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NARROWS LANDSLIDE, GILES COUNTY, VIRGINIA

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"Landslide" has become a general term for any one of a number of types of downslope movement of soil or rock under the influence of gravity. Movement typically occurs along a distinct basal slip plane which separates the body of the landslide from the undisturbed soil or rock. Figure 1 is a generalized sketch of an idealized "landslide" showing morphologic features and terminology used in this article.

The head of a landslide is characterized by downward motion which exposes the main (or head) scarp. If the motion at the head of the landslide has a rotational component, a closed depression may be formed which, if subsequently filled by rain water or ground water, forms a sag pond. Movement at the toe of the landslide is characterized by upward bulging (toe bulge) and lateral spreading. Tension cracks form at the toe due to the outward component of motion. The body of the landslide is characterized by subsidiary motions paralleling the head scarp. These motions are minor "landslides within landslides" and show all the main components previously described.

The main scarp of a landslide is typically arcuate in plan and narrows to the toe area. If the accumulated debris at the toe tends to fan out, an "hourglass" shape may result. Otherwise, the debris at the toe tends to buttress the body of the landslide against further movement. Excavations at the toe of the landslide, which remove this

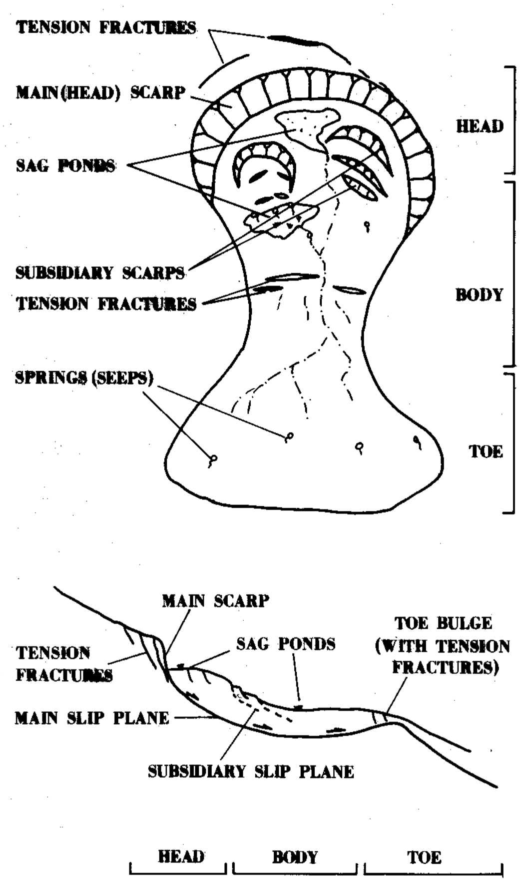

Figure 1. Generalized sketch of an idealized landslide.

natural buttress, tend to promote continued movement. Springs and seeps are commonly found throughout the landslide. A more complex description of 27 different types of landslide motion can be found in Sowers and Royster (1978).

LOCATION

The Narrows landslide (Figure 2) is located in Giles County, Virginia at approximately 37°21'N latitude and 80°46'30"W longitude. The area is situated along U. S. Highway 460 about two miles east of the town of Narrows and about three miles northwest of Pearisburg (Figure 3).

Figure 2. View of the Narrows landslide, looking north from the south bank of the New River. Eastern half of the cleared slope is not involved in current movements. Turnhole Knob is immediately behind the landslide and Peters Mountain is in the background.

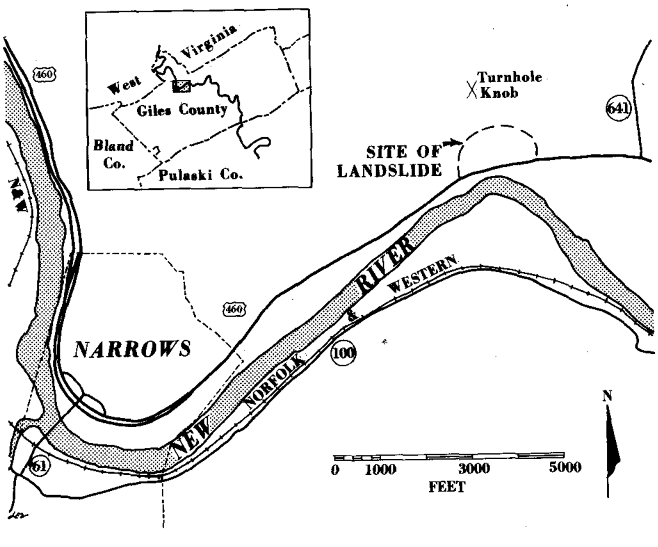

Figure 3. Location map of Narrows landslide.

The landslide affects about 2,000 feet along U. S. Highway 460 and extends approximately 400 to 700 feet north above the highway and about 200 feet below the highway to the New River. Turnhole Knob and Peters Mountain rise to the north of the area; Wolf Creek and Pearis mountains rise to the south. The New River locally flows from east to west, parallel to U. S. Highway 460, south of the slide area.

U. S. Highway 460 crosses a small rise at the toe of the landslide at an elevation of about 1,625 feet. The elevation of the top of the highest scarp of the landslide is about 1,830 feet; the elevation of the New River is approximately 1,590 feet.

