GEOLOGY OF THE CERROS DE AMADO AREA
SOCORRO COUNTY, NEW MEXICO

by

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ABSTRACT

The Cerros de Amado area is located about 5 miles east-northeast of Socorro, Socorro County, New Mexico.

The rocks exposed range in age from pre-Pennsylvanian to Recent. The pre-Pennsylvanian rocks, possibly Precambrian, constitute a basement complex of slightly metamorphosed igneous rocks.

The Pennsylvanian System nonconformably lies on the basement complex. It consists of alternating limestones, shales, and sandstones, deposited in shallow and protected marine environment, close to a deltaic area. A reef located south of the Cerros de Amado area seems to have existed during most of Pennsylvanian time.

The Pedernal landmass to the northeast was the positive area of greatest influence in sedimentation during the Pennsylvanian.

There is an increase in clastic sediments as compared with the Pennsylvanian sections described by Thompson southeast of Socorro. However, most of Thompson's Pennsylvanian units are definitely usable in Cerros de Amado area.

The transition between Pennsylvanian and Permian environments is marked by several disconformities with small hiatus.

The Permian sediments represent an alternation of marine and nonmarine environments. They are disconformable with the Pennsylvanian sediments.

Mesozoic rocks are absent due to erosion of the Triassic and Cretaceous Systems, and to nondeposition of the Jurassic System.

Tertiary and Quaternary rocks consist of alluvial and volcanic de-

posits lying with angular unconformity on older rocks.

Structures are northwesterly-southeasterly trending folds and three systems of high angle normal faults.

Fault system no. 1 trends approximately N. 40° E. and is dated as late Cretaceous or Paleocene. (Laramidian orogeny).

Overturned, Z-shaped folds occurred after fault system no. 1 and before the Eocene.

Fault systems nos. 2 and 3 trend north-south. Although it is possible that the latter represents a reactivation of the former, they do represent two different periods of tectonic activity which are dated as middle Miocene and middle or late Pleistocene respectively.

Small amounts of copper minerals, barite, and fluorite occur locally along faults. They are not of commercial importance.

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Acknowledgment is also made to International Petroleum Company, Talara, Peru, for its generous financial support in this project.

GEOLOGY OF THE CERROS DE AMADO AREA

SOCORRO COUNTY, NEW MEXICO

INTRODUCTION

Location, size and accessibility

The area studied is located along the eastern margin of the Rio Grande depression, about five miles east-northeast of Socorro in Loma de las Cañas Quadrangle, Socorro County, New Mexico (Fig. 1), between the following coordinates:

106° 49' 35" E and 106° 45' 57" E longitude

34° 07' 11" N and 34° 04' 41" N latitude.

The area is about twelve square miles in extent and comprises sections 25, 26, 35, 36, and part of sections 22, 23, 24, 27, and 34, in T. 2 S., R. 1 E.; sections 30, 31, and part of section 19, in T. 2 S., R. 2 E.; part of sections 1, 2, 3, in T. 3 S., R. 1 E.; and part of section 6, T. 3 S., R. 2 E. (Plate 1).

Access to the area is relatively well provided for by gravel roads going to ranches and mine prospects in the area.

Purpose

The purpose of this study is a tentative correlation of the stratigraphic units with emphasis on the Pennsylvanian System; their relations to the work of Thompson (1942) and Hambleton (1959); and an interpretation of the geologic history of the area.

Methods of investigation

The areal geology was plotted in the field by the Brunton triangulation method on the topographic map - Loma de las Cañas Quadrangle - made by the U. S. Geological Survey, with a scale of 1:24,000 (1 inch= 2,000 feet), (Fig. 2). An aneroid barometer was used to check elevations.

Thicknesses of the stratigraphic units were determined by the Brunton compass method (Lahee, 1961) and by direct measurement with a steel tape.

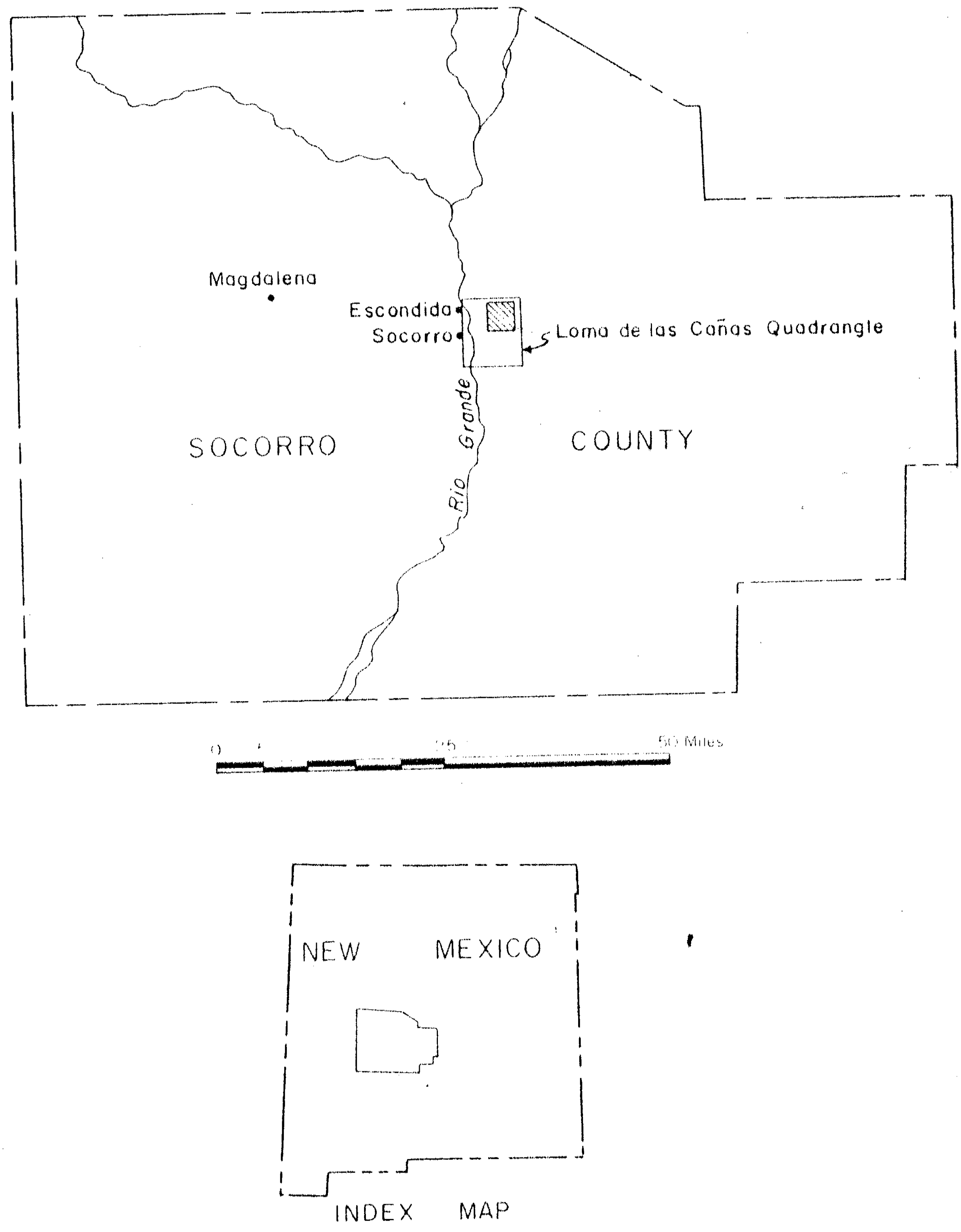
Rock samples were collected in the field at every change in the lithology rather than at a systematic interval, and all of them were studied and classified in the laboratory with a binocular microscope. Folk's classification of limestones (1959) and Carozzi's classification of clastic rocks (1960) have been used with only slight modifications in their terminology where convenient; such modified or incorporated terms are described in the glossary of this report.

