TRAVERTINE-MARL DEPOSITS OF THE VALLEY AND RIDGE PROVINCE OF VIRGINIA - A PRELIMINARY REPORT

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The travertine and marl deposits of Virginia's Valley and Ridge province are the result of precipitation of calcium carbonate from fresh water streams and springs. Travertine is white to light yellowish brown and has a massive or concretionary structure. Buildups of this material tend to form cascades or waterfalls along streams (Figure 1). Marl refers to white to dark yellowish brown, loose, earthy deposits of calcium carbonate (Figure 2). Deposits of these carbonate materials are related and have formed during the Quaternary period. This preliminary report is a compilation of some literature and observations of these materials. A depositional model is proposed.

These deposits have long been visited by man. Projectile points, pottery fragments, and firepits record the visitation of American Indians to Frederick and Augusta county sites. Thomas Jefferson (1825) wrote an account of the Falling Spring Falls from a visit prior to 1781. Aesthetic and economic considerations continue to attract interest in these deposits.
The authors have observed travertine and marl along streams and springs in seventeen counties of western Virginia. Calcium carbonate deposition assumes a variety of forms: rimstone dams (Figure 3), terrace cascades, drapery-like features, encrustation of organic materials, and oncolites. Encrusted materials and associated fossils include leaf impressions, twigs, seeds, stem and trunk casts, land and water snails and crustacean fragments.

Distinctive well-drained dark-colored soils (Mollisols) have developed over a number of travertine-marl deposits. These characteristic soils may be used with topographic signatures to aid in identification of potentially economic deposits.

RANGE AND SCOPE OF DEPOSITS

Travertine and marl deposits were located along 57 streams and springs in the Valley and Ridge province of western Virginia (Figure 4). Further examination is expected to reveal additional deposits.

Deposits are generally found downstream from faulted carbonate rocks (Thornton, 1953; Mathews, 1962 and 1962a; McFarland, 1981; McFarland and Sherwood, 1981). Over fifty percent of the sites examined are associated with mapped faults. The remaining sites are in highly fractured and folded rocks and are commonly associated with springs. Falling Springs, as well as other thermal springs on the Warm Springs anticline, is associated with lineaments observable on LANDSAT imagery (Gathright, 1981). Gathright (1981) suggested that the thermal springs are a result of deep groundwater circulation in vertical fracture zones that are expressed as lineaments.

The term, travertine, refers to a white (10YR 8/1), very pale brown (10YR 8/3) or light yellowish brown (10YR 6/4), massive or concretionary limestone with a radiating or concentric structure. Spongy or less compact varieties are commonly referred to as calcareous tufas. Julia (1983) notes the present trend is to term encrusting varieties of calcium carbonate, related to plants, as travertine, regardless of pore volume or density. Travertine commonly forms rimstones, terraces,
cascades and dams. A series of cascades and falls may total over one hundred and fifty feet in height. Travertine features are intimately associated with less spectacular deposits of marl.

The term, marl, applies to white (10YR 8/1), light gray (10YR 7/1), light yellowish brown (10YR 6/2) or dark yellowish brown (10YR 4/4), loose, earthy deposits of calcium carbonate and insoluble clays, silts or sands. Marl is defined as containing 35 to 65 percent calcium carbonate (Pettijohn, 1957). However, some marls reported in the literature and materials considered marls in this report, contain up to 98 percent calcium carbonate (see Economic Development). Deposited as valley fills, some Virginia marls extend to widths of 500 feet across terraced flood plains and have thicknesses up to 60 feet.

Buildups of travertine and/or calcareous tufa result from precipitation from stream and spring waters supersaturated with calcium carbonate (Emig, 1917; Woodward, 1936; Thornton, 1953). Accumulations are usually found where streams cross bedrock ledges or boulder lags. Marl overgrowths behind travertine and tufa structures. Travertine-marl deposits often consist of a series of travertine-dam and marl-terrace sequences which may extend for several miles along a stream. Marl materials can be fine to coarse textured. Coarse textured marls are associated with the larger dam sequences and higher stream flow regimes.

Precipitating calcium carbonate encrusts organic as well as inorganic materials. Concretions and concentrically layered oncolites are common features in stream beds and banks (Roddy, 1915; Thornton, 1953). Green and blue-green algae and mosses identified in streams as having encrustations of calcium carbonate include Philonomonotis calcarea (Steidtmann, 1934b); Oocoractus stratum, Chara vulgaris and Calothrix viguieri (Mathews, 1962 and 1962a); Cladophora glomerata, Phormidium incrustatum, Oscillatoria agardii, Vancheria spp., Spirogyra spp. and Oscillatoria cf. splendid (Gillespie and Clendening, 1964). Encrustations of calcium carbonate have been observed on plant stems and roots and result in hollow tube fragments of various sizes (Gillespie and Clendening, 1964; Dean, 1981). Leaf impressions are commonly observed in travertine masses and include angiosperm varieties: black gum, black walnut, sycamore, pine and oak (Trainer, 1948; Thornton, 1953; Gillespie and Clendening, 1964).

Fragments of encrustations may act as nuclei for further concentric encrustation, forming pisoliths. Pisoliths, oncolites and other loose calcium carbonate materials including fragments of travertine can make up a large portion of the carbonate materials in marls.

Erosion of travertine dams and other buildup forms result from periodic floods (Emig, 1917; Steidtmann, 1936; Chafez and Folk, 1984). During Hurricane Camille, in 1969, rainfall exceeded 30 inches for eight hours in local areas of Virginia. Reports and observations indicate this storm had a catastrophic affect on travertine buildups in Moores Creek and Gibbs Falls in Rockbridge County, Virginia. Both falls were nearly stripped of travertine, exposing the underlying bedrock. One observer (Phillip Lucas, 1984, personal communication) estimated only 20 percent of the travertine still remains at the Moores Creek Falls.

**DEPOSITIONAL FACTORS**

Travertine-marl deposits form downstream from sites where groundwater emerges from carbonate rocks. These emergent waters generally mix with surface water prior to calcium carbonate deposition. Faults and fractures in carbonate rocks are important in providing conduits for migration of groundwater to the surface. Where faults are transected by surface streams, groundwater can emerge, either directly at the surface as discrete discharge (spring) or as a diffuse discharge. Diffuse discharge may extend a considerable distance downstream from an incised fault through unconsolidated surficial materials.