HISTORY

Reconstruction of the timing of movements of the Narrows landslide was made from existing records of the Virginia Department of Highways and Transportation in both Richmond and Salem, Virginia. The first known movement of the landslide was in 1916. The Virginian Railroad (now Norfolk and Western Railway) reported displacement of a section of track (Thurston, 1940). Landsliding was active again in April 1940 shortly after the construction and upgrading of State Road 640 to State Highways 8 and 100, and U. S. Highway 460. "Hard rains" preceded this movement which involved an estimated 2,000 cubic yards of material (King, 1940). Further movement in September 1940 was described as "approximately 250 feet wide, extending through the roadway and below the Virginian Railroad tracks" (Thurston, 1940).

In August 1948, a 300-foot long scarp, as much as 10 feet high, developed (Parrott, 1948). Following this movement, an extensive grouting program was implemented as a joint venture between the Virginia Department of Highways and Transportation (VDHT) and the Virginian Railroad. The program lasted from July 1950 through March 1951. Holes were drilled on 15-foot centers, from just above the roadway to the New River (Meadors, 1967), and several boxcars of grout were pumped into the holes (Kuehn, personal communication, 1981).

Three months after the grouting program was completed, a major landslide began. The landslide grew progressively worse in November, when it "sheared off almost vertically from the edge of the roadbed, down 15 feet, then flattened onto the track" (Loughborough, 1951). Johnson (1952) comments that because of "considerable movement", a $25,000 allocation was needed immediately to maintain the roadway. Notations also indicate that over $60,000 was allocated for "clean-up and maintenance" of the landslide from 1950 to 1971, implying continued sporadic movements.

In February 1971, after the 1970 widening of U. S. Highway 460 to four lanes, major movements started again and lasted through March 1971. Periods of 24-hour surveillance were maintained as cracks opened in the roadway; two lanes of the newly refinished roadway were closed because of vertical offsets in the pavement, and a concrete-beam retaining wall failed.

Meadors (1977) notes that inclinometers emplaced in 1976 indicated a slip plane at about 30 feet, implying continued movements throughout the period since 1971, and Hunsberger (1974) notes that the slide had been showing minor movements for 18 months and "at the present time [March] ...has become very active."

Offsets across tension cracks and scarp lines that were monitored by the author from May 1981 through September 1981 show that the landslide is still active. Monitoring was accomplished by measuring the distance between fixed points. A subsequent visit to the landslide in January 1983 confirmed continued movement, although the monitoring stations were no longer available for quantitative analyses. Current movements within the landslide include tension fracturing, block falls, mud flows, rotational slumping, and bedding plane slides (Figures 4 through 8). The diversity of style of motion within the landslide is because of a variation in the lithologies across the landslide and a difference in the number of times different portions of the landslide have moved. These points will be discussed along with the controlling factors of the landslide.

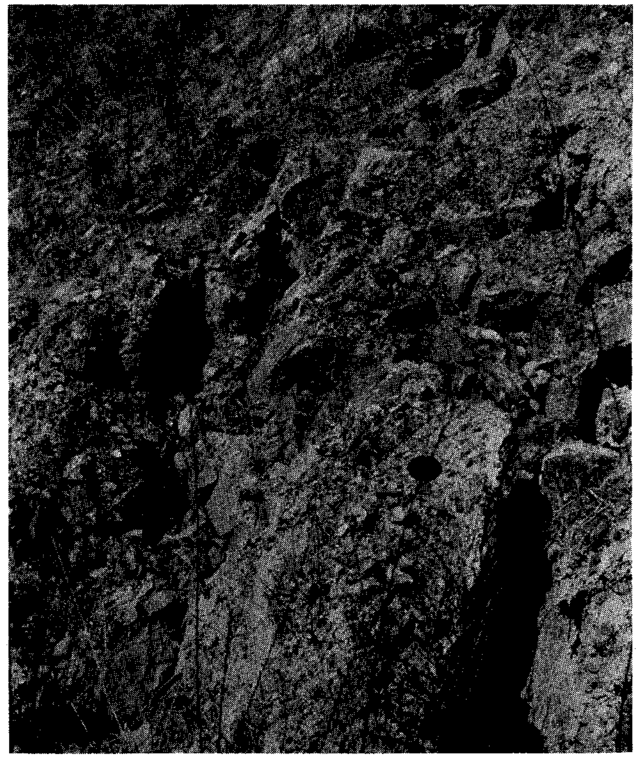

Figure 4. Tension fracturing in the Rose Hill sandstones of the Narrows landslide. Lens cap is approximately 2 inches in diameter. U. S. Highway 460 is to the left.

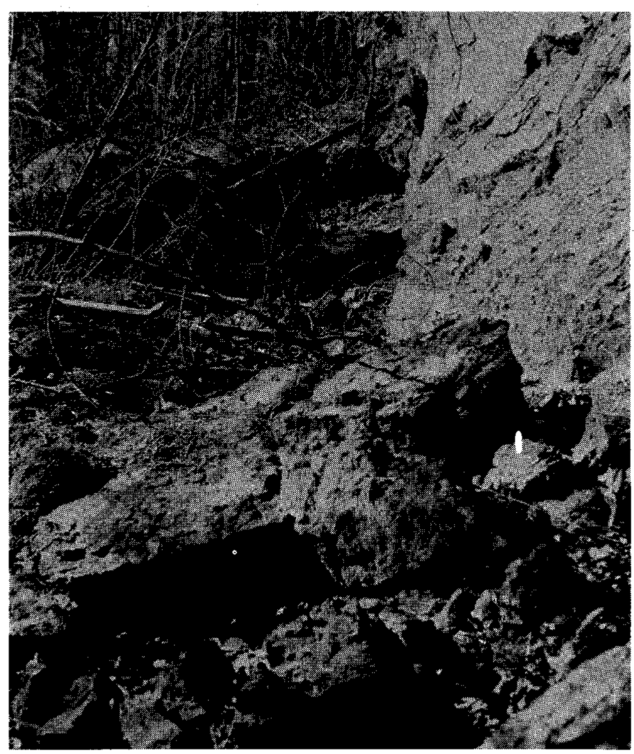

Figure 5. Block fall along the main scarp of the Narrows landslide. This portion of the scarp is about 10 feet high.

