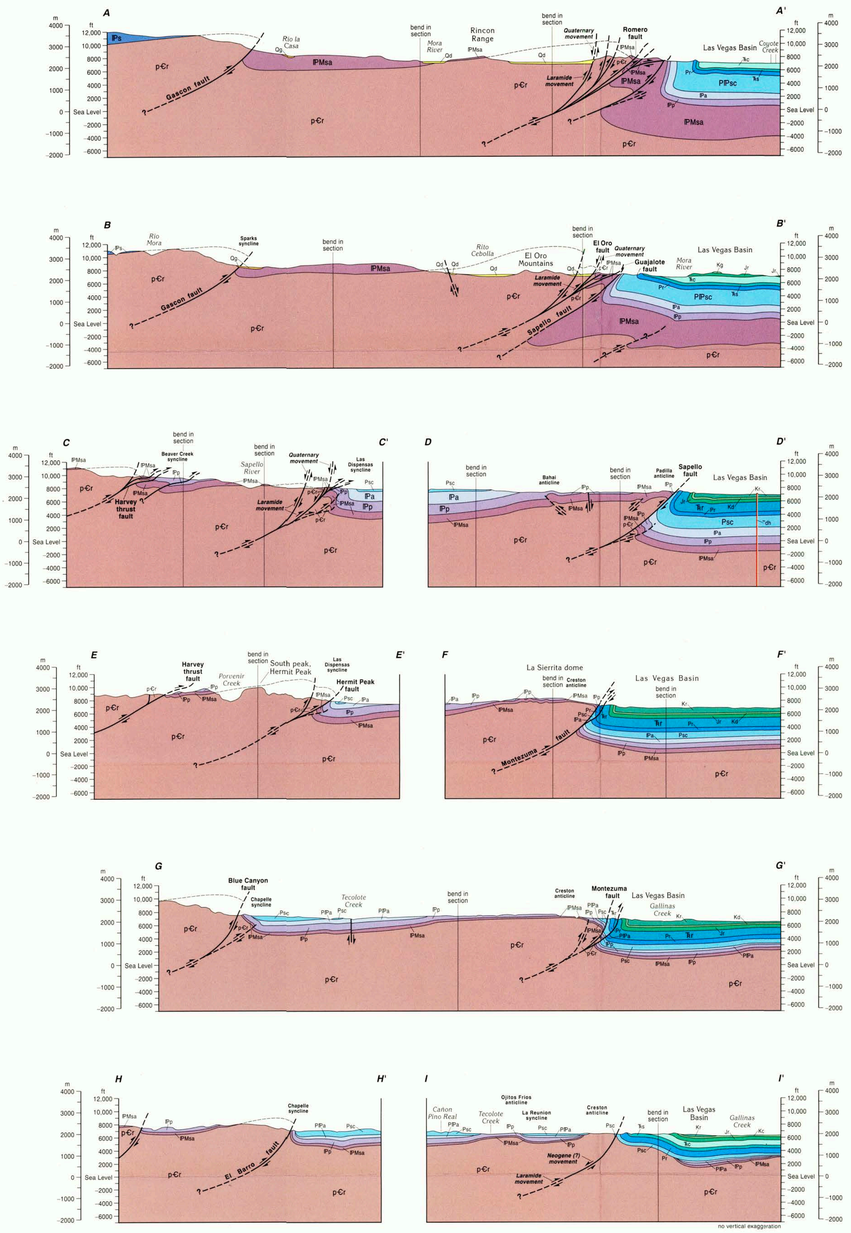
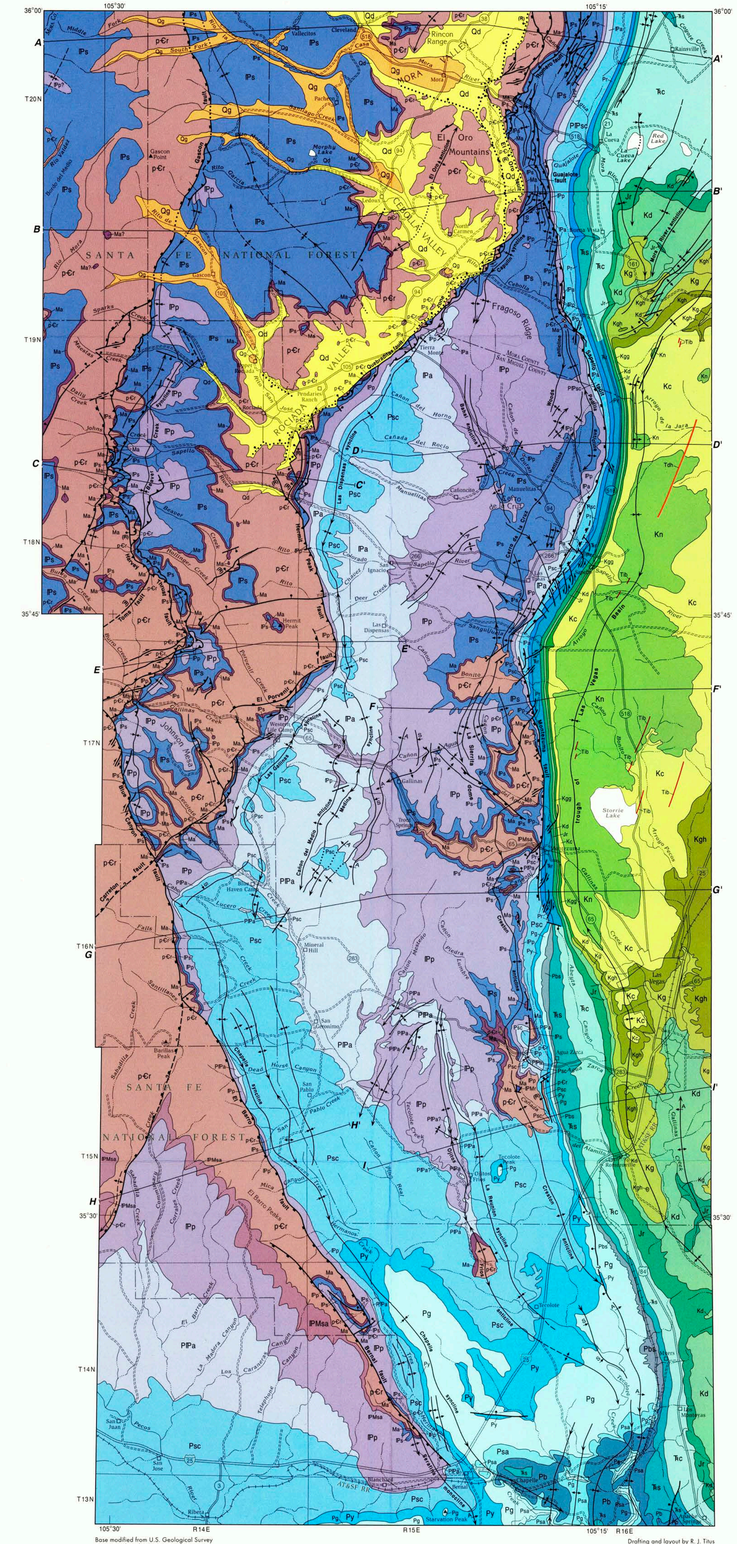




Map of bedrock geology and cross sections of southeastern Sangre de Cristo Mountains and western part of Las Vegas Basin

by Elmer H. Baltz, 1999

Lakewood, Colorado 80226

Scale 1:125,000

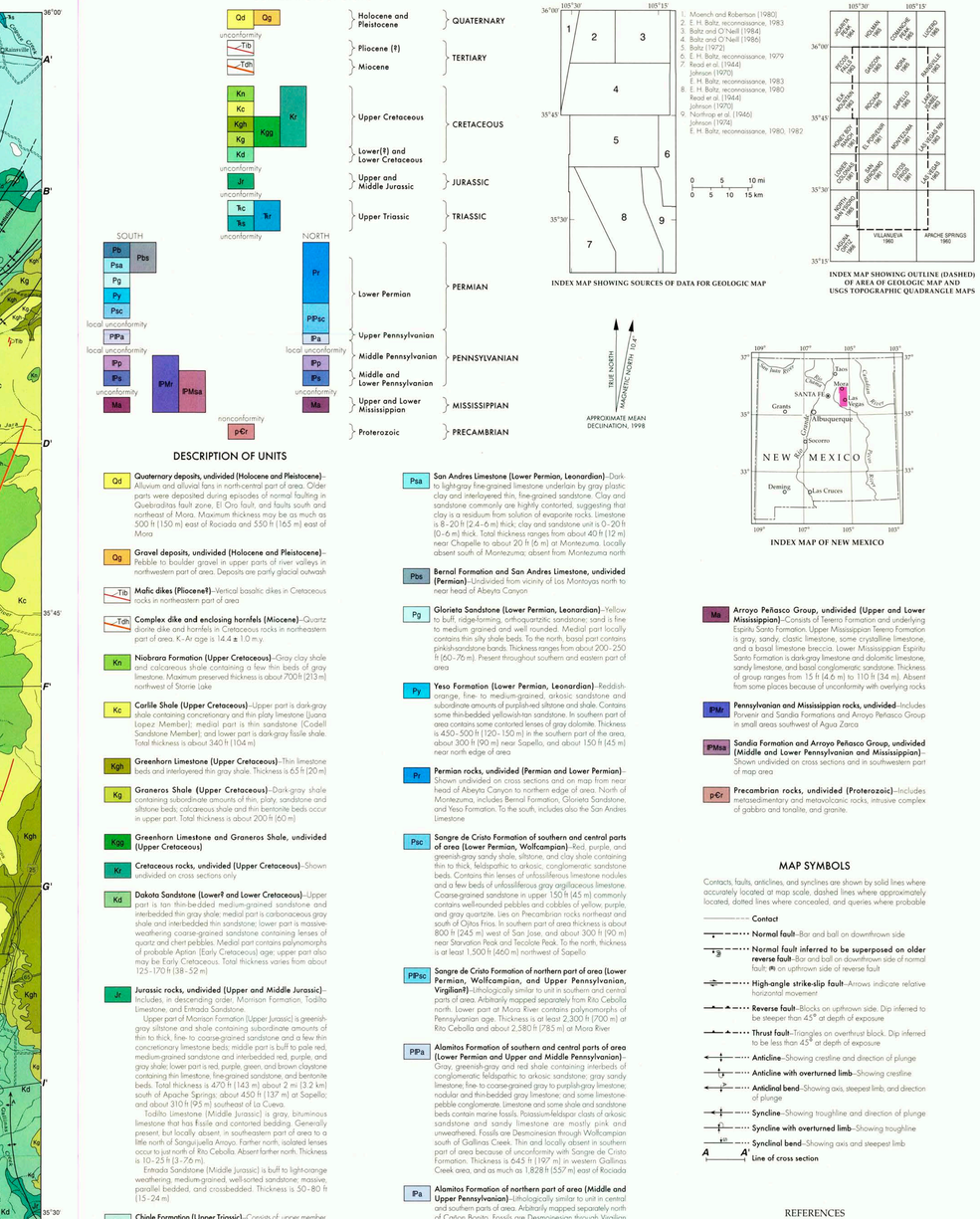
5 4 3 2 1 0 5 MILES

5 4 3 2 1 0 5 KILOMETERS

Base modified from U.S. Geological Survey Santa Fe 1° x 2° quadrangle, 1954, scale 1:250,000

Drafting and layout by R. J. Titus
Edited by N. S. Gilson

CORRELATION OF UNITS



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   Johnson (1974)
   E. H. Baltz, reconnaissance, 1980; 1982

INDEX MAP SHOWING SOURCES OF DATA FOR GEOLOGIC MAP

APPROXIMATE MEAN DECLINATION, 1998

INDEX MAP SHOWING OUTLINE (DASHED) OF AREA OF GEOLOGIC MAP AND USGS TOPOGRAPHIC QUADRANGLE MAPS

INDEX MAP OF NEW MEXICO

DESCRIPTION OF UNITS

Qd **Quaternary deposits, undivided (Holocene and Pleistocene)**—Alluvium and alluvial fans in north-central part of area. Older parts were deposited during episodes of normal faulting in Quebradillas fault zone, El Oro fault, and faults south and northeast of Mora. Maximum thickness may be as much as 500 ft (150 m) east of Rociada and 550 ft (165 m) east of Mora

Qg **Gravel deposits, undivided (Holocene and Pleistocene)**—Pebble to boulder gravel in upper parts of river valleys in northwestern part of area. Deposits are partly glacial outwash

Tih **Mafic dikes (Pliocene?)**—Vertical basaltic dikes in Cretaceous rocks in northeastern part of area

Tch **Complex dike and enclosing hornfels (Miocene)**—Quartz diorite dike and hornfels in Cretaceous rocks in northeastern part of area. K–Ar age is 14.4 ± 1.0 m.y.

Kn **Niobrara Formation (Upper Cretaceous)**—Gray clay shale and calcareous shale containing a few thin beds of gray limestone. Maximum preserved thickness is about 700 ft (213 m) northwest of Storrie Lake

Kc **Carlile Shale (Upper Cretaceous)**—Upper part is dark-gray shale containing concretionary and thin platy limestone (Juana Lopez Member); medial part is thin sandstone (Codell Sandstone Member); and lower part is dark-gray fissile shale. Total thickness is about 340 ft (104 m)

Kgh **Greenhorn Limestone (Upper Cretaceous)**—Thin limestone beds and interlayered thin gray shale. Thickness is 65 ft (20 m)

Kg **Graneros Shale (Upper Cretaceous)**—Dark-gray shale containing subordinate amounts of thin, platy, sandstone and siltstone beds; calcareous shale and thin bentonite beds occur in upper part. Total thickness is about 200 ft (60 m)

Kgg **Greenhorn Limestone and Graneros Shale, undivided (Upper Cretaceous)**

Kr **Cretaceous rocks, undivided (Upper Cretaceous)**—Shown undivided on cross sections only

Kd **Dakota Sandstone (Lower? and Lower Cretaceous)**—Upper part is tan thin-bedded medium-grained sandstone and interbedded thin gray shale; medial part is carbonaceous gray shale and interbedded thin sandstone; lower part is massive-weathering coarse-grained sandstone containing lenses of quartz and chert pebbles. Medial part contains palynomorphs of probable Aptian (Early Cretaceous) age; upper part also may be Early Cretaceous. Total thickness varies from about 125–170 ft (38–52 m)

Jr **Jurassic rocks, undivided (Upper and Middle Jurassic)**—Includes, in descending order: Morrison Formation, Todilto limestone, and Entrada Sandstone.

Upper part of Morrison Formation (Upper Jurassic) is greenish-gray siltstone and shale containing subordinate amounts of thin to thick, fine- to coarse-grained sandstone and a few thin concretionary limestone beds; middle part is buff to pale red, medium-grained sandstone and interbedded red, purple, and gray shale; lower part is red, purple, green, and brown claystone containing thin limestone, fine-grained sandstone, and bentonite beds. Total thickness is 470 ft (143 m) about 2 mi (3.2 km) south of Apache Springs; about 450 ft (137 m) at Sapello; and about 310 ft (95 m) southeast of La Cueva.

Todilto Limestone (Middle Jurassic) is gray, bituminous limestone that has fissile and contorted bedding. Generally present, but locally absent, in southeastern part of area to a little north of Sangrijuella Arroyo. Farther north, isolated lenses occur to just north of Rito Cebolla. Absent farther north. Thickness is 10–32 ft (3–7.6 m).

Entrada Sandstone (Middle Jurassic) is buff to light-orange weathering, medium-grained, well-sorted sandstone; massive, parallel bedded, and crossbedded. Thickness is 30–80 ft (15–24 m)

Trc **Chinle Formation (Upper Triassic)**—Consists of: upper member, composed of red shale containing subordinate amounts of thin, fine-grained sandstone and a few thin lenses of limestone and limestone pebbles; middle member, composed of red shale and interbedded buff to red, fine- to coarse-grained sandstone that locally contains limestone pebbles; and lower member, composed of red shale containing subordinate amounts of thin sandstone and a few lenses of concretionary limestone. Total thickness is about 800 ft (245 m) at the south, and about 1,100 ft (335 m) at the north

Trs **Santa Rosa Sandstone (Upper Triassic)**—Brown, gray, and red, ledge-forming, thick, fine- to coarse-grained sandstone units, interbedded with thin to thick, red, purple, and greenish-gray shale. Basal sandstone commonly contains quartz and chert pebbles; limestone- and chert-pebble conglomerate occurs in upper third. Total thickness is about 450 ft (135 m) at the south, and about 300 ft (90 m) at Mora River

Trr **Triassic rocks, undivided (Upper Triassic)**—Chinle Formation and Santa Rosa Sandstone, undivided, between head of Abeyta Canyon and Rito Cebolla

Pb **Bernal Formation (Permian)**—Orange-red to purplish-red, fine- to medium-grained sandstone and siltstone and subordinate interbedded red to purplish shale. In the southern part of the area a bed of chalky-white gypsum occurs in the lower part. Locally, in the southern part of the area, the basal part of the formation grades downward into a solution breccia of commingled blocks of red siltstone and shale of the Bernal and limestone of the underlying San Andres Limestone. Thickness is 145–200 ft (44–61 m) near Bernal and Myers, and 80–150 ft (25–45 m) in the northern part of the area. Present throughout southern and eastern parts of area

Psa **San Andres Limestone (Lower Permian, Leonardian)**—Dark- to light-gray fine-grained limestone underlain by gray plastic clay and interlayered thin, fine-grained sandstone. Clay and sandstone commonly are highly contorted, suggesting that clay is a residuum from solution of evaporite rocks. Limestone is 8–20 ft (2.4–6 m) thick; clay and sandstone unit is 0–20 ft (0–6 m) thick. Total thickness ranges from about 40 ft (12 m) near Chapelle to about 20 ft (6 m) at Montezuma. Locally absent south of Montezuma; absent from Montezuma north

Pbs **Bernal Formation and San Andres Limestone, undivided (Permian)**—Undivided from vicinity of Los Montoyas north to near head of Abeyta Canyon

Pg **Glorieta Sandstone (Lower Permian, Leonardian)**—Yellow to buff, ridge-forming, orthoquartzitic sandstone; sand is fine to medium grained and well rounded. Medial part locally contains thin silty shale beds. To the north, basal part contains pinkish-sandstone bands. Thickness ranges from about 200–250 ft (60–70 m). Present throughout southern and eastern part of area

Py **Yeso Formation (Lower Permian, Leonardian)**—Reddish-orange, fine- to medium-grained, arkosic sandstone and subordinate amounts of purplish-red siltstone and shale. Contains some thin-bedded yellowish-tan sandstone. In southern part of area contains some contorted lenses of gray dolomite. Thickness is 450–500 ft (120–150 m) in the southern part of the area, about 300 ft (90 m) near Sapello, and about 150 ft (45 m) near north edge of area

Pr **Permian rocks, undivided (Permian and Lower Permian)**—Shown undivided on cross sections and on map from near head of Abeyta Canyon to northern edge of area. North of Montezuma, includes Bernal Formation, Glorieta Sandstone, and Yeso Formation. To the south, includes also the San Andres Limestone

Psc **Sangre de Cristo Formation of southern and central parts of area (Lower Permian, Wolfcampian)**—Red, purple, and greenish-gray sandy shale, siltstone, and clay shale containing thin to thick, feldspathic to arkosic, conglomeratic sandstone beds. Contains thin lenses of unfossiliferous limestone nodules and a few beds of unfossiliferous gray argillaceous limestone. Coarse-grained sandstone in upper 150 ft (45 m) commonly contains well-rounded pebbles and cobbles of yellow, purple, and gray quartzite. Lies on Precambrian rocks northeast and south of Ojitos Frios. In southern part of area thickness is about 800 ft (245 m) west of San Jose, and about 300 ft (90 m) near Starvation Peak and Tecolote Peak. To the north, thickness is at least 1,500 ft (460 m) northwest of Sapello

PPsc **Sangre de Cristo Formation of northern part of area (Lower Permian, Wolfcampian, and Upper Pennsylvanian, Virgilian?)**—Lithologically similar to unit in southern and central parts of area. Arbitrarily mapped separately from Rito Cebolla north. Lower part at Mora River contains palynomorphs of Pennsylvanian age. Thickness is at least 2,300 ft (700 m) at Rito Cebolla and about 2,580 ft (785 m) at Mora River

PPa **Alamitos Formation of southern and central parts of area (Lower Permian and Upper and Middle Pennsylvanian)**—Gray, greenish-gray and red shale containing interbeds of conglomeratic feldspathic to arkosic sandstone; gray sandy limestone; fine- to coarse-grained gray to purplish-gray limestone; nodular and thin-bedded gray limestone; and some limestone-pebble conglomerate. Limestone and some shale and sandstone beds contain marine fossils. Potassium-feldspar clasts of arkosic sandstone and sandy limestone are mostly pink and unweathered. Fossils are Desmoinesian through Wolfcampian south of Gallinas Creek. Thin and locally absent in southern part of area because of unconformity with Sangre de Cristo Formation. Thickness is 645 ft (197 m) in western Gallinas Creek area, and as much as 1,828 ft (557 m) east of Rociada

IPa **Alamitos Formation of northern part of area (Middle and Upper Pennsylvanian)**—Lithologically similar to unit in central and southern parts of area. Arbitrarily mapped separately north of Carton Bonito. Fossils are Desmoinesian through Virgilian (?) north of Carton Bonito and are Desmoinesian and Missourian at Mora River. Thickness is as little as 100 ft (30 m) north of Rito Cebolla, but is 1,050 ft (329 m) at Mora River

IPp **Porvenir Formation (Middle Pennsylvanian, Desmoinesian)**—Gray shale interbedded with nodular to thick-bedded gray limestone, sandy gray limestone, fine-grained to very coarse-grained sandstone, and feldspathic to conglomeratic sandstone. Potassium-feldspar clasts generally weathered yellow to yellowish-pink. Generally, south of Rociada and Sapello most of the formation is limestone and gray shale containing minor proportions of sandstone. Near Manuelitas Creek and Sapello River the proportion of sandstone increases northeastward, and in the northeastern part of the area the formation consists of shale, interbedded thick feldspathic to arkosic sandstone, and subordinate amounts of limestone. In southern part of area the Porvenir is absent locally because of angular unconformity with overlying rocks. Thickness is 500–800 ft (152–244 m) in southwest part of area, 1,614 ft (492 m) east of Rociada, and 680 ft (207 m) at Mora River

IPs **Sandia Formation (Middle and Lower Pennsylvanian)**—Gray to dark-gray shale, sandy shale, and calcareous shale containing interbeds of buff to brown, coarse-grained, quartzose and feldspathic to arkosic sandstone and conglomerate that range from thin bedded to massive; also contains some gray to dark-gray, dense, fossiliferous limestone beds. Thin beds of carbonaceous to coaly shale occur throughout most of the formation. Fossils are Morrowan and Atokan. In southeastern part of area the Sandia is absent because of angular unconformity with overlying rocks. Thickness is 33–245 ft (10–75) in southwestern part of area, 1,030 ft (314 m) east of Rociada, and more than 5,030 ft (1,533 m) 1 mi north of Mora River

Ma **Arroyo Peñasco Group, undivided (Upper and Lower Mississippian)**—Consists of Terrero Formation and underlying Espiritu Santo Formation. Upper Mississippian Terrero Formation is gray, sandy, clastic limestone, some crystalline limestone, and a basal limestone breccia. Lower Mississippian Espiritu Santo Formation is dark-gray limestone and dolomitic limestone, sandy limestone, and basal conglomeratic sandstone. Thickness of group ranges from 15 ft (4.6 m) to 110 ft (34 m). Absent from some places because of unconformity with overlying rocks

IPMr **Pennsylvanian and Mississippian rocks, undivided**—Includes Porvenir and Sandia Formations and Arroyo Peñasco Group in small areas southwest of Agua Zarca

IPMsa **Sandia Formation and Arroyo Peñasco Group, undivided (Middle and Lower Pennsylvanian and Mississippian)**—Shown undivided on cross sections and in southwestern part of map area

p€r **Precambrian rocks, undivided (Proterozoic)**—Includes metasedimentary and metavolcanic rocks, intrusive complex of gabbro and tonalite, and granite.

MAP SYMBOLS

Contacts, faults, anticlines, and synclines are shown by solid lines where accurately located at map scale, dashed lines where approximately located, dotted lines where concealed, and queries where probable

- Contact
- Normal fault—Bar and ball on downthrown side
- Normal fault inferred to be superposed on older reverse fault—Bar and ball on downthrown side of normal fault; on upthrown side of reverse fault
- High-angle strike-slip fault—Arrows indicate relative horizontal movement
- Reverse fault—Blocks on upthrown side. Dip inferred to be steeper than 45° at depth of exposure
- Thrust fault—Triangles on overthrust block. Dip inferred to be less than 45° at depth of exposure
- Anticline—Showing crestline and direction of plunge
- Anticline with overturned limb—Showing crestline
- Anticlinal bend—Showing axis, steepest limb, and direction of plunge
- Syncline—Showing troughline and direction of plunge
- Syncline with overturned limb—Showing troughline
- Synclinal bend—Showing axis and steepest limb
- A A' Line of cross section

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