Twenty insoluble residues were obtained from some of the prominent limestone units in the stratigraphic sections measured, and studied with a binocular microscope in order to determine their mineralogical composition where possible.

Previous work in the area

No prior detailed geologic mapping has been done in this area.

Wilpolt and Wanek (1951) included this area in their reconnaissance geologic map of the region from Socorro and San Antonio east to Chupadera Mesa, with a scale of 1:62,500 (1 inch = 1 mile). Hambleton (1959) measured three sections of the Missourian series in Socorro County in order to reconstruct paleoenvironments by means of carbonate fabrics; one of these sections was measured in SE 1/4, Sec. 27, T. 2 S., R. 1 E.



Magdalena
Escondida
Socorro
Loma de las Cañas Quadrangle
Rio Grande
SOCORRO
COUNTY
0
25
50 Miles
NEW MEXICO
INDEX MAP

Figure 1

PHYSICAL CONDITIONS

Topography, relief, and drainage

The topographic expression of the area represents, essentially, a cycle of arid erosion which together with repeated uplift has prevented the area from attaining a stage of maturity. The Late Tertiary rocks cropping out in the western part of the area and extending toward the Rio Grande were deposited in a downdropped trough and consequently protected from erosion to a great extent.

The area is one of very moderate relief; the elevation ranges from about 4900 feet to a maximum of 5447 feet above sea level.

The drainage pattern is dendritic but controlled largely by folding and faulting.

Vegetation

The vegetation consists of mesquite bush (*Prosopis juliflora*), creosote bush (*Covillea glutinosa*), ocotillo (*Fouquieria splendens*), and other cacti, chamiso (*Altriplex canescens*), grass (*Panicum* sp.), needle grass, gramma grass, and a few scattered junipers (*Juniperus utahentis*) which grow along the stream bottoms.

The vegetation is very sparse; however, it affords grazing land for five to seven head of cattle per section.

The species of plant life are scattered indiscriminately over the area, and no correlation was discovered between plants and formational distribution.

Climate

The climatic conditions of the area studied are very similar to those in Socorro; however, due in part to the higher elevation, the average minimum temperature is lower than at Socorro and the amounts of rainfall and snowfall are slightly greater in the field area.

Since there is no weather station in the area covered in this report, data recorded at the U. S. Weather Bureau Station in the New Mexico Institute of Mining and Technology is given as a reference: the mean annual minimum temperature is 43.3° F.; the mean annual maximum temperature is 74.4° F.; the mean annual precipitation is 8.76 inches and the greater precipitation occurs in August. Occasional light snowfalls occur in the winter but rarely remain longer than a day.

	THOMPSON (1942)			THIS REPORT			WILPOLT AND WANEK (1951)		
	SERIES	GROUP	FORMATION						
PENNSYLVANIAN	VIRGIL	Fresnal	Bruton		Bursum			Bursum	
						DISCONFORMITY			
		Keller	Moya	Keller	Moya	Upper Member	Magdalena group	Madera Limestone	Arkosic Limestone Member
						DISCONFORMITY			
						Lower Member			
			Del Cuerto		Del Cuerto	Upper Member			
						Middle Member			
						Lower Member			
	MISSOURI	Hanson-burg	Story	Hanson-burg	Story	Upper Member			
						Lower Member			
			Burrego		Burrego				
		Veredas	Council Spring Ls.	Veredas	Council Spring Ls.				
			Adobe		Adobe - Coone (undifferentiated)				
			Coone						?
	DES MOINES	Bolander		Socorro	Amado Limestone				Lower Gray Limestone Member
					Bartolo				
		Armendaris	Garcia	Armendaris	Garcia	Upper Member			
						Lower Member			
			Whiskey Canyon Ls.		Whiskey Canyon Ls.				
			Elephant Butte		Elephant Butte				
	DERRY	Mud Springs	Cuchillo Negro		Sandia			Sandia Fm.	Upper Clastic Member
			Hot Springs						
		Green Canyon	Apodaca						
			Arrey						

GEOLOGY

Stratigraphy

GENERAL STATEMENT

The rocks exposed in Cerros de Amado area range in age from pre-Pennsylvanian to Recent. The pre-Pennsylvanian rocks constitute the basement complex and consist of igneous intrusive rocks and a minor amount of metamorphosed sediments. The overlying sedimentary sequence includes the Pennsylvanian, Permian, Tertiary, and Quaternary Systems. This report emphasizes details of the Pennsylvanian System.

A generalized stratigraphic section of the Cerros de Amado area is shown on plate 2.

Figure 3 shows the correlation between the stratigraphic units recognized by Thompson (1942) and Wilpolt and Wanek (1951) in the Pennsylvanian System in Central and Southern New Mexico and the ones recognized in the Cerros de Amado area and described in this paper.

In general, all the Pennsylvanian units in Cerros de Amado area show a marked increase in clastic content with respect to their type localities southeast of Socorro.

There is no lithologic correlation between the Derryan Series described by Thompson as consisting largely of limestones and the dominantly clastic rocks assigned to the Derryan Series in the Cerros de Amado area. Wilpolt and Wanek refer to these clastic deposits as the upper clastic member of the Sandia Formation and have recognized a lower limestone member in other areas to the north in New Mexico. Presumably, the lower limestone member was not deposited in this area and the term Sandia Formation is here used to refer to the mostly clastic Derryan Series that overlies the basement complex in Cerros de Amado area.