REMEDIAL EFFORTS AND INVESTIGATIONS

Since 1940, when the VDHT began the first of several studies of the landslide in an effort to locate the main slip plane, no fewer than three slip planes have been identified: one at about 20 feet, one at about 35 feet, and another at about 110 feet. The main slip plane however, has not been identified, so it is impossible to make an accurate estimate of the overall volume of the landslide. As far as known, no borings have penetrated undisturbed bedrock beneath the landslide.

Efforts to stabilize the landslide have had quite variable results. The grouting

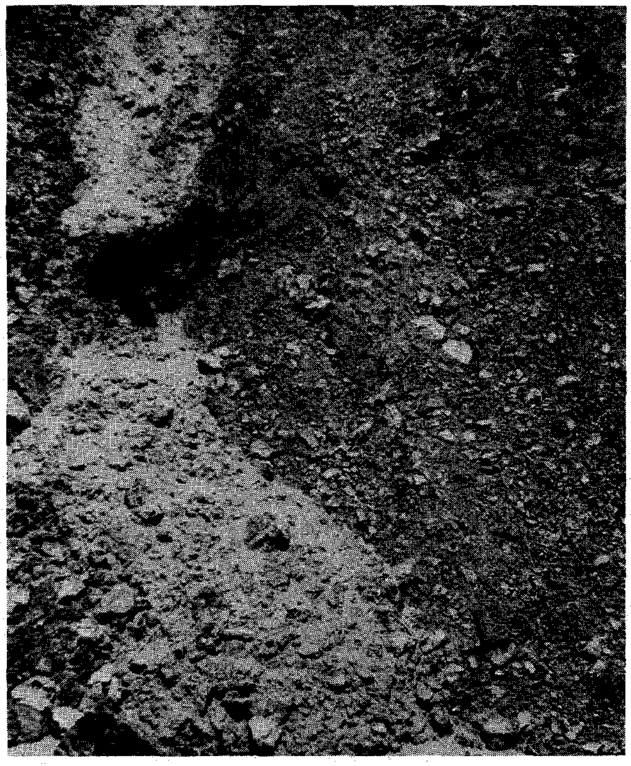

Figure 6. Mudflow in the Narrows landslide. This mudflow was located in the nearly vertical cut made for U. S. Highway 460. Height of the cut at this locality is about 8 feet.

Figure 7. Hummocky topography and en echelon scarp formation in the Narrows landslide. This style of motion appears to be restricted to the western half of the landslide and to material which may be generally colluvial in nature.

program carried out from July 1950 through March 1951 may have contributed to landslide movements in June 1951 by restricting the flow of groundwater and increasing the hydraulic head, which then facilitated movement of the unstable mass.

Prior to 1971 a concrete-beam retaining wall was constructed, and then following

Figure 8. Rotational slump feature of the Narrows landslide. Tilted trees in the left foreground illustrate a clockwise rotation of a slump block, U. S. Highway 460 is out of the photo to the left.

the major movements in 1971, a 400-foot long "Armco bin-type metal wall" was constructed. This wall required an excavation 400 feet long, 20 feet deep and 40 feet wide. It was placed at the south edge of the east-bound lanes of the newly widened U. S. Highway 460 to support not only the hillside, but also the roadway. To brace the excavation, steel "H" piles were driven 40 feet deep on 4 foot centers along the centerline of the eastbound lanes of the highway. Once the excavation was complete, timber lagging was emplaced between the piles to further support the cut. The bin wall was subsequently installed and the bin backfilled with "porous free draining material such as commercial aggregate No. 8" (Meadors, 1971) (Figure 9). Shortly after construction, the wall began showing considerable distress (Kuehn, personal communication, 1981). The wall has bulged out of line, there are tears in the sheet metal allowing piping of the gravel backfill, and numerous bolts have been bent and/or sheared (Figures 10 and 11).

Figure 9. Completed Armco bin retaining wall. Notice the regular alignment of the wall. Photo courtesy Carl Kuehn.

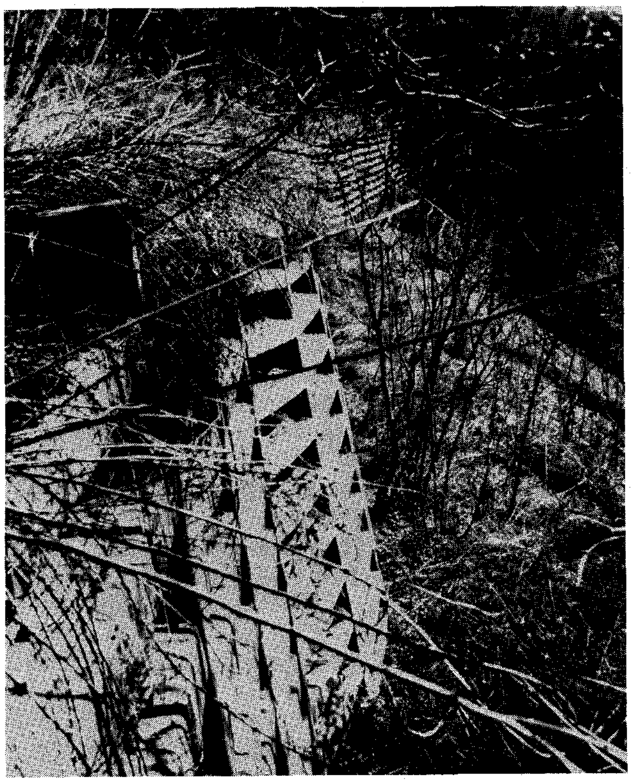

Figure 10. Alignment of Armco bin retaining wall in April, 1981.

