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FIELD GUIDE TO THE ORDOVICIAN WALKER MOUNTAIN SANDSTONE MEMBER: PROPOSED TYPE SECTION AND OTHER EXPOSURES

John T. Haynes[1] and Keith E. Goggin[1]

STRATIGRAPHY AND TYPE SECTION

The Walker Mountain Sandstone Member is a thin but widespread sheet deposit in the Ordovician (Mohawkian) Bays, Moccasin, and Eggleston Formations of the Valley and Ridge province, Virginia and Tennessee (Figure 1). It was defined by Butts and Edmundson (1943) as "... the upper of two sandstones in the Moccasin formation. It is a thick-bedded, gray quartzose rock 8 to 12 feet thick ... best displayed along Keywood Branch road about half a mile north of Seven Springs and along State Route 91 about a mile northwest of McCall Gap ... . Thin sandstones near the horizon of the Walker Mountain sandstone member persist northward along the same belt of outcrop at least to a point about a mile north of Newport, Giles County ... . The Walker Mountain sandstone is believed to be the same as the sandstone which Keith (1905, p. 6) called Clinch in Bays Mountain. Both are overlain by the Martinsburg formation."

The stratigraphic setting of the Walker Mountain Sandstone Member has been discussed by Cooper (1956), Hergenroder (1966), Kreisa (1980), and Haynes (1992). Cooper (1956) merely noted its existence and the origin of the name. Hergenroder (1966) and Kreisa (1980) recognized it in outcrops along Buckeye and Spruce Run Mountains in Giles County in addition to the entire Big Walker Mountain outcrop from New Castle south to Abingdon. Hergenroder (1966) tentatively correlated it with the "middle sandstone member" of the Bays Formation in the Bays Mountains of east Tennessee. Based on its petrography and stratigraphic relationship to certain K-bentonites, Haynes (1992) recognized the sandstone in several outcrop belts north and east of Big Walker Mountain and confirmed that it is the white sandstone below the Trenton ("Martinsburg") Formation in the Bays Mountains, which Keith (1905) mistakenly called Clinch; this is also the "middle sandstone member" of Hergenroder (1966). In addition, we recognize it for the first time in the Rich Patch and Warm Springs Valleys (Cliff Dale Chapel, Rich Patch, and Falling Spring sections in Figure 1) as the "buff quartz arenite" that Kay (1956) identified as the basal bed of the Eggleston Formation in his measured sections for Richpatch Cove and McGraw Gap. Because Kay identified this sandstone at several other sections in the western anticlines, those sections are included in Figure 1 as well. These studies define the areal extent of the Walker Mountain Sandstone Member.

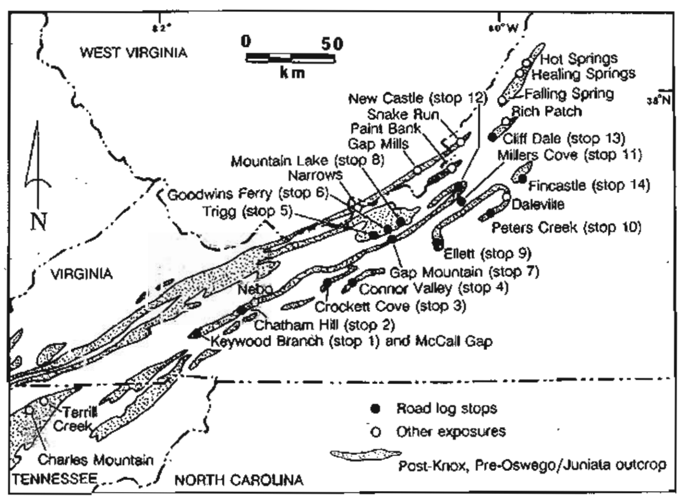

Figure 1. Outcrop pattern of Ordovician strata showing exposures where the Walker Mountain Sandstone Member or its lateral equivalent is present.

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[1] George Mason University, Fairfax, Virginia 22030

A specific type section has never been designated, thus it is here proposed that the exposure on State Road 750, the road along Keywood Branch, in Washington County serve as a type section for the Walker Mountain Sandstone Member (Figure 2), and be known as the Keywood Branch section. This exposure is in the Big Walker Mountain outcrop belt (Figure 1), which is appropriate because the Walker Mountain Sandstone Member, a lithostratigraphic unit, takes its name from that mountain. Further, it is our judgment that this outcrop of the Walker Mountain, shown in Plate 3 of Butts and Edmundson (1943), along with the lesser outcrop on the immediately adjacent railroad right-of-way, is the most accessible, good exposure along the southwestern end of Big Walker Mountain, since 1943 the *de facto* stratotype of the sandstone. At the proposed type section and at the nearby McCall Gap section Hergenroder (1966) recognized that the Walker Mountain is in the red calcareous mudrocks of the Bays Formation (Lowville-Moccasin Formation of Butts and Edmundson); these redbeds are now poorly exposed at McCall Gap and their exposure at Keywood Branch is only marginally better.

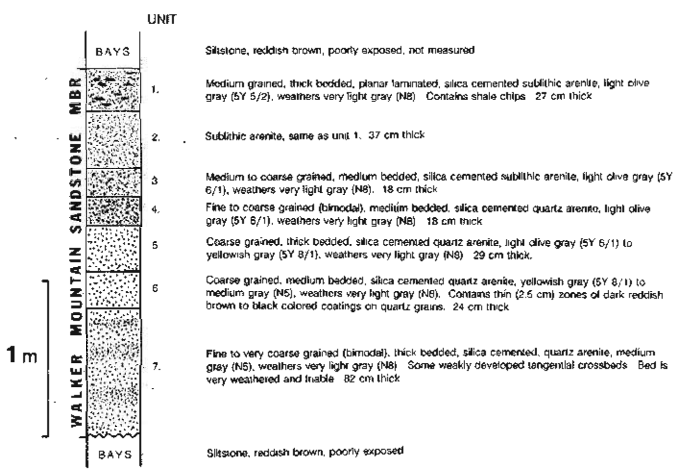
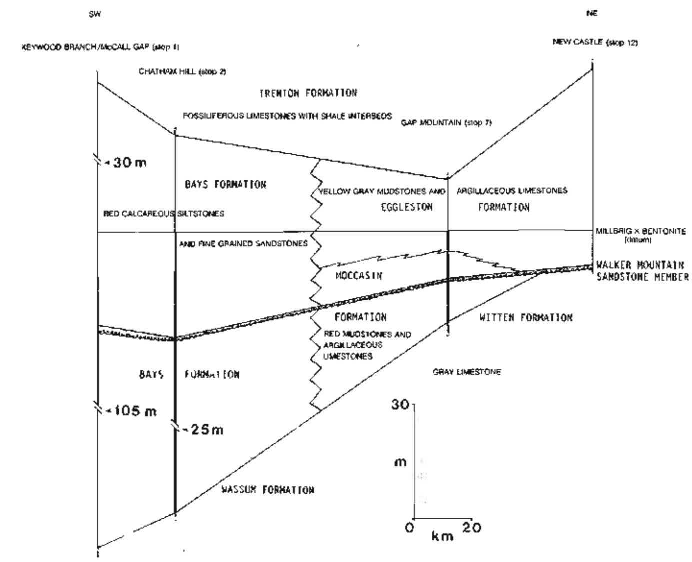


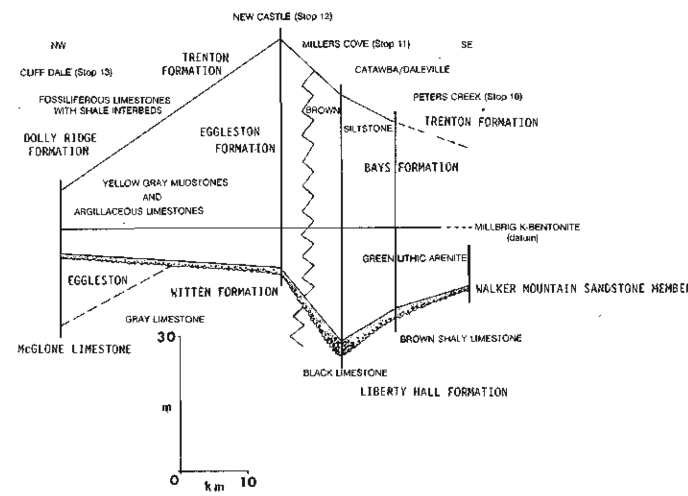
Figure 2.Stratigraphic column and description of the Walker Mountain Sandstone Member at Keywood Branch, Washington County, Virginia, the proposed type section. This is Stop 1 of the Road Log.

