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NOTES ON SOME ABANDONED COPPER, LEAD, AND ZINC MINES IN THE PIEDMONT OF VIRGINIA

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INTRODUCTION

The Piedmont province of Virginia is bordered on the east by unconsolidated and semiconsolidated sediments of the Coastal Plain and on the west by mainly igneous and metamorphic rocks of the Blue Ridge province. Igneous and metamorphic rocks of Precambrian and Paleozoic age constitute the major part of the Piedmont, but in places there are elongated basins containing large areas of Triassic sedimentary and minor igneous rocks. In this province mineral wealth has been sought since the earliest colonial settlements. Copper, lead, and zinc minerals were probably some of the earliest ores prospected; mining of these metallic minerals has been done intermittently from pre-Revolutionary War days until 1945.

There are four main types of copper, lead, or zinc occurrences in the Piedmont province of Virginia.

- (1) The mineralized district in Prince William, Spotsylvania, Louisa, and Buckingham counties includes base- and precious metal deposits in metasedimentary and metavolcanic rocks that are of early Paleozoic (and possibly late Precambrian) age.
- (2) The Virgilina district is a mineralized area in the southern part of the State where copper minerals occur in quartz veins in the Virgilina greenstone of late Precambrian(?) and early Paleozoic age.
- (3) Disseminations of copper minerals occur in marble of the early Paleozoic(?) Mount Athos Formation.
- (4) Copper minerals are found in Triassic sedimentary rocks, usually along fractures, faults, or bedding planes, and are most common in the northern part of Virginia.

Also, several small copper, lead, or zinc prospects in Fairfax, Spotsylvania, and Franklin counties were

noted by Luttrell (1966, p. 57, 67, 73, 92, 108, and 128) but they are not discussed in this paper.

PRINCE WILLIAM, SPOTSYLVANIA, LOUISA, AND BUCKINGHAM COUNTIES

In the Piedmont province a series of metasedimentary and metavolcanic rocks form a continuous belt that has been traced southwestward from Maryland for more than 40 miles into north-central Virginia. These rocks, mapped as the upper part of the Glenarm Series in northern Virginia by Higgins (1972, Fig. 1), may be in part correlative (Higgins, 1972, p. 1009, Fig. 21) with the Evington Group(?) and Arvonja Formation of Buckingham County (Brown, 1969). Base-metal and gold deposits in this belt were mined intermittently from the 1700's to 1945. The base-metal deposits are

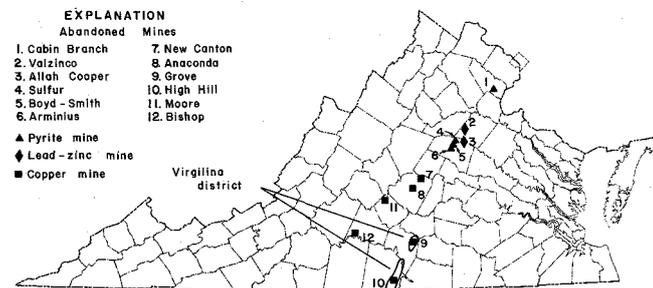


Figure 1. Locations of abandoned lead, zinc, copper, and pyrite mines in the Piedmont of Virginia.

massive sulfides in which the most common mineral is pyrite (iron sulfide), with lesser amounts of chalcopyrite (copper-iron sulfide), sphalerite (zinc sulfide), and galena (lead sulfide). Several abandoned gold mines in this district were described by Sweet (1971, p. 25-33).

Cabin Branch mine is located in northern Virginia in Prince William County (Figure 1). The history, geology, and description of the mine were discussed by Lonsdale (1927, p. 86-87) and Poole (1973, p. 30). This mine was essentially operated for pyrite but chalcopyrite was common enough to be handpicked to make a matte; copper was also plated on scrap iron from mine water. Chalcopyrite and sphalerite are common in medium-grained, subhedral to anhedral forms in dump rock. The mineral textures and lenticular shape of the orebody appear to be very similar to the sulfide deposits in Louisa County to the southwest. The mine is in mafic- and felsic-derived metasedimentary rocks near the contact of andesitic extrusives, all of which occur in the early Paleozoic Chopawamsic Formation of the Glenarm Series (Mixon, Southwick, and Reed, 1972). The Chopawamsic is a sequence, 6,000 to 10,000 feet thick, of andesitic and felsic intrusives with associated volcanoclastics (Southwick, Reed, and Mixon, 1971, p. D1-D2).

