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DEPOSITIONAL MODEL OF MISSISSIPPIAN BANGOR LIMESTONE EXPOSED IN HUGDEN BRANCH, RACCOON MOUNTAIN, MARION COUNTY, TENNESSEE

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ABSTRACT--A portion of the Mississippian Bangor Limestone exposed in Hugden Branch located on the northern side of Raccoon Mountain in the Tennessee River Gorge, Marion County, Tennessee, is described in detail and the environment of deposition is interpreted. A depositional model shows the Bangor to represent a low intertidal facies of a Bangor Limestone-Pennington Formation regional tidal flat complex that prograded from east to west over a Mississippian carbonate platform. Through time, this tidal flat likely records a succession of both positive and negative eustatic shifts.

Bergenback et al. (1972) and Bergenback et al. (1980) suggested that the Bangor Limestone and overlying Mississippian Pennington Formation are time-equivalent facies of a generally westward prograding regional tidal flat complex, modeled after the Holocene northwest Andros Island tidal flat complex in The Bahamas, described by Shinn et al. (1969). It is important to note that this Bahamian complex does not have the terrigenous contribution that the Mississippian complex does. Further, Bergenback et al. (1980) considered the Bangor to represent a low-intertidal time-equivalent facies of the high-intertidal to supratidal Pennington. In Hugden Branch, the Bangor and Pennington stratigraphic units show a transitional relationship. The present paper offers a detailed description and interpretation (environment of deposition) of a portion of the Mississippian Bangor Limestone exposed in Hugden Branch located on the northern side of Raccoon Mountain in the Tennessee River Gorge, Marion County, Tennessee (Figs. 1 and 2).

STRATIGRAPHY AND PETROLOGY

Figure 3 graphs a stratigraphic section measured and described in Hugden Branch. This section was measured beginning at the road level of Dixie Lee Highway, routes 41 and 64 (Fig. 2). The first 27.4 m of this section are covered, and the Bangor-Pennington transitional contact is located at a level 71.1 m above Dixie Lee Highway. Four major rock types have been recognized in this Hugden Branch section. They include: 1) limestone, gray with fining-upward cyclic, thin-bedded rippled units or small scale trough crossbedded units, 1.8 to 6.1 m thick; 2) limestone, gray, lime sand and lime mud, occurs as scour fill, 0.3 to 0.9 m thick; 3) shale, gray to dark gray, 0.5 to 3.7 m thick; and 4) dolomicrite, buff, mud-cracked with birdseye structures, occurs as scour fill, 0.2 to 1.5 m thick. Thin-section sample locations and numbers (S-1 to S-103) are indicated on Fig. 3. Thin-section descriptions of sedimentary structures and texture and composition of these Bangor carbonate rocks are presented in Table 1.

Microscopic description of these carbonate rocks utilizing a blend of carbonate rock classifications developed by Folk (1959) and Dunham (1962). Folk (1959) considered carbonate rocks to form a textural spectrum made up of grains, matrix, and cement. The contribution of Dunham (1962) is his concept of a grain-supported framework (most grains touching) formed under relatively high water-energy conditions versus a mud-supported framework where grains "float" in a mud-dominated carbonate rock (the product of accumulation of fine-grained carbonate particles under low water-energy conditions).

The grains of Folk (1959) consist of fossil "shell" fragments of echinoderms (especially crinoids), bryozoans, ostracods, gastropods, endothyrids, sponge spicules, trilobites, lime mud (micritic) peloids (of fecal origin or rounded grains of pre-existing mud-rich carbonate rocks), ooids, and silt-sized quartz. The matrix is formed of lime mud of grain size $\leq 2\ \mu$. It is described microscopically as microcrystalline calcite which is abbreviated as micrite. The cement or spar consists largely of well-formed (euhedral) to poorly-formed (anhedral) crystals of calcite that show pore-filling structures. Certain micrite may contain microscopic crystal clusters of clear spar that are the result of reorganization (recrystallization) of lime mud (micrite).

Microscopic euhedral to anhedral crystals of dolomite replace micrite-rich portions (like micrite peloids set in a micrite matrix that, when dolomitized, form a dolomicrite) of these carbonates. A plethora of models exist that attempt to explain the dolomitization process in carbonate rocks; however, it seems that most models require periodic exposure to air and fresh water (rain) to facilitate the dolomitization process.

Folk's (1959) textural spectrum ranges from an end-member composed largely of micrite to a mud-supported framework with grains "floating" in micrite (fossiliferous micrite), followed by a grain-supported framework with grains of fossil debris, ooids, or peloids set in a micrite matrix (e.g., biomicrite, pelmicrite, and oomicrite), to another end-member consisting of a grain-supported framework with grains of fossil debris, ooids, peloids, and other substances set in a crystalline calcite cement or spar (e.g., biosparite, oosparite, and pelsparite). This textural spectrum reflects degrees of water energy ranging from sluggish micrite-depositing currents to high-energy currents forming winnowed biosparites or oosparites.

Birdseye structures in carbonate rocks have been interpretated by Shinn (1968) as isolated bubble-like vugs in dolomicrite that are filled with calcite. According to Shinn (1968), these birdseye structures are particularly abundant in supratidal dolomicrite. Birdseye structures occur in dolomitized peloidal scour-filling in the Bangor.

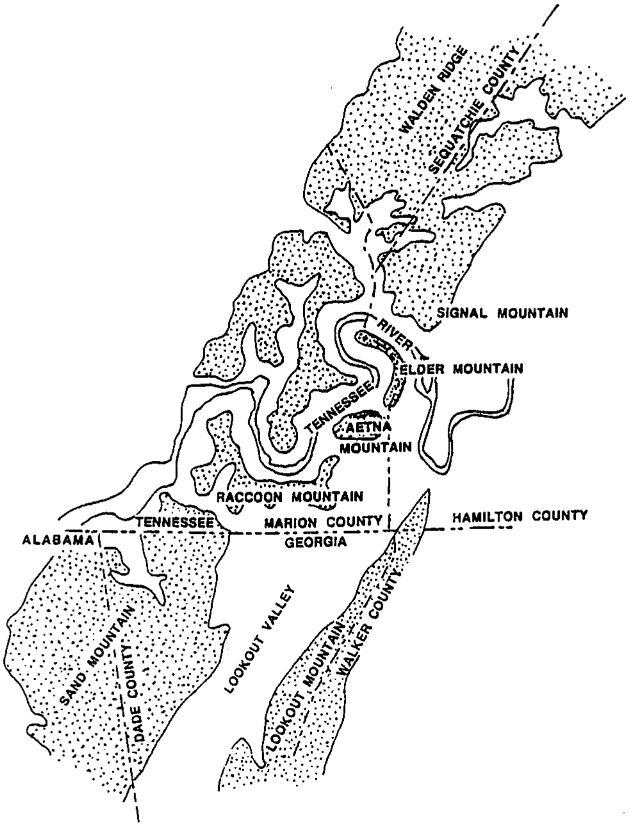

FIG. 1. Sketch map of Cumberland Plateau (Walden Ridge-Sand Mountain).

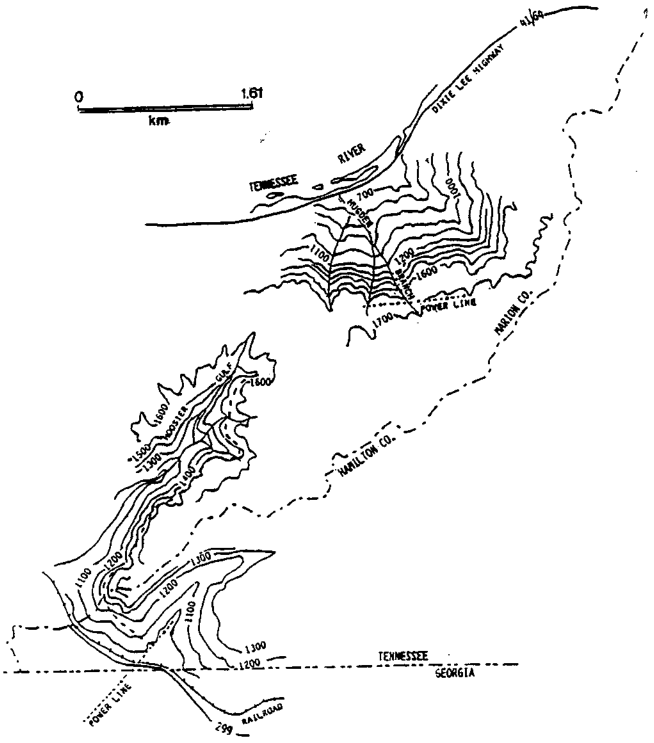

FIG. 2. Location map of Raccoon Mountain area in Marion County, Tennessee. Note location of Hugden Branch along Dixie Lee Highway in the Tennessee River Gorge.

DISCUSSION

Figure 3 presents a measured section, including megascopic rock descriptions and sedimentary structures, of the Bangor Limestone exposed in Hugden Branch on the north side of Raccoon Mountain in Marion County, Tennessee (Fig. 1). Microscopic details of texture and composition of thin-section samples of these Bangor carbonates are given in Table 1.

Four type 1 gray to dark gray shale types have been recognized in this measured section of the Bangor. Type 2 gray limestone is composed of fining-upward sequences of thin-bedded, rippled units, or small-scale trough crossbedded units associated with thin, tan stringers. Microscopic examination of samples numbered 1, 6, 10, 12, 13, and 15 show that type 2 limestones consist of mud-supported biomicrite with laminated grains of fossil debris from echinoderms, bryozoans, ostracods, and sponge spicules plus peloids and silt-sized quartz grains. The micrite matrix indicates partial to extensive (pervasive) dolomitization by anhedral to euhedral dolomite crystals. The thin, tan stringers are largely laminated and micritic and are extensively dolomitized by anhedral to euhedral dolomite crystals.

Type 3 gray limestone units are situated in the interval 50.3 to 53.0 m on the measured section of Fig. 1. These thin (0.3 to 0.9 m) carbonate units are associated with scour structures (undulating base and relatively smooth top) that are filled with lime sand (fossil hash) and lime mud. Thin-section samples 5, 11, and 101 (Table 1) reveal a mud-supported, oo-biomicrite. The micrite matrix is partially to extensively reorganized to clusters of anhedral calcite. Grains consist of fossil fragments (hash) of echinoderms, bryozoans, ostracods, sponge spicules, trilobites, brachiopods, gastropods, and peloids plus ooids (incipient = one rim, to well-formed = two or three rims) with fossil grain nucleii of echinoderms, bryozoans, gastropods, ostracods, endothyrids, trilobites, brachiopods, and peloids.

Buff-colored dolomicrite forms type 4 carbonate. These units range in thickness from 0.2 to 1.5 m, contain infilled scour structures as well as birdseye and mud-cracked structures. Samples 2, 3, 4, 7, 14, 102, and 103 reveal under microscopic analysis that type 4 carbonate consists of micritic peloid grains set in a micritic matrix, all of which has been pervasively (extensively) dolomitized by dolomite euhedra. Further, type 4 carbonates locally contain birdseye structures, burrows, highly comminuted fossil debris, and ripup clasts (associated with mudcracks).

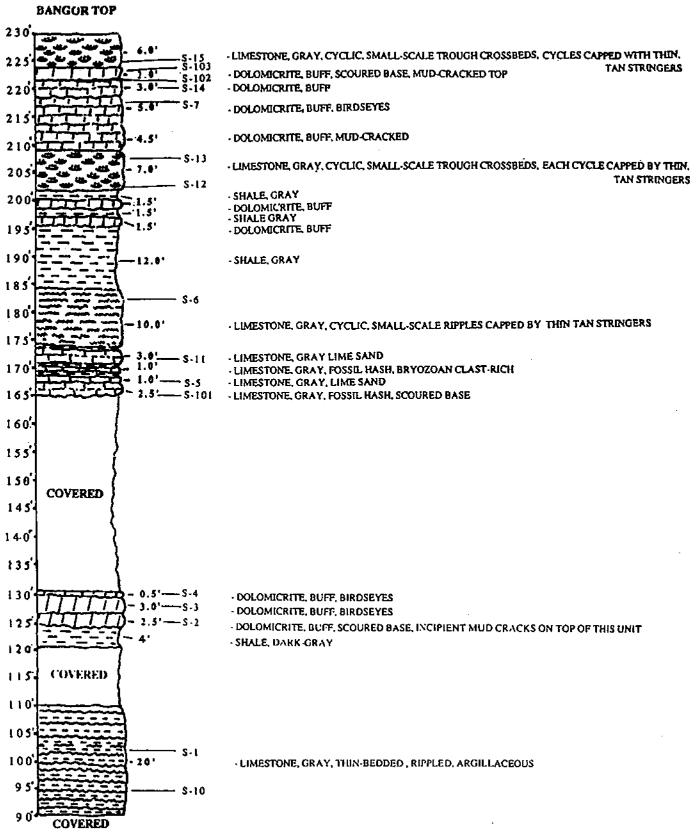

FIG. 3. Measured partial section (27.4 to 71.1 m = 90 to 230 feet) of Mississippian Bangor Limestone exposed in Hugden Branch on the north side of Raccoon Mountain, Marion County, Tennessee (Tennessee River Gorge) showing layer thicknesses (0.2 to 6.1 m = 0.5 to 20.2 feet), sample numbers (S-1 to S-103), and locations as well as rock layer descriptions.

CONCLUSIONS

Figure 4 shows a depositional model of a portion of the Bangor Limestone exposed in Hugden Branch. This model considers the Bangor to represent a low intertidal facies of a Bangor Limestone-Pennington Formation regional tidal flat complex that prograded from east to west over a Mississippian carbonate platform.

Type 1 gray shale deposits, that represent terrigenous contributions from the east (winnowed materials), settled in low places (ponds) on carbonate tidal flat. Type 2 carbonates are interpreted as extensive carbonate mud and sand tidal flats marked by low water-energy rippled and small-scale megarippled sedimentary structures. Fragmented, cyclic, laminated, fining-upward fossil debris was washed by tidal activity on this tidal flat complex from carbonate platform seas situated to the west. A terrigeous clastic contribution of silt-sized quartz grains stemmed from higher lands to the east. The thin, tan stringers are dolomitized algal mats that encrusted tidal flat carbonate muds and sands. The partial to extensive dolomitization of tidal flat muds (micrite) on this tidal flat expanse suggests that it was truly low intertidal.

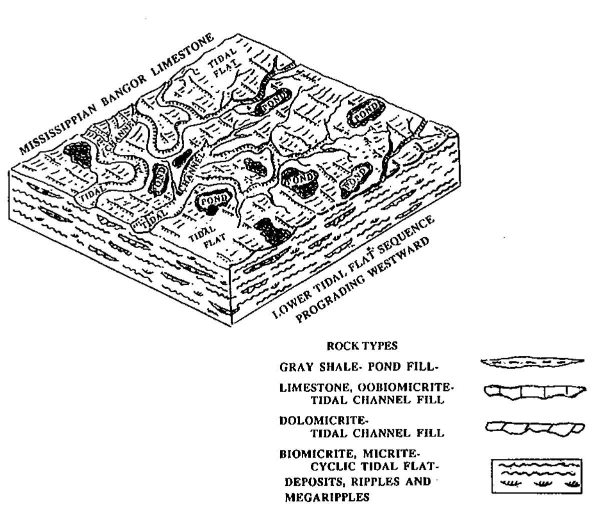

FIG. 4. Depositional model of Bangor limestone exposed in Hugden Branch of Raccoon Mountain in the Tennessee River Gorge, Marion County, Tennessee.

Type 3 limestones accumulated as scour fill in tidal channels as evidenced by fragments of marine organisms and ooids that lived and formed in shallow carbonate platform seas to the west. The fact that ooids form in shallow, warm, agitated sea water attest to the fact that these ooids did not form in tidal channels choked with lime mud and fossils hash but rather along carbonate shelf edges. Also, the observation that dolomite is not present in type 3 carbonate units indicates that they formed in an environment that was largely subtidal (transgressing seas).

Type 4 dolomicrites (pelmicrites) that have been extensively dolomitized and occur as scour fills with birdseye and mud crack structures suggests accumulation in tidal channels during low stands of sea level. Thus, through time, this regionally prograding, low intertidal, largely carbonate tidal flat likely records a succession of both positive and negative eustatic shifts.

LITERATURE CITED

BERGENBACK, R. E., J. C. HORNE, AND R. F. INDEN. 1972. Depositional environments of Mississippian carbonate rocks at Monteagle, Tennessee. Pp. 14-18 *in* Carboniferous depositional environments in the Cumberland Plateau of southern Tennessee and northern Alabama (J. C. Ferm, R. C. Milici, and J. E. Eason, eds.). Tennessee Div. Geol. Rept. Invs. 33.

BERGENBACK, R. E., ET AL. 1980. Carboniferous paleodepositional environments of the Chattanooga area. Pp. 262-264 *in* Excursions of the southeastern geology. Vol. 1 (R. W. Frey, ed.). Geol. Soc. Amer.

DUNHAM, R. J. 1962. Classification of carbonate rocks according to depositional texture. Pp. 108-121 *in* Classification of carbonate rocks (W. E. Ham, ed.). Amer. Assoc. Petrol. Geol., Memoir, 1:1-279.

TABLE 1. Generalized textural and compositional description of thin sections of Bangor Limestone (27.4 to 70.1 m).

Sample number	Thin-section description
S-10	Biomicrite; grain-supported; grains = echinoderm, bryozoan, sponge spicules, scattered silt-sized quartz, abundant peloids; euhedral dolomite rhombs in micrite matrix
S-1	Biomicrite; mud-supported; grains = echinoderm (partial replacement by chert), peloids, scattered silt-sized quartz; dolomite uehedra in micrite
S-2	Dolomicrite; peloids; pervasive tiny dolomite euhedra
S-3	Dolomicrite; peloids; birdsey structures; pervasive dolomite euhedra
S-4	Dolomicrite; peloids; birdseyes; rip-up micrite clasts; pervasive dolomite euhedra
S-101	Oo-biomicrite; mud-supported, extensive reorganization of icrite matrix to tiny anhedral calcite; grains = echiniderm (some with partial chert replacement), bryozoan, ostracod, trilobite, brachiopod, gastropod, ooids (well-formed with echinoderm, ostracod, and bryozoan grain nucleii)
S-5	Oo-biomicrite; mus-supported, reorganized (to calcite) micrite matrix; grains = echinoderm, bryozoan, ostracod, ooids (incipient with echinoderm, bryozoan, gastropod, endothyrid, ostracod and peloidal grain nucleii)
S-11	Oo-biomicrite; mud-supported, reorganized (to calcite) micrite matrix; grains = peloids, ostracod, sponge spicules, ooids (incipient with echinoderm and bryozoan grain nucleii)
S-6	Biomicrite; mus-supported, partial dolomitization of micrite matrix by small dolomite euhedra; laminated grains = silt-sized quartz, peloids, bryozoan, ostracod
S-12	Biomicrite; mud-supported, partial dolomitization of micrite matrix; mud-cracked; laminated grains = silt-sized quartz, echinoderm, peloids, ostracod
S-13	Biomicrite; mus-supported, partial dolomitization of micrite matrix; laminated grains = silt-sized quartz, echinoderm, bryozoan, peloids, ostracod
S-7	Dolomicrite; peloids; birdseyes; pervasive dolomite euhedra
S-14	Dolomicrite; peloids; scattered, highly-comminuted fossil debris; pervasive dolomite euhedra
S-102	Dolomicrite; peloids; pervasive dolomite euhedra
S-103	Dolomicrite; peloids; mus-cracked; burrowed; pervasive dolomite euhedra
S-15	Biomicrite; mud-supported, partial dolomitization of micrite matris; laminated grains = silt-sized quartz, peloids, highly comminuted fossil debris

FOLK, R. L. 1959. Practical petrographic classification of limestone. Amer. Assoc. Petrol. Geol. Bull., 43:1-38.

SHINN, E. A. 1968. Practical significance of birdseye structures in carbonate rocks. J. Sedimentary Petrol., 38:215-223.

SHINN, E. A., R. M. LLOYD, AND R. N. GINSBURG. 1969. Anatomy of a modern carbonate tidal-flat, Andros Island, Bahamas. J. Sedimentary Petrol., 39:1202-1228.