U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

El Malpais National Monument

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for El Malpais National Monument

elma_geology.pdf

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Geologic Resources Inventory Map Document for El Malpais National Monument

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Geologic Resources Inventory Map Document

El Malpais National Monument, New Mexico

Document to Accompany Digital Geologic-GIS Data

elma_geology.pdf

Version: 8/8/2012

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for El Malpais National Monument, New Mexico (ELMA).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

For information about the status of GRI digital geologic-GIS data for a park contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park

(s), enter “GRI” as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for El Malpais National Monument, New Mexico (ELMA), as well as the source map used for each map, are listed below.

GRI Digital Geologic Map of El Malpais National Monument and Vicinity, New Mexico (*GRI MapCode ELMA*)

Maxwell, Charles H., 1986, Geologic Map of El Malpais Lava Field and Surrounding Area, Cibola County, New Mexico, U.S. Geological Survey Miscellaneous Investigations Series Map I-1595, 1:62,500 scale. (I-1595). (*GRI Source Map ID 1076*)

GRI Digital Geologic Map of the McCarty's Quadrangle, New Mexico (*GRI MapCode MCCA*)

Maxwell, C.H., 1977, Preliminary Geologic Map of the McCarty's Quadrangle, Valencia County, New Mexico, U.S. Geological Survey, Open-File Report OF-77-380, 1:24,000 scale. (OF-77-380). (*GRI Source Map ID 19127*)

Additional information pertaining to each source map is also presented in the Source Map Information (MAP) table included with the GRI geology-GIS data.

GRI El Malpais National Monument and Vicinity Map (ELMA)

Map Unit List

The geologic units present on the GRI Digital Geologic Map of El Malpais National Monument and Vicinity, New Mexico (*GRI MapCode ELMA*) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the map's Geologic Unit Information (ELMAUNIT) table included with the GRI geology-GIS data.

Geologic Map Units

Cenozoic Era

Quaternary Period

- Qe - Eolian deposits (Qe)
- Qal - Alluvium (Qal)
- Ql - Landslide deposits (Ql)
- Qac - Alluvium, colluvium, and soil (Qac)
- Pyroclastic debris and basalt flows
  - McCartys flow and cinder cone
    - Qbm - McCartys flow (Qbm)
    - Qcm - McCartys cinder cone (Qcm)
  - Bandera flows, crater, and cinder field
    - Qbb - Bandera flows (Qbb)
    - Qcb - Bandera crater (Qcb)
    - Qvb - Bandera cinder field (Qvb)
  - Hoya de Cibola flows and shield volcano
    - Qbw - Hoya de Cibola flows (Qbw)
    - Qvw - Hoya de Cibola shield volcano (Qvw)
  - Paxton Springs flows, crater, and cinder field
    - Qbp - Paxton Springs flows (Qbp)
    - Qcp - Paxton Springs crater (Qcp)
    - Qvp - Paxton Springs cinder field (Qvp)
  - Zuni flows
    - Qbz - Zuni flows (Qbz)
  - Oso Ridge flows and lava cone
    - Qbo - Oso Ridge flows (Qbo)
    - Qvo - Oso Ridge lava cone (Qvo)
  - Twin Craters flows, cones, and mixed pyroclastics
    - Qbt - Twin Crater flows (Qbt)
    - Qct - Twin Crater cinder cones (Qct)
    - Qvt - Twin Crater mixed pyroclastics and flows (Qvt)
  - El Calderon flows, crater, and cinder field
    - Qbc - El Calderon flows (Qbc)
    - Qcc - El Calderon crater (Qcc)
    - Qvc - El Calderon cinder field (Qvc)
- Qc - Cinder cones (Qc)
- Qv - Volcanic debris (Qv)
- Qbu - Basalt flows (Qbu)
- Qb - Old basalt flows (Qb)

Tertiary Period

Tb - Basalt flows on Cebollita Mesa, Mesa Negra, and Horace Mesa (Tb)

Mesozoic Era

Cretaceous Period

Kcc - Crevasse Canyon Formation (Kcc)
Kg - Gallup Sandstone (Kg)
Mancos Shale
  Kmd - Mancos Shale - D-Cross Tongue (Kmd)
  Kmr - Mancos Shale - Rio Salado Tongue (Kmr)
  Kmw - Mancos Shale - Whitewater Arroyo Tongue (Kmw)
Kth - Tres Hermanos Sandstone (Kth)
Dakota Sandstone
  Kdt - Twowells Tongue of Dakota Sandstone (Kdt)
  Kdp - Paguate Tongue of Dakota Sandstone (Kdp)
Kdo - Clay Mesa Tongue of Mancos Shale and Lower Part of Dakota Sandstone (Kdo)

Jurassic Period

Jm - Morrison Formation (Jm)
Jz - Zuni Sandstone and Wanakah Formation (Jz)
  Jt - Todilto Limestone Member of Wanakah Formation (Jt)
Je - Entrada Sandstone (Je)

Triassic Period

TRcm - Chinle and Moenkopi Formations (TRcm)

Paleozoic Era

Permian Period

Psa - San Andres Limestone (Psa)
Pg - Glorieta Sandstone (Pg)
Py - Yeso Formation (Py)
Pa - Abo Formation (Pa)

Precambrian

PChb - hornblendite, gabbro, and intrusive basalt (PChb)
PCpa - porphyritic aplite (PCpa)
PCap - gneissic aplite (PCap)
PCpg - porphyritic granite (PCpg)
PCag - aplitic granite (PCag)
PCgg - gneissic granite (PCgg)
PCmg - quartz monzonite gneiss (PCmg)
PCqt - quartzite (PCqt)
PChg - hornblende gneiss (PChg)
PCig - injection gneiss (PCig)
PCsc - biotite schist (PCsc)

Unknown/Undetermined Age

f - Fluorite vein (f)

Map Unit Descriptions

Descriptions of all geologic map units are presented below.

Qe - Eolian deposits (Holocene)

Recent accumulations of windblown silt and sand. Deposits on lava flows not shown but are generally sheet accumulations; those shown on eastern part of map are largely dune fields. Only the most prominent accumulations shown; innumerable smaller deposits occur along eastern side of map; extensive but thin longitudinal dunes and sheets with west-southwest trend occur throughout southwestern part of map. *GRI Source Map ID 1076* (I-1595).

Qal- Alluvium (Holocene and Pleistocene)

Composed largely of silt and fine-grained sand; a few local lenses contain coarse sand or pebbles. As much as 50 ft (15 m) exposed in recent gullies. Includes some eolian and colluvial deposits. *GRI Source Map ID 1076* (I-1595).

Ql - Landslide deposits (Holocene and Pleistocene)

Composed mostly of toreva-block slides of Tertiary basalt and Cretaceous sandstone and shale that have slid over soft shale units. Includes some rock and mudflow slides and talus and fan accumulations, some of which are derived from outcrops and some from landslide debris. Landslides generally older than alluvium and formed during an early wet period, which was followed by progressive changes in climate to present-day arid conditions. During the wet period large amounts of water percolated through porous basalt and sandstones and soaked and weakened underlying shales so that large blocks of basalt and sandstone broke away from mesa edges and slid down shale slopes. As precipitation lessened, landslides occurred less frequently and less alluvial material was carried away. Eventually slides stabilized and valleys were choked with alluvium that covered many of the lower slides and filled valleys to form broad, flat floors. Flash flooding, characteristic of present-day arid conditions, produced deep gullies in alluvium, exhuming some landslide blocks. *GRI Source Map ID 1076* (I-1595).

Qac - Alluvium, colluvium, and soil (Holocene and Pleistocene)

Soil and alluvium uplifted by recent faulting in southern part of the map area. Locally covered by recent alluvial and eolian deposits. *GRI Source Map ID 1076* (I-1595).

Pyroclastic debris and basalt flows

Basalt flows are divided into two informal groups, the younger malpais and an older group. Older group is deeply weathered, largely covered by more or less well-developed soil. Oldest flows (Qb) locally overlain by slightly younger flows (Qbu) and by pyroclastic debris (Qv) and cinder cones (Qc); some might be as young as the Malpais. The Malpais basalt field is divided into five units, each having basalt flows and associated volcanic debris and cinder cones.