The Walker Mountain is 2.36 meters thick at Keywood Branch; elsewhere its thickness ranges from 0.6 meter at Gap Mountain along the New River in Giles County (Stop 7) to about 6.5 meters at Crockett Cove along Interstate Highway 77 in Wythe County (Stop 3). In general it is thicker and coarser toward the Salem synclinorium, the present-day eastern margin of the depositional basin. Appreciable thickening also occurs in the Bays Mountains of Tennessee (Hergenroder, 1966). To the west and northwest of Big Walker Mountain and the Bays Mountains the Walker Mountain sandstone is finer grained, and in the westernmost outcrop belts it has not been recognized (Figure 3).

The contact of the Walker Mountain Sandstone Member with underlying units is everywhere very sharp. A distinct



A.



B.

Figure 3.Cross-sections showing the persistence of the Walker Mountain Sandstone Member through major regional facies changes. See Figure 1 for section locations. **A.** Along strike facies changes, Big Walker Mountain outcrop. **B.** Across strike facies changes, Rich Patch Valley to the Salem synclinorium.

break in the sedimentary sequence is indicated by medium to coarse grained to conglomeratic sandstone of the Walker Mountain resting directly on finer grained sandstone, siltstone, and limestone (Figure 4). Except in the Rich Patch and Warm Springs Valleys this contact is an erosional unconformity, and at many exposures it reflects the regional change in depositional regime from the ramp-to-basin carbonate sequence below (Read, 1980) to the clastic sequence above (Haynes, 1992). This unconformity is most pronounced in the eastern exposures (Crockett Cove, Connor Valley, Millers Cove, Ellett, Peters Creek, and Daleville sections of Figure 1), where the basal bed of the Walker Mountain is commonly a coarse grained to conglomeratic quartz arenite. Pebble lags and abrupt changes in depositional regime define several unconformities in Silurian and Devonian strata of this region as well, and like the sub-Walker Mountain unconformity those unconformities are most pronounced in the eastern outcrop belts (Dennison and others, 1992).

At Crockett Cove and Conner Valley 0.5 to 3.0 meters of fine to medium grained sandstone separates the underlying limestone of the Witten and Wassum Formations respectively from the overlying conglomeratic bed that elsewhere is the base of the Walker Mountain. The sandstone is assigned to the Walker Mountain on the basis of practical mappability; the unconformity beneath them is the most readily mapped contact, and sedimentologically the sandstone belongs with the overlying clastic rocks of the Bays even though a second unconformity may exist between the finer grained sandstone and the overlying conglomeratic sandstone.

Unlike the lower contact, the upper contact of the Walker Mountain is gradational, and thus more difficult to define; however, where the Walker Mountain is a member of the "red" Bays, Moccasin, or Eggleston Formations, we map it at the top of the youngest medium to coarse grained sandstone, either a quartz or sublithic arenite, and where it is a member of the "green" Bays Formation we map the contact at the top of the youngest quartz arenite.

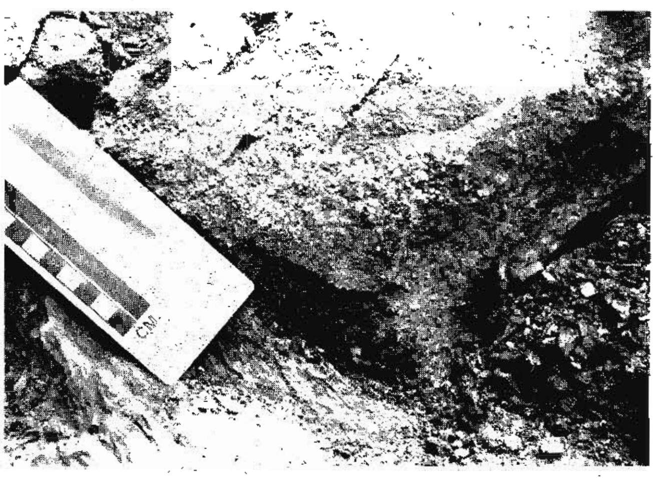


Figure 4. Abrupt contact of Moccasin Formation red siltstones below and conglomeratic white quartz arenite above, which is the basal bed of the Walker Mountain Sandstone. Goodwins Ferry section, bedding top to right (Stop 6).

PETROLOGY AND ORIGIN

In most exposures the basal bed of the Walker Mountain Sandstone Member is a conglomeratic quartz arenite, and the succeeding beds are medium to coarse grained quartz and sublithic arenites (terminology of Pettijohn and others, 1987). This conglomeratic sandstone is the most distinctive and recognizable bed of the Walker Mountain. The rock is compositionally very mature, and texturally many samples exhibit marked bimodality (Figure 5). Grains of the larger mode are very well-rounded, and strained and unstrained monocrystalline quartz is the predominant framework grain. Strained and unstrained polycrystalline quartz, chert, tourmaline, zircon, and, in the most conglomeratic zones, vein quartz (some with vermicular chlorite), metamorphic and sedimentary rock fragments, micritic rip-up clasts, and calcareous bioclasts occur (Figure 6 and 7). The smaller mode is almost exclusively subrounded to subangular monocrystalline quartz. In the Cliff Dale Chapel, Rich Patch, and Falling Spring sections there are no conglomerates; instead the unit is a medium to fine grained quartz and sublithic arenite with an appreciable clay matrix (Figure 8). Silica is the principal cement, with calcite present in appreciable amounts in some samples. Other cements are pyrite, hematite, sericite, and chlorite, the latter two being notably present in samples from the New Castle, Cliff Dale Chapel, Rich Patch, and Falling Spring exposures.

The quartz arenite is typically very light in color (Figure 9). Bedding in the coarsest beds is defined by alignment of the pebbles (Figure 10). In some beds both planar bedding, and high angle (near 30°) tabular and trough crossbedding occur (Figures 11 and 12). Both the unit as a whole and individual beds commonly are normally graded (Figure 12), and the basal bed may contain rip-up clasts of the underlying unit.

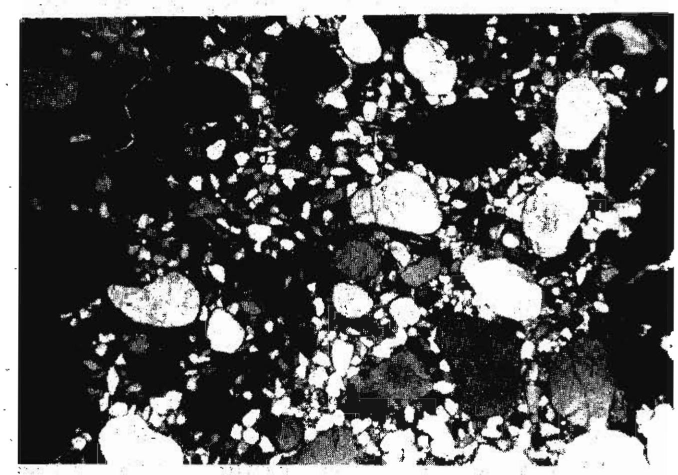


Figure 5. Bimodal texture in the Walker Mountain at Chatham Hill (Stop 2). Thin section, x 10, cross-polarized light.

Bimodal sands are found in deflation lags (desert armor) in modern deserts (Warren, 1972), and in ancient sediments bimodal textures are especially common in Lower Paleozoic sandstones (Folk, 1968). In both modern and ancient sediments bimodality is commonly attributed to eolian reworking of alluvial sediments into two components: (1) dunes of very well sorted medium grained sand, and (2) a deflation lag consisting of the more extreme grain sizes. Subsequent transgression across a deflation lag will result in a marine deposit that retains the bimodal texture.

Figure 6. Siltstone rock fragment (center) and large chert grain (upper left) in the coarse grained sandstone of the Walker Mountain at Mountain Lake Turnoff (Stop 8). Thin section, x 10, cross-polarized light.

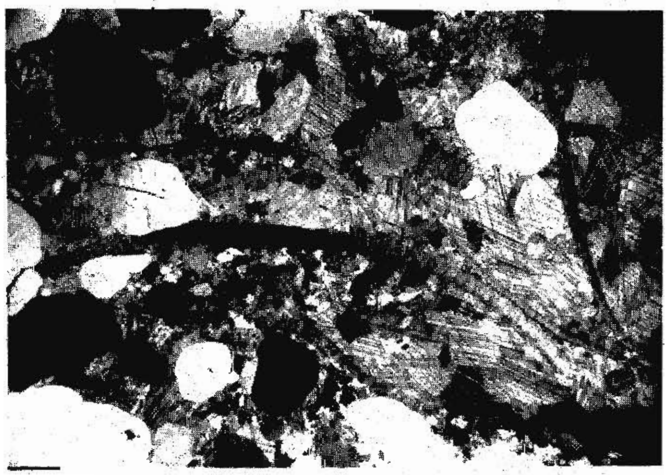


Figure 7. Bioclastic debris in the coarse grained sandstone of the Walker Mountain at Mountain Lake Turnoff (Stop 8). Thin section, x 10, cross-polarized light.