Most of the units assigned by Thompson (1942) to the Desmoinesian, Missourian, and Virgilian Series are readily recognizable in Cerros de Amado area although formations of the Bolander Group and the Adobe-Coane contact could not be mapped. The Bolander Group lies between the Armendaris and the Veredas Groups (see figure 3) and at the type locality consists largely of limestone; whereas in Cerros de Amado area the rocks lying between the same two groups include mostly clastic sediments. The Bolander Group loses its lithologic identity in this area and the term "Socorro Group" is proposed as its equivalent.

The Adobe-Coane contact was not recognized and both formations were mapped as undifferentiated. The terms Adobe-Coane are retained despite the fact that the boundary is not clear, because the formations exhibit many typical lithologic characteristics.

The Brucon Formation as defined by Thompson (1942) includes the red shales, arkosic sandstone and conglomerates, with interbedded nodular to irregularly bedded limestones that occur between the Moya Formation below and the base of the Permian Wolfcamp above. Wilpolt and Wanek (1951) have used the term Bursum Formation, in Socorro and surrounding areas, to refer to the dark red shales, arkosic conglomerates, nodular limestones, and medium-bedded limestones which overlie the arkosic limestone member of the Madera Limestone and underlie the Permian Abo Formation. Some of the lower limestones have been dated as Permian Wolfcamp in age and Wilpolt and Wanek consider the Bruton Formation to be equivalent to all of the Bursum Formation except the uppermost and lowermost beds. Since the Bruton Formation is Virgilian in age (Thompson, 1942) and the Bursum Formation is Wolfcampian in age (Wilpolt and Wanek, 1951), they cannot be equivalent. Thompson has studied the Bruton Formation in central and southern New Mexico at several localities in the Oscura Mountains, the Loma de las Cañas hills, Cadronito Hill, Los Pinos Mountains, Abo Canyon, Manzano Mountains, Sandia Mountains, and also in the southwestern part of New Mexico. This wide areal distribution of the Bruton Formation suggests that the Bruton Formation is absent in Cerros de Amado area due to pre-Permian erosion.

The Missourian Series exhibit such a rapid lateral variation in lithology across the Amado fault zone that at first glance a correlation seems to be impossible. For this reason, two stratigraphic sections of the Pennsylvanian System were measured, one west of the Amado fault zone and another one east of it. (Plate 1) The Sandia Formation, Whiskey Canyon Limestone, Amado Limestone, Council Spring Limestone, and Story and Moya Formations constitute excellent markers for stratigraphic correlation and most were recognized in both sections measured. The Moya Formation has been eroded from the Pennsylvanian exposures immediately east of the Amado fault zone. The lithologic correlations are substantiated by a fusulinid fauna collected from the Elephant Butte Formation, Whiskey Canyon Limestone, and Garcia Formation. According to Dr. R. V. Hollingsworth of the Paleontological Laboratory, Midland, Texas, these beds should be assigned to the Early Desmoinesian, Upper Cherokee age.

Similar rapid lateral variations in lithofacies occur in the upper member of the Moya Formation and are described on page 35.

The lithology and paleontology of the Pennsylvanian System are shown on plate 3 and 4. A more complete description of the Pennsylvanian stratigraphic sections measured is presented in Appendix A.

SEDIMENTARY ROCKS

Pennsylvanian System

Sandia Formation

The term Sandia series was originally proposed by C. L. Herrick, in 1900, for the lower 150 feet of the Pennsylvanian rocks in the Sandia Mountains. These beds are shales, sandstones, and conglomerates, with a few interbedded sandy limestones. G. H. Gordon, in 1907, used the term Sandia Formation for the lower 500 to 700 feet of Pennsylvanian rocks underlying the Madera Limestone in the Rio Grande Valley and composed of interbedded blue and black clay shale, compact earthy limestone, conglomerate, and quartzite. The term Sandia is still used as defined by Gordon. (Jicha and Lochman-Balk, 1958).

The Sandia Formation nonconformably overlies the pre-Pennsylvanian basement complex (Plates 5 and 6A). It is 581 feet thick and consists almost entirely of olive gray laminated calcareous shale, light gray pebbly feldspathic sandstone, light brownish gray pebbly quartzitic pure quartz sandstone,light olive gray laminated argillaceous (?) shale, and light olive gray silty quartzose shale. A few interbedded yellowish brown and medium dark gray sandy biomicrites appear scattered in the sequence. They are slightly lenticular and become thicker and have abundant crinoid remains toward the west. The sandstones are cross-bedded and lenticular; a few of them have graded bedding; there is a slight increase in coarseness toward the west.

X-ray analysis of a silty shale sample of unit 18 (Appendix A) revealed it consists mostly of quartz with small amounts of kaolinite and traces of montmorillinoid. A mechanical analysis of the same rock sample by the pipette method using times of settling velocity computed according to Stokes' law (Krumbein and Pettijohn, 1930) yielded 66% of clay-sized particles (smaller than 1/256 mm.) and 34% of larger particles. Since the shale consists mostly of quartz, it has been called quartzose shale (Krumbein and Sloss, 1963). It is possible that some of the other shales in the Sandia Formation may have a similar composition.

The fauna consists of abundant crinoid stems, Composita, spiriferids, productids, and shell fragments. The abundance of brachiopods decreases westward while the crinoid stems become extremely abundant. Large solitary corals are scarce near the top in the western outcrops.

In other areas of New Mexico an upper clastic member and a lower limestone member have been recognized by Wilpolt and Wanek (1951) in the Sandia Formation. What is called Sandia Formation in Cerros de Amado area is equivalent to the upper clastic member, and the lower limestone member was not deposited in this area.

ARMENDARIS GROUP

Elephant Butte Formation

The Elephant Butte Formation was named by Thompson (1942) for exposures in the northern part of the Mud Springs Mountains where it attains a thickness of about 82 feet and consists largely of limestone and several beds of calcareous gray silty shale.

It conformably overlies the Sandia Formation and conformably under-

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A. The Sandia Formation nonconformably overlies the leucogranite (lgr). A granitic intrusion (gr) can be observed. Looking E., NE. 1/4, Sec. 3, T. 3 S., R. 1 E.

