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Lithology and Petrography of the Virgin Limestone (Lower Triassic) at Blue Diamond Hill and Vicinity, Clark County, Nevada

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ABSTRACT.—Interbedded limestones, claystones, shales, and dolostones comprise the Virgin Limestone (Lower Triassic, and part of the Moenkopi) in 5 measured stratigraphic sections at Blue Diamond Hill and vicinity, west of Las Vegas, Clark County, Nevada. Within these sections which aggregate from 750 to about 1,000 feet in thickness, limestones of oolitic, pelletal, oopelletal, micritic, skeletal, algal stromatolitic, algal oncolitic, and pelecypod coquinite varieties, along with dolomicrites, form prominent ledges, while claystones and shales form slopes and benches. The area of investigation is about 20 miles west of the Las Vegas hinge line, and therefore sediments which accumulated in this region are interpreted as a shallow marine environment, possibly proximal to the basin which was farther west.

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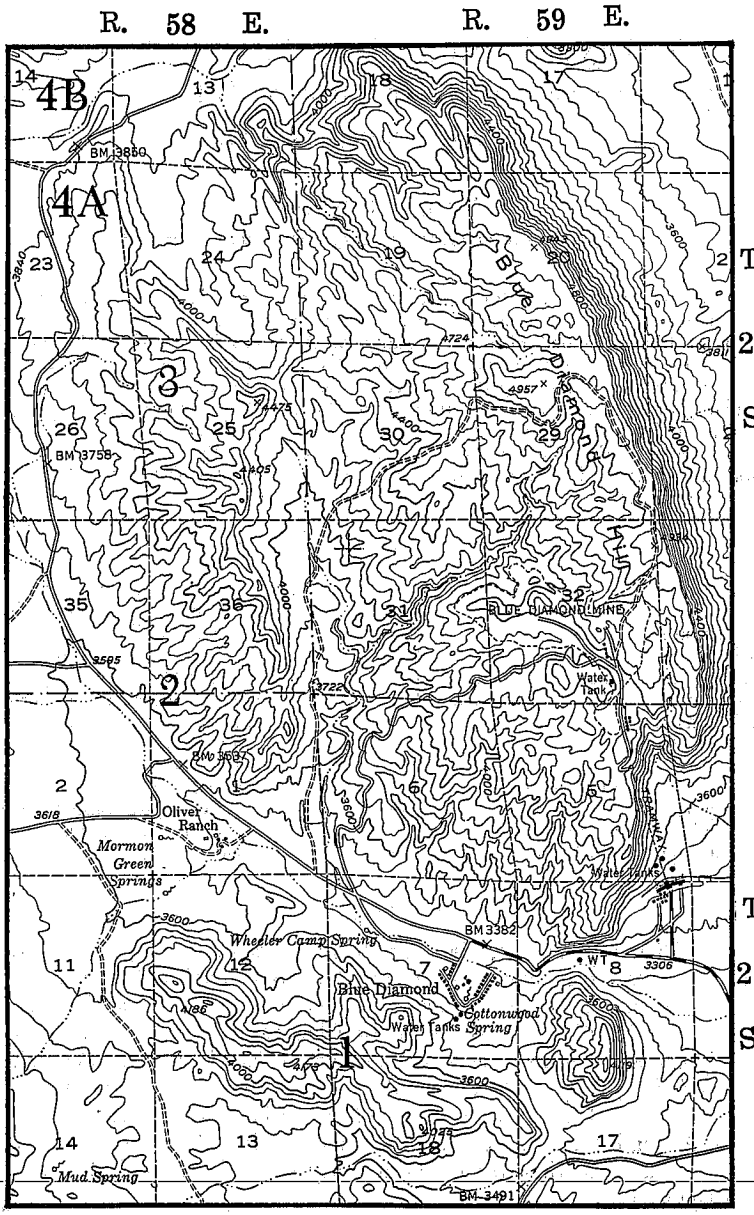
INTRODUCTION

Blue Diamond Village, the only town immediately adjacent to the study area, is a small company town (Blue Diamond Division, Flintkote Gypsum Mining Company), located about 20 miles southwest of Las Vegas, Nevada. Blue Diamond Hill is directly north of Blue Diamond Village and consists of superbly exposed Permo-Triassic sedimentary rocks which strike generally north-south and dip gently west. The study area lies mostly along the west flank of the mountain, and in a low hill west of the village; all or parts of sections 14, 23, 25, 26, and 36, T. 21 S., R. 58 E., and sections 1 and 12, T. 22 S., R. 58 E. are embraced in the area under investigation, all in Clark County, Nevada (Text-figure 1).