Quartz arenites are the most compositionally mature sandstones. They can be single cycle (Johnson and others, 1988; Savage and Potter, 1991) or multicycle (Pettijohn and others, 1987, and references therein) in origin. In any terrigenous sand the presence of chert grains and sedimentary rock fragments unequivocally implies the recycling of older sediments, pointing in part to a multicycle origin. The coarsest beds in the Walker Mountain contain one or both of these constituents, therefore these sands are interpreted as having a multicycle component.

The framework grain composition, the compositional maturity, the bimodal texture, and the presence of intrabasinal bioclastic debris indicate that the typical Walker Mountain sands underwent transport and reworking in more than one sedimentary environment. These sands are derived not from underlying sediments, but from reworking of alluvial sands brought into the depositional basin by rivers moving across

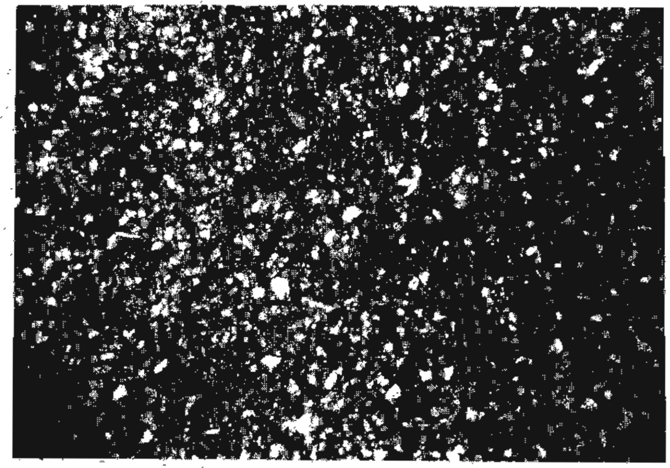


Figure 8. Medium grained sublithic arenite that comprises the Walker Mountain in the western anticlines. Sericite and chlorite make up the matrix. Cliff Dale Chapel South section (Stop 13). Thin section, x 10, cross-polarized light.

Figure 9. Typical sample of the conglomeratic bed of the Walker Mountain. The ubiquitous dark chert grains contrast with the overall light color of the rock, a quartz arenite. Oiled slab from Crockett Cove (Stop 3).

the subaerially exposed ramp and basin margin carbonate sediments (Witten, Wassum, and Liberty Hall Formations). These alluvial sediments, lithic sediments like most big river sands (Potter, 1978), came from the weathering and erosion of the low-grade metamorphic and igneous rocks, and Lower Paleozoic passive margin sedimentary rocks that were present in tectonic highlands to the southeast (present day). Sediment from these highlands, probably part of an accretionary wedge,

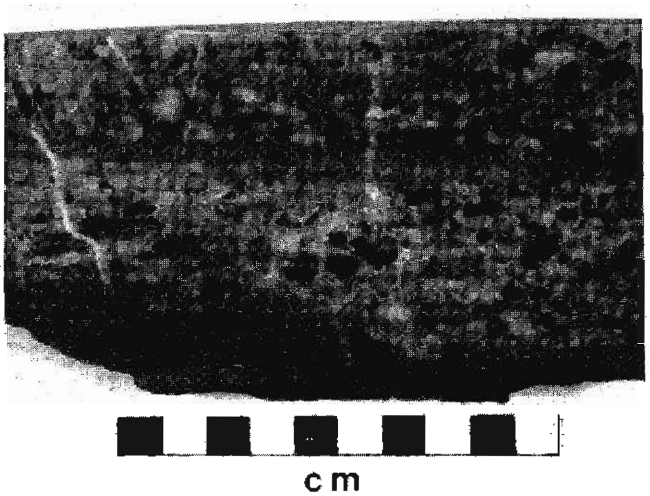


Figure 10.Basal, conglomeratic bed of the Walker Mountain showing planar bedding defined by pebbly zones. Oiled slab from Mountain Lake Turnoff (Stop 8).

Figure 11.Trough crossbedding in the conglomeratic bed of the Walker Mountain. Oiled slab from Connor Valley North (Stop 4).

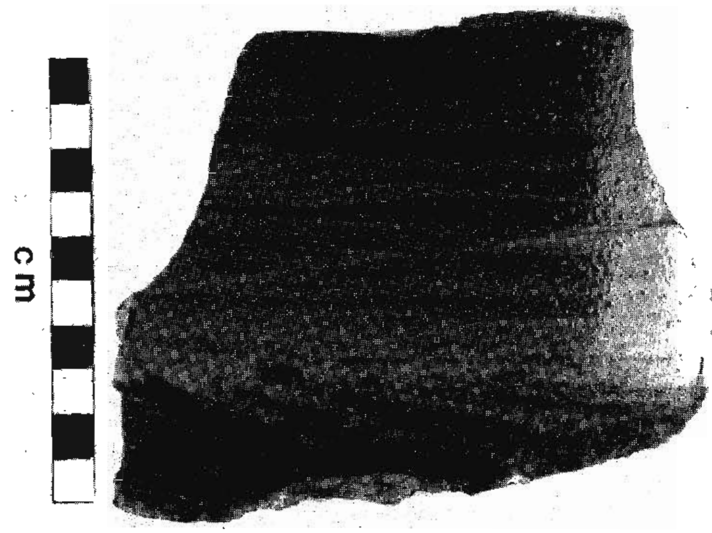


Figure 12.Tabular crossbedding and normal grading in the Walker Mountain. At this locality this is the coarsest grained bed in the member. Oiled slab from the New Castle Fish Hatchery (Stop 12).

also became part of the Fincastle Conglomerate Member (Rader and Gathright, 1986; Zhenzhong and Eriksson, 1991), a unit that Haynes (1992) has proposed as being in part a lateral equivalent of the Walker Mountain Sandstone Member. Rocks of the Walker Mountain are coarsest in the proximal areas of the basin, and reworking by eolian processes produced the extreme rounding and bimodality. Final reworking occurred in a nearshore marine to beach environment during subsequent transgression. At this time longshore currents continually sorted and washed the sand, eventually producing the compositionally mature sands of the Walker Mountain, as in all but the basal lags the labile grains (feldspars, micas, rock fragments, etc.) are nearly absent. Locally derived marine fossil fragments were incorporated into the sand during this time as well. In many areas migrating sand waves produced crossbedding. Transport by longshore currents probably produced the thicker accumulations and more well-sorted and texturally mature sands of the Bays Mountains exposures (Hergenroder, 1966). The finer-grained, less-washed sandstones of the western anticlines sections were deposited in a subtidal nearshore marine environment and are more distal sediments that were never subaerially exposed and thus were never appreciably reworked and sorted. Likewise, the sedimentary rocks of the Fincastle Conglomerate Member, a proximal to distal submarine fan deposit (Rader and Gathright, 1986; Zhenzhong and Eriksson, 1991), were not subsequently reworked.

The proximal sands of the Walker Mountain were reworked in a nearshore marine environment until the influx into the basin of the locally voluminous lithic sands of the "green" Bays Formation (Kreisa, 1980; Haynes, 1992). These less-well-sorted, less-mature sands and muds, are delta front deposits that differ greatly from the Walker Mountain both texturally and compositionally (Kreisa, 1980). They prograded into the depositional basin, burying the cleaner sands of the Walker Mountain. The wedge geometry, localized lateral extent, and appreciable thickness of the "green" Bays contrast with the sheet geometry, regional lateral extent, and overall thinness of the Walker Mountain, evidence that different depositional processes are responsible for the present texture and composition of the two units.

REGIONAL SIGNIFICANCE

Throughout its known area of occurrence the conglomeratic bed of the Walker Mountain Sandstone Member occurs below the Millbrig and Deicke (where present) K-bentonites, whose significance as time planes in the eastern midcontinent has recently been documented (Haynes, 1992; 1993). Although not an ideal time plane like the K-bentonites, we suggest that the Walker Mountain is a significant regional marker bed. It persists across several thrust sheets and through significant facies changes in the depositional basin, and it overlies an unconformity of regional significance (Haynes, 1992; 1993). In its area of occurrence this unconformity is the only significant one above the post-Knox unconformity and below the sub-Silurian unconformity (Dennison and others, 1992), two very widespread and stratigraphically important unconformities in the southern Appalachians. The recognition and description of the lateral extent of Walker Mountain Sandstone Member and the unconformity beneath it furthers our understanding of Ordovician stratigraphy in the eastern outcrop belts of Virginia and Tennessee.

ROAD LOG

The following road log serves as a guide to the proposed type section of the Walker Mountain Sandstone Member at the Keywood Branch locality and to other exposures of this sandstone. The various stops, which serve as reference sections of the sandstone, have been selected to show the stratigraphic relations and major lithotypes of the Walker Mountain Sandstone Member in Virginia. Except for Stops 7, 11, and 12, all exposures are roadcuts. Abbreviations: S.H. = State Highway; S.R. = State Road; I = Interstate Highway; U.S. = U.S. Highway.

CUMULATIVE (miles)	EXPLANATION
0.0	Starting point: beneath the Interstate Highway 81 overpass south of Glade Spring, Washington County, on State Highway 91 at the junction with State Road 1312. *Proceed north* on S.H. 91 toward Glade Spring.
0.5	S.H. 91 Bypass bears to right, continue on Business 91.
1.1	Junction S.H. 91 and S.R. 609. *Turn left* on S.R. 609 (Maple Ave.)
1.2	Junction S.R. 750 and S.R. 609. *Proceed straight ahead* on S.R. 750 (north), and immediately cross railroad tracks.
1.5	Cross railroad tracks. Continue northward on S.R. 750.
3.0	The small structures to left are the remains of spring houses marking the former community of Seven Springs.
3.5	*Pull off on right side of road and park.*

STOP 1. KEYWOOD BRANCH SECTION, THE TYPE SECTION OF THE WALKER MOUNTAIN SANDSTONE MEMBER

The Walker Mountain Sandstone Member is the low ledge on the left (west) side of the road in an otherwise mostly covered exposure. Its appearance is little changed from Plate 3, Figure 2 of Butts and Edmundson (1943). Locally, strike is N55°-85°E, dip is 30-45°SE (Hergenroder, 1966). The Walker Mountain is 2.36 meters thick here, and is stratigraphically about 70 meters below the top of the Bays. It is medium-gray (N5) to light olive-gray (5Y 5/2), weathering very light-gray (N8), and is a medium- to very thickly-bedded, silica-cemented, coarse to very coarse grained quartz and sublithic arenite (Figure 2), with some black chert grains of up to 1.0 cm (long dimension). Slabbed samples show zones of normal grading and tangential crossbedding. The beds appear to be truncated by a local backthrust fault normal to bedding. A composite of this section and the nearby McCall Gap section (Hergenroder, 1966, section 55) indicates that the Bays Formation ("red" facies here) is about 235 meters thick in this area (Figure 3). Very limited exposures of Bays redbeds occur along the road both above and below the sandstone. A lesser outcrop of the Walker Mountain occurs up the embankment along the railroad right-of-way.

3.5	*Turn around* and return to I-81.
7.0	Interchange S.H. 91 and I-81; *turn left* onto I-81 North and proceed toward Marion.
25.3	Exit 47. *Exit* to U.S. 11 South.
25.4	*Turn left* onto U.S. 11 South and proceed toward Marion.
26.5	Junction U.S. 11 and S.H. 16. *Turn right* onto S.H. 16.
30.2	Entrance to Hungry Mother State Park. Continue on S.H. 16.
33.7	Crest of Big Walker Mountain. Begin descent down north slope past cuts in Juniata, Reedsville, Trenton and Bays Formations.
35.4	Cross quickly and carefully to the left shoulder, and *pull off on left side of road and park.*

STOP 2. CHATHAM HILL SECTION

The Walker Mountain Sandstone Member is exposed on the right (east) side of the road directly behind the highway signpost (Figure 13). Hergenroder (1966; section 56) measured 125 meters of the Bays Formation ("red" facies) here, where three normally graded beds comprise the Walker Mountain. Total thickness is 0.7 meters, and the color is dark reddish-brown (10R 3/4) to pale yellowish-brown (10YR 6/2), weathers dark reddish-brown (10R 3/4). It is a medium- to thick-bedded, calcite-cemented, coarse-grained to conglomeratic, quartz and sublithic arenite with minor chert grains. The basal bed contains the coarsest material, with a maximum grain size of one centimeter (long axis). Small void spaces (dissolved shells or mudchips?) occur in the middle bed along with lenses of coarser material. There are several thin sandstones located about 3 meters above the Walker Mountain, but these are finer grained, and are not included in the member. The Walker Mountain is within sandy siltstones of the "red" Bays here, and is approximately 55 meters stratigraphically below the top of the Bays (Figure 3). The Millbrig K-bentonite bed is well exposed 28 meters upsection (Haynes, 1992, 1993).

35.4 *Turn around* Return to I-81.
45.4 Interchange U.S. 11 and I-81; *proceed north* onto I-81 toward Wytheville.
70.3 Exit 72. *Exit to right* onto ramp to Interstate Highway 77 North, toward Bluefield.
70.7 Pass beneath I-81 overpass.
71.1 Exit 41. *Exit to right* to S.R. 610 (Peppers Ferry Road).
71.3 *Turn right* onto S.R. 610 (Peppers Ferry Road) and immediately cross bridge over I-77.
72.1 *Turn right* onto S.R. 603 (Cove Road).
72.5 Cross bridge over I-81.

Figure 13.The Walker Mountain Sandstone Member at Chatham Hill (Stop 2). Upper contact is below ledge above man's head, lower contact is base of massive bed at man's bended knee. Bedding top to right.

74.7 Cross bridge over I-77.
75.1 Large cut on right through Cove Mountain in the Tuscarora, Oriskany, Huntersville, Millboro, and Brailler Formations, and the Tioga K-bentonite.
75.4 *Pull off road and park.* Proceed on foot downhill (on Reedsville Formation) to the shoulder of northbound I-77. Walk north along shoulder, crossing Cove Creek, to roadcut on right in small ridge before large valley to the north. *Be cautious of traffic!*

STOP 3. CROCKETT COVE SECTION

The Walker Mountain Sandstone Member unconformably overlies the Witten Limestone at the north end of this cut, and it is the basal unit of the Bays Formation Haynes, 1992, Section 12). There are 0.45 meters to 0.9 meters of fine to medium grained quartz arenites below the first conglomeratic beds that elsewhere are the base of the Walker Mountain. Black chert pebbles are noticeable in these conglomeratic sandstones. Total thickness of the Walker Mountain here is about 6.5 meters. The Millbrig K-bentonite is in the Bays 18 meters upsection from the Walker Mountain above a sequence of redbeds and just below a ledge of resistant greenish gray sublithic arenites (Haynes, 1992; 1993). Upsection from this interval are more redbeds. The thin zone of sublithic arenites in an otherwise mostly redbed sequence is interpreted as a tongue of the "green" Bays facies that is best developed in the Salem synclinorium sections (Stops 9 and 10). The presence of this tongue reflects the intermediate position of the Crockett Cove section (Cove Mountain thrust sheet) relative to the sections of the Big Walker Mountain outcrop belt to the west (Saltville thrust sheet) and the sections of the Salem synclinorium to the northeast (Catawba thrust sheet of the Pulaski thrust system).

75.4 Return to car. *Turn around* and return to I-77.
79.4 Junction S.R. 610 and I-77. *Turn left* onto ramp to I-77 South.
80.8 Merge with I-81 North and proceed toward Roanoke on combined I-81 North/I-77 South.
88.7 Exit 81. I-77 South veers right toward Charlotte. Continue on I-81 North toward Roanoke.
96.8 Exit 89A. Prepare to exit I-81 to right.
97.1 Exit 89B. *Exit* and merge with U.S. 11, passing under I-81. Proceed north toward Pulaski on U.S. 11.
97.6 *Turn right* onto S.R. FO64 (Draper Valley Road).
97.7 *Pull off road and park.*

STOP 4. CONNOR VALLEY NORTH SECTION

At this locality the Wassum Limestone is unconformably overlain by the basal beds of the Bays Formation ("green" facies), with the distinctive conglomeratic bed of the Walker Mountain Sandstone Member occurring 3.5 meters above the Wassum/Bays contact (Haynes, 1992, Section 13). Although the strata are folded and faulted, a measurable section of the Walker Mountain occurs in the center of both the first and second benches. Slabbed samples of the Wassum/Bays contact reveal a scalloped and pinnacled erosional surface, with the basal zone of the Bays containing rounded rip-up clasts of the underlying Wassum as well as a few intact fossils. This contact is interpreted as a paleokarst surface. The conglomeratic bed of the Walker Mountain here is 0.3 meter thick, and consists of a thickly bedded, silica cemented, coarse to very coarse grained quartz arenite. At the base of this bed is a zone of reddish brown iron staining that is typical of the basal conglomeratic bed where it occurs in the "green" Bays. A thin conglomeratic zone overlain by well developed trough crossbeds occurs in this bed (Figure 11). The Millbrig K-bentonite occurs several meters above the Walker Mountain

(Haynes, 1992; 1993). Redbeds are absent between the Walker Mountain and the Millbrig, a significant change from the Crockett Cove section (Stop 3). This locality illustrates the facies change from the "red" Bays to the "green" Bays. The upper Bays, exposed at the Connor Valley South section (Hergenroder, 1966, section 86), includes several redbeds, which persist just beneath the basal Trenton limestone into the Salem synclinorium at the Ellett section (Stop 9).

97.7 *Turn around* .and return to I-81.
98.0 Junction U.S. 11 and I-81. *Turn right* onto I-81 North, and proceed toward Roanoke.
106.4 Exit 98. *Exit* to S.H. 100.
106.7 *Turn left* on S.H. 100, pass under I-81, and proceed north toward Dublin.
108.6 Interchange with U.S. 11. Continue on S.H. 100 (Cleburne Boulevard).
115.2 Crest of Little Walker Mountain.
117.1 Cross bridge over Little Walker Creek and enter water gap through Big Walker Mountain.
118.6 Junction S.H. 100 and S.H. 42 at Poplar Hill. Continue on S.H. 100.
121.5 Junction S.H. 100 and S.R. 730. *Turn right* on S.R. 730 and proceed toward Trigg.
121.8 Junction S.R. 730 and old S.H. 100 at bridge over Big Walker Creek on right. *Proceed straight ahead* on S.R. 730.
123.2 Low anticline capped by the Walker Mountain Sandstone Member on left (Stop 5, described below). Proceed on S.R. 730 to parking area.
123.3 Junction S.R. 730 and S.R. 622. *Turn right* onto S.R. 622. *Park on right side of road just past this junction*, and walk back along S.R. 730 to outcrops.

STOP 5. TRIGG SECTION

Walking west (towards Staffordsville) along S.R. 730 provides a traverse downsection of the lower beds of the Trenton ("Martinsburg") Formation, the Eggleston Formation, the Moccasin Formation, and the upper Witten Formation (Hergenroder, 1966, section 89). The Walker Mountain Sandstone Member is exposed on the right (north) side of the road in a small symmetrical anticline (Figure 14). It is a medium to thick bedded, calcite-cemented, fine to very coarse grained quartz and sublithic arenite. The conglomeratic quartz arenite bed is the massive bed that unconformably overlies the red fenestral micrites of the Moccasin Formation and is overlain by greenish-gray sublithic arenites that closely resemble the Bays Formation ("green" facies). Granule-sized grains occur in the lower third of the basal massive bed. The competence of the Walker Mountain makes it easily recognizable in the Moccasin siltstones, which exhibit marked slaty (axial plane) cleavage in the anticlinal core. In a recessed zone overlying the massive sandstone bed is a K-bentonite that Hergenroder (1966) terms "probably V-3"; Haynes (1992) has identified V-3 as the Deicke K-bentonite bed.

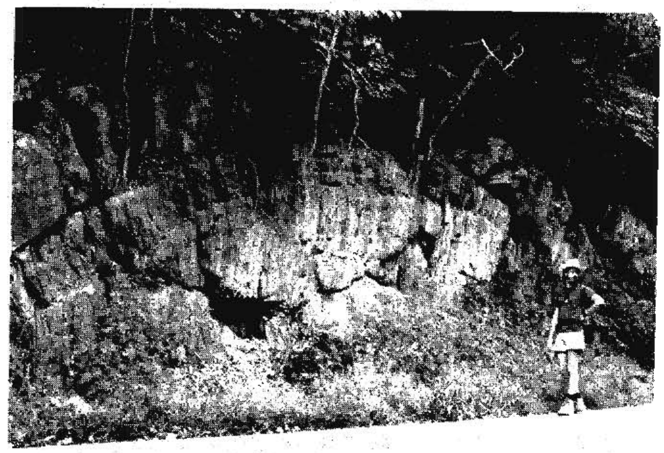


Figure 14. The Walker Mountain Sandstone Member at Trigg (Stop 5). The base is the massive bed capping the symmetrical anticline. Note the lack of axial plane cleavage in that bed compared with the underlying Moccasin Formation redbeds.

123.3 Return to car. *Turn around and turn right* onto S.R. 730 and proceed east toward Eggleston.
128.8 Cross bridge over the New River at Eggleston.
130.5 Junction S.R. 730 and S.R. 682. *Turn right* onto S.R. 682.
130.7 Junction S.R. 682 and S.R. 625. *Turn right* on S.R. 625.
132.2 *Pull off on right side of road and park.*

STOP 6. GOODWINS FERRY SECTION

At this structurally complex section (Hergenroder, 1966, section 84), the stratigraphy is like that at the Trigg section (Stop 5), along strike to the south. The Walker Mountain includes the basal white conglomeratic sandstone and the overlying two to three meters of greenish-gray sublithic arenites. The conglomeratic bed is noticeably white, and the abrupt contrast in grain size and structural competence with the underlying Moccasin redbeds is striking (Figure 4). The Deicke K-bentonite is well exposed but very structurally disrupted (Haynes, 1992).

132.2 *Continue downhill* on S.R. 625.
132.5 Cross railroad tracks.
132.9 Junction S.R. 625 and S.R. 605 at railroad overpass. Continue on S.R. 625. Road soon turns to gravel.
133.1 Cross railroad tracks.
134.0 Cross railroad tracks.
134.3 *Pull off on right side of road and park.*

STOP 7. GAP MOUNTAIN SECTION

Obtain permission from Norfolk Southern before making this stop. Walk up embankment to railroad. *Be alert and listen for trains!* Exposed here are the nearly vertical beds of the Witten, Moccasin, Eggleston, and Trenton Formations. The Walker Mountain Sandstone Member is exposed in the ravine that parallels local strike (Hergenroder, 1966, section

83). Proceed up this ravine about 50 meters. On the low ridge immediately to the left are gray limestone ledges of the Witten overlain by the basal redbeds of the Moccasin. The Walker Mountain is exposed for several meters in the creek bed as a low resistant mossy ledge. It is only about 0.6 meter thick, but its distinct texture contrasts with the surrounding redbeds. Its basal bed is markedly bimodal and contains pebbles of quartz and chert. Thinning of the Moccasin is indicated by the small interval between the Walker Mountain and the basal Moccasin - upper Witten contact. Compare this with the thickness of the Moccasin below the Walker Mountain at the Trigg section (Stop 5), Goodwins Ferry section (Stop 6) and at the next stop, Mountain Lake Turnoff (Stop 8). These three are all on the Narrows thrust sheet; this section (Gap Mountain) is on the Saltville thrust sheet and in the Big Walker Mountain outcrop belt directly along strike from the Keywood Branch and Chatham Hill sections, Stops 1 and 2 (Figure 3). Along the railroad the Millbrig and V-7 K-bentonite beds are very well-exposed in the Eggleston Formation (Haynes, 1992; 1993).

134.3 *Turn around.* Proceed north along the New River on S.R. 625 to the junction with S.R. 605, on right after the second railroad crossing.
135.7 Junction S.R. 625 and S.R. 605. *Turn right* onto S.R. 605, pass beneath railroad overpass and proceed east on S.R. 605.
141.9 Junction S.R. 605 and U.S. 460. *Turn left* on U.S. 460 West.
143.3 *Pull off road and park on right shoulder--be cautious of traffic!.*

STOP 8. MOUNTAIN LAKE TURNOFF SECTION

The stratigraphy here is like that at Trigg and Goodwins Ferry (Stops 5 and 6). The Walker Mountain is within the Moccasin Formation redbeds, and its structural competence is a striking contrast to the Moccasin siltstones, in which slaty cleavage is well developed. The basal Walker Mountain is a thickly bedded, calcite-cemented conglomeratic quartz arenite with abundant quartz, and black and red chert pebbles. Grains as large as two centimeters (long axis) occur along with fossil fragments in the basal Walker Mountain. This section is approaching the more proximal region of the depositional basin. Above the white conglomeratic basal bed is the thin sequence of "green" Bays-like sublithic arenites that are also present at Trigg and Goodwins Ferry. The section is repeated by faulting; the uppermost gray limestones of the Witten Formation occur in a ravinejust east along the road, and upsection is a complete sequence of the Moccasin (including the Walker Mountain), Eggleston, and Trenton Formations (Hergenroder, 1966, section 90). The Deicke K-bentonite is present just above the basal bed of the Walker Mountain (Haynes, 1992).

143.3 *Carefully proceed west* on U.S. 460, and move to the left lane.
143.6 *Turn left (U-turn).* Proceed east on U.S. 460.
148.6 Crest of Brushy Mountain.
150.1 U.S. 460 splits into Business and Bypass Routes. *Proceed straight* on Bypass route of U.S. 460 around Blacksburg.
153.5 Junction S.H. 412 (Prices Fork Road) and U.S. 460. Continue on U.S. 460.
156.9 *Continue east* on U.S. 460 at merger of U.S. 460 Business and Bypass Routes.
157.5 Junction U.S. 460 and S.R. 642. *Turn left* onto S.R. 642 (Jennelle Road), and proceed east toward Ellett.
159.9 Junction S.R. 642 and S.R. 603. Proceed straight onto S.R. 603, immediately cross the railroad tracks.
160.3 Junction S.R. 603 and S.R. 723. *Turn left* and proceed east on S.R. 603/S.R. 723 to Ellett.
160.4 *Turn right* on S.R. 603 at 3-way intersection where S.R. 723 veers left, and continue on S.R. 603.
160.8 Cross bridge over Wilson Creek.
160.9 *Pull off road and park on right.*

STOP 9. ELLETT SECTION

At this stop, the base of the Ellett section (Hergenroder, 1966, section 66), the conglomeratic sandstone at the base of the Walker Mountain is at the base of the Bays Formation ("green" facies here). It unconformably overlies the calcareous silty shales of the Liberty Hall Formation. The basal Walker Mountain displays the vivid reddish orange iron staining typically found at this contact. It is a thick-bedded, calcite-cemented, very coarse grained to conglomeratic quartz and sublithic arenite. Some crossbedding is present in the beds that overlie the basal conglomeratic bed. The unconformity beneath the Walker Mountain is the same one that is seen at Crockett Cove (Stop 3), where the Walker Mountain overlies the Witten, and at Connor Valley (Stop 4), where it overlies the Wassum. At Ellett, on the eastern margin of the depositional basin, the Liberty Hall is beneath the Walker Mountain. Thus a progressively greater uplift from west to east (present-day) of the ramp-to-basin sequence of which these units are a part (Read, 1980) is indicated. Refer to Haynes (1992) for a discussion of the geology of the Bays Formation in the Ellett area and a reinterpretation of the local structure.

160.9 *Proceed east* on S.R. 603.
161.2 Junction S.R. 603 and S.R. 641 at the bridge over the North Fork of the Roanoke River. *Proceed straight* on S.R. 641 (do not cross the bridge). On right is a thick sequence of greenish gray lithic sandstones of the "green" Bays Formation, with some redbeds and thin K-bentonites at the top (Haynes, 1992). These are overlain by the Trenton ("Martinsburg") Formation (Hergenroder, 1966) at the top of the Ellett section.
161.8 Good exposure of the near vertical Walker Mountain Sandstone Member and upper Liberty Hall Formation on left.

164.2 Pass beneath I-81.
164.4 Cautiously pass through the one-lane tunnel beneath the railroad tracks. Twin railroad tunnels on left after emerging.
165.3 Junction S.R. 641 and U.S. 460/U.S. 11. *Turn right* onto U.S. 460/U.S. 11 and proceed west toward Christiansburg.
168.2 *Turn right* onto entrance ramp to I-81 North, and proceed toward Salem on I-81.
191.0 Exit 141. *Exit to right* to S.H. 419 South.
191.2 *Turn left* onto S.H. 419 South.
191.3 Junction S.H. 419 and S.R. 780. *Turn left* onto S.R. 780, carefully crossing the northbound lane of S.H. 419.
191.6 Junction S.R. 780 and S.R. 628. *Turn left* onto S.R. 628, and proceed eastward.
192.4 Junction S.R. 628 and S.R. 629. *Pull off on right side of S.R. 629 and park.* Walk eastward across road.

STOP 10. PETERS CREEK SECTION

The quartz arenites of the Walker Mountain Sandstone Member unconformably overlie the calcareous shales of the Liberty Hall Formation, and the contact, which is clearly erosional, is exposed near the base of the hillslope by the large culvert carrying Peters Creek under S.R. 629 (Haynes, 1992, Section 65). The basal bed of the Walker Mountain contains zones of crumbly, pyrite-cemented quartz sand that rapidly oxidizes to form the distinctive reddish orange to brown iron staining that characterizes this contact where the Walker Mountain is in the green" Bays. Above the basal bed is a massive bed with well developed tangential crossbedding. The stratigraphic position of this crossbedded sandstone is similar to the position of crossbedded sandstones at Connor Valley (Stop 4) and Ellett (Stop 7), and at the Daleville section along strike to the north (Hergenroder, 1966, section 2). Above the Walker Mountain are intermittent exposures of the "green" Bays, which is the characteristic lithofacies in the Salem synclinorium sections (Figure 3).

192.4 *Turn around.* Return to S.H. 419.
193.5 Junction S.R. 780 and S.H. 419. *Turn right* onto S.H. 419 and proceed north.
193.7 Cross bridge over I-81.
194.2 Junction S.H. 419 and S.H. 311. *Turn right* onto S.H. 311, and proceed north toward New Castle.
199.7 Crest of Catawba Mountain.
200.4 Catawba section (Hergenroder, 1966 section 1) of the Bays Formation with the Millbrig K-bentonite (Haynes, 1992) on left just before bridge over Catawba Creek. Cross creek and continue north on S.H. 311.
203.1 Junction S.H. 311 and S.R. 624. *Turn left* onto S.R. 624 (Newport Road).
205.3 Junction S.R. 624 and S.R. 620. *Turn right* onto S.R. 620.
206.1 Junction S.R. 620 and S.R. 701. *Turn right* onto S.R. 620 (Millers Cove Road). *Immediately cross creek and park on left side of road.*

STOP 11. MILLERS COVE SECTION

This stop is on PRIVATE PROPERTY. Obtain permission from the landowner before examining this outcrop.

Walk across S.R. 620 and cross fence to the base of the Millers Cove section (Hergenroder, 1966, section 91). The nearly vertical ledges of light-gray-weathering, black, micritic limestone exposed in and along the creek are the upper Liberty Hall Formation, which here is a limestone, not the calcareous shales seen in the Salem synclinorium at Ellett (Stop 9) and Peters Creek (Stop 10). This indicates a shallower, more shelfward position than the sections farther east. At the base of the hill immediately to the left (north) of the creek the black micrite is abruptly overlain by a limestone conglomerate that has a maximum thickness of 3.2 meters (Hergenroder, 1966). The contact between this conglomerate and the Liberty Hall is erosional in nature, with appreciable relief. Above the limestone conglomerate are yellowish brown siltstones and fine grained sandstone of the Bays Formation. There are quartz grains in the matrix of the upper beds of the conglomerate, and in the top of the Millers Cove composite section, on S.R. 620, in the Bays upsection from the conglomerate, a K-bentonite tentatively identified as the Millbrig is present. Because this limestone conglomerate unconformably overlies the Liberty Hall and is the basal unit of the Bays, it occupies the same stratigraphic position as the Walker Mountain Sandstone Member in the nearby sections in the Salem synclinorium. The correlation of this unit and the Walker Mountain is therefore indicated (Figure 3), but is somewhat problematic, given the texture and composition of the strata in this interval. We interpret the absence of typical Walker Mountain lithologies at this horizon as perhaps resulting from localized emergence of the Liberty Hall during deposition of the Walker Mountain sediments. The presence of this isolated topographic high thus prevented deposition of the typical coarse sands typical of the Walker Mountain at this locality.

206.1 *Turn around* Return to S.H. 311.
209.1 Junction of S.R. 624 and S.H. 311. *Turn left* onto S.H. 311. Proceed north toward New Castle.
219.2 Junction S.H. 311 and S.H. 42 in the town of New Castle. *Turn left* onto S.H. 42 and proceed west up Sinking Creek Mountain.
221.9 *Pull off and park on right side of road immediately before crossing the bridge over Meadow Creek-- be cautious of traffic!* The fish hatchery is ahead on the right.

STOP 12. NEW CASTLE FISH HATCHERY SECTION

This stop is on PRIVATE PROPERTY. Obtain permission from the landowner before examining this outcrop.

From the road walk along the north bank of Meadow Creek to the base of the slope to the north, where massively bedded gray limestones of the Witten Formation are overlain by thin bedded shales, and siltstones, and shaly limestones of the

Eggleston Formation (Collierstown and Moccasin Formations, respectively, of Hergenroder, 1966, Section 92). At this section we have used the stratigraphy of Bregman (1967) over that of Kay (1956) or Hergenroder (1966). The Witten - Eggleston contact is near the break in slope, and just above the contact are the coarse grained quartz and sublithic arenites of the Walker Mountain Sandstone Member, but the exact location is problematic due to the relatively poor exposure. Here the Walker Mountain is a transitional lithofacies; the coarsest bed (Figure 12) is noticeably finer grained than the coarsest beds seen in sections to the south and east, but it is still appreciably coarser than the Walker Mountain in Rich Patch Valley to the north (Stop 13). The section here marks the northern terminus of the Big Walker Mountain outcrop belt, which also includes the Keywood Branch (type), Chatham Hill and Gap Mountain sections (Stops 1, 2, and 7). The Moccasin redbeds have completely pinched out between Gap Mountain (Stop 7), where they are quite thin, and this section, which is about 30 miles along strike from Gap Mountain (Figure 3).

- 221.9 *Turn around and return to New Castle* via S.H. 42.
- 224.6 Junction S.H. 42 and S.H. 311. *Turn left* onto S.H. 311 toward Paint Bank.
- 229.0 Cross bridge over Johns Creek.
- 229.2 Junction S.H. 311 and S.R. 611. *Turn right* onto S.R. 611 and proceed eastward.
- 234.1 Junction S.R. 611 and S.R. 617. *Turn left* onto S.R. 617 and proceed north.
- 239.1 The Pines, a National Forest campground, on left.
- 243.7 Crest of saddle between Potts and Rich Patch Mountains.
- 245.8 *Pull off on right side of road and park.*

STOP 13. CLIFF DALE CHAPEL SOUTH SECTION

A few meters to the north of the steep, chute-like ravine at the parking spot are the interbedded shales and abundantly fossiliferous limestones of the Dolly Ridge Formation of Perry (1972), the equivalent of the Trenton ("Martinsburg") Formation. Walk down section (south) along the road from the contact between the Dolly Ridge and the underlying shaly limestones of the Eggleston Formation to the ravine. The Walker Mountain Sandstone Member is approximately 30 meters stratigraphically down section beyond the ravine. It can be identified by its color and by the lack of the slaty cleavage that is omnipresent in the surrounding shaly limestones of the Eggleston (Figure 15). Here the Walker Mountain is a fine to medium grained sublithic arenite that is quite similar to the "green" Bays-like beds immediately above the basal conglomeratic quartz arenite at the Trigg, Goodwins Ferry, and Mountain Lake Turnoff sections (Stops 5, 6, and 8). The Millbrig K-bentonite is about 20 meters above the Walker Mountain. The Walker Mountain at this exposure represents the distal edge of the "green" Bays lithofacies (Figure 3).

Figure 15. The Walker Mountain Sandstone Member at the Cliff Dale Chapel South section (Stop 13), where it is a thin sequence of medium bedded, medium grained sublithic arenites. Note the difference in structural competence between the thin bedded sandstones to left of man's hand and the underlying shaly limestones of the Eggleston Formation. Bedding top to left.

- 245.8 *Proceed north* on S.R. 617.
- 246.0 Junction S.R. 617 and S.R. 616. *Turn right* onto S.R. 616.
- 246.9 On left is the Cliff Dale Chapel North section (Richpatch West section of Kay, 1956), which includes the upper Benbolt to the upper Eggleston Formations, including the Walker Mountain Sandstone Member. Continue north on S.R. 616.
- 247.1 On left is Blue Spring, the upper outlet of the principal discharge point for the karst aquifer in southern Rich Patch Valley. Continue north on S.R. 616.
- 252.2 Junction S.R. 616 and S.R. 620. Beginning at the junction and continuing for about 60 meters north along S.R. 620 is the Rich Patch section, an exposure of the upper Benbolt, McGlone, and lower Eggleston Formations (including the Walker Mountain) that Kay (1956) used to describe the Trentonian in his Richpatch East section. *Continue north* (straight) on S.R. 616.
- 254.3 Junction S.R. 616 and S.R. 621. *Turn right* onto S.R. 621 towards Strom.
- 255.8 Roaring Run Furnace on right. Continue on S.R. 621.
- 256.7 Junction S.R. 621 and S.R. 615. *Turn left* onto S.R. 615.
- 262.1 Junction S.R. 615 and U.S. 220. *Turn right* onto U.S. 220 South and proceed toward Fincastle.
- 262.6 The impressive cut on the right is the Eagle Rock section described by Gathright and Rader (1981). Continue south on U.S. 220.
- 273.1 In quarry on left, used for heavy equipment storage, and adjacent roadcut on U.S. 220, are two excellent

exposures of the Fincastle Conglomerate Member of the Martinsburg Formation (Rader and Gathright, 1986; Zhenzhong and Eriksson, 1991). Continue south on U.S. 220.

273.4 *Pull off on right shoulder and park--be cautious of traffic.*

STOP 14. FINCASTLE SECTION

Carefully cross the highway to the hillside above the northbound lanes of U.S. 220. This is Locality 1 of Rader and Gathright (1986), the designated principal reference section of the Fincastle Conglomerate Member of the Martinsburg Formation. The Fincastle overlies the Paperville Shale, a lateral equivalent of the Liberty Hall Formation, and underlies the Martinsburg Formation, thus it occupies the stratigraphic position that the Bays Formation occupies in the Salem synclinorium, and correlation of the two is suggested. Sandstones in the nearby quarry studied by Zhenzhong and Eriksson (1991) are strikingly similar to the greenish gray, lithic sandstones of the "green" Bays in the Salem synclinorium such as occur at Ellett and Peters Creek (Stops 9 and 10). Below these sandstones are poorly sorted pebble to boulder conglomerates, and at the base of this is a conglomeratic sandstone that is the likely lateral equivalent of the Walker Mountain Sandstone Member. This sandstone is exposed part way up the hill at this stop.

273.4 *Continue south* on U.S. 220

282.7 Interchange of U.S. 220 and I- 81 at Troutville.

END OF ROAD LOG

ACKNOWLEDGEMENTS

The need for the stratigraphic work presented herein became apparent during the senior author's continuing regional study of Ordovician K-bentonite beds. The road log was developed with assistance from the junior author as part of his undergraduate Senior Thesis project. Eugene K. Rader and Thomas M. Gathright II of the Virginia Division of Mineral Resources provided helpful discussion, and we also acknowledge the field assistance, input, or comments of Richard J. Diecchio, Virginia Edwards, Kenneth A. Eriksson, Kevin Foley, David R. Green, Warren D. Huff, Randall C. Orndorff, Paul E. Potter, and Jeff L. Watson.

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NEW GEOLOGIC MAP OF VIRGINIIA RELEASED

The new Geologic Map of Virginia was officially released September 15, 1993 in a ceremony held at the State Capitol Building. A specially framed copy of the map, which provides a regional overview of the state's geology, was presented to Secretary of Commerce and Trade, Cathleen A. Magennis by Department of Mines, Minerals, and Energy (DMME) Director O. Gene Dishner.

Secretary Magennis noted the importance of geologic research and mapping in today's rapidly growing society. "In addition to the importance of locating and mapping our mineral resources, we must also have a clear understanding of the influence of Virginia's unique geology on current and future growth and development. The undating of the Geologic Map of Virginia demonstrates our commitment to promote the knowledgeable and responsible development and conservation of our resources," stated Magennis.

The 1993 Geologic Map of Virginia was prepared by DMME's Division of Mineral Resources and the U.S. Geological Survey. Much of the geologic data in the Blue Ridge and Piedmont was acquired under the joint State-Federal Cooperative Geologic Mapping Program (COGEOMAP) from 1984 to 1992. It is the product of many years of geologic mapping by geologists from the state and federal agencies. The map compilation entailed a massive effort of evaluating hundreds of geologic maps from many sources. As a result of this mapping research, much of the geology shown for the Blue Ridge and Piedmont Provinces is published for the first time.

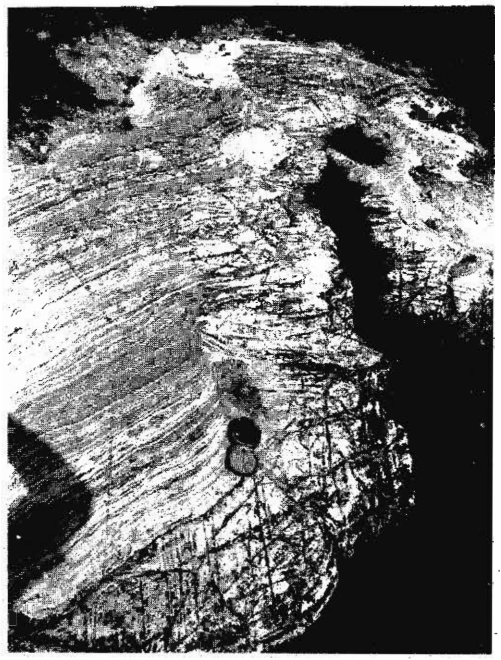
Last updated in 1963, the state geologic map is one of the more requested map products produced by the Division of Mineral Resources and is used by oil and mineral exploration companies, school/universities, consultants and consulting companies, state and federal agencies, and the general public The new edition has over 300 colors and patterns representing the different rock formations in Virginia at a scale of 1:500,000 or one inch equals approximately eight miles. Previous editions of the geologic map were published in 1884, 1916, 1928, and 1963. A map at this scale shows a generalized overview of Virginia's geology.

The map is accompanied by a booklet that contains an expanded explanation of the rock units on the map and contains a list of references that provide important geologic data. References for the geologic maps used in the compilation of the state map are listed on the back of the map and are included in the reference list in the companion booklet.

Geologic maps are important elements in the decision making process regarding energy and mineral resources development. They identify the availability and limitations of land for various uses. The maps are also used to identify basic data for planning most engineering construction jobs such as dams and highways, and related earth-rock problems such as unstable foundations and natural hazards. Distribution and availability of groundwater resources are also depicted on certain geologic maps.

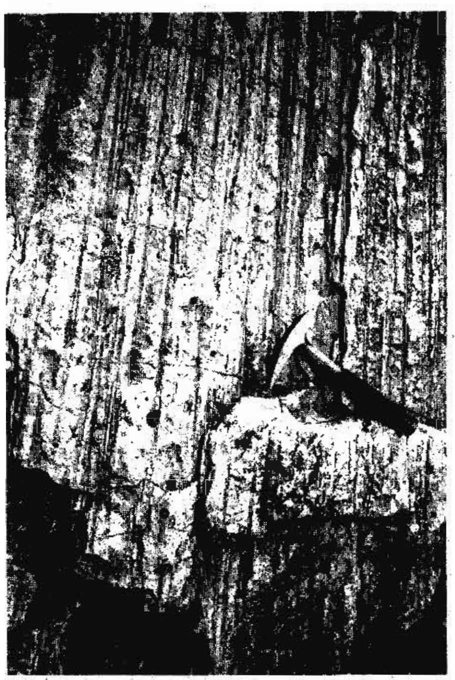
INTERESTING SEDIMENTARY STRUCTURES FROM VIRGINIA

Photographs by T. M. Gathright, II

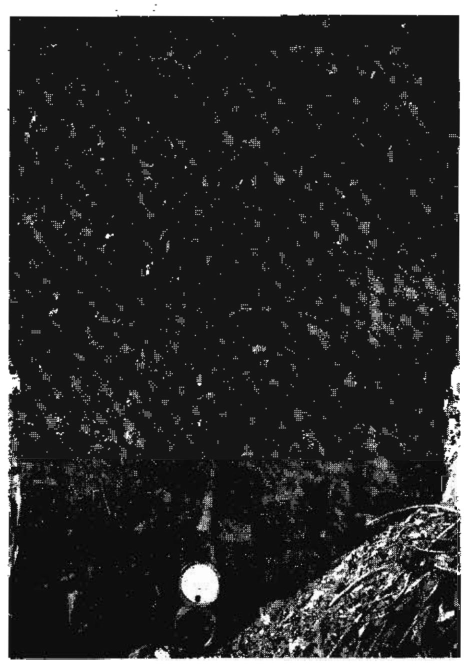


Interlaminated limestone and dolomite (left) and dolomitic thrombolite (right) in the Elbrook Formation, Augusta County.

Algal colony in limestone of the Elbrook Formation, Rockingham County.

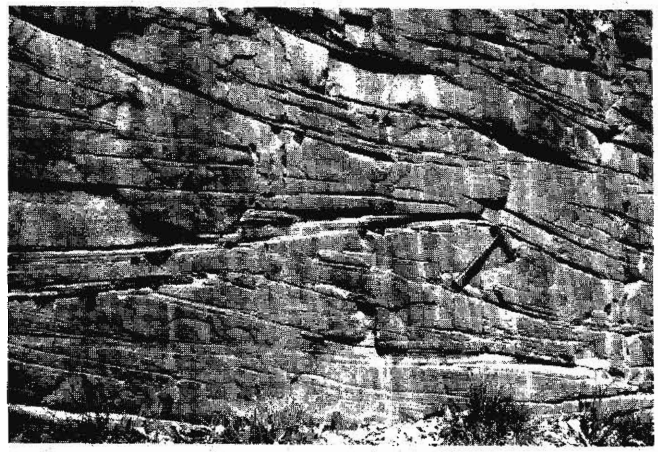


Skolithos tubes (some more than one meter in length) in quartzite of the Antietam Formation, Augusta County.

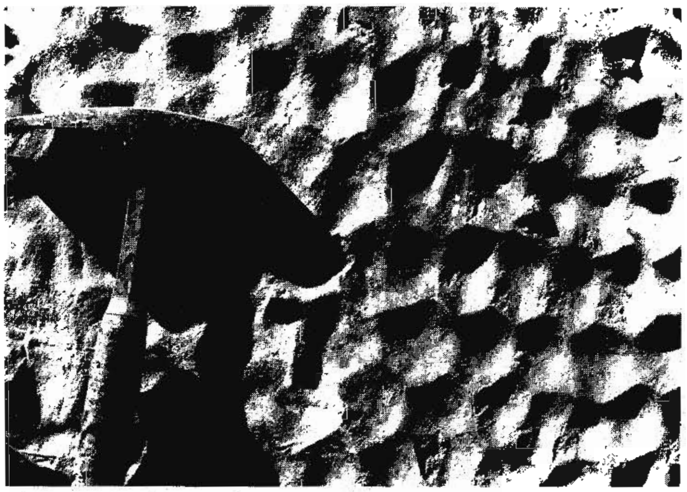


Prod marks and minor flute casts on base of sandstone in the Martinsburg Formation, Page County.

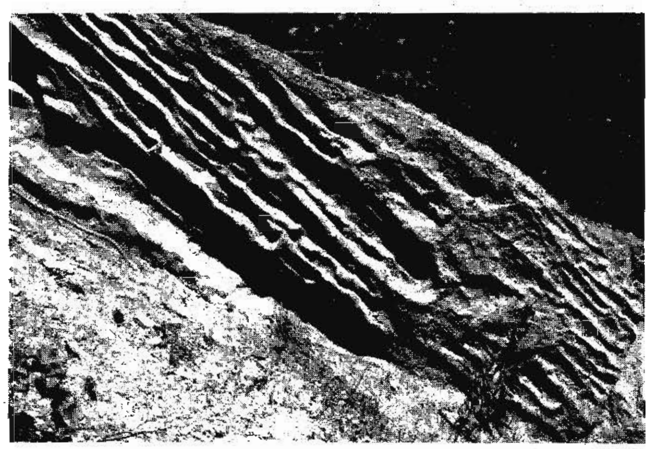
Feeding trails in the Elbrook limestone, Rockingham County.



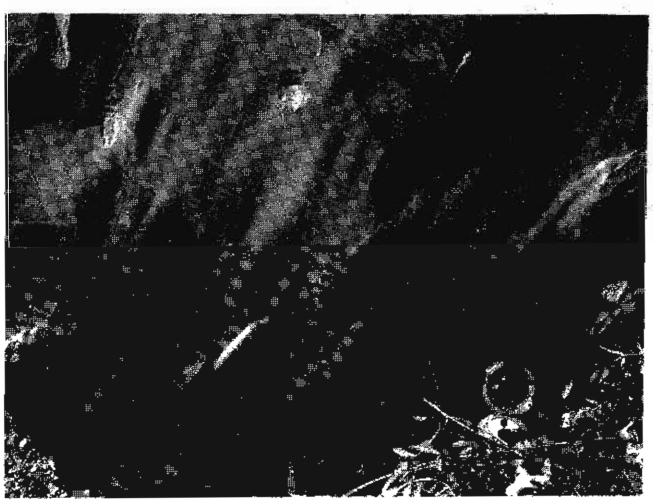
Cross-bedded sandstone in the Hampshire Formation, Rockingham County.



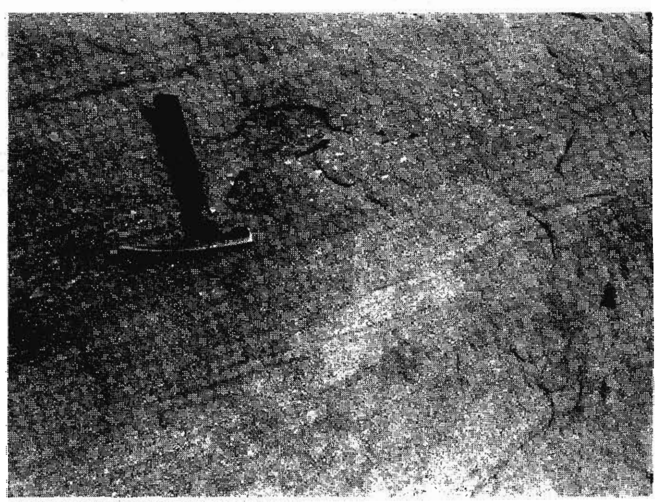
Interference ripple marks in sandstone of the Bluestone Formation, Wise County.



Casts of linear erosional features on the lower surface of the basal quartzarenite of the Lee Formation, Wise County.



Flute casts on the lower surface of a sandstone bed in the Martinsburg Formation, Page County.



Graded bedding, cross-bedding, and planar bedding in conglomeratic sandstone of the Lynchburg Formation, Madison County.

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