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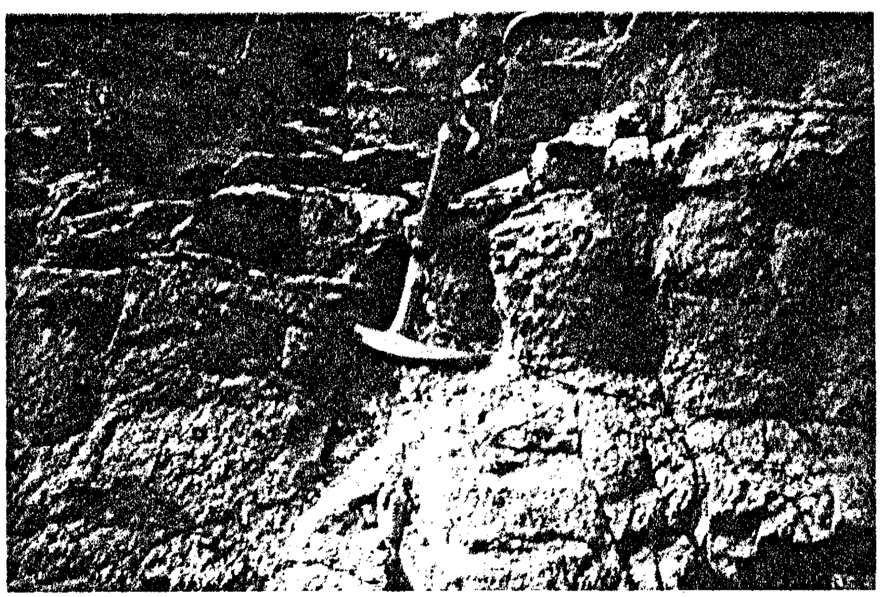

B. A close-up of the same contact at C.

PLATE 5

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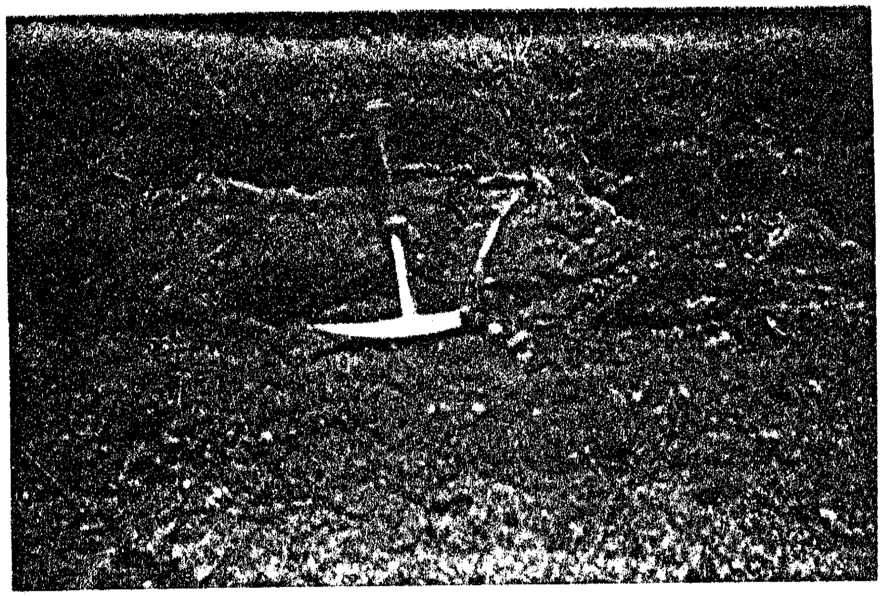

A. Steeply dipping beds of the Sandia Formation nonconformably overlie quartz-monzonite. Looking E., NE 1/4, Sec. 2, T. 3 S., R. 1 E.

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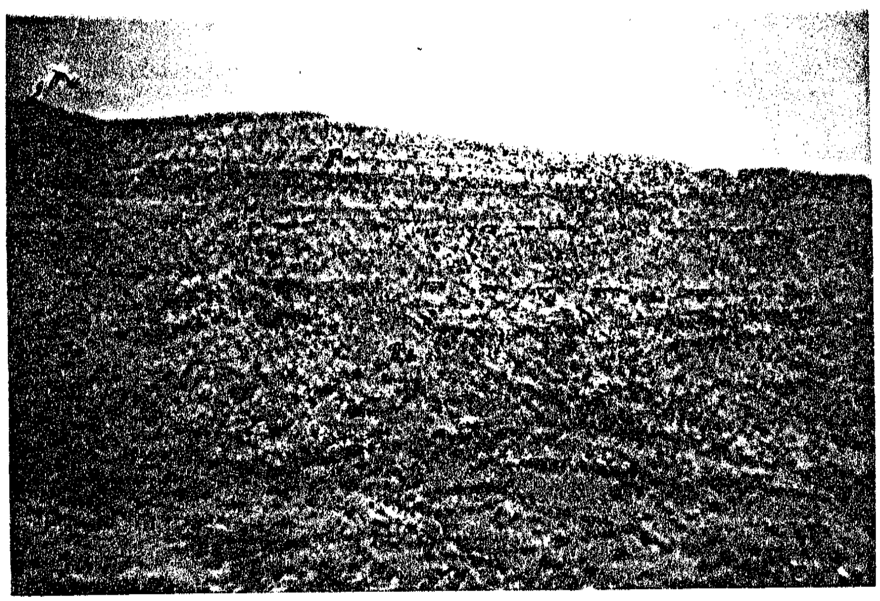

B. Sandia Formation - Elephant Butte Formation contact. A normal fault with a displacement of about 130 feet is shown. Looking E., SE 1/4, NE 1/4, Sec. 2, T. 3 S., R. 1 E.

PLATE 6

lies the Whiskey Canyon Limestone. (Plate 6B)

East of the Amado fault zone the Elephant Butte Formation is about 187 feet thick and is composed of medium gray biomicrite, biomicrosparite, and dismicrite, slightly cherty and nodular in places. Cross-bedded, pinkish gray, pebbly quartzitic pure quartz sandstone and olive gray laminated calcareous shale occur in subordinate amounts.

West of the Amado fault zone it is only 127 feet thick and consists mostly of medium gray crinoidal biosparite, dusky yellow biomicrite and micrite, very slightly cherty, with a few beds of light olive gray laminated calcareous shale and a 3-foot bed of pinkish gray pebbly pure quartz sandstone near the base.

There is an increase in thickness and clastic content toward the east.

Composita, spiriferids, productids, and crinoid stems are abundant in the western outcrops, especially in the upper limestones. Large solitary corals are scattered throughout the unit. Fusulinids collected from the eastern outcrops belong to the genus *Fusulina* of Early Desmoinesian, upper Cherokee age.

Whiskey Canyon Limestone

The term, Whiskey Canyon Limestone, was proposed by Thompson (1942) for the thick bluish gray to gray cherty limestone cropping out at Whiskey Canyon, northern Mud Springs Mountains, Sierra County, New Mexico, where it is about 163 feet thick.

It conformably overlies the Elephant Butte Formation and conformably underlies the Garcia Formation.