Figure 11. Distress in Armco bin retaining wall. Notice the tears in the sheet metal, the sheared bolts and the piping gravel. Geologic hammer is for scale.

In response to the stress in the retaining wall the VDHT removed an estimated 250,000 cubic yards of material from the landslide to relieve the "overburden" pressure on the unstable mass and reduce the slope angle. In conjunction with this effort, drainage was planned for the landslide but never installed. One of the significant factors contributing to most landslides is the presence of excess water, and investigations into the causes of landsliding should always include evaluation of the groundwater situation within the unstable mass. Sowers and Royster (1978) state that "identification of the source, movement, amount of water, and water pressure is as important as identification of the soil and rock strata [in a landslide]."

Today there are several "sag ponds" on the surface of the landslide which formed when rotational slumping created a depression at the head of the slump filled with water. These ponds allow seepage of water into the landslide, contribute to its instability, and indicate ongoing movements (Figure 12).

GEOLOGY

Geologic mapping of the area of Giles County encompassing the landslide has been

Figure 12. Sag pond in the Narrows landslide. Ponds such as this allow slow seepage of water into the disturbed soils.

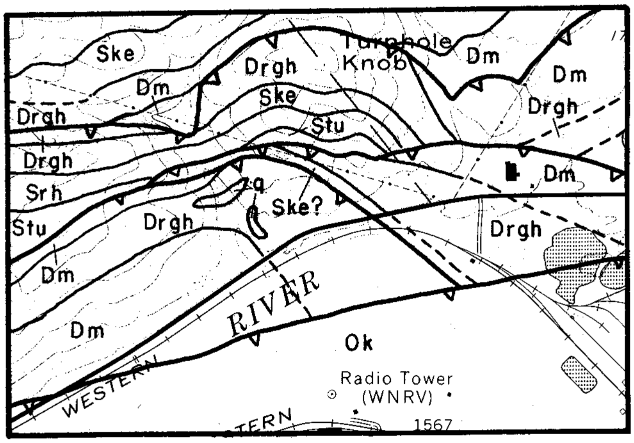

Figure 13. Geologic map of slide area (Lewis, in progress). Units are: Ok, Knox dolomite; Stu, Tuscarora Formation; Srh, Rose Hill Formation; Ske, Keefer Sandstone; Drgh, Rocky Gap Sandstone/ Huntersville Formation with q, quartzite lenses; and Dm, Millboro Shale.

performed by Cooper (1961), Hale (1961), and is currently being revised by Lewis (in progress). The Narrows landslide has formed in severely brecciated and overturned strata of the Silurian Rose Hill Formation (Figure 13).

The Rose Hill Formation consists of interbedded layers of sandstone and shale. The sandstone layers range from clean, well-sorted orthoquartzites to fine-grained hematitic sandstones. The shale layers typically range from quartzitic to hematitic and are thinly bedded. The shale layers are frequently interbedded with thin sandstone layers. Arthrophycus alleghaniensis (a trace annelid) burrows are common on some sandstone bedding surfaces. In one location, along the main landslide scarp, V-shaped (pelecypod?) burrows were found. These burrows were found in quartzitic sandstone with the terminations of the "V's" pointing upwards. This primary (stratigraphic) evidence confirms the overturned nature of the beds on the south face of Turnhole Knob.

Silurian Keefer Sandstone (orthoquartzite) stratigraphically overlies the Rose Hill Formation. Keefer sandstones are very similar to the orthoquartzites of the Rose Hill Formation, but generally lack the hematite cement commonly found in the Rose Hill.

Hale (1961) mapped Silurian Tonoloway Limestone which stratigraphically overlies the Keefer Formation. This limestone is typically thin-bedded and argillaceous. In places it is weathered to clay, leaving only a shallow swale to indicate its presence. Tonoloway Limestone is exposed on the adjacent ridge west of Turnhole Knob, but no trace of it was found on Turnhole Knob during this study. The Tonoloway Limestone is the youngest formation of the Silurian System found in this area.

Stratigraphically overlying the Tonoloway Limestone is the Devonian Rocky Gap Sandstone. The Rocky Gap Sandstone forms the ridge crest of Turnhole Knob. Lithologically, the Rocky Gap Sandstone generally is a fairly clean, fine-grained sand with calcareous cement. locally the rocks have been extensively replaced with various forms of iron and has occasionally been prospected or mined for iron ore. On the crest of Turnhole Knob, the replacement is extensive and in some outcrops, an intricate honeycomb texture has developed. Cobbles and boulders of Rocky Gap Sandstone are scattered across the surface of the landslide and in places obscure the in-place lithologies. A reference to a layer of "friable sandstone" in one VDHT boring log may be Rocky Gap Sandstone in which the calcareous cement has been leached by ground water with no replacement by iron.

Stratigraphically above the Rocky Gap Sandstone is the Devonian Huntersville Formation. The Huntersville Formation in the Narrows area is very poorly exposed but thought to be a thin, discontinuous layer of chert and glauconitic siltstone (Hale, 1961). On the southeast side of Turnhole Knob there is one outcrop of glauconitic siltstone which may represent the Huntersville Formation in this area.