The emerging groundwater differs in chemical composition and seasonally in temperature from surface stream waters. The content of CO$_2$ in surface waters is generally near equilibrium with atmospheric CO$_2$, which is 0.03 percent by volume or 10^{-3.5} atmospheres. The CO$_2$ content in groundwater can be much higher because rainwater infiltrating through soil may dissolve additional CO$_2$ from the soil air. Soil air can contain several percent CO$_2$ because of plant root respiration and the decomposition of organic material by microorganisms (Holland and others, 1964). Diffusion of CO$_2$ from overlying soils can add more CO$_2$ to the groundwater (Jacobson and Langmuir, 1970). A study of 14 carbonate springs in the Central Appalachians showed that all waters contained about an order of magnitude more CO$_2$ than they would if they were in equilibrium with the atmosphere (Shuster and White, 1971). The high CO$_2$ content of groundwater greatly increases the amount of the calcium carbonate groundwater can dissolve relative to surface waters. The equation for the dissolution of calcium carbonate by a
solution of water and CO₂ (carbonic acid) can be written:

\[
\begin{align*}
\text{H}_2\text{O} + \text{CO}_2 & \leftrightharpoons \text{CaCO}_3 + \text{H}_2\text{CO}_3 \\
\end{align*}
\]

The solubility of calcite depends on the amount of CO₂ available. Any process that increases the amount of CO₂ in the solution causes more calcium carbonate to dissolve, whereas processes that decrease the amount of CO₂ can cause calcium carbonate to precipitate.

Waters from springs in Virginia are usually at about the mean annual temperature of their respective areas. During summer and early fall, surface waters are warmer than spring waters. At this time atmospheric precipitation is also at a low for the year; thus, stream levels are down, and groundwater flow can be significant relative to surface flow. When groundwater joins a low-flow summer stream, dissolved calcium carbonate and CO₂ content of the stream can increase dramatically.

The main factor controlling deposition of calcite to form travertine-marl deposits appears to be the loss of CO₂ from the mixed stream waters. As the CO₂ enriched groundwater issues to the surface and mixes with a stream, the water loses CO₂ as it approaches equilibrium with the atmosphere (Jacobson and Langmuir, 1970). The equilibrium solubility of calcite decreases substantially as CO₂ degasses, and the water becomes supersaturated with respect to calcite (Jacobson and Langmuir, 1970). The degree of calcite supersaturation increases downstream as the CO₂ content of the water decreases (Jacobson and Usdowski, 1975; Dandurand and others, 1982). When groundwater joins a warm summer stream, CO₂ degasses more readily from the water because CO₂ is less soluble at higher temperatures. Agitation of the stream water also results in more rapid outgassing of CO₂; thus, calcite precipitation tends to be most rapid in turbulent zones of the stream.

Metabolic interaction of biologic agents such as algae, fungi and bacteria can result in further loss of CO₂ and a corresponding increase in supersaturation with respect to calcite (Dean, 1981; Chafetz and Folk, 1984). Osmotic uptake of H₂O could result in the exclusion and subsequent deposition of calcium carbonate on these plants (Emig, 1917). Fungal influence on calcium carbonate deposition in streams is implied by Emig (1917) and Dennen and Diecchio (1984). Bacterially-constructed travertine is reported by Chafetz and Folk (1984), and evidence suggests that bacteria may be partly responsible for travertine deposition at Falling Spring Falls in Virginia (Dennen and Diecchio, 1984).

**DEPOSITIONAL MODEL**

Based on the depositional factors previously discussed, a depositional model for Virginia travertine-marl is proposed. Travertine-marl deposits form downstream from where a significant flow of carbonate-rich groundwater joins a surface stream (Figure 5, B and/or C) and are commonly associated with fractures or faults. The deposits form in summer or early fall during periods of the warmest water temperature and lowest surface flow. Precipitation of calcium carbonate proceeds downstream from the zone of mixing of the warm low calcium surface water and cool higher calcium groundwater (Figure 5, D). Deposition occurs only after the mixed waters reach supersaturation with respect to calcium carbonate, a result of CO₂ outgassing. CO₂ evolves from the stream by diffusion into the atmosphere which is enhanced by agitation. Buildups of travertine on ledges can cause pools to develop. Environmental warming of pooled waters, agitation of plunging and cascading waters, and the metabolic activity of biologic agents further increase the saturation index of calcium carbonate. Precipitation includes carbonate encrustation on plants, cobbles and bedrock exposures along the stream. As the travertine structures grow, loose calcium carbonate materials accumulate behind them. The agrading stream migrates across the valley in such a way that the dams and fill deposits of travertine and marl may become extensive. Large dams can form in a few hundred years (Emig, 1917).

Clastic sediments derived from mass wasting may be locally interbedded in travertine-marl deposits. Burial of some travertine-marl deposits by aluviation and incision of travertine structures have increased as a result of agricultural practices over the last two hundred years. Many deposits have undergone enrichment of calcium carbonate along the banks of incising streams. At most deposits seasonal deposition is not keeping pace with erosion.
SOIL DEVELOPMENT

The continued incising and resulting drainage of travertine-marl deposits often results in a distinctive soil development. Mollisols are dark basic soils (Soil Conservation Service, 1975); at least two of these soil types have been identified in association with travertine-marl deposits in Virginia.

The Weaver soil is associated with marl deposits in Clarke County. This is a brown to dark brown soil which contains up to 10 percent lime concretions and effervesces with dilute hydrochloric acid. The subsoil contains layers of marl (Edmonds, Circa 1970). A Weaver soil that contains two buried soil profiles is described in a recent soil survey of Clarke County (Edmonds and Stiegler, 1982). Interlayered and basal marls can be recognized from this description. A second important Mollisol, the Massanetta Series, is found in Rockingham County. The Massanetta Series soils contain anomalously high percentages of solid calcium carbonate material (McFarland, 1981).

ARCHAEOLOGICAL ASSOCIATIONS

Fragments of Indian pottery and charcoal were reported by Collins (1924) at a travertine-marl deposit in Augusta County. These materials were found at a depth of several feet, apparently in a terrace marl. The owner of the property noted that there were "several rings of fire discolored stones with charcoal in their midst" beneath the overburden overlying a travertine bluff.

A number of projectile points and pottery fragments were found at a commercial marl deposit in Frederick County. These artifacts were found beneath the soil layer near the top of the marl, in association with a number of stones believed to have outlined a fire pit.

Artifacts from Frederick County are identified as having been made by late middle to early late Woodland Indians of about 750 AD to 1000 AD (W. Boyer, 1984, personal communication). These were horticultural indians and their campsites are frequently found associated with the range of flora and fauna found in the swampy depositional environment of an aggrading marl.