The Whiskey Canyon Limestone is about 108 feet thick and is composed of medium gray, very cherty, recrystallized, fossiliferous micrite. A 15-foot unit of covered shale (?) is present in the eastern section about 60 feet above the base which consists of biomicrosparite. The basal beds in the western section are pelmicrite; the limestone near the middle part becomes nodular, and thin laminated calcareous shale occurs only very occasionally.

The fauna consists of abundant crinoid stems with Composita, productids, spiriferids, and solitary corals common. The uppermost limestone beds in the western section contain extremely abundant Fusulina and Wedekindellina of Early Desmoinesian, upper Cherokee age.

Garcia Formation

The Garcia Formation was named by Thompson (1942). The type locality is in the northern part of the Mud Springs Mountains where it consists of about 213 feet of fossiliferous limestone, argillaceous limestone, and several thin gray to red shales.

The Garcia Formation conformably overlies the Whiskey Canyon Limestone and conformably underlies the Bartolo Formation. It attains a thickness of about 201 feet and in Cerros de Amado area is separated into two members.

Lower Member

The lower member is about 126 feet thick and in the eastern section is largely composed of olive gray, laminated, calcaraous shale, light
e

brownish-gray, cross-bedded, feldspathic sandstone and arkose having graded bedding, and subordinate amounts of dark gray biomicrite, biosparite, and micrite. The limestones become argillaceous, sandy, and much more abundant than the clastic sediments toward the west.

Upper Member

The upper member is about 75 feet thick and consists of medium-gray, cherty, recrystallized biomicrite, recrystallized micrite, argillaceous biomicrite, and a few thin beds of olive gray, laminated, calcareous shale. Its lithology remains fairly constant throughout the area.

The fauna is more abundant in the upper member and consists of *Composita*, spiriferids, productids, and crinoid stems abundant; bryozoans common. Fusulinids are very abundant in the limestones of the upper member; the following genera were rocognized: *Fusulina*, *Wedekindellina*, and "*Fusulinella-Fusulina*," all of them dated as being Early Desmoinesian, upper Cherokee age.

"SOCORRO GROUP"

The term "Socorro Group" is proposed for the dominantly clastic rocks of the Upper Des Moines that conformably overlie the Garcia Formation and underlie the Adobe-Coane undifferentiated formations. The name is derived from the town of Socorro. This group is about 254 feet thick and is divided into the "Bartolo Formation" and the "Amado Limestone". It is considered to be equivalent to the Bolander Group named by Thompson (1942) which is about 233 feet thick and consists largely of limestones.

The term Socorroan Series was applied by C. R. Keyes, in 1906, to 300 feet of Missourian limestones underlying his Ladronesian Series and overlying Devonian limestones in southwestern New Mexico. The New Mexico Bureau of Mines and Mineral Resources recommended the suppresion of this name as used by Keyes. (Jicha and Lochman-Balk, 1958)

"Bartolo Formation"

The name "Bartolo Formation" is introduced for all sediments conformably overlying the Garcia Formation and conformably underlying the "Amado Limestone". The term Bartolo is derived from the Arroyo de Tio Bartolo. The type locality, however, is 3200 feet northeast of the most northeasterly head water of the Arroyo de Tio Bartolo.

The type section is composed of about 220 feet of rocks, including olive gray, laminated, calcareous shale, medium gray, cross-bedded, pure quartz sandstone, light gray, calcareous arkose, and a few beds of light gray, sandy biomicrite and algal biomicrite. A medium bed of sandy pebbly intraclasts is present about 130 feet above the base and represents a diastem. West of the type locality the sandstones gradually wedge out and the shales become more dominant. X-ray analysis of a shale sample of unit no. 4 suggests that the shale is a quartzose shale (App. C).

The fauna consists of crinoid stems abundant, and Composita, spiriferids, productids, gastropods, and shell fragments which are scattered in the limestones but become locally common.

"Amado Limestone"

The term "Amado Limestone" is proposed for the thin - to medium-bedded dark gray, cherty limestones conformably capping the "Bartolo Formation" and underlying the Adobe-Coane undifferentiated. The name is derived from the Cerros de Amado hills although the type locality is 1600 feet southwest of the top of Cerros de Amado.

It forms a prominent limestone cliff in the area and it is easily traceable.

The type section consists of about 35 feet of medium to dark gray, highly cherty, recrystallized biomicrite and recrystallized micrite. Layers of dark brown chert up to 4 inches thick are fairly continuous.

Large productids, up to 3 inches long, are abundant; Composita, spiriferids, crinoid stems, and bryozoans are common.

VEREDAS GROUP

Adobe-Coane undifferentiated

The Adobe and Coane Formations were named by Thompson (1942) for rocks including mostly limestones in the Oscura Mountains where they attain a thickness of 105 feet.

Since there is no clear lithologic boundary between these two formations in the Cerros de Amado area, they were mapped as undifferentiated. Although they contain more clastic sediments here than at their type localities, the term Adobe-Coane is used because the formation still retain some of their lithologic identities.

A pronounced lateral variation in lithology occurs across the Amado

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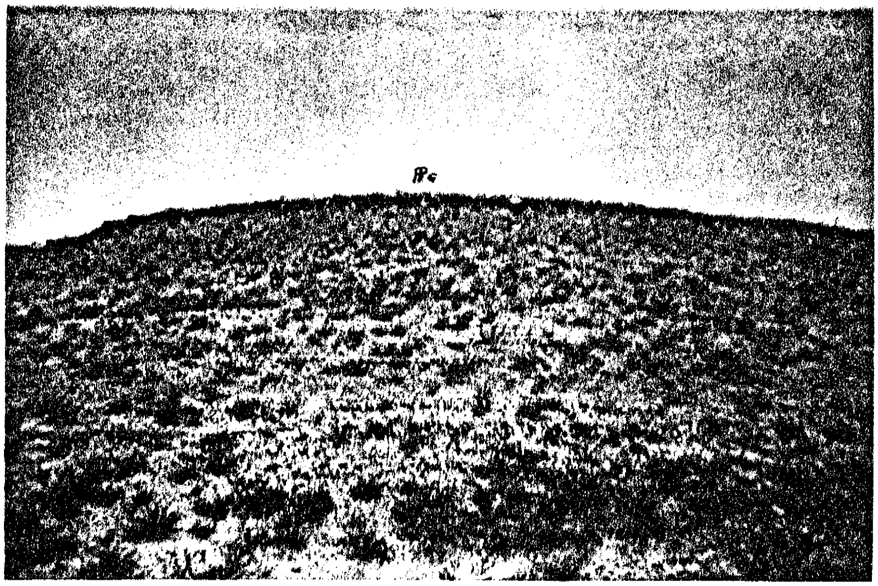

A. Contact between the Adobe-Coane undifferentiated and the Council Spring Limestone. Looking N, SW 1/4, Sec. 26, T. 2 S., R. 1 E.