Stratigraphically above the Huntersville Formation is the Devonian Millboro Shale. The Millboro Shale is the youngest formation exposed in the Turnhole Knob area and can be found on both the east and west flanks of Turnhole Knob. Hale (1961) also mapped Millboro Shale north of Turnhole Knob. The Millboro Shale consists of thinly bedded, sparsely fossiliferous, black shale. The shale is typically highly sheared, contorted and slickensided.

Structurally, the Narrows landslide has formed in the footwall block of the Narrows fault. In the Turnhole Knob area, the Narrows fault has a northwestward displacement and stratigraphically throws Cambrian aged Knox Group carbonates over the Siluro-Devonian clastic rocks previously described. The trace of the Narrows fault is probably located in the New River, south of the landslide. Narrows faulting is believed to be responsible for the contemporaneous overturning of the Hemlock Ridge syncline. Narrows thrusting probably occurred in the Mississippian Period, accounting for the absence of Mississippian strata in the Hemlock Ridge syncline whereas more than 6,000 feet of Mississippian strata are preserved in the Hurricane Ridge syncline north of Turnhole Knob (Lowry, oral communication, 1981). Turnhole Knob is a portion of the overturned southeast limb of the Hemlock Ridge syncline, while Peters Mountain is the normal, northwest limb. Millboro Shale occupies the trough of the syncline. Additionally, lithologic discontinuities and the extensive shearing of the Millboro Shale imply that Turnhole Knob may be detached on a sole fault through the trough of the syncline and possibly detached to the east and west by cross faults.

CONTROLS OF THE NARROWS LANDSLIDE

Controls of a landslide are those factors which directly contribute to or facilitate movement of an unstable area. Possible controlling factors that were considered in this study include seismicity (earthquakes), lithology, structure, man-made causes, and rainfall. Of these, only earthquakes were discounted as a significant factor. Despite being located at the juncture of two active seismic zones, earthquake events could not be correlated with known times of landslide movements. Movement due to earthquakes however, cannot be ruled out as a future concern. The other four factors are probably interrelated.

The lithologies involved in the landslide belong to the Rose Hill Formation. In addition to this, however, there are some areas which appear to be remnants of earlier disturbed material. These areas within the landslide are characterized by en echelon scarps, hummocky topography, and rotational slumping with sag pond development. It is possible that they are simply colluvial deposits caught up in the current activity, but they may also be remnants of older landslides. The more competent Rose Hill lithologies exhibit block fall and bedding-plane types of motion. In these instances, the combination of bedding inclined subparallel to the hillside and interbedded relatively weak shales and sandstones is an inherently unstable situation.

Structurally, Narrows faulting has created the inclined bedding and caused extensive brecciation of the Rose Hill lithologies. This served to further weaken the hillside.

Five visually distinct clay samples were taken from the most active areas of the landslide and were analyzed for clay mineral content using X-ray diffraction techniques. Of these samples, only two contained trace amounts of montmorillonite. The structure of the montmorillonite crystal lattice allows it to absorb large quantities of water and swell to many times its "dry" size. This property has earned it the nickname of "swelling clay". As the montmorillonite lattice expands to accommodate water, the shear strength of the mineral is reduced. The apparently low quantity of swelling montmorillonite present is probably not as significant as the occurrence of clay layers as relatively weak interbeds between more competent sandstones dipping southward, toward the highway.

Construction has played a major role in Narrows landsliding. Between 1916 and 1940, movement of the landslide is not documented by the VDHT, although there were many periods of heavy rainfall and at least one Intensity V earthquake (1924) in this 24-year period. Modern construction along the roadway began early in 1940; April 22, 1940 marks the beginning of the major landslide activity that continues today.

Preceding the 1951 failure, an extensive program to grout the landslide was completed. Preceding the month of severe movement from February to March 1971, the highway was widened to four lanes, necessitating a wider cut into the unstable hillside.

Terzaghi (1943) shows that the ultimate strength of sedimentary deposits is directly proportional to the effective stress acting on the system and that effective stress decreases with increasing pore pressure. If the Narrows landslide is underlain at depth by Millboro Shale, then groundwater, after percolating through the fractured sandstones of the landslide may become impeded by the impermeable shale. This would cause an elevation of pore pressure at the base of the landslide with the resultant decrease in strength. The landslide would be able to move more readily and on a lower gradient under these conditions. Assuming subsurface shale interbeds in the Rose Hill Formation, this process could be operating on many levels within the landslide, possibly helping to account for the various slip planes identified by the VDHT. In order to evaluate this process with respect to the Narrows landslide, it is necessary to know something about the water table conditions within the unstable mass.

Rainfall data, tabulated for each year since 1916, show only a general correlation with times of landslide movements. Before rainfall data can be effectively used, however, it is necessary to be able to monitor the response of the water table to various durations and intensities of precipitation. The New River may also have contributed to landslide activity by undercutting the toe of the landslide. Periods of excessive rainfall would also impact the effectiveness of erosion by the river. This factor was not evaluated.

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MINERAL RESOURCE NEWS

Mineralization in the Gold-pyrite belt in the Virginia Piedmont province is of continued interest. In late September, Fauquier County gave Callahan Mining Corporation permission to prospect at two abandoned mine sites in the Morrisville area. Several core holes have already been drilled near the old Franklin mine.

In mid 1983, the Mead Corporation agreed to sell Lynchburg Foundry to Columbus Foundry of Columbus, Georgia. The foundry monthly produces 30-40,000 pounds of gray iron, high-alloy gray iron, ductile iron, and high-alloy ductile iron in the form of transmission housings, flywheels, crankshafts, hydraulic, automotive and refrigeration castings, and gas and diesel truck castings.