PALEONTOLOGICAL ASSOCIATIONS

In addition to the leaf impressions mentioned previously, a number of other fossils and sub-fossils have been found in association with travertine-marl deposits. Downstream from Natural Bridge, Rockbridge County, *Helix alternata* and *Physa*...
mollusk shells were identified (Britton, 1886). *Bythinella nickliniana* Lea, *Planorbus bicornatus* Say, *Planorbus parvus* Say and *Pisidium* sp. were identified by Dr. Paul Bartsch from an Augusta County deposit (Kindle, 1911). Molluscs collected from a second Augusta County deposit were identified by Dr. H. A. Pilsbry as: *Circinaria concava* (Say), *Polygyra tridentata* (Say), *Polygyra brandulenta* (Pilsbry), *Gonyodiscus alternatus* carinatus (Beck), *Gastrodonta ligera* (Say), *Polygyra thyroidus* (Say), *Physa heterostropia* (Say), *Planorbus bicornatus* Say, (or *P. antrosus* of Conrad), *Campeloma decisum* (Say), *Sphaerium concava* (Trainer, 1948). Gillespie and Clendening (1964) reported gastropods and pelecypods in the stream at the site on Red Bud Run were identified by J. J. Murray (George L. Hayth, 1984, personal communication). Travertine-marl was put through a drier and then a crusher before being screened. Mr. Hayth reported his wages as a laborer in 1919 or 1920 as ninety cents a day, the scraper operator made two dollars and fifty cents a day. U. S. Bureau of Mines data indicates that agriculture lime from this deposit sold for about $3.00 a ton. Travertine or calcareous tufa material from Falling Spring Falls, Alleghany County was marketed as Barbers “Fallingsprings” Lime in the early to mid 1920’s (Ohio C. Barber Fertilizer Company, circa 1926). In 1944 the Falling Springs Lime Company was quarrying travertine just west of the falls. Raw material was hauled two miles by narrow gauge railroad to the town of Falling Springs where it was ground for agricultural use. A travertine sample from the locality contained 97.85 percent calcium carbonate, 0.90 percent magnesium carbonate, and 0.48 percent silica (Edmundson, 1958).

Marl from Valley and Ridge areas was marketed for many years. Rogers (1884) noted values for “carbonate of lime” (CaCO₃) ranging from 76 to 91 “grains in the 100” for ten Virginia marl localities. Some Virginia marls were used as a flux in iron-making (Watson, 1907). He cited four analyses of “lime” ranging from 48 to 53 percent for Alleghany, Frederick and Rockbridge counties. Analyses of four Virginia freshwater marls were presented by Shubert (circa 1921):
Table 1. Travertine-marl production for the Valley and Ridge province.

<table>
<thead>
<tr>
<th>County</th>
<th>Producer/Location</th>
<th>Deposit Name</th>
<th>Years of Production</th>
<th>Tonnage Sold</th>
<th>Total Yield of Deposit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alleghany</td>
<td>1a. Ohio C. Barber Fert. Co.</td>
<td>Barber, VA</td>
<td>1914-1926</td>
<td>201,570</td>
<td>387,760</td>
</tr>
<tr>
<td></td>
<td>1b. Falling Springs Lime Co.</td>
<td>Barber, VA</td>
<td>1927-1941</td>
<td>186,190</td>
<td></td>
</tr>
<tr>
<td>Augusta</td>
<td>1a. A.S. Bailey</td>
<td>Mount Sidney, VA</td>
<td>1929</td>
<td>30</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>1b. G.S. Bailey</td>
<td>Mount Sidney, VA</td>
<td>1940</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. James L. Coffey</td>
<td>Staunton, VA</td>
<td>1941-1944</td>
<td>285</td>
<td>285</td>
</tr>
<tr>
<td></td>
<td>3. Farmers Marl Lime Co.</td>
<td>Verona</td>
<td>1921-1922</td>
<td>2,250</td>
<td>2,250</td>
</tr>
<tr>
<td></td>
<td>4. Bennett W. Huff</td>
<td>Fort Defiance, VA</td>
<td>1921-1929</td>
<td>865</td>
<td>865</td>
</tr>
<tr>
<td></td>
<td>5a. J.S. Jordan</td>
<td>Staunton, VA</td>
<td>1921-1945</td>
<td>70,502</td>
<td>70,502</td>
</tr>
<tr>
<td></td>
<td>b. leased to Carver F. Marshall</td>
<td></td>
<td>1942</td>
<td>13,394</td>
<td>13,394</td>
</tr>
<tr>
<td></td>
<td>6a. Arthur B. Kerr</td>
<td></td>
<td>1940-1941</td>
<td>265</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Wilson &amp; Taylor</td>
<td>Staunton, VA</td>
<td>1942-1945</td>
<td>1,000</td>
<td>1,206</td>
</tr>
<tr>
<td></td>
<td>c. leased to Verona Marl Co.</td>
<td></td>
<td>1946-1947</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Botetourt</td>
<td>1a. Daleville Lime Marl Co.</td>
<td>Roanoke, VA</td>
<td>1919-1921</td>
<td>4,170</td>
<td>12,072</td>
</tr>
<tr>
<td></td>
<td>b. Botetourt Lime Marl Co.</td>
<td>Roanoke, VA</td>
<td>1922-1930</td>
<td>7,905</td>
<td></td>
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<tr>
<td></td>
<td>2. Roanoke Lime Co.</td>
<td>Roanoke, VA</td>
<td>1919-1920</td>
<td>4,189</td>
<td>4,189</td>
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<tr>
<td></td>
<td>3. Robinson Lime Marl Co.</td>
<td>Fincastle, VA</td>
<td>1947</td>
<td>No production reported</td>
<td></td>
</tr>
<tr>
<td>Clarke</td>
<td>1. Clarke Farmers Coop, Inc.</td>
<td>Berryville, VA</td>
<td>1940-1960</td>
<td>137,497</td>
<td>137,497</td>
</tr>
<tr>
<td></td>
<td>2a. W. R. Thompson</td>
<td>White Post, VA</td>
<td>1946</td>
<td>18,545</td>
<td>118,429</td>
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<tr>
<td></td>
<td>b. J. C. Digges &amp; Sons</td>
<td>White Post, VA</td>
<td>1947-1956</td>
<td>99,884</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(excl. 1947-1955)</td>
<td>Old Chapel Marl Pit</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>3. Fincham Marl Plant</td>
<td>Berryville, VA</td>
<td>1947-1949</td>
<td>26,272</td>
<td>26,272</td>
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<tr>
<td></td>
<td>4. A. Golightly &amp; Burkner</td>
<td>Berryville, VA</td>
<td>1950</td>
<td>13,000</td>
<td>13,000</td>
</tr>
<tr>
<td></td>
<td>5. Elmer Kinney</td>
<td>Berryville, VA</td>
<td>1958-1962c</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1966</td>
<td>500</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frederick</td>
<td>1. Cornwall Lime Marl</td>
<td>Winchester, VA</td>
<td>1923</td>
<td>1,942</td>
<td>1,942</td>
</tr>
<tr>
<td>Giles</td>
<td>2. Blankenship</td>
<td></td>
<td>1950</td>
<td>No production reported</td>
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<tr>
<td></td>
<td>2. Gatewood &amp; Talbott Co.</td>
<td>Huntington, WV</td>
<td>1945-1948</td>
<td>84,242</td>
<td>84,242</td>
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<tr>
<td></td>
<td>(sold to Langhorne &amp; Langhorne-1948)</td>
<td>Narrows</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>3. Rufus C. Hale</td>
<td>Narrows, VA</td>
<td>1941-1947</td>
<td>2,650</td>
<td>2,650</td>
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<tr>
<td></td>
<td>4. Langhorne &amp; Langhorne</td>
<td>Huntington, WV</td>
<td>1942-1947</td>
<td>141,056</td>
<td>141,056</td>
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<tr>
<td></td>
<td>5a. Wolf Creek Marl</td>
<td>Narrows, VA</td>
<td>1945-1946</td>
<td>42,640</td>
<td>84,571</td>
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<td></td>
<td>b. leased to Narrows</td>
<td>Narrows, VA</td>
<td>1947-1950</td>
<td>41,931</td>
<td>41,931</td>
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<tr>
<td></td>
<td>(contracting company)</td>
<td></td>
<td>(1952c)</td>
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<td>Montgomery</td>
<td>1a. J.N. Lantz</td>
<td>Salem, VA</td>
<td>1930-1938</td>
<td>911</td>
<td>911</td>
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<td></td>
<td>b. J. Gilbert Cox</td>
<td>Ellison, VA</td>
<td>1948-1949</td>
<td>No production reported</td>
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<tr>
<td>Rockbridge</td>
<td>1a. Calcium-Phosphate &amp; Fertilizer Company</td>
<td>Roanoke, VA</td>
<td>1918-1923</td>
<td>16,540</td>
<td>29,121</td>
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<td></td>
<td>b. Farmers Marl Lime Co.</td>
<td>Roanoke, VA</td>
<td>1918-1923</td>
<td>12,581</td>
<td>12,581</td>
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<tr>
<td></td>
<td>(name change)</td>
<td>Riverside</td>
<td>1918-1923</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>2. Dupont Chemical</td>
<td>Roanoke, VA</td>
<td>1918</td>
<td>6,000</td>
<td>6,000</td>
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<td></td>
<td>3. F.M. Hughson</td>
<td>Roanoke, VA</td>
<td>1922-1923</td>
<td>No production reported</td>
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<td>4. Marlbrook Lime Co.</td>
<td>Marlbrook, VA</td>
<td>1913-1931</td>
<td>109,205</td>
<td>109,205</td>
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<td></td>
<td>5. United Chemical Products</td>
<td>Buena Vista, VA</td>
<td>1923-1931</td>
<td>24,951</td>
<td>24,951</td>
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</table>