Field work consisted of measuring stratigraphic sections, sampling, mapping on enlarged aerial photographs, and photographing lithologic features of the Virgin Limestone (Lower Triassic), which is part of the Moenkopi Formation of McKee (1954), or Group of Poborski (1954). Laboratory work consisted of making acetate peels from large slabbed specimens, preparing thin sections (2"



TEXT-FIGURE 1.—Index map (from Blue Diamond, Nevada, topographic sheet), showing locations of the five measured stratigraphic sections of the Virgin Limestone from near Blue Diamond Village northward.

x 3" and 1" x 2"), taking photomicrographs and enlarging them to appropriate scale, and drafting the five stratigraphic sections which were measured and described in detail. Insoluble residues were prepared of some representative bioclastic limestones in hope of finding conodonts, but of rocks treated with weak acetic acid, none yielded these fossils.

Acknowledgments

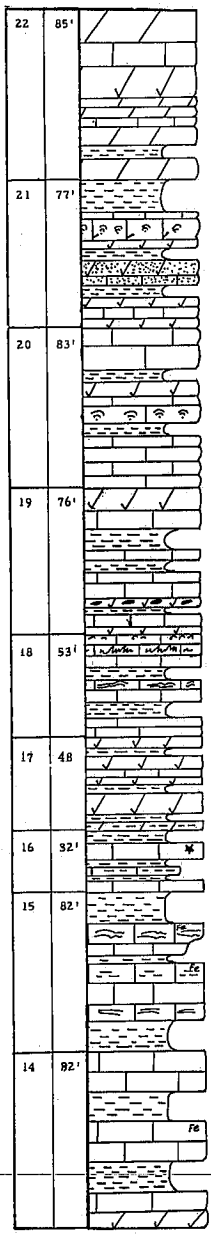
Financial support for the field investigations and for laboratory study of samples and specimens was provided by an Undergraduate Research Participation Grant by the National Science Foundation to the Department of Geology, Brigham Young University. Page charges were also covered by the grant. Dr. H. J. Bissell supervised the field and laboratory studies by aiding the author in both realms of investigation, and by obtaining permission from personnel of the Blue Diamond Division, Flintkote Gypsum Mining Company, to gain access to the west side of Blue Diamond Hill; thanks are accorded those persons for their kindness.

LITHOLOGY

The name Virgin Limestone, as applied herein, refers to a sequence of rather evenly spaced beds of alternately resistant limestones and minor dolostones, and nonresistant shale, claystone, and mudstone. Measured stratigraphic sections indicate the presence of from 750 to as much as 1,000 feet of rhythmically to almost cyclically accumulated oolitic, algal, micritic, pelletal, and skeletal limestones interbedded with shale, claystone, mudstone and minor dolostone. Outcrops and some exposures (bulldozed and other excavations at Blue Diamond Mountain) are good to excellent, and form rather striking bands in gently west-dipping strata in the study area, particularly along the erosional escarpment which forms the west flank of Blue Diamond Mountain (Plate 1, fig. 1). In the area near Cottonwood Wash (southwest of Blue Diamond Village) northward to the north end of Blue Diamond Mountain, the Virgin Limestone is unconformably underlain by the Lower Red Member of the Moenkopi, or if this is locally absent, by the gypsiferous Harrisburg Member of the Kaibab Formation (Permian). Relations of the Triassic to subjacent Permian are shown in Plate 1, fig. 1, with details of section No. 1 in Text-figure 2.