The new quarry site of Luck Stone Corporation, north of Ruckersville, Greene County is currently under construction. Acceleration and deceleration lanes along U. S. Highway 29 have been completed and some overburden has been stripped from the site. The plant, when installed, will be part portable and part permanent; production of crushed stone will begin in early 1984.

Virginia Polytechnic Institute and State University is conducting a study of the methods that might be required to clean up an unidentified jellylike, acidic substance that has been discovered along the Piney River in Nelson-Amherst counties. The substance is believed to be a residue from operations of the old American Cyanamid plant, which closed in 1971.

STATE MINERALS MANAGEMENT PLAN

State agencies and institutions in Virginia frequently receive inquiries concerning the possibility of mineral leasing, exploration, and extraction on State-owned lands. Many of these inquiries are the result of increased industry interest in the potential for finding large reserves of oil and gas in the Appalachian area. Other inquiries reflect interest in various metallic or non-metallic minerals. Until recently, however, overall guidelines and procedures, under which the various affected entities of State government could deal uniformly with such inquiries or requests, did not exist. The Code of Virginia contained only scattered sections relating to mineral activities on State lands. Requirements in these various sections were diverse and applied to only a few specific land-holding agencies or institutions. To correct this situation, the 1982 General Assembly enacted legislation that now enables the Commonwealth to act in a consistent and appropriate manner when dealing with various aspects of minerals on State lands. This legislation, now §2.1-512.1 of the Code of Virginia, established certain basic procedural requirements and required development of a State Minerals Management Plan.

The legislation stipulated that the Plan be developed by the Department of Conservation and Economic Development, Division of Mineral Resources, in cooperation with the Department of General Services, Division of Engineering and Buildings, and with the assistance of affected State agencies, departments, and institutions. Development of the Plan, incorporating and elaborating upon the requirements of §2.1-512.1, was begun in the spring of 1982. During preparation, review drafts were distributed to 33 appropriate agencies and educational institutions for their suggestions, concerns, and comments, and meetings were held as necessary. The resulting input from a broad spectrum of regulatory, environmental, and land-holding entities of the State government was invaluable in formulating an appropriate document. The final Plan was approved by the Council on the Environment in May 1983. Copies of the document were distributed to various units of State government in June 1983 for implementation.

The State Minerals Management Plan sets forth procedures for applicants seeking to lease State lands or to explore or conduct mineral extraction operations upon them, and also for such activities under agency initiative. Procedures that will be followed by State agencies in response to such requests are outlined in detail. The Plan includes provisions for a determination by the Governor whether proposed leasing, exploration, or extraction of minerals is in the public interest, competitive bid and proposal processes, public hearings, environmental impact statements, and appropriate review processes involving environmental, regulatory, and other agencies. The document also includes, as appendices, a copy of §2.1-512.1 of the Code of Virginia and summaries of requirements for mineral activities as supplied by several State agencies having regulatory authority.

The State Minerals Management Plan provides an overall framework of guidelines within which mineral activities may take place on State-owned lands if such are determined, on a case-by-case basis, to be in the best interest of the State. Mineral development is of secondary interest to many land-holding agencies and would be allowed only if consistent with current or intended land uses and individual agency goals. Mineral-related activities would obviously be incompatible with certain categories of State land but might be appropriate and desirable for others.

Those interested in mineral exploration and/or leasing of State lands should address their inquiries to the appropriate landholding agency or institution. Copies of the State Minerals Management Plan may be obtained from the Virginia Division of Mineral Resources, P. O. Box 3667, Charlottesville, VA 22903 for $5.00 per copy, third-class mail.

OIL AND GAS PROJECTS IN VIRGINIA

LONG TERM PROJECTS: The Division of Mineral Resources (DMR) has been engaged in oil and gas activities for many years as part of its program. The Division is the repository for samples for oil and gas tests drilled within the Commonwealth. These samples are routinely collected by the Virginia Oil and Gas Inspector, Division of Mines and Quarries, and are turned over to DMR after any required period of confidentiality has elapsed. In addition, the Oil and Gas Inspector provides DMR with written records and logs of all tests, so that these are generally available for inspection at our offices. During the past several years, the Oil and Gas Inspector has provided DMR with well location maps and well summary sheets by 7½ minute quadrangle; and blue lines of these are available from us for the cost of copying.

CURRENT PROJECTS: One of our most recent efforts has been to prepare these file data, both maps and documents, in publishable forms, so they would be more readily available to the oil and gas industry and other interested clients.

Scout tickets showing pertinent data for each test of record have been prepared and are currently being processed for publication. Well location maps at a scale of 1:50,000 on a topographic base have been prepared for Lee, Wise, Dickenson, Buchanan, and Tazewell counties. These, too, are in manuscript form and are being processed for publication. We are also making studies of sample sets and preparing regional stratigraphic cross sections, and porosity studies on core samples are being made for the Division by the Department of Geophysical Sciences at Old Dominion University.

One of our current efforts involves regional compilation of a tectonic map of western Virginia and adjacent West Virginia - from the eastern side of the Blue Ridge to the Allegheny structural front. Field work for this project has almost been completed. The map is being prepared in cooperation with the West Virginia Geologic and Economic Survey, together with the U. S. Geological Survey, Branch of Oil and Gas Resources. The map will be published in color at a scale of 1:250,000 and will show the locations of significant pools, fields, and wildcat tests. The anticipated year of publication for this map is 1985.

