Stratigraphy and Microfaunas of the Oquirrh Group in the Southern East Tintic Mountains, Utah

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STRATIGRAPHY AND MICROFAUNAS OF THE OQUIRRH GROUP IN THE SOUTHERN EAST TINTIC MOUNTAINS, UTAH

By H. T. Morris, R. C. Douglass, and R. W. Kopf

ABSTRACT

The Oquirrh Group of Pennsylvanian and Permian age in the southern East Tintic Mountains, Utah, is more than 15,000 feet (4,572 m) thick and consists of an incomplete section of the West Canyon Limestone (Morrowan) 960 feet (293 m) thick, a nearly complete section of the Butterfield Peaks Formation (Atokan(?) and Des Moinesian) about 5,800 feet (1,768 m) thick, a complete section of the Bingham Mine Formation (Missourian) 3,200-3,400 feet thick (975-1,036 m), and a complete section of the newly named Furner Valley Limestone (Missourian to Wolfcampian) 5,000-6,000 feet (1,524-1,829 m) thick. The formations below the Furner Valley Limestone are generally similar to their counterparts in their type areas in the central and southern Oquirrh Mountains but are somewhat thinner and less arenaceous. The Furner Valley Limestone, more than 90 percent carbonate, is apparently unique. Strata of the same age in the Wasatch, Stansbury, Cedar, Hogup, and Promontory Mountains in Utah are all considerably arenaceous; in the southern Oquirrh Mountains in the upper plate of the Midas thrust fault they have been largely removed by erosion.

The Oquirrh Group in the East Tintic Mountains is overlain by the Diamond Creek Sandstone; the latter, in turn, is overlain by the Park City Formation. No units lithologically resembling the Kirkman Limestone of the Wasatch Mountains are recognized.

Fusulinids are common in the Butterfield Peaks and Bingham Mine Formations and are present throughout the Furner Valley Limestone. The faunas are comparable to those of the Oquirrh Group in the Oquirrh and Cedar Mountains to the west and in the Wasatch Mountains to the east.

INTRODUCTION

Geologic studies in the southern East Tintic Mountains of central Utah (fig. 1 and plate 1*A*) have disclosed the presence of at least parts of all the formations composing the Bingham sequence of the Oquirrh Group (Tooker and Roberts, 1970) and in addition, a heretofore unnamed formation, logically a part of the group, that is not present in the type area of the group in the central Oquirrh Mountains. This newly recognized, predominantly carbonate unit, herein named the Furner Valley Limestone, is designated the uppermost unit of the Bingham sequence of the Oquirrh Group. It is 5,000-6,000 feet (1,524-1,829 m) thick and contains fossils of Late Pennsylvanian and Early Permian age.

ACKNOWLEDGMENTS

This paper is largely a byproduct of geologic mapping in the Furner Valley quadrangle and adjacent areas in west-central Utah by Morris (1977), correlative stratigraphic studies by Morris and Kopf (1970a, b), and other studies. A total of 46 collections of fusulinids were studied by Douglass, who also examined the principal rock units in the field and made additional collections of fusulinids in 1975. Other acknowledgments are made in the text,

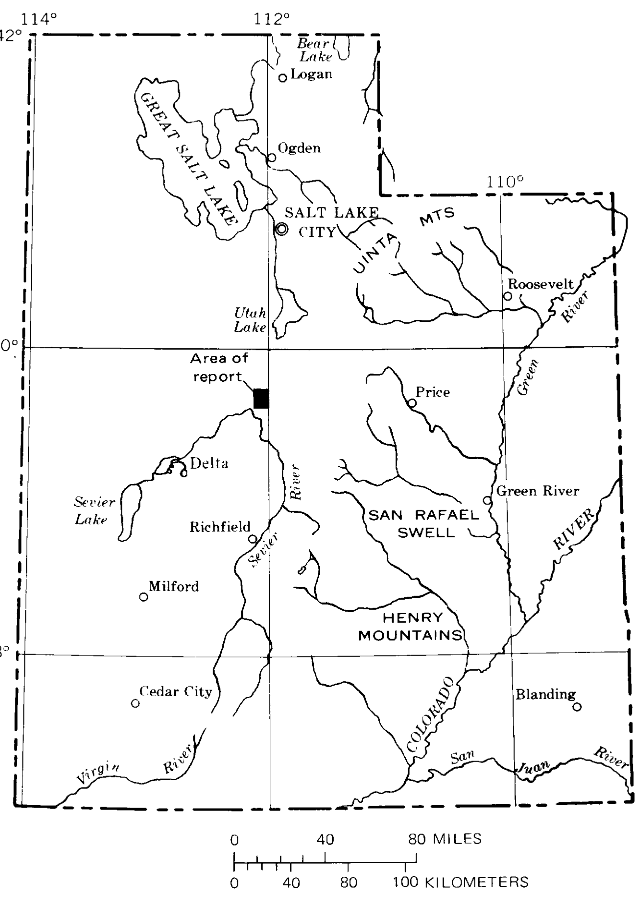


FIGURE 1.—Map of Utah showing location of report.

chiefly in regard to the identifications of collections of megafossils.

LOCATION

As shown on plate 1*A*, the southern East Tintic Mountains are about 55 miles (88 km) south of the central Oquirrh Mountains, the type area of the Oquirrh Group (Upper Mississippian to Lower Permian), and about the same distance southwest of well-studied sections of Pennsylvanian and Permian rocks in the southern Wasatch Mountains (Bissel, 1936; Baker 1947). Pennsylvanian and Permian beds similar to the strata in the southern East Tintic Mountains also are present in the Gilson Mountains (Costain, 1960; Wang, 1970) 10 miles (16 km) southwest of Furner Valley and on Long Ridge (Muessig, 1951) 7 miles (11 km) to the east. All these rocks are in the upper plate of either the Nebo-Charleston or Tintic Valley thrust faults, which have been described in reference to Pennsylvanian and Permian basins in northwestern Utah, northeastern Nevada, and south-central Idaho by Roberts and others (1965).

DESIGNATION OF THE OQUIRRH GROUP

The strata composing the Oquirrh Group were first named the Oquirrh Formation by Gilluly (1932) from exposures in the central and southern Oquirrh Mountains. This formation, as originally defined and mapped by Gilluly, consisted of more than 16,000 feet (4,879 m) of alternating sandstone (or quartzite) and limestone and was believed to be entirely of Pennsylvanian age, although the top was missing in the type area. Later studies of complete sections in the Wasatch Mountains and other areas (Bissel, 1936; Baker, 1947; and others) indicated the presence of Permian strata in the upper part of the formation.

As geologic studies progressed in central Utah, the great thickness of the Oquirrh Formation proved to be a handicap in the preparation of geologic maps, particularly in areas of ambiguous structural relations in the West Mountain (Bingham) and adjacent mining districts where many of the intercalated limestone beds are important host rocks for ore bodies. As a consequence, several proposals were made to subdivide this unwieldy formation into units of more manageable size. These include proposals by Nygreen (1958), Bissell (1959), Welsh and James (1961), and Tooker and Roberts (1961, 1963, 1970).

Welsh and James (1961, p. 7-8) were the first to propose a redesignation of the Oquirrh Formation to group rank and to subdivide it into named formational units. Tooker and Roberts (1961, 1963, 1970), whose studies in the Oquirrh Mountains overlapped those of Welsh and James, also recommended the elevation of the Oquirrh to group status and its subdivision into several formations. However, their regional mapping in the central and northern parts of the range disclosed three distinctly different sequences of upper Paleozoic rocks separated from each other by the Midas and North Oquirrh thrust faults. To emphasize the lithologic differences between these three sequences, Tooker and Roberts (1970, p. A2–A5) formally defined the strata of the Oquirrh Group north of the north-dipping North Oquirrh thrust in the northern Oquirrh Mountains as the Rogers Canyon sequence, the strata south of the southwest-dipping Midas thrust in the central Oquirrh Mountains as the Bingham sequence, and the strata between these two low-angle faults as the Curry Peak sequence. Both the Rogers Canyon and Bingham sequences were subdivided into several lithologically distinctive formational units retaining, where possible, the names proposed by Nygreen (1958, p. 13–14) and Welsh and James (1961, p. 8–9). Because of its wide distribution and economic importance, the Bingham sequence, which is more than 17,820 feet (5,431 m) thick, was designated the type section of the Oquirrh Group.

TYPE SECTION OF THE OQUIRRH GROUP

The Bingham sequence of the Oquirrh Group in the Oquirrh Mountains includes, in ascending order: (1) the West Canyon Limestone, (2) the Butterfield Peaks Formation, and (3) the incomplete Bingham Mine Formation. The West Canyon Limestone is 1,450 feet (438 m) thick in its type section (Nygreen, 1958, p. 14, 39) and consists chiefly of interlayered clastic arenaceous limestone and dense cherty argillaceous crystalline limestone in beds averaging 1–2 feet (30–60 cm) thick. Thin calcareous quartzite or sandstone beds, generally banded or crossbedded, separate the much thicker limestone strata. Fossils are locally abundant throughout the formation and indicate a Morrowan (Early Pennsylvanian) age (Gordon and Duncan in Tooker and Roberts, 1970, p. A50).

The Butterfield Peaks Formation is 9,072 feet (2,765 m) thick in its type section (Tooker and Roberts, 1970, p. A28–A31). It is about 60 percent silica-cemented orthoquartzite and calcareous sandstone and about 40 percent cherty, arenaceous, and argillaceous fine-grained limestone, all in units that range in thickness from a few feet (1 m) to more than

600 feet (183 m). Many of the limestone units are fossiliferous and indicate a Des Moinesian (Middle Pennsylvanian) age for the greater part of the formation and an Atokan age for the lower few hundred feet (100-200 m) (Gordon and Duncan in Tooker and Roberts, 1970, p. A50–A53).

The Bingham Mine Formation is 7,311 feet (2,228 m) thick in its type area (Tooker and Roberts, 1970, p. A33–A38) and is subdivided into two members: the Clipper Ridge Member, 2,985 feet (910 m) thick, and the overlying partial section of the Markham Peak Member, which is 4,326 feet (1,319 m) thick. The Clipper Ridge Member consists mostly of cyclically interbedded orthoquartzite and calcareous quartzite but also contains a number of prominent limestone layers 10-300 feet (3-91 m) thick. Several of the limestone units are important host rocks for replacement ore bodies in the West Canyon (Bingham) and adjacent mining districts. The Markham Peak Member is almost entirely orthoquartzite, calcareous quartzite, calcareous sandstone, and calcareous siltstone. The predominance of these arenaceous rocks, except for a few thin argillaceous limestone beds, distinguishes it from the Clipper Ridge Member. The contact of the Clipper Ridge and Markham Peak Members is conformable, but the top of the Markham Peak and the units above it have been removed by erosion. Fossils, particularly fusulinids, are moderately abundant in the limestone units of the Clipper Ridge Member and indicate a Missourian (Late Pennsylvanian) age (Gordon and Duncan, in Tooker and Roberts, 1970, p. A53). Fossils from the Markham Peak Member indicate that most of it is also Missourian, but that the upper part may be of Virgilian (Late Pennsylvanian) age (Gordon and Duncan, in Tooker and Roberts, 1970, p. A53–A55). Collections of fossils from the southern East Tintic Mountains, however, do not support a Virgilian age for any of the strata of the Bingham Mine Formation in that area.

No rocks of Permian age were recognized by Tooker and Roberts (1970) in the Bingham sequence, although they noted strata of questionable Wolfcampian age in the Rogers Canyon sequence (Tooker and Roberts, 1970, p. A49), and Welsh and James (1961, p. 5-7) reported Wolfcampian and Leonardian(?) fossils from the Curry Peak sequence exposed north of Bingham in the Oquirrh Mountains, and at South Mountain, which separates Tooele and Rush Valleys.

OQUIRRH GROUP IN THE SOUTHERN EAST TINTIC MOUNTAINS

In the southern East Tintic Mountains, the Oquirrh Group has an aggregate thickness of more than 15,000 feet (4,572 m). Its formations generally resemble those of the Bingham sequence in the Oquirrh Mountains, but overall, they are individually thinner and somewhat less arenaceous. All these formations are moderately fossiliferous, and correlations are readily made not only on the basis of their distinctive lithologies, but paleontologically as well. As shown on plate 1*B*, the formations of the Oquirrh Group in the East Tintic Mountains are overlain successively by the Diamond Creek Sandstone and the Park City Formation, both of Permian age.

WEST CANYON LIMESTONE

Owing to faulting and cover of volcanic rocks, the base of the Oquirrh Group and the lower part of the West Canyon Limestone are not exposed in the southern East Tintic Mountains. However, the upper part of the West Canyon Limestone and its contact with the overlying Butterfield Peaks Formation are exposed near Jericho Pass, approximately in the center of the boundary between secs. 19 and 30, T. 13 S., R. 2W. This partial section of the West Canyon is 960 feet (293 M) thick and consists mostly of medium-blue-gray medium-grained thin- to medium-bedded silty and sand-streaked limestone. Many of the limestone beds contain scattered nodules and thin layers of black to dark-brown chert that weather rusty brown. A few thin sandstone beds are present, but they constitute less than 10 percent of the exposed strata. Many of the limestone beds are stained brown by accumulations of silt and sand on the weathered surface. The top of the West Canyon Limestone is placed at the base of a thick, distinctive bed of quartzitic sandstone that is readily distinguished from the relatively sand-free limestone below it.

Fossils are moderately abundant in the partial exposure of the West Canyon Limestone near Jericho Pass; they confirm a Morrowan age, and indicate the Morrowan-Atokan boundary to be at or near the top of the formation. Costain (1960, p. 73-74) reported *Spirifer opimus*, *Composita subtilata*, *Composita trilobata*, *Dictyoclostus* sp., and *Linoproductus* sp. about 100 feet (30 m) below the top of the West Canyon Limestone in this area. Brill (1963, pl. 1) collected *Rhipidomella* sp. near the base of the exposed section in the same outcrops. Later, Wang (1970, p. 34-35) reported *Rhynchopora* sp., *Antiquatonia* sp., ***Rugoclostus*** aff. *R. semistriatus* (Meek), *Chonetipustula*? sp., *Cleiothyridina orbicularis*, *Composita* sp., *Enchinoconchus* sp., *Linoproductus* sp., *Anthracospirifer occiduus* (Sadlick), *Orbiculoidea* sp., *Chonetes* sp., and other forms from beds about 500 feet (152 m) below the top.

During a rapid reconnaissance of the southern East Tintic Mountains in 1955, a small collection of fossils was made from beds about 100 feet (30 m) below the top of the formation. It was examined by Helen Duncan (written commun., Jan. 25, 1956).

Collection U.S.G.S. 15926. Southernmost East Tintic Mountains, Utah. N½NW¼NE¼ sec. 30, T. 13 S., R. 2 W. (about 100 feet (30 m) below top of West Canyon Limestone).

Lophophyllidium sp.

According to Duncan, this horn coral is common in the Pennsylvanian but also occurs in Permian rocks.

BUTTERFIELD PEAKS FORMATION

In the southern East Tintic Mountains the lower(?), middle, and upper parts of the Butterfield Peaks Formation are most fully exposed near County Canyon on Jericho Ridge. This section is approximately 5,800 feet (1,768 m) thick, and although the basal contact and an unknown thickness of overlying beds are cut out by the County Canyon fault, the base and lower 1,100 feet (335 m) of the formation overlie the West Canyon Limestone in the upper plate of the Tintic Valley thrust fault near Jericho Pass about 5 miles (8 km) to the south. The middle and upper parts of the Butterfield Peaks also are exposed in the northern part of Furner Ridge. In this area the basal contact and lower part are concealed by lava, but they also may have been cut out by a pre-lava fault.

In general, the Butterfield Peaks Formation looks striped, owing to interbedded medium- to dark-gray limestone and brown-weathering sandstone and quartzite, which are chiefly in units a few feet to rarely more than 75 feet (23 m) thick. In the exposures near Jericho Pass, the base is conformable with the West Canyon Limestone and is placed at the base of a prominent bed of medium-grained sandstone about 20 feet (6 m) thick above which the strata consist of approximately 40 percent sandstone, quartzite, and siltstone and 60 percent limestone and dolomite, in contrast to the largely carbonate West Canyon Limestone below it. The top is also conformable, and in the area south of County Canyon and on Furner Ridge it is placed at the base of a reddish-brown-weathering quartzite more than 100 feet (30 m) thick that forms the basal unit of the predominantly arenaceous Bingham Mine Formation. The limestone beds of the Butterfield Peaks Formation are mostly fine to medium grained, medium bedded, and commonly are silty. Many are cherty, and some are moderately fossiliferous. The arenaceous beds range from fine-grained siltstone to coarse-grained quartzite and sandstone. On freshly broken surfaces they are buff to dark olive green. Silica-cemented quartzite appears to be more abundant than calcite-cemented sandstone; shale is rare.

Fossils occur throughout the Butterfield Peaks Formation in the southern East Tintic Mountains, but the principal collections made during the present study have come only from the lower part and near the top. All of them indicate a Des Moinesian age.

From the exposures of the lower part of the formation near Jericho Pass, two collections of fossils were made in 1955 and an additional collection of fusulinids in 1975. In the earlier collections the corals and bryozoa were identified by Helen Duncan (written commun., Jan. 25, 1956), the brachiopods by Mackenzie Gordon, Jr. (written commun., Dec. 16, 1955, emended Apr. 5, 1976), and the foraminifera by Lloyd G. Henbest (written commun., Jan. 26, 1956). The fusulinids of the 1975 collection were identified by R. C. Douglass.

Collection U.S.G.S. 15927. Southernmost East Tintic Mountains in NW¼NW¼NE¼ sec. 30, T. 13 S., R. 2 W. (about 150 feet (46 m) above base of Butterfield Peaks Formation). Collected in 1955.

Polypora sp.
Fenestella (*Polyporella*) sp.
Septopora
Anthracospirifer occiduus (Sadlick)

Collection U.S.G.S. 15928. Southernmost East Tintic Mountains in SW¼NW¼NE¼ sec. 30, T. 13 S., R. 2 W. (about 450 feet (137 m) above base of Butterfield Peaks Formation). Collected in 1955.

Textularia sp.
Endothyra sp.
Tetrataxis sp.
Tolypammina sp.
Chaetetes cf. *C. milleporacus* (Milne-Edwards and Haime)
Pseudoromingeria? sp.
Rhabdomeson sp.
Antiguatonia cf. *A. hermosana* (Girty)
Kozlowskia cf. *K. haydenensis*
Hystriculina? sp.
Phricodothyris perplexa (McChesney)
Composita subtilita (Hall)
Neospirifer cf. *N. coloradoensis* (Stevens)

Collection f13652. Southernmost East Tintic Mountains in NW¼NE¼ sec. 30, T. 13 S., R. 2 W. (about 775 feet (235 m) above base of Butterfield Peaks Formation).

Collected in 1975.
Fusulinella sp.
Wedekindellina sp. 1

The faunas of the lower part of the Butterfield Peaks Formation are similar to those reported from the lower part of the formation in the Oquirrh Mountains (Gordon and Duncan, in Tooker and Roberts, 1970, p. A49–A52). Here, as there, no definite Atokan forms were found, but the lowermost strata may be of Atokan age.

The collections from the upper part of the Butterfield Peaks Formation all came from beds within 700 feet (211 m) of the contact with the Bingham Mine Formation. They consist of fusulinids of Des Moinesian age.

Collection f13560. Jericho Ridge, southern East Tintic Mountains, NW¼NE¼NW¼ sec. 6, T 13 S., R. 2 W. (from limestone beds 700 feet (211 m) below top of Butterfield Peaks Formation).
Millerella sp.
Pseudostaffella(?) sp.
Beedeina sp. 1

Collection f24785. Jericho Ridge, southern East Tintic Mountains, N½NE¼NW¼ sec. 6, T 13 S., R. 2 W. (from limestone beds 500 feet (152 m) below top of Butterfield Peaks Formation).
Wedekindellina sp. aff. *W. henbesti* (Skinner)

Collection f13649. Jericho Ridge, southern East Tintic Mountains, NW¼NE¼NW¼ sec. 6, T. 13 S., R. 2 W. (from limestone 475 feet (143 m) below top of Butterfield Peaks Formation).
Wedekindellina sp. 2
Beedeina sp. 2

Collection f13648. Jericho Ridge, southern East Tintic Mountains, NW¼NE¼NW¼ sec. 6, T. 13 S., R. 2 W. (from limestone 450 feet (137 m) below top of Butterfield Peaks Formation).
Wedekindellina sp. aff. *W. euthysepta* (Henbest)
Beedeina sp. 3
Beedeina sp. 4

Collection f24698. Furner Ridge, southern East Tintic Mountains, SW¼NW¼NW¼ sec. 33, T. 12 S., R. 2 W. (from sandy limestone beds 110 feet (35 m) below top of Butterfield Peaks Formation).
Beedeina sp. aff. *B.* sp. A of Thompson, Verville, and Bissell, 1950.

BINGHAM MINE FORMATION

Complete sections of the Bingham Mine Formation crop out on both Jericho and Furner Ridges in the southern East Tintic Mountains, and the section at the crest of Jericho Ridge was selected for detailed measurement and study. It is 3,200 feet (975 m) thick and the measured section is presented below. The section on Furner Ridge, as scaled from a detailed map, appears to be about 3,400 feet (1,036 m) thick. These thicknesses are less than half the thickness of the preserved part of the BIngham Mine Formation in the Oquirrh Mountains.

In the southern East Tintic Mountains, it is not possible to subdivide the formation into the Clipper Ridge and Markham Peak Members as was done in the Oquirrh Mountains, despite the general lithologic similarity and comparable age span of the formation in the two areas. The base of the Bingham Mine Formation in the East Tintic Mountains is placed at the base of a rusty-brown-weathering quartzite about 100 feet (30 m) thick that overlies the cyclically bedded units of the Butterfield Peaks Formation. The top is placed at the top of a similar unit of brown-weathering sandstone more than 300 feet (91 m) thick that is succeeded by the predominantly carbonate beds of the Furner Valley Limestone. No other formation of the Oquirrh Group in the southern East Tintic Mountains contains arenaceous units as thick and as prominent as those in the Bingham Mine Formation. Both the lower and upper contacts are conformable with adjacent units.

In its exposures in the southern East Tintic Mountains, the Bingham Mine Formation consists of about 65 percent quartzite, sandstone, and siltstone, and 35 percent limestone and dolomite, in units that are a few feet to more than 300 feet (91 m) thick. In general, the quartzite and siltstone units are thicker than the limestone units and impart a rusty brown color to the formation when it is viewed from a distance. They generally are medium bedded to massive, and medium to fine grained. On freshly broken surfaces they are chiefly light olive brown, but most of them weather medium reddish brown. In most of these rocks silica cement is more abundant than calcite or dolomite cement, although some friable calcareous sandstone and limy siltstone are locally common.

The carbonate units of the Bingham Mine Formation are largely of two types. One is gray thin- to medium-bedded fine-grained silty limestone, commonly containing nodules and stringers of black chert with indistinct boundaries. The other is blue-gray medium-bedded to massive medium-grained commonly fossiliferous ledge-forming limestone. Chert is also common in the blue-gray limestone, but most of it occurs as sharply bounded nodules and stringers.

Collections of fusulinids and other foraminifers from the Bingham Mine Formation in the East Tintic Mountains indicate a Missourian age, and the Des Moinesian-Missourian boundary to be at or near its lower contact.

Collection f24701. Jericho Ridge, southern East Tintic Mountains, SW¼SE¼NW¼ sec. 6, T. 13 S., R. 2 W. (from beds 1,000 ft (305 m) above base of Bingham Mine Formation).

Bradyina sp.
Climacammina sp.
Bartramella sp.
Eowaeringella sp.

Collection f24696. Furner Ridge, southern East Tintic Mountains, NE¼SW¼SE¼ sec. 33, T. 12 S., R. 2 W. (from beds 1,600 ft (488 m) above base of Bingham Mine Formation).

Pseudofusulinella sp.

Collection f13578. Jericho Ridge, southern East Tintic Mountains, NW¼NW¼SE¼ sec. 6, T. 13 S., R. 2 W. (from beds 690 ft (210 m) below top of Bingham Mine Formation; in unit 34 of measured section).

Triticites sp. aff. *T. springvillensis* Thompson, Verville, and Bissell, 1950.

Collection f24778. Jericho Ridge, southern East Tintic Mountains, E½NW¼NW¼ sec. 7, T. 13 S., R. 2 W. (from beds 675 ft (206 m) below top of Bingham Mine Formation).

Triticites sp. aff. *T.* sp. B? of Thompson, Verville, and Bissell, 1950.

Collection f24779. Jericho Ridge, southern East Tintic Mountains, SE¼NW¼NW¼ sec. 7, T. 13 S., R. 2 W. (from beds 550 ft (168 m) below top of Bingham Mine Formation).

Triticites sp. aff. *T.* sp. B of Thompson, Verville, and Bissell, 1950.

Collection f24780. Jericho Ridge, southern East Tintic Mountains, NE¼SW¼NW¼ sec. 7, T. 13 S., R. 2 W. (from beds 160 ft (49 m) below top of Bingham Mine Formation).

Triticites sp. aff. *T.* sp. B? of Thompson, Verville, and Bissell, 1950.

Collection f13580. Furner Ridge, southern East Tintic Mountains, SE¼NE¼NW¼ sec. 4, T. 13 S., R. 2 W. (from beds about 95 ft (29 m) below top of Bingham Mine Formation).

Triticites sp. aff. *T. provoensis* Thompson, Verville, and Bissell, 1950.

Many of the medium-bedded to massive blue-gray limestone beds contain a great variety of other fossils including corals, bryozoa, and brachiopods, but since these forms are not particularly helpful in identifying the rock series, they were not collected or studied in detail. Costain (1960, p. 74–85), however, presented lists of the megafossils that he collected from beds here included in the Bingham Mine Formation.

FURNER VALLEY LIMESTONE (NEW NAME)

The Furner Valley Limestone is here named for a thick section of carbonate rocks that conformably overlies the Bingham Mine Formation and disconformably underlies the Diamond Creek Sandstone (Permian) on both Jericho and Furner Ridges. The name is taken from Furner Valley, which separates the two ridges. Its type section was measured on the east side of Jericho Ridge (see p. 17). It is 5,233 feet (1,595 m) thick and consists of 90 percent limestone and dolomite and 10 percent quartzite, sandstone, and siltstone and thus is readily distinguished from the more arenaceous Butterfield Peaks and Bingham Mine Formations stratigraphically below it. A reference section was measured on the west side of Jericho Ridge (see p. 18). It is 5,454 feet (1,662 m) thick and is closely similar but not identical to the type section three-quarters of a mile (1.2 km) to the east. The section exposed on Furner Ridge, though considerably faulted, is comparable to the sections on Jericho Ridge. Measurements from detailed maps indicate it may exceed 6,000 feet (1,829 m) in total thickness.

The base of the Furner Valley Limestone is placed at the base of a gray thin-bedded cherty silty limestone that overlies the thick unit of red-brown-weathering limy quartzite marking the top of the Bingham Mine Formation. The top is placed at the base of a pinkish-red-weathering sandy limestone or dolomite that underlies the lowermost pink- or red-weathering limy siltstone of the Diamond Creek Sandstone. This contact commonly is marked by a thin bed of sedimentary breccia and probably is locally disconformable.

The lower three-fourths or more of the type Furner Valley is limestone and the upper fourth or less is hydrothermal dolomite. The limestone of the lower part is predominantly of two varieties: one is blue-gray medium-bedded ledge-forming limestone that is commonly studded with nodules and stringers of black and brown chert, and the other is thin-bedded silty limestone, with indistinct masses and segregations of gray-bordered black chert. Both types of limestone are locally fossiliferous; corals, bryozoa, and brachiopods are abundant in the blue-gray limestone and foraminifers are common in the gray silty and sandy limestone. The dolomite in the upper part of the Furner Valley Limestone is obviously a replacement of the two varieties of limestone. One variety is gray, medium bedded to massive, and medium to coarse grained. This dolomite commonly contains nodules of brown chert and remnants of recrystallized megafossils. The other variety is gray thin-bedded sandy and silty dolomite or limy dolomite, commonly with zones of silicified fusulinids.

The subordinate arenaceous units of the Furner Valley Limestone are chiefly fine-grained quartzite or siltstone, commonly containing interlayered beds of silty limestone or dolomite. On freshly broken surfaces they range in color from buff to olive green, and like the arenaceous units of the underlying Bingham Mine Formation, they weather brown and red-brown.

Seventeen collections of fusulinids and other foraminifers were made from exposures of the Furner Valley Limestone on Jericho and Furner Ridges. These collections indicate a Missourian age for the lower 2,100-2,300 feet (640-700 m) of the formation, a Virgilian age for the middle 1,000 feet (305 m), and a Wolfcampian age for the upper 2,500-3,000 feet (672-914 m). More precise designation of these boundaries probably will come from detailed stratigraphic studies in faulted areas, and more closely spaced paleontological collections.

Collection f24697. Furner Ridge, southern East Tintic Mountains, SW¼NE¼NE¼ sec. 4 T. 13 S., R. 2 W. (from beds 275 ft (84 m) above base of Furner Valley Limestone).
- *Triticites* sp. aff. *T. pygmaeus* Dunbar and Condra, 1927.
- *Triticites* sp. aff. *T. grangerensis* Thompson, Verville, and Bissell, 1950.

Collection f13577. Jericho Ridge, southern East Tintic Mountains, SE¼NW¼SE¼ sec. 6, T. 13 S., R. 2 W. (from beds 450 ft (137 m) above base of Furner Valley Limestone).
- *Triticites* sp. aff. *T. pygmaeus* Dunbar and Condra, 1927.

Collection f13579. Furner Ridge, southern East Tintic Mountains, NE¼SE¼NW¼ sec. 4, T. 13 S., R. 2 W. (from beds 465 ft (142 m) above base of Furner Valley Limestone).
- *Triticites* sp. aff. *T. grangerensis* Thompson, Verville, and Bissell, 1950.

Collection f24700. Jericho Ridge, southern East Tintic Mountains, SE¼SE¼NW¼ sec. 7, T. 13 S., R. 2 W. (from beds 700 ft (123 m) above base of Furner Valley Limestone).
- *Bradyina* sp.
- *Climacammina* sp.
- *Triticites* sp. aff. *T. pygmaeus*(?) Dunbar and Condra, 1927.

Collection f24776. Jericho Ridge, southern East Tintic Mountains, SE¼NW¼SW¼ sec. 7, T. 13 S., R. 2 W. (from beds 1,225 ft (373 m) above base of Furner Valley Limestone).
- *Triticites* sp. aff. *T. mediocris angustus*(?) Dunbar and Henbest, 1942.

Collection f24777. Jericho Ridge, southern East Tintic Mountains, SE¼NW¼SW¼ sec. 7, T. 13 S., R. 2 W. (from beds 1,400 ft (427 m) above base of Furner Valley Limestone).
- *Triticites* sp. aff. *T. mediocris angustus* Dunbar and Henbest of Thompson, Verville, and Bissell, 1950.

Collection f24699. Jericho Ridge, southern East Tintic Mountains, NE¼NE¼SW¼ sec. 7, T. 13 S., R. 2 W. (from beds 1,500 ft (457 m) above base of Furner Valley Limestone).
- *Triticites* sp. aff. *T. mediocris angustus* Dunbar and Henbest, 1942.

Collection f24783. Furner Ridge, southern East Tintic Mountains, SW¼NW¼SE¼ sec. 4, T. 13 S., R. 2 W. (from beds 1,815 ft (553 m) above base of Furner Valley Limestone).
- *Triticites* sp. 1

Collection f24695. Furner Ridge, southern East Tintic Mountains, NW¼SW¼SE¼ sec. 4, T. 13 S., R. 2 W. (from beds 2,135 ft (651 m) above base of Furner Valley Limestone).
- *Kansanella* sp. aff. *K. plicatulus* (Merchant and Keroher) 1939.

Collection f24782. Furner Ridge, southern East Tintic Mountains, NW¼SW¼SE¼ sec. 4, T. 13 S., R. 2 W. (from beds 2,415 ft (736 m) above base of Furner Valley Limestone).
- *Triticites* sp. 2.

Collection f24784. Furner Ridge, southern East Tintic Mountains, SW¼SW¼SE¼ sec. 4, T. 13 S., R. 2 W. (from beds 2,900 ft (884 m) above base of Furner Valley Limestone).
- *Bradyina* sp.
- *Triticites* sp. aff. *T. cullomensis* Dunbar and Condra, 1927.
- *Pseudofusulinella* sp.

Collection f13581. Furner Ridge, southern East Tintic Mountains, NE¼NW¼NE¼ sec. 9, T. 13 S., R. 2 W. (from beds 3,175 ft (968 m) above base of Furner Valley Limestone).
- *Triticites* sp. aff. *T. cullomensis* Dunbar and Condra, 1927.

Collection f24781. Furner Ridge, southern East Tintic Mountains, E½NE¼NW¼ sec. 9, T. 13 S., R. 2 W. (from beds 3,265 ft (995 m) above base of Furner Valley Limestone).
- *Triticites cellamagnus* Thompson and Bissell, 1954.

Collection f24693. Furner Ridge, southern East Tintic Mountains, SW¼SE¼NE¼ sec. 9, T. 13 S., R. 2 W. (from beds 2,425 ft (739 m) below top of Furner Valley Limestone).

Triticites sp.(?)

Schwagerina sp.(?)

Collection f24694. Furner Ridge, southern East Tintic Mountains, SE¼SW¼NW¼ sec. 10, T. 13 S., R. 2 W. (from beds 2,250 ft (686 m) below top of Furner Valley Limestone).

Bradyina sp.

Schwagerina sp. aff. *S. punguncrulus* Ross, 1959.

Collection f24692. Furner Ridge, southern East Tintic Mountains, center NE¼NE¼ sec. 16, T. 13 S., R. 2 W. (from beds 760 ft (232 m) below top of Furner Valley Limestone).

Schwagerina sp. 5?

Collection f24702. Jericho Ridge, southern East Tintic Mountains, SW¼SE¼NW¼ sec. 18, T. 13 S., R. 2 W. (from beds 750 ft (229 m) below top of Furner Valley Limestone).

Schwagerina sp. aff. *S. pinosensis* Thompson, 1954.

Schwagerina sp. 5.

In addition, 16 collections of fusulinids from Long Ridge, 7 miles (11.2 km) east of Furner Valley, were examined. These collections were made from an undolomitized but otherwise identical section of the upper part of the Furner Valley Limestone, and because the fusulinids are more faithfully preserved, they were used to check and supplement the somewhat degraded collections from the dolomitized parts of the Furner Valley Limestone on Jericho and Furner Ridges. They are not listed separately.

In a paper describing the Permian rocks of parts of Nevada, Utah, and Idaho, Bissell (1962a, p. 1,102–1,103) assigned the uppermost 1,150 feet (350 m) of the unit here named the Furner Valley Limestone in the exposures on Jericho Ridge to the Kirkman Limestone. This formation was originally described and named by Baker and Williams (1940) from exposures near Kirkman Hollow in the south-central Wasatch Mountains 18 miles east of Provo. There it is 1,590 feet (485 m) thick and overlies the dominantly arenaceous Oquirrh Formation and underlies the Diamond Creek Sandstone. Baker, Huddle, and Kinney (1949, p. 1187) described it as being "***gray to black, in part finely laminated, fetid limestone that commonly is a recemented breccia of small angular fragments of the laminated limestone," and as containing "a small amount of phosphatic nodules."

In his descriptions of the Kirkman Limestone in the Jericho Ridge exposures, Bissell (1962a, p. 1103) described the unit as consisting of "***interbedded gray sandy dolomite, calcareous dolomite, dolomitic limestone, and thin-bedded limestone." No mention is made of finely laminated gray to black fetid limestone, recemented breccia, or phosphatic nodules, and thus we assume that he assigned the unit to the Kirkman Limestone largely on the basis of its dolomitic character (see also Bissell, 1962b, p. 34–35) and more particularly on the presence of Wolfcampian fossils. Our somewhat more detailed studies in the southern East Tintic Mountains indicate that the dolomite in the upper part of the Furner Valley Limestone is of hydrothermal origin (see Morris and Lovering, 1961, p. 114–118) and thus it is not a valid basis for either establishing it as a new formational unit or for correlating it with other established formations. Continuing studies have shown that prior to dolomitization, the strata of the upper part of the Furner Valley Limestone consisted predominantly of fossiliferous cherty and sandy limestone, with minor beds of sandstone and quartzite, that was much like the unaltered lower part of the formation. None of the distinctive lithologic characteristics of the type Kirkman Limestone are present, and although parts of both units may well be the same age, they appear to have been deposited in separate sedimentary basins or subbasins, under different conditions. In consideration of these relations, the Furner Valley Limestone is here defined as a new formation, and the upper part is considered only to be a temporal correlative of the Kirkman Limestone. Other geologists, including Costain (1960) and Wang (1970) in their studies in the Gilson Mountains, and Muessig (1951) in his studies of Long Ridge, also have followed the interpretation used here.

POST-OQUIRRH GROUP ROCKS

The Paleozoic formations that overlie the Oquirrh Group in the southern East Tintic Mountains are the Diamond Creek Sandstone, probably of Leonardian age, and the dolomitized Park City Formation, of Leonardian and Guadalupian age. The Park City Formation is terminated upward by a fault, and rocks of Mesozoic age, which overlie it elsewhere, are not exposed in the range. The Cenozoic rocks in the area include Oligocene volcanic units and Pleistocene and Holocene deposits of several types (Morris, 1957; Morris and Lovering, 1961).

The Diamond Creek Sandstone disconformably overlies the Furner Valley Limestone and consists chiefly of buff, yellow, and pinkish-red fine- to coarse-grained crossbedded friable sandstone. In the lower third of the formation, thin units of limestone or dolomite and red conglomeratic siltstone are interlayered with the sandstone. On Jericho Ridge the Diamond Creek Sandstone is 685-875 feet (209-267 m) thick, and on Furner Ridge it is 822 feet (250 m) thick. No fossils have been collected from the Diamond Creek Sandstone in the East Tintic Mountains or adjacent areas, but Baker, Huddle, and Kinney (1949, p. 1188) have provisionally correlated it with the lithologically similar Coconino Sandstone of the San Rafael Swell, the upper part of which Heylmun (1958, p. 1793-1794) believed may contain some equivalents of the type Coconino of the Grand Canyon region, and the lower part of which probably includes parts of the Toroweap Formation and the White Rim and Cedar Mesa Sandstone Members of the Cutler Formation (Heylmun, 1958).

The Park City Formation is the youngest Paleozoic unit in central Utah. In the exposures in the southern East Tintic Mountains, it is penetrated by a tongue of the Meade Peak Phosphatic Shale Member of the Phosphoria Formation, separating it into its lower or Grandeur Member and its upper or Franson Member (Morris and Lovering, 1961, p. 119-123). The Grandeur Member of the Park City Formation conformably overlies the Diamond Creek Sandstone and is about 750 feet (229 m) thick on Jericho Ridge and about 960 feet (293 m) thick on Furner Ridge. In both areas it consists of light-gray thin- to medium-bedded medium-grained hydrothermal dolomite. All of it is cherty, and large nodules of white chert are especially abundant in the lower part. The tongue of the Meade Peak Phosphatic Shale Member is 333 feet (101 m) thick on Jericho Ridge and about 250 feet (76 m) thick on Furner Ridge. It is olive-brown fine-grained dolomitic mudstone, with many indistinct segregations of black chert and a few thin interlayered beds of dolomite. Some narrow lenses of oolitic phosphorite were noted near the base of its exposures on Jericho Ridge. The partial section of the Franson Member of the Park City Formation is about 540 feet (165 m) thick on Jericho Ridge and about 303 feet (92 m) thick on Furner Ridge. In both areas it is light-gray thin- to medium-bedded hydrothermal dolomite with many nodules of white, buff, and brown chert.

Hydrothermal dolomitization has extensively recrystallized the abundant fossils in both the Grandeur and Franson Members, rendering them useless in confirming the age of the Park City Formation. However, in the Wasatch Mountains (Baker and others, 1949, p. 1,188-1,189), the Grandeur Member locally contains the productid *Dictyoclostus ivesi* (Newberry), which occurs in the Kaibab Limestone (Leonardian) of the Colorado Plateaus, and the Meade Peak Phosphatic Shale and Franson Members contain a fauna including *Punctospirifer pulcher* (*Spiriferina pulchra*)(Meek), *Spirifer pseudocameratus* (Girty), and other species characteristic of the Phosphoria Formation (Guadalupian) (McKelvey and others, 1956, p. 2,857-2,858).

CORRELATION

The abundant and commonly well preserved fossils that occur in all of the formations of the Oquirrh Group, and in particular the fusulinids that are ubiquitous in the strata of Des Moinesian through Wolfcampian and younger age, permit reasonably accurate time-stratigraphic correlations of the Pennsylvanian and Permian sedimentary rocks throughout the Rocky Mountains and Great Basin region. Such correlations for sections in the Oquirrh basin and adjacent areas in western and northern Utah and their relations to the Sevier thrust belt are shown on plate 1*C* and *D*.

Throughout the Oquirrh basin the lower part of the Oquirrh Group is largely limestone. This unit is the West Canyon Limestone (Morrowan) of the Oquirrh and southern East Tintic Mountains. It is correlated with the lower part of the Bridal Veil Limestone Member of the Oquirrh Formation in the Wasatch Mountains (Baker and Crittenden, 1961) and undivided units in the Cedar Mountains (Maurer, 1970, p. 33-38) and the Promontory Mountains (Olson, 1960, p. 142-144). This basal limestone unit commonly overlies the Manning Canyon Shale (Mississippian and Pennsylvanian) and thus is entirely Pennsylvanian, but in the Rogers Canyon sequence of the northernmost Oquirrh Mountains (Tooker and Roberts, 1970, p. A38), where the Manning Canyon Shale is not recognized, and in the Cedar Mountains (Maurer, 1970, p. 38), where the Manning Canyon is believed to be entirely of Mississippian age, the basal limestone also appears to include some Mississippian strata.

The enormous volume of orthoquartzite, sandstone, and siltstone, with only subordinate clastic and crystalline limestone, that makes up the great bulk of the Oquirrh Group above the basal limestone unit has been long considered a unique and characteristic feature of the central and eastern parts of the Oquirrh basin, and particularly in the southern Wasatch Mountains, its general sameness seemed to preclude its subdivision into component units. In the Oquirrh and East Tintic Mountains, however, the relative abundance of limestone in the part of the section that is of Atokan(?) to Missourian age has permitted the differentiation of these strata into the Butterfield Peaks Formation, which is 40-50 percent limestone, and the Bingham Mine Formation of Missourian age, which is 10-35 percent limestone. In the Cedar Mountains (Maurer, 1970, p. 39-63), in the western part of the Oquirrh basin, the Atokan to lower Virgilian strata contain more than 90 percent limestone and dolomite, and are more similar in general lithologic character to the lower part of the Ely Limestone (Morrowan to Des Moinesian) of westernmost Utah and eastern Nevada (Hose and Repenning, 1959). North of the Cedar Mountains, the wide separation of continuous fossil-bearing sections of the Oquirrh Formation makes accurate correlation difficult, but in the Promontory Mountains, Olson (1960, p. 142-147) recognized an equivalent of the West Canyon Limestone and overlying strata that is comparable to the Butterfield Peaks and Bingham Mine Formations.

Strata of late Virgilian and Wolfcampian age that occur in the upper part of the Oquirrh Formation or Group in the Oquirrh basin also are somewhat varied in their lithologic character. They have been removed by erosion in the central and southern Oquirrh Mountains, but in the southern Wasatch Mountains they consist of more than 10,000 feet (3,048 m) of sandstone, quartzite, and siltstone, with 5 percent or less of intercalated limestone or dolomite beds. In the Cedar Mountains (Maurer, 1970, p. 57-68), strata of this age are more than 4,700 feet (1,433 m) thick and also consist predominantly of arenaceous rocks, although they contain considerably more carbonate strata, particularly in the Virgilian beds, than the exposures in the Wasatch Mountains. In the Terrace and Hogup Mountains (Stifel, 1964, p. 14-37), the Virgilian and Wolfcampian strata probably exceed 8,000 feet (2,438 m) in thickness and are similar in general character to the arenaceous units in the Wasatch and Cedar Mountains, but with relatively fewer carbonate beds in the lower (Virgilian) part of the section as compared to the exposures in the Cedar Mountains which have somewhat more carbonate beds in the upper (Wolfcampian) part of the section. Similar strata also have been noted in the Promontory Mountains by Olson (1960, p. 144-147). In the Newfoundland Mountains Paddock (1956, p. 52-54) reported 2,900 feet (884 m) of interbedded limestone, dolomite, and quartz sandstone of probable middle Leonardian age resting directly on Devonian dolomite and shale. A basal conglomerate indicates a sedimentary rather than a structural contact and suggests an interval of epeirogenic uplift prior to the deposition of the Permian strata.

In marked contrast to the highly arenaceous upper Virgilian and Wolfcampian strata in the upper part of the Oquirrh Group in the central and northern parts of the Oquirrh basin, the age-equivalent strata in the southern East Tintic Mountains are dominantly limestone and hydrothermal dolomite. These carbonate rocks may exceed 6,000 feet (1,829 m) in total thickness and contain less than 10 percent interbedded quartzite, sandstone, and siltstone. No other section of upper Virgilian and Wolfcampian carbonate strata approaching this thickness is recognized elsewhere in Utah, and on this basis this sequence is herein designated the Furner Valley Limestone. It is somewhat similar to the Ferguson Mountain Limestone of Berge (1960) in east-central Nevada and west-central Utah, which consists predominantly of Wolfcampian bioclastic limestone, argillaceous cherty limestone, and thin-bedded silty limestone. In the Gold Hill district in the northern Deep Creek Mountains of western Utah (Bissell, 1962a, p. 1090), the Ferguson Mountain Limestone of Berge (1960) is 1,715 feet (523 m) thick, but the absence of exposed Pennsylvanian and Permian rocks in the area between the Gold Hill district and the southern East Tintic Mountains precludes a direct correlation of the Ferguson Mountain and the Furner Valley Limestones.

In southern Utah, in the undisturbed area east of the Sevier orogenic belt, the upper Virgilian and lower Wolfcampian carbonate strata are relatively thin and are more logically correlated with the upper part of the Callville Limestone (Longwell, 1921, p. 47; Bissell, 1963, p. 42-43) and the Pakoon Dolomite of McNair (1951, p. 524-525) of the southwestern part of the state, and with the Wolfcampian Elephant Canyon Formation of Baars (1962, p. 172-177) and possibly the uppermost part of the Honaker Trail Formation (Des Moinesian to Virgilian) of Wengerd (1958, p. 115) of southeastern Utah.

The distinctive aeolian-crossbedded Diamond Creek Sandstone, which overlies the Oquirrh Formation or Group in the southern Wasatch and southern East Tintic Mountains, ranges from 500 to 1,000 feet (152 to 305 m) in thickness. In the Cedar Mountains (Maurer, 1970, p. 81-91) and in the Terrace and Hogup Mountains (Stifel, 1964, p. 37-46), the age-equivalent strata are respectively 3,950 feet (1,204 m) thick and 2,850 feet (869 m) thick and consist mostly of calcareous sandstone and orthoquartzite but with a considerable amount of interbedded limestone and dolomite in the Cedar Mountains. Although both of these sequences have been provisionally referred to the Diamond Creek Sandstone, they may be more closely allied to the Arcturus

Formation (Hose and Repenning, 1959, p. 2174-2178), or to the Pequop Formation of Steele (1959) and the Loray Formation of Steel (1960, p. 106-107).

At South Mountain, west of the central Oquirrh Mountains, and in the Curry Peak sequence north of Bingham, Welsh and James (1961, p. 4-5) identified about 1,000 feet (305 m) of platy calcareous sandstone and siltstone as the Diamond Creek Formation, but no detailed sections have been published. These rocks are part of a dominantly arenaceous sequence of Wolfcampian and Leonardian(?) strata that is more than 6,000 feet (1,829 m) thick (W. J. Moore, written commun., May 19, 1976). The rocks below the so-called Diamond Creek Formation, which have an aggregate thickness of 4,800 feet (1,463 m), have been subdivided into the Clinker and Curry Formations by Welsh and James (1961, p. 5-7). The rocks of unstated thickness above the so-called Diamond Creek Formation in this area have been termed the Kirkman Limestone by Welsh and James (1961, p. 5); they describe the rocks as being identical with the type Kirkman Limestone of the Wasatch Mountains. Considered as a whole, however, all these strata more closely resemble the units of equivalent age in the Cedar Mountains (Maurer, 1970, p. 81-91) than the formations of the Bingham sequence, and partly for this reason, Tooker and Roberts (1970, fig. 2) have indicated that South Mountain is separated from the Bingham sequence by the inferred Stockton thrust in the same manner that the Curry Peak sequence is separated from it by the Midas thrust. If this structural interpretation is valid, the Stockton thrust is probably a branch of the northerly-trending Tintic Valley thrust.

CONFIGURATION OF OQUIRRH BASIN

Geologic mapping and field investigations over the past two decades have provided much information concerning the distribution and character of the Pennsylvanian and Lower Permian rocks of western Utah and eastern Nevada. However, in large parts of this area these strata are either eroded or concealed beneath eruptive rocks and valley fill deposits, and as a result considerable disagreement has arisen concerning the location, configuration, orientation, and relations of the basins in which the Pennsylvanian and Permian sedimentary rocks accumulated in this area, and about the subdivision, nomenclature, and lithologic correlations of the highly varied stratigraphic sequence (see Bissell, 1962a and 1974, and Roberts and others, 1965). A major complicating factor in the eastern part of the Sevier orogenic belt is the effect of the great thrust faults, along which the middle of the Oquirrh sedimentary basin was emplaced over its eastern borderlands during Late Cretaceous time (Baker, 1947; Baker and others, 1949; Crittenden, 1961). In addition, the wide scatter of all or parts of the more critical Pennsylvanian and Permian sections in this area also prevents precise reconstructions of the late Paleozoic sedimentary basins, thus making all reconstructions of these basins highly subjective (Bissell, 1962b; Roberts and others, 1965; Bissell, 1967, 1974).

In general, the Oquirrh basin appears to be centered on what is now the Wasatch Mountains east of Provo, Utah (fig. 2). It is obviously limited to the upper plate of the Nebo-Charleston and related thrust faults, and thus its true eastern limit is not known. In addition, its western limit is not precisely defined, so the basin continues to be the subject of much dispute. Roberts and others (1965, p. 1934) stated that the Oquirrh basin extended from central and northeastern Nevada to the Utah-Wyoming shelf, apparently encompassing the northern part of the Butte-Deep Creek or Ely sedimentary basin of Steele (1960, p. 92) and Bissell (1962a, p. 1085). Roberts and others (1965, p. 1934) further believed that it was separated into a northern and southern lobe by a positive area centered on the present Newfoundland Mountains (Paddock, 1956, p. 50) where middle(?) Leonardian rocks unconformably overlie the Three Forks(?) Shale (Devonian). In contrast, Bissell (1974, p. 86-89) believed that the Oquirrh basin was limited to north-central Utah, extending irregularly northward and merging with the Wood River basin of central Idaho, and that it was separate from the Ely basin of northeastern Nevada although connected to it and the Bird Springs basin of southeastern Nevada by shallow passages. Bissell did not refer to the relations in the Newfoundland Mountains, nor does he apparently accept large-scale tectonic transport by thrust faulting. There is agreement, however, that the Oquirrh basin occupies the site of an earlier Mississippian sedimentary basin, that from Morrowan through Wolfcampian time it received, at its deepest point, more than 26,000 feet (7,925 m) of dominantly clastic sediments, and that it stabilized during Leonardian time and thereafter received smaller amounts of clastic debris.

On the basis of current data, it would appear that elements of both interpretations are valid. It is probable that the Oquirrh basin has been tectonically transported eastward as much as 100 miles (160 km) or more from its original site and that the

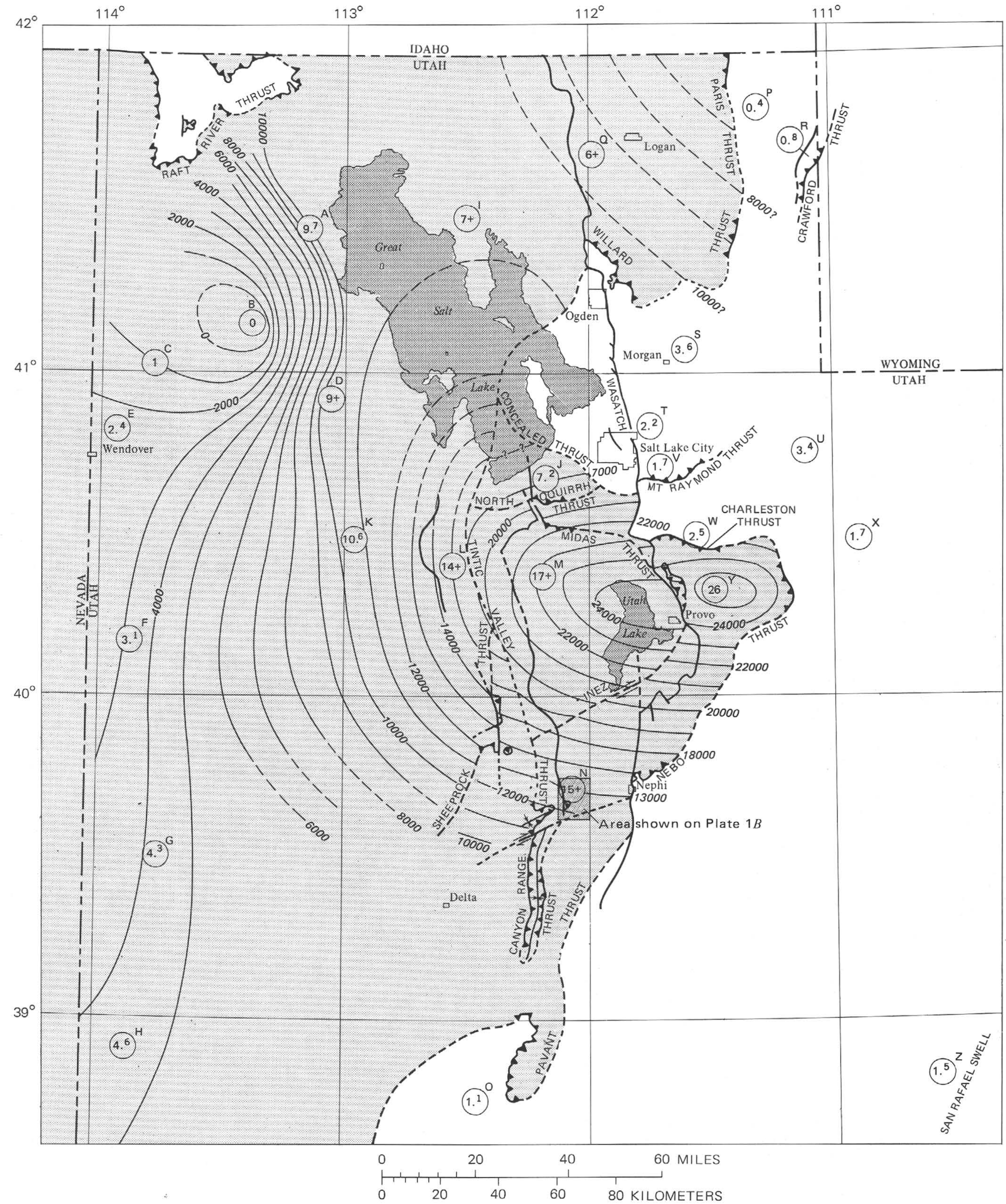


FIGURE 2.—Isopach map of Pennsylvanian and Lower Permian strata in northwestern Utah showing configuration of the Oquirrh basin and its relations to the upper plates of the major thrust faults of the Sevier orogenic belt. Redrawn from Roberts and others (1965, fig. 16).

EXPLANATION

Strata above Pavant, Nebo, Charleston, Willard, and Paris thrust faults

Strata below Pavant, Nebo, Charleston, Willard, and Paris thrust faults

High-angle fault
Dashed where inferred or concealed; arrows show relative movement on tear faults

Thrust fault
Dashed where inferred or concealed; sawteeth on upper plate

Syncline
Showing trace of trough plane

—6000—
Isopach of Pennsylvanian and Lower Permian strata
Interval 1,000 feet; dashed where uncertain

(14+) L
Location of measured section
Thickness in thousands of feet; incomplete sections indicated by +

Sources of data

A Hogup Mountains (Stifel, 1964)
B Newfoundland Mountains (Paddock, 1956)
C Northern Silver Island Mountains [Desert Range] (Anderson, 1960)
D Grassy Mountains (Doelling, 1964)
E Southern Silver Island Mountains [Desert Range] (Schaeffer, 1960)
F Deep Creek Mountains (Nolan, 1935; Bissell, 1964)
G Confusion Range (Hose and Repenning, 1959)
H Burbank Hills (Bissell, 1962b)
I Promontory Mountains (Olson, 1960)
J Northern Oquirrh Mountains (Tooker and Roberts, 1970)
K Cedar Mountains (Maurer, 1970)
L Southern Stansbury Mountains (Rigby, 1958; Hintze, 1973)
M Southern Oquirrh Mountains (Tooker and Roberts, 1970)
N Southern East Tintic Mountains (this report)
O Southern Pavant Mountains (Crosby, 1959; Langenheim and Larson, 1973)
P Laketown Canyon (Sando, Dutro, and Gere, 1959)
Q Northern Wasatch Mountains (Williams, 1958)
R Crawford Mountains (Sando, Dutro, and Gere, 1959)
S Weber Canyon (Eardley, 1944)
T City Creek Canyon (Granger, 1953)
U Northwestern Uinta Mountains (Bissell and Childs, 1958; Sadlick, 1959)
V Mill Creek Canyon (Calkins and Butler, 1943)
W Midway area (Baker, Huddle, and Kinney, 1949)
X Duchesne River (Baker, Huddle, and Kinney, 1949)
Y Southern Wasatch Mountains (Baker, 1947)
Z San Rafael Swell (Heylmun, 1958)

eastern boundary of the basin in central Utah is largely or wholly concealed beneath the upper plate of the Nebo-Charleston-Willard-Paris thrust zone. Also, the lithologic and stratigraphic characteristics of the Oquirrh Group are more comparable with the Wood River Formation of southern Idaho than with the predominantly calcareous and thinner Ely Limestone. As recently redefined by Hall, Batchelder, and Douglass (1974), the Wood River Formation consists of 9,800 feet (2,987 m) of gray limestone, calcareous sandstone, and quartzite that ranges in age from Des Moinesian to Leonardian(?); the formation is subdivided into seven as yet unnamed units. The great thickness and arenaceous character indicate a similar environment of deposition for both the Oquirrh Group and Wood River Formation, although a direct correlation of the two units is precluded by the extensive cover of basalts in the Snake River Plain. As shown in figure 2, however, the Oquirrh basin apparently merges with the Ely basin across a relatively shallow berm, and that locally, as in the area of the Newfoundland Mountains, epeirogenic uplift created small positive areas.

FUSULINID FAUNAS

BUTTERFIELD PEAKS FORMATION

Fusulinids were studied from six collections through the exposed Butterfield Peaks Formation. All the fusulinids found are of Middle Pennsylvanian (Des Moinesian) age. The distribution of the fusulinid faunas is shown in figure 3 and representative specimens are illustrated on plate 2. The oldest sample yields *Fusulinella* sp. associated with *Wedekindellina* sp. 1.

This fauna is approximately equivalent in age to the oldest fusulinid fauna found in the type section in the Oquirrh Mountains. A slightly older fauna was recognized in the Traverse Mountains (Douglass and others, 1974, p. 101) where probably late Atokan *Fusulinellas* are found below the lowest rocks of Des Moinesian age.

All the higher faunas within the Butterfield Peaks Formation are of Des Moinesian age and include species of *Wedekindellina* and *Beedeina*.

BINGHAM MINE FORMATION

Seven collections of fusulinids from this formation were studied. The distribution of the fusulinid faunas is shown in figure 3 and representative specimens are illustrated on plate 2. The oldest fauna includes *Bartramella* sp. and *Eowaeringella* sp. Both of these genera are known from rocks of Desmoinesian age in

SYSTEM	SERIES	Provincial Series	Formation	Map locality No. (pl. 1*B*)	U.S.G.S. Foraminifera Catalog No.	*Millerella* sp.	*Pseudostaffella* sp.	*Fusulinella* sp.	*Wedekindellina* spp.	sp. 1	aff. *W. henbesti*	sp. 2	aff. *W. euthysepta*	*Beedeina* spp.	sp. 1	sp. 2	sp. 3	sp. 4	aff. *B.* sp. A	*Bartramella* sp.	*Eowaeringella* sp.	*Triticites* spp.	aff. *T. springvillensis*	aff. *T.* sp. B	aff. *T. provoensis*	*Pseudofusulinella*
PENNSYLVANIAN	Upper	Missourian	Bingham Mine	28	f13580																				□	
				8	f24696																					□
				19	f24780																			?		
				18	f24779																			□		
				17	f24778																			?		
				26	f13578																		□			
				13	f24701															□	□					
	Middle	Des Moinesian	Butterfield Peaks	10	f24698														□							
				30	f13648								□				□	□								
				31	f13649							□				□										
				24	f24785						□															
				32	f13650	×	?								□											
				33	f13652			□		□																

EXPLANATION
□ Illustrated form
× Identified but not illustrated
? Questionable identification

FIGURE 3.—Distribution of fusulinids in the Butterfield Peaks and Bingham Mine Formations.

Nevada (Verville and others, 1956) where they are associated with *Fusulina weintzi*. In the East Tintic Mountains the species are different and are not associated with *Fusulina*. This lowermost sample is possibly of early Missourian age but is most likely late Des Moinesian. *Bartramella* is known to occur as late as Early Permian time and *Eowaeringella* is common in rocks of Missourian age.

The other fusulinid samples from the Bingham Mine Formation suggest a Missourian age and correlate with the lower parts of the Bingham Mine Formation in its type area and in the Traverse Mountains. The specimens identified with *Triticites* sp. B of Thompson, Verville, and Bissell (1950) seem advanced for their stratigraphic position. Their large form suggests a younger age but they were also found low in Missourian rocks of the Wasatch Mountains.

FURNER VALLEY LIMESTONE

Seventeen fusulinid samples from the Furner Valley Limestone exposed on Jericho and Furner Ridges were studied. An additional 16 samples from Long Ridge, the next ridge to the east, were also studied because of the better preservation of the fossils in the upper part of the formation there. The distribution of some of the samples is shown in figure 4 and representative specimens are illustrated on plates 3 and 4.

The fusulinid faunas of the Furner Valley Limestone range in age from Missourian through Virgilian and into Wolfcampian. Some of them are the same age as the fusulinids of the upper part of the Bingham Mine Formation in the Oquirrh and Traverse Mountains but others from higher strata in the Furner Valley Limestone are younger than any described from those areas. The upper part of the Furner Valley Limestone has fusulinids similar to those reported by Maurer (1970) from unit 5 of the Oquirrh Formation in the Cedar Mountains in Tooele County, Utah. Similar forms were described by Thompson and Bissell (1954) from the Oquirrh Formation in the Wasatch Mountains. Though the dolomitization of the upper part of the Furner Valley Limestone has partly or totally destroyed many of the fusulinids on Jericho and Furner Ridges, it has not affected this part of the section on Long Ridge. Several of the illustrated specimens are, therefore, taken from samples of the Long Ridge section. None of the fusulinid faunas represents the late Wolfcampian; the youngest suggests an approximately middle Wolfcampian age.

CONCLUSIONS

The formations of the Oquirrh Group, including the West Canyon Limestone, Butterfield Peaks Formation, and the Bingham Mine Formation, all originally described in their type areas in the Oquirrh Mountains, are present in the southern East Tintic Mountains, where they are more than 15,000 feet (4,572 m) thick. In the Oquirrh Mountains the Bingham Mine Formation is terminated upward by erosion, but in the East Tintic Mountains its top is present, and it is conformably overlain by the apparently unique Furner Valley Limestone of Missourian to Wolfcampian age, which is 5,000–6,000 feet (1,524–1,829 m) thick and is here designated the uppermost formational unit of the Oquirrh Group. The Furner Valley Limestone is disconformably overlain by the Diamond Creek Sandstone, presumably of

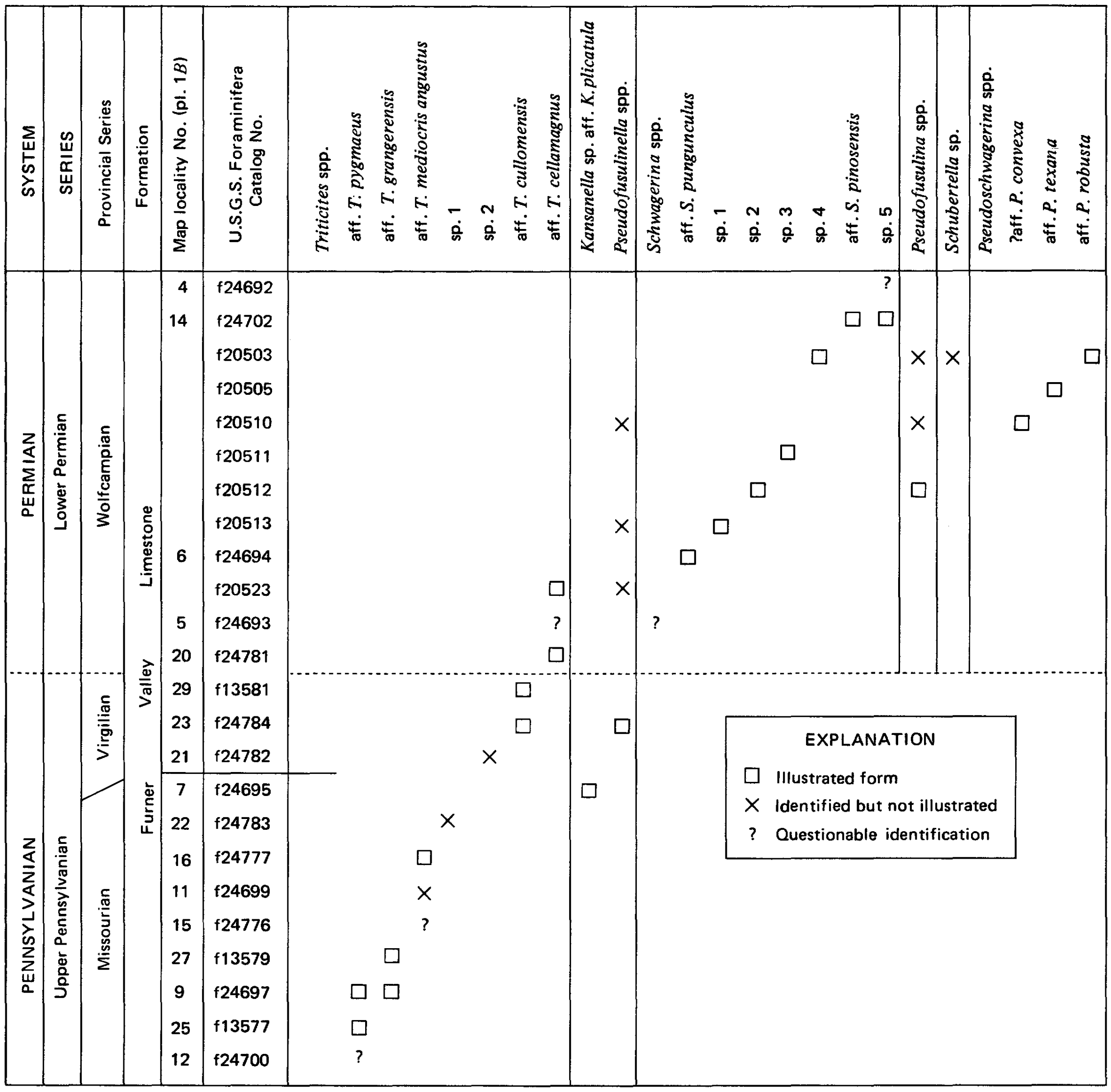


FIGURE 4.—Distribution of fusulinids in the Furner Valley Limestone.

Leonardian age. No beds comparable to those of the fetid dark-gray to black finely laminated phosphatic Kirkman Limestone, which underlies the Diamond Creek Sandstone in the Wasatch Mountains, have been recognized in the prominent exposures in the East Tintic Mountains.

The fusulinid faunas from the Oquirrh Group in the southern East Tintic Mountains are largely similar to faunas from correlative units in the southern Oquirrh Mountains. The most notable difference is that some of the fusulinids from the Furner Valley Limestone are the same age as the fusulinids of the upper part of the Bingham Mine Formation in the Oquirrh and Traverse Mountains, but that other fusulinids are younger and apparently are from younger strata. Similar forms of these younger fusulinids, however, previously have been described from the Cedar and Wasatch Mountains.

MEASURED SECTION OF BINGHAM MINE FORMATION

[Section measured on east side of Jericho Ridge in sec. 36, T. 12 S., R. 2½ W., *and sec. 6,* T. 13 S., R. 2 W., *S.L.B.M., in Furner Ridge quadrangle, Utah]*

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Furner Valley Limestone:				
Basal unit is gray, medium-bedded, silty and cherty limestone that weathers tan, brown, and pink			3,200	(975)
Contact conformable.				

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Bingham Mine Formation:				
41. Sandstone, limy; light-olive-green, weathers red and brown; fine-grained; contains some beds of sandy limestone and quartzite	316	(96.3)	2,884	(879)
40. Limestone, gray; medium-bedded; locally silty; many chert nodules	69	(21.0)	2,815	(858)
39. Sandstone, buff; fine-grained	23	(7.0)	2,792	(851)
38. Limestone, gray, buff-weathering; silty; medium- to fine-grained	33	(10.1)	2,759	(841)
37. Limestone, blue-gray; medium-bedded	38	(11.6)	2,721	(829)
36. Limestone, blue-gray; massive	7	(2.1)	2,714	(827)
35. Limestone, gray; sandy; many chert nodules; thin- to medium-bedded	66	(20.1)	2,648	(807)
34. Quartzite, light-olive; weathers brown; medium-grained. At 80 ft above base contains a bed of limestone 5 ft thick with abundant fusulinids (colln. f13,578)	137	(41.8)	2,511	(765)
33. Limestone, gray; sandy; medium- to thin-bedded; contains scattered chert nodules	139	(42.4)	2,372	(723)
32. Limestone, blue-gray; contains many fossils	18	(5.5)	2,354	(718)
31. Siltstone, limy; buff, weathers red to brown; thin-bedded; contains scattered lenses of quartzite	79	(24.1)	2,275	(693)
30. Limestone, blue-gray; fossiliferous; forms massive ledge	13	(4.0)	2,262	(689)
29. Quartzite, light-olive; weathers brown to red	35	(10.7)	2,227	(679)
28. Limestone, blue-gray; massive	2	(0.6)	2,225	(678)
27. Quartzite, light-olive; weathers brown to red; medium-grained	61	(18.6)	2,164	(660)
26. Limestone, blue-gray; sand streaked	5	(1.5)	2,159	(658)
25. Siltstone, limy; thin-bedded; contains a few beds of blue-gray limestone	317	(96.6)	1,842	(561)
24. Quartzite, light-olive; weathers brown; medium-grained; medium-bedded	85	(25.9)	1,757	(536)
23. Limestone, gray; sandy; thin-bedded	202	(61.6)	1,555	(474)
22. Limestone, blue-gray; fossiliferous	5	(1.5)	1,550	(472)
21. Limestone, gray; sandy; medium-bedded	20	(6.1)	1,530	(466)
20. Limestone, blue-gray; massive	3	(0.9)	1,527	(465)
19. Limestone, gray; sandy;				
Bingham Mine Formation—Continued				
19. Limestone, etc.—Continued chert nodules abundant; medium-bedded	23	(7.0)	1,504	(458)
18. Quartzite, light-olive; weathers tan; medium-grained; poor outcrop	14	(4.3)	1,490	(454)
17. Limestone, silty and sandy; weathers brown; many indistinct chert segregations; contains lenses and beds of quartzite	69	(21.0)	1,421	(433)
16. Quartzite, light-olive-green to buff; weathers tan, brown, and red; fine-grained; medium-bedded	341	(103.9)	1,080	(329)
15. Siltstone, limy; locally grading to silty limestone; grayish-tan, weathers red to brown; massive but weathers to a litter of small chips; indistinct chert segregations common in limy parts; makes poor outcrop	134	(40.8)	946	(288)
14. Quartzite, light-olive-green; weathers brown; fine-grained	69	(21.0)	877	(267)
13. Limestone, blue-gray; massive	10	(3.1)	867	(264)
12. Limestone, silty, with many indistinct nodules of black chert	30	(9.1)	837	(255)
11. Quartzite, olive-green; weathers brown; medium-grained	45	(13.7)	792	(241)
10. Limestone, brownish-gray; silty; cherty	54	(16.5)	738	(225)
9. Quartzite, olive-green; weathers brown; fine-grained	120	(36.6)	618	(188)
8. Limestone, gray; locally dolomitic; silt-streaked; cherty	151	(46.0)	467	(142)
7. Quartzite, olive-green; weathers reddish brown; fine-grained	133	(40.5)	334	(102)
6. Siltstone, limy; sand-streaked; massive, but weathers to thin chips and splinters	38	(11.6)	296	(90)
5. Quartzite, greenish-tan; weathers red-brown; fine-grained	52	(15.9)	244	(74)
4. Siltstone, dolomitic; cherty	10	(3.1)	234	(71)
3. Dolomite, gray; silty	50	(15.2)	184	(56)
2. Limestone, gray; dolomitic; streaked with silt	80	(24.4)	104	(32)
1. Quartzite, olive-green; weathers reddish brown; medium-grained	104	(31.7)	0	(0)
Total Bingham Mine Formation	3,200 ft		(975 m)	

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Contact conformable.				
Butterfield Peaks Formation:				
Uppermost unit is blue-gray, cherty, fossiliferous limestone.				

TYPE SECTION OF FURNER VALLEY LIMESTONE

[*Section measured on east side of Jericho Ridge in east half of secs. 6, 7, and 18,* T. 13 S., R. 2 W., *in Furner Ridge quadrangle, Utah*]

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Diamond Creek Sandstone:				
Basal unit is pink-weathering fine-grained dolomitic siltstone; largely covered			5,233	(1,595)
Contact disconformable.				
Furner Valley Limestone:				
63. Dolomite, gray; medium-bedded, medium-grained; granular	147	(44.8)	5,086	(1,550)
62. Dolomite, gray; medium-bedded to massive	210	(64.0)	4,876	(1,486)
61. Covered area (beds on strike are gray, medium-bedded dolomite as above)	156	(47.6)	4,720	(1,439)
60. Dolomite, gray; massive	63	(19.2)	4,657	(1,419)
59. Dolomite, gray; medium- to thick-bedded	63	(19.2)	4,594	(1,400)
58. Dolomite, gray; massive to thick-bedded; some buff-weathering sandstone	152	(46.3)	4,442	(1,354)
57. Dolomite, gray; medium-bedded; many fragments of recrystallized fossils	251	(76.5)	4,191	(1,277)
56. Dolomite, gray; massive to medium-bedded	101	(30.8)	4,090	(1,247)
55. Dolomite, gray; medium-bedded; much pink-weathering chert	70	(21.3)	4,020	(1,225)
54. Siltstone, pink; brown weathering; interbedded with silty dolomite	81	(24.7)	3,939	(1,201)
53. Dolomite, gray; medium-bedded	41	(12.5)	3,898	(1,188)
52. Dolomite, gray; thin-bedded	176	(53.6)	3,722	(1,134)
51. Dolomite, gray; thick-bedded	134	(40.8)	3,588	(1,094)
50. Dolomite, gray; massive	33	(10.1)	3,555	(1,084)
49. Quartzite, red-weathering; fine-grained; medium-bedded; contains some interlayered silty dolomite in beds 1-10 ft thick	94	(28.7)	3,461	(1,055)
48. Dolomite, silty, gray; thin-bedded; many recrystallized fossils	85	(25.9)	3,376	(1,029)
47. Dolomite, gray; medium- to thick-bedded; some beds are streaked with brown- and red-weathering silt	44	(13.4)	3,332	(1,016)
46. Siltstone, brown; red-weathering; thin-bedded	53	(16.2)	3,279	(999)

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Furner Valley Limestone—Continued				
45. Dolomite, gray; silty; thin-bedded	138	(42.1)	3,141	(957)
44. Dolomite, gray; silty; medium-bedded	17	(5.2)	3,124	(952)
43. Dolomite, gray; cherty; medium-bedded	128	(39.0)	2,996	(913)
42. Sandstone, brown; weathers yellow; fine-grained; forms a single bed	5	(1.5)	2,991	(912)
41. Dolomite, gray, cherty; medium-bedded	80	(24.4)	2,911	(887)
40. Dolomite, gray; massive- to medium-bedded; some beds contain nodular chert	276	(84.1)	2,635	(803)
39. Interbedded siltstone and dolomite. Siltstone, buff; weathers yellow; units about 20 ft thick. Dolomite, gray; medium bedded; in units about 8 ft thick	170	(51.8)	2,465	(751)
38. Dolomite, silty; weathers brown	79	(24.1)	2,386	(727)
37. Dolomite, gray; massive; weathers to a litter of thin chips 1-3 inches (2-7 cm) in diameter. Unit contains a few beds of brown, fine-grained sandstone	262	(79.9)	2,124	(647)
36. Interbedded dolomite and dolomitic siltstone. Dolomite, gray; massive to medium-bedded. Siltstone, buff; weathers brown to brick red	119	(36.3)	2,005	(611)
35. Interlayered gray dolomite and blue-gray limestone	167	(50.9)	1,838	(560)
34. Limestone, blue-gray; massive; some beds are sand streaked, others contain indistinct chert nodules	99	(30.2)	1,739	(530)
33. Limestone, blue; medium-bedded; most beds contain scattered chert nodules	62	(18.9)	1,677	(511)
32. Limestone, gray; weathers brown, thin-bedded; many beds are silty	124	(37.8)	1,553	(473)
31. Limestone, blue-gray; forms massive ledge	7	(2.1)	1,546	(471)
30. Interbedded blue-gray ledgy limestone and massive, fine-grained, brown-weathering silty limestone with indistinct chert nodules	25	(7.6)	1,521	(464)
29. Limestone, blue; fossiliferous; some spotty zones of hydrothermal dolomite	20	(6.1)	1,501	(458)
28. Limestone, gray; thin- to medium-bedded; scattered zones of hydrothermal dolomite	41	(12.5)	1,460	(445)
27. Limestone, blue-gray; fossiliferous, cherty	62	(18.9)	1,398	(426)

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Furner Valley Limestone—Continued				
26. Limestone, massive; somewhat silty; weathers to a litter of thin chips	84	(25.6)	1,314	(401)
25. Quartzite, light-olive; weathers brown; fine-grained near base, medium-grained above	38	(11.6)	1,276	(389)
24. Limestone, gray; silty; thin-bedded	56	(17.1)	1,220	(372)
23. Limestone, blue-gray; medium-bedded; forms prominent ledge	8	(2.4)	1,212	(369)
22. Limestone, gray; silty, weathers pink; thin-bedded	45	(13.7)	1,167	(356)
21. Limestone, blue-gray; medium-bedded	8	(2.4)	1,159	(353)
20. Limestone, gray; thin-bedded	9	(2.7)	1,150	(351)
19. Limestone, blue-gray; massive	10	(3.1)	1,140	(347)
18. Limestone, blue-gray; medium-bedded	29	(8.8)	1,111	(339)
17. Interbedded limy siltstone and silty limestone; gray to olive; entire unit weathers brown	17	(5.2)	1,094	(333)
16. Limestone, blue-gray; cherty; massive	23	(7.0)	1,071	(326)
15. Limestone, blue-gray; thin-bedded; makes poor outcrop	86	(26.2)	985	(300)
14. Limestone, blue-gray; massive; forms prominent ledge	11	(3.4)	974	(297)
13. Limestone, gray; silty; weathers buff to brown	17	(5.2)	957	(292)
12. Limestone, gray; cherty; massive; forms prominent ledge	11	(3.4)	946	(288)
11. Siltstone, limy; buff; weathers brown	18	(5.5)	928	(283)
10. Limestone, blue-gray; medium-bedded; cherty; forms ledge	15	(4.6)	913	(278)
9. Limestone, blue-gray; thin-bedded	57	(17.4)	856	(261)
8. Limestone, blue-gray; thick bedded	47	(14.3)	809	(247)
7. Limestone, gray; massive	24	(7.3)	785	(239)
6. Limestone, blue-gray; medium-bedded; contains scattered lenses and beds of medium-grained, brown and buff weathering sandstone	165	(50.3)	620	(189)
5. Limestone, blue-gray; medium-bedded; fossils abundant; some sandstone pods and beds	228	(69.5)	392	(119)
4. Limestone, gray; cherty; thin-bedded	56	(17.1)	336	(102)
3. Limestone, blue-gray; medium-bedded	70	(21.3)	266	(81)
2. Limestone, blue-gray; thick-bedded	28	(8.5)	238	(73)
1. Limestone, gray; weathers tan, brown, and pink; contains many nodules of black and brown chert	238	(72.5)	0	(0)
Total thickness Furner Valley Limestone	5,233 ft		(1,595 m)	
Contact conformable.				
Bingham Mine Formation: Uppermost unit is red-brown-weathering light-olive-brown fine-grained limy sandstone.				

REFERENCE SECTION OF FURNER VALLEY LIMESTONE

[*Section measured on west side of Jericho Ridge in west half of secs. 6, 7, and 18,* T. 13 S., R. 2 W., *S.L.B.M., in Furner Ridge quadrangle, Utah*]

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Diamond Creek Sandstone: Basal unit is pink-weathering sandy and silty limestone bed about 20 feet (6.1 m) thick			5,454	(1,662)
Contact disconformable.				
Furner Valley Limestone:				
92. Dolomite, pinkish-gray; medium-bedded; silty	74	(22.6)	5,380	(1,640)
91. Dolomite, gray; massive; cherty	91	(27.7)	5,289	(1,612)
90. Dolomite, brown-weathering; thin-bedded	66	(20.1)	5,223	(1,592)
89. Dolomite, gray; massive	22	(6.7)	5,201	(1,585)
88. Dolomite, gray; thin- to medium-bedded; cherty	15	(4.6)	5,186	(1,581)
87. Dolomite, pink-weathering; thin-bedded	34	(10.4)	5,152	(1,570)
86. Dolomite, gray; medium-bedded	42	(12.8)	5,110	(1,558)
85. Quartzite, olive-brown; weathers red-brown; medium- to fine-grained	4	(1.2)	5,106	(1,556)
84. Dolomite, gray; massive; cherty	31	(9.5)	5,075	(1,547)
83. Dolomite, pinkish-gray; thin-bedded	27	(8.2)	4,048	(1,539)
82. Dolomite, gray; massive; cherty	26	(7.9)	5,022	(1,531)
81. Dolomite, pinkish-gray; medium-bedded	51	(15.5)	4,971	(1,515)
80. Covered interval; adjacent outcrops chiefly thin-bedded, gray silty dolomite, with some ledges of massive gray cherty dolomite 8–10 ft thick	482	(146.9)	4,489	(1,368)
79. Dolomite, gray; massive	42	(12.8)	4,447	(1,355)
78. Dolomite, gray; thin-bedded; 8-inch (20 cm) sandstone bed near center; outcrop partly covered	21	(6.4)	4,426	(1,349)
77. Dolomite, gray; massive	63	(19.2)	4,363	(1,330)

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Furner Valley Limestone—Continued				
76. Dolomite, gray; medium-bedded	94	(28.7)	4,269	(1,301)
75. Dolomite, pink-weathering; lower half brecciated	34	(10.4)	4,235	(1,291)
74. Siltstone, brown; limy	18	(5.5)	4,217	(1,285)
73. Dolomite, gray; thick-bedded	54	(16.5)	4,163	(1,269)
72. Siltstone, brown; sand-streaked	19	(5.8)	4,144	(1,263)
71. Dolomite, gray; massive	96	(29.3)	4,048	(1,234)
70. Dolomite, gray; brown-weathering; thin-bedded; cherty	58	(17.7)	3,990	(1,216)
69. Dolomite, gray; massive	33	(10.1)	3,957	(1,206)
68. Dolomite, gray; thin-bedded, cherty	42	(12.8)	3,915	(1,193)
67. Dolomite, brown-weathering; silty; some chert nodules	30	(9.1)	3,885	(1,184)
66. Dolomite, gray; massive; cherty	5	(1.5)	3,880	(1,183)
65. Dolomite, brown; thin-bedded; silty	70	(21.3)	3,810	(1,161)
64. Dolomite, gray; massive; medium- to fine-grained; forms ledge	18	(5.5)	3,792	(1,156)
63. Siltstone and shale, yellow- and red-weathering	27	(8.2)	3,765	(1,148)
62. Dolomite, gray; massive; coarse-grained; forms double-crested outcrop	24	(7.3)	3,741	(1,140)
61. Dolomite, gray; massive	38	(11.6)	3,703	(1,129)
60. Siltstone; brown-weathering; cherty	42	(12.8)	3,661	(1,116)
59. Dolomite, gray; massive; coarse-grained; forms ledge	17	(5.2)	3,644	(1,111)
58. Dolomite, brown-weathering; fine-grained; cherty	17	(5.2)	3,627	(1,106)
57. Dolomite, gray; massive; medium-grained with many broken fossils; forms ledge	30	(9.1)	3,410	(1,039)
56. Dolomite, brown-weathering; thin-bedded; silty; cherty in upper 20 feet	80	(24.4)	3,330	(1,015)
55. Dolomite, gray; massive	13	(4.0)	3,317	(1,011)
54. Siltstone, dolomitic; red- and brown-weathering; thin-bedded; sparsely cherty	53	(16.2)	3,264	(995)
53. Dolomite, gray; massive	23	(7.0)	3,241	(988)
52. Siltstone, dolomitic; red- and brown-weathering; cherty	26	(7.9)	3,215	(980)
51. Dolomite, gray; massive	23	(7.0)	3,192	(973)
50. Dolomite, light-gray; thin-bedded; poor outcrop	29	(8.8)	3,163	(964)
49. Dolomite, gray; massive; sparsely cherty; forms ledge	34	(10.4)	3,129	(954)
48. Dolomite, gray; medium-bedded; coarse-grained, with many fragments of broken fossils; faintly crossbedded	246	(75.0)	2,883	(879)
47. Dolomite, gray; medium-bedded to massive; scattered nodules of black and brown chert. Base a prominent ledge	331	(100.9)	2,552	(778)
46. Limestone, brown-weathering; silty; thin-bedded; poor outcrop	94	(28.7)	2,458	(749)
45. Dolomite, gray; medium-bedded; sparsely cherty	51	(15.5)	2,407	(734)
44. Dolomite, brown-weathering; sandy; moderately cherty	63	(19.2)	2,344	(714)
43. Dolomite, gray; medium-bedded; medium-grained; sparsely cherty	99	(30.2)	2,245	(684)
42. Dolomite, gray; thin-bedded; poor outcrop	75	(22.9)	2,170	(661)
41. Dolomite, gray; medium-bedded; forms ledge	42	(12.8)	2,128	(649)
40. Dolomite, brown-weathering; silty; medium-bedded	24	(7.3)	2,104	(641)
39. Dolomite, gray; medium-bedded	124	(37.8)	1,980	(604)
38. Dolomite, gray; massive; sparsely cherty	75	(22.9)	1,905	(581)
37. Limestone, buff-weathering; fine-grained; silty	80	(24.4)	1,825	(556)
36. Quartzite, brown-weathering; medium-grained; limy	10	(3.1)	1,815	(553)
35. Dolomite, gray; massive	57	(17.4)	1,758	(536)
34. Limestone, gray; thin-bedded; abundant chert	18	(5.5)	1,740	(530)
33. Dolomite, gray; medium-bedded	39	(11.9)	1,701	(518)
32. Limestone, buff- to brown-weathering; silty; medium-bedded	77	(23.5)	1,624	(495)
31. Limestone, blue-gray; thin- to medium-bedded; sparsely cherty. Beds separated by thin layers of limy siltstone	57	(17.4)	1,567	(478)
30. Dolomite, blue-gray; medium-bedded; fine-grained; sparsely cherty; some interlayered beds of silty dolomite	83	(25.3)	1,484	(452)
29. Dolomite, brown-weathering; silty	69	(21.0)	1,415	(431)
28. Dolomite, gray; many fragments of broken fossils	27	(8.2)	1,388	(423)
27. Siltstone, red-weathering; fine-grained	27	(8.2)	1,361	(415)
26. Dolomite, gray; medium-grained	15	(4.6)	1,346	(410)
25. Quartzite, red- and brown-weathering; limy; fine-grained	33	(10.1)	1,313	(400)
24. Dolomite breccia, gray; massive	16	(4.9)	1,297	(395)
23. Siltstone, brown-weathering; limy	34	(10.4)	1,263	(385)
22. Dolomite, gray; massive; medium-grained	32	(9.8)	1,231	(375)
21. Interlayered limestone and dolomite. Limestone blue-gray;				

	Thickness in feet	(meters)	Distance above base in feet	(meters)
Furner Valley Limestone—Continued				
21. Interlayered limestone, etc.—Continued fossiliferous. Dolomite medium-gray; recrystallized	168	(51.2)	1,063	(324)
20. Limestone, buff to brown; silty and shaly; locally dolomitic	23	(7.0)	1,040	(317)
19. Dolomite, gray; massive; medium-grained; forms ledge	35	(10.7)	1,005	(306)
18. Dolomitic limestone, blue-gray; medium-bedded; fine- to medium-grained; some brown-weathering silty zones	127	(38.7)	878	(268)
17. Dolomite, gray; thin-bedded; fine-grained; silty	48	(14.6)	830	(253)
16. Dolomite, brown-weathering; silty	43	(13.1)	787	(240)
15. Limestone, blue-gray; medium-bedded; fine-grained	12	(3.7)	775	(236)
14. Dolomite, gray; medium-bedded; medium-grained	20	(6.1)	755	(230)
13. Sandstone, buff; fine-grained; calcite cement	3	(0.9)	752	(229)
12. Limestone, gray; thin- to medium-bedded; fine-grained	28	(8.5)	724	(221)
11. Limestone, gray; medium-bedded; medium-grained; cherty	37	(11.3)	687	(209)
10. Dolomite, blue-gray; medium-bedded; fossiliferous	74	(22.6)	613	(187)
9. Limestone, yellow-weathering; thin-bedded; silty	15	(4.6)	598	(182)
8. Limestone, blue-gray; medium-bedded; fossiliferous; sparsely cherty	47	(14.3)	551	(168)
7. Sandstone, yellow-weathering; fine-grained	21	(6.4)	530	(162)
6. Siltstone, pink-weathering; limy	7	(2.1)	523	(159)
5. Limestone, gray; medium-bedded; silty	27	(8.2)	496	(151)
4. Siltstone, yellow- and pink-weathering; limy; buff on fresh fracture	34	(10.4)	462	(141)
3. Limestone, blue-gray; medium-bedded; fossils abundant	101	(30.8)	361	(110)
2. Limestone, blue-gray; medium-bedded; fine-grained; sparsely cherty	125	(38.1)	236	(72)
1. Limestone, blue-gray; silty; fine-grained; sparsely cherty	236	(71.9)	0	(0)
Total thickness Furner Valley Limestone	5,454 ft		(1,662 m)	

Contact conformable.

Bingham Mine Formation:

Uppermost beds are brown-weathering fine-grained sandstone that merges upward into basal silty limestone of Furner Valley Limestone.

REFERENCES CITED

Anderson, W. L., 1960, Stratigraphic section of the northern Silver Island Mountains, *in* Geology of the Silver Island Mountains, Box Elder and Tooele Counties, Utah, and Elko County, Nevada; Utah Geol. Soc., Guidebook to the geology of Utah, no. 15, p. 114-117.

Baars, D. L., 1962, Permian system of Colorado Plateau: Am. Assoc. Petroleum Geologists Bull., v. 46, no. 2, p. 149-218.

Baker, A. A., 1947, Stratigraphy of the Wasatch Mountains in the vicinity of Provo, Utah: U.S. Geol. Survey Oil and Gas Inv., Chart 30.

Baker, A. A., and Crittenden, M. D., Jr., 1961, Geologic map of the Timpanogos Cave quadrangle, Utah: U.S. Geol. Survey Geol. Quad. Map GQ-132, scale 1:24,000.

Baker, A. A., Huddle, J. W., and Kinney, D. M., 1949, Paleozoic geology of north and west sides of Uinta Basin, Utah: Am. Assoc. Petroleum Geologists Bull., v. 33, no. 7, p. 1,161-1,197.

Baker, A. A., and Williams, J. S., 1940, Permian in parts of Rocky Mountain and Colorado Plateau regions: Am. Assoc. Petroleum Geologists Bull., v. 24, no. 4, p. 619-635.

Berge, J. S., 1960, Stratigraphy of the Ferguson Mountain area, Elko County, Nevada: Brigham Young Univ. Research Studies Geology Ser., v. 7, no. 5, 63 p.

Bissell, H. J., 1936, Pennsylvanian and Lower Permian stratigraphy in the southern Wasatch Mountains, Utah: The State University of Iowa, M.S. thesis, 29 p.

——1959, Stratigraphy of the southern Oquirrh Mountains-Upper Paleozoic succession, Pennsylvanian system, *in* Utah Geol. Soc., Guidebook to the geology of Utah, no. 14, p. 37-58, 93-127.

——1962a, Permian rocks of parts of Nevada, Utah, and Idaho: Geol. Soc. America Bull., v. 73, p. 1083-1110.

——1962b, Pennsylvanian-Permian Oquirrh basin of Utah: Brigham Young Univ. Research Studies Geology Ser., v. 9, pt. 1, p. 26-49.

——1963, Pennsylvanian and Permian systems of southwestern Utah, *in* Geology of southwestern Utah—Intermountain Assoc. Petroleum Geologists, 12th Ann. Field Conf. 1963, Guidebook: Utah Geol. and Mineralog. Survey. p. 42-58.

——1964, Ely, Arcturus, and Park City Groups (Pennsylvanian-Permian) in eastern Nevada and western Utah: Am. Assoc. Petroleum Geologists Bull., v. 48, no. 5, p. 565-636.

——1967, Pennsylvanian and Permian basins in northwestern Utah, northeastern Nevada, and south-central Idaho—Discussion: Am. Assoc. Petroleum Geologists Bull., v. 51, no. 5, p. 791-802.

——1974, Tectonic control of Late Paleozoic and Early Mesozoic sedimentation near the hinge line of the Cordilleran Miogeosynclinal Belt: Soc. Econ. Paleontologists and Mineralogists Spec. Pub. no. 22, p. 83-97.

Bissell, H. J., and Childs, O. E., 1958, The Weber formation of Utah and Colorado, *in* Rocky Mtn. Assoc. Geologists, Symp. on Pennsylvanian rocks of Colorado and adjacent areas, p. 26-30.

Brill, K. G., Jr., 1963, Permo-Pennsylvanian stratigraphy of western Colorado Plateau and eastern Great Basin regions: Geol. Soc. America Bull., v. 74, p. 307-330.

Calkins, F. C., and Butler, B. S., 1943, Geology and ore deposits of the Cottonwood-American Fork area, Utah: U.S. Geol. Survey Prof. Paper 201, 152 p.

Costain, J. K., 1960, Geology of the Gilson Mountains and vicinity, Juab County, Utah: Utah Univ., Salt Lake City, Ph. D. thesis., 139 p.

Crittenden, M. D., Jr., 1961, Magnitude of thrust faulting in northern Utah, *in* Geological Survey research 1961: U.S. Geol. Survey Prof. Paper 424-D, p. D128-D131.

Crosby, G. W., 1959, Geology of the South Pavant Range, Millard and Sevier Counties, Utah: Brigham Young Univ. Research Studies Geology Ser., v. 7, no. 3, 59 p.

Doelling, H. H., 1964, Geology of the northern Lakeside Mountains and the Grassy Mountains and vicinity, Tooele and Box Elder Counties, Utah: Utah Univ., Salt Lake City, Ph. D. thesis, 354 p.

Douglass, R. C., Moore, W. J., and Huddle, J. W., 1974, Stratigraphy and microfauna of the Oquirrh Group in the western Traverse Mountains and northern Lake Mountains, Utah: U.S. Geol. Survey Jour. Research, v. 2, no. 1, p. 97-104.

Dunbar, C. O., and Condra, G. E., 1927, The Fusulinidae of the Pennsylvanian system in Nebraska: Nebraska Geol. Survey, Bull. 2, 2d ser., 130 p.

Dunbar, C. O., and Henbest, L. G., 1942, Pennsylvanian Fusulinidae of Illinois: Illinois Geol. Survey Bull. 67, 167 p.

Dunbar, C. O., and Skinner, J. W., 1937, Permian Fusulinidae of Texas: Texas Univ. Bull. 3701, p. 517-825.

Eardley, A. J., 1944, Geology of the north-central Wasatch Mountains, Utah: Geol. Soc. America Bull. v. 55, no. 7, p. 819-894.

Gilluly, James, 1932, Geology and ore deposits of the Stockton and Fairfield quadrangles, Utah: U.S. Geol. Survey Prof. Paper 173, 171 p.

Granger, A. E., 1953, Stratigraphy of the Wasatch Range near Salt Lake City, Utah: U.S. Geol. Survey Circ. 296, 14 p.

Hall, W. E., Batchelder, John, and Douglass, R. C., 1974, Stratigraphic section of the Wood River Formation, Blaine County, Idaho: U.S. Geol. Survey Jour. Research, v. 2, no. 1, p. 89-95.

Heylmun, E. B., 1958, Paleozoic stratigraphy and oil possibilities of Kaiparowits region, Utah: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 8, p. 1781-1811.

Hintze, L. H., 1973, Geologic history of Utah: Brigham Young Univ. Geology Studies, v. 20, pt. 3, 181 p.

Hose, R. K., and Repenning, C. A., 1959, Stratigraphy of Pennsylvanian, Permian, and Lower Triassic rocks of Confusion Range, west-central Utah: Am. Assoc. Petroleum Geologists Bull., v. 43, p. 2167-2196.

Langenheim, R. L., Jr., and Larson, E. R., 1973, Correlation of Great Basin stratigraphic units: Nevada Bur. Mines and Geology Bull., 72, 36 p.

Longwell, C. R., 1921, Geology of the Muddy Mountains, Nevada, *with a section on* the Grand Wash Cliffs in western Arizona: Am. Jour. Sci., 5th ser., v. 1, no. 1, p. 39-62.

McKelvey, V. E., and others, 1956, Summary description of Phosphoria, Park City, and Shedhorn formations in western phosphate field: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 12, p. 2826-2863.

McNair, A. H., 1951, Paleozoic stratigraphy of part of northwestern Arizona: Am. Assoc. Petroleum Geologists Bull., v. 35, no. 3, p. 503-541.

Maurer, R. E., 1970, Geology of the Cedar Mountains, Tooele County, Utah: Utah Univ., Salt Lake City, Ph. D. thesis. 184 p.

Meek, F. B., 1864, Description of the Carboniferous fossils *in* Paleontology of California: California Geol. Survey, v. 1, p. 1-16.

Merchant, F. E., and Keroher, R. P., 1939, Some fusulinids from the Missouri Series of Kansas: Jour. Paleontology, v. 13, no. 6, p. 594-614.

Morris, H. T., 1957, General geology of the East Tintic Mountains, Utah, *in* Utah Geol. Soc., Guidebook to the geology of Utah, no. 12, p. 1-56.

——1977, Geologic map and sections of the Furner RidgeQuadrangle, Juab County, Utah: U.S. Geol. Survey Misc. Inv. Series Map I-1045.

Morris, H. T., and Kopf, R. W., 1970a, Preliminary geologic map and cross section of the Cherry Creek quadrangle and adjacent part of the Dutch Peak quadrangle, Juab County, Utah: U.S. Geol. Survey open-file map, scale 1:24,000.

——1970b, Preliminary geologic map and cross section of the Maple Peak quadrangle and adjacent part of the Sabie Mountain quadrangle, Juab County, Utah: U.S. Geol. Survey open-file map, scale 1:24,000.

Morris, H. T., and Lovering, T. S., 1961, Stratigraphy of the East Tintic Mountains, Utah: U.S. Geol. Survey Prof. Paper 361, 145 p.

Muessig, S. J., 1951, Geology of a part of Long Ridge, Utah: Ohio State Univ., Columbus, Ph. D. thesis, 213 p.

Nolan, T. B., 1935, The Gold Hill mining district, Utah: U.S. Geol. Survey Prof. Paper 177, 172 p.

Nygreen, P. W., 1958, The Oquirrh Formation—Stratigraphy of the lower portion in the type area and near Logan, Utah: Utah Geol. Mineralog. Survey Bull., v. 61, 67 p.

Olson, R. H., 1960, Geology of the Promontory Range, Box Elder County, Utah: Utah Univ., Salt Lake City, Ph. D. thesis, 351 p.

Paddock, R. E., 1956, Geology of the Newfoundland Mountains, Box Elder County, Utah: Utah Univ., Salt Lake City, M.S. thesis, 101 p.

Rigby, J. K., 1958, Geology of the Stansbury Mountains, eastern Tooele County, Utah, *in* Utah Geol. Soc., Guidebook to the geology of Utah, no. 13, p. 1-133.

Roberts, R. J., and others, 1965, Pennsylvanian and Permian basins in northwestern Utah, northeastern Nevada, and south-central Idaho: Am. Assoc. Petroleum Geologists Bull., v. 49, no. 11, p. 1926-1956.

Ross, C. A., 1959, The Wolfcamp series (Permian) and new species of fusulinids, Glass Mountains, Texas: Washington Acad. Sci. Jour. v. 49, no. 9, p. 299-311.

Sadlick, Walter, 1959, Fusuline correlations—Oquirrh Formation and Durst Group [Utah], *in* Intermountain Assoc. Petroleum Geologists, Guidebook, 10th Ann. Field Conf., p. 82-89.

Sando, W. J., Dutro, J. T., Jr., and Gere, W. C., 1959, Brazer dolomite (Mississippian), Randolph quadrangle, northeast Utah: Am. Assoc. Petroleum Geologists Bull., v. 43, no. 12, p. 2741-2769.

Schaeffer, F. E., 1960, Stratigraphy of the Silver Island Mountains, *in* Geology of the Silver Island Mountains, Box Elder and Tooele Counties, Utah, and Elko County, Nevada: Utah Geol. Soc., Guidebook to the Geology of Utah, no. 15, p. 15-113.

Steele, Grant, 1959, Basin and Range structure reflects Paleozoic tectonics and sedimentation [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 43, p. 1105.

——1960, Pennsylvanian-Permian stratigraphy of east-central Nevada and adjacent Utah, *in* Geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists, 11th Ann. Field Conf., 1960 Guidebook, p. 91-113.

Stifel, P. B., 1964, Geology of the Terrace and Hogup Mountains, Box Elder County, Utah: Utah Univ., Salt Lake City, Ph. D. thesis, 173 p.

Thompson, M. L., and Bissell, H. J., 1954, Central Utah, *in* Thompson, M. L., American Wolfcampian fusulinids: Kansas Univ. Paleont. Contrib., art. 5, 226 p.

Thompson, M. L., Verville, G. J., and Bissell, H. J., 1950, Pennsylvanian fusulinids of the south-central Wasatch Mountains, Utah: Jour. Paleontology, v. 24, no. 4, p. 430-465.

Tooker, E. W., and Roberts, R. J., 1961, Stratigraphy of the north end of the Oquirrh Mountains, Utah, *in* Geology of the Bingham mining district and northern Oquirrh Mountains: Utah Geol. Soc. Guidebook to the Geology of Utah, no. 16, p. 17-35.

——1963, Comparison of Oquirrh Formation sections in the northern and central Oquirrh Mountains, Utah, *in* Geological Survey research 1962: U.S. Geol. Survey Prof. Paper 450-E, p. E32-E36.

——1970, Upper Paleozoic rocks in the Oquirrh Mountains and Bingham mining district, Utah: U.S. Geol. Survey Prof. Paper 629-A, p. A1-A76.

Verville, G. J., Thompson, M. L., and Lokke, D. H., 1956, Pennsylvanian fusulinids of eastern Nevada: Jour. Paleontology, v. 30, no. 6, p. 1277-1287.

Wang, Y. F., 1970, Geological and geophysical studies of the Gilson Mountains and vicinity, Juab County, Utah: Utah Univ., Salt Lake City, Ph. D. thesis, 126 p.

Welsh, J. E., and James, A. H., 1961, Pennsylvanian and Permian stratigraphy of the central Oquirrh Mountains, Utah, *in* Geology of the Bingham mining district and northern Oquirrh Mountains: Utah Geol. Soc. Guidebook to the Geology of Utah, no. 16, p. 1-16.

Wengerd, S. A., 1958, Pennsylvanian stratigraphy, southwest shelf, Paradox basin [Colorado Plateau], *in* Intermountain Assoc. Petroleum Geologists, Guidebook, 9th Ann. Field Conf., p. 109-134.

Williams, J. S., 1958, Geologic atlas of Utah—Cache County: Utah Geol. Mineralog. Survey Bull. 64, 104 p.

PLATES 2–4

[Contact photographs of the plates in this report are available, at cost, from U.S. Geological Survey Library, Federal Center, Denver, Colorado 80225]

PLATE 2

[All unretouched photographs (x 10)]

FIGURES 1–22. Bingham Mine Formation.

1–4. USGS f13580. *Triticites* sp. aff. *T. provoensis* Thompson, Verville, and Bissell, 1950.
- 1, 2. Axial sections, slides 1 and 2 USNM Nos. 240543, 240544.
- 3, 4. Equatorial sections, slides 3 and 4 USNM Nos. 240545, 240546.

5–9. USGS f24696. *Pseudofusulinella* sp.
- 5–7. Axial sections slides 1, 4, and 2 USNM 240547, 240548, 240549.
- 8, 9. Equatorial sections slides 7 and 5 USNM 240550, 240551.

10–12. USGS f24779. *Triticites* sp. aff. *T.* sp. B of Thompson, Verville, and Bissell, 1950.
- 10, 11. Axial sections slides 3 and 1 USNM 240552, 240553.
- 12. Equatorial section slide 4 USNM 240554.

13–16. USGS f13578. *Triticites* sp. aff. *T. springvillensis* Thompson, Verville, and Bissell, 1950.
- 13. Equatorial section slide 5 USNM 240555.
- 14. Axial section slide 2 USNM 240556.
- 15. Equatorial section slide 4 USNM 240557.
- 16. Axial section slide 1 USNM 240558.

17–19. USGS f24701. *Bartramella* sp.
- 17, 18. Axial sections slides 10 and 12 USNM 240559, 240560.
- 19. Equatorial section slide 13 USNM 240561.

20–22. USGS f24701. *Eowaeringella* sp.
- 20. Equatorial section slide 6 USNM 240562.
- 21, 22. Axial sections slides 1 and 2 USNM 240563, 240564.

23–48. Butterfield Peaks Formation.

23–26. USGS f24698. *Beedeina* sp. aff *B.* sp. A of Thompson, Verville, and Bissell, 1950.
- 23. Axial section slide 2 USNM 240565.
- 24. Equatorial section slide 7 USNM 240566.
- 25, 26. Axial sections slides 4 and 1 USNM 240567, 240568.

27–31. USGS f13648. *Beedeina* sp. 3.
- 27–29. Axial sections slides 9, 12, 11 USNM 240569, 240570, 240571.
- 30, 31. Equatorial sections slides 5 and 6 USNM 240572, 240573.

32. USGS f13648. *Beedeina* sp. 4, dolomitized specimen.
Axial section slide 13 USNM 240574.

33. USGS f13648. *Wedekindellina* sp. aff. *W. euthysepta* (Henbest).
Axial section slide 15 USNM 240575.

34, 35. USGS f13649. *Beedeina* sp. 2.
- 34. Axial section slide 1 USNM 240576.
- 35. Equatorial section slide 3 USNM 240577.