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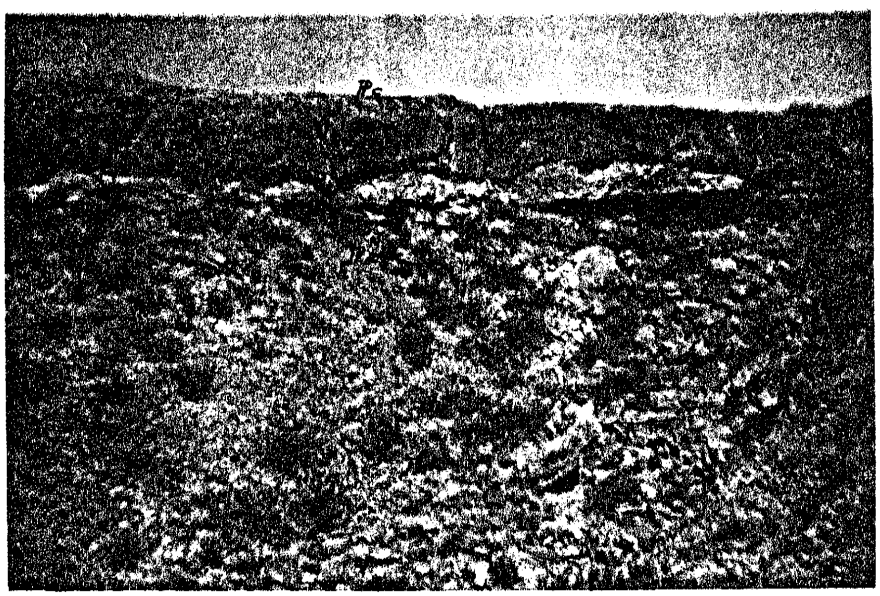
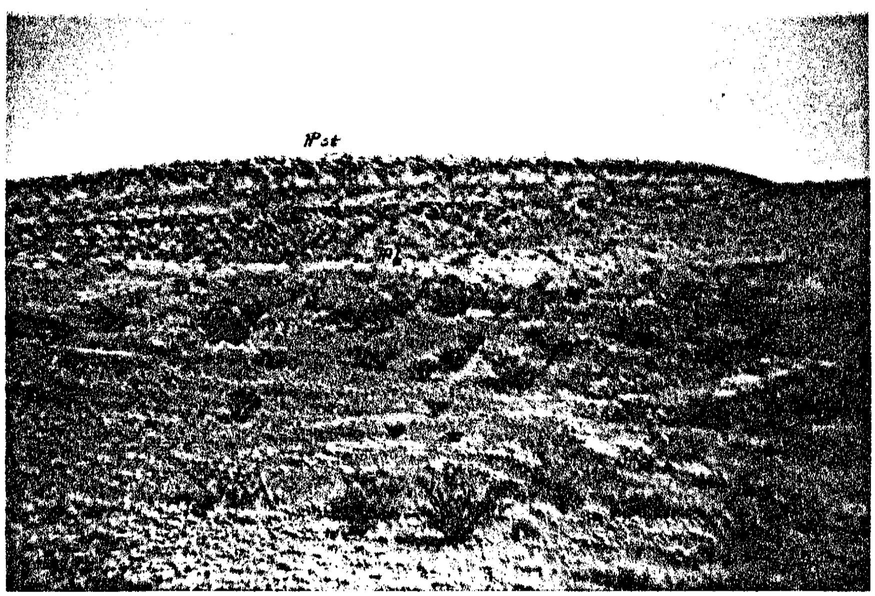


B. A close-up of the Adobe-Coane undifferentiated - Council Spring Limestone contact. A bioherm can be observed. Looking NNW, NE 1/4, SE 1/4, Sec. 27, T. 2 S., R. 1 E.

PLATE 7

A. Missourian Series faulted against the "Bartolo Formation". (Des Moines). The prominent cliff is the Council Spring limestone. Looking WNW, central part of Sec. 25, T. 2 S., R. 1 E.



B. Contact between the Burrego and Story Formations. Upper and lower members of the Story Formation are shown. Dark stripe in the Story Formation represents the dark red shales. Looking N: NW 1/4, SW 1/4, Sec. 26, T. 2 S., R. 1 E.

PLATE 8

fault zone. The Adobe-Coane undifferentiated on the western side of the fault attains a thickness of about 299 feet and is largely composed of medium gray micrite, dismicrite, and biomicrite; pelmicrite and algal biogenic limestones are rare; and thick units of olive gray, laminated, calcareous shale are occasionally present. A 34 foot-unit of thin-bedded to laminated, slightly argillaceous, recrystallized micrite, dark gray, slightly fetid, and showing penecontemporaneous deformation, is present about 60 feet above the base. East of the Amado fault zone the Adobe-Coane undifferentiated consists mostly of olive gray, laminated, calcareous shale[1] with a subordinate amount of yellowish-gray to greenish-gray arkose and feldspathic sandstone, highly cross-bedded; a few thin to medium beds of dark gray micrite, dismicrite, biomicrite, and pelmicrite are scattered throughout the formation and become more abundant near the base. The thickness in the eastern section is about 258 feet.

The fauna consists of crinoid stems abundant, large productids, *Composita*, spiriferids, and bryozoans common; algae become abundant locally. The abundance of fossils decreases markedly in the eastern outcrops due to the scarcity of limestones.

Council Spring Limestone

The term Council Spring Limestone was proposed by Thompson (1942)

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[1]X-ray analysis of a shale sample of unit no. 11 suggests that the shale is a quartzose shale (Appendix C). The shales of units nos. 7, 9, and 10 may also be quartzose shale although no complete analysis was done.

for the light gray to white limestones overlying the Adobe Formation near the top of the Oscura Mountains where they are 18 feet thick.

It constitutes a distinctive cliff-forming and easily mappable unit in the area. (Plate 7A-B and plate 8A)

Although Council Spring Limestone overlies apparently conformably the Adobe-Coane undifferentiated, a horizon of sandy intraclasts at its base indicates they are separated by a diastem.

The Council Spring Limestone is about 20 feet thick and consists of thin - to irregularly-bedded, medium gray to medium light gray, crinoidal biomicrosparite, fossiliferous micrite and dismicrite. A local biohermite, very lenticular, is present in the SE 1/4, Sec. 27, T. 2 S., R. 1 E; it attains a maximum thickness of almost 7 feet and is about 80 feet long; no fossils are recognizable due to recrystallization. A thickening of the bedding may be observed at different places and this probably represents biohermal tendencies that did not develop completely. Vertical joints are prominent and give a columnar appearance.

