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THE LEAD CAMP LIMESTONE AND ITS CORRELATIVES IN SOUTH-CENTRAL NEW MEXICO

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INTRODUCTION

Nomenclature of Pennsylvanian rocks in New Mexico has posed many problems. Facies changes that cross time lines (faunal zones) are characteristic of these rocks. This characteristic has contributed to two major types of nomenclature: (1) naming of mappable or rock-stratigraphic units, and (2) naming of faunal zones or biostratigraphic units, with little regard to how they relate to each other. Both nomenclatures result in a great number of stratigraphic names, but most workers have applied the first type because it follows the conventions of mappability as outlined by the Code of Stratigraphic Nomenclature (American Commission on Stratigraphic Nomenclature, 1970). Some workers, however, have applied biostratigraphic names, because of the intricate biostratigraphic relations of these rocks and because it appears more practical, in some places, to correlate faunal zones from one mountain range to another than to try to correlate rock units. In deep basins in the subsurface, it is more difficult to divide Pennsylvanian rocks on a lithologic basis alone, and faunal zones serve a useful purpose.

Our approach to this problem of stratigraphic nomenclature has been to use principles of both physical stratigraphy and biostratigraphy. We have traced rock units in the field and have attempted to fit these units and their changes in facies into mappable formations. While tracing units we collected fusulinids; these fusulinids were used as the basis for a framework of faunal zones for the formations.

Owing to the problems of correlating rock units from one mountain range to another, our approach encourages a multiplicity of stratigraphic names. Regardless of this disadvantage, we believe that this approach will lead ultimately to a better understanding of the stratigraphy and to a more precise interpretation of the paleogeography. Our correlations are shown on Table 1 and Figure 2.

Local names are preferable to the usage of "Magdalena Formation" or "Magdalena Group." The Magdalena has been used in the past to designate rocks of predominantly Pennsylvanian age in New Mexico and West Texas. Where exposed, individual formations can usually be mapped on the basis of lithology; the term Magdalena Group is superfluous and its use should be discouraged.

The fusulinid zones used in this report are those outlined by Thompson (1964, p. C389-393). The generic name *Beedeina* is now used for most North American species that were formerly referred to *Fusulina* (Ishi, 1957, 1958). Hence, the "zone of *Beedeina"* is used instead of "zone of *Fusulina."*

The zone of *Millerella* includes latest Mississippian and Early Pennsylvanian time; the zone of *Profusulinella,* early Middle Pennsylvanian time; the zone of *Fusulinella,* middle Middle Pennsylvanian time; the zone of *Beedeina,* late Middle Pennsylvanian time; and the zone of *Triticites,* Late Pennsylvanian time.

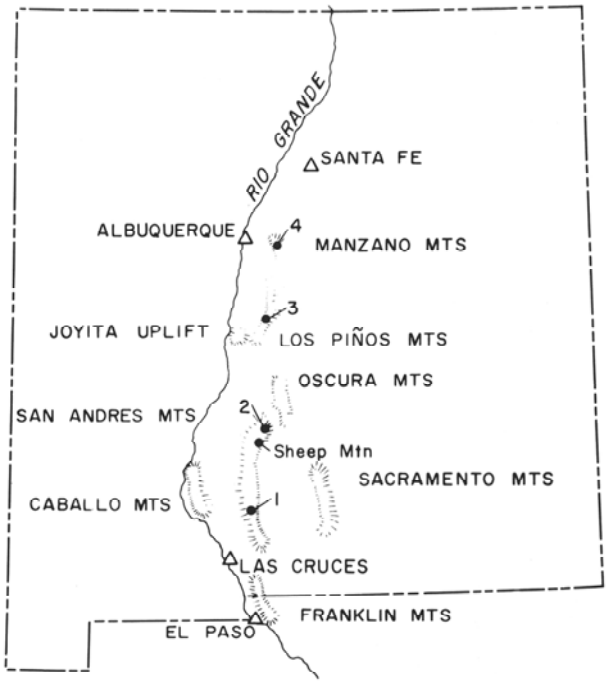


Figure 1. Index map of New Mexico showing location of stratigraphic sections discussed in text. 1, Type section, Lead Camp Limestone; 2, Northern San Andres Mountains; 3, Type section, Los Moyos Limestone; 4, Northern Manzano Mountains.