Within the succession of alternately thin- to thick-bedded carbonates and fine-textured clastics of the Virgin, there are various algal stromatolites (see Plate 1, fig. 3) which are as much as six feet thick, and are mappable across the area of current study. Thinner units of oncolite limestones may occur in connection with the stromatolitic rocks, or are independent of them and may occur as the first unit above dolomicrites, particularly those which likely are the nearest approximation to "primary" dolostones in this area. Stylolites, from those of a moderately large scale to those seen only in thin sections, are typical of many oolitic, pelletal, and oopelletal micrites, and mud-supported oolite. Some units no more than four feet in thickness may contain as many as six bands of stylolites arranged mostly parallel to the bedding planes, and rather evenly spaced in the bed. Some stylolites were observed which are transverse to the stratification.

Most rocks are medium gray, medium gray-brown to brown-gray, and some are light blue-gray. Dolostones, particularly the dolomicrites, are cream-colored,



Interbedded dolomicrite, micrite, calcite, dolomite, claystones and shale. White, cream, light tan-grey, green grey, and medium pinkish grey. Thin to thick bedded. Some limestones contain algae and oolites. Overlapped by Quaternary alluvium

Interbedded calcarenites, shale, claystones, micrite, oncolite limestones, algal micrite, dolomicrite, sandy calcareous dolomite and dolomitic limestone. Light grey, cream, light tan-grey, green-grey, and light pinkish-grey. Thin to thick bedded.

Sequence of interbedded micrite, pelecypod limestones, algal micrite, claystones and shales, algal oncolites and minor dolomite and calcareous dolomite. Colors as overlying units. Thin to medium bedded.

Sequence of interbedded dolomicrite, micrite, dolomitic limestone and calcareous dolomite, along with oolite-pellet micrite, algal micrite and claystone shale interbeds. Medium grey-brown, light tan-grey, cream, red-grey and white. Thin to medium bedded. Minor amount of chert.

Interbedded micrite, pelecypod limestones, oolite-micrite with prominent pelecypod bed at the top. Few shales and siltstones are present, with algal-stromatolites. Medium grey, blue-grey, tan and cream. Thin to thick beddd.

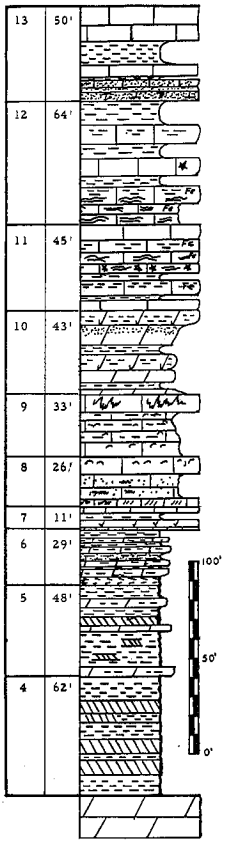
Dolomite Key Bed. Cream-yellow, yellow light-tan to light grey and white dolomicrite, algal dolomicrite, micrite, with interbedded claystones and shales. Medium light-grey, light grey to cream, light-tan and red-grey. Thin to thick bedded. Prominent algal dolomicrite in basal 5 feet.

Sequence of interbedded laminated micrite, skeletal limestones (mollusks and Pentacrinus whitei) argillaceous limestone, shales and claystones. Colors and bedding as above.

Interbedded claystones and shales, siltstones, platy to medium-bedded micrite, oolite-micrite, algal micrite, algal-stromatolites, and argillaceous limestone. Ironstone (Fe) nodules are present. Some pelecypod beds. Red-grey, grey-brown, light tan, buff and yellow-tan. Thin to thick bedded.

Interbedded micrites, skeletal limestones, oolitic algal-micrites, claystones, shales and siltstones, with calcareous dolomite at base. Pink-grey, red-grey, lavendar-grey, grey-brown, tan, buff and yellow light grey. Thin to thick bedded, Some ironstone pellets and buttons.

TEXT-FIGURE 2.—Stratigraphic section of the Lower Triassic Virgin Limestone in the Blue Diamond area, Clark County, Nevada. This is section 3 of Text-fig. 1, and was measured by H. J. Bissell in 1966 and is used here with his permission.



Interbedded skeletal limestones, micrites, algal to pelletal limestones and bioclastic limestone, with green-grey shales and claystones. A few stylolites, some ironstone buttons. Medium grey, brown-grey, red-grey. Some beds thin, some medium to thick, slightly cross-bedded. Calcareous sandstone and quartzite near base.

Interbedded argillaceous limestones, mudstones and claystones, crinoidal limestones (Pentacrinus whitei); some pelecypod limestones, various micrites, algal micrites and algal stromatolites. Brown-grey, medium reddish-grey, grey-brown, olive grey, and dusty grey. Thin to knobby bedded, laminated, medium and thick, some ironstone nodules, shales and claystone.

Limestone, micrite, oolite-micrite, pelletal and algal limestones, and some pelecypod limestones, with rare crinoidal limestones (Pentacrinus whitei). Brown-grey, grey-brown, red-grey. Some argillaceous limestones and much ironstone material. Thin to thick bedded with shale partings.

Dolomite, argillaceous and silty. Calcareous with interbedded dolomicrite, silty dolomite, claystones and shales, and slightly sandy dolomite. Yellow-tan, yellow-grey, grey-yellow, light grey, cream, buff to dusky light brown. Laminated to wavy and platy to medium bedded.

Limestone, argillaceous, oolitic, algal, micritic. Some beds have ironstone buttons and pseudomorphs. Top 4' has stylolites. Medium tan-grey, grey-brown, red-grey, buff and tan. Thin to thick bedded. Few pelecypod coquinas.

Limestone, micrite, algal micrite, oolite micrite, and skeletal limestones. Top 6' was pelecypods. Basal 3' prominently cross-bedded limestone. Thin to thick bedded, few shale partings, some stylolites.

Algal, oolitic, and micritic limestone, with light yellow-tan wavy-laminated silty dolomite. Minor shale interbeds.

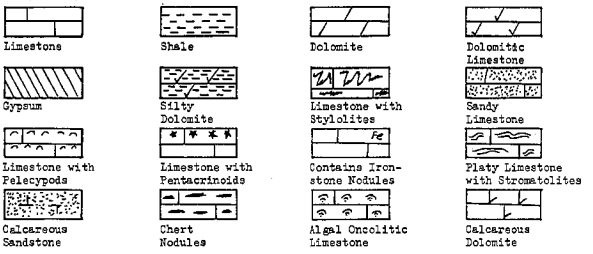
Gypsiferous crinkly-wavy siltstone in basal 4', overlain by a sequence of shales, mudstones, siltstones, dolomicrites, primary dolomites and silty dolomites. Cream, tan, buff, maroon, blood-red to brick-red. Thin to medium bedded.

Shale, gypsiferous below but not above with interbedded medium light grey dolomicrite and silty dolomite. Thin gypsum interbeds. Blood-red, deep maroon, brick-red, dusky red-brown, cream, tan and white. Chippy to fissile to thin bedded.

Red Beds: Consisting of interbedded gypsum, gypsiferous mudstone and shale, argillaceous siltstones. Deep blood-red, maroon, red-brown, brick red and white. Impure, thin and platy to thick bedded.

Total Thickness 1039 feet

Underlain by white dolomite, Upper Permian Kaibab Formation.



TEXT-FIG. 2 (Continued)

light-gray and light tan-gray. Many of these are thinly laminated and wavy-laminated; some may contain negative relics of algal filaments. Both lateral and vertical facies changes occur, but more on a gradual or subtle fashion when traced along or across depositional strike. Vertical changes, on the other hand, are very striking in some beds in that algal oncolites may be directly in sharp contact upon dolomicrite, or so-called "primary" dolostone may be in knife-edge contact on mud-supported oolite (oolite supported by micrite). Interestingly enough, when a succession, about 20 feet for example, consisting of alternating thin and thick beds of limestones and dolostones is traced along the outcrop band, it is discovered that gradual facies changes occur, and the sequence may then consist only of limestones. Or, if traced across depositional strike (westerly, in this instance), it may be replaced laterally by dolostones only.

Not all the sections which were measured on this project are depicted herein as illustrations, but one of the thick ones (about midway north-south along the west flank of Blue Diamond Mountain) is presented (Text-fig. 2); approximate position of the traverse along which it was measured and from which samples were taken (between numbers painted at each unit change) is shown on Plate 1, fig. 1. At this locality contact relations to the underlying Lower Red (Moenkopi), and that in turn to the subjacent Harrisburg gypsiferous and red bed units of the Kaibab Formation are readily discernible. This section also contains essentially all the lithologic entities which characterize the Virgin in this part of the ancient depocenter.

Petrography

Oolitic limestones, particularly ooids in micrite (oolitic micrite), oolite in sparite (oosparite), mud-supported oolite, pelletal, and oopelletal limestone, recrystallized oolite, encrinal limestone, algal micrite, algal stromatolite, oncolite limestone, and pelecypod coquinite are very common to the succession of carbonates in the Virgin. Algal dolomicrite, micrite, dolomicrite ("primary" dolostone), and some bioclastic limestones are also present. Certain units contain microlaminated micrite and calcilutite or calcisiltite (Plate 1, fig. 2), within or

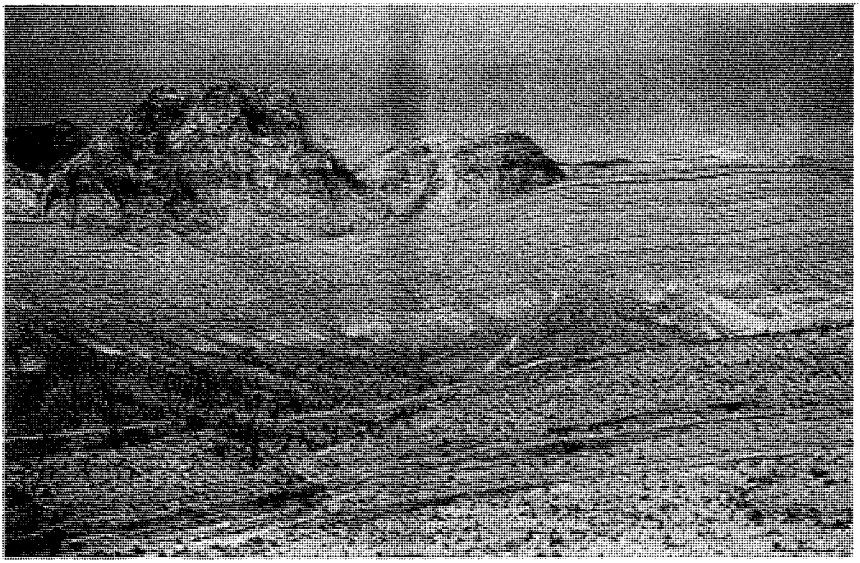
Explanation of Plate 1

BLUE DIAMOND HILL EXPOSURES AND PHOTOMICROGRAPHS OF CARBONATE ROCKS

Fig. 1.—View northwest across west-central part of Blue Diamond Hill over gently west-dipping Permo-Triassic sedimentary rocks. Upper limestone of the Kaibab Limestone (Permian) are in the foreground and light-colored material above is the Harrisburg Member of the Kaibab Limestone. The Virgin Limestone (Lower Triassic), above, consists of ledge-and-bench units of limestone, dolostone, claystone, and shale. Wilson Cliffs in the background are of Jurassic Aztec Sandstone. Section 3 was measured across northern one-third of picture.

Fig. 2.—Photomicrograph of interbedded micrite and calcisiltite, characteristic of some of the prominent ledge-forming units shown in Fig. 1 above. (x4).

Fig. 3.—Photomicrograph of a unit of algal stromatolite which forms the fourth prominent ledge from the base, at extreme right in Fig. 1 above. (x4).



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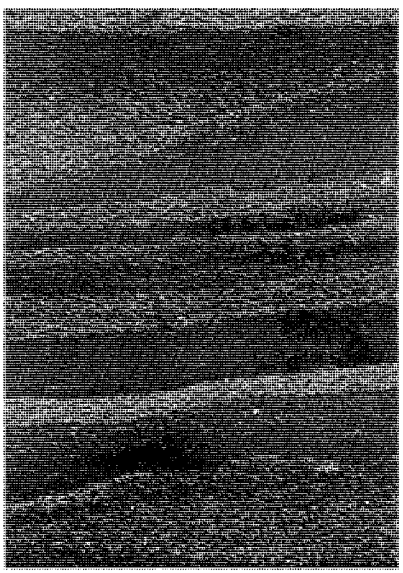

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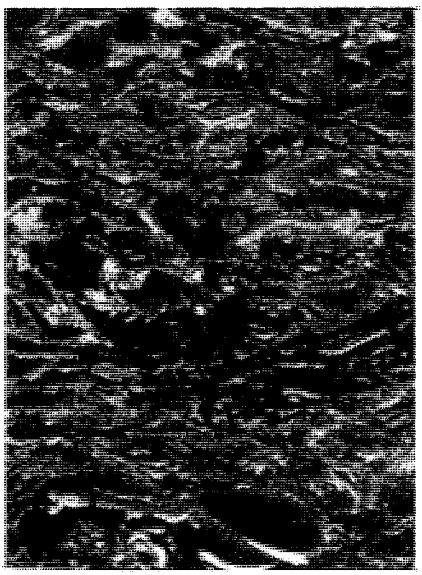

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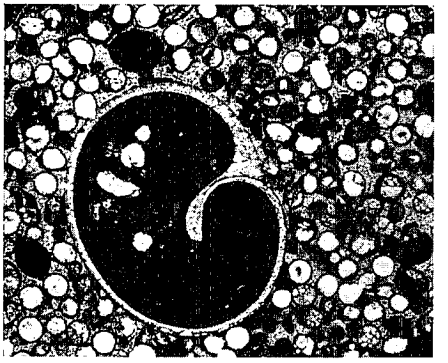

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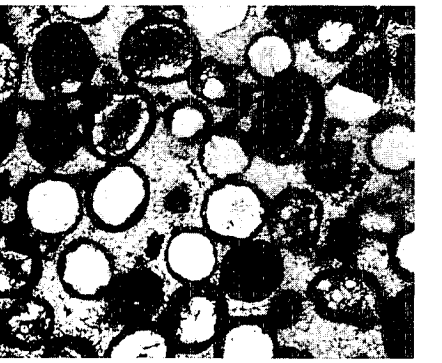

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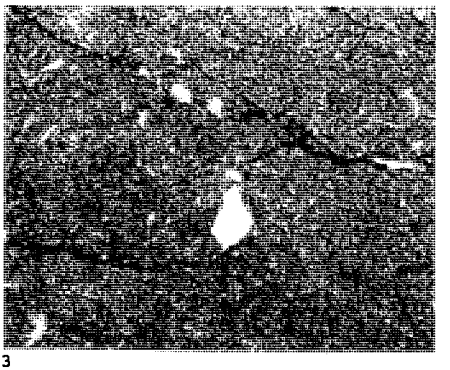

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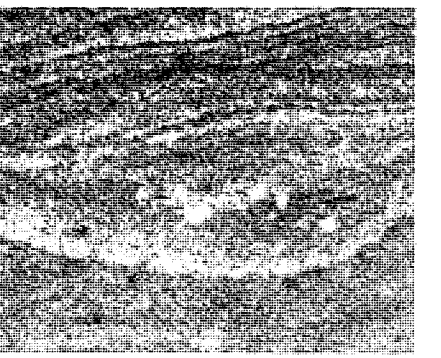

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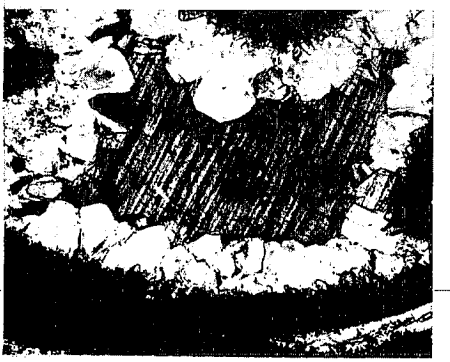

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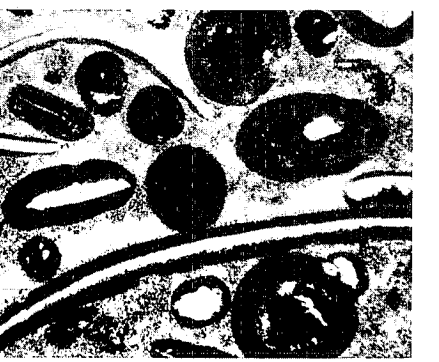

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EXPLANATION OF PLATE 2

PHOTOMICROGRAPHS OF VIRGIN LIMESTONE
(All x48 except Fig. 2 which is x90)

FIG. 1.—Crystallized mud-supported oolitic limestone, with a mud-filled gastropod in center of picture. Most ooids have an envelope of micrite, but their internal structures are destroyed by crystallization. The matrix is also largely crystalline, a sparite.

FIG. 2.—Crystallized algal-oolitic limestone. This was a mud-supported oolitic limestone, but most of the ooids and the matrix are now sparite. Some of the dark bodies are unaffected algal pellets, or some which have incipient crystallization.

FIG. 3.—Calcisiltite which has a bifurcating microstylolite, and a few centers of sparite development.

FIG. 4.—Calcisiltite displaying microlaminations of more calcareous-rich materials displaying incipient crystallization.

FIG. 5.—Cavity filling by calc-spar. This cavity was lined with sparite (light-colored) but the process of grain-growth of the dark-colored sparite has continued to the point of replacing and recrystallizing the light sparite.

FIG. 6.—Mud-supported skeletal limestone being recrystallized. Dark-colored algal pellets and pelecypod shells and matrix are being recrystallized.

separate from algal stromatolites. Some of the carbonates which display coated grains, complete or superficial, are grain supported but more commonly they are mud supported with micrite forming a thin interstitial matrix. Many such coated grains also have a micrite envelope. Within many of the limestones which in the field appear as oolites, there are round to subround and almost elliptical grains from one to as much as ten mm long that prove to be oncolites consisting of algae encrusting nuclei of small gastropods or shell fragments.

The name micrite, as used in this report, relates to carbonate sediment whether crystalline or finely grained, that is 0.05 mm or smaller in diameter or across faces. Micrite, then, is lime mud or its indurated equivalent, and dolomicrite is dolomite mud or its indurated equivalent. Most micrites or micritic limestones studied for this project fall within the 0.05 to 0.03 mm grade scale, but dolomicrites (particularly those which are normally termed "primary") fall below the 0.03 mm size, even to a dimension of 0.005 mm. Micrites, micritic limestone and dolomicrite comprise significant parts of some of the measured sections.

Diagenetic alteration in the form of early-stage crystallization, and syndiagenetic recrystallization are common to some units. Petrographic studies bear out the petrologic (field) studies which suggested selective diagenetic changes; that is, most coated grain or oolitic limestones display a moderate- to high-degree of crystallization of the centers of ooids, and many also show mosaics of calcite in the matrix (interstitial) areas as well, yet one or more "protective" rinds or envelopes seemingly are unaffected in many of these ooids. Furthermore, stylolites and microstylolites are common, locally abundant, and display an interesting pattern of impingement and displacement within oolitic and other limestones. Merely a few of the many photomicrographs prepared for this study have been assembled in an illustration (Plate 2) depicting some of the textures and fabrics.

Conclusions

Field and laboratory data document the conclusion that this part of the Triassic seaway was mostly within the shallow neritic realm, that transgressions are demonstrated in the oolitic to algal stromatolitic units, and that regressions are shown in the dolomicrites ("primary" dolostones), and algal dolomicrites. Encrinal limestones and algal stromatolites are areally extensive and locally accumulated to form thick units; open marine environments to the point of water depths possibly as much as 60 feet may have characterized environmental realms at times and places. This area represents one of the westerly outcrop bands of the Virgin Limestone, and is directly east of the leading edge of the Keystone Overthrust. The hinge line evidently was about 20 miles to the east (near the present site of Las Vegas), and the shelf was east of that tectonic feature.

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