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# CRETACEOUS STRATIGRAPHY AND BIOSTRATIGRAPHY, WESTERN FRANKLIN MOUNTAINS, EL PASO, TEXAS

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**Abstract**—Cretaceous strata crop out at four principal localities along the western fault zone of the Franklin Mountains. Detailed lithostratigraphy and biostratigraphy indicates the presence of relatively thin sections of the Muleros, Mesilla Valley, Anapra, Del Rio, Buda, and Boquillas Formations. One location preserves an apparent depositional contact of the Muleros Formation on Paleozoic limestone. These observations suggest the presence of an emergent depositional high—the Franklin Mountains Island—in west Texas during part of the late Albian.

## INTRODUCTION

Lower Cretaceous strata are best exposed in the El Paso area by the Cerro de Cristo Rey uplift, west of the Rio Grande (Böse, 1910; Lovejoy, 1976a). However, several fault-bounded Cretaceous outcrops are also present along the western front of the Franklin Mountains (Fig. 1). Richardson (1909) first described some of these Cretaceous outcrops, and a variety of articles have mentioned them (e.g., McAnulty, 1968; Lovejoy, 1976b; Kuhfal, 1977; LeMone and Simpson, 1981; Corbitt and Hoffer, 1992), but they have not been described in detail. Here, we provide such a description and argue that the Cretaceous outcrops on the western flank of the Franklin Mountains suggest a local depositional feature of positive relief—here termed the Franklin Mountains Island—was present in this area during the late Early Cretaceous. In this article, NMMNH refers to the New Mexico Museum of Natural History and Science, Albuquerque.

## LITHOSTRATIGRAPHY

### Introduction

We examined outcrops of Cretaceous strata along the western front of the Franklin Mountains between the Trans-Mountain Highway and the Crazy Cat landslide (Fig. 1). These outcrops are directly associated with the western boundary fault zone of the Franklin Mountains. Outcrops further west, near the Three Sisters and Coronado andesites (cf. Kufal, 1977) were not studied by us during this investigation.

The northernmost outcrops we examined are around the Thunderbird andesite, so we term them "Thunderbird A" and "Thunderbird B." To the south, in suburban El Paso, Cretaceous strata crop out just east of Festival Drive. The southernmost outcrops we examined are those in the Crazy Cat landslide (Lovejoy, 1976b).

### Thunderbird A

The outcrop we term Thunderbird A is on the southern slope of an unnamed east-west canyon at UTM 357512E, 3527485N (zone 13, datum NAD27). To our knowledge, this outcrop has not been described previously. Cretaceous strata here (Fig. 2) are in fault contact with sandstones of the Cambrian Bliss Formation. The Cretaceous section dips 50° to N80°W and begins with about 14 m of pale orange, pinkish gray and brownish gray, trough-crossbedded quartzose sandstone and siltstone that we assign on a lithologic basis to the Anapra Sandstone.

On a similar lithologic basis, we assign the overlying 3.4 m of yellowish brown, sandy shale to the Del Rio Formation. This is supported by the presence of a gastropod-bearing, 0.5-m-thick pinkish gray limestone above the Del Rio strata. The lithology and gastropod fossils (mostly *Tylostoma* and indeterminate turritellids: NMMNH locality 3572) support correlation of this limestone to the Buda Limestone (Fig. 2).

Arkosic red-bed sandstones and boulder conglomerates overlie and truncate the Buda at Thunderbird A. These appear to be Laramide synorogenic sediments correlative to the Lobo Formation in the Florida Mountains and to the Love Ranch Formation in the San Andres Mountains.

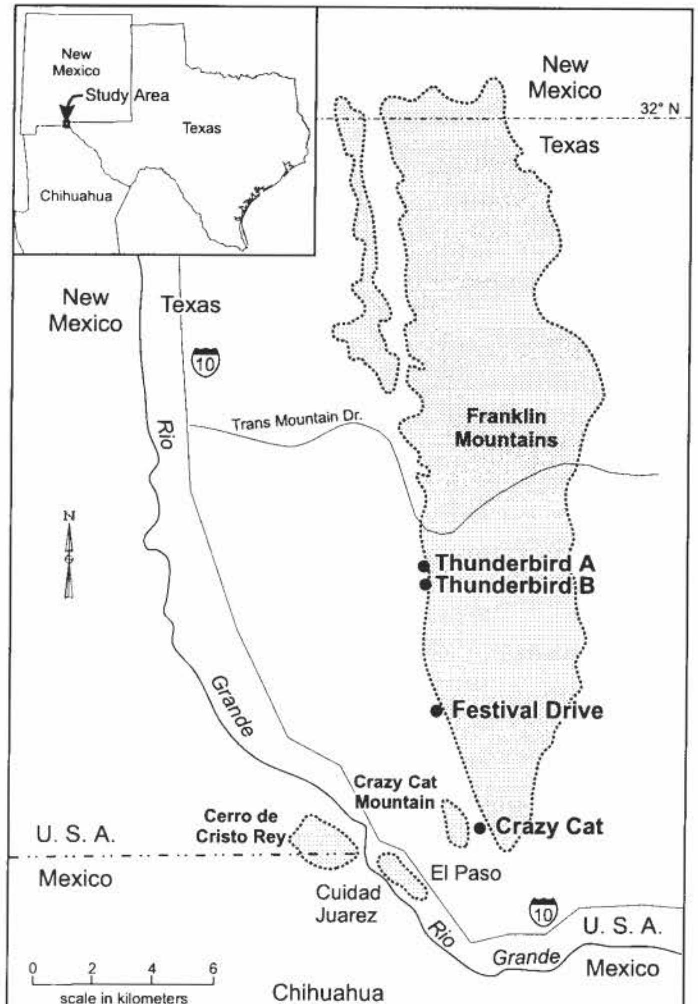


FIGURE 1. Map of the western front of the Franklin Mountains, showing location of measured sections and fossil localities discussed in the text.

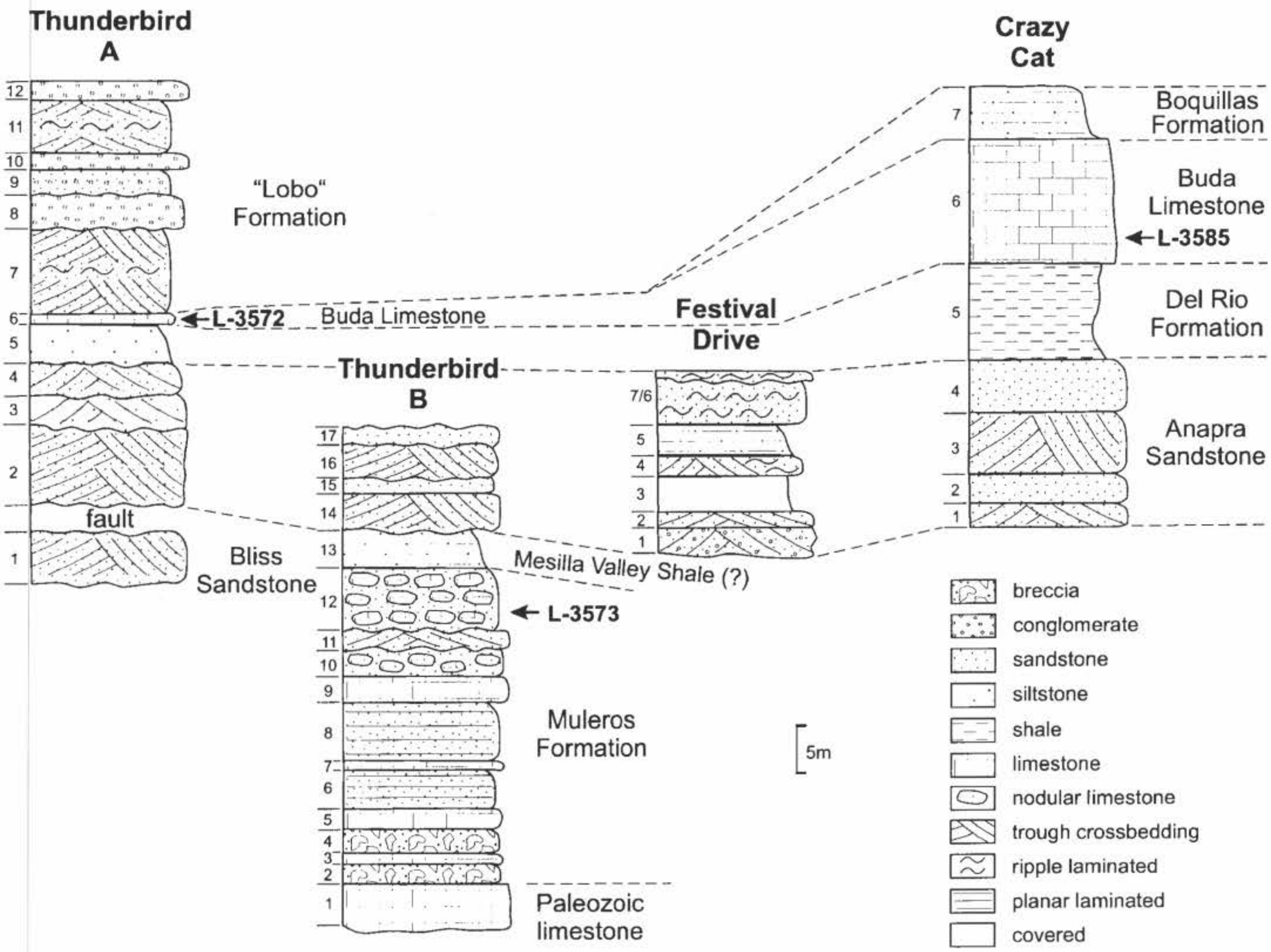


FIGURE 2. Measured stratigraphic sections of Cretaceous outcrops exposed along western flank of Franklin Mountains. See Figure 1 for location of sections and Appendix for lithologic descriptions.

## Thunderbird B

The locality Thunderbird B is an unnamed, east-west canyon at UTM 357745E, 3526701N (zone 13, datum NAD27). Richardson (1909) described this locality and suggested that the Cretaceous section here is in depositional contact with the underlying Paleozoic limestone. Indeed, both the Paleozoic strata and the Cretaceous strata dip to S70°W, though the dip of the Paleozoic is somewhat higher (~30°) than that of the overlying Cretaceous (19°). This change in dip seems, however, to be the result of folding, and we interpret the base of the Cretaceous section—with an extensive rip-up breccia of underlying Paleozoic limestone—to be in depositional contact with underlying Paleozoic limestone.

Most of the Cretaceous section at this locality (Fig. 2) is nodular limestones and calcarenites with abundant fossils of *Texigryphaea washitaensis* (Hill) or *T. pitcheri* (Morton). Lithologically and paleontologically, these strata are readily assigned to the Muleros Formation (also see LeMone and Simpson, 1981). A relatively thin shale slope above the Muleros (3.7 m thick) may correlate to the Mesilla Valley Shale and is overlain by sandstones lithologically similar to the Anapra Sandstone to which they are accordingly assigned (Fig. 2).

## Festival Drive

The Anapra Sandstone crops out in the canyon east of Festival Drive at UTM 357204E, 3522061N (zone 13, datum NAD27). Here, the exposed section of Anapra is about 16 m of quartzarenite sandstone and siliceous conglomerate (Fig. 2; Appendix). Farther east, up the canyon, richly fossiliferous strata of the Muleros Formation crop out intermittently. These Muleros outcrops are packstones of *Texigryphaea washitaensis* (Hill) or *T. pitcheri* (Morton) and *Cribratina*, but the section is not well enough exposed to allow measurement. Moreover, these Muleros strata appear to be in fault contact with underlying Paleozoic limestone.

## Crazy Cat landslide

The Crazy Cat landslide exposes several fault blocks of Cretaceous strata (Lovejoy, 1976b) (Fig. 3). The section we measured at UTM 358920E, 3517671N (zone 13, datum NAD27) is well exposed and readily correlated (Fig. 2). Strata dip 48° to S80°W and consist of a basal 15 m plus of crossbedded and massive, pale orange and red quartzarenites assigned on a lithologic basis to the Anapra Sandstone. The 10-m-thick yellowish gray shale above the Anapra is identified as the Del Rio Formation based on lithology and stratigraphic position. Pinkish gray limestone, 12.1 m thick, above the Del Rio Formation contains numerous turritellid gastropod steinkerns and is readily assigned to the Buda Limestone. The overlying sandy shale thus can be identified as the basal Boquillas Formation.

Lovejoy (1976b) mapped the Crazy Cat landslide in detail (Fig.

3), and subsequent workers (e.g., LeMone and Simpson, 1981; McAnulty, 1968) have commented on the Cretaceous stratigraphy in this area. Unfortunately, because of recent home construction, much less of the outcrop is currently accessible.

Our measured section at this locality (Fig. 2) documents the presence of a fault block preserving intact an Anapra-Del Rio-Buda-Boquillas section dipping to the west/southwest. Immediately to the southeast, we are not able to document a similar fault block dipping southwest of Lagrima-Muleros-Mesilla Valley-Anapra mapped by Lovejoy (1976b), partly because of recent homes and road construction. Remaining exposures consist of pinkish gray limestone that contains abundant turritellid gastropods, oysters and *Exogyra clarki* Shattuck (see below). These are strata mapped by Lovejoy (1976b) as Lagrima Formation, and we tentatively retain his designation. Similar fossils and lithologies to the north at NMMNH localities 3586 and 3588 support identification of the Lagrima Formation there. At NMMNH locality 3587, a grayish yellow silty shale produces fragments of shells of a very large, relatively smooth *Exogyra*, possibly *E. whitneyi* (Böse). On a lithologic and tentative paleontologic basis, these strata are assigned to the Del Rio Formation. Immediately to the southwest are outcrops of sandstones of Anapra lithology.

Lovejoy (1976b) mapped two small outcrops of calcarenite and conglomerate (marked H in Fig. 3) as Lagrima Formation. However, these strata can be seen to be interbedded with brachiopod-bearing limestones of the Permian Hueco Formation, to which they are assigned.

## BIOSTRATIGRAPHY

The most fossiliferous strata examined are those of the Muleros Formation at the Thunderbird B and Festival Drive sections. Muleros strata at NMMNH locality 3574 contain numerous specimens of the large, uniserial, arenaceous foraminifer *Cribratina texana* (Conrad) (Fig. 4A). These specimens have relatively large, uniserial, coarsely arenaceous, free tests that have a circular cross section and straight sutures. The terminal aperture of some specimens is cribate, and identification as *Cribratina texana* thus is justified (Tappan, 1943; Loeblich and Tappan, 1946; Lucas, 1991).

At the Thunderbird B section, echinoids are common in the Muleros Formation (NMMNH locality 3573). Most specimens belong to the relatively large species *Coenholectypus transpecosensis* (Cragin) (Fig. 4B–C), whereas others are a *Hemiaster* species (Fig. 4D) (cf. Cooke, 1946; Kues and Lucas, 1993).

*Neithea* is a common bivalve in the Muleros Formation at the same outcrop (Fig. 4E–F). Specimens show a wide size range and belong to the evenly and coarsely ribbed *N. texana* (Roemer) (cf. Stanton, 1947, p. 45, pl. 38, figs. 2, 4, 5, pl. 39, figs. 3–5, 7). Specimens of *Lima wacoensis* (Roemer) are also common, and are characterized by their subquadrate to rounded shell with an elongate axis and about 20–24 radiating ribs (cf. Adkins, 1928, p. 132, pl. 18, fig. 4). Specimens here assigned to *Ludbrookia* cf. *L. wenoensis* (Fig. 4H–I) most resemble *L. wenoensis* (Adkins) in having strongly prosogyrate and incurved beaks, angular ribs that are much narrower than the U-shaped interspaces, and strongly arched, flaring nodes (cf. Scott, 1977, p. 1154, pl. 1, figs. 21–23).

The most common fossil found in the Muleros Formation outcrops at Thunderbird B and Festival Drive belong to the gryphaeid genus *Texigryphaea* Stenzel (Fig. 4J–M). Most specimens can be assigned to the small species called *T. pitcheri* (Morton) (cf. Kues, 1989; Kues and Lucas, 1993) (Fig. 4J–M).

Two species of *Exogyra* were collected from the Lagrima Limestone in the Crazy Cat landslide area (see above). The larger is *Exogyra clarki* Shattuck (Fig. 4N), characterized by its numerous, fine, concentric lamellae and fine, radiating sculpture (cf. Böse, 1910, pl. 26, figs. 4, 8–10, 12; Stanton, 1947, p. 34, pl. 23, figs. 1, 4). The smaller *"Exogyra"* is similar to *Ceratostreon texana* (Roemer). The depressed beak and plications are characteristic of this species (cf. Adkins, 1928, p. 114, pl. 2, fig. 1, pl. 15, fig. 5; Stanton, 1947; Kues and Lucas, 1993, fig. 9A-B).

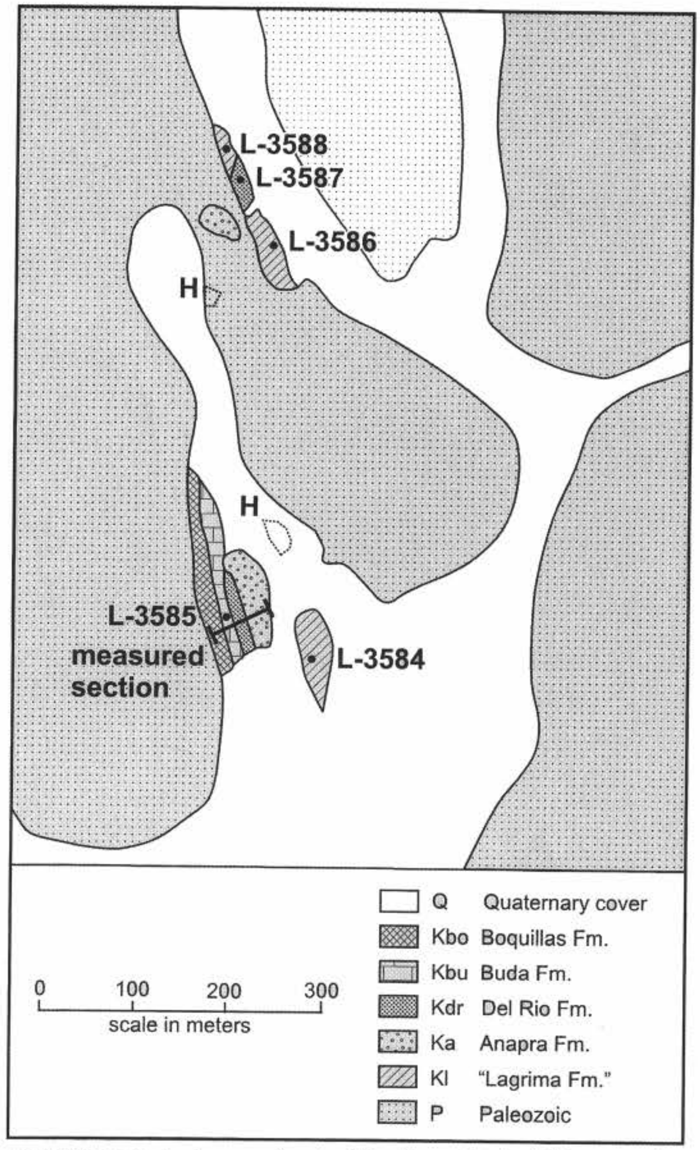


FIGURE 3. Geologic map of part of the Crazy Cat landslide area, where Cretaceous strata are exposed. Modified from Lovejoy (1976b). See text for discussion.

LeMone and Simpson (1981) provided much more extensive lists of the fossil taxa collected from Cretaceous outliers along the western front of the Franklin Mountains than we can verify from our collecting. However, the fossils they list and those we collected support identification of the Muleros, Mesilla Valley(?), Anapra, Del Rio, Buda and Boquillas Formations along the western front of the Franklin Mountains (Fig. 2).

## FRANKLIN MOUNTAINS ISLAND

The Cretaceous outcrops along the western front of the Franklin Mountains are most directly comparable to the Cretaceous section exposed at Cerro de Cristo Rey, about 6 km to the west-southwest (Fig. 5). This comparison indicates that the lower part of the Cretaceous section exposed at Cerro de Cristo Rey (Finlay, Del Norte and Smeltertown Formations) is not present along the west-

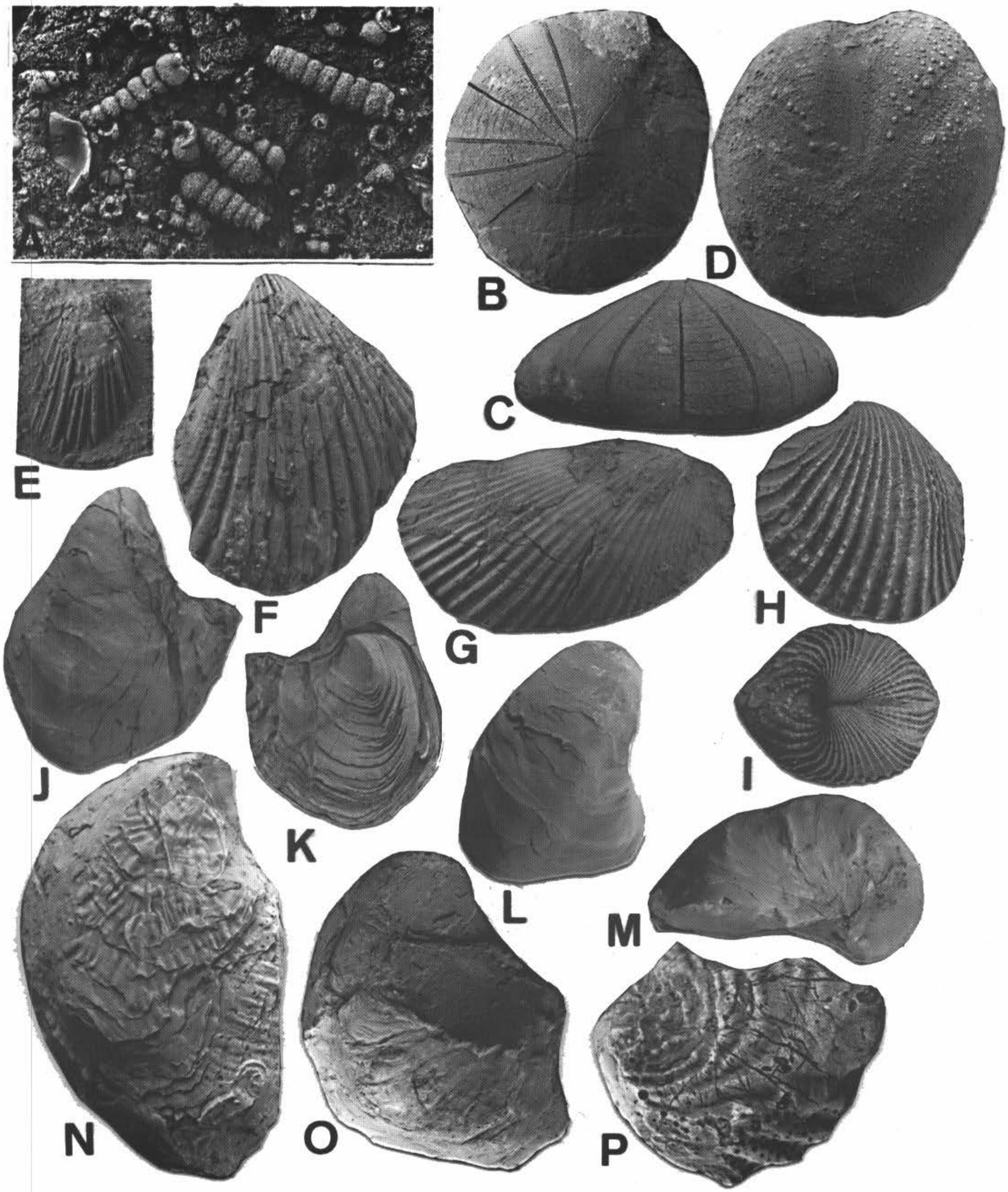


FIGURE 4. Selected Lower Cretaceous fossils. **A**, NMMNH P-27265 from locality 3574, *Cribratina texana* (Conrad), 4x. **B–C**, NMMNH P-27262 from locality 3573, *Coenholectypus transpecosensis* dorsal (B) and side (C) views, 1.4x. **D**, NMMNH P-27260 from locality 3573, *Hemiaster* sp., 4x. **E**, NMMNH P-26980 from locality 3584, *Neithea texana*, 3x. **F**, NMMNH P-27256 from locality 3573, *Neithea texana* (Roemer) right valve, 1.4x. **G**, NMMNH P-27257 from locality 3573, *Lima wacoensis* Roemer, 1.4x. **H–I**, NMMNH P-26969 from locality 3574, *Ludbrookia* cf. *L. wenoensis* (Adkins), 2x. **J–K**, NMMNH P-27254 from locality 3576, *Texigryphaea pitcheri* (Morton), 1x. **L–M**, NMMNH P-27259 from locality 3573, *Texigryphaea pitcheri* (Morton), 2x. **N**, NMMNH P-27264 from locality 3584, *Exogyra clarki* Shattuck 1x. **O–P**, *Ceratostreon texana* (Roemer), (O) NMMNH P-27263 from locality 3554, 1.4x, and (P) NMMNH P-27255 from locality 3576, 1x. Specimens A–M are from the Muleros Formation; specimens N–P are from the "Lagrima Formation."

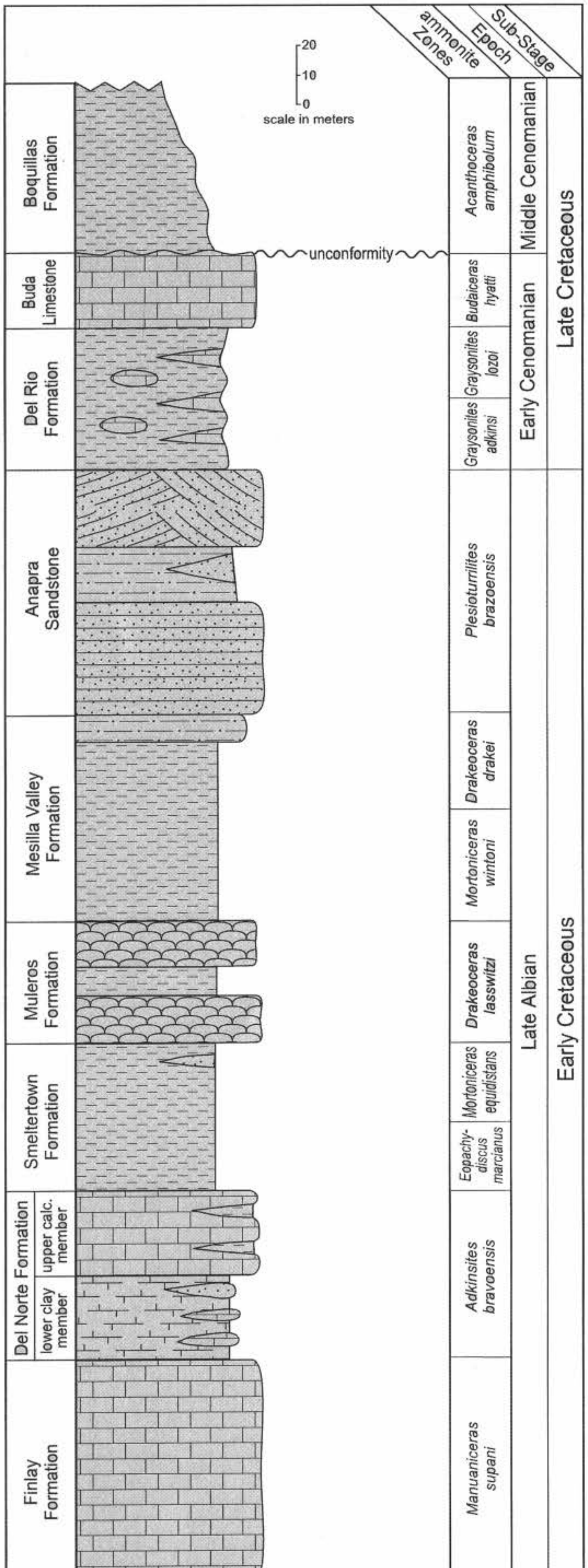


FIGURE 5. Generalized Cretaceous section at Cerro de Cristo Rey, showing ages of units (after Böse, 1910 and Strain, 1976).

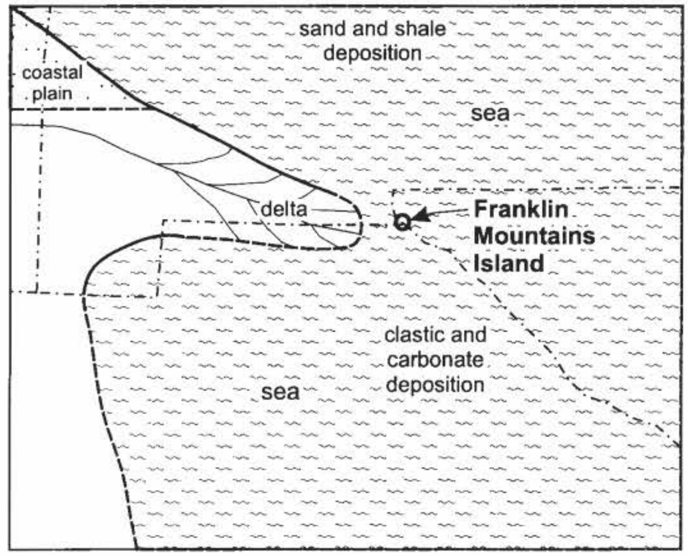


FIGURE 6. Paleogeographic map of southern New Mexico, northern Mexico and west Texas during part of the late Albian (modified from Hayes, 1970) showing location of Franklin Mountains Island.

ern front of the Franklin Mountains. Also, the Cretaceous units exposed along the western front of the Franklin Mountains are much thinner than their equivalents at Cerro de Cristo Rey (cf. Fig. 2 and 5).

One possible explanation of these differences is that the outcrops on the western flank of the Franklin Mountains are fault slices that have been tectonically thinned. It could also be argued it is purely fortuitous that only units equivalent to the upper part of the Cretaceous section at Cerro de Cristo Rey are preserved in the western fault zone of the Franklin Mountains. However, our field observations do not support either of these explanations.

Instead, we suggest that at one location the Muleros Formation is in depositional contact with Paleozoic limestone (Fig. 2). Homoclinally-dipping sections at three locations preserve thin sections of the Muleros-through-Buda interval without any obvious structural disruption (Fig. 2). The data thus support the conclusion that a thin Cretaceous section, missing the Finlay-Smeltertown interval, was deposited along what is now the western fault zone of the Franklin Mountains, as already noted by Corbitt and Hoffer (1992). Apparently, the area of the Franklin Mountains was an emergent depositional high during the time of Finlay-Smeltertown deposition. Subsequently, it was inundated during Muleros-Buda deposition, though the thin deposits of this interval indicate a condensed section, and that the area was still a relative depositional high. The emergent high during part of the late Albian (Fig. 6) here is termed the Franklin Mountains Island, an important local paleogeographic feature of the late Early Cretaceous.

## ACKNOWLEDGMENTS

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## APPENDIX: DESCRIPTIONS OF MEASURED SECTIONS

### Thunderbird A

Measured on south flank of unnamed canyon at UTM 357512E, 3527485N (zone 13, datum NAD27). Strata dip 50° to N80°W.

| Unit | Lithology | Thickness (m) |
|---|---|---|
| **Love Ranch Formation** | | |
| 12 | Boulder conglomerate; clasts are Paleozoic limestone up to 0.3 m in diameter. | 2.0 |
| 11 | Sandstone; pale red (5R6/2) and moderate pink (5R7/4); coarse- to very coarse-grained; arkose; ripple laminated and trough crossbedded; some pebbly lenses. | 7.0 |
| 10 | Conglomerate/conglomeratic sandstone; matrix is pale yellowish brown (10YR6/2) and grayish orange (10YR7/4), coarse to very coarse; lithic sandstones; clasts are mostly cherts up to 1 cm in diameter. | 1.0 |
| 9 | Sandstone; same color and lithology as matrix of unit 10; some chert pebbles; forms a slope. | 2.3 |
| 8 | Conglomerate/conglomeratic sandstone; same colors and lithology as unit 10; clasts are Paleozoic limestones, Buda limestones, and Bliss sandstones up to 30 cm in diameter. | 3.1 |
| 7 | Sandstone; pale red (5R6/2); fine- to medium-grained; arkose; clayey; very calacareous; trough crossbedded and ripple laminated; some pebbly lenses. | 7.1 |
| **unconformity** | | |
| **Buda Limestone** | | |
| 6 | Limestone; pinkish gray (5YR8/1); some bioclastic lenses; nodular. | 0.5 |
| 5 | Sandy shale; moderate yellowish brown (10YR5/4) with calcarenite lenses that are pale yellowish brown (10YR6/2); very calcareous; forms a slope. | 3.4 |
| **Anapra Sandstone** | | |
| 4 | Sandstone; pinkish gray (5YR8/1); very fine-grained; quartzarenite; silty; calcareous; trough crossbedded. | 2.8 |
| 3 | Siltstone; light brownish gray (5YR6/1); not calcareous; trough crossbedded lenses; color mottled purple, red and gray. | 3.0 |
| 2 | Sandstone; very pale orange (10YR8/2); very fine-grained; hematitic quartzarenite; very calcareous; trough crossbedded. | 8.0 |
| **fault** | | |
| **Bliss Sandstone** | | |
| 1 | Sandstone; pale red (10R6/2); very fine- to fine-grained; wacke; slightly calcareous; trough crossbedded. | not measured |

### Thunderbird B

| Unit | Lithology | Thickness (m) |
|---|---|---|
| **Anapra Sandstone** | | |
| 17 | Silty sandstone; same colors and lithology as unit 15. | 2.2 |
| 16 | Sandstone; same colors and lithology as unit 14. | 2.7 |
| 15 | Silty sandstone; grayish red (5R4/2) and brownish black (5YR2/1); coarse-grained; hematitic quartzarenite; massive. | 1.7 |
| 14 | Sandstone; grayish orange pink (5YR7/2); very fine grained; hematitic quartzarenite; trough crossbedded; calcareous. | 3.1 |
| **Mesilla Valley Shale** | | |
| 13 | Shale; pale yellowish brown (10YR6/2); calcareous; slightly sandy; thin calcarenite lenses; slope. | 3.7 |
| **Muleros Formation** | | |
| 12 | Packstones and calcarenites; grayish orange (10YR7/4); packstones are nodular and mostly composed of *Texigryphaea* shells. | 6.0 |
| 11 | Calcarenite; grayish orange (10YR7/4); extensive bioturbation and some shell debris. | 1.5 |
| 10 | Nodular limestone / calcarenite; grayish orange (10YR7/4); ledge forming. | 2.6 |
| 9 | Limestone; medium gray (N5); micritic; some chert nodules; ledge. | 1.3 |
| 8 | Calcarenite; pale yellowish brown (10YR6/2); laminated; slope. | 5.3 |
| 7 | Limestone; light gray (N7); micrite; ledge. | 0.2 |
| 6 | Calcarenite; grayish orange (10YR7/4); laminated; some lenses of pale yellowish brown (10YR6/2) limestone. | 4.3 |
| 5 | Limestone; same color and lithology as unit 3. | 1.7 |
| 4 | Limestone breccia; same color and lithology as unit 2. | 1.3 |
| 3 | Limestone; pale yellowish brown (10YR6/2); lenticular; some bivalve shell debris. | 0.8 |
| 2 | Limestone breccia; light gray (N7). | 1.7 |
| **unconformity (fault?)** | | |
| **Paleozoic** | | |
| 1 | Limestone; medium dark gray (N4); micrite. | not measured |

## Festival Drive

Strata dip 28° to S10°W.

| Unit | Lithology | Thickness (m) |
|---|---|---|
| **Anapra Sandstone** | | |
| 7 | Sandstone; sandy siltstone; same color and lithology as unit 6, but massive and a bench former. | 0.7 |
| 6 | Sandstone, sandy siltstone; pale brown (5YR5/2) to light gray (N7); mottled moderate reddish brown (10R4/6) and dark yellowish orange (10YR6/6); ripple laminated and flaggy; calcareous. | 4.1 |
| 5 | Sandy shale; brownish gray (5YR4/1); some sandstone lenses; not calcareous. | 3.0 |
| 4 | Sandstone; grayish pink (5R8/2) with pale reddish brown (10R5/4) hematitic specks; very fine-grained; quartzarenite; clayey; ripple laminated, some trough crossbeds; forms a cuesta. | 1.6 |
| 3 | Covered. | 3.0 |
| 2 | Sandstone; pinkish gray (5YR8/1) with moderate reddish orange (10R6/6) hematitic stains; quartzose; calcareous; trough crossbedded. | 1.2 |
| 1 | Conglomeratic sandstone; sandstone is grayish orange pink (10R8/2), except hematitic portions, which are light brown (5YR5/6), coarse-grained, calcareous, hematitic quartzarenites; clasts are pink and yellow limestone and mudstone up to 1.5 cm in diameter; clast supported; trough crossbedded. | 2.3 |

## Crazy Cat

Strata dip 48° to S80°W.

| Unit | Lithology | Thickness (m) |
|---|---|---|
| **Boquillas Formation** | | |
| 7 | Sandy shale; moderate yellowish brown (10YR5/4); very calcareous; mostly covered. | not measured |
| **Buda Limestone** | | |
| 6 | Limestone; pinkish gray (5YR8/1); shelly micrite and packstone; forms a prominent white bench. | 12.1 |
| **Del Rio Formation** | | |
| 5 | Shale; yellowish gray; some thin nodular limestone beds; slope. | 9.8 |
| **Anapra Sandstone** | | |
| 4 | Sandy siltstone; same colors and lithology as unit 2. | 4.5 |
| 3 | Sandstone; very pale orange (10YR8/2); hematitic portions are moderate brown (5YR4/4); fine- to medium-grained; hematitic quartzarenite; slightly calcareous; trough crossbedded; some ripple laminates; forms a ledge. | 5.8 |
| 2 | Sandy siltstone; pale red (10R6/2); mottled moderate reddish brown (10R4/6); slope. | 3.3 |
| 1 | Sandstone; very pale orange (10YR8/2) and grayish orange (10YR7/4); silty; very fine-grained; litharenite; calcareous; trough crossbedded; ledge. | 1.6+ |

View of the west-facing scarp of the Caballo Mountains near Longbottom Canyon. Exposed on the cliff face are the Bliss (Upper Cambrian–Lower Ordovician), El Paso (Lower Ordovician), Montoya (Upper Ordovician), Red House (Pennsylvanian), and Nakaye (Pennsylvanian) Formations. Slope in foreground is underlain by Precambrian metamorphic and granitic rocks. Photograph by Greg Mack.