Cinder cones composed of basaltic ash, cinders, bombs, and large angular blocks of scoria, and minor

flows of glassy lava. Range in height from a few feet to more than 560 feet (170 m), and many are three-quarters of a mile (1 km) or more in diameter. A few cones are symmetrical with a central depression as much as 230 ft (70 m) deep over the vent, but most have been breached on one side by lava flows and have a cresent shape.

Pyroclastic debris composed largely of basalt flows mixed with and covered by cinders, bombs, scoria blocks, and flow breccia. Deposits around Bandera Crater are mostly cinders covering sedimentary rocks. *GRI Source Map ID 1076* (I-1595).

Qbm and Qcm - McCartys flow and cinder cone (Holocene and Pleistocene)

Includes: **Qbm (McCartys flow)** and **Qcm (McCartys cinder cone)**

Originated at a small cinder cone (Qcm) in southern part of Malpais; some flows to the south and more to the north, along the eastern margin of the Malpais, extending northward to the Rio San Jose and eastward along Interstate Highway 40. Not accurately dated; age inferred to be about 1,000 years old (Nichols, 1946) on basis of Acoma Indian legends and presence of archeological material in nearby valley fill that was correlated with the alluvium underlying the McCartys flow in the Rio San Jose valley. Flows could be as young as 400 years old. Generally unweathered, uneroded, and relatively barren of vegetation; in good exposures, flows exhibit grooved lava, squeeze ups, pahoehoe, aa, ropes, collapse depressions, pressure ridges, spatter cones, and a few lava tubes. Basalt is hypocrystalline, porphyritic; contains subhedral to euhedral phenocrysts of plagioclase and olivine in groundmass of subhedral plagioclase, anhedral olivine, pyroxene, and tachylyte heavily dusted with opaque minerals; plagioclase phenocrysts predominant near crater (within 2.5 mi, <4 km), olivine phenocrysts predominant in remainder of the flows (Carden and Laughlin, 1974, p. 1481). *GRI Source Map ID 1076* (I-1595).

Bandera flows, crater, and cinder field

Qbb - Bandera flows (Holocene and Pleistocene)

Originated at Bandera Crater (Qcb) adjacent to State Highway 53. Rock is similar to the McCartys flow. Ultramafic inclusions in final tephra eruptions contain spinel-bearing dunitic and pyroxene-rich rock. *GRI Source Map ID 1076* (I-1595).

Qcb - Bandera crater (Holocene and Pleistocene)

Ideal example of breached cinder cone. Cone is steep sided, symmetrical, almost three-quarters mile (a kilometer) in diameter and 500 ft (150 m) high; has a central depression 600 ft (180 m) below rim and 260 ft (80 m) below breach on southwest side. Large lave tube begins at breach, totally collapsed to half mile (800 m), may extend to south and east for 12 mi (20 km) or more. Ice cave, and its deposit of perpetual ice, developed in lava tube near crater; other ice caves occur at other localities in tube. *GRI Source Map ID 1076* (I-1595).

Qvb - Bandera cinder field (Holocene and Pleistocene)

Fine cinders surround north, east, and west sides of crater, and cover sedimentary rocks and older basalt flows. *GRI Source Map ID 1076* (I-1595).

Qbw and Qvw - Hoya de Cibola flows and shield volcano (Holocene and Pleistocene)

Includes: **Qbw (Hoya de Cibola flows)** and **Qvw (Hoya de Cibola shield volcano)**

Western flows originated from Hoya de Cibola crater and shield volcano (Qvw) in western part of the Malpais. Lava flowed south, east, and probably northeast; covered by the Bandera and McCartys flows. Flows, exposed in NE part of the map, tentatively correlated with western flows on the basis of similarity of composition, flow characteristics, weathering, and vegetation. Rock is similar to the McCartys flows but slightly higher in Al2O3 and alkalis, and lower in MgO. *GRI Source Map ID 1076* (I-1595).

Qbp, Qcp and Qvp - Paxton Springs flows, crater, and cinder field (Holocene and Pleistocene)

Includes: **Qbp (Paxton Springs flows)**, **Qcp (Paxton Springs crater)**, and **Qvp (Paxton Springs cinder field)**

Originated from a volcanic center in the Precambrian core of the Zuni Mountains and flowed 2 mi (3 km) down Agua Fria Creek, and 17 mi (27 km) to the northeast down Zuni Canyon to the area between Grants and San Rafael. Rock is nepheline normative alkali-olivine basalt; holocrystalline, vesicular, microporphyritic; contains euhedral olivine phenocrysts, rare clinopyroxene and plagioclase, in groundmass of plagioclase, pyroxene, and opaque minerals (Laughlin and others, 1972, p. 1547). *GRI Source Map ID 1076* (I-1595).

Zuni flows

Qbz - Zuni flows (Holocene and Pleistocene)

Originated from centers about 1 mi (1.7 km) north of boundary. *GRI Source Map ID 1076* (I-1595).

Oso Ridge flows and lava cone

Qbo - Oso Ridge flows (Holocene and Pleistocene)

Originated from a lava cone (Qvo) on Oso Ridge northwest of Bandera Crater. Basalt flows ran eastward to Agua Fria Creek and southward almost to the Malpais flows. Overlain by the Paxton Springs flow. *GRI Source Map ID 1076* (I-1595).

Qvo - Oso Ridge lava cone (Holocene and Pleistocene)

Composed largely of breccia, welded pyroclastic debris and glassy flows. *GRI Source Map ID 1076* (I-1595).

Twin Craters flows, cones, and mixed pyroclastics

Qbt - Twin Crater flows (Holocene and Pleistocene)

Originated from complex of cinder cones (Qct). Composed of several overlapping flow units emanating from different vents; difficult or impractical to separate. Includes most flows under or adjacent to State Highway 53. *GRI Source Map ID 1076* (I-1595).

Qct - Twin Crater cinder cones (Holocene and Pleistocene)

Extends in northeast-trending line with Twin Craters in about the center of the line, Lost Woman center to southwest, and La Tetra center to northeast. *GRI Source Map ID 1076* (I-1595).

Qvt - Twin Crater mixed pyroclastics and flows (Holocene and Pleistocene)

Surround cinder cones (Qct) and partially obscure sedimentary rocks in the area. *GRI Source Map ID 1076* (I-1595).

Qbc, Qcc and Qvc - El Calderon flows, crater, and cinder field

Includes: **Qbc (El Calderon flows)**, **Qcc (El Calderon crater)**, and **Qvc (El Calderon cinder field)**

Originated from El Calderon crater (Qcc) below and northeast of Cerritos de Jaspe. Oldest of the Malpais flows, largely covered by alluvium or younger flows near source. Flows in northeast part of map area have similar morphology and weathering and are correlated with the Calderon flows; probably the same as the Laguna flows of Nichols (1946). Rock is coarse grained, porous, diktytacitic; groundmass of plagioclase, subophitic augite, and brownish glass (Lipman and Moench, 1972, p. 1341). Some rocks included with the old basalt flows (Qb), notably Cerro Bandera and Cerro Rendija, are similar and may correlate with this unit. *GRI Source Map ID 1076* (I-1595).

Qc - Cinder cones (Holocene and Pleistocene)

Cones in western part of map appear older than those associated with the Malpais flows; however, some could be contemporary, but without recent lava flows. *GRI Source Map ID 1076* (I-1595).

Qv - Volcanic debris (Holocene and Pleistocene)

Volcanic debris in western part of the map area associated with cinder cones and with a few older flows; composed largely of weathered lava covered with coarse lava blocks and scoria. *GRI Source Map ID 1076* (I-1595).

Qbu - Basalt flows (Holocene and Pleistocene)

Associated with volcanic debris in western part of map area; apparently older than the Malpais but younger than oldest flows. *GRI Source Map ID 1076* (I-1595).

Qb - Old basalt flows (Holocene and Pleistocene)

Deeply weathered; cover much of western half of map area. Largely covered with soil and alluvium; produce open grasslands having only small outcrops of basalt. Dated 0.788 m.y. near Cerro Bandera, and 1.38 m.y. old several miles west of map area (Luedke and Smith, 1978). *GRI Source Map ID 1076* (I-1595).

Tb - Basalt flows on Cebollita Mesa, Mesa Negra, and Horace Mesa (Pliocene)

Cap mesas; generally aphanitic and vesicular olivine basalt and associated scoria. Largely covered with soil, alluvium, and pine trees. Flows generally 65-100 ft (20-30 m) thick, 300 ft (100 m) or more near smaller centers of eruption, and 1,000 ft (300 m) or more Cebollita Peak. Similar basalt flows at about the same elevation on La Jara mesa and Mt. Taylor, about 18 mi (28 km) north of Mesa Negra, gave

potassium-argon ages of 2.3-3.5 m.y. old (Basett and others, 1963). Flows on Cebollita Mesa probably contemporary. *GRI Source Map ID 1076* (I-1595).

Kcc - Crevasse Canyon Formation (Upper Cretaceous)

Comprises a 260- to 330-ft thick (80- to 100-m) sequence of nonmarine sandstone, siltstone, carbonaceous shale, and coal beds. A few exposures of overlying Point Lookout Sandstone in northeastern part of area mapped with the Crevasse Canyon Formation. Youngest member of the Crevasse Canyon is the Gibson Coal Member, 60-75 ft (20-25 m) thick, composed of light-yellowish-gray to white, thin-bedded sandstone and siltstone, and interbedded light- to dark-gray carbonaceous shale and coal beds; at southern edge of map area, grades into marginal marine shale and sandy limestone. Dalton Sandstone Member underlies the Gibson Coal Member; Dalton composed of light-gray and yellowish-gray, fine- and medium-grained, thin-bedded to massive sandstone that grades southward into thin-bedded silty sandstone and interbedded carbonaceous shale indistinguishable from the Dilco Coal Member; about 50-65 ft (15-20 m) thick. In northern part of map area, the Mulatto Tongue of the Mancos Shale underlies the Dalton and overlies the Stray and Dilco, but pinches out southward. This fissile olive-gray shale grades southward into yellowish-gray siltstone and sandstone. At the base of the Crevasse Canyon Formation, Dilco Coal Member is composed of light-yellowish-gray to white, thin-bedded sandstone and siltstone interbedded with light- to dark-gray carbonaceous shale and coal beds (1.5 to as much as 5 ft (0.5-1.5 m) thick); may constitute an economic resource in the future; 115-150 ft (35-45 m) thick). Contact of Dilco with underlying Gallup Sandstone was arbitrarily placed at a prominent change in weathering characteristics that locally may 3 ft (1 m) or more above the marine to nonmarine transition, but below the first coal beds. Sandstone lenses overlying the Dilco in northern part of area tentatively correlated with the Stray sandstone (an economic term). *GRI Source Map ID 1076* (I-1595).

Kg - Gallup Sandstone (Upper Cretaceous)

Composed of the upper sandstone member at the top, a silty shale unit, and a lower unit at the base. Upper member light-brown and light-gray, fine- to medium grained, thin- to massive-bedded sandstone containing local areas of cross stratification and lenses of dark-brown-weathering sandy limestone and calcareous sandstone. Lower silty unit light- to dark-gray and yellowish-gray silty shale in northern part of area, grading southward into light-yellowish-gray, laminated silty sandstone and, near southern boundary, into interbedded thin sandstone and dark-gray carbonaceous shale containing coaly lenses. Total thickness of 260-330 ft (80-100 m). *GRI Source Map ID 1076* (I-1595).

Mancos Shale

Tongues weather to steep, soft slopes almost entirely covered by landslides, talus, or colluvium; outcrops sparse and generally confined to small areas under cliffs to overlying sandstones. *GRI Source Map ID 1076* (I-1595).

Kmd - Mancos Shale, D-Cross Tongue (Upper Cretaceous)

Light- to dark-gray shale containing local lenses and concretionary zones of sandy fossiliferous limestone, and thin-bedded sandstone in southeastern part of area. *GRI Source Map ID 1076* (I-1595).

See also: Mancos Shale

Kmr - Mancos Shale, Rio Salado Tongue (Upper Cretaceous)

Light- to dark-gray, friable shale and silty shale containing local lenses of calcareous, siliceous, and sandy siltstone, and fine-grained sandstone in upper part. Thickness 230-300 ft (70-90 m). *GRI Source Map ID 1076* (I-1595).

See also: Mancos Shale

Kmw - Mancos Shale, Whitewater Arroyo Tongue (Upper Cretaceous)

Dark-gray shale, weathers to light gray and grayish tan; uppermost part is silty shale and siltstone that is transitional into overlying Twowells Tongue. *GRI Source Map ID 1076* (I-1595).

See also: Mancos Shale

Kth - Tres Hermanos Sandstone (Upper Cretaceous)

Composed of three units, a sandstone at top, a highly variable middle unit, and a light-yellowish-gray sandstone at base. Middle unit around Mesa Negra is similar to the D-Cross or Rio Salado Tongue but grades southward to interbedded carbonaceous shale and sandstone containing lenticular coal beds; locally grades into predominantly thin-bedded shaley sandstone and siltstone. In southern part grades into dark-gray, fossiliferous shale and light-gray and brown, thin-bedded, calcareous sandstone. *GRI Source Map ID 1076* (I-1595).

Dakota Sandstone

Kdt - Twowells Tongue of Dakota Sandstone (Upper Cretaceous)

Fine to very fine grained, silty, local, thin lenses of medium- to coarse-grained sandstone; light gray, weathers to grayish orange, light brown and tan; thin to medium bedded. Resistant, slabby beds at top grade downward to silty sandstone containing thin interbeds of siltstone. Contains many imprints, burrows, trails, and disturbed bedding. Uppermost part and overlying shale contain Pycnodonte newberryi (Stanton) (Hook and Cobban, 1977). Thickness 3-80 ft (1-25 m). *GRI Source Map ID 1076* (I-1595).

Kdp - Paguate Tongue of Dakota Sandstone (Upper Cretaceous)

Light-brown and tan, fine to very fine grained sandstone; local lenses medium- to coarse-grained, thin- to medium-bedded. Forms prominent cliffs along northeast side of the Malpais. Thickness 30-100 ft (10-30 m). *GRI Source Map ID 1076* (I-1595).

Kdo - Clay Mesa Tongue of Mancos Shale and Lower Part of Dakota Sandstone (Upper Cretaceous)

Map unit includes, from top to bottom, the Clay Mesa Tongue of Mancos Shale, Cubero Tongue of Dakota Sandstone, the Oak Canyon Member, and a basal sandstone and conglomerate unit of Dakota Sandstone; 90-200 ft (30-70 m) thick. The Clay Mesa is dark-gray, fissile shale containing greenish-gray bentonite beds and numerous, brown-weathering limestone concretions; unit is about 30 ft (10 m) thick. The Cubero Tongue pinches out in northern corner of area; lithology similar to the Twowells and Paguate. The Oak Canyon Member is light-gray and grayish tan, locally calcareous or carbonaceous sandstone and siltstone, very fine grained and thin-bedded sandstone; generally shaly siltstone with abundant, finely comminuted, carbonaceous material; numerous thin-bedded, light-gray, brown-weathering

fossiliferous limestone lenses and concretions, and limestone or aragonite cone-in-cone concretions; 60-90 ft (20-30 m). The basal sandstone and conglomerate unit of Dakota is light gray to white, medium to coarse grained, poorly sorted, crossbedded, and has siliceous cement. Lenses of conglomerate, especially near the base, have prominent scour and fill structures. In northeastern part of map area, thin-bedded, fine-grained sandstone, locally disturbed by trails and burrows, pinches out southward; locally absent; shales rest directly on the Zuni Sandstone. Thickness 0-65 ft (0-20 m). *GRI Source Map ID 1076* (I-1595).