a. U.S. Bureau of Mines Mineral Production Data
b. On file with the Virginia Division of Mineral Resources file data
c. From U.S. Bureau of Mines “Minerals Yearbook”
Table 2. Travertine-marl production by year for the Valley and Ridge province for 1913-1956.

<table>
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<tr>
<th>Year</th>
<th>Tonnage</th>
<th>No. of Producers</th>
<th>Year</th>
<th>Tonnage</th>
<th>No. of Producers</th>
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<td>1913</td>
<td>3,750</td>
<td>1</td>
<td>1936</td>
<td>8,190</td>
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<tr>
<td>1914</td>
<td>10,400</td>
<td>2</td>
<td>1937</td>
<td>6,173</td>
<td>1</td>
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<tr>
<td>1915</td>
<td>22,500</td>
<td>2</td>
<td>1938</td>
<td>17,169</td>
<td>3</td>
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<td>1916</td>
<td>25,000</td>
<td>1</td>
<td>1939</td>
<td>19,603</td>
<td>2</td>
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<tr>
<td>1917</td>
<td>12,500</td>
<td>1</td>
<td>1940</td>
<td>37,500a</td>
<td>5</td>
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<tr>
<td>1918</td>
<td>37,720</td>
<td>4</td>
<td>1941</td>
<td>32,735</td>
<td>6</td>
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<tr>
<td>1919</td>
<td>37,790</td>
<td>5</td>
<td>1942</td>
<td>13,541</td>
<td>5</td>
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<td>1920</td>
<td>36,276</td>
<td>5</td>
<td>1943</td>
<td>61,659</td>
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<td>1921</td>
<td>27,248</td>
<td>7</td>
<td>1944</td>
<td>68,617</td>
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<td>1922</td>
<td>28,346</td>
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<td>1945</td>
<td>88,831</td>
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<td>1923</td>
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<td>3,265</td>
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Total 1,297,239

a. U.S. Bureau of Mines Mineral Production Data
b. Includes production figure from correspondence not reported by U.S. Bureau of mines

Virginia. Bath and Rockingham counties are noted as having preparations underway in 1912 for utilization of marls for agricultural purposes (Watson, 1913).

One deposit continues to yield lime in Frederick County, Virginia. This working initially contained an estimated 100,000-ton reserve of marl containing in excess of 90 percent calcium carbonate.

REFERENCES NOT LISTED IN ANNOTATED BIBLIOGRAPHY


ANOTATED BIBLIOGRAPHY OF THE VALLEY AND RIDGE TRAVERTINE-MARL DEPOSITS OF VIRGINIA

David A. Hubbard, Jr.


Quaternary (Recent) tufa terraces or dams have been observed in several Shenandoah Valley streams. Tufa or travertine is chemically deposited from streams having high concentrations of calcium carbonate. Precipitation results from the loss of carbon dioxide at riffles and small waterfalls. The tufas observed were brown to buff, porous, and punky. The loss of carbon dioxide at riffles and small waterfalls. The greatest accumulations were observed downstream from Hamburg on Mill Creek.


Travertine is found in some parts of the stream beds in and near Bristol. One deposit occurs along Beaver Creek in Monroe Park northwest of the intersection of Valley Drive and Old Abingdon Place.


Numerous springs in western Virginia are depositing quantities of calcareous tufa or travertine. Analysis of a Staunton deposit containing "a calcareous marl or travertine 10 or 12 feet deep" yielded 90.4 percent CaCO₃. Ellett and Eskridge, and Roger's works were acknowledged.

BRENT, W. B., 1960, Geology and mineral resources of Rockingham County: Virginia Division of Mineral Resources Bull. 78, 174 p.

"Travertine" is found in old and present stream beds in Rockingham County. Travertine is defined as a precipitation product from hot springs. Therefore, most of the deposits of calcium carbonate in stream beds of the county would not commercially be classed as travertine. They are classed commercially with the marbles.


Quantities of calcareous tufa occur along the banks of a small stream entering Cedar Creek below Natural Bridge. Mollusk shells of Helix alternata and Physa and twigs of Arbor Vitae are found in the deposit. Deposition is recent and may still be occurring.


Travertine and marl occur along Falling Springs Creek, near Staunton, Virginia. The run is fed by springs in the upper valley. Three distinct terraces with small water-falls at their abrupt lower slopes extend over 40 acres. The deposits occur in two distinct forms, one a massive hardened variety forming the retaining walls of the terraces, the second type a fine, unconsolidated, sandy granular calcium carbonate of cream color, commonly known as marl. The second type is often used by farmers for liming the soil. The third terrace has been worked and fragments of Indian pottery and rings of fire blackened stones and charcoal were found. Tree limb and trunk casts, leaf impressions, fragments of bone and teeth, and molluscan shells were found. Mollusks identified include:

- Circinaria concavae (Say)
- Polypyrus tridentata (Say)
- Polypyrus pseudoulenta (Pilsbry)
- Gymnodiscus alternatus carinatus (Beck)
- Gastrodonta ligera (Say)
- Polypyrus thyroides (Say)
- Physa heterostropha (Say)
- Planorbis bicarinatus Say, (or P. antreas of Conrad)
- Campeloma decticum (Say)
- Sphaerium sulvatum (Lamarck)

Leaf impressions were of common chestnut oak and sycamore. The deposit may be of late Pleistocene age, but in all probability is recent.


Precipitation of calcium carbonate occurs along Falling Springs Creek, below the falls, in late summer and fall. Deposition is the result of degassing of CO₂, evaporation and biologic factors including: algae, fungi, and bacteria. Ancient travertine at an elevation higher than the spring indicates that the travertine started to form when the valley floor was higher than it is today.


The Falling Springs precipitates downstream from Falling Springs Creek waterfall. Seasonal changes in surface runoff and the activity of algae and bacteria are important to the formation of travertine. Ancient travertine consisting of waterfall/cascade deposits formed under conditions similar to those today, but at higher elevations.


Weaver series soils form on calcareous alluvial sediments and massive deposits of travertine. A soil section is recorded from approximately 660 feet west-northwest of where Virginia Highway 621 crosses Spout Run. Carbonate concretions, mollusk shells, and soft marly material make up 5 to 10 percent of the A and B horizons noted. The C horizons contain 40 to 50 percent calcareous materials. This soil profile contains two buried A and B horizon sequences. The deepest C horizon contains lime concretions with leaf imprints.

* refers to gastropod and pelecypod (misidentifiable as brachiopod by Edmonds and Stiegler)


A calcareous marl deposit at Calmes Neck, about two miles east of Millwood in Clarke County, is being operated for agricultural lime.


The travertine deposit on Falling Springs Creek was
actively quarried when visited in 1944, but is not now. Analysis of a sample shows 97.85 percent calcium carbonate, 0.90 percent magnesium carbonate, and 0.48 percent silica.


Marls occupying the flood plains of Clarke County streams are intermixed with variable amounts of sand and clay. Calcium carbonate content ranges from 65 to 94 percent with a magnesium carbonate content of less than one percent. Where free from other sediments, marls contain more than 97 percent CaCO_3. Commercial operations for agricultural lime were along Chapel Run. Massive travertine, coated pebbles and mollusk shells were observed in many streams. Some floodplains mapped as alluvium may contain marl deposits of commercial importance.


Marl is a earthy material of variable composition with a considerable percent of carbonate of lime. Analyses of five Valley and Ridge marls are listed with twenty or more percent lime: Allegheny Co. - 50.8 percent, Frederick Co. - 52.19 percent and 52.62 percent and Rockbridge Co. - 47.87 percent and 88.79 percent.


These tufa deposits are common along spring-fed streams incised in flood-plain alluvium. These impure deposits contain organic debris and fine grained silicious sediment.


Calcareous tufa extends along Falling Springs Creek from the 60- to 70-foot falls upstream to the spring. The tufa forms a broad floodplain and was deposited by the thermal waters from the spring.


Massive travertine deposits were found downstream from Falling Spring. The deposit was extensively quarried during the 1940’s. Travertine has been found 60 feet higher than the present stream level. The spring system is estimated to be at least 3 x 10^9 years old based on average rates of erosion in the region.


Travertine and travertine depositing waters along Marl Creek in Rockbridge County were observed. Summer travertine layers have only half as much quartz, feldspar and clay as winter layers. Calcium content of the winter stream was twice the summer.


Marl occurs along a minor tributary of Lewis Creek. Accumulations of clay and marl range from twenty to sixty feet. Great numbers of fresh water shells in the marls afford indisputable evidence of pond conditions of accumulation. A well at the ice plant reportedly passed through 12 feet of marl. Shells collected from marl beds represented:

- *Bythinella stickinsoni* Lea
- *Planorbus bicorinatus* Say
- *Planorbus parvus* Say
- *Pisidium* sp.

These species indicate a post-Pleistocene age of the beds.


Calcium carbonate dissolved from highly fractured and faulted carbonates was found to be precipitated by the algae *Oocardium stratum* in swift streams, and in smaller amounts by *Chara vulgaris* in still and eddy waters. *Calothrix viguieri* was observed, but thought to play a very minor role in the deposition.


Groundwater rising from highly fractured and faulted dolomitic limestone is responsible for precipitation of CaCO_3 in Montgomery County. The presence of *Oocardium stratum* is of major importance to the deposition of CaCO_3 downstream from these springs. Inorganic factors affecting deposition include increasing temperature and loss of CO_2 to the atmosphere. *Chara vulgaris* and *Calothrix viguieri* are other algae influencing deposition.


A tufa/travertine fan lies just beneath the surface between the parking lot and Palmer Spring.


Massanetta Series soils contain a large percentage of solid carbonate material. This soil type typically occurs along small streams downstream from the point at which a fault or fault zone in carbonate rock crosses the stream. Carbonate layers and deposits in the soil are attributed to soil forming processes. Travertine was observed to be forming in the stream channel.


Massanetta Series soils were mapped along streams draining faulted carbonate rocks. Carbonate content in these soils increased with depth to 65 percent in the C horizon. The deposition of calcite in these soils is attributed to surface evaporation.


The commercial marl deposit 0.5 mile northwest of Daleville is cited from Woodward (1932). No commercial operation involving marl deposits is known to have occurred since the 1930’s.


An analysis of precipitated lime: 97.84 percent CaCO_3, 0.13 percent MgCO, and a table of comparison values of CaCO_3 and “Percentage Soluble in Rain Water or Soil Moisture” for “Precipitate lime”, Murate (sic), Helderburg, Shenandoah and Lewiston Limestones are presented. A number of letters from satisfied customers indicate production has been carried out since the early 1920’s.


Travertine along Folly Mills Creek may be greater than fifteen feet thick. Plant fragments and leaves are a common feature in this travertine.


Some warm springs are currently forming marl, and some are cutting away earlier deposits. Other springs have not formed.
such deposits. Deposits are a few feet wide and possibly several hundred feet long in the valleys fed by warm springs. Deposits are not limited to warm springs, marls occur below cold springs, as along Falling Springs Creek.


Analyses of "carbonate of limes" are given for eleven Virginia marl locations, ten of which are within the current state boundaries. Analyses ranged from 76 to 91 "grains in the 100".

SCHUBERT, F. A., circa 1921, Fresh water marl in the Virginias: Norfolk and Western Railway, 6 p.

Fresh water marls are found throughout the Shenandoah Valley and southwest Virginia from the Potomac River to the Tennessee line. Spring waters highly charged with acids act on limestones. As the stream comes in contact with waters of a different chemical composition or the waters of the streams become supersaturated with lime, precipitation takes place down the stream to where it empties into another stream, where the precipitation is the most active.

Analyses of Virginia samples include: Montgomery County - 94.75 percent calcium carbonate and 4.20 percent magnesium carbonate, Rockbridge County - 96.70 percent calcium carbonate and 1.39 percent magnesium carbonate; Rockingham County - 97.75 percent calcium carbonate and 0.73 percent magnesium carbonate; and Washington County - 93.00 percent calcium carbonate and 1.94 percent magnesium carbonate.

The principle use for fresh water marl is for agricultural purposes. Fresh water marl deposits collectively contain "a number of" million tons. Fresh water marls can be transported to any rail station in Virginia at a price ranging from $2.00 to $3.00 a ton depending on distance. Virginia manufactures along the Norfolk and Western Railway include: R. C. Copenhaver, Abingdon, Va.; Daleville Marl Company, Cloverdale, Va.; Marlbrook Lime Company, Roanoke, Va.; and F. M. Hughson, Roanoke, Va.


Massive porous deposits of tuffa or travertine have formed along a number of streams draining areas underlain by carbonate rocks. These materials are formed generally at waterfalls, rapids, or cascades where agitation has resulted in a loss of carbon-dioxide and promoted precipitation of calcium carbonate.


Mosses and algae furnished a framework for travertine deposition on rapids and falls near Lexington, Virginia. Travertine was classified into cascade, pool and fan deposits. Winter layers were thin compact and relatively elastic compared to summer layers. The present destructive erosion of the deposits is a consequence of land cultivation. Increases in water temperatures result in the deposition of travertine.


The moss Philonotis calceara is the most important travertine builder. Calcite gathered on the dead tissues of these mosses. Decay is believed to be a factor in deposition. Travertine may have imprints of leaves, tree trunks and other plant structures, all species are living today. Travertine deposits are found only associated with rapids and falls. Falls grow vertically as well as downstream. Some falls were raised 25 feet and possibly several hundred feet long in the valleys fed by warm springs. Deposits are small and occur as fillings in parts of a fault zone. Thickest accumulation occurs on Cambrian carbonates near Wolf Creek.

Such deposits are tough and mossy or algal, and plainly show summer and winter layers. Travertine is forming on mosses and algae on cascades and as encrustations in pools. Muddy waters are not causing erosion to exceed retention. Waters downstream from the feeder spring show progressive loss of CaCO$_3$ but are still supersaturated.


Monthly testing of Wilson Creek in Rockbridge County revealed CaCO$_3$ content of two or three times saturation. CaCO$_3$ content decreased downstream from the feeder spring except during the coldest months, a period of maximum stream flow, when a weaker uniform content was found along the profile. Physical factors of deposition were ascribed to a rise in temperature, aeration, and close contact with calcite.


A feeder spring was more supersaturated with CaCO$_3$ than Wilson Creek. When the stream was cold (below 8°C) sampling showed that little or no CaCO$_3$ was deposited. At higher temperatures, the stream showed a progressive loss of CaCO$_3$ downstream. The supersaturation of the stream with respect to both CaCO$_3$ and CaCO$_3$ results from the high CaCO$_3$ content of soil gas, reported as ranging from 1 to 8 percent by volume. Cultivation has resulted in a decline in the CaCO$_3$ content of the springs, as a result of reduced levels of CO$_2$ in the soils. Floods have resulted in the entrenchment of travertine deposits to depths of 25 feet. Where deposition occurs on cascades, calcite is deposited at the base of Philonotis calceara. Concentrations of these plants result in a framework for the calcite deposit.


Tufa deposits were found in three locations along Smith Creek, Holman Creek, and a tributary of Passage Creek. The deposits were of two types: 1) dams, and 2) concretionary masses and pellets. A number of dams were observed to be partially buried under alluvium. Some of these dams were growing where exposed by the stream. "In all three areas of tufa deposition the material is deposited from a stream at points downstream from where the stream carries a fault... The calcium carbonate is brought to the surface by underground water circulating in the fault plane or fault zone; the crushed condition of the limestone makes its solution easy." A reduction in the solubility of calcium carbonate in streams is the result of outgassing of carbon dioxide by agitation and solar heating. The presence of algae is noted but their responsibility for deposition of CaCO$_3$ is uncertain. Dams were formed under drier conditions, perhaps during the Post-Glacial Thermal Maximum from 6000 to 4000 years ago.


Organic and inorganic agencies appear to be responsible for deposition of travertine. Fossils found in the deposit include leaf impressions from elm, black walnut, sycamore, and black gum trees and freshwater as well as land snails. Part of the deposit may be of Pleistocene age.


An old stream valley has been filled to some depth with marl and alluvial wash. Springs are numerous along the valley borders.


Quaternary calcareous tufa is locally associated with limestones and dolomites. Deposits are small and occur surficially or as fillings in parts of a fault zone. Thickest accumulation occurs on Cambrian carbonates near Wolf Creek.
in the vicinity of Shumate.


Analyses from Ellett and Baker are quoted. Uses of marl as a fertilizer and limited use as a fluxing material in some iron furnaces are cited.


Calcarenous marls are found in the Valley region west of the Blue Ridge. Their only development in Virginia has been for local use.

WATSON, T. L., 1913, Biennial report on the mineral production of Virginia during the calendar years 1911 and 1912: Virginia Geol. Survey Bull. 8, 76 p.

Fresh water calcarenous marls of excellent grade and in quantity are found in several counties of the Valley region west of the Blue Ridge. Preparations were under way in 1912 in Bath and Rockingham counties to utilize these marls for agricultural purposes.


The largest of several small scattered marl deposits occurs about half a mile northwest of Daleville in Botetourt County. The marl was irregularly deposited on the floor of an old lake less than one acre in extent and had a maximum thickness of twenty feet. Abundant fossil leaves, stems of plants and gastropod shells were found in the deposit. Owned by Messrs. Ikenberry and Thomas, this occurrence was worked until 1920. A small crusher was used to process the material for use as fertilizer. Other marl beds are located west of Blue Ridge Springs near the Lynchburg or Grubb iron mines and along Catawba Creek on the old McCormick farm approximately 6 miles southwest of Catawba Sanatorium.

WOODWARD, H. P., 1936, Geology and mineral resources of the Natural Bridge region, Virginia: Virginia Division of Mineral Resources Open File Rept. 12, 350 p.

Calcarenous fluvial deposits of travertine are precipitated from solution by ground and surface waters. Cellular or frothy, in structure, these deposits are common in stream channels at, or near, small waterfalls, where they tend to increase the size of the falls. Deposits were observed along Lipsley Run, Cascade Creek and in the area south and southwest of Springwood. The deposits are extremely local and of no economic value. An analysis is reported for Rockbridge County.

SINKHOLE STUDY

The Virginia Division of Mineral Resources is collecting current and historic reports of sinkhole collapse. Newspaper accounts (including name of newspaper and date) or other written reports are being sought. Reports should include date of formation of the sinkhole, location — including road directions from nearest town, shape and dimensions, extent of property damage, name and address of landowner, and any information related to possible cause of the sinkhole (eg. new well tested 100 feet away, water main leaking, or heavy equipment had been working over the site, etc.).

Please report sinkhole collapses to:

D. A. Hubbard
Virginia Division of Mineral Resources
P.O. Box 3667
Charlottesville, Virginia 22903

JERRYGIBBSITE DISCOVERED

A violet-pink mineral discovered in Franklin, New Jersey has been named jerrygibbsite in honor of G. V. Gibbs, professor of mineralogy at Virginia Polytechnic Institute and State University, Blacksburg.

The mineral was discovered by a group of scientists doing a survey of the chemical composition of specimens of leucophoenicite, a non-commercial humite mineral. They found a second, closely related, mineral and named it for Gibbs “in recognition of his outstanding contributions to the science of mineralogy and the society of mineralogists.”

Jerrygibbsite is made up of the same elements as leucophoenicite but put together differently and is probably a member of the leucophoenicite group. Both minerals have a Mohs hardness of approximately 5.5, but jerrygibbsite is denser at 4.0 than leucophoenicite at 3.8. Jerrygibbsite is more brown and violet colored than most leucophoenicite but is not easily recognized without X-ray or chemical data, according to the scientists who discovered it (Pete J. Dunn, Donald R. Peacor, William B. Simmons and Eric J. Essene, in American Mineralogist, 1984). Gibbs is the second Virginia Tech professor with a mineral named after him; in 1981, wonesite, a mica mineral, was named for David R. Wones.

MINERAL RESOURCE NEWS

Texasgulf Chemicals Company is presently renovating the old Greer Lime Company high-calcium lime plant in Saltville, Smyth County. There will also be some new phases of construction on the site. The company plans the ship phosphate rock from its active operation on Lee's Creek, North Carolina by railroad to Saltville. In Saltville, the raw material will be defluorinated by heating the material in coal-fired rotary kilns. The product will be marketed as an animal and poultry feed supplement. It will be shipped in bulk by truck. Plant and kiln renovation and new construction work should be complete by late summer, 1985.

United Fiberglass, Inc. is operating a home insulation plant in northern Virginia, in Prince William County at Woodbridge. The company utilizes a ground dolomite from Virginia and feldspar and glass-grade sand from out-of-state sources. A borate mineral is also imported from out of state, prepared in Virginia, and utilized in their batch process. The ingredients are heated in an electric furnace to produce a mineral wool for home insulation.
Refractory-grade dolomite is used in open-hearth steel furnaces to cover and increase the life of the refractory brick and maintain the hearths. The lime (CaO) component helps to resist the erosive effect of high-acid slag. Presently, seawater periclase (stable form of MgO), which is expensive and imported chromite are more widely used for various refractory processes in the United States. In 1982, the U.S. Bureau of Mines reported refractory dolomite production of just over 450,000 short tons. The Bureau is conducting studies on potential refractory dolomite resources in order to decrease domestic dependence on imported chromite and the more expensive seawater-derived periclase.

In early 1983, the Virginia Division of Mineral Resources, during the course of its long-term carbonate evaluation project, sampled several dolomites units between Clarke County in the northeastern part of the Valley and Ridge province and Lee County in the extreme southwestern part of the State. Samples were taken at six different locations (Figure) from three different rock units, and tests were made as a preliminary reconnaissance study of materials potentially suitable for refractory grade dolomite. Differential Thermal Analysis (DTA) (Table 1) was run on six samples by heating the material at a definite rate to produce a particular curve or pattern to identify the mineral under examination. Chemical analyses (Table 2) and physical tests (Table 3) were also performed on the six samples.

Table 1. Differential Thermal Analysis (DTA).

<table>
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<th>Sample</th>
<th>Formation</th>
<th>CaCO₃</th>
<th>MgCO₃</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>SiO₂</th>
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<td>Mayn.</td>
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<td>Shady</td>
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<td>0.27</td>
<td>1.52</td>
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<td>87-C</td>
<td>Honaker</td>
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<td>43.01</td>
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<td>0.05</td>
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<td>0.28</td>
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<tr>
<td>216-B</td>
<td>Shady</td>
<td>54.44</td>
<td>44.05</td>
<td>0.10</td>
<td>0.27</td>
<td>1.97</td>
</tr>
</tbody>
</table>


Figure. Dolomite sample locations.
Table 2: Chemical Analyses (percent).

<table>
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<th>Sample</th>
<th>Formation</th>
<th>Endothermic peak temperatures, °C</th>
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<td>Shady</td>
<td>805 984</td>
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<td>87-C</td>
<td>Honaker</td>
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<td>Shady</td>
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</tr>
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<td>797 982</td>
</tr>
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<td>796 980</td>
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<td>Standard (1st)</td>
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<td>812 967</td>
</tr>
<tr>
<td>Standard (2nd)</td>
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<td>815 955</td>
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</table>


Table 3. Physical tests performed at Dept. of Geophysical Sciences laboratory, Old Dominion University, Norfolk, Virginia.

<table>
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<th>Sample</th>
<th>Bulk Volume</th>
<th>Porosity</th>
<th>Grain Density</th>
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<td>31-C</td>
<td>2.32</td>
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<td>2.56</td>
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<tr>
<td>53-D</td>
<td>2.08</td>
<td>0.02</td>
<td>2.76</td>
</tr>
<tr>
<td>87-C</td>
<td>2.32</td>
<td>0.04</td>
<td>3.07</td>
</tr>
<tr>
<td>135-C</td>
<td>2.21</td>
<td>0.03</td>
<td>2.64</td>
</tr>
<tr>
<td>135-D</td>
<td>2.03</td>
<td>0.04</td>
<td>2.65</td>
</tr>
<tr>
<td>216-B</td>
<td>2.08</td>
<td>0.04</td>
<td>2.65</td>
</tr>
</tbody>
</table>

*Although the grain density of this sample appears anomalously high, an X-ray analysis indicated only dolomite, calcite, and quartz. No barite or celestite was noted. Visible pyrite appears in the sample and may account for the difference in weight. Another sample from the same formation in the vicinity was also evaluated; density of sample No. 2 was 2.91.*

ROCK UNIT LITHOLOGIES

Honaker Dolomite -- thin to medium-bedded, light gray to medium-dark gray, micro- to fine-grained dolomite. Thickness of the unit ranges up to 2000 feet.

Maynardville Formation -- medium to dark gray micrograined limestone with dolomitic lamination (ribbon-banding), and fine-to-medium grained, very light to light gray dolomite intervals (Chances Branch Member). Thickness of the unit is approximately 100 feet.

Shady Dolomite -- massive, white to pinkish gray and light to dark gray, fine-to-medium-grained high-magnesium dolomite. In Clarke County, thickness of this unit is estimated at 1000-1500 feet.

SAMPLE LOCATIONS

31-C, Lee County, Coleman Gap 7.5-minute quadrangle (N4,053,450 E287,380, Zone 17) Maynardville Formation (Chances Branch Member), 10-foot section, west side of State Road 683 and 2700 feet north of Virginia-Tennessee line.

53-D, Wythe County, Sylvatus 7.5-minute quadrangle (N4,078,350 E512,770, Zone 17) Shady Dolomite, grab sample from quarry of H. D. Crowder and Sons.

87-C, Russell County, Honaker 7.5-minute quadrangle (N4,097,730 E417,450, Zone 17) Honaker Dolomite, 4-foot section from southwest quarry wall of E. Dillon and Co.

135-C, Botetourt County, Buchanan 7.5-minute quadrangle (N4,153,620 E617,900, Zone 17) Shady Dolomite, 8-foot section from south-southeast quarry wall of James River Lime Stone Co., Inc.

135-D, Rockbridge County, Arnold Valley 7.5-minute quadrangle (N4,164,480 E631,450, Zone 17) Shady Dolomite, 10-foot section in roadcut on the northwest side of State Road 708, 0.25 mile by road southwest of its intersection with Virginia Highway 130 at Natural Bridge Station.

216-B, Clarke County, Berryville 7.5-minute quadrangle (N4,334,580 E247,940, Zone 18) Shady Dolomite, 8-foot section from north quarry wall of Stuart M. Perry, Inc.

CONCLUSIONS

Each sample gave DTA curves typical of dolomite, showing a deep endothermic peak at about 800°C representing decomposition of the MgCO₃ component and another deep endothermic peak at about 980°C representing decomposition of the CaCO₃ component. Chemical analyses indicate that two of the samples (135-C, 135-D) fall within the generally accepted range of refractory dolomite specifications of a maximum of 0.75% SiO₂, 0.4% Fe₂O₃ and 0.3% Al₂O₃ in the raw material.

Besides chemical composition requirements, physical properties of dolomite such as porosity and density values are also important in determining suitability. Bulk volume, porosity and density values were determined for this study.

These data can be used with data for refractory properties of actual calcined grain prepared in the kiln to determine which materials may be suitable for producing refractory-grade dolomite. Raw materials with variances in hydration, microstructure and thermal behavior may have different grain densities when calcined, some of which may not be suitable for lining steel furnaces.
ABINGDON OFFICE

The Virginia Division of Mineral Resources has opened a Southwest Regional Office in Abingdon, Virginia. It is located in Room No. 100, Johnson Center, 468 East Main Street (Phone 703-628-3940). Geologists in the office are conducting field investigations in the Appalachian Plateau, Valley and Ridge, and Blue Ridge provinces of southwest Virginia. In addition, the staff will provide information to individuals, companies and governmental agencies. A complete set of Virginia Division of Mineral Resources publications and selected U.S. Geological Survey publications are available for use in the office. Because of the field duties of the personnel, an appointment should be made before visiting to ensure the office is open.

MINERAL UPDATE

Wm. F. Giannini1 and Richard S. Mitchell2

Anglesite (lead sulfate), sphalerite (zinc, iron sulfide), and brochantite (hydrous copper sulfate) were recently discovered in the Albemarle-Nelson county soapstone belt (W.F. Giannini). X-ray analyses were used to confirm the identification of the three specimens (R.S. Mitchell). All minerals were found in a dump adjacent to an abandoned soapstone quarry (Figure). This is the first known occurrence of these minerals from the soapstone belt.

Anglesite occurs as gray, prismatic, tabular crystals associated with sphalerite, brochantite, chalcopyrite, and millerite. All five minerals were found in cavities occurring in a ferroan dolomite vein cutting soapstone. The sphalerite exhibits a tetrahedral crystal form and is amber colored, whereas the brochantite occurs as a dark green crust on chalcopyrite.

Anglesite is an ore of lead, sphalerite a zinc ore, and brochantite an ore of copper. The scarcity of these minerals in the soapstone near the surface renders them of interest only to mineralogists and collectors, however, this occurrence may be a reflection of larger deposits elsewhere.

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tesville, VA.
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OIL AND GAS NEWS

Thirty-nine thousand acres in seven eastern states including more than 1400 acres in Virginia National forests may contain oil and natural gas potential according to the Bureau of Land Management. In Virginia the lands are 729 acres in George Washington National Forest in Highland County and 693 acres in Jefferson National Forest in Dickenson County.

The revised version of State Minerals Management Plan of Virginia is available from Virginia Division of Mineral Resources and the Department of General Services, Division of Engineering and Buildings. This Plan outlines the regulations regarding mineral surveys, exploration, leasing, and extraction of State-owned lands.

Over 20 million acres off the coasts of New Jersey, Maryland, Delaware, Virginia, North Carolina, New York, and Rhode Island are tentatively scheduled for competitive oil and gas leasing in 1985 by the Department of Interior. Blocks offered for leasing are located from 50 miles (25 miles off North Carolina) to 140 miles offshore. The water depths are between 132 feet and 10,560 feet.

ANR Production Company expects 20 million dollars in sales this year from 63 gas wells in Wise County. ANR expects to drill 35 wells in 1985.
TOPOGRAPHIC COUNTY MAPS

Multicolor county topographic maps, scale 1:50,000, are now available for 13 Virginia counties (map). These maps show by color and symbols cultural and natural features of the county and sell for $4.16 each.

Information for these maps was obtained from the interpretation of recent aerial-mapping photography, from review by planning district commissions, and from compositions of detailed 1:24,000 scale maps. They were prepared by the U. S. Geological Survey within a jointly funded program with the Division of Mineral Resources and the Appalachian Regional Commission.

The county maps are useful for planning, governmental land-use programs, and personal recreational activities such as hunting, fishing, and camping. They are also valuable as route locators for emergency response to fires and accidents.

Ozalid one-color paper copies are available for Dickenson, Russell, Scott, and Wise counties at $4.16 each (map).