The outcrops east of the Amado fault zone contain thin-layers, up to 4 inches thick, of dark brown chert, otherwise, the lithology remains fairly constant throughout the area.

The fauna consists of crinoid stems abundant, and bryozoans, solitary corals and Composita rare.

HANSONBURG GROUP

Burrego Formation

The Burrego Formation was named by Thompson (1942) for the 52 feet of thick-bedded and nodular limestones that overlie the Council Spring

Limestone in the Oscura Mountains.

The Burrego Formation conformably overlies the Council Spring Limestone and conformably underlies the Story Formation. (Plate 8 A - B) Like the Adobe-Coane undifferentiated it also undergoes a marked lateral variation in lithology across the Amado fault zone.

The section measured on the eastern side of the fault is about 37 feet thick and consists of medium-bedded light gray crinoidal biosparite, crinoidal biomicrite, orange micrite and pelmicrite, with several limestone-rubble-covered intervals that might actually be thin nodular limestones interbedded with thin shales. Light yellowish-orange, calcareous concretions are common in the shales. Crinoid stems are abundant, bryozoans common, Composita and solitary corals rare. Petrified wood logs and pseudomorphs of limonite after pyrite are scattered throughout the covered intervals.

The western section is about 85 feet thick and is composed of light olive gray, laminated, calcareous shale and siltstone, greenish gray arkose, light brown quartzitic arkose, and a subordinate amount of medium gray and orange fossiliferous micrite and fossiliferous dismicrite. Fusulinids, crinoid stems, and algae are scattered throughout the limestones.

Story Formation

The name Story Formation was applied by Thompson (1942) to exposures on the northeastern side of the Oscura Mountains consisting of about 58 feet of reddish brown shale, arkosic and micaceous sandstone, and light gray, thick-bedded, fossiliferous limestones.

The Story Formation is about 40 feet thick, conformably overlies the

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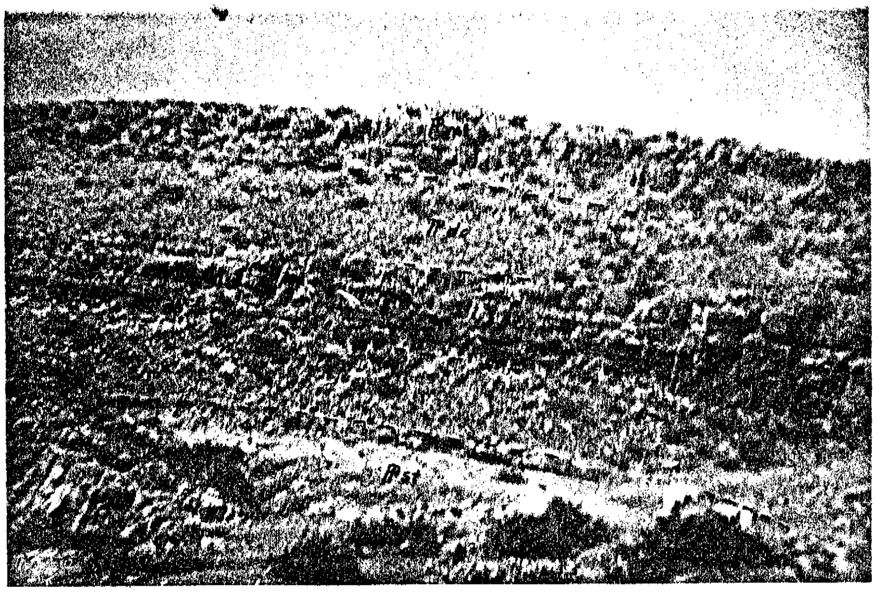

A. Virgilian Series conformably overlies the Story Formation. (Missourian). The three members of the Del Cuerto Formation are shown. Looking SSW, SW 1/4, NE 1/4, Sec. 26, T. 2 S., R. 1 E.

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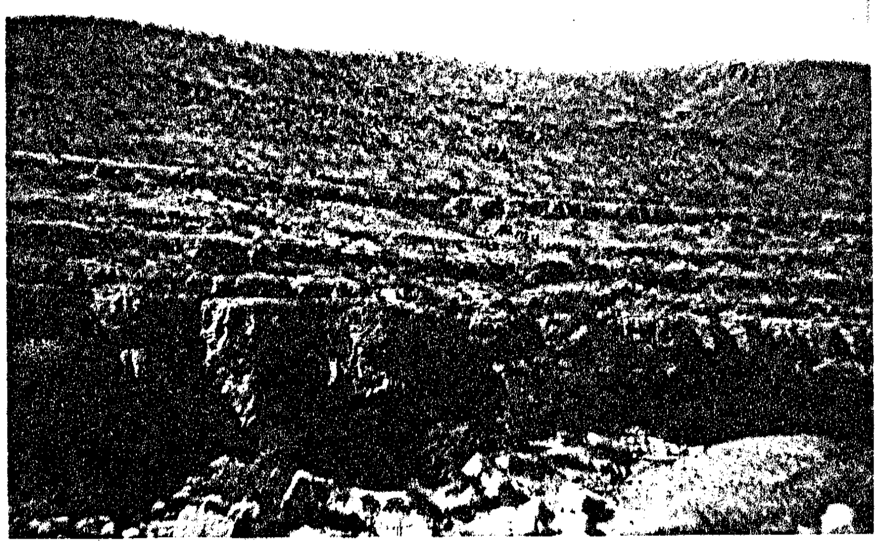

B. Pennsylvanian rocks disconformably overlain by Permian rocks. Tertiary rocks gently bevel the Permian rocks. The two members of the Moya Formation are separated by a disconformity (Pmu = Moya upper members; Pml = Moya lower member). Looking NNW, SE 1/4, NE 1/4, Sec, 27, T. 2 S., R 1 E.

PLATE 9

Burrego Formation and conformably underlies the Del Cuerto Formation. Two members are recognized in this map area. (Plate 8B)

Lower Clastic Member

The lower clastic member is about 23 feet thick and consists of light gray arkose overlain by grayish-red, laminated, micaceous, calcareous shale containing dark red calcareous concretions. The member thins to the east, and the shales grade laterally into siltstone and sandstone.

Upper Limestone Member

The upper limestone member is about 16 feet thick and is composed of thin - to medium-bedded, very light gray to medium dark gray, crinoidal biomicrite, biomicrosparite, and biodismicrite. Large crinoid stems are abundant, some of them are pink, silicified, and weather in relief. *Composita* specimens are scarce; a few of them are also pink and silicified.

KELLER GROUP

Del Cuerto Formation

The Del Cuerto Formation was named by Thompson (1942) for the rocks between the top of the Story Formation and the base of the Moya Formation. The type locality is on the northeastern side of the Oscura Mountains where the formation is about 81 feet thick and is composed of irregularly bedded limestone, arkosic sandstone, limestone conglomerate, and gray and red shale.