See also: Mancos Shale

Jm - Morrison Formation (Upper Jurassic)

Grayish-green mudstone and siltstone and lenticular yellowish- and reddish-gray fine- to medium-grained sandstone. Lenticular, pale-brown to white, crossbedded pebble conglomerate and sandstone at base. Pinches out about 3 mi (5 km) south of Interstate 40. Thickness 0-100 ft (0-30 m). *GRI Source Map ID 1076* (I-1595).

Jz - Zuni Sandstone and Wanakah Formation (Middle Jurassic)

Variable color, generally yellowish-gray or tan, locally chalk white, fine- to medium-grained sandstone; well rounded grains largely of quartz; very well sorted, large-scale eolian crossbeds. Conspicuous bleached zone at tip of unit. The Wanakah Formation in the northeastern corner of map area is white to pale-brown, thin- to medium-bedded, very fine-grained, silty sandstone interbedded with thin, dark-brown mudstone and claystone. Grades southward into thin-bedded, fluviatile sandstone at base of Zuni. The Wanakah is underlain by the Todilto Member and Entrada Sandstone in northeastern part of map area; the Todilto pinches out in northern part of area and its position is then occupied by a pebble conglomerate above the next exposure of Entrada to the south. The Zuni and Wanakah are 360-600 ft (110-180 m) thick in area. *GRI Source Map ID 1076* (I-1595).

Jt - Todilto Limestone Member of Wanakah Formation (Middle Jurassic)

Only in northeastern part of map area. Composed of 10-40 ft (3-12 m) of pale-olive-gray, pale-olive-brown, and pale yellow limestone, thick bedded, coarsely crystalline in top part, crinkly bedded in middle part, and platy bedded at base. *GRI Source Map ID 1076* (I-1595).

Je - Entrada Sandstone (Middle Jurassic)

Reddish-orange to reddish-brown, fine- to medium-grained, eolian, crossbedded, silty sandstone. The Entrada is present in northeast corner of map area and with the overlying conglomerate is exposed at north end of The Narrows. *GRI Source Map ID 1076* (I-1595).

TRcm - Chinle and Moenkopi (?) Formations (Upper Triassic, and Middle? and Lower Triassic)

Chinle Formation is 1,180-1,500 ft (360-460 m) thick in the region but only lowermost part, which is predominantly reddish-brown claystone and siltstone, is exposed in map area. Basal part of map unit, tentatively correlated with the Moenkopi Formation (Thaden and others, 1967; Hackman and Olson, 1977), is composed of pale-reddish-brown and grayish-red arkosic and micaceous sandstone interbedded with pebble conglomerate and reddish-brown, lenticular siltstone and mudstone. Thickness 0-50 ft (0-15 m). *GRI Source Map ID 1076* (I-1595).

Psa - San Andres Limestone (Lower Permian)

Mostly gray to yellow, thick-bedded, fossiliferous dolomitic limestone with thin, calcareous, shale partings and thin, sandy limestone lenses; a yellowish-gray sandstone bed about 20 ft (6 m) thick locally present in lower part. Thickness 115-145 ft (35-44 m). Forms cliff or persistent dip slope. *GRI Source Map ID 1076* (I-1595).

Pg - Glorieta Sandstone (Lower Permian)

White to buff, very pure, well-sorted, medium-grained, crossbedded quartz sandstone and siltstone; weathers yellow to light brown; well cemented with silica or calcite, generally about 150-165 ft (45-50 m) thick; forms cliff, ridge, or dip slopes. *GRI Source Map ID 1076* (I-1595).

Py - Yeso Formation (Lower Permian)

Pale-reddish-brown, medium- to fine-grained, thick- to thin-bedded, locally crossbedded sandstone and siltstone; grades upward into pink, white, and yellow alternating layers of friable sandstone. Three dense, fine-grained, light- to medium-gray limestone beds 10-13 ft (3-4 m) thick are present in upper part of formation; locally overlain by 13-16 ft (4-5 m) of white to light-gray, poorly exposed gypsum beds. Formation about 1,300 ft (400 m). *GRI Source Map ID 1076* (I-1595).

Pa - Abo Formation (Lower Permian)

Moderate-brick-red to dusky-red. Medium- to fine-grained sandstone and siltstone, locally crossbedded; forms cliffs and steep slopes. At base is 3-10 ft (1-3 m) of arkosic conglomerate containing white quartz pebbles, overlain by about 30 ft (10 m) of dusky-red arkose containing thin, medium-gray, limestone beds. Formation was deposited on an undulating surface of Precambrian rocks. Thickness about 1,300 ft (400 m). *GRI Source Map ID 1076* (I-1595).

PChb - Hornblendite, gabbro, and intrusive basalt (Precambrian)

Hornblendite, gabbro, and intrusive basalt—Dikes and small irregular bodies. *GRI Source Map ID 1076* (I-1595).

PCpa - Porphyritic aplite (Precambrian)

Moderate-orange-pink, slightly gneissic, porphyritic aplite composed of scattered microcline phenocrysts in medium-grained groundmass of quartz, orthoclase, and minor biotite. Stocks and dikes intrude gneissic granite (gg) and gneissic aplite (ap). *GRI Source Map ID 1076* (I-1595).

PCap - Gneissic aplite (Precambrian)

Grayish- to moderate-orange-pink, sugary, well foliated, consists of microcline, quartz, and some orthoclase and oligoclase; contains minor amounts of muscovite and biotite. Occurs as irregular masses and dikes intruding or locally gradational into gneissic granite (gg). *GRI Source Map ID 1076* (I-1595).

PCpg - Porphyritic granite (Precambrian)

Light-brownish-gray, porphyritic dikes that intrude gneissic granite (gg). Large, white orthoclase and small bluish quartz phenocrysts in fine-grained groundmass of quartz, orthoclase, hornblende, and

biotite; slightly gneissic. *GRI Source Map ID 1076* (I-1595).

PCag - Aplitic granite (Precambrian)

Grayish to pink, gneissic, fine- to medium-grained, composed of potassium feldspar, quartz and small amounts of oligoclase, biotite and muscovite. Gradational with gneissic granite (gg). *GRI Source Map ID 1076* (I-1595).

PCgg - Gneissic granite (Precambrian)

Pinkish- to medium-gray, fine- to coarse-grained, locally porphyritic, gneissic granite composed of orthoclase, quartz oligoclase, and abundant hornblende and biotite. *GRI Source Map ID 1076* (I-1595).

PCmg - Quartz monzonite gneiss (Precambrian)

Medium- to dark-gray, medium-grained, strongly gneissic, slightly banded; composed of oligoclase, biotite, quartz, and some orthoclase. Occurs as xenolithic masses in gneissic granite (gg). *GRI Source Map ID 1076* (I-1595).

PCqt - Quartzite (Precambrian)

Brown, fine- to medium-grained, locally contains phyllite beds. *GRI Source Map ID 1076* (I-1595).

PChg - Hornblende gneiss (Precambrian)

Dark green; contains lenses of gneissic gabbro and layers of aplite. *GRI Source Map ID 1076* (I-1595).

PCig - Injection gneiss (Precambrian)

Quartz biotite gneiss. *GRI Source Map ID 1076* (I-1595).

PCsc - Biotite schist (Precambrian)

Biotite schist. *GRI Source Map ID 1076* (I-1595).

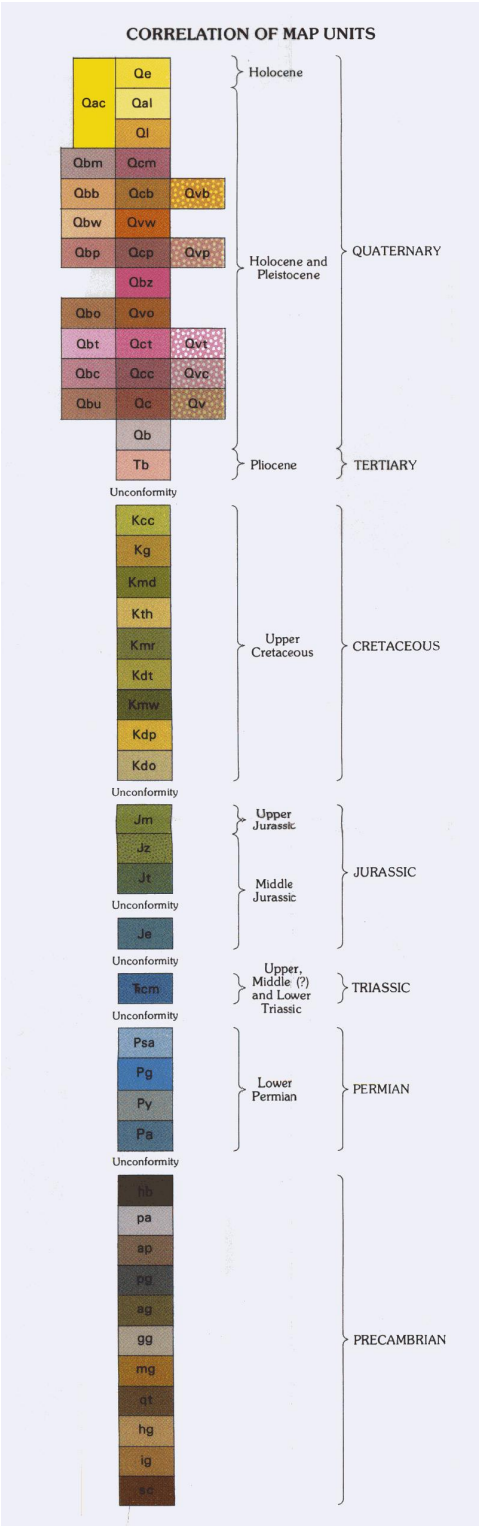
f - Fluorite vein (unknown/undetermined age)

See Mineral Deposits for information concerning these intrusives. *GRI Source Map ID 1076* (I-1595).

GRI Source Map Citation (I-1595)

Maxwell, Charles H., 1986, Geologic Map of El Malpais Lava Field and Surrounding Area, Cibola County, New Mexico, U.S. Geological Survey Miscellaneous Investigations Series Map I-1595, 1:62,500 scale. (*GRI Source Map ID 1076*)

Correlation of Map Units



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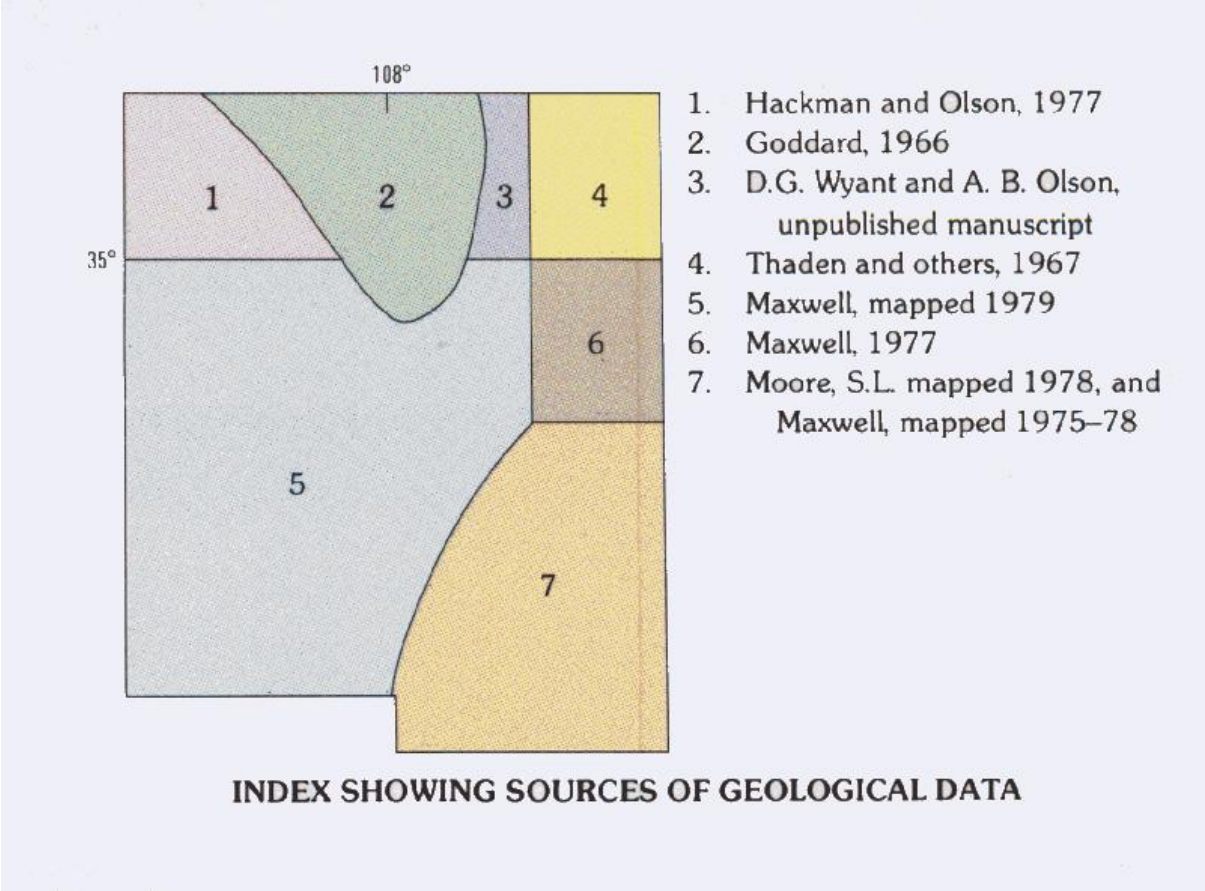
Location Map

Extracted from: (I-1595).

Sources Map



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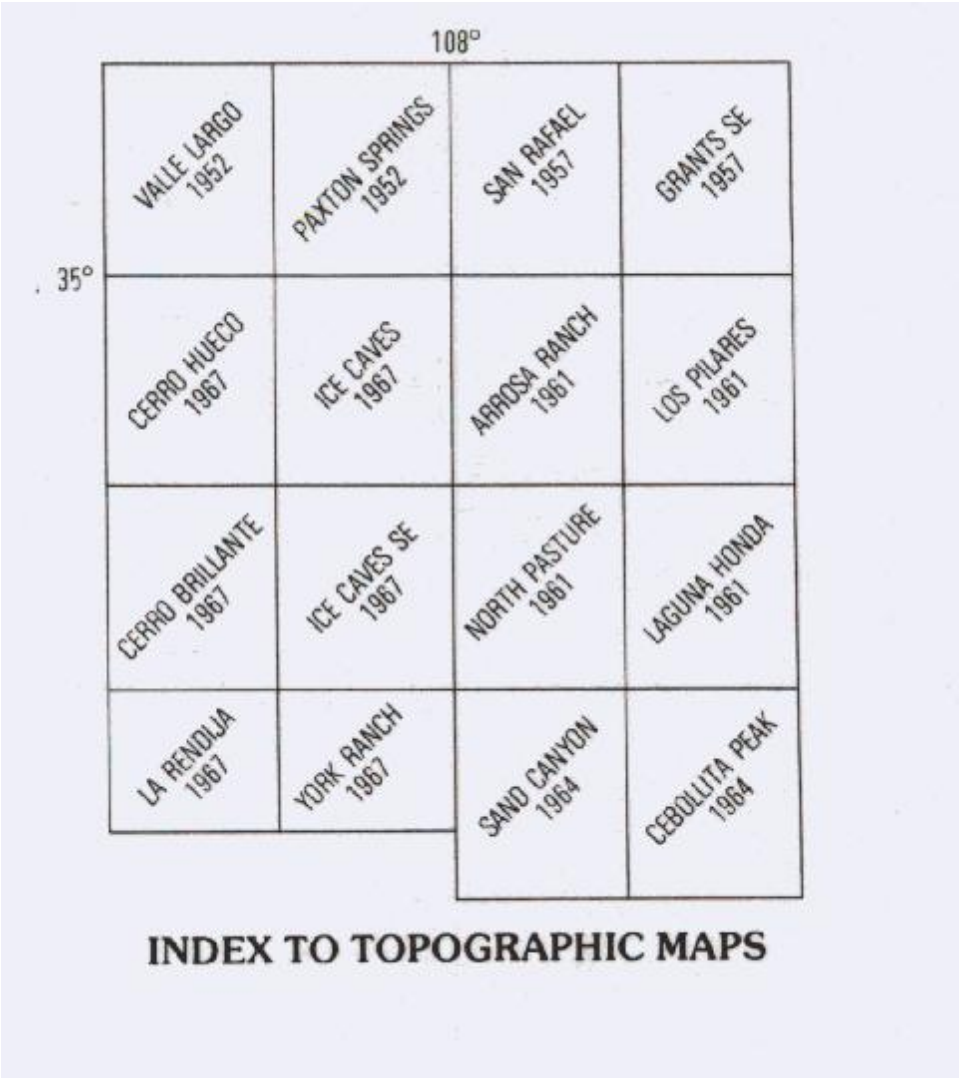
Index Map



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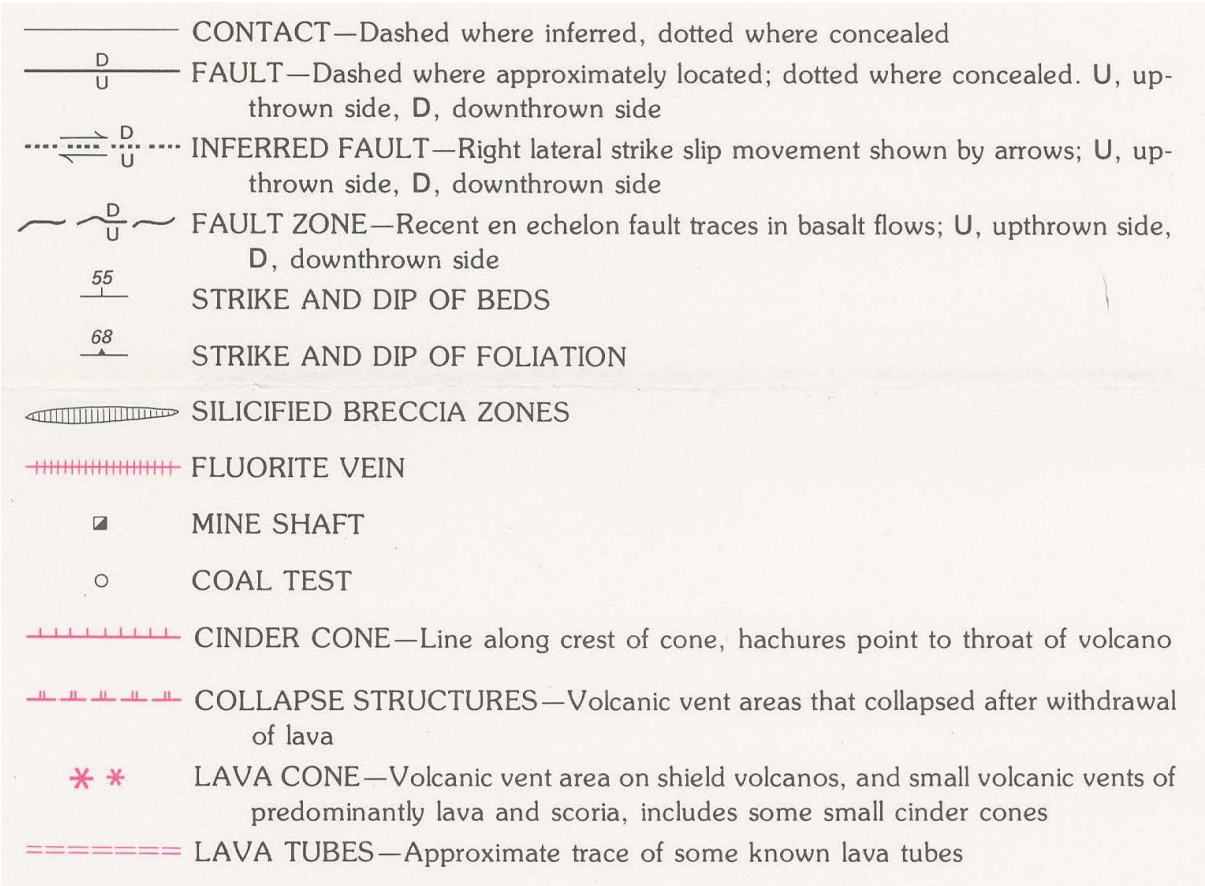
Legend



Extracted from: (I-1595).

Structure

North Plains and Cebolita Mesa are separated by a complex fault zone that trends N. 25-30E., west side generally down, and that has a postulated right-lateral component based largely on the orientation and displacement of lateral faults, for example the wedge-shaped block of Tres Hermanos Sandstone at the south end of North Pasture, downfaulted about 650 ft (200 m) relative to the surrounding Dakota Sandstone. In the northeast corner of the map area, and to the north, the fault zone fans out to east- and northeast-trending faults and into the north-trending, east-dipping Grants monocline. The cluster of cinder cones in the western part of the map area appears to have extruded along a series of north-trending en echelon faults in a zone that trends about N.30E. and has a right-lateral component of movement, impinging on and distorting the southwestern flank of the Zuni uplift. The positions and attitudes of several steptoes in the basalt flows south of the Zuni uplift imply the presence of faults or folds having a north to west trend, now completely hidden by the lava cover. Three prominent Holocene faults in the southern part of the map area, and extending several miles to the south, are expressed in the lava flows by a series of short en echelon open crevices or fissures. The lack of alluvial fill in the fissures indicates a very young age for the faulting. Numerous small fault scarps in unconsolidated alluvium at the eastern edge of North Plains are also very young. Only the most prominent of these north-trending faults are shown on the map.

Extracted from: (I-1595).

Mineral Deposits

Fluorite deposits were discovered in the Zuni Mountains about 1908, and approximately 224,000 tons of ore were produced between 1937 and 1953. The largest mines are the 21 and 27, near the southeastern end of the district. The deposits are confined to the Precambrian rocks, generally in northeast- and east-trending, south- to southwest-dipping veins. The mineralization was apparently controlled by the major northwest-trending faults (Goddard, 1966). Significant features of the deposits are an almost complete lack of sulfide minerals and an associated alteration characterized by mild silicification and finely disseminated hematite. Veins range from a few centimeters to 5 m in width and are filled with coarsely crystalline, bright-green fluorite that is generally brecciated and locally mixed with wall-rock fragments. The breccia is locally cemented by fine-grained, purple fluorite. Associated gangue minerals are sparse calcite, barite, and quartz.

Extracted from: (I-1595).

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Extracted from: (I-1595).

GRI McCarty's Quadrangle Map (MCCA)

Map Unit List

The geologic units present on the GRI Digital Geologic Map of the McCarty's Quadrangle, New Mexico (*GRI MapCode MCCA*) are listed below. Units are listed with their assigned unit symbol and unit name (e. g., Qal - Alluvium). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the map's Geologic Unit Information (MCCAUNIT) table included with the GRI geology-GIS data.

Geologic Map Units

Cenozoic Era

Quaternary Period
Qal - Alluvium (Qal)
Basalt flows from Zuni Centers
  Qbd - McCartys flow (Qbd)
  Qba - Oldest Zuni basalt flow (Qba)
Qtg - Terrace alluvium and gravel (Qtg)
Ql - Landslide deposits (Ql)
Qc - Colluvium of McCartys Mesa (Qc)

Tertiary Period
Tb - Basalt on Horace Mesa (Tb)
Td - Diabase dikes (Td)

Mesozoic Era

Cretaceous Period
Crevasse Canyon Formation
  Kcg - Crevasse Canyon Formation, Gibson Coal Member (Kcg)
  Kcd - Crevasse Canyon Formation, Dalton Sandstone Member (Kcd)
  Kcs - Crevasse Canyon Formation, Stray sandstone member (Kcs)
  Kcdi - Crevasse Canyon Formation, Dilco Coal Member (Kcdi)
Gallup Sandstone
  Kgm - Gallup Sandstone, main body (Kgm)
  Kgu - Gallup Sandstone, upper tongue (Kgu)
  Kgl - Gallup Sandstone, lower tongue (Kgl)
Mancos Shale
  Kmm - Mancos Shale, Mulatto Tongue (Kmm)
  Km - Mancos Shale, main body (Km)
  Kmwc - Mancos Shale, Whitewater Arroyo and Clay Mesa Shale Tongues, undivided (Kmwc)
  Kmw - Mancos Shale, Whitewater Arroyo Shale Tongue (Kmw)
  Kmc - Mancos Shale, Clay Mesa Shale Tongue (Kmc)
Dakota Sandstone
  Kdt - Dakota Sandstone, Twowells Sandstone Tongue (Kdt)
  Kdp - Dakota Sandstone, Paguate Sandstone Tongue (Kdp)
  Kdc - Dakota Sandstone, Cubero Sandstone Tongue (Kdc)
  Kdo - Dakota Sandstone, Oak Canyon Member (Kdo)
  Kds - Dakota Sandstone, Basal sandstone unit of the Oak Canyon Member (Kds)

MCCA Map Unit Descriptions

Descriptions of all geologic map units are presented below.

Qal - Alluvium (Holocene and Pleistocene)

Composed largely of clayey silt and fine sand, locally a few coarse sand grains or pebbles. Includes extensive colluvial deposits in northeastern part of quadrangle, and recent eolian deposits, especially on slopes west-facing mesas. As much as 15 m exposed in gullies. *GRI Source Map ID 1076. (*OF-77-380)

Qbd and Qba - Basalt from Zuni Centers (Holocene and Pleistocene)

Includes: **Qbd (McCartys flow),** and **Qba (Oldest Zuni basalt flow)**

The youngest (Qbd - McCartys flow) and the oldest (Qba) of four extensive flows that originate at the Zuni volcanic centers southwest of the quadrangle (Thaden and others, 1967). The McCartys flow is apparently about 1,000 years old (Nichols, 1946). It is coarse grained, porous with small voids between groundmass plagioclase and subophitic augite. Brownish glass with micro-lites of Fe-Ti oxides partly fills Interstices between plagioclase laths; olivine tholeiite (Lipman and Moench, 1972). *GRI Source Map ID 1076. (*OF-77-380)

Qtg - Terrace alluvium and gravel (Holocene and Pleistocene)

Composed largely of pebbles, cobbles, and boulders of volcanic and Precambrian rocks in a matrix of silt and sand. *GRI Source Map ID 1076. (*OF-77-380)

Ql - Landslide deposits (Holocene and Pleistocene)

Mostly toreva-block slides of basalt, Gallup and Dakota Sandstones and Mancos Shale. Includes some rock and mud-flow slides, talus, fan accumulations and alluvium, some of which are derived from outcrops and some from landslide debris. The slides are generally older than the alluvium (Qal). *GRI Source Map ID 1076. (*OF-77-380)

Qc - Colluvium of McCartys Mesa (Holocene and Pleistocene)

Mantling deposits composed largely of colluvial, soil, caliche, terrace sand and gravel, alluvium, and wind-blown sand. Includes local small outcrops of Mancos Shale and Twowells Sandstone. *GRI Source Map ID 1076. (*OF-77-380)

Tb - Basalt on Horace Mesa (Pleistocene? and Pliocene?)

Several separate flows originating from local vents north of quadrangle. Composed of silicic alkali-olivine basalt with 1-2 percent olivine phenocrysts and a few large resorbed plagioclase grains in a groundmass of trachytic augite and plagioclase, sparse interstitial glass. *GRI Source Map ID 1076. (*OF-77-380)

Td - Diabase dikes (Pleistocene? and Pliocene?)

Very fine grained, subophitic, composed of randomly oriented laths of plagioclase, interstitial anhedral augite, and minor scattered small grains of magnetite and apatite. Contacts with the enclosing rock are

generally marked by a thin aphanitic chill border in the dike and a hardened or silicified zone in the enclosing sandstone or shale. Range in thickness from a few decimeters to slightly more than 6 m. *GRI Source Map ID 1076.* (OF-77-380)

Crevasse Canyon Sandstone

Kcg - Crevasse Canyon Formation, Gibson Coal Member (Upper Cretaceous)

Largely covered by landslide debris, most exposures interpreted from aerial photographs; sparse data indicate thin-bedded sandstone, siltstone, and shale with numerous interbeds of highly carbonaceous shale and coal a few decimeters to a probable maximum of I m thick. Total thickness about 20-25 m. *GRI Source Map ID 1076.* (OF-77-380)

Kcd - Crevasse Canyon Formation, Dalton Sandstone Member (Upper Cretaceous)

Light-gray and Yellowish-gray, fine- and medium-grained thin- to thick bedded sandstone. Thickness about 15 m. *GRI Source Map ID 1076.* (OF-77-380)

Kcs - Crevasse Canyon Formation, Stray sandstone member (Upper Cretaceous)

Yellowish-gray, fine- to coarse-grained thin- to medium-bedded sandstone. Thickness 35-45 m. *GRI Source Map ID 1076.* (OF-77-380)

Kcdi - Crevasse Canyon Formation, Dilco Coal Member (Upper Cretaceous)

Light yellowish-gray to white thin-bedded sandstone and siltstone with interbedded light- to dark-gray carbonaceous shale and coal beds 1/2 to as much as 1 1/2 m thick, some of which may constitute a future resource. Thickness 35-45 m. *GRI Source Map ID 1076.* (OF-77-380)

Gallup Sandstone

Kgm - Gallup Sandstone, main body (Upper Cretaceous)

Sandstone, tan to pale brown, fine to medium grained. Upper 1 m thin bedded, has shale partings, is heavily iron stained and capped by ironstone concretions. Underlying sandstone is massive, forms prominent cliff. Lower 1-2 m is massive sandy siltstone. Thickness 20-25 m. *GRI Source Map ID 1076*. (OF-77-380)

Kgu - Gallup Sandstone, upper tongue (Upper Cretaceous)

Sandstone, light tan to light gray, very fine to medium grained, massive, crossbedded, silty at base; lenses of calcareous sandstone and sandy limestone at top. Thickness 3.5-12 m. *GRI Source Map ID 1076.* (OF-77-380)

Kgl - Gallup Sandstone, lower tongue (Upper Cretaceous)

Sandstone, light gray and tan, brown weathering, fine to medium grained, medium bedded to massive. Top 1 m resistant bed of brown weathering calcareous sandstone and sandy limestone. Lower part is interbedded siltstone and calcareous sandstone with limestone lenses. Thickness 6-20 m. *GRI Source Map ID 1076.* (OF-77-380)

Mancos Shale

Kmm - Mancos Shale, Mulatto Tongue (Upper Cretaceous)

Poorly exposed, forms rubble covered slope; composed of tan and gray calcareous sandstone and siltstone, and greenish-gray fissile shale. Thickness 13-20 m. *GRI Source Map ID 1076. (*OF-77-380)

Km - Mancos Shale, main body (Upper Cretaceous)

Includes two units that intertongue with the Gallup Sandstone, and the main body below the lowest Gallup Sandstone tongue. The upper tongue, 25-30 m thick, is greenish-gray and grayish-brown silty shale with shaly siltstone in the upper part. The lower tongue, 12-20 m thick, is dark-gray carbonaceous shale with light-gray and tan silty shale and siltstone in the upper part. The main body below the lowest Gallup Sandstone Tongue is 100-110 m thick. The upper 15 m is siltstone, light to dark gray, thin bedded calcareous carbonaceous, with lenses of fine-grained sandstone; the underlying 40 m is shale, light brown, purplish brown, purplish gray and gray, fissile to blocky with about 10 percent interbedded thin siltstone and sandstone layers. The lower 55 m is shale, dark gray to black, wavy laminated and fissile. Exposures are poor; much of the alluvium shown on the northern half of the quadrangle may be colluvium on Mancos Shale. *GRI Source Map ID 1076. (*OF-77-380)

Kmwc - Mancos Shale, Whitewater Arroyo and Clay Mesa Shale Tongues, undivided (Upper Creta

Dark-gray shale, mapped only in southeastern corner of the quadrangle. *GRI Source Map ID 1076. (*OF-77-380)

Kmw - Mancos Shale, Whitewater Arroyo Shale Tongue (Upper Cretaceous)

Dark-gray soft slope-forming shale and siltstone; uppermost part is light-gray silty shale and siltstone transitional into the overlying Twowells Sandstone Tongue of the Dakota Sandstone. Contains lenticular bentonite layers and yellow-brown weathering cone-in-cone limestone concretions. Thickness 45-50 m. *GRI Source Map ID 1076. (*OF-77-380)

Kmc - Mancos Shale, Clay Mesa Shale Tongue (Upper Cretaceous)

Shale, medium to dark gray, silty in part. Grayish-tan sandstone and siltstone in upper part grades into overlying Paguate Sandstone Tongue of Dakota Sandstone. Lower 15 m contains bentonite beds and brown weathering limestone concretions. Thickness about 20 m. *GRI Source Map ID 1076. (*OF-77-380)

Dakota Sandstone

Kdt - Dakota Sandstone, Twowells Sandstone Tongue (Upper Cretaceous)

Sandstone, fine to very fine grained, silty, local thin lenses medium to coarse grained; light gray, weathers to grayish orange, light brown and tan; thin to medium bedded. Local thicker lenses have foreset-type crossbeds, resistant slabby beds at top grading downward to silty sandstone with thin interbeds of siltstone in lower part, contains many imprints, burrows, and trails, and disturbed bedding. Uppermost part contains "Gryphaea" newberryi Stanton (Landes and others, 1973, p. J9). Thickness 5-25 m. *GRI Source Map ID 1076. (*OF-77-380)

Kdp - Dakota Sandstone, Paguate Sandstone Tongue (Upper Cretaceous)

Paguate Sandstone Tongue (Upper Cretaceous)—Light brown and tan, fine to very fine grained, local lenses are medium to coarse grained, thin to medium bedded. Thickness 0-30 m. Pinches out in southeastern corner of quadrangle. *GRI Source Map ID 1076. (*OF-77-380)

Kdc - Dakota Sandstone, Cubero Sandstone Tongue (Upper Cretaceous)

Light grayish-tan, weathers yellowish-gray, very fine grained sandstone and siltstone. Carbonaceous plant fragments, tracks, trails, and borings are abundant, especially near top. Brown-weathering limestone concretions, locally very fossiliferous, occur in upper part of unit; lower part contains thin to very thin interbeds of very fine grained sandstone, siltstone, limestone, and shale, locally very fossiliferous. About 0.5 m exposed in southeastern part of quadrangle. *GRI Source Map ID 1076. (*OF-77-380)

Kdo - Dakota Sandstone, Oak Canyon Member (Upper and Lower Cretaceous)

Sandstone and siltstone, light gray and grayish tan, locally calcareous or carbonaceous; sandstone is very fine grained and thin bedded, siltstone is generally shaly with abundant finely comminuted carbonaceous material ; numerous thin-bedded light-gray, brown weathering, fossiliferous limestone lenses and concretions, and limestone or aragonite cone-in-cone concretions. Thickness 15-30 m. *GRI Source Map ID 1076. (*OF-77-380)

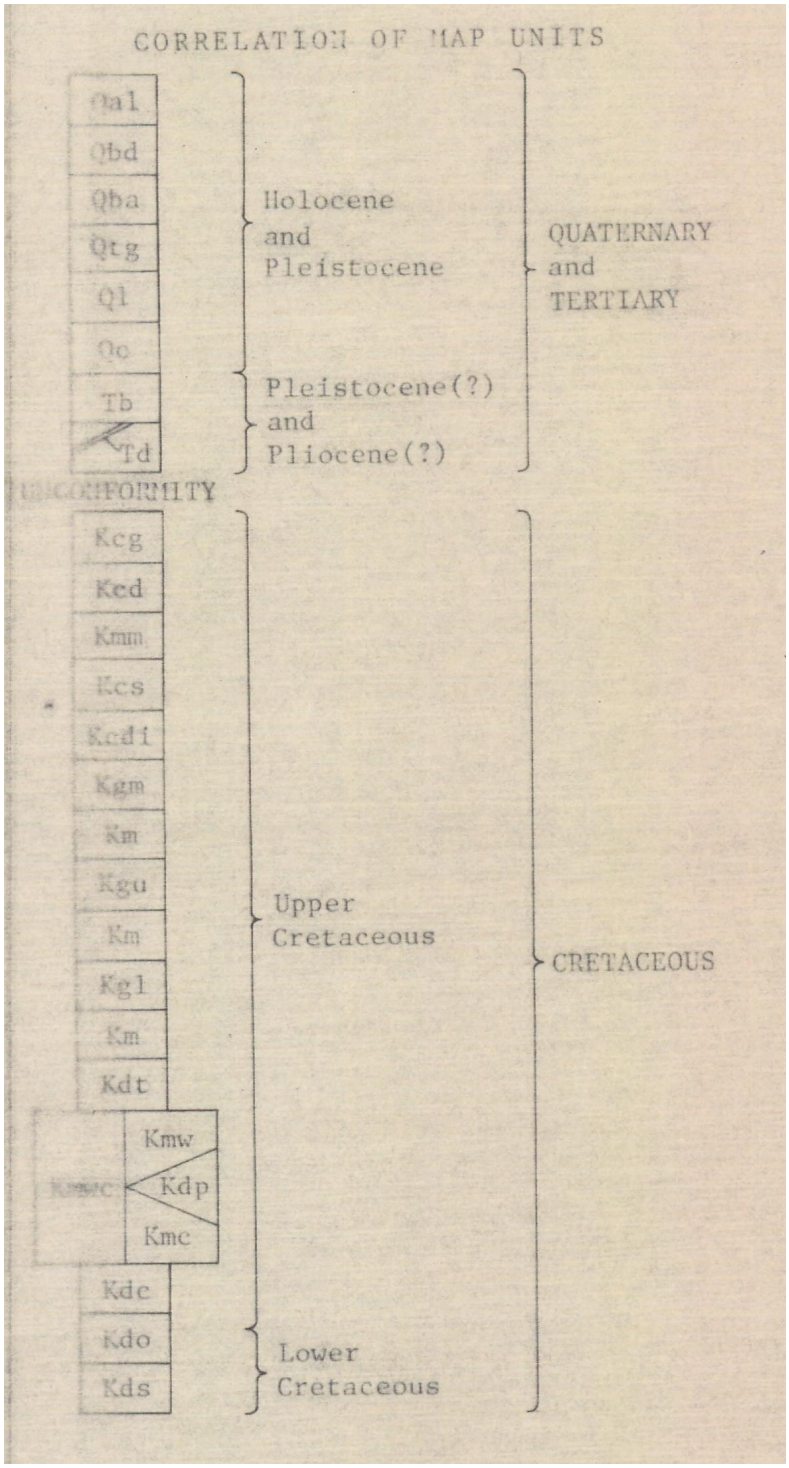
Kds - Dakota Sandstone, Basal sandstone unit of the Oak Canyon Member (Lower Cretaceous)

Sandstone, light gray to white, fine to medium grained, siliceous cement. *GRI Source Map ID 1076. (* OF-77-380)

GRI Source Map Citation (OF-77-380)

Maxwell, C.H., 1977, Preliminary Geologic Map of the McCarty's Quadrangle, Valencia County, New Mexico, U.S. Geological Survey, Open-File Report OF-77-380, 1:24,000 scale. (*GRI Source Map ID 19127*)

Correlation of Map Units



Extracted from: (OF-77-380).

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