Perhaps one of the most significant publicly funded projects relative to oil and gas exploration in Virginia is the recently published U. S. Geological Survey's VIBROSEIS line along Interstate 64 from Staunton to Richmond and beyond. The Staunton-to-Richmond segment was published at a relatively small scale (Chart OC-123). Because of the significance of this work the Division, in cooperation with the U. S. Geological Survey, Branch of Oil and Gas Resources, is currently preparing another publication of the line, but at a larger scale. The new publication will feature the geological interpretation superimposed over the VIBROSEIS data, and will contain a geologic strip map along the route of the line.

Similarly, we have recently started a project to publish interpretations of publicly available seismic lines off the coast of Virginia. The project was arranged by the Association of American State Geologists and is funded by the U. S. Minerals Management Service. This project, too, is being accomplished in cooperation with the U.S.G.S. Branch of Oil and Gas Resources.

RECENT PUBLICATIONS: The Division has recently published several articles in Virginia Minerals and several more detailed reports pertaining to Virginia's oil and gas potential. These include: Natural Gas in Virginia (Virginia Minerals, Vol. 27, No. 1, 1981), Gas Plays in Overthrust Belts: Activity in Virginia Is Increasing (Vol. 27, No. 4, 1981), Geologic Structure and Hydrocarbon Potential Along the Saltville and Pulaski Thrusts in Southwestern Virginia and Northeastern Tennessee (Virginia Division of Mineral Resources Publication 23, 1980), Lineament and Fracture Trace Analysis and Its Application to Oil Exploration in Lee County, Virginia (Virginia Division of Mineral Resources Publication 28, 1981), Relation of Stratigraphy to Occurrences of Oil and Gas in Western Virginia (Virginia Division of Mineral Resources Publication 43, 1983), and Coal-bed Methane Resource Evaluation, Montgomery County, Virginia (Virginia Division of Mineral Resources Final Report to the U. S. Department of Energy, 1983).

These studies in progress, and recent publications of the Division of Mineral Resources and U. S. Geological Survey, together with older geological reports and maps, combine to form an extensive, documented data base for continued exploration and development of Virginia's oil and gas resources.

A GOOD MATCH

Unique map and aerial photograph pairs, which show natural and man-made features, are now available for 15 Virginia counties. These pairs are complimentary and consist of a multicolor topographic map and a black and white aerial photograph, called an orthophotoquad, of the same area.

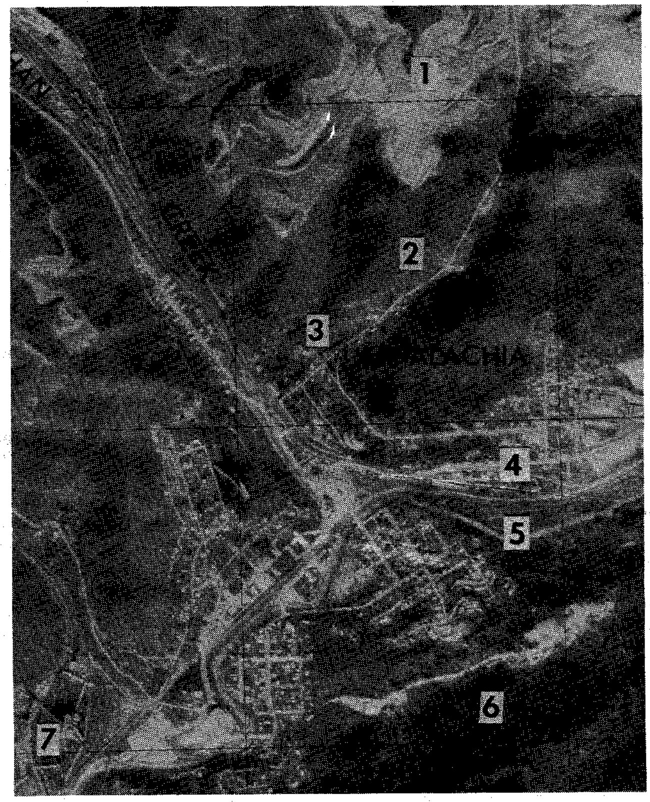
Each pair shows about 60 square miles of Virginia, so several adjacent pairs are needed for county coverage. Each product is prepared to scale so that each 2000 feet of ground distance is represented by one inch.

The topographic map shows buildings, roads, rivers, forests, political boundaries, feature names, and landform shapes and elevations. By comparing the orthophotoquad with the corresponding topographic map, individual properties, fields, and deciduous versus coniferous forests can be identified.