LEAD CAMP LIMESTONE

Southern San Andres Mountains

We named the Lead Camp Limestone for "the massive cliff-forming cherty limestone beds that unconformably overlie the Mississippian and underlie the rocks of the Panther Seep Formation" in the southern part of the San Andres Mountains (Bachman and Myers, 1969, p. 22) (Figs. 1, 2). The lower part of the Lead Camp includes temporal equivalents of the Sandia Formation and may be traced into the northern part of the San Andres Mountains (Bachman, 1965; Bachman and Harbour, 1970). In the northern part of the mountains, the calcareous beds typical of the lower-part of the Lead Camp at its type section have been replaced by shale and sandstone typical of the Sandia Formation, and the northern rocks are separable into these two formations.

We have applied the name Lead Camp Formation to the massive limestone of Pennsylvanian age in the San Andres Mountains. This name is useful in this local area because the rock units can be traced through lateral facies and faunal changes. The nomenclature of the Franklin Mountains to the

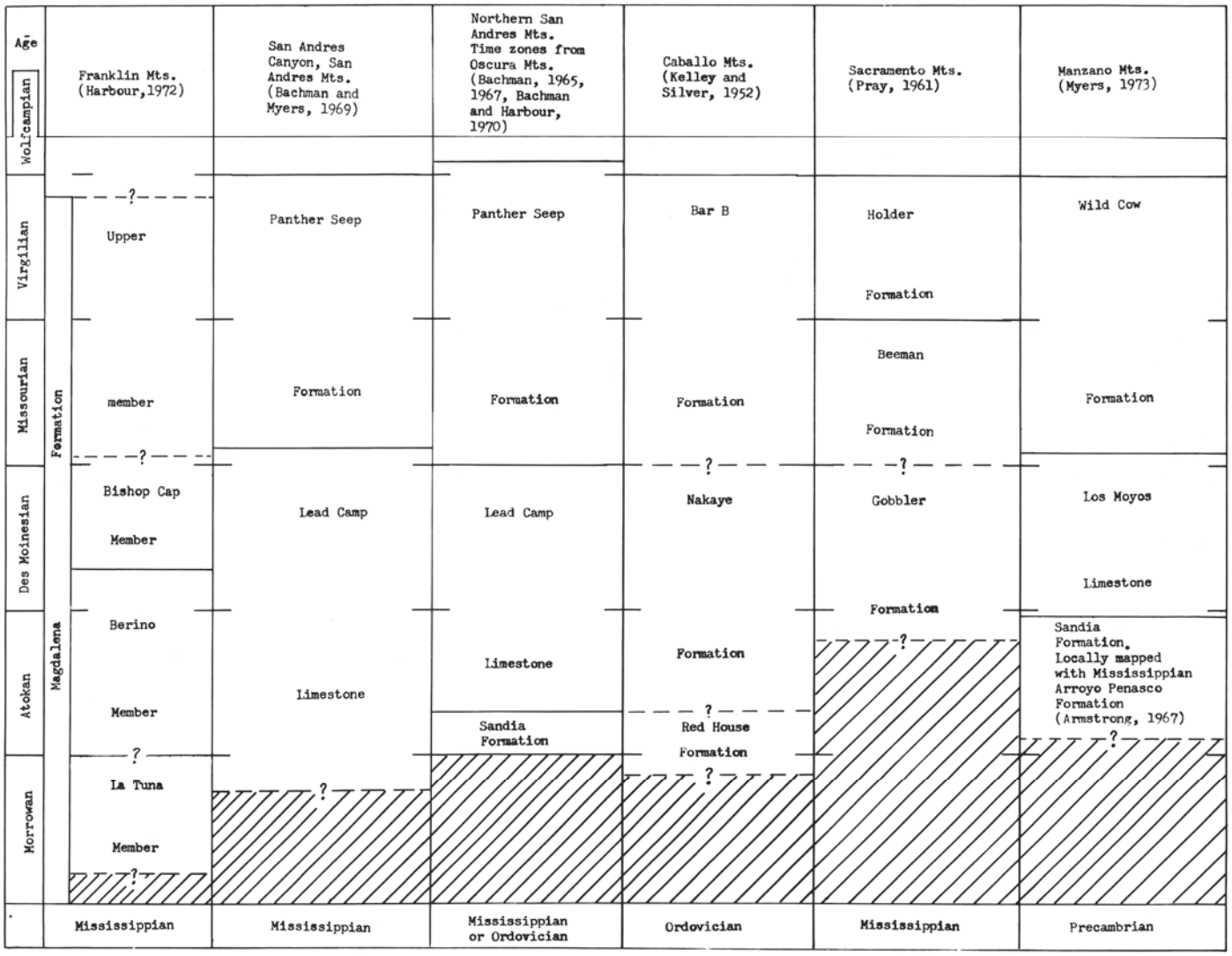


Table 1. Correlation of Pennsylvanian formations, south-central New Mexico.

south (Harbour, 1972) and of other nearby mountain ranges is inapplicable because the sequence of rocks in those locations is different. The rock units most easily correlated between mountain ranges are those between the Caballo Mountains (Kelley and Silver, 1952) to the west and the northern part of the San Andres Mountains. To the east of the San Andres Mountains, different facies relations prevail and local names have been introduced (Pray, 1961). We have not attempted to use the nomenclatures of either the Caballo or the Sacramento Mountains, because the east-west facies relations of Pennsylvanian rocks are not known.

The Lead Camp consists mostly of massive, cliff-forming, cherty limestone. The limestone is medium to dark gray and weathers gray to brown. Chert is common as nodules and lenses, and replaces some intervals of limestone 4 to 5 ft (1.2 to 1.5 m) thick. In the type section, calcareous shale is present in the basal 240 ft (75 m) of the formation. The presence of these clastic beds suggests lithologic equivalence to the Sandia Formation in the northern part of the San Andres.

The Lead Camp is about 860 ft (265 m) thick in the southern San Andres Mountains. At the type section, the lowermost 85 ft (26 m) contain *Millerella* cf. *M. marblensis* Thompson. The overlying 188 ft (56 m) of rocks contain *Fusulinella* aff. *F. devexa* Thompson and other species of *Fusulinella*. These fusulinids indicate deposition during Atokan time. About 12 mi south, in Little San Nicholas Canyon, where the Lead Camp is about 320 ft (98 m) thick, fusulinids transitional between *Fusulinella* and *Beedeina* are present 228 ft (70 m) above the base. These specimens are poorly preserved, but they suggest that the boundary between Atokan and Des Moinesian faunas in Little San Nicholas Canyon may be stratigraphically near this horizon.

Rocks at the type section are overlain by about 100 ft (32 m) of non-fusulinid-bearing limestone and shale. The remaining interval, to within about 125 ft (38 m) of the top of the formation, contains an assemblage of the fusulinid genera *Beedeina* and *Wedekindellina,* with strongly fluted specimens of *Beedeina* in the upper part. These fusulinids indicate deposition during Des Moinesian time.

The uppermost limestone bed in the Lead Camp contains *Triticites* aff. *T. nebraskensis* Thompson, which indicates deposition during early Missourian time.

In summary, the Lead Camp Limestone embraces the fusulinid zones of *Fusulinella* and *Beedeina,* and the lowermost part of the zone of *Triticites.* If the basal beds of the Lead Camp are of Morrowan age, then the zones of *Millerella*

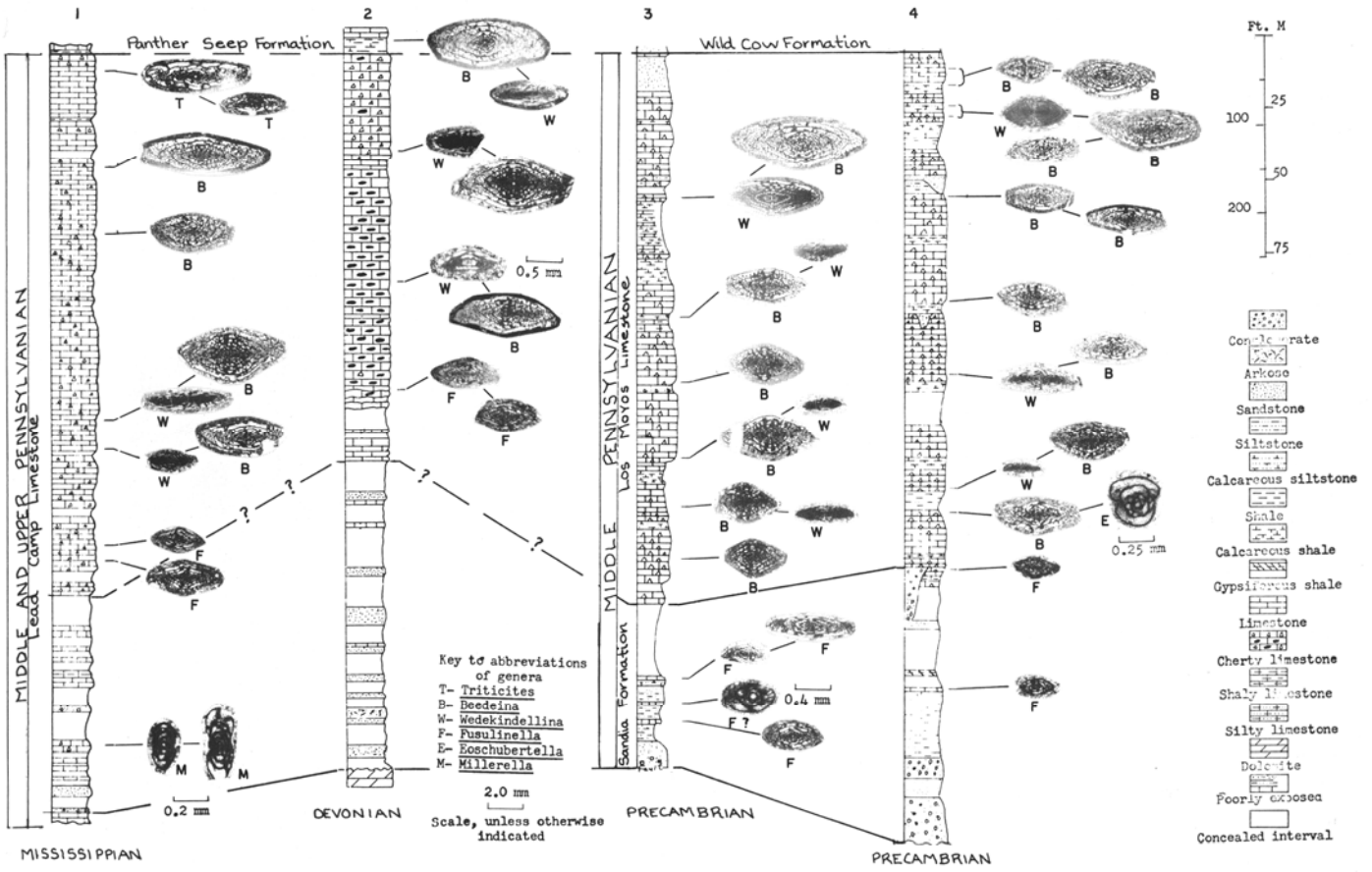


Figure 2. Stratigraphic sections and fusulinids from Lead Camp and Los Moyos Limestones. 1), Type section, Lead Camp Limestone, southern San Andres Mountains; 2) Capitol Peak, northern San Andres Mountains; 3) Type section, Los Moyos Limestone, southern Manzano Mountains; 4) Sol se Mete, northern Manzano Mountains.

and *Profusulinella* may also be represented. Deposition of the Lead Camp took place during Morrowan (?), Atokan, Des Moinesian, and earliest Missourian time.

Northern San Andres Mountains

The Lead Camp Limestone generally thins toward the north in the San Andres Mountains, and both basal and upper contacts of the limestone cross time lines; the lower contact is younger, and the upper contact is older than to the south. Clastic rocks interfinger with both the basal and upper parts of the Lead Camp. In general the Lead Camp is no more than 450 ft (137 m) thick in the northern part of the range, but locally near Sheep Mountain it thickens to about 850 ft (260 m). A mappable clastic unit is present beneath the Lead Camp in the northern San Andres Mountains and it has been called the Sandia Formation (Bachman and Harbour, 1970).

In the northern part of the San Andres Mountains, fusulinids in the Lead Camp comprise the genera *Beedeina* and *Wedekindellina.* The entire formation is referred to the zone of *Beedeina* and is of Des Moinesian age. Fusulinids have not been reported from the underlying clastic portion of the Pennsylvanian.

CORRELATION OF LEAD CAMP LIMESTONE

Franklin Mountains, West Texas and New Mexico

Rocks of Pennsylvanian age in the Franklin Mountains have been called the Magdalena Formation and divided into four members (Nelson, 1940; Harbour, 1972). These are, in ascending order, the La Tuna, Berino, Bishop Cap, and an upper unnamed member. Of these, the lower part of the La Tuna includes rocks somewhat older than the Lead Camp Limestone, but the upper part of the La Tuna, as well as the Berino and Bishop Cap, are general time equivalents of the Lead Camp.

Lithologically, these members in the Franklin Mountains differ considerably from the Lead Camp. Shale and sandstone are absent in the La Tuna, and both the La Tuna and the Bishop Cap resemble the cherty limestone portion of the Lead Camp. The intervening Berino includes much shale, and a lithologic equivalent of this member appears to be absent in the Lead Camp. These three members in the Franklin Mountains are about 1,500 ft (460 m) thick as compared with 860 ft (262 m) of Lead Camp at its type section.

Sacramento Mountains, New Mexico

In the Sacramento Mountains there are pronounced local facies changes in the Pennsylvanian rocks. The limestone includes high percentages of bioclastic and terrigenous clastic debris. Pray (1961, p. 72) recognized that nomenclature of Pennsylvanian rock units was not well established in New Mexico and was inadequate for the purposes of his mapping. He mapped three major rock units (Pray, 1961, p. 74): the Gobbler Formation, Beeman Formation, and Holder Forma-

tion. Pray recognized that his nomenclature was based on locally distinctive lithologies. The Gobbler and Beeman Formations of Pray are partial time equivalents of the Lead Camp at its type section (Table 1). The combined thickness of the Gobbler and Beeman Formations is about 1,600 ft (490 m).

Caballo Mountains, New Mexico

Rocks of Pennsylvanian age in the Caballo Mountains have been placed in the Magdalena Group and divided into three formations, in ascending order, the Red House Formation, the Nakaye Formation, and the Bar B Formation (Kelley and Silver, 1952). In their published description, the contacts are not well defined (Kelley and Silver, 1952, p. 91-94, 253-256), and these formations do not appear to be cartographic units. Faunal evidence is not available, but the two lower units, the Red House and the Nakaye, may be general time equivalents to the Lead Camp at its type section. The Red House is comprised largely of clastic sedimentary rocks, but it interfingers southward with beds of limestone and may have facies relations similar to those of the Lead Camp in the San Andres Mountains. The Nakaye Formation is similar lithologically to the Lead Camp Limestone.

Manzano Mountains

In the Manzano Mountains, the Sandia Formation and the Los Moyos Limestone are approximate time equivalents to the Lead Camp Limestone.

The Sandia generally rests upon the eroded surface of Precambrian rocks. Locally, there are thin beds of limestone between the Sandia and the Precambrian that have been referred to the Mississippian Arroyo Penasco Formation by Armstrong (1967). The Sandia Formation, from less than 50 ft (15 m) to at least 300 ft (90 m) thick, is a sequence of conglomerate, dark-colored shale and siltstone, and a few thin, discontinuous beds of marine limestone. Many, but not all, of the clastic beds contain plant debris. The upper few feet are black calcareous shale and silty limestone that grade up into the overlying Los Moyos Limestone. Fusulinids older than those from the zone of *Fusulinella* have not been found in the Manzano Mountains. The youngest fusulinids from the Sandia are close to *Fusulinella famula* Thompson. Hence, the Sandia is referred to the zone of *Fusulinella*.

The Los Moyos Limestone, about 600 ft (185 m) thick, is a sequence of ledge- and cliff-forming cherty marine limestone that contains minor amounts of interbedded dark-colored marine shale and light-colored sandstone, and lenses of conglomerate that may contain plant debris. The lowermost few feet of the Los Moyos locally contain species of *Fusulinella* that resemble *F. iowensis* Thompson. These beds are overlain by rocks that contain *Beedeina* and *Wedekindellina*. *Beedeina novamexicana* (Needham) is common in the lower half of the limestone and it is often associated with species of *Wedekindellina.* Near the top of the Los Moyos, rare specimens of *Eowaeringella* have been found. Hence, the Los Moyos is referred to the zones of *Fusulinella* and *Beedeina,* and, because of the occurrence of *Eowaeringella* to the lowermost part of the zone of *Triticites*.

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