The Del Cuerto Formation conformably overlies the Story Formation and conformably underlies the Moya Formation. It attains a thickness of about 57 feet and is here divided into three members. (Plate 9A)

Lower Member

The lower member is about 16 feet thick and consists of light gray, slightly cross-bedded, calcareous arkose that weathers moderate brown and overlies dark red and light purple, laminated, calcareous shale.

Middle Member

The middle member reaches a thickness of 20 feet and is composed of medium - to thick-bedded, light gray crinoidal biosparite. It becomes slightly cherty near the top. Crinoid stems are extremely abundant; some of them are pink, silicified, and weather in relief.

Upper Member

The upper member is about 21 feet thick. The lower part consists of medium-bedded, light gray, sandy micrite grading upward into pale purple, cross-bedded arkose which shows local slump structures.

Moya Formation

The term Moya Formation was proposed by Thompson (1942) for 51 feet of thick-bedded and irregularly bedded to nodular limestones that overlie the Del Cuerto Formation on the northeastern side of the Oscura Mountains.

The Moya Formation is about 77 feet thick and conformably overlies the Del Cuerto Formation; although its strata appear parallel to the strata of the overlying Bursum Formation, the field relationships indicate that the units are separated by a disconformity.

It is here divided into two members. (Plate 9B).

Lower Member

The lower member is about 39 feet thick and consists of light gray, thick-bedded, recrystallized micrite and dismicrite. The lower 6 feet are highly nodular. The member is a cliff-forming unit, very distinctive and easy to trace. A vertical joint system is prominent locally and produces a columnar effect. Its lithology remains identical throughout the area.

Upper Member

The upper member is separated from the lower member by a thin to medium bed of sandy intraclasts which grades upward into pebbly calcareous arkose and represents a disconformity. Small cracks and very shallow erosional channels filled with the arkose indicate that the lower member was subjected to erosion after lithification.

The upper member is about 38 feet thick and shows a very rapid lateral variation in lithology.

The exposures at Minas del Chupadero consist of interbedded olive gray, laminated, calcareous shale and black, laminated, carbonaceous shale containing lenses of copper-bearing arkose and capped by medium-bedded light gray to very light purple, fossiliferous micrite.

At Ojo de Amado, 3/4 of a mile west of Minas del Chupadero, the upper member of the Moya Formation consists entirely of thin beds of light gray, nodular recrystallized micrite interbedded with light to medium gray, medium-bedded, fossiliferous micrite. The uppermost limestones are colored very light purplish gray. A thin bed of sandy intraclasts representing the basal disconformity is still recognizable despite the rapid change in lithofacies.

The transition in lithology is well exposed between these two localities where at least three other similar disconformities can be recognized within the upper member in addition to the disconformity between this member and the overlying Bursum Formation. Such disconformities represent the beginning of the transition from the Pennsylvanian marine environment to the Permian continental environment.

Permian System

Bursum Formation

The Bursum Formation was named by Wilpolt et. al. (1946) from exposures west of Bursum triangulation point in the SE 1/4, Sec. 1, T. 6 S., R. 4 E. Socorro County. No type location was given. The unit ranges from 28 to 234 feet in thickness and consists of thick beds of dark purplish-red and green shale with interbeds of arkose, arkosic conglomerate, and gray limestone. The fusulinid Schwagerina in association with very obese Triticites ventricosus show that the Bursum Formation is of Wolfcampian age.

The Bursum Formation in the Cerros de Amado area is 200 feet thick,

Conglomerate
hematite staining

estimated from the structure section; it disconformably overlies the Moya Formation and is conformably overlain by the Abo Formation. (Plate 9B).

It consists of medium to thick beds of grayish-brown, pebbly, quartzitic arkose and arkosic pebbly conglomerate, thick beds of dark red, laminated, calcareous shale and mudstone, and occasional beds of sandy pebbly intraclast, biosparite and nodular recrystallized micrite.

The quartzitic arkose and arkosic pebble conglomerate are poorly sorted and subangular with scattered subrounded quartz pebbles. They normally contain about 35% to 40% of fresh pink orthoclase and occasionally up to 65%. Most of them are very quartzitic and contain some residual (?) calcareous cement and scattered calcite grains. Hematite staining is abundant. The abundance of pink orthoclase contrasts markedly with the low percentage of pink orthoclase and the predominance of white feldspar in the underlying Pennsylvanian arkosic beds.

The thin to medium beds of sandy pebbly intraclasts are medium light gray-colored and contain about 60% of subrounded limestone pebbles in a quartzitic, pebbly, arkose matrix. They grade rapidly upward into calcareous arkose. These several beds represent diastems during the deposition of the Bursum Formation. Medium beds of light gray biosparite containing crinoid stems common and brachiopods scattered underlie the sandy intraclasts.

our conglom.

Thin beds of light gray, nodular, rubbly, recrystallized micrite are occasionally exposed.

The contact between the Bursum and Abo Formations is gradational and was arbitrarily placed immediately above the uppermost thick, grayish-red, pebbly quartzitic arkose which is overlain by the thick, dark red mudstone characteristic of the Abo Formation.

X Abo Formation

The Abo Sandstone was named by Lee (1909) from a type section in Abo Canyon, Torrance County, New Mexico. It is 650 feet thick and consists of red and purple sandstone with a subordinate amount of shale and earthy limestone.

The Abo Formation conformably overlies the Bursum Formation and conformably underlies the Yeso Formation. It is 460 feet thick and is composed largely of thick beds of reddish-brown, slightly massive, calcareous shale and mudstone, slightly bentonitic, and silty; these are interbedded with thinner beds of laminated to thin-bedded, reddish-brown, pure quartz siltstone, pure quartz siltstone with argillaceous matrix, and very fine-grained feldspathic sandstone with calcareous cement. Occasional beds of pebbly calclithite up to 1 foot thick occur near the base; they contain about 65% pebbles and 35% sandy matrix. The pebbles include subrounded limestone pebbles abundant, dolomite pebbles common and orthoclase pebbles scattered.

The characteristic dark red color is due to iron oxide stain on the quartz grains. Circular, whitish-gray spots of about 1 inch in diameter are common in the red mudstones; although there is no definite explanation for this phenomenon, it is possible that the spots are related to reduction of the ferric oxide by organic remains.

Current ripple marks, cross-bedding, lensing and mud cracks are common features in the red Abo Formation and together indicate a continental origin.

Fossil plants collected and identified by C. B. Read (Wilpolt and Wanek, 1951) from the Sacramento Mountains indicate that at least the upