured around 6 meters, widening out to over 12 meters near the Lonage shaft.

A report dated 1766 described the vein thus:

> She is a strong vein running East and West, or rather two veins, east of the engine. Against the North cheek is a soft dowk, partly shivery, next to that, a strong cawk or spar a yard or more wide which is joined on the south side by a strong rider mixed with Spar several yards wide, the southernmost part of which is all or mostly Spar, in which lies ore in ribs of 4, 5, or 6 inches wide. This spary part is 1½-2 yds wide, but instead of the rib the Spar is sometimes flowered with ore. In some places opposite the Little Limestone the vein seems to form a sort of flat, and that spary bearing part of the vein flutters in among the riders towards the north cheek.

MINERALS

Alstonite $BaCa(CO_3)_2$

The Fallowfield mine is one of the two type localities for alstonite (the other being the Brownley Hill mine). The original description of alstonite (Johnson, 1835, 1837; Thomson, 1835, 1837; Breithaupt, 1841), which at first was thought to be a form of barytocalcite, was based on specimens collected from both the Fallowfield mine and the Brownley Hill mine near Alston. The mineral is trimorphous with barytocalcite and paralstonite, and forms white to colorless or faintly pink acute pseudohexagonal pyramids or dipyramids up to 6 mm long.

Witherite $BaCO_3$

Witherite, named after the English physician and mineralogist William Withering (1741–1799), has been found at a number of localities in England, and over a million tonnes have been mined from the Alston Block section of the Northern Pennine orefield. The Fallowfield mine is the most important locality for collectors, having produced some of the world's finest specimens. They consist of classic, colorless to pale yellowish green pseudohexagonal dipyramidal crystals with stepped sides or showing rough, striated prism faces. Although the mineral is orthorhombic, repeated twinning on (110) results in the pseudohexagonal appearance. Luster ranges from vitreous to waxy and dull. Witherite is occasionally found intergrown with alstonite crystals. Johnston (1837) wrote:

> The lead-mine of Fallowfield near Hexham, in Northumberland, is known to modern collectors of minerals as the locality where the finest specimens of crystallized carbonate of barytes [witherite] have yet been obtained. In this mine the mineral has for some time been met with, crystallized in six-sided pyramids, pure white, often transparent, having occasionally a beautiful pink tinge, and sometimes opaque, from an incrustation, apparently of sulphate of barytes.

Greg and Lettsom (1858), in their famous book *Manual of the Mineralogy of Great Britain and Ireland*, wrote as follows:

> It is here at Fallowfield near Hexam that the finest crystals yet known are met with. They are frequently very perfect, and are occasionally remarkable for their size. The largest crystals are often coated with a white deposit of barites; sometimes, however, they are quite translucent, and occasionally 5 inches [12.7 cm] long. Flat or lenticular forms have been noticed, composed of only the low pyramid.

Witherite formed by the decomposition of barite in solutions rich in carbonate and sulfuric acid (Emmons, 1917). Specimens can still be found on the dumps at Fallowfield, though the surface is now mostly overgrown and planted with trees. The nearby Settlingstones mine and the New Brancepeth colliery near Durham, 30 miles southeast of Fallowfield, have also yielded witherite and alstonite specimens (Spencer, 1909).

OTHER MINERALS

Galena was the original ore mineral; the remainder of the vein matter consisted primarily of white to pale yellowish green masses of witherite with occasional pockets containing beautiful crystals and crystal clusters. Barite was commonly found in association, though not in good crystal specimens, and calcite formed about 10% of the vein filling in the area near the old engine shaft. Minor amounts of alstonite, barytocalcite and sphalerite were also encountered, but quartz was entirely absent.

NOTE:

The Fallowfield mine has been identified as being of "national importance" in the Geological Conservation Review, and is a Site of Special Interest under Section 28 of the Wildlife and Countryside Act of 1981.

THE HILTON MINE

by Wendell E. Wilson

INTRODUCTION

The Hilton mine is among the best known of the Cumbrian fluorite localities, famous for brilliant yellow crystals of large size. The mine is located near the head of Scordale, a narrow valley about 5.5 miles northeast of the town of Appleby on the western margin of the Pennine Mountains. Few good specimens were collected there prior to the activities of amateur collectors in the 1960s and later. The locality has been described by Fisher (2009), and further information can be found in Winrow (1986) and Dunham (1990).

HISTORY

Ancient workings of undetermined date were found in the Mason's Hole outcrop near the Murton mine. However the earliest modern work in the area was conducted between 1824 and 1876 by the Quaker-owned London Lead Company. About 10,000 tons of slightly argentiferous lead concentrate were produced. Lead mining in the area came to halt when the price of lead collapsed in the 1880s, but the Hilton mine was reopened by the Scordale Mining Company in 1896 for the production of barite (and witherite). The mining leases were picked up by Brough Baryte Company in 1906, followed by the Scordale Baryte, Ltd. Company from 1912–1919; over 7,000 tons of barite were produced by these companies. No further work of any significance was done; the mining leases expired in 1963 and were not renewed.

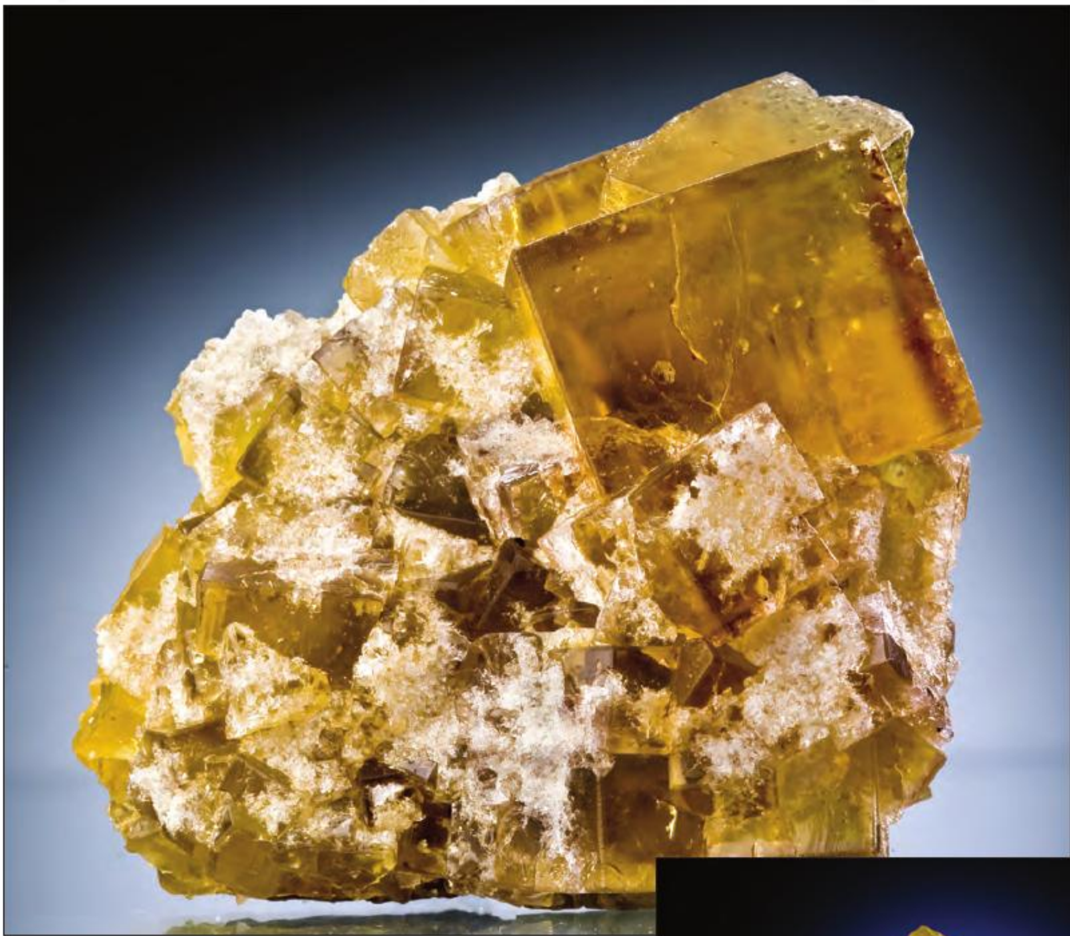
In 1978, several members of the Northern Mines Research Society

The Hilton mine seen from the floor of the Scordale valley. The entrance to the Dow Scar level is near the head of the ravine center-right, just below the Whin Sill, which forms the prominent rock outcrop at the top of the bluffs. Jesse Fisher photo, 2008.

explored the Dow Scar and Middle levels of the mine, cleared away muck and rebuilt the Dow Scar portal. The Hardside Low level, however, was blasted shut at the request of the Army. In 1981, members of the Doncaster Mines Research Group and the Harlow Mineral Society cleared more rubble from the mine and made an accurate survey of the Dow Scar and Middle levels.

Very little specimen-quality fluorite was collected at the Hilton mine prior to its abandonment. The area was incorporated into

Fluorite, 6.5 cm, from the Hilton mine, Scordale, Westmoreland (LG-249). The large twinned crystal at the top is unusual in showing zoning. Collected in the early 1970s by Anthony Walshaw, and passed to Lindsay Greenbank in 1989. Joe Budd photo.



Fluorite, 10 cm, from the Dow Scar vein, 350 feet from the portal of the Hilton mine, Scordale, Westmoreland (LG-268). It was collected by Mick Sutcliffe in the early 1970s; Joe Budd photo.

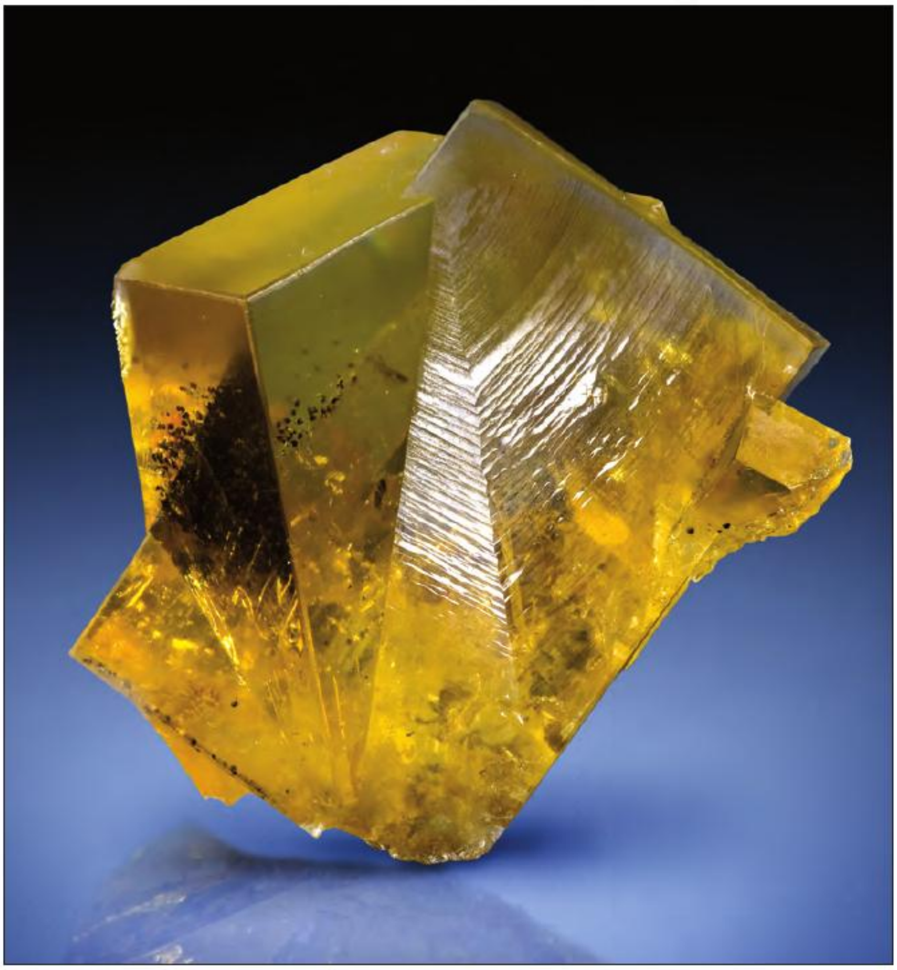
Fluorite, 4.5 cm, from the Dow Scar vein, Hilton mine, Scordale, Westmoreland (LG-11). Collected by Lindsay Greenbank in 1969; Joe Budd photo.

the Warcop military range, and during the 1960s and 1970s the mines were visited regularly by amateur collectors who recovered many of the specimens for which the Hilton mine is now deservedly famous. Prominent among them were Lindsay Greenbank, Richard Barstow, Anthony Walshaw, Ralph Sutcliffe, and Mick and Barbara Sutcliffe.

Since the early 1980s, public access to the military range has been more restricted, and entering the underground workings has been discouraged because of their deteriorated condition. However, the collecting of crystal clusters of fluorite nevertheless proceeded intermittently throughout the rest of the 20th century, both from the dumps and from the underground workings, in the early 2000s.

Fluorite, a large 4.6-cm penetration twin from the Hilton mine, Scordale, Westmoreland (LG-710). It was collected by Michael Sutcliffe in 1972 and kept in his collection; upon his death in 2005 he bequeathed it to Lindsay Greenbank. Joe Budd photo.

Fluorite, 4.5 cm penetration twin, from the Hilton mine, Scordale, Westmoreland (LG-267). It was collected by Lindsay Greenbank in the early 1970s; Joe Budd photo.



Fluorite crystals to 4 cm (unusually large for this mine) from the Dow Scar vein, Hilton mine, Scordale, Westmoreland (LG-268). It was collected by Michael Sutcliffe in 1970; Joe Budd photo.

GEOLOGY

The North Pennine Mountains include two large, fault-bounded, uplifted crustal blocks called the Alston Block (on the north) and the Askrigg Block (to the south). Both blocks consist mainly of Carboniferous limestone, sandstone and shale plus the occasional beds of coal, intruded by Permian-age diabase dikes and sills. Regional-scale doming, probably related to the Hercynian Orogeny, produced a network of fractures throughout the Alston Block, and these served as pathways for mineralizing solutions driven by heat emanating from the underlying Weardale granite pluton. The resulting Mississippi-Valley-type replacement deposits, collectively known as the North Pennine Orefield, have yielded lead, zinc, iron and silver as well as fluorite and barite.

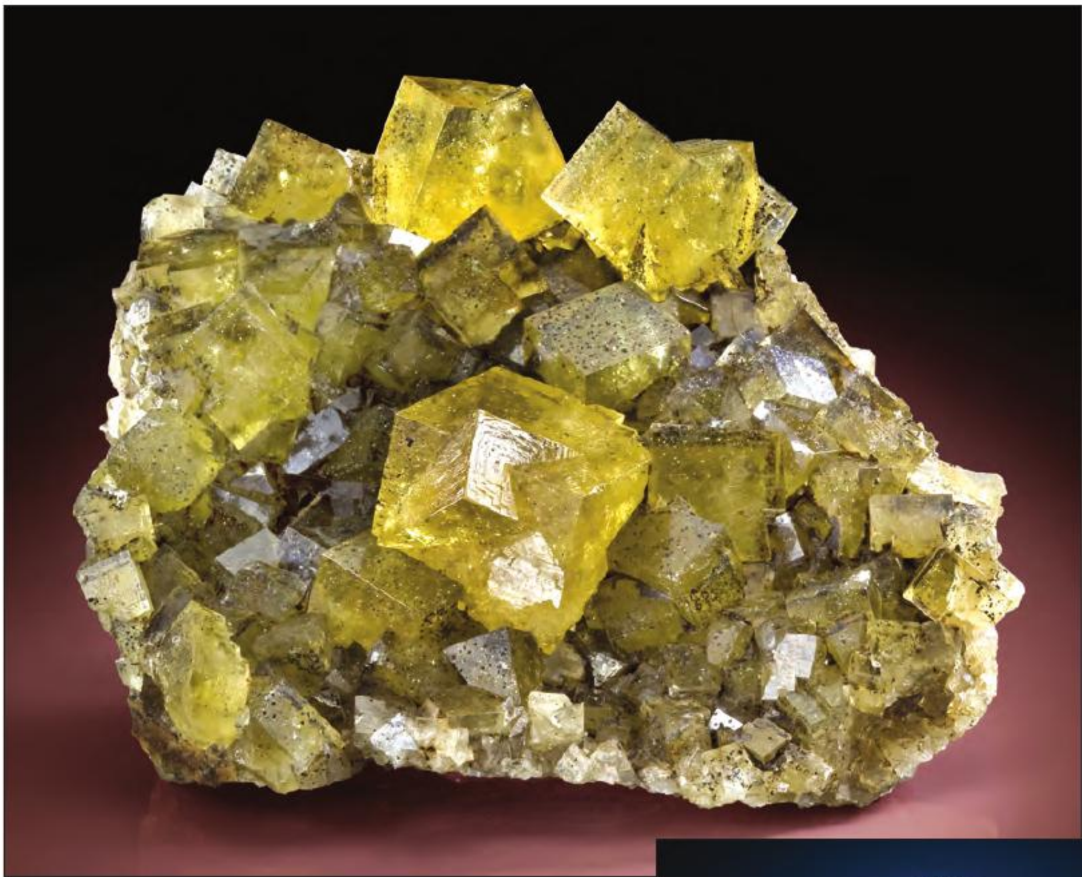
At the center of the Alston Block is a fluorite-rich zone around Allenheads and Stanhope in Durham County and extending into the neighboring Allendale region of Northumberland, and the Alston Moor area in Cumbria. The galena-rich veins in this area were deposited at higher temperature than those in surrounding regions and favored the deposition of fluorite, resulting in a substantial number of important specimen occurrences. The Hilton mine is unusual in being situated on the margin of the fluorite zone, where barite and witherite would normally have predominated.

The Hilton mine and the nearby Murton mine exploit the same system of veins, the Hilton mine on the east side of the valley and the Murton mine on the west side. Farther to the south are the Middle vein and the Dow Scar vein.

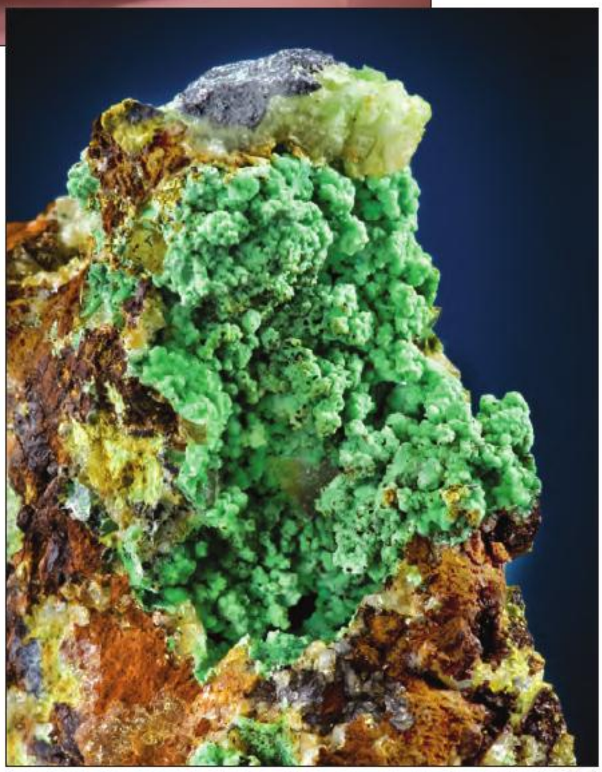
The ore deposits take the form of a series of horizontal metasomatic replacement bodies, known locally as ***flats***, which lie within the upper part of the Melmerby Scar limestone and connect with the system of mineralized veins. Mineralization consists primarily of galena with massive barite and accessory fluorite, witherite, calcite and quartz. Occasional crystals of barite are encountered, but they are not of particularly high quality relative to other more famous Cumbrian occurrences.

FLUORITE

The best specimens by far have come from the Middle and Dow Scar veins, accessed by the Middle and Dow Scar High levels of the



Fluorite, 12 cm, with crystals to 2.5 cm containing pyrite inclusions, from the Dow Scar vein, Hilton mine, Scordale, Westmoreland (LG-251). Collected underground in 1969 by Patricia Greenbank from a roof pocket on the Horse level. Joe Budd photo.



Annabergite crystals lining a 4-cm pocket, from the Hilton mine, Scordale, Westmoreland (LG-258). This specimen, probably the finest annabergite ever found in the region, was recovered from the roof area about 80 meters in from the portal of the Dow Scar level. It was collected by Lindsay Greenbank on March 21, 1988, during an underground exploratory trip with members of the British Geological Survey. This single specimen constituted nearly the whole find of annabergite. Joe Budd photo.

Hilton mine, just below the Whin Sill which caps the Melmerby Scar limestone. The workings connect underground and have exploited a 500-foot stretch of both veins.

Hilton mine fluorite specimens occur in open pockets in massive fluorite and barite-rich matrix. Crystals are typically cubic, in

Barite, 13 cm, collected in the Hilton mine, Murton Fell North Vein, in the 1970s (LG-486). Jesse Fisher photo.

some cases showing penetration twins formed by rotation about the three-fold axis—a habit common in Weardale-area fluorite. Crystals can reach 7 cm on an edge, and show fine transparency and beautiful color, in some cases also with distinctive inclusions of pyrite, chalcopyrite or marcasite.

At the 2005 Denver show, an American dealer offered some small specimens found recently on the dumps, and an English dealer offered some beautiful cabinet specimens taken, also recently, from underground.

OTHER MINERALS

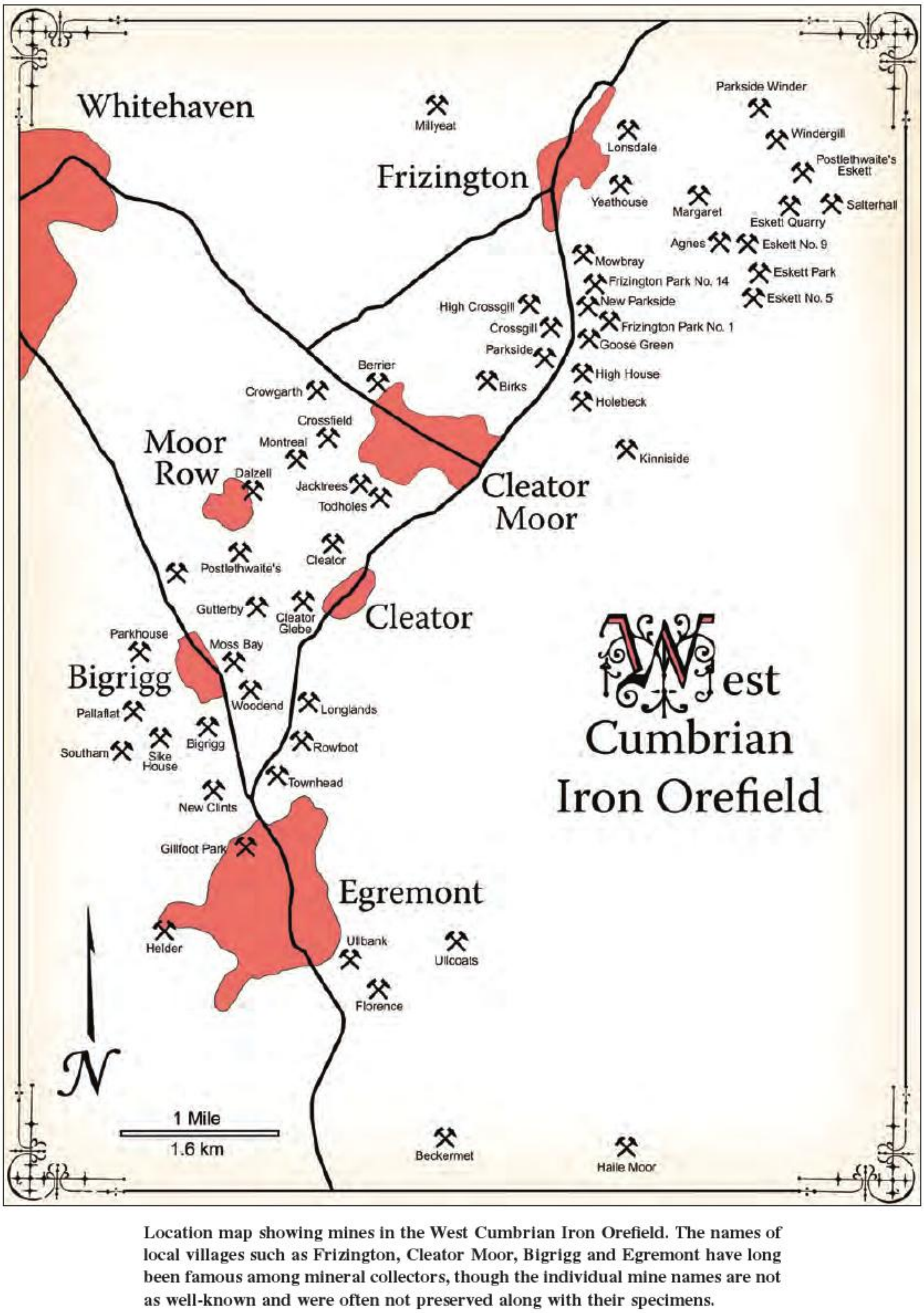
For many years **galena** was the principal ore mineral, though it was usually found massive. Winrow (1986) wrote: "One of the best exposures [of galena] is in the Dow Scar High level, near to the crosscut, where the roof is covered in modified cubes and cubo-octahedral crystals of a dull gray color." Inclusions of **pyrite, chalcopyrite** and **marcasite** in fluorite have already been noted.

Barite has been found in a variety of habits in the Hilton mine. In a deep area near the North vein it occurs as pseudomorphs after **witherite**. Cream-white, heavily iron-stained crystals to 12 cm long and 2 cm thick were found in one small flat. Around the crosscut that connects the Dow Scar and Middle levels barite was found as cream-colored rosettes of lamellar platy crystals, sometimes stained black by manganese oxides. And on a lower horizon, dark gray, chisel-shaped barite crystals form epimorphs.

A number of other species besides galena, barite and fluorite have been collected from the Hilton mine workings. Sprays of acicular white **cerussite** crystals to about 5 mm long were common in the Middle level. Small, tabular anglesite crystals on galena have been found, as well as rare sky-blue to sea-green **aurichalcite** sprays (Middle level), and nondescript coatings of green **malachite** and pale brown **hemimorphite**. Small **quartz** crystals to 5 mm are sometimes found on the faces of fluorite crystals. **Calcite** is very common in certain parts of the mine, and a large chamber was encountered on the lower level that proved to be completely filled with gray to cream-white "nailhead" crystals of calcite. In the early 1980s, members of the Russell Society discovered a small pod of nickel minerals (**nickeline, gersdorffite** and **millerite**).

Patricia Greenbank wrapping specimens in the Hilton mine, ca. 1970.

In 1988 Lindsay Greenbank led a group from the British Geological Survey through the mine, and found a small cavity in the roof that yielded what is certainly the finest known annabergite specimen from the Pennines (shown here).



Location map showing mines in the West Cumbrian Iron Orefield. The names of local villages such as Frizington, Cleator Moor, Bigrigg and Egremont have long been famous among mineral collectors, though the individual mine names are not as well-known and were often not preserved along with their specimens.

THE WEST CUMBRIAN IRON OREFIELD

by Wendell E. Wilson & Thomas P. Moore

INTRODUCTION

The West Cumbrian Iron Orefield is not a name familiar to many collectors as a "classic" locality. However, the names Frizington, Egremont and Cleator Moor immediately conjure images of fabulous, classic barite, calcite and fluorite crystal clusters, mammillated to reniform hematite "kidney ore" specimens, and beautiful, lustrous, colorless to smoky quartz crystals of a stout habit on sparkling drusy hematite. In the decades following 1830 and into the early 20th century, when the mining of red hematite iron ore flourished in West Cumbria, the region was one of the world's most prolific mineral localities. It produced specimens of barite, fluorite, and calcite by the thousands; some say that the finest of the region's calcite specimens have never been equaled for beauty by calcites from any other locality in the world.

HISTORY

Ancient slag heaps near known deposits are evidence of iron working, perhaps as long ago as Roman times or even earlier. The earliest record of iron mining in Cumbria is a Royal grant for an iron mine near Egremont given in 1179 to the Holme Cultram Abbey. Iron ore was being mined at Bigrigg continuously from 1635 to 1701, and in the last years of the 17th century was being shipped by boat to the iron smelter in the Forest of Dean. New furnaces were built periodically thereafter, at Langdale, Parton near Whitehaven, Maryport and Seaton. Mines were opened one after another, and by the end of the 18th century over 20,000 tons of hematite per year were being shipped from Cleator Moor to the Corran Foundry in Scotland.

The mid-19th century saw even larger-scale production, but by the end of the century many of the mines had closed or had greatly reduced their output. By the 1920s only a few of the older mines were still in operation, though newer mines such as the Florence and the Beckermet were still going strong. The last mine to be opened in the district, the Haile Moor mine, was started in 1939. The newer mines were located south of Egremont, where the productive Carboniferous limestone horizon is concealed beneath a cover of Permo-Triassic rocks.

MINES

Beckermet Mine

The Beckermet mine was opened in 1903, and eventually developed into an extensive collection of underground workings extending nearly a mile and a half to the south. The discontinuous mineralization manifested itself as a series of orebodies controlled by several northwest-trending faults. Ultimately the Beckermet workings connected underground with those of the Florence and Ullcoats mines. In 1982, it was the last to close of the major hematite mines in western Cumbia.

The Haile Moor mine was sunk in 1939 just a mile east of the Beckermet mine, and was the last mine to be opened in the district. It closed in 1973. The Haile Moor and Beckermet mines produced a substantial number of fine specimens of hematite, quartz, calcite and barite. Unlike in the other mines, however, the mining company considered mineral specimens to be company property, not a miner's perquisite. Specimens were collected by the company and marketed to mineral dealers from the company offices at Workington.

The Beckermet mine orebodies were not known for producing calcite specimens until the early 1970s when a very long fissure in the limestone above the lower orebodies was encountered at around 400 meters depth in the Beckermet section of the joined Florence-Beckermet underground complex. It contained a zone of pockets that miners named the "Banana Slide Fault" because of the huge sloping piles of wet, greasy, iron-stained rubble stacked below it. This fissure, which extended for about 1.6 km, was lined with hexagonal prismatic calcite crystals toward one end and sharp scalenohedral calcites towards the other, all colored red from included hematite. To collect specimens, miners entered the fissure from below and then worked above the rubble. To descend and exit, one had to suffer a wet and slippery 45-meter slide (preferably on soft sacks) down the piles of rubble and back to the haulage level (personal communication from mine surveyor Raymond Clements).

Specimens from this find are easily distinguishable from classic 19th century Cumbrian calcite specimens, which typically show thick, pellucid, colorless, scalenohedral crystals or butterfly twins. By contrast, Banana Slide specimens are clusters of thin calcite crystals to 10 cm long, either coming to points or showing trigonal "nailhead" terminations; the crystals are stained red by hematite inclusions, and many show complex red or black phantoms caused by finely divided hematite and/or manganese oxides. The crystal groups reach large-cabinet size.

After the mines closed in 1982, a group of former employees organized to conduct small-scale mining of a near-surface deposit called the Lonely Hearts orebody; work there continued until 2007, and some fine specimens of hematite with blue fluorite were recov-

Hematite-stained calcite crystal plate, 18 cm, from the Banana Slide, Beckermet mine, Egremont, Cumbria. Large plates such as this are uncommon; it was collected immediately after a blast in the mid-1970s by the Beckermet mine surveyor, Raymond Clements of Egremont. It remained in his private collection of choice local cabinet specimens for over 30 years, before he sold it to Ralph Sutcliffe and Lindsay Greenbank. Ralph Sutcliffe photo.

ered (these are now eagerly sought after by collectors, as antique specimens are even harder to obtain). The "Lonely Hearts" orebody was named because of its isolated location from the other workings of the Beckermet and Florence complex; it was not flooded when the Florence mine was left idle in 1968–1970. The few miners who worked that small deposit constantly complained of being separated from their friends!

Bigrigg Mines

Over a dozen mines are situated between the town of Egremont and the village of Bigrigg about a mile to the north. There is a Bigrigg mine, but specimens labeled simply "Bigrigg" could be from any of the various mines near the town. Bigrigg is probably the site of the earliest mining for hematite in west Cumbria, but no physical evidence of the earliest workings survives. Most of the

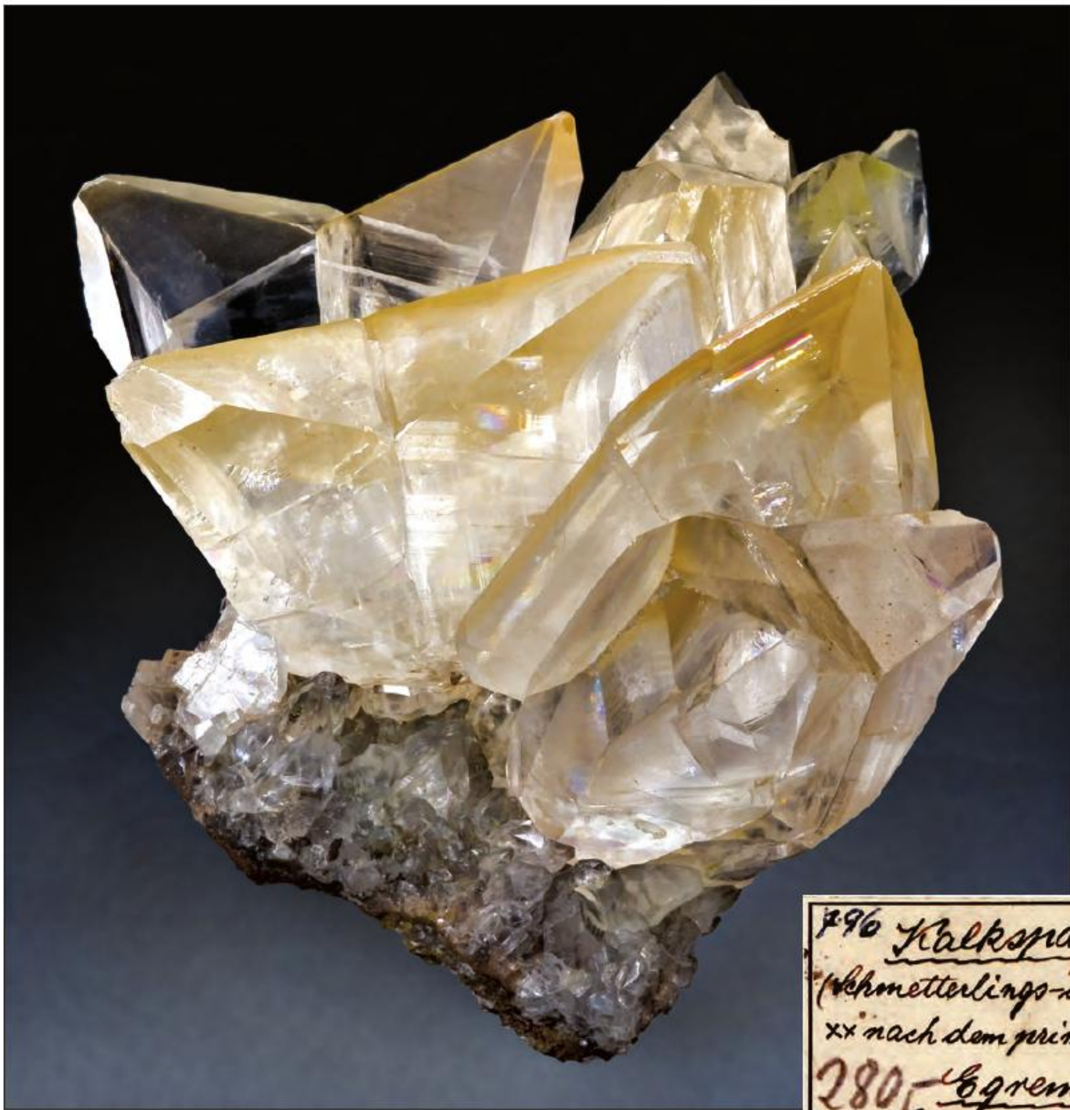
Calcite in sharp prismatic crystals on limonitic matrix, 7 cm, from Bigrigg, Cumbria (LG-121). Ex David Corse Glen collection via Kelvingrove Museum, Glasgow, exchange to Richard Barstow. To Sutcliffe in 1982, to Greenbank in 1991. Joe Budd photo.

Calcite crystal group, 5 cm, from the Bigrigg mine, Cumbria (LG-117). Ex David Corse Glen collection via Kelvingrove Museum, Glasgow, exchange to Richard Barstow. To Sutcliffe in 1982, to Greenbank in 1991. Joe Budd photo.

Calcite crystal cluster, 16.3 cm, from the Bigrigg mine, Cumbria (LG-57). It was purchased by the British Museum (BM76288) in 1894 from Frizington mineral dealer John Graves. Ralph Sutcliffe obtained it by exchange in 1987, and sold it to Lindsay Greenbank in 1991. During a bout of ill health in the mid-1990s Lindsay sold it to French collector Eric Asselborn, who later sold it to Rob Lavinsky and Wayne Thompson in 2007. Rob then sold it to Wiliam Larson in 2007. Jeff Scovil photo.

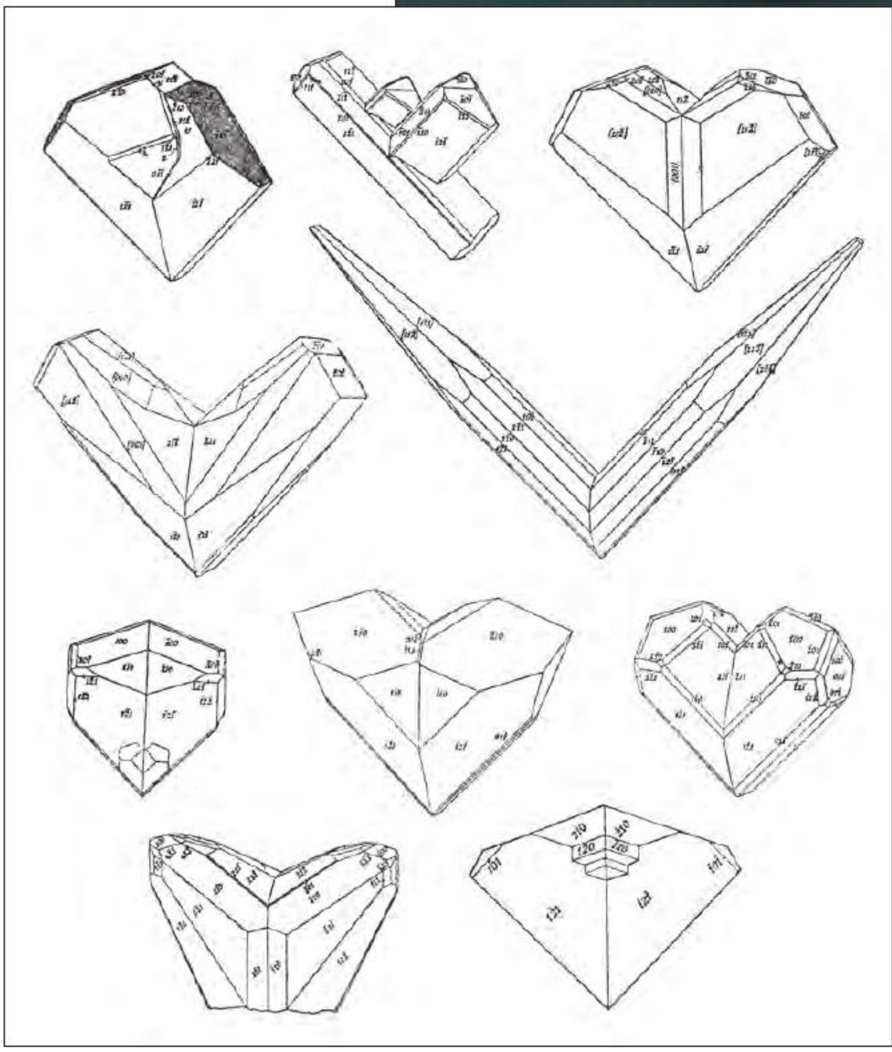
Calcite crystal cluster, 16 cm overall with crystals to 4 cm, from Egremont, Cumbria (LG-650). Formerly in the collection of W. W. Jefferis (1810–1911) of Pennsylvania, whose number (2239) is affixed to the back of the specimen (Jefferis paid $1.50 for it in 1892). It was acquired by the Carnegie Museum of Natural History in Pittsburgh in 1905, along with the rest of the Jefferis collection, and was traded in 1980 to St. Louis mineral dealer Gary Hansen, eventually finding its way into the Greenbank collection. Joe Budd photo.

Barite crystal on matrix, 17 cm (shown almost actual size), from the Parkhouse mine, Bigrigg, Egremont, Cumbria (LG-2). Two doubly terminated, dark golden yellow crystals, opaque but with transparent terminations and a brown central zone, perched on a very thin plate of hematite matrix overgrown with creamy dolomite crystals on the reverse—a fine specimen from one of the best barite occurrences in the country. The Northern Pennines have produced some of the most beautiful barite specimens in the world. Specimens are much prized by collectors. The Greenbank collection contains an excellent suite with a variety of examples from several of the best known occurrences. Specimen LG-2 is accompanied by four previous collection labels, the oldest possibly in the hand of John Graves, the 19th-century mineral collector and dealer of Frizington, Cumberland. The second label is from mineral dealer Samuel Henson (1848–1930) of 97 Regent Street, London (he operated from this address from 1888 to 1915), and there is a third label from the Department of Geology and Mineralogy, University of Aberdeen, Registration No. G.2782 from the Harry Gordon collection (see preface). The specimen was obtained by exchange from the University of Aberdeen by Simon Harrison, a mineral dealer from Bath, who sold it to Ralph A. Sutcliffe, whose collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.



Calcite, 11 cm, from Egremont, Cumbria (LG-45). Five colorless butterfly twins, the largest 6 cm across, on a thin matrix. Butterfly twins are usually seen alone and off-matrix; groups such as this are most uncommon. Moreover, there are two different twinning habits on the same matrix piece: both "open" butterfly and "closed" butterfly twins. An old German label with the specimen describes it as *selten schöne xx Stufe!*—"rare and beautiful crystallized piece." Formerly in the collection of sauerkraut manufacturer K. Rau, who specialized in high-quality aesthetic minerals. Following his death in the 1970s, his Saxon minerals went to the Staatliche Naturhistorische Sammlungen in Dresden and the remaining worldwide material was acquired by Humboldt University in Berlin. This specimen was no. 796 in the University collection and was 922/87 in the Rau collection. The Mineral Gallery of Frankfurt acquired the specimen from the University and sold it to Simon Harrison, who in turn sold it to Ralph Sutcliffe in 1986. This is certainly the most historically important calcite in the collection, and is unique among surviving Egremont specimens. It was later part of a display of English twins shown at the 1999 Munich Show. It was illustrated in *Calcit: Das Formenreichste Mineral der Erde* (ExtraLapis no. 14) and in *Calcite: The Mineral with the Most Forms* (ExtraLapis English no. 4, 2003). Joe Budd photo.

Calcite twin colored reddish brown by fine-grained hematite inclusions, 6 cm, from Egremont, Cumbria (LG-520). It was purchased at the Rochester Mineralogical Symposium in 1994 from an old collection that was being sold. It was later part of a display of English twins shown at the 1999 Munich Show. It was illustrated in *Calcit: Das Formenreichste Mineral der Erde* (ExtraLapis no. 14) and in *Calcite: The Mineral with the Most Forms* (ExtraLapis English no. 4, 2003). Joe Budd photo.



Calcite twin crystal drawings, Egremont (Kreutz, *Denkschrift Akademie der Wissenschaften Wien*, 1907).

(*Facing page, top*) Calcite in a rare twin habit, 8.5 cm, from Egremont (LG-29). Ex Richard Barstow collection; ex Ralph Sutcliffe collection, acquired by Lindsay Greenbank in 1991. Possibly from the David Corse Glen collection that Barstow obtained by exchange from the Kelvingrove Museum in Glasgow, Scotland, in the 1970s. It was part of a display of English twins shown at the 1999 Munich Show. Illustrated in *Calcit: Das Formenreichste Mineral der Erde* (ExtraLapis no. 14) and in *Calcite: The Mineral with the Most Forms* (ExtraLapis English no. 4, 2003). Joe Budd photo.

(*Facing page, bottom*) Calcite, 6 cm, from Egremont, Cumbria (LG-34). Frizington mineral dealer John Graves sold it for £1 to the British Museum in 1901 (BM85593). It was traded to Ralph Sutcliffe for an exceptional Cornish ludlamite from a then-recent find at Wheal Jane, Kea. Illustrated in *Minerals of Cornwall and Devon* (Embrey and Symes, 1987). Joe Budd photo.

Calcite "heart twin," 9 cm, from the Gillfoot mine, Egremont (LG-622). Ex E. Mitchell Gunnell collection, who purchased it from Alvina Pohndorf in Denver in 1940. Joe Budd photo.

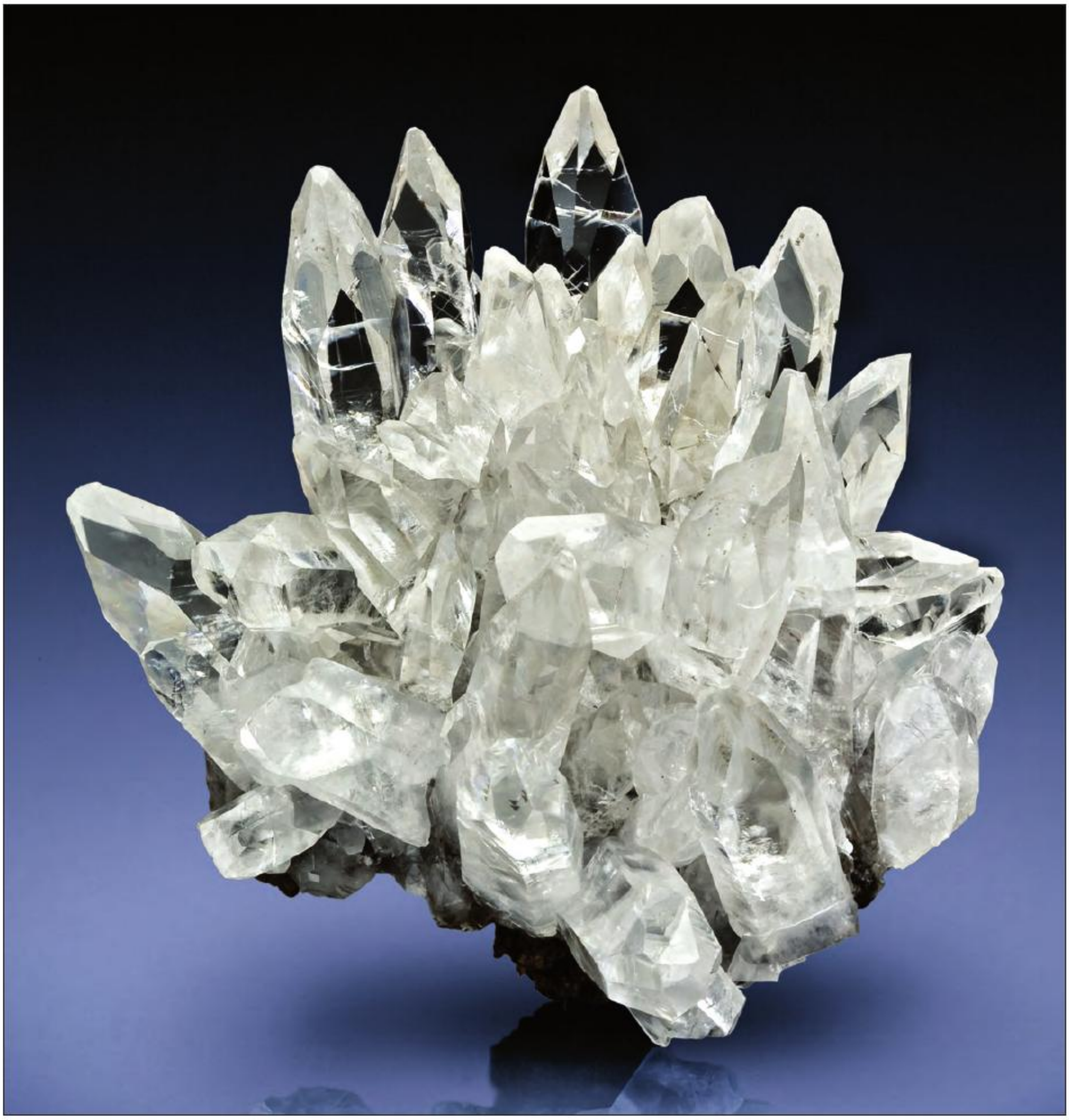
Calcite twin, 4 cm, from Egremont, Cumbria (LG-125). John Graves (1842–1928) sold this completely transparent "heart twin" specimen for £1 to the British Museum in 1901 (along with LG-34). It was traded by the Museum to Richard Barstow in the 1970s. This specimen was later part of a display of English twins shown at the 1999 Munich Show. It was illustrated in *Calcit: Das Formenreichste Mineral der Erde* (ExtraLapis no. 14) and in *Calcite: The Mineral with the Most Forms* (ExtraLapis English no. 4, 2003). Joe Budd photo.

Calcite twin, 5.2 cm, from Egremont (LG-128). This transparent and lustrous specimen shows a unique twinning habit in which the "wings" are swept forward. It was purchased by the British Museum (BM63670) in 1888 from London mineral dealer Francis H. Butler, the same year that Prof. Henry Miers' famous paper on the occurrence was read at Oxford (published in *Mineralogical Magazine* in 1889). Simon Harrison obtained it by exchange and sold it to Ralph Sutcliffe, whose collection was obtained by Lindsay Greenbank in 1991. Joe Budd photo.

Calcite "heart twin," 8 cm, from the Gillfoot mine, Egremont, Cumbria (LG-120). It is accompanied by an old handwritten German label, and was purchased from the Mineralien und Fossilien Galerie, Frankfurt, by Simon Harrison, who sold it to Ralph Sutcliffe, whose collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.

Calcite crystal, 8.5 cm, from Egremont, Cumbria (LG-10). It was sold to the British Museum by London mineral dealer Francis H. Butler in 1889, and was traded out by curator Peter Tandy to Simon Harrison, who sold it to Ralph Sutcliffe; the Sutcliffe collection was acquired by Lindsay Greenbank in 1991. This remarkable crystal has unusual clarity and luster, and is considered a stereotypic example of the classic elongated prismatic habit often attributed to "Bigrigg." Joe Budd photo.

Calcite twin, 5.5 cm, from Egremont, Cumbria (LG-114). It is accompanied by a handwritten label in the hand of Frizington mineral dealer John Graves (1842–1928), priced at 7 shillings. It was acquired by the Reverend John More Gordon (1849–1922), vicar of St Johns, Redhill, Surrey; he bequeathed his collection of Swiss minerals to the British Museum in 1922, but the majority of his mineral collection (named in honor of his grandfather, Harry Gordon) went to Aberdeen University Museum. This specimen was obtained from the University in 1989 by Simon Harrison, a mineral dealer from Bath, who sold it to Ralph A. Sutcliffe; the Sutcliffe collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.



Calcite crystal cluster, 9.5 cm, from Egremont, Cumbria (LG-134). It was acquired by the Reverend John More Gordon (1849–1922), vicar of St. Johns, Redhill, Surrey; he presented his collection (named in honor of his grandfather, Harry Gordon) in 1922 to Aberdeen University Museum. This specimen was obtained from the University in 1989 by Simon Harrison, a mineral dealer from Bath, who sold it to Ralph A. Sutcliffe, whose collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.

Calcite crystals, 12.5 cm, from Egremont, Cumbria (LG-111). It was obtained by Lindsay Greenbank by exchange with the Tullie House Museum in Carlisle. Joe Budd photo.

Calcite crystal cluster showing discrete black manganese inclusions, 8.5 cm, from the Haile Moor mine, Egremont, Cumbria (LG-490). It was obtained from Arthur Scobie in 1994. Joe Budd photo.

more important mines were opened in the 19th century and all except the Wyndham (Langhorn) pit had closed by 1910. The Wyndham pit yielded manganese oxide minerals, including well-crystallized specimens of twinned black hausmannite crystals and also some attractive specimens of pink rhodochrosite (collected by Sir Arthur Russell in the 1930s).

The Bigrigg mines (particularly the Croft pit) are as famous for fine calcite crystals as the closely adjacent Egremont mines (it is arbitrary where you divide one group of mines from the other because of the complex connections underground). Crystal habits range from elongated hexagonal prisms with low-angle rhombohedron terminations to prism and scalenohedron combinations in varying proportions. Thick to thin "butterfly twins" or "heart twins"

An iron mine near Cleator Moor, late 1800s.

are particularly sought after by collectors. The luster of these crystals tends to be almost silky and is rather distinctive. Many specimens show an attractive, light dusting of reddish hematite here and there, while others carry black inclusions of manganese oxides. Even in their time, they were treasured specimens.

Cleator Moor Mines

According to Mayer (1909), the Cleator Moor mines were owned and operated by Lord Leconfield as early as the 1600s. The village of Cleator Moor grew up as a mining settlement during the mid-1800s, and hematite specimens from the area are usually identified only by the village name. From 1840 to 1880 the population grew from under 750 to over 10,000, largely as a result of immigrant miners arriving from Ireland to work in the iron mines and foundries.

At Cleator Moor the hematite-bearing limestone dips beneath the Coal Measures, placing all three of the components necessary for iron smelting (hematite, limestone and coal) in close juxtaposition; the first blast furnaces were erected in 1842. The hematite orebodies averaged around 23 meters thick and plunged at an angle of 20° to 45°. As mining progressed, vertical pillars 20 meters square and 25 meters tall were left in place for support (no timbering was used).

The Crowgarth mine was opened in the 1780s but within a few decades was declared exhausted and was closed. However, it was reopened in 1840 and new shafts were sunk. Much high-quality hematite, including "kidney ore" and "pencil ore," and also fine specimens of quartz, calcite and barite were recovered. Lenses of malachite were also encountered in the orebody. In the early 1900s some parts of the town had to be relocated in order for mining of the underlying orebody to proceed.

The Montreal mines were opened in 1861 and closed in 1925. Kidney ore was abundant and pockets up to a meter across were found lined with "spar" (presumably quartz and calcite).

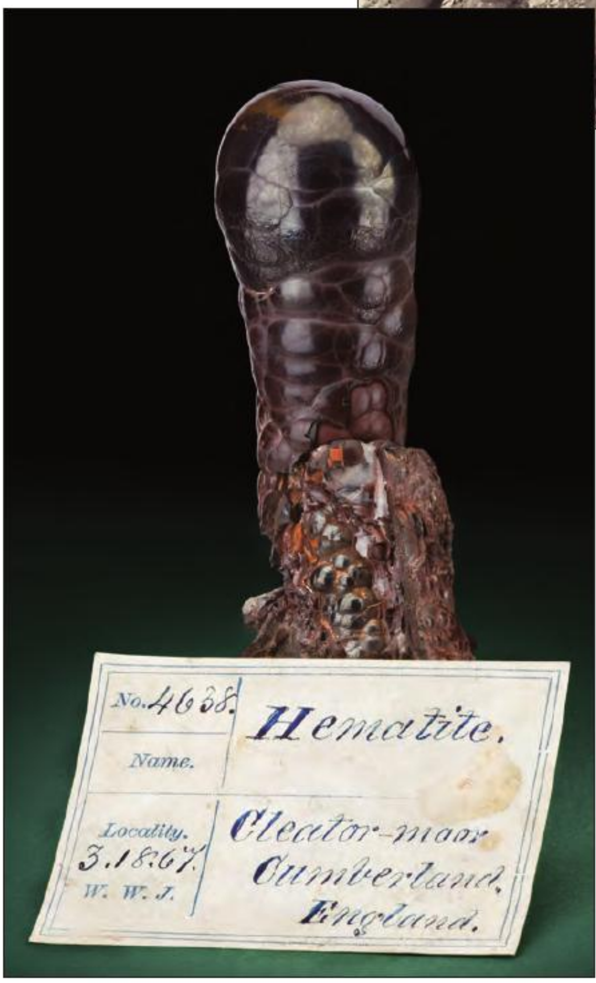
Southwest about a mile from Cleator Moor are the towns of Cleator and Moor Row. In the 1980s the nearby Gutterby mine yielded a few fine specimens of bright sky-blue fluorite from pockets in the orebody found by mine explorers.

Florence Mine

The Florence mine is thought to have opened initially in the mid-1800s but later closed. It was best known for producing spectacular specimens of fluorite. In 1914 a huge deposit of hematite was discovered, reviving the mine. This turned out to be the same orebody as that being exploited by the Ullcoats mine, and the workings eventually merged underground. The Florence-Ullcoats orebody proved to be the largest in all of Cumbria, and the Florence mine was the richest mine in the orefield, yielding 58–59% iron by weight. The Number 1 Shaft was sunk to a depth of 290 meters, and the Number 2 shaft reached 280 meters (personal communication, Raymond Clements). It was particularly rich in crystal-lined cavities containing fine specimens of calcite, dolomite, quartz, specular hematite and "kidney ore" (for which the mine became especially famous). Most cavities measured around 30 cm in size, but large ones up to 4 meters or more in height were also encountered. Specimens of "kidney ore" hematite were always a staple of this locality, and continued to be found sporadically until the mine complex closed. They are botryoidal growths, deep black and (in the best specimens) extraordinarily smooth-surfaced and lustrous, in some cases reaching giant sizes. These aesthetically impressive "kidney ore" specimens remain much prized, although most extant ones are pre-1960 antiques.

Iron miners near Cleator Moor, late 1800s.

Hematite, 10 cm, from Cleator Moor, Cumbria (LG-75). Ex Bryce M. Wright, March 18, 1867; ex William Jefferis collection, which was acquired by the Carnegie Museum of Natural History in Pittsburgh. Ralph Sutcliffe obtained this unusual specimen from the museum by trade; his collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.



The finest blue fluorites from the Florence mine were found in the late 1960s and early 1970s in the 6 West orebody which surrounded the Florence 2 shaft in the strata known as the Lower 7th limestone—around 260 to 275 meters deep. This was in the richest part of the orebody and it was consequently difficult to suspend mining for the purpose of collecting, thus few specimens were saved. Here also was found the finest "pencil ore" hematite, a material which, because of its structure, could be broke into long, thin, pencil-like fragments. Sometimes hematite of small crystal size, called "specularite" by the miners, was found throughout an orebody—however, very few fine examples were collected during the life of the mine (personal communication, Raymond Clements).

Rarely, the Florence-Beckermet-Ullcoats mine complex also produced specimens showing rosettes of lustrous, jet-black hematite crystals, with individuals to 1 cm, covering matrix plates to large-cabinet size. The mine certainly produced the finest specimens of specular hematite with quartz crystals; these are now considered mineral classics for the region.

The Florence mine closed in 1968, but by 1970 the underground workings had been connected with the nearby Beckermet and Ullcoats mines. The enlarged operation, having been found still unprofitable, ceased working around 1980 and closed formally in 1982.

Frizington Mines

A number of mines operated east and south of the village of Frizington, but most of the classic specimens are labeled with the town name rather than a particular mine name. Surprisingly little has been written on this famous area, and specific localities can easily be confused with each other; for example, the Frizington Parks,

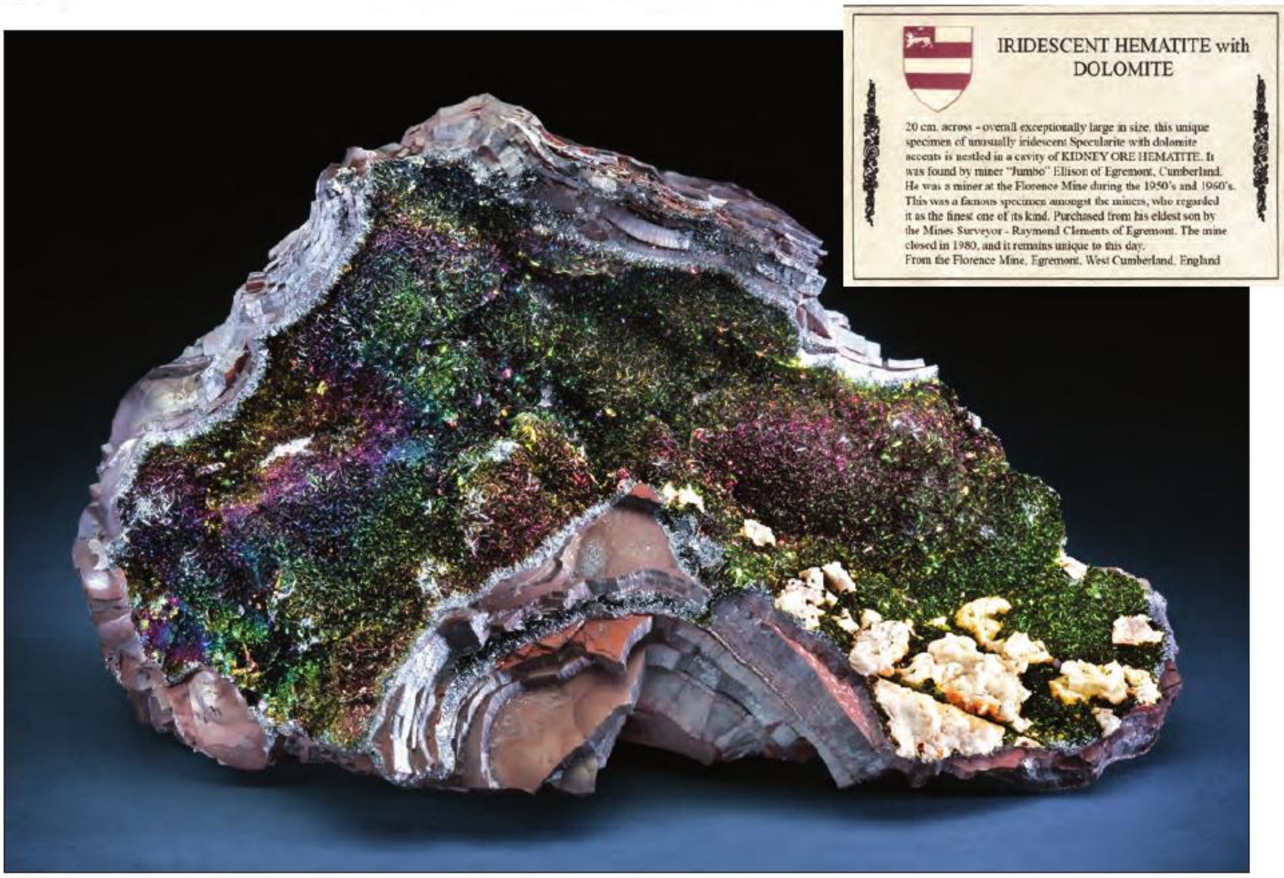
The Florence mine near Egremont. Peter Eckersley photo.

Fluorite crystal, 2 cm, on dolomite, collected from the Florence mine, Egremont, Cumbria in the mid-1970s by the mine surveyor, Raymond Clements of Egremont. Ralph Sutcliffe photo.

Hematite with quartz, 19 cm, from the Florence mine, Egremont, Cumbria; collected underground by mine surveyor Raymond Clements ca. 1978, from a pocket that had just been exposed by blasting. It remained in his private collection for over 30 years until being sold recently to Ralph Sutcliffe and Lindsay Greenbank. Joe Budd photo.

(*Below*) Hematite "horse tooth," 8 cm, from the West Cumbrian iron ore field, probably from the Florence mine near Egremont (LG-83). Ex Herbert Thomas collection, ex Richard Barstow collection, and ex Ralph Sutcliffe collection; Lindsay Greenbank acquired it in 1991. Joe Budd photo.

Hematite with quartz, 13 cm (with a 4-cm quartz crystal) from the Florence mine near Egremont (LG-243); collected ca. 1970. Joe Budd photo.



(*Above*) Hematite with dolomite, 20 cm, from the Florence mine, Egremont, Cumbria. Collected in the 1950s, it was the premiere piece in the collection of the Beckermet mine surveyor Raymond Clements. Iridescence such as this is rare at the Florence-Beckermet-Ullcoats mines, where nearly all hematite is shiny and jet-black. Joe Budd photo. *Inset:* Typical Lindsay Greenbank label detailing the specimen's history.

Quartz and specular hematite crystals within a pocket of hematite "kidney ore," 11 cm, from the Florence mine, Egremont, Cumbria. This unusual specimen was collected underground in the mid-1970s by the mine surveyor, Raymond Clements of Egremont. It remained in his private collection for over 30 years, until it was recently sold to Ralph Sutcliffe and Lindsay Greenbank. Joe Budd photo.

Hematite with dolomite, 12 cm, from the Florence mine near Egremont (LG-4). The specimen was purchased from Peter Blezard, who was working as a miner at the Florence mine in the late 1960s. Joe Budd photo.

Parkside, Crossgill, Goose Green and High House mines all worked the same orebody, which extended laterally over 16 hectares. It has been speculated that the lack of specificity in Frizington mineral specimen labels may possibly have been deliberate, in order to conceal sources from competing collectors and dealers.

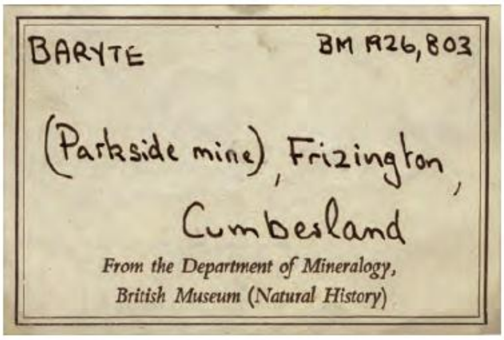
At the Lonsdale mine large cavities (called "loughs") up to 9 meters across were encountered regularly in the orebody; minerals found included hematite-stained calcite, marcasite, hematite, chalcopyrite and pyrite. Although the mineral contents of cavities opened in the nearby Windergill and Eskett mines were not recorded, the dumps contained good examples of hematite "kidney ore" and quartz crystals.

The Margaret mine, worked from 1854 to 1923, produced substantial amounts of hematite "kidney ore."

The quarries at Kelton and Eskett, among others, yielded beautiful radiating clusters of tapered, cream-white aragonite crystals to several tens of centimeters, collected from cavities in dolomitized limestone. These are quite often seen on the mineral market today, and in old museum collections they are labeled simply as "Frizington."

The Mowbray mine yielded excellent "kidney ore," some attractive fluorite and calcite specimens, and also many beautiful "classic" pale blue to pale green and golden yellow barite crystals and clusters on "pearl spar" dolomite; some crystals are tinted red by hematite inclusions. Studies (Sweet, 1930) have shown that the Mowbray mine barite is unusual in its tendency to undergo a color change when exposed to sunlight; yellow crystals will turn green and then blue after a few hours in the sun. Some modern-day dealers (e.g. Cal Graeber) have reported that the original blue color in old Frizington barites tends to fade very gradually over several decades to a gray-blue color, but can be easily restored by exposure again to sunlight for a few hours.

The Goose Green mine was the source of superb specimens of "kidney ore" as well as dolomite, hematite-colored quartz crystals


BARYTE BM 1926,803

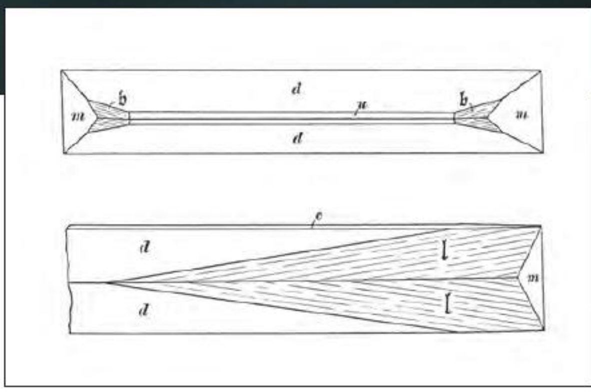
(Parkside mine), Frizington, Cumberland

From the Department of Mineralogy, British Museum (Natural History)

(*Above*) Barite crystal (with phantoms) on calcite and hematite, 7.5 cm, from the Dalmellington mine, Frizington (LG-94). Richard Barstow obtained it by exchange from the British Museum and traded it to Lindsay Greenbank circa 1980. Joe Budd photo.

(*Left*) Barite crystal, 6 cm, from the Parkside mine, Frizington (LG-46). This beautifully gemmy, prismatic crystal was traded to Anthony Walshaw of Witherslack by curator John Fuller of the British Museum in the 1970s. The Walshaw collection was purchased jointly by Ralph Sutcliffe and Lindsay Greenbank in 1989. Joe Budd photo.

Barite crystal cluster, 10 cm, from the Parkside mine, Frizington, Cumbria (LG-54). The largest crystal measures 1.5 × 9.5 cm and is doubly terminated. The mineralogist Dr. Charles Otto Trechmann (1851–1917), a collector of minerals and insects, bought this specimen from John Graves of Frizington in 1904 for 2 shillings. Graves' original label, a simple affair scribbled on lined paper, still accompanies the specimen. Trechmann's collection was bequeathed in 1926 to the British Museum, where this specimen was registered as BM1926.802. Ralph Sutcliffe obtained it in part-exchange for a Wheal Jane ludlamite (see also LG-34); Sutcliffe's collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.



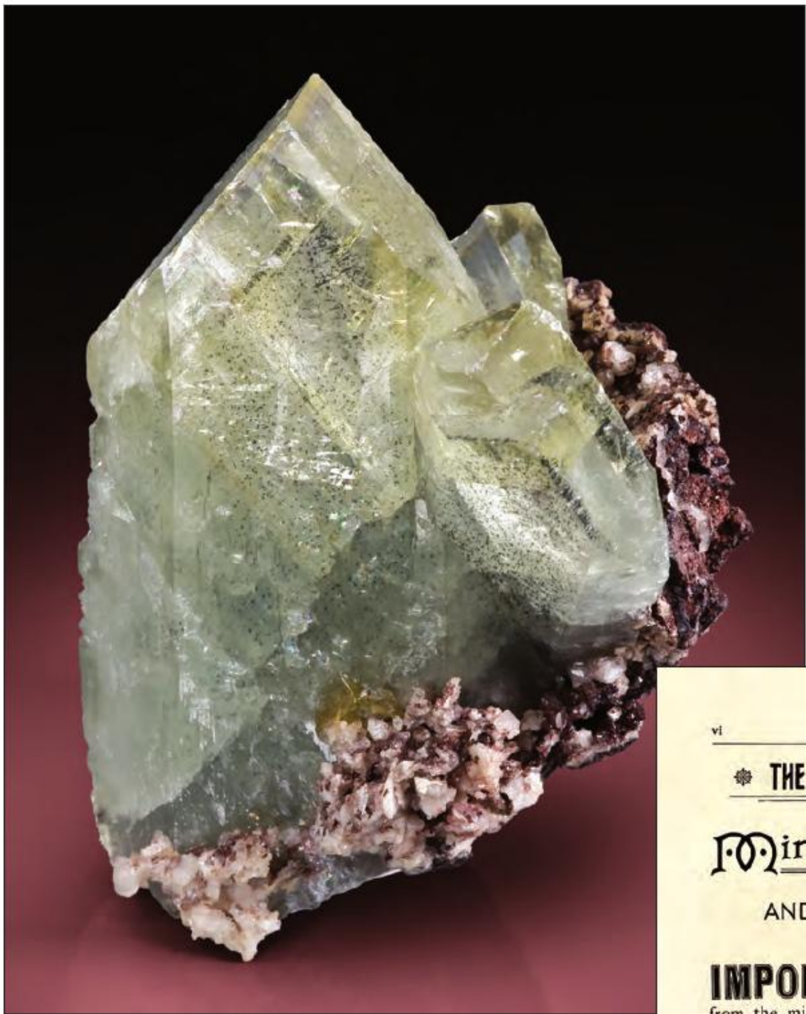
Barite crystal drawings, Dalmellington mine, Frizington (from Sweet, 1930).

Barite crystal cluster, 7 cm, from the Parkside mine near Frizington (LG-90). Sold by Philadelphia mineral dealer Dr. A. E. Foote (1845–1895) and later acquired by P. Jonas in 1946, who sold it to E. Mitchell Gunnell in 1947 for $7.50. Lindsay Greenbank purchased it from Cornwall mineral dealer Nick Carruth in 1988. Joe Budd photo.

and large, brownish crystals of barite on dolomite matrix dusted over with red hematite. Good specimens of kidney ore could still be collected on the dumps as recently as the 1980s.

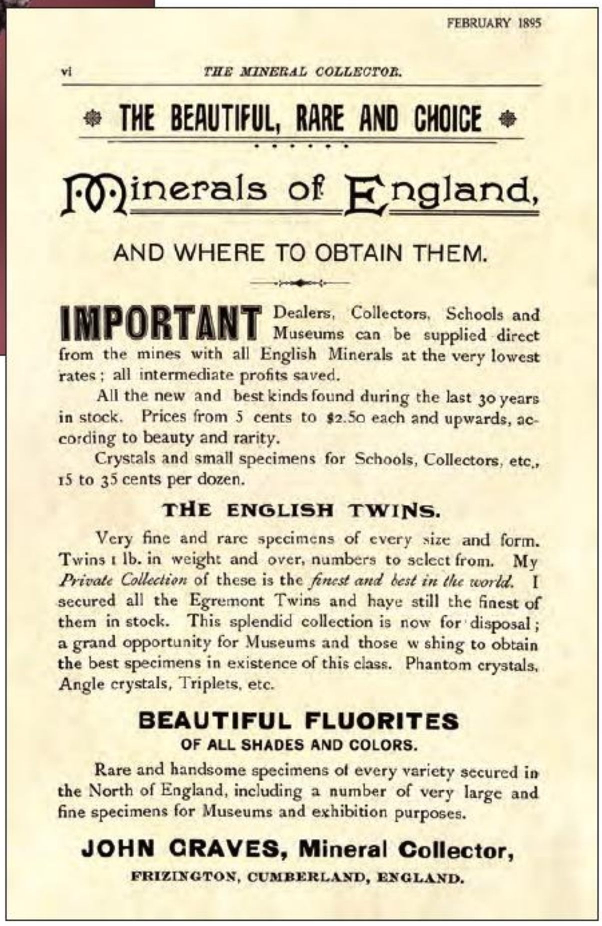
A large subsidence pond near the Goose Green mine marks the location of some of the Parkside mine workings (which are actually closer to Cleator Moor than Frizington). The Parkside mine was opened in the 1880s by the Parkside Mining Company. It produced extremely fine, large barite crystals and clusters in shades of pale blue, pale green and honey-yellow, especially from a shaft known as the Dalmellington mine (part of the Parkside mine complex). The crystals tend to be rather elongated in comparison to the more tabular crystals from the Mowbray mine. According to Briscoe (2009), the so-called "Dalmellington mine" cited on old specimen labels cannot be positively identified today, and there are no production records for a mine of that name. However, the Dalmellington Iron Company opened the Holbeck mine in 1869 and operated it until 1900 when it closed. They mined ore from the Dalmellington fault. One of their shafts (No. 7) was turned over in 1900 to the Parkside Company, which operated the nearby Parkside mine, so it is probable that this is the area referred to by the old labels. The Greenbank collection contains several unusually fine barites from these mines.

The Parkside mine was one of the pioneer iron mines in the Frizington district, but by 1909 it had been nearly depleted. The original orebody took the form of a huge near-vertical wedge. Near-horizontal pillars 10 meters square were left in place for support as the ore was mined away. As the ore deposit neared exhaustion



Barite, 6 cm, from the Dalmellington mine, Frizington, Cumbria (LG-100). The specimen was in the collection of William Weigand in Berlin around the turn of the last century. Joe Budd photo.

An ad published in *The Mineral Collector* (January 1895) by Frizington mineral dealer John Graves (1842–1928) offering Egremont calcite twins and fluorite. Graves was also an important source for Frizington barite specimens.



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vi THE MINERAL COLLECTOR.

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these pillars were finally removed (a process called "robbing the pillars"), and significant surface subsidence resulted from the underground collapse, driving the shafts out of alignment and damaging the surface facilities. Areas mined thereafter consisted mostly of narrow, steeply inclined side-veins.

Pallaflat Mines

The Pallaflat mines (including the Southam pit and the Syke House pit) are famous for superb specimens of calcite in a variety of habits and combinations of rhombohedrons and scalenohedrons. The so-called "butterfly twins" are particularly well known. The white calcite crystals often carry a partial dusting of red hematite. Mining at Pallaflat ended in 1914. However, in 1980 excavations by collectors working over a dump from the Southam pit yielded

Calcite, 7 cm, from the Pallaflat mine, Egremont, Cumbria (LG-558). Nicknamed "the fan" by Lindsay, this was one of his favorite specimens. It was owned circa 1900–1920 by a collector named Sibson, whose bequest placed it in the Darlington Library until Lindsay Greenbank obtained it by exchange in the 1980s. Joe Budd photo.

Calcite, 6 cm, from the Pallaflat mine, Egremont, Cumbria (LG-172); obtained through an exchange with the British Museum by Anthony Walshaw in the 1970s, and acquired by Lindsay Greenbank in 1989. Joe Budd photo.

many fine specimens of typical Pallaflat mine calcite in sharp, lustrous, colorless scalenohedral and butterfly-twinned crystals, some with faint red (hematite) staining. They were collected from cavities in boulders; most of the crystals were damaged when found, but a few, protected by hydrothermal mud, were recovered in pristine condition.

Superb cabinet-size clusters of pale blue or yellow platy barite crystals, some of them tinted red by hematite inclusions, were also produced by the Pallaflat mine in the early 1900s.

Ullcoats Mine

The Ullcoats mine, south of Egremont, opened in 1900 and continued in operation until 1968. During the 1970s the mine produced good specimens of hematite and some fine fluorite specimens of different styles. In one style, blue, translucent to transparent cubic fluorite crystals to 5 cm on edge perch on cream-white dolomite matrix; in another, colorless fluorite crystals, some stained red by

Fluorite, 4 cm, from the "Lonely Hearts orebody" in the Ullcoats mine (LG-657). Some of the gemmy, turquoise-blue crystals show hematite staining along the edges, and have associated dolomite crystals on hematite matrix. This specimen was collected in the early 2000s, and is one of the last pieces added to the Greenbank collection. Joe Budd photo.

hematite, are associated with white barite; in still other Ullcoats specimens the fluorite crystals are yellow, purple or green.

In the early 1990s the Ullcoats No. 1 pit produced superb hematite "iron rose" specimens, with individual roses to 2 cm across perched on crystalline quartz. And vividly sparkling snow-white spheres to 3 mm of calcite microcrystals were found densely scattered on sparkling black drusy hematite coating seams in massive red-brown hematite ore.

Fluorite on hematite, 7 cm, from the Ullcoats mine, Egremont (LG-203). Jeff Scovil photo.

Fluorite with quartz, 4.5 cm, collected in 1976 in the Ullcoats mine near Egremont (LG-103). Joe Budd photo.

About Raymond Clements . . .

by Ralph Sutcliffe

Many mineral specimens on the market today owe their existence to observant mine geologists and mine surveyors who are often the first to see mineralized pockets after a blast, and who have the best opportunity to save specimens from the crusher and the smelter. Sometimes even a single person's actions can preserve important mineral heritage. So it was with Raymond Clements, who became Chief Surveyor for the mines operated in western Cumbria by British Steel during their final decade, and who through his quiet self-collecting saved much of the district's mineral heritage that would otherwise have been lost. I had known about his fine mineral collection for some time, and it was with great excitement that Lindsay Greenbank and I finally had the chance to acquire it. Lindsay integrated some of the choicest pieces into his own collection just before he sold a large part of his collection in 2008.

Raymond Clements began his career with the Millom Iron Ore Company as an apprentice surveyor in the Florence mine; he worked there until it closed in 1968 and was allowed to flood. He then transferred to the nearby Beckermet mine as an assistant surveyor. This mine was operated by the British Steel Company, which took over the royalty payments and rights for the Florence mine and the Ullcoats mine at that time. (Interestingly, if the royalty had been given up, the mine would have reverted back to the ancestral owner of the mineral rights, Lord Leaconfield.) They initiated an ambitious tunneling project to connect the Beckermet mine and the Florence mine lodes underground. It took a year and a half to drive the half-mile tunnel and de-water the Florence mine workings in 1968–1970.

Clements soon became Chief Surveyor for the Florence mine, Ullcoats mine, Beckermet mine and Haile Moor mine. He remained in this position until British Steel finally ceased mining commercial iron ore in 1982. He then traveled overseas for employment in Libya and South Africa, leaving his fine collection in England, untouched and intact. This collection therefore represents a window in time into the final decade of England's famous iron mines, when modern mining was used to work vast stretches of the underground lodes not reachable in past eras. The collection contained several hundred carefully chosen specimens, all recovered by someone with unique access between the mid-1960s and 1982. His finest specimen is the large, 20-cm, iridescent hematite shown here (page 129, top), which is unique in my experience. I visited him at his home recently, where he lamented that: ***"Less than one-half of one percent of the specimens which I could have recovered from the mines, just in the time I was there, were actually saved from the crushers!"***

THE STANK MINE

by Wendell E. Wilson

The Stank mine (named after the local Stank parish) is located south of Dalton-in-Furness and east of Barrow-in-Furness in the South Cumbrian Iron Orefield. It was formerly located in Lancashire but after the county lines were redrawn it ended up in the new County of Cumbria.

The hematite vein at the Stank mine was discovered by accident while drilling for coal around 1780. It operated as a hematite mine from 1871 to 1901, and about 350 people were put out of work when it closed. At its peak it was a very active mine, yielding 2.5 million tons of iron ore in 1885 alone. Nine shafts in all were sunk and the facilities included a Cornish beam engine that had come from Wheal Mary Ann in Cornwall.

Though it was never a producer of specimens on the scale of some of the other iron mines in northern England it did yield many

Calcite, 15 cm, from the Stank mine, Barrow, Furness district, Cumbria (LG-513). The strong red color, caused by hematite inclusions, is characteristic of calcite specimens from the Stank mine. It was acquired in England by American collector and dealer Maynard Bixby (1853–1935), and sold in 1905 to the Field Museum of Natural History in Chicago. In the 1980s it was repatriated when the Field Museum collection was sold. Patricia Greenbank photo.

Calcite with subtle inclusions of dispersed hematite, 7.5 cm, from the Stank mine, Barrow, Furness district, Cumbria (LG-112). It was part of the collection of William W. Jefferis, who had probably acquired it from Bryce M. Wright; the Jefferis collection was purchased in 1904 by the Carnegie Museum of Natural History in Pittsburgh; this specimen was traded by the museum to Ralph Sutcliffe in 1980, whose collection was acquired by Lindsay Greenbank in 1991. Joe Budd photo.

fine specimens over the years. In 1890, for example, the American mineral dealer George L. English (1864–1944) advertised "Stank mine calcites, ever popular and deservedly so, are strongly represented in our stock. The groups which are in part colored red by their hematite gangue are most in demand. Prices 25c. to $2.50 for cabinet sizes; $3.00 to $10.00 for museum specimens." And in 1899 he advertised in the *American Journal of Science*: "Showy English calcites—Groups of yellow phantom crystals from the Stank mine, 25c. to $4. Gorgeous red Stank mine calcites, 25c. to $2." The Natural History Museum in London has Stank mine specimens acquired from a number of 19th-century mineral dealers including Francis H. Butler (in 1885) and A. E. Foote (in 1888).

The mine is a famous "classic" locality for calcite crystal clusters, many of which carry reddish hematite inclusions. Crystals are typically scalenohedral, in radiating clusters. Pseudomorphs of hematite after scalenohedral calcite and cubic fluorite are also known. The Stank mine has also produced small blue tabular crystals of barite with calcite crystals.

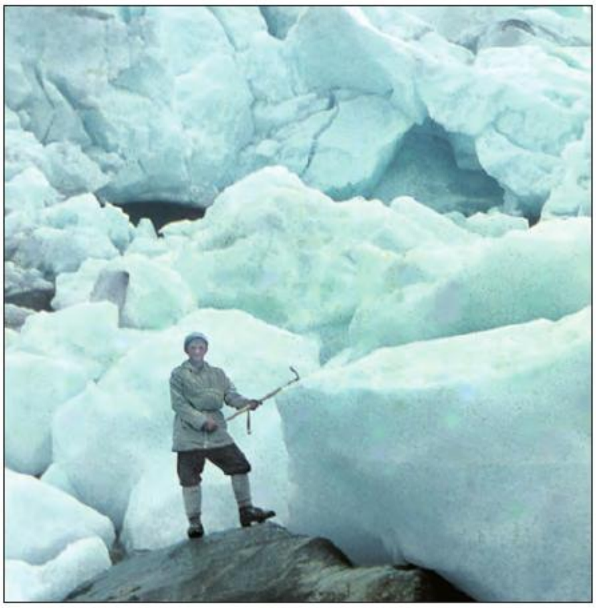
BIOGRAPHICAL NOTES:

LINDSAY GREENBANK

by Michael P. Cooper

Lindsay Greenbank was born July 11, 1941 in Kendal, Cumbria, England, the son of Mary and Nelson Greenbank, a self-employed businessman. He was raised and educated in Kendal and left school at the age of 15 to join his two older brothers in the family businesses of farmland management, metal brokering and tire sales. He was fascinated with the underground as a boy, especially after seeing mineral specimens in a neighbor's garden. In his mid teens, he became a serious caver. On a Cambridge University-affiliated Speleological Expedition to Arctic Norway in 1961 he collected his first specimens (garnets in mica schist) from outcrops on the mountainside. Lindsay fondly recalls that he asked so many questions that the expedition geologist gave him a copy of Rutley's *Mineralogy* to read.

In 1963, in Cigalere cave in the Pyrenees, Lindsay saw for the first time huge gypsum crystals in the caverns and felt the urge to collect mineral specimens (strictly forbidden in caving!). When he returned home from this expedition he gave up caving in favor of mineral collecting.

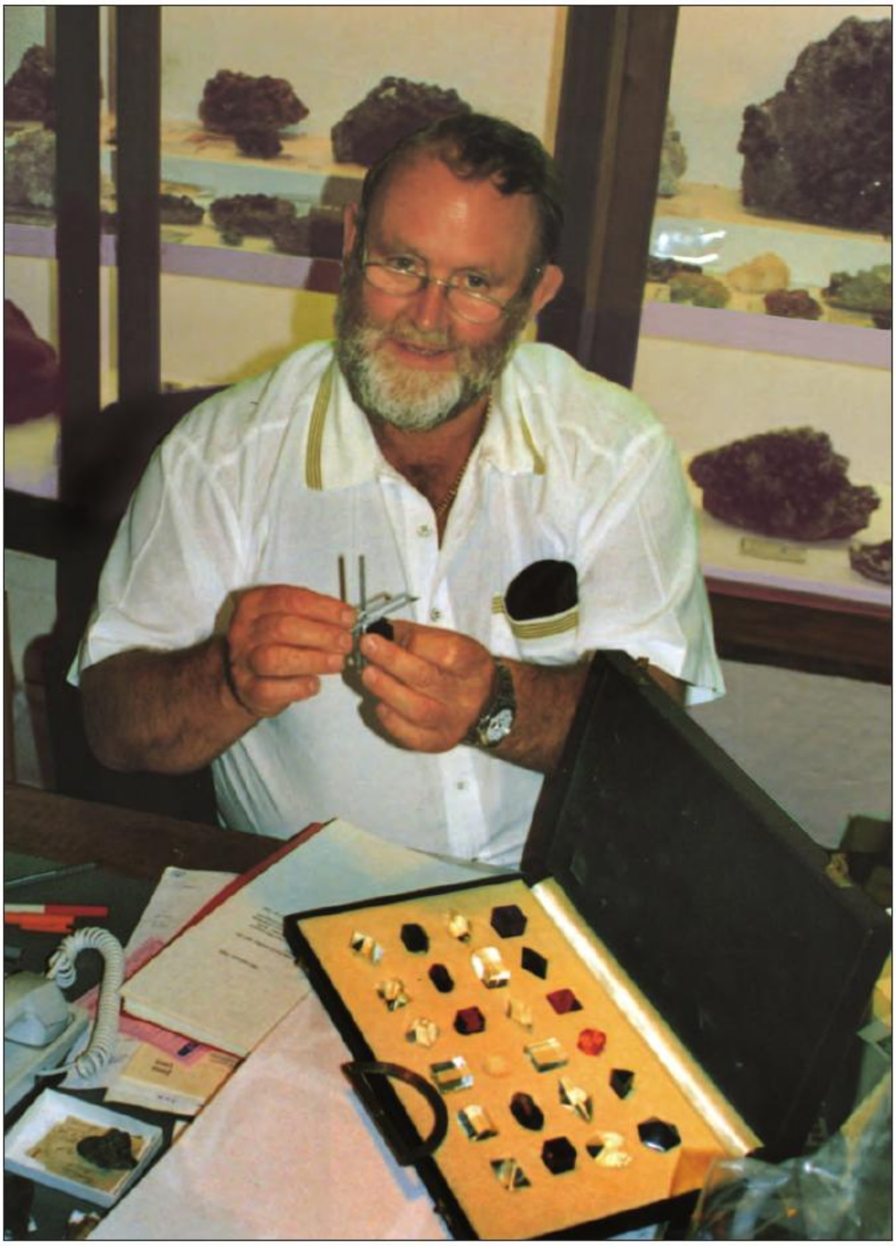


Lindsay in Arctic Norway, 1961.

Lindsay drilling on the Zero level of the Rogerley mine in the early 1980s.

Lindsay's first mineral collecting partner was Tony (Walter) Walshaw, in the early to mid 1960s. Their friend and mentor was William F. (Bill) Davidson (1907–2002) of Penrith, Cumbria. Davidson, an avid collector and dealer, was generous with advice on where to collect and gave them assistance with identifying their finds. It was also in the mid 1960s that Lindsay and Tony met Ralph Sutcliffe at the Brandy Gill mine in Cumbria; they began collecting together occasionally and became lifelong friends.

Around the mid 1960s Lindsay started to build his collection by buying specimens from miners working at the Blackdene mine, the Groverake mine and others in the Weardale district, and also

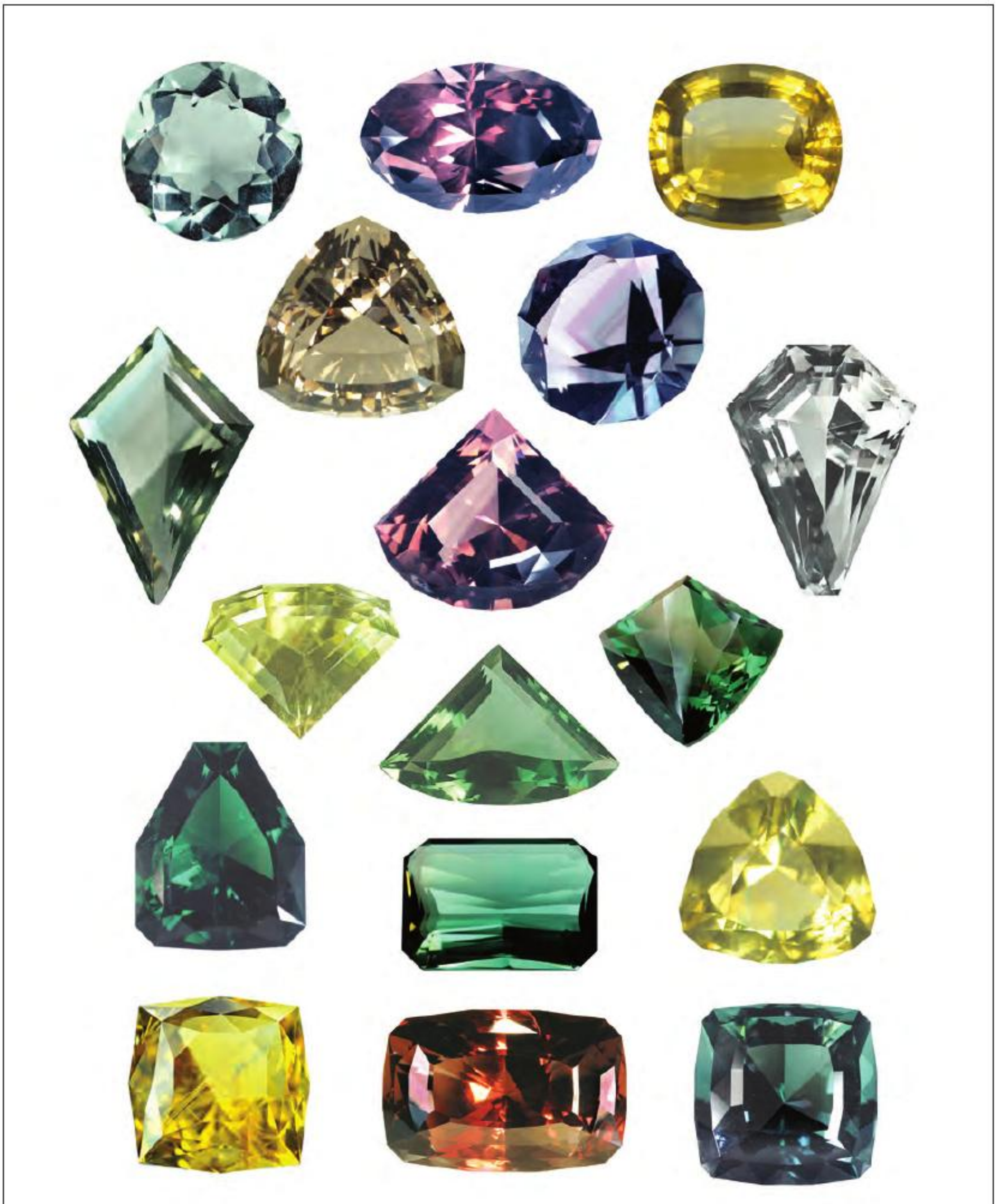


Lindsay in his office at home, with his collection.

from miners at the Settlingstones mine in Northumberland. In 1968 Patricia became Lindsay's collecting partner, and they were married in 1973. With Michael (Mick) and Brenda Sutcliffe they spent much time underground in the Hilton mine and the mines of Alston Moor, including the Nentsberry Haggs, Brownley Hill and Smallcleugh mines. They explored the mines of the Caldbeck Fells, digging out collapsed entrances at the Brandy Gill mine, the Mexico mine, and others. In 1969 Lindsay and Patricia holidayed in Europe, selling specimens in Idar-Oberstein to cover the cost; this marked the start of their mineral dealing business.

In 1970 Lindsay and Mick decided to operate the Dry Gill mine commercially for specimens. With Patricia and Brenda they formed the *Cumbria Mining and Mineral Company*, registering the company in London in 1972. Unfortunately their application to the owners of the mineral rights was refused, and so the new specimen mining company obtained a license to open a previously unworked fluorite vein in the Rogerley quarry in Weardale. The Rogerley mine became the first commercial mine in the country to be exploited exclusively for mineral specimens.

In 1982 Lindsay and Mick with two other partners, Peter Blezard



Faceted fluorite from localities in northern England. From left to right: *Top row:* Blackdene mine, 12.44 ct. (14 mm); Rotherhope Fell mine, 139.65 ct. (36 mm); Pike Laws, 70.1 ct. (37 mm). *Second row:* Boltsburn mine, 31.5 ct. (19 mm); Newlandside mine, 34.95 ct. (18 mm). *Third row:* Frazer's Hush mine, Greencleugh vein, 43.69 ct. (33 mm); Rotherhope Fell mine, 198.85 ct. (42 mm); Heights quarry south vein, 39.35 ct. (25 mm). *Fourth row:* Hilton mine, 20.45 ct. (19 mm); Frazer's Hush mine, Greencleugh vein, 36.55 ct. (31 mm); Frazer's Hush mine, 48.5 ct. (26 mm). *Fifth row:* Rogerley mine, 127.05 ct. (33 mm); Frazer's Hush mine, Greencleugh vein, 47.75 ct. (28 mm); Hilton mine, 40.4 ct. (22 mm). *Bottom row:* Hilton mine, 15.6 ct. (13 mm); Rookhope mine, 346 ct. (45 mm); Heights mine, 65.2 ct. (21 mm).

and Anne Danson, formed the *New Coledale Mining Company, Ltd.* and took on another mining project at the Force Crag mine near Keswick in the Lake District, but the mine closed in 1990. For years Lindsay had sought to relocate the original occurrence of the mineral alstonite, finally succeeding in 1987 at the Brownley Hill mine. In 1988–1990 the mines of Weardale yielded many fine specimens, mostly fluorites from the Frazer's Hush mine and the Cambokeels mine, but also calcites, galenas and rare pyrrhotites. Patricia made many journeys to Weardale buying specimens from all the miners. From the 1970s on, most of the mineral dealing by the Cumbria Mining and Mineral Company has been done from Kendal, but they have also attended the major British mineral shows. Lindsay and Patricia established a second mineral dealership called *Secured Minerals*, and they have regularly attended the shows in Munich, Sainte Marie aux Mines, Turin, Springfield and Tucson.

Lindsay was involved in the purchase and dispersal of the Anthony Walshaw mineral collection in 1989, the collection of Ralph Sutcliffe in 1991, the Leadhills-Wanlockhead collection of Nick Carruth in 1994, and the small Greenbank-Behier Leadhills-Wanlockhead collection. Specimens from the Sutcliffe and Carruth collections are illustrated in *Minerals of Scotland Past and Present* by Dr. Alec Livingstone. The Derbyshire content of Ralph's collection was sold to the Derby Museum.

Secured Minerals became the vehicle for purchasing many classic British specimens abroad for Lindsay's personal collection. When Dick Barstow died in 1982, Ralph Sutcliffe was able to purchase from his widow some of the specimens from his collection, adding them to his own; in 1991 Lindsay acquired Ralph Sutcliffe's collection. By this time the Greenbank collection had come to be recognized as one of the finest private mineral collections in Britain, both for breadth and for quality. Exhibits from the collection have since been shown at the Springfield Show, the Tucson Show and twice at the Munich Show. Greenbank specimens have been illustrated in numerous publications, including Mick Cooper's 1996 book about Lindsay's collection, *Classic Minerals of Northern England* (printed in Kendal in a limited edition of 50 copies for friends and family), as well as *The UK Journal of Mines and Minerals, Matrix, Lapis, Rocks & Minerals*, and the book *Minerals of the English Lake District—Caldbeck Fells.*

Lindsay suffered an overwhelming illness in 1996 (from which he has largely recovered since) which put a stop to business and forced the suspension of mining operations at the Rogerley mine. The decision was made to sell off the mine and also the mineral collection. Although Lindsay had hoped that a British institution could acquire his collection in its entirety, including the considerable associated documentation (mine plans and sections, letters and other documents and ephemera), efforts to that end were unsuccessful. So it was decided to break up the collection for sale. A small sub-collection of fluorites passed to the Royal Museum in Scotland, and since then other small sub-collections and individual pieces have also been sold to various buyers.

NOTE ADDED: The core of the Greenbank collection was still intact in 2008 when American dealer Rob Lavinsky visited Kendal and purchased about half of the remaining collection, including some of the most important specimens shown in this book. Despite this sale, Lindsay and Patricia still retain specimens in Kendal, including many historic specimens and an exhaustive locality suite of fluorites from the various mines. Lindsay's other collections include a trove of vintage corkscrews, a comprehensive and beautiful suite of faceted fluorites from the north of England (probably the most expansive collection of English gems assembled to date), scientific instruments, and earth science-related items.

WEW

Current Owners

OF SPECIMENS FORMERLY IN THE GREENBANK COLLECTION

Cal and Kerith Graeber—page 84, 83 (bottom), 137 (top)
Lindsay Greenbank—page 48
Al and Sue Liebetrau—page 98, 74 (lower left), 118
Wallace Mann—page 49
William Larson—page 114
Jesse Fisher and Joan Kurescka—page 72, 76, 92, 90, 109
Ralph Sutcliffe—page 44, 112, 127
Jeff Starr—page 105 (bottom)

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THE LINDSAY GREENBANK COLLECTION

CLASSIC MINERALS OF NORTHERN ENGLAND