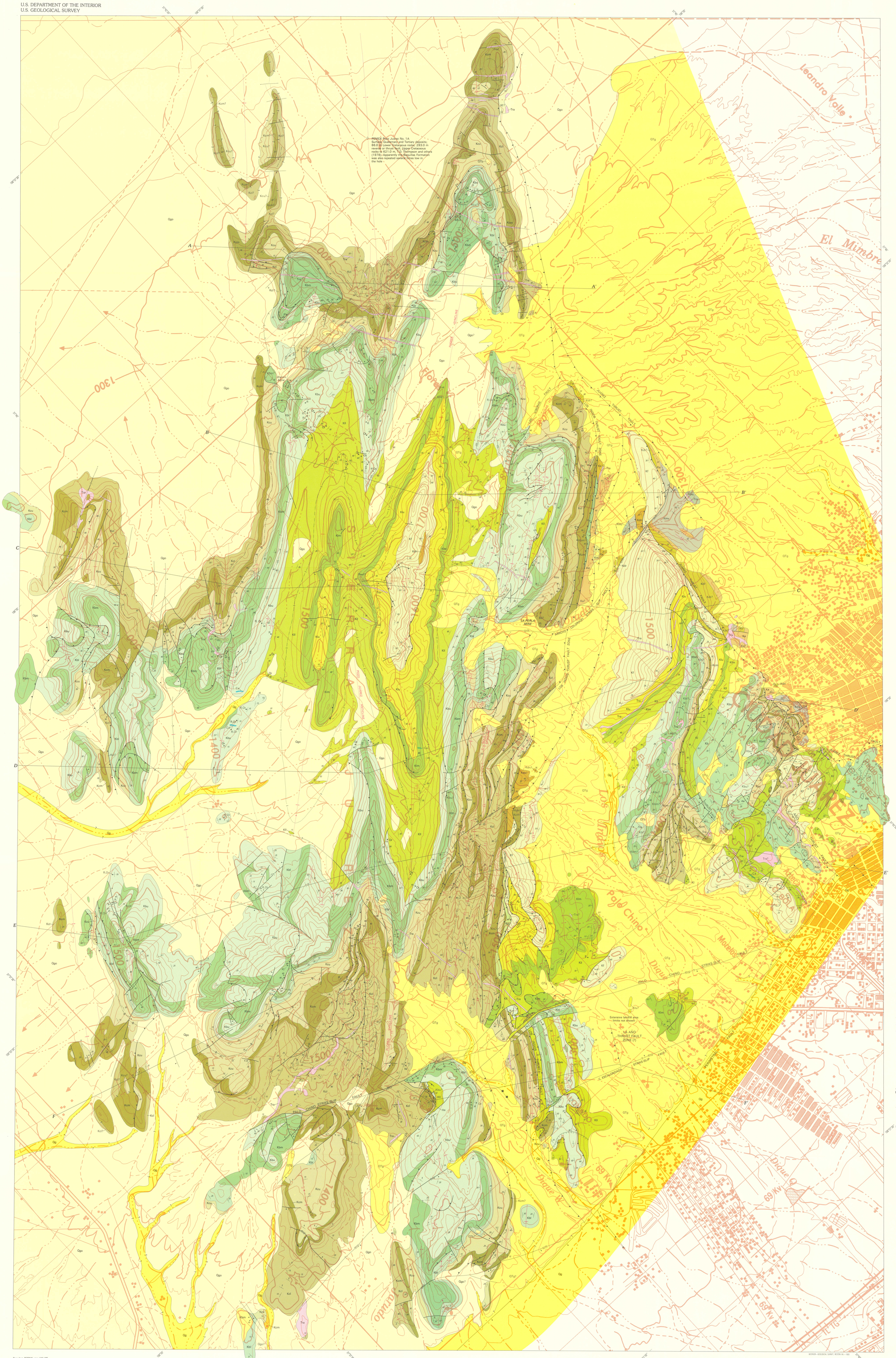
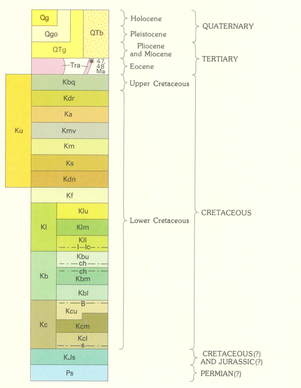


CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[Thicknesses throughout this description are chiefly from Nodeland (1977), *in* Lovejoy (1980), in which some unspecified changes were made of Nodeland's work by Lovejoy, probably after Lovejoy (1976)]

Qg — **Gravel and sand (Holocene)**—Youngest alluvium, along watercourses and on low terraces; grades upslope into unmapped colluvium

Qgo — **Gravel, sand, and silt (Holocene and Pleistocene)**—Older alluvium, on high terraces, alluvial aprons, and pediments. Includes some younger deposits along closely spaced watercourses too small to map

QTg — **Gravel and conglomerate (Holocene to Miocene)**—Oldest alluvium, filling intermontane basins and extending up some larger arroyos. Clasts commonly range in size from pebbles to boulders, but unit also has lentils of sand and silt. Conglomerate weakly indurated, probably with carbonate cement. Locally includes older alluvium (**Qgo**), which caps the formation, and younger alluvium (**Qg**), which occurs along widely spaced watercourses. Largely correlative with the Fort Hancock Formation (Nodeland, 1977). Includes older deposits in the basins (Lovejoy, 1980, p. 28)

QTb — **Block deposits (Holocene to Miocene)**—Landslide, slump, and debris flow detritus related to existing topography. Mostly coarse blocks, of local provenance; locally grading into talus

Tra — **Rhyolite to andesite (Eocene)**—Aphanitic to porphyritic dikes of pale-reddish-gray to medium-gray rock that may contain large crystals of feldspar, biotite, hornblende, and quartz, in various assemblages and in small amounts. Probably the more common occurrence of small intrusive pods in the Cerro (C.) La Cruz area on the northeast flank of the Sierra Juárez than elsewhere reflects the style of mapping in colluvium-covered areas that was used by Nodeland (1977), rather than a real change in intrusive habit. From field observations, only sparsely supported by petrographic study, rhyodacite and rhyolite appear to be more common to the northwest and dacite or andesite to the southwest. One andesite or rhyodacite body along the foot of the sierra, 1.4 km north of C. La Cruz, contains xenoliths of diorite or diabase. A rhyodacite dike 1.5 km east of the Pozo Juárez No. 1A drill site was radiometrically dated by the K-Ar method on amphibole and biotite, at 47.8±2.2 and 48.2±1.7 Ma, respectively (R.F. Marvin, H.H. Mehnert, and E.L. Brandt, written commun., 1985)

UPPER SEDIMENTARY SEQUENCE

Ku — **Sedimentary rocks, undivided (Cretaceous)**—Principally shale that is sparsely exposed in the Sierra Juárez but probably abundant in the subsurface. Shown only in structure sections

Kbq — **Boquillas Formation (Upper Cretaceous)**—Olive-gray to dark-gray, sparsely fossiliferous, platy, calcareous shale with interbedded very pale orange to pinkish-gray, thinly bedded, calcareous siltstone. The formation was provisionally identified along the lower part of Arroyo (A.) Colorado by W.C. Cornell (oral commun., 1984), and was identified at three horizons in a faulted sequence penetrated by the Pozo Juárez No. 1A drill hole. Ammonites from nearby and close to the base of the formation establish its Late Cretaceous (Cenomanian and Turonian) age (Cobban, 1988a, b). Nearby, the formation is 10–256 m thick

The Buda Formation, which typically underlies the Boquillas, has not been recognized in the Sierra Juárez but occurs in the C. Cristo Rey area and possibly underlies the gravel northeast of the mountains

Kdr — **Del Rio Formation (Lower Cretaceous)**—Yellowish-brown, flaky calcareous shale and interbedded nodular limestone that contains *Exogyra whitneyi* and a fragment of an unidentified ammonite. The formation was provisionally identified by W.C. Cornell (oral commun., 1984). Nearby, it is 24–30 m thick

