

GM-67—Geology of French Mesa quadrangle, Rio Arriba County, New Mexico  
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(Discussion text on back of map sheet)

## PREVIOUS AND PRESENT WORK

The earliest published geologic work to include the area of the French Mesa quadrangle was a reconnaissance survey by Cope (1875). Renick (1931) included the western part of the quadrangle on a reconnaissance geologic map in a regional ground-water report. An MS thesis, concerned mainly with stratigraphy, included a geologic map at 1:63,360 scale that covered the quadrangle (Fitter, 1958). The western part of the quadrangle was covered on a regional map at 1:63,360 scale by Baltz (1962, 1967) as part of a study of Upper Cretaceous and Tertiary strata in the central-eastern San Juan Basin. Geologic 7<sup>1</sup>/<sub>2</sub>-min quadrangle maps published by the New Mexico Bureau of Mines and Mineral Resources that are adjacent to the French Mesa quadrangle are the Regina quadrangle (Merrick and Woodward, 1982) to the southwest and the Gallina quadrangle (Woodward et al., 1976) to the south. The French Mesa quadrangle was mapped by Crouse (1985) and Hultgren (1986) as parts of MS theses supervised by Woodward.

## STRATIGRAPHY

The oldest rock unit exposed in the French Mesa quadrangle is the Lower Permian Cutler Formation (*Pc*). Only the upper 700 ft are exposed, but information from a completion card for the Skelly–Federal Carey No. 1 well (sec. 36 T24N R1E) suggests that the total thickness of the Cutler in the French Mesa quadrangle is about 2,340 ft. This figure is in close agreement with a regional isopach map by Baars (1962) that shows between 2,300 and 2,400 ft of Cutler in this area.

The completion card for the Skelly well also suggests that about 2,400 ft of Pennsylvanian Madera Formation are present in the subsurface. In the Regina quadrangle to the southwest the Madera is up to 1,775 ft thick (Merrick and Woodward, 1982), and in the Gallina quadrangle to the south the Madera has a maximum thickness of 1,500 ft (Woodward et al., 1976).

Mississippian beds are present locally in the Nacimiento uplift to the south where much of the area was uplifted and eroded before deposition of Pennsylvanian rocks (Merrick and Woodward, 1982); it is possible that Mississippian strata may be present locally in the subsurface in the French Mesa quadrangle as well. Precambrian metamorphic and igneous rocks unconformably underlie Carboniferous rocks in the Nacimiento uplift to the south (Woodward et al., 1977); therefore, it is likely that red granite beneath Pennsylvanian beds in the Skelly well is also of Precambrian age.

In central-northern New Mexico the Upper Triassic Chinle Formation typically consists of four units; they are, in ascending order, the Agua Zarca Sandstone Member, Salitral Shale Tongue, Poleo Sandstone Lentil, and upper shale member. The lower two units pinch out northward, and in the French Mesa quadrangle the Poleo (*Fp*) is disconformable on Permian beds and is gradationally overlain by the upper shale member (*Fu*).

In the French Mesa quadrangle the Jurassic Morrison Formation was mapped as one unit (*Jm*), but three stratigraphic divisions are recognized; they are, in ascending order, a maroon member, a green member, and a kaolinitic sandstone member. Owen (1984) and Saucier (1974) considered white, kaolinitic sandstone present beneath the Dakota Formation (Cretaceous) in central-northern New Mexico to be correlative with the Burro Canyon Formation (Lower Cretaceous), but to the south along the eastern edge of the San Juan Basin the kaolinitic sandstone has been correlated with the Jackpile Sandstone Member of the Morrison Formation (Woodward and Schumacher, 1973). Although the correlation of the kaolinitic sandstone member is uncertain, we prefer to include it with the Morrison Formation.

The Mancos Shale (*Km*) comprises seven units, but poor exposures precluded mapping them individually. These units are, in ascending order, the Graneros Shale Member, the Greenhorn Limestone Member, the lower part of the Carlile Shale Member, the Juana Lopez Member, the upper part of the Carlile Shale Member, the Niobrara Shale Member, and the unnamed upper part of the Mancos Shale. The Greenhorn in the French Mesa quadrangle consists of interbedded shale, siltstone, and silty limestone concretions. The Juana Lopez is composed of thin interbeds of calcarenite, very fine grained quartzose sandstone, and shale. A regional unconformity separates rocks of Carlile and Niobrara age (Dane, 1960).

The Lewis Shale (*Kl*) contains numerous thin beds of bentonite. A bed that is several feet thick and present throughout the San Juan Basin was named the Huerfanito bentonite by Fassett and Hinds (1971, p. 6). The Pictured Cliffs Sandstone, present above the Lewis Shale in the San Juan Basin to the west, is absent for a considerable distance along the east side of the basin. Fassett and Hinds (1971) suggested that uplift along the Nacimiento–Gallina front at the time of deposition of the Pictured Cliffs or shortly after resulted in either nondeposition or erosion of this unit.

The Fruitland Formation and the Kirtland Shale were mapped as a single, undivided unit (*Kkf*). Fassett and Hinds (1971) reported that the Kirtland may be absent in the French Mesa quadrangle, but this could not be determined because of generally poor exposures and the gradational contact between these units.

## STRUCTURE

In the French Mesa quadrangle the San Juan Basin is separated from the Gallina–Archuleta arch to the east by the Hogback monocline. These major tectonic elements developed principally during Laramide (Late Cretaceous–early Tertiary) time, although movement on some faults in the quadrangle may be younger. There are about 9,000 ft of structural relief between the San Juan Basin and the Gallina–Archuleta arch, with most of the relief accounted for by folding along the monocline (cross sections A–A' and B–B'). The anticlinal bend of the Hogback monocline is shown

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as noted by Baltz (1967). The accompanying synclinal bend is approximately 2 mi to the west but is poorly defined because of lack of a sharp bend along the hinge. A structural terrace is inferred in the southwestern part of the quadrangle (cross section B-B'). Also in the southwest part of the quadrangle there is a west-northwest-trending syncline that appears to be continuous with the central axis of the San Juan Basin as defined by Baltz (1967).

Two major, north-northeast-trending faults are present. The Gallina fault, on the west, is nearly vertical at the surface and is characterized by variable offset along its trace (Fig. 1). At the southern edge of the quadrangle there are approximately 700 ft of stratigraphic separation with the west side down. About 2.6 mi to the north there are at least 1,600 ft of stratigraphic separation where a shallow syncline on the west side of the fault is juxtaposed with a poorly defined northwest-plunging anticline on the east side of the fault. In the northern part of sec. 2 T24N R1E the east side is downthrown about 100 ft. Farther north at the boundary of the quadrangle, the west side is again downthrown with approximately 250–300 ft of stratigraphic separation. This geometry suggests strike-slip as well as dip-slip motion. There are no readily correlated piercing points along the Gallina fault in the French Mesa quadrangle that would enable precise calculation of the slip. Kelley (1955) suggested that the eastern margin of the Colorado Plateau underwent right shift with respect to the Nacimiento uplift to the east. Baltz (1967) proposed that right shift occurred along the Gallina fault as the San Juan Basin was downbuckled and shortened relative to the French Mesa arch. Near the north end of the French Mesa quadrangle there are about 1,200 ft of left separation of the Todilto Formation along the Gallina fault, suggesting that right slip dies out northward and that movement on the fault there is mainly dip slip.

The Cañada normal fault dips 65°–75° to the west and has at least 500 ft of stratigraphic separation at the south edge of the quadrangle. Displacement dies out northward, and the fault cannot be traced north of sec. 11 T24N R1E.

The French Mesa fault dips 75° to the north and trends west-northwestward. Stratigraphic separation is about 30 ft near its western end where the Poleo Sandstone Lentil is offset, but the offset at the east end is in the opposite sense, suggesting a scissors fault. Other faults in the quadrangle are high angle and generally have separations of a few tens of feet.

The arcuate French Mesa anticline trends north-northeastward and is doubly plunging. The west limb of this broad fold is broken by the Gallina and Cañada faults (cross sections A-A' and B-B'). Cañada de la Cueva anticline in sec. 10 T24N R1E plunges gently to the south-southwest. A small syncline in secs. 33 and 34 T24N R1E between the Gallina and Cañada faults plunges west-southwestward; this fold is asymmetric, with the southeast limb dipping as much as 60° and the northwest limb dipping 33°.

Nine wells have been drilled for hydrocarbons in the French Mesa quadrangle; four produced oil, presumably from the Niobrara interval of the Mancos Shale (M. L. Davies, pers. comm. 1984), with initial production ranging from 55 to 360 barrels of oil per day. Production from the Niobrara is from fracture reservoirs in brittle siltstone and carbonate-rich interbeds in the Mancos (Gorham et al., 1979) where there is maximum curvature or flexure of these beds at fairly shallow depths (i.e., at low confining pressures). The area of production in the French Mesa quadrangle (sec. 5 T24N R1E and sec. 32 T25N R1E) may be related to a flexure indicated by the change in strike of beds in the Mesaverde Group to the east of the oil field. Other areas with flexures in the Mancos Shale are indicated by changes in strike in this unit in the southwestern part of the quadrangle and should be considered for exploration. This latter area is also cut by several transverse faults that might enhance permeability in the Niobrara.

Gypsum in the Todilto Formation is exposed in large outcrops in sec. 4 T23N R1E and secs. 3 and 10 T24N R1E, but difficult access, low unit value, and distance from a market make it uneconomic at this time.

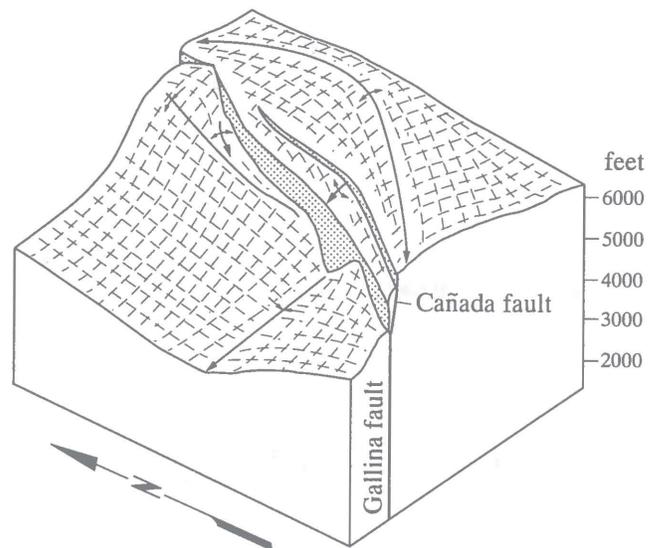


FIGURE 1—Generalized block diagram showing configuration of top of Cutler Formation, Gallina fault, and Cañada fault in French Mesa quadrangle.

Thin seams of coal in the Mesaverde Group have been mined on a small scale, probably for local use. Steep dip of the beds, thinness of the coal seams, and the amount of overburden covering most of the coal make conventional mining uneconomic.

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