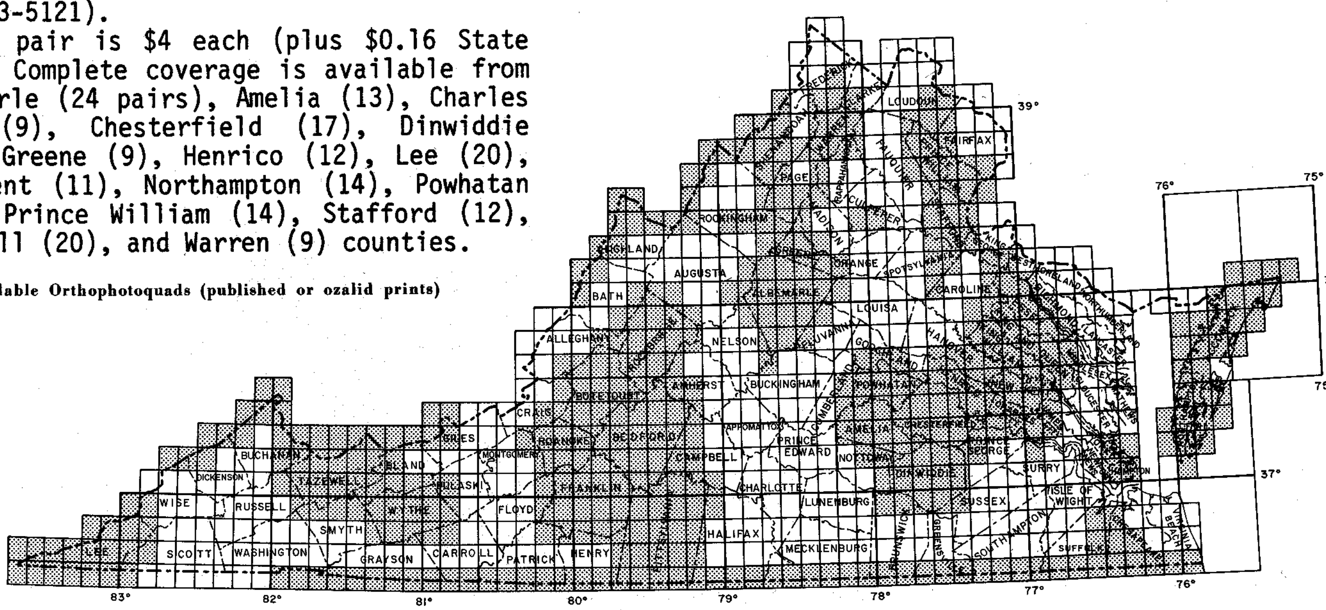
Topographic maps and orthophotoquads paired together are useful in selecting industrial sites, planning recreational trips, and assisting in environmental studies. These pairs are being produced by the U. S. Geological Survey in Reston, Virginia, for projects funded by the Virginia Division of Mineral Resources of the Department of Conservation and Economic Development and by the U. S. Soil Conservation Service.

Information on the availability of topographic maps and orthophotoquads can be obtained from the Virginia Division of Mineral Resources, P. O. Box 3667, Charlottesville, Virginia (telephone 804/293-5121).

Each pair is $4 each (plus $0.16 State tax). Complete coverage is available from Albemarle (24 pairs), Amelia (13), Charles City (9), Chesterfield (17), Dinwiddie (18), Greene (9), Henrico (12), Lee (20), New Kent (11), Northampton (14), Powhatan (13), Prince William (14), Stafford (12), Tazewell (20), and Warren (9) counties.



Portion of Appalachia orthophotoquad with the following numbered cultural and natural features: 1) stripped area, 2) deciduous tress, 3) buildings, 4) highway, 5) river, 6) evergreen trees, and 7) railroad.



Available Orthophotoquads (published or ozalid prints)

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MINERAL UPDATE

Wm. F. Giannini and D. Allen Penick Jr.

Two minerals not previously reported from Virginia have recently been discovered by the writers near Schuyler. Cobaltite, (cobalt arsenic sulfide) and millerite (nickel sulfide) have been found in Albemarle and Nelson counties respectively in the Virginia soapstone belt (Figure 1). Both minerals were found in dumps situated adjacent to abandoned soapstone quarries. Identification was confirmed by Dr. Richard S. Mitchell of the University of Virginia by x-ray diffraction analysis.

Cobaltite occurs as small black grains (to 1 mm) in talc seams within the soapstone at the Old Dominion quarry. The mineral is closely associated with erythrite (hydrated cobalt arsenate) which is a pink mineral known as "cobalt bloom." Erythrite, a secondary mineral formed by the oxidation of cobaltite, was first recognized from this site by T. V. Dagenhart in 1977 (R. S. Mitchell, personal communication, 1983). Both cobaltite and erythrite are relatively rare minerals. Cobaltite is a major ore of cobalt and is considered a strategic mineral.

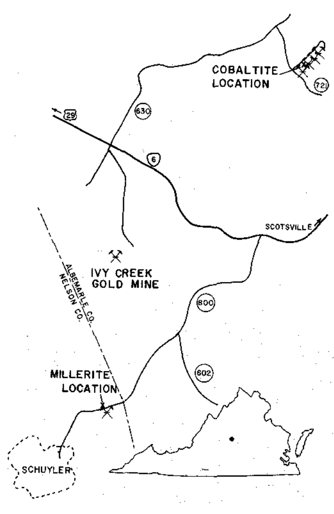

Figure 1. Location map for two newly discovered minerals from Virginia: cobaltite and millerite.

Millerite occurs as slender gold colored rod or needle-like crystals up to 2 mm in length (Figure 2). The mineral was found in a ferroan dolomite vein in the soapstone associated with chalcopyrite (copper sulfide). Millerite is a subordinate ore of nickel.

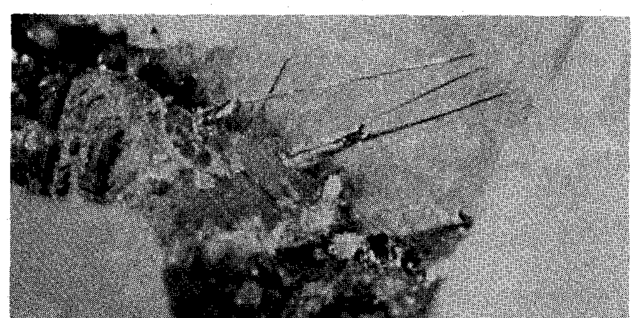

Figure 2. Needle-like crystals of millerite (nickel sulfide) attached to chalcopyrite. "Stadia rod" appearance of one crystal is produced by rotation around c-axes. White area is ferroan dolomite. Longest crystal is 1.75 mm (Photo by T. M. Gathright, II).