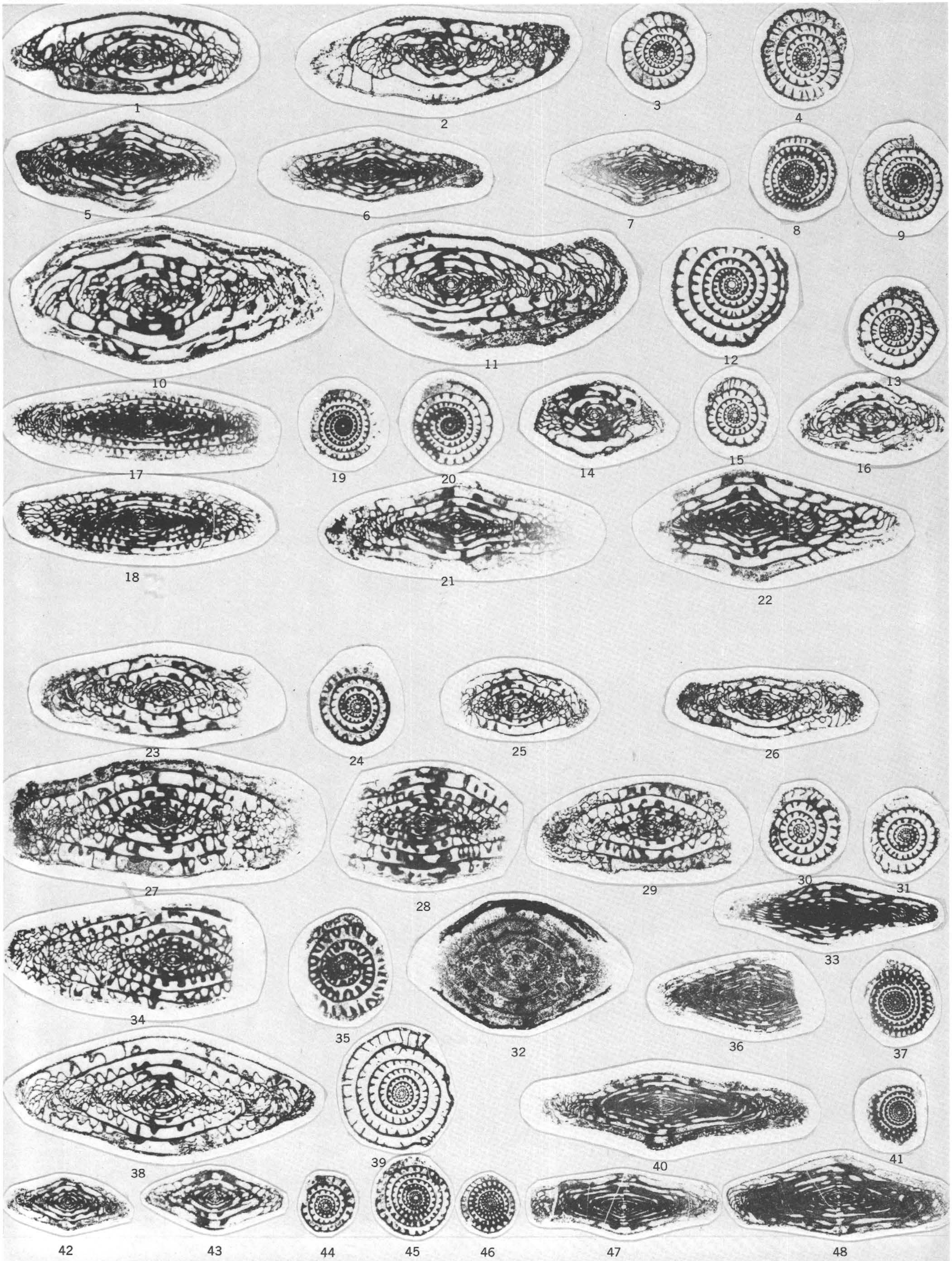
36, 37. USNM f13649. *Wedekindellina* sp. 2.
- 36. Axial section slide 4 USNM 240578.
- 37. Equatorial section slide 5 USNM 240579.

38, 39. USGS f13650. *Beedeina* sp. 1.
- 38. Axial section slide 1 USNM 240580.
- 39. Equatorial section slide 5 USNM 240581.

40, 41. USGS f24785. *Wedekindellina* sp. aff. *W. henbesti* (Skinner).
- 40. Axial section slide 1 USNM 240582.
- 41. Equatorial section slide 2 USNM 240583.

42–44. USGS f13652. *Fusulinella* sp.
- 42, 43. Axial sections slides 1 and 4 USNM 240584, 240585.
- 44. Equatorial section slide 8 USNM 240586.

45–48. USGS f13652. *Wedekindellina* sp. 1.
- 45, 46. Equatorial sections slides 17 and 12 USNM 240587, 240588.
- 47, 48. Axial sections slides 14 and 15 USNM 240590.



FUSULINIDS FROM THE BUTTERFIELD PEAKS AND BINGHAM MINE FORMATIONS ON JERICHO AND FURNER RIDGES

PLATE 3

[All unretouched photographs (x 10)]

FIGURES 1-4. USGS f24781. *Triticites* sp. aff. *T. cellamagnus* Thompson and Bissell, 1954.
1, 2. Axial sections slides 1 and 2 USNM 240591, 240592.
3, 4. Equatorial sections slides 5 and 6 USNM 240593, 240594.

5-8. USGS f13581. *Triticites* sp. aff. *T. cullomensis* Dunbar and Condra, 1927.
5, 6. Axial sections slides 1 and 2 USNM 240595, 240596.
7, 8. Equatorial sections slides 5 and 4 USNM 240597, 240598.

9, 10. USGS f24784. *Triticites* sp. aff. *T. cullomensis* Dunbar and Condra, 1927.
9. Axial section slide 1 USNM 240599.
10. Equatorial section slide 3 USNM 240600.

11, 12. USGS f24784. *Pseudofusulinella* sp.
11. Equatorial section slide 7 USNM 240601.
12. Axial section slide 4 USNM 240602.

13-18. USGS f24695. *Kansanella* sp. aff. *K. plicatula* (Merchant and Keroher).
13-16. Axial sections slides 4, 6, 9, and 10 USNM 240603, 240604, 240605, 240606.
17, 18. Equatorial sections slides 16 and 20 USNM 240607, 240608.

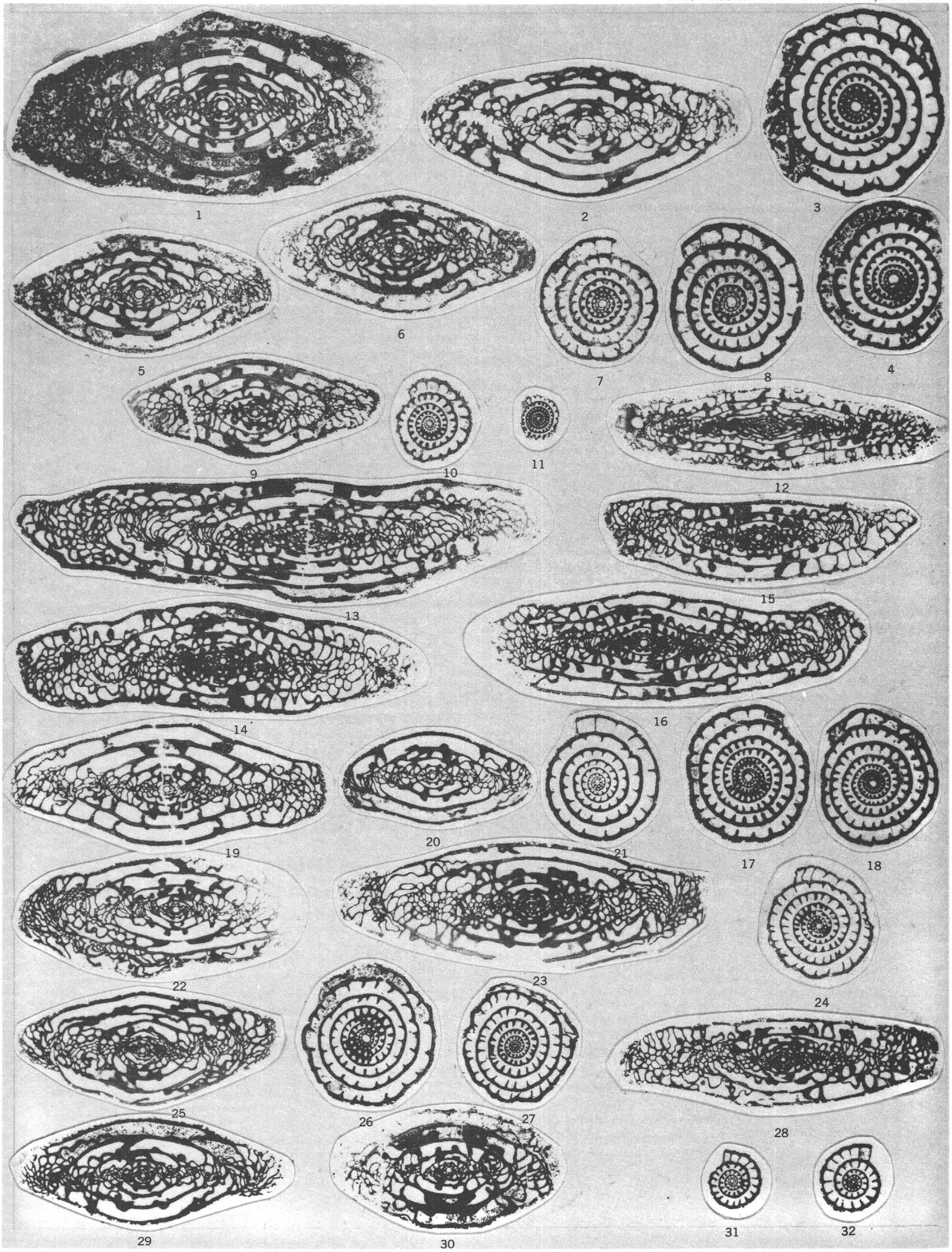
19-21. USGS f24777. *Triticites* sp. aff. *T. mediocris angustus* Dunbar and Henbest, 1942.
19, 20. Axial sections slides 1 and 2 USNM 240609, 240610.
21. Equatorial section slide 4 USNM 240611.

22-24. USGS f13579. *Triticites* sp. aff. *T. grangerensis* Thompson, Verville, and Bissell, 1950.
22, 23. Axial sections slides 2 and 1 USNM 240612, 240613.
24. Equatorial section slide 5 USNM 240614.

25-27. USGS f24697. *Triticites* sp. aff. *T. pygmaeus* Dunbar and Condra, 1927.
25. Axial section slide 2 USNM 240615.
26, 27. Equatorial sections slides 8 and 6 USNM 240616, 240617.

28. USGS f24097. *Triticites* sp. aff. *T. grangerensis* Thompson, Verville, and Bissell, 1950. Axial section slide 4 USNM 240618.

29-32. USGS f13577. *Triticites* sp. aff. *T. pygmaeus* Dunbar and Condra, 1927.
29, 30. Axial sections slides 3 and 4 USNM 240619, 240620.
31, 32. Equatorial sections slides 8 and 9 USNM 240621, 240622.



FUSULINIDS FROM THE FURNER VALLEY LIMESTONE ON JERICHO AND FURNER RIDGES

PLATE 4

[All unretouched photographs (x 10)]

FIGURES 1. USGS f24702. *Schwagerina* sp. 5 (dolomitized). Axial section slide 9 USNM 240623.

2. USGS f24702. *Schwagerina* sp. aff. *S. pinosensis* Thompson, 1954. Axial section slide 3 USNM 240624.

3. USGS f20503. *Schwagerina* sp. 4. Axial section slide 12 USNM 240625.

4. USGS f20503. *Pseudoschwagerina* sp. aff. *P. robusta* (Meek). Axial section slide 7 USNM 240626.

5. USGS f20505. *Pseudoschwagerina* sp. aff. *P. texana* Dunbar and Skinner, 1937. Axial section slide 12 USNM 240627.

6. USGS f20510. ?*Pseudoschwagerina* sp. aff. *P. convexa* Thompson, 1954. Axial section slide 4 USNM 240628.

7. USGS f20511. *Schwagerina* sp. 3. Axial section slide 3 USNM 240629.

8. USGS f20512. *Schwagerina* sp. 2. Axial section slide 2 USNM 240630.

9. USGS f20512. *Pseudofusulina* sp. Axial section slide 6 USNM 240631.

10. USGS f20513. *Schwagerina* sp. 1. Axial section slide 6 USNM 240632.

11, 12. USGS f24694. *Schwagerina* sp. aff. *S. punguncul us* Ross, 1959.

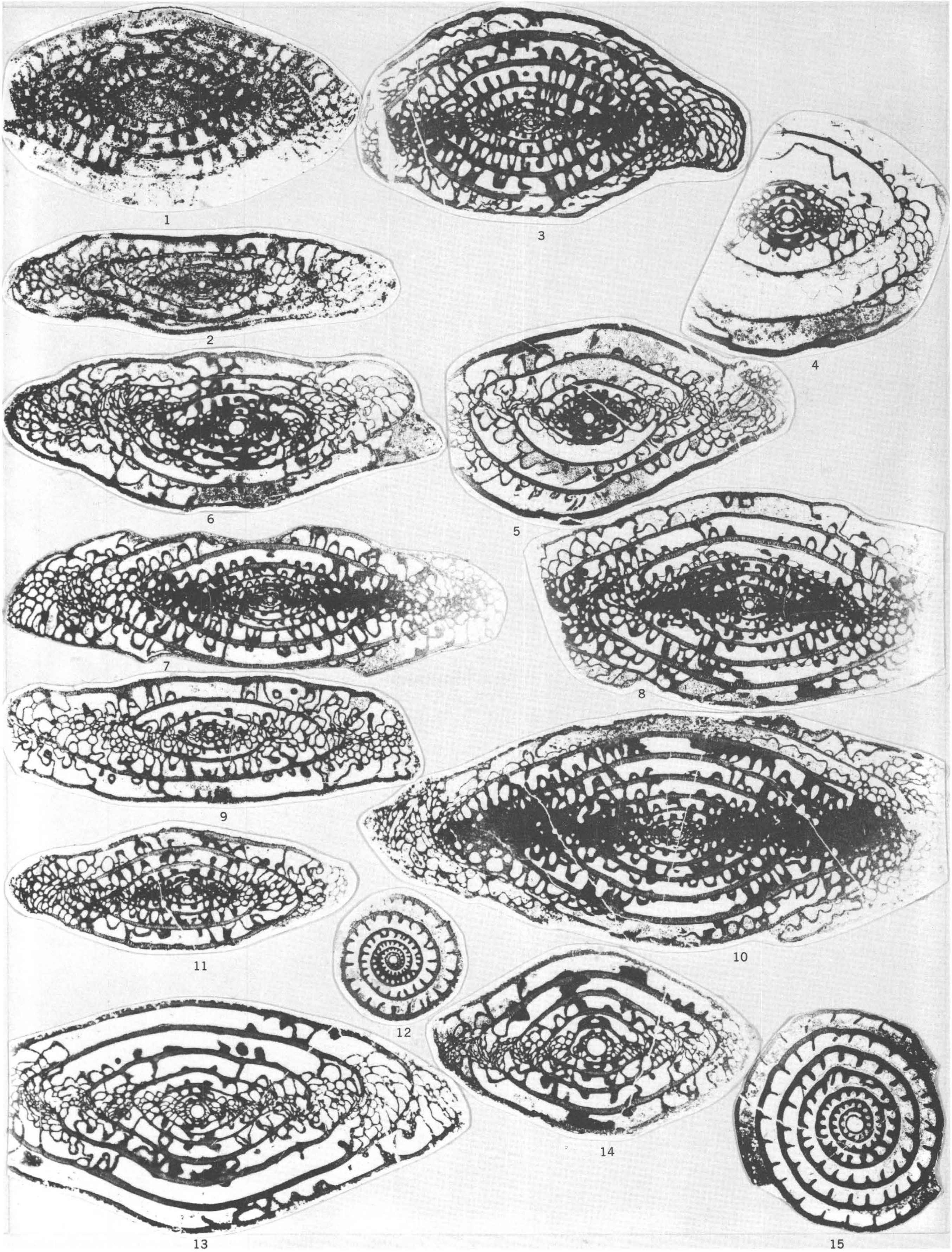
11. Axial section slide 1 USNM 240633.

12. Equatorial section slide 5 USNM 240634.

13-15. USGS f20523. *Triticites* sp. aff. *T. cellamagnus* Thompson and Bissell, 1954.

13, 14. Axial sections slides 4 and 2 USNM 240635, 240636.

15. Equatorial section slide 6 USNM 240637.



FUSULINIDS FROM THE FURNER VALLEY LIMESTONE