Valzinco mine, also known as the Halladay or Holloday mine (Luttrell, 1966, p. 134), is located in Spotsylvania County approximately 1.25 miles south of Porters. The first known activity at the mine was from 1909 to 1912 by the Bertha Mineral Company, during which some surface work was done, a 150-foot shaft constructed, and at least one hole drilled. The property was later acquired by the Virginia Lead and Zinc Corporation and work at the mine began in 1914 with dewatering of the shaft. Production was continuous from about 1914 to 1918; the ore was milled at the Allah Cooper mine approximately 8 miles to the southwest. The estimated total production by the time the Valzinco mine closed in 1918 was 5,000 tons of ore assaying 12.5 percent zinc and 5 percent lead (Grosh, 1949a, p. 3). The Valzinco mine remained closed from 1918 until it was reopened for development work in 1926 by the Virginia Lead and Zinc Corporation. Ventures Ltd. of Canada purchased the property in 1929 but no further development was done until Panaminas Inc. bought the property in 1942. A 100-tpd (tons per day) flotation plant was built on the property and the 350-foot level was dewatered in 1942. In 1943 the U. S. Bureau of Mines drilled nine holes totalling 4,213 feet and Panaminas Inc. drilled five holes totalling 1,642 feet. The purpose of this exploration was to locate extensions of the Holloday vein, but during drilling a second mineralized zone, referred to as the Discovery vein, was found (Grosh,

1949a, p. 4). Underground development along the Discovery vein established more reserves and extended the life of the mine. Production ceased in 1945 with the apparent exhausting of mineable reserves. In 1955 The New Jersey Zinc Company subsequently leased the property and the surrounding abandoned gold mines to conduct geochemical and geophysical exploration surveys. Presently, the concrete mill foundation and a small concrete silo are at the mine site. Most of the dump has been removed for road metal for nearby logging roads and for fill material.

The mine was worked from one, single-compartment, 250-foot-vertical shaft with a 120-foot winze on the 250-foot level connecting with the 350-foot level. There were five working levels, at 100, 150, 200, 250, and 350 feet below the shaft collar, with more than 5,000 feet of underground workings (Grosh, 1949a, p. 3). A second shaft, Shaft No. 2 (Cline, Watson, and Wright, 1921), is approximately 1,200 feet northeast of the main shaft but is only 100 feet deep with two drifts, neither of which connect with the main mine. The mining method used at first was shrinkage stoping but because of the bad ground it was abandoned in favor of stull stoping (Grosh, 1949a, p. 3).

Mineralization at the Valzinco mine occurs in two lens-shaped massive sulfide bodies, the Holloday and Discovery veins. The Holloday vein is larger and is 340 feet west of the Discovery. The Holloday vein has a strike of N.40°E. and a dip of 60 to 70°SE., whereas the foliation of the country rock has a strike N.25°E. and a dip of 60 to 70°SE. The vein was mined to a depth of 370 feet and for 600 feet along strike, and ranged in thickness from 2 to 10 feet but was commonly 4 feet. The Discovery vein has a strike and dip parallel to the Holloday vein. The Discovery was mined from the 250-foot level to within 50 feet of the surface and for 310 feet along strike (Brown, 1953, p. 102). Sphalerite, galena, and minor chalcopyrite are the principal ore minerals in the two veins. Banded and nebulitic ore textures are common in dump samples with massive sphalerite containing pyrite and quartz spheres. Gangue minerals are pyrite, quartz, chlorite, pyrrhotite, and magnetite. Pyrite and magnetite also occur in the footwall adjacent to the ore in veins from a few inches to 6 feet in thickness (Brown, 1953, p. 102). The country rock was mapped by Neuschel (1970, Fig. 4) as quartz-sericite schist. The wallrock has been silicified, pyritized, and chloritized in both the hanging wall and footwall (Brown, 1953, p. 102). The metamorphic grade appears to be upper greenschist or lower amphibolite although no definite determination has been made.

Allah Cooper mine, also known as the Valcooper mine (Luttrell, 1966, p. 7), is in Louisa County about 5.5 miles northeast of Mineral. The mine was first

opened for gold and silver. Boyd-Smith Mines, Incorporated obtained the property in 1915 and started lead and zinc mining. An inclined shaft was sunk in the ore and a 50-tpd gravity-concentration mill was erected on the property in 1915. Virginia Lead and Zinc Corporation acquired the property in 1916 and closed the Allah Cooper mine but kept the adjacent mill running until 1918 by shipping ore from the nearby Valzinco mine. Ventures Ltd. secured the Allah Cooper mine site in 1929 and sold it to Panaminas Inc. in 1942. A 650-foot hole was diamond drilled in 1943 by the U. S. Bureau of Mines to test the ore zone downdip from the lowest mine level. No mineralization was found where the hole was expected to intersect the projected ore zone and no further drilling was done (Grosh, 1949b, p. 1-3). The old shaft (now water-filled) and the concrete foundation for the mill can be seen. The dump is small and much of the waste material is probably from the Valzinco mine because of the milling arrangement from 1916 to 1918. Sphalerite and pyrite can be found on the dump at the Allah Cooper mine, which is identical texturally to material found at the Valzinco mine. Rock exposures at and near the mine site are virtually nonexistent.

The Allah Cooper mine was operated from one inclined shaft 350 feet deep with six working levels at 50-foot intervals and 1,200 feet of underground workings (Grosh, 1949b, p. 3). Little else is known about the mine or the mining system but the method was probably similar to the Valzinco mine, or to that described for other mines in Louisa County (Watson, 1907, p. 204).

The ore is said to have occurred in a "vein" (Grosh, 1949b, p. 3) that has a northeast strike and a southeast dip and cuts across the schistosity of the country rock. The ore minerals were galena, sphalerite, and some chalcopryrite. Gangue minerals were quartz, tourmaline, pyrite, and magnetite (Grosh, 1949b, p. 3). The country rock is mapped as quartz-sericite schist by Neuschel (1970, Figure 4).

Sulfur, Boyd-Smith, and Arminius mines are located in northern Louisa County southwest of the Allah Cooper mine. The history, description, and geology of the mines are discussed in Watson (1907, p. 199-202), Katz (1961), Kinkel (1967, p. 36-39), and Poole (1973, p. 30-32). Although the mines were operated predominantly for pyrite, both sphalerite and chalcopryrite were common constituents of some of the ores. Plating of copper on scrap iron was done at the Sulfur mine and some copper mining was done at the Boyd-Smith and Arminius mines in the later 1800's. The sphalerite and chalcopryrite at these mines are similar in that they form fine- to medium-grained,

subhedral to euhedral crystals. The ore bodies are generally lens-shaped and usually parallel the local schistosity. The mines appear to be located along the contact between quartz-sericite schist and chlorite-actinolite schist with intercalated metabasalts (Neuschel, 1970, Figures 2 and 4).

Anaconda mine, also known as the Eldredge Mill mine (Luttrell, 1966, p. 8), is located in Buckingham County approximately 4.5 miles north of Dillwyn. In 1903 the mine was operated by the Q. Q. Copper Company, which sank a 60-foot shaft. The United States Mineral Company operated the mine from 1905 to 1910; the shaft was deepened 15 feet and a short drift was driven northeastward. During this time 3,300 tons of ore assaying 10.75 percent copper was shipped to Norfolk for smelting (Taber, 1913, p. 243-244). The mine closed soon after this and little work has been done there since that time. A corrugated aluminum building and a water-filled shaft may be seen at the mine site adjacent to State Road 607. Much of the dump material has been removed for use as road metal.

The mine is located on the southeast flank of the Hardware anticline in greenstones of the Evington Group(?) (Brown, 1969, Plate 1). The mineralization occurs in sheared, epidotized greenstone and associated quartz veins. Anhedra chalcopryrite, bornite, and pyrite are the common sulfide minerals. The greenstone in which the deposit occurs is a fine-grained, dark-green schistose rock with abundant epidote, quartz, and chlorite. Brown (1969, p. 9) describes the rock as an altered mafic volcanic that has been metamorphosed to the greenschist facies. The deposit and host rock at this mine are very similar to that at the abandoned Lightfoot copper mine, which is located 7.6 miles to the northeast along strike (Brown, 1969, Plate 1).

New Canton mines include the Hudgins, Johnson, Margaret, and McKenna mines, which are in Buckingham County from 0.5 to 1.5 miles southwest of New Canton. The mines are all located along the same mineralized zone, and the country rock and sulfide mineralization are similar.

The New Canton mines were first opened during the Revolutionary War as gossan iron-ore mines. The first iron furnace was constructed in the area in the 1830's, and the gossan was smelted at this furnace until 1840 (Taber, 1913, p. 246-247). The Johnson mine, earlier known as the Staples mine (Luttrell, 1966, p. 73), was the first copper mine in the area. It was opened in the 1880's by a 78-foot shaft, and 780 tons of ore assaying 8 percent copper were shipped for smelting at this time. The mine was operated again from 1891 to 1894. The Johnson Mining Com-

pany purchased the property in 1903 and deepened the shaft to 278 feet, drove an adit to meet the shaft, and added 1,000 feet of underground workings in three levels (Taber, 1913, p. 247). The McKenna mine is approximately 500 feet northeast of the Johnson mine and was first prospected for copper in 1895. In 1906 the Virginia Copper Company Ltd. sank a 53-foot shaft and drove two drifts but the mine was closed in 1907. The Margaret mine, also known as the Terrell mine (Luttrell, 1966, p. 90), is located 300 feet northeast of the McKenna. It was first opened in 1910 with the sinking of an 86-foot shaft (Taber, 1913, p. 247-248), but little was done after that time. The Hudgins mine was not found by the writer, but a history and a description are in Taber (1913, p. 248 and 256-257). The New Canton mines were diamond drilled in 1956 by R. F. Beers Inc. under a contract with the Defense Minerals Exploration Administration but the results are unknown (Espenshade and Potter, 1960, p. 54). The shaft and adit at the Johnson mine, two shafts at the McKenna mine, and one water-filled shaft at the Margaret mine can be seen. The dumps at all of the mines are small and partially hidden because of the heavy undergrowth.

The New Canton deposit is described by Kinkel (1967, p. 39) as containing "massive sulfide with minor quartz and sericite as well as disseminated sulfides." The ore zone is 1,100 feet long and 20 feet thick and contains pyrite, pyrrhotite, sphalerite, chalcopryrite, some galena, and minor gold and silver. Some of the pyrite and less commonly chalcopryrite exhibit a porphyroblastic texture. Usually the sulfides occur as medium-grained, euhedral to subhedral masses that show banding in places. The mineralization is on the southeast flank of the Arvonina syncline. The country rocks in the vicinity of the mines are metavolcanics and metasediments probably of the Evington Group(?) but some may possibly belong to the Arvonina Formation (Brown, 1969, p. 64).

VIRGILINA DISTRICT

The Virgilina district is located in the eastern parts of Charlotte and Halifax counties in southern Virginia and in adjacent North Carolina (Figure 1). The district produced copper ore from the mid-1800's until about World War I. The abandoned copper mines and many prospects in the two Virginia counties are in the Virgilina greenstone of Laney (1917, p. 27). The Virgilina greenstone is a series of metamorphosed andesitic tuffs and porphyritic or amygdaloidal flows (Laney, 1917, p. 24) in the central portion of the Virgilina synclinorium, which is a northern extension of the Carolina slate belt. The Virgilina greenstone is strati-

graphically underlain by the Aaron slate, part of which is probably volcanoclastic in origin. The Aaron slate is underlain by porphyritic rhyolite and rhyolitic tuff known as the Hyco quartz porphyry. Zircon from the upper portion of the Hyco was dated radiometrically at 620 million years. A granodiorite near Roxboro, North Carolina, that intruded the Hyco quartz porphyry, Aaron slate, and Virgilina greenstone has yielded age dates of 544-573 million years (Glover and others, 1971, p. 313). Metamorphic grade of the rocks in the Virgilina synclinorium increases to the west. The Virgilina and the Aaron have been metamorphosed to lower greenschist facies; the Hyco increases in metamorphic grade from lower greenschist to lower amphibolite grade to the west (Tobisch and Glover, 1969, Figure 2).

The mineralization in the district occurs as chalcocite, bornite, and minor chalcopryrite in quartz veins that generally cut across the schistosity of the greenstone. Minor sulfides and native copper have been noted in sheared or epidotized portions of the greenstone but most of the mineralization occurs in well-defined quartz veins that usually have a strike of N. 10-30°E. and less commonly N. 10-45°W. The veins are composed almost entirely of quartz but chlorite and orthoclase are common in some areas. The quartz veins range in thickness from paper thin to about 15 feet but most mined veins averaged 3 feet, and boudinage structures are common in places (Laney, 1917, p. 63-67).

Only four mines, the Grove, High Hill, Seaboard, and Anaconda mines, had any know production in the Virginia portion of the Virgilina district. Because of the similarity of these four, only the Grove and High Hill mines are discussed.

Grove mine is located in Charlotte County approximately 1.75 miles southwest of Keyesville and approximately 28 miles northeast of the mining area in Halifax County. It has been the only producing mine in the northern section of the district and was worked from two inclined shafts and a vertical shaft. The mine was developed on one vein that ranges in width from 4.5 to 5.5 feet that has a strike of N. 35°E. and a dip of 75°SE. The main ore minerals were chalcocite, bornite, and minor chalcopryrite. The copper minerals occur in typical Virgilina-type quartz veins similar to those described above. The mined ore was handpicked and hauled by wagon to a railroad where it was shipped to Norfolk for smelting. The production for 1916-1917 was estimated to be about 2,500 tons of ore (Laney, 1917, p. 147). The mine closed soon after this and little work has been done since. The area where the Grove mine is located has recently been clear-cut for timber and the dump and shafts have

been graded over, leaving virtually no evidence of the mine site.

High Hill mine is located in Halifax County approximately 7.8 miles north of Virgilina. The mine was first opened in 1899 with the sinking of eight shafts and the digging of numerous prospect pits. About 1900 the mine was purchased by the Virginia Copper Company Ltd. Two more attempts to mine and concentrate the ore were made in 1901 and 1907 but both were failures because of the inability to treat the ores. The estimated production to 1905 was 10,014 tons of ore averaging 3 percent copper (Laney, 1917, p. 125-129). The U. S. Bureau of Mines worked on the High Hill property from September 1942 to August 1943, trenching across the veins, rehabilitating several shafts to collect samples, and drilling 11 holes totaling 2,281 feet. Little has been done at the mine since that time. Several caved shafts and the concrete foundations for a mill can be seen. Part of the dump material has been crushed and used on local roads.

The ore minerals are chalcocite, bornite, and minor chalcopyrite that occur in a quartz vein similar to the other mineralized quartz veins of the Virgilina district. The vein ranges in thickness from 2 to 15 feet and has a strike of N.6°W., cutting the strike of the schistosity by 20 to 30°.

PROSPECTS IN THE MOUNT ATHOS FORMATION

Moore Property, also known as the Wreck Island Creek mine (Luttrell, 1966, p. 96), is located in Appomattox County on Wreck Island Creek approximately 1 mile east of Beckham. The copper mine was said to have been operated before the Revolutionary War, ore being shipped down Wreck Island Creek to a nearby smelter. The operation consisted of several pits and a 40-foot tunnel (Furcron, 1935, p. 110).

The mineralization occurs as disseminations of pyrite and copper sulfides in quartz lenses or stringers in marble and schist. The country rock in which the mine is located has been mapped as the marble member of the Mount Athos Formation of the Evington Group (Espenshade, 1954, Plate 1). The opening of the tunnel, however, appears to be in a dark-green quartz-garnet-chlorite schist. No copper mineralization was seen by the writer, although pyrite was relatively common as disseminations in the country rock.

Bishop mine is located in Campbell County approximately 1.05 miles west of Lynch Station. Although this property was primarily a manganese prospect, some attempt at copper mining may have taken place in 1885. In 1909 and 1910 the Rivers

Mining and Manufacturing Corp. prospected this property for copper but apparently with little success (Luttrell, 1966, p. 21). The mine is now noted as a collecting locality for turquoise crystals (Sweet, 1974, p. 6).

The mineralization occurs as pyrite and chalcopyrite disseminations in white marble of the Mount Athos Formation. Some malachite and pyrite have been noted by the writer on the dump of the old copper prospect.

TRIASSIC OCCURRENCES

Chalcopyrite, pyrite, and associated secondary minerals are common in conglomerate, sandstone, and shale of Triassic age in northern Virginia (Roberts, 1928, p. 134). Most are in Loudoun, Prince William, Fauquier, Culpeper, and Orange counties. The mineralization usually occurs in fractures or bedding planes. Although prospecting and some mining have been attempted at several of the localities, there has been no significant commercial development.

CONCLUSIONS

Although mining in the mineralized district in Prince William, Spotsylvania, Louisa, and Buckingham counties ceased in 1945 with the closing of the Valzinco mine, this area has been explored intermittently since that time. The most extensive exploration programs were done in the mid-1950's. The New Jersey Zinc Company explored several tracts in Louisa and Spotsylvania counties and diamond-drilled the Arminius mine. The London and Virginia gold mine (Sweet, 1971, p. 29) in Buckingham County was diamond drilled by Belleville Gold Mines Ltd. in 1953, and R. F. Beers, Inc. under a Defense Minerals Exploration Administration contract drilled the Johnson mine in the same county in 1956. The results of these exploration programs have not been released as public record. Since the 1950's, exploration in this district has been intermittent and generally on a small scale. However, the development of better geophysical and geochemical techniques, plus the growth of geologic knowledge about this district in the last 10 to 15 years, make exploration programs in this area more attractive.

Since the U. S. Bureau of Mines work in the Virgilina district in the 1940's, little exploration has been done. These deposits with their limited vein system do not provide sufficiently large and connected tonnages for modern mining. The other base-metal deposits in the Mount Athos Formation and in the Triassic rocks have been too small and too isolated to interest any large exploration effort.

wide extent. Between Mattaponi and Nanjemoy time, the regional tectonic framework changed to produce an areally restricted basin with its deepest portion to the north. From Nanjemoy, through Calvert, to Yorktown time the tectonic framework changed to produce a gradually expanded basin whose deepest portion shifted progressively southward. Effects of basement evolution on sediment distribution during the Tertiary are subtle but nevertheless correlate satisfactorily with the distribution of formations and their characteristics as presently mapped.

Part 3—PLEISTOCENE-HOLOCENE ENVIRONMENTAL GEOLOGY, by Emil Onuschak, Jr., p. 103-153, 5 pls., 8 figs., 1 table.

Detailed geologic mapping on the Coastal Plain of Virginia shows it is possible to subdivide and map the Pleistocene-Holocene sediments on the basis of sedimentary parameters that reflect the processes which were active during deposition. Units defined in this way can be grouped into *depositional systems* that consist of large-scale, naturally occurring assemblages of genetically related facies. Each depositional system has a number of characteristic criteria by which it can be recognized on modern topographic maps and aerial photographs.

Maps of such systems portray the physical geology of an area, selectively identify additional areas requiring detailed mapping, and can be used to derive a wide variety of environmental geologic maps that are valuable to persons concerned with land-use applications.

Price of Bulletin 83 complete: \$4.00 (plus 4 percent State sales tax).

Information Circular 20. GEOGRAPHIC AND PLACE NAMES IN VIRGINIA, by Thomas H. Biggs; 374 p. Price: \$2.75 (plus 4 percent State sales tax).

Geographic and cultural names that are on the 805 modern, 7.5-minute topographic quadrangle maps which completely depict Virginia are indexed under four categories—place names, water features, landforms, and religious institutions. The 30,000-name index lists all named features that are in all four categories. Names are listed alphabetically under the category to which it is assigned. The county or independent city in which the feature is located and the particular quadrangle map(s) that show the feature are listed with each entry.

Report of Investigations 34, GEOLOGY OF THE BERRYVILLE, STEPHENSON, AND BOYCE QUADRANGLES, VIRGINIA, by Raymond S. Edmundson and W. Edward Nunan; 112 p., 3 maps in color, 21 figs., 5 tables, 1973. Price: \$5.00 (plus 4 percent State sales tax).

The Berryville, Stephenson, and Boyce 7.5-minute quadrangles, covering an area of about 150 square miles, are located in northern Virginia. The quadrangles are underlain by bedrock ranging in age from younger Precambrian(?) (Catoctin Formation) through Middle Ordovician (Martinsburg Formation). Paleozoic rocks, exposed along the western slope of the Blue Ridge and adjoining lowlands of the Shenandoah Valley, are assigned to 17 formations and members of which 13 are lithologically distinct to be separately mapped. Cenozoic alluvium and terrace deposits were also mapped.

The major structural features consist of a part of the Massanutten Mountain synclinorium and a small segment on the northwestern limb of the Blue Ridge anticlinorium. The present attitude of the rocks is the result of tectonic transport from the east which produced oversteepened and locally overturned east limbs of synclines and west limbs of anticlines and the easterly dip of low-angle faults.

Crushed stone is produced from high-magnesium dolomite in the Berryville quadrangle and marl from alluvial deposits in the Boyce quadrangle; in the past, limestone and dolomite and shale for building roads have been quarried. Raw materials having the chemical requirements for some of the uses of limestone and dolomite as standardized by various consuming industries, shale potentially useful for brick, tile, and lightweight aggregate, and quartzite potentially useful high-silica sand are available.

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TOPOGRAPHIC MAPPING PROGRESS

By means of the cooperative Commonwealth of Virginia-U. S. Geological Survey mapping program the following new products are in progress: orthophotoquads, orthophoto maps, and slope maps. Orthophotoquads are rectified aerial photographic depictions of 7.5-minute series map areas on which scale measurements can be made. Differentiation of coniferous and deciduous tree types, interpretation of land use, and delineation of fields can be determined. Optimum information on the land surface is available by use of these orthophotoquads with the corresponding 7.5-minute series topographic maps. Orthophotoquads are being prepared for the cities of Charlottesville, Fredericksburg, Waynesboro, Winchester, and other growth areas in northern and southeastern Virginia. Orthophoto maps are a multicolor combination of a photographic image with topographic map information on which scale measurements can be made of 7.5-minute series areas. The Dismal Swamp area and the Wachapreague quadrangle will be available in this form. Slope maps are 7.5-minute series topographic maps on which the inclination of the land surface is portrayed by percent categories as well as by contour lines. These will be available for the cities of Martinsville, Richmond, and Staunton and other areas.

As an aid for ordering and using 7.5-minute series topographic maps the following are available from the Virginia Division of Mineral Resources for individual requests:

- (1) List of photorevised maps with designations of available quad-centered aerial-mapping photographs.
- (2) Supplement to Index to Topographic Mapping listing recently published maps and those in progress.
- (3) List of out-of-print maps with their survey dates.
- (4) List of numbers and costs of maps to depict individual cities, towns, counties, and planning districts; parks, forests, and refuges; public fishing areas; rivers; and unique landforms.
- (5) An article on topographic maps explaining their preparation, uses, and the Virginia program.

Return Postage Guaranteed

*NOTE: No up-dated 7.5-minute topographic quad-
rangle maps were published from December 15, 1973
to March 31, 1974.*

ORTHOPHOTOQUADS, ORTHOPHOTO MAPS, AND SLOPE MAPS

7.5-MINUTE QUADRANGLE MAP PRODUCTS

-  Orthophotoquads in progress
-  Orthophoto maps in progress
-  Slope maps in progress