Ka — **Anapra Sandstone (Lower Cretaceous)**—Pinkish-gray and very pale orange to reddish-brown, well-sorted, fine-grained, crossbedded, quartz sandstone and two interbedded units of bluish-gray siliceous siltstone and coaly shale. Nearby, formation is 67 m thick

Kmv — **Mesilla Valley Formation (Lower Cretaceous)**—Comprises a lower unit of carbonaceous black shale and an upper unit of light-brownish-gray siltstone, thin-bedded fossiliferous limestone, and ferruginous sandstone. Some beds are a pelecypod (*Trigonia* sp.) packstone. *Cribratina texana* is also diagnostic. Nearby, it is 42–55 m thick

Km — **Muleros Formation (Lower Cretaceous)**—Comprises a lower unit of nodular-bedded argillaceous limestone, a middle unit of olive-gray shale, and an upper unit of interbedded shale and thin-bedded limestone. Limestone contains abundant *Texigryphaea* sp. The formation was provisionally identified along lower part of A. Colorado by W.C. Cornell (oral commun., 1984). Nearby, it is 21–38 m thick

Ks — **Smeltertown Formation (Lower Cretaceous)**—Medium- to dark-gray to light-olive-gray shale, silty calcareous shale, nodular limestone, and some ferruginous sandstone near the top. Fossils include *Texigryphaea* sps., *Pecten* sp., *Ostrea* sp., and ammonites. Nearby, the formation is 44–140 m thick

Kdn — **Del Norte Formation (Lower Cretaceous)**—Comprises a lower calcareous shale and interbedded fine-grained sandstone and nodular limestone unit, and an upper medium-gray limestone and brown shale unit. Fossils include *Turritella* sp., *Texigryphaea* sp., *Exogyra* sp., *Pecten* sp., *Ostrea* sp., *Pholadomya* sp., ammonites, echinoids, and corals. Nearby, the formation is 15–27 m thick

LOWER SEDIMENTARY SEQUENCE

Kf — **Finlay Limestone (Lower Cretaceous)**—Light-gray to medium-bluish-gray, thick- and medium-bedded, cliff-forming rudistid reef limestone. Some beds are micritic; others are bioclastic or abundantly fossiliferous. Fossils include *Gryphaea* sp., *Toucasia* sp., *Dictyoconus* sp., *Haplostichy texana*, and corals. It is 130–186 m thick

• D **Key fossil site**—*Dictyoconus* sp. foraminifera

Kl — **Lagrima Formation, undivided (Lower Cretaceous)**— Dominantly yellowish-brown to light-gray shale containing subordinate light-gray, thin-bedded and some medium-bedded limestone 440–500 m thick but only 208–239 m thick nearby. Contacts of formation and of members within the formation are gradational

Klu — **Upper member**—Olive-gray to pale-yellowish-brown shale, marlstone, and thin-bedded micritic limestone containing abundant small pelecypods, algal or seaweed marks, and burrow marks. Fossils include *Gryphaea mucronata* and *Sperula* sp. (Nodeland, 1977). About 95–150 m thick

Klm — **Middle member**—Light-gray to light-brownish-gray, medium- to thick-bedded, micritic to biostromal limestone underlying a small cliff. Contains small pelecypods and corals. About 50–95 m thick here but only 20 m nearby

Kll — **Lower member**—Largely light-gray to pale-yellowish-brown, calcareous shale and some light-gray, thin-bedded limestone containing *Orbitolina* sp., *Trigonia* sp., echinoids, pelecypods, and gastropods (Nodeland, 1977). About 120–360 m thick

—|• · ·|e— **Marker horizon**—l, base of limestone unit; le, locally limestone has a limestone-conglomerate facies

• Or **Key fossil site**—*Orbitolina* sp. foraminifera

• E **Key fossil site**—Echinoid

Kb — **Benigno Limestone, undivided (Lower Cretaceous)**—Dominantly light-gray limestone having some marly or shaly beds above and a bold cliff-forming reefal limestone below. The formation is characterized by its uniform light-gray color, which is consistently different from the browner gray of the adjacent formations. The base of the formation was mapped within the shale and thin-bedded limestone rather than at the base of the cliff, which is the older tradition. Only in the C. La Cruz area was it necessary to follow the older tradition in compilation. The reported thickness of the Benigno Limestone, of 206 m, is thus a minimum; it may be 250–300 m thick

Kbu — **Upper member**—Thin- to medium-bedded limestone and interbedded marlstone or calcareous shale. Many beds are micritic; some are packstones of *Orbitolina* sp., or rudistid beds. Fossils also include *Pecten* sp., *Toucasia* sp., *Trigonia* sp., *Lunatia* sp., and *Hemiaster* sp. (Nodeland, 1977). About 50–95 m thick and possibly thicker where basal contact drops at site of thinning of underlying reef

— · ·ch· · — **Marker horizon**—Cherty limestone unit a few meters thick. Chert occurs as dark-gray to brownish-gray, small irregular to lenticular nodules mostly in a single bed but rarely in two or three beds

• Or **Key fossil site**—*Orbitolina* sp. foraminifera

• R **Key fossil site**—Rudistid reef-making pelecypod

Kbm — **Middle member**—Thick-bedded to massive reefal limestone underlying the most prominent cliff in the sierra. Reef made up of caprinid, rudistid, and algal material. Thickness commonly 50–120 m but locally thins to 10 m, apparently between reef banks

— · ·ch· · — **Marker horizon**—Base of cherty limestone, as in upper member. Where a single such marker bed is shown, its variable appearance either just below or just above the contact between middle and upper members of the Benigno (as based on bedding thickness) suggests that that contact is slightly time transgressive

• Or **Key fossil site**—*Orbitolina* sp. foraminifera

• R **Key fossil site**—Rudistid pelecypod

Kbl — **Lower member**—Light-gray, thin-bedded limestone like that of the upper member except that the *Orbitolina* sp. are sparse rather than in packstone beds, and chert is absent. About 40–90 m thick

• Or **Key Fossil Site**—*Orbitolina* sp. foraminifera

Kc — **Cuchillo Formation, undivided (Lower Cretaceous)**—Brown to brownish-gray limestone, sandstone, siltstone, and shale, and a small amount of conglomerate, the thickest beds of limestone and calcareous sandstone forming a medial cliff-making unit. Shown only in structure section *F–F'*. May be about 500 m thick

Kcu — **Upper member**—Thin-bedded siltstone, sandstone, shale, and limestone, mostly reddish brown to yellowish brown, and some gray to olive-gray shale and marlstone. A few oolitic beds and, low in the member, some conglomerate beds are present. To the southeast a brown sandstone unit forms the bottom of the member. It is 45–110 m thick, typically thickening where the underlying member thins

— · ·B· · — **Marker horizon**—Top of brown sandstone unit

Kcm — **Middle member**—Brownish-gray, thick-bedded, reefal limestone and some sandy limestone generally forming a major cliff but locally underlying a less prominent cliff apparently without reefal structure. Fossils include coral heads, razor clams, *Orbitolina* sp., as well as some *Isastrea whitneyi*, *Stefanocoenia* sp., *Astrocoenia* sp., *Monastrea* sp., and *Diploastrea* sp. (Nodeland, 1977). It is 35–80 m thick in the area but may be only 8–21 m thick nearby

• P **Key fossil site**—Pelecypod, commonly razor clams or oysters

Kcl — **Lower member**—Interbedded brownish-gray limestone, yellowish-brown calcareous quartz sandstone, and olive-gray, greenish-gray, or pale-reddish-brown shale, siltstone, and marlstone, with a few chert-pebble conglomerate and grit beds near the top of the unit. Some limestone beds are oolitic, others are *Exogyra quitmanensis* packstones. Bedding mostly thin and induration moderate, but locally some beds are medium to thick bedded and strongly indurated so that they weather out as bold features. Thickness at least 280 m and may be more than 340 m, with the base unexposed. In the Dique Wash (W) area to the southeast and in an area 1–2 km south of the Pozo Juárez No. 1A well, where the lowest part of the member is exposed, a *drowning* increase in interbedded limestone and sandstone may mark the presence of the Las Vigas Formation. The Las Vigas is possibly recognized but requires acceptance of facies changes from nearby sites in the Sierra Samalayuca, to the southeast, where it contains more limestone

— · ·s· · — **Marker horizon**—Base of a thin unit of calcareous sandstone that underlies a small cliff

• W **Key fossil site**—Silicified wood

KJs — **Sedimentary rocks (Lower Cretaceous? and Jurassic?)**—Probably mainly clastic and carbonate rocks, possibly including some gypsum and anhydrite. Shown only in southern structure sections nearest a small range in which such rocks are exposed. Stratigraphic position beneath the top of the Cuchillo Formation and thickness are assumed

Ps — **Sedimentary rocks (Permian?)**—Probably clastic rocks, limestone, and dolomite. Shown only in structure sections. Their presence and thickness inferred from the East Potrillo Mountains to the northwest

Contact—Dotted where concealed; queried where inferred

Marker horizon or bed—Undesignated contact or unit typically in a sequence consisting of repeated rock types. In a clastic sequence the marker commonly is a sandstone or conglomerate bed; in a carbonate sequence it commonly is the base of a thicker bed among thinner ones

Fault—Showing dip (full arrow) and plunge of lineation (half arrow). Dotted where concealed or intruded; dip values preceded by three dots indicate dip values obtained by the three-point method rather than at an outcrop

Normal or reverse fault—Ball and bar on downthrown side; showing vertical dip

Thrust fault—Sawteeth on upper plate

Thrust fault or low-angle normal fault—Younger rocks are found over older ones, under conditions explained in section on Geologic Notes

Strike-slip fault—Arrow couple shows relative movement. (This symbol used for all faults in structure section.) Double-headed arrow indicates probable reversal of movement in a late stage. In structure section, A, movement from viewer; T, movement toward reviewer

Other fault—Faults having oblique or uncertain movement, showing relative movement; ball and bar on downthrown side

Fold—Showing axis, direction and amount of plunge of axis, and dip of axial plane. Where no plunge value is shown, amount of plunge is unknown. Dotted where concealed

Anticline

Overturned anticline

Syncline

Overturned syncline

Monocline

Anticline and syncline having faulted axial plane—Dotted where concealed

Strike and dip of beds—Queried where estimated

Horizontal

Inclined

Inclined—Indicating tops of beds determined from sedimentary structures

Vertical

Overturned

Strike and dip of cleavage

Cu, Ba, Ba?, He — **Prospect not shown on topographic base, indicating minerals**—Cu, copper minerals; Ba, barite; Ba?, possible barite; He, specular hematite (secondary iron minerals not noted)

Prospect without observed minerals

Quarry

47.8 — **Radiometrically dated rock, and approximate age in Ma (million years)**

Drill hole—Dry well

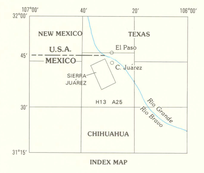
R,E,Or, W,D,P — **Key fossil sites**—Letters indicate fossil, as explained in description of map units

House

Ruin

Ca_{CO_3} — **Calcite veins**

Spring



INDEX MAP

CONVERSION FACTORS

Multiply	By	To obtain
centimeters (cm)	0.3937	inches (in)
meters (m)	3.281	feet (ft)
kilometers (km)	0.6214	miles (mi)

Base from DETENAL map H13 A25, Ciudad Juárez, scale 1:50,000, 1978

APPROXIMATE MEAN DECLINATION, 1993

SCALE APPROXIMATELY 1:12 500

CONTOUR INTERVAL 20 METERS

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1993

Geology by J.R. Dyer, 1984–1987, and Harald Drewes, 1984–1988 (for a total of about 70 man-days); assisted by M.L. Brown, Robert Guthrie, and J.W. Handschy; spur near C. Las Cruz compiled, with minor modification, from Nodeland (1977)

Color design by Virginia D. Scott
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Cartography by Steven Federowicz

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GEOLOGIC MAP AND STRUCTURE SECTIONS OF THE SIERRA JUÁREZ, CHIHUAHUA, MEXICO

By
Harald Drewes[1] and Russ Dyer[2]
1993

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[2] Formerly at University of Texas El Paso; currently of U.S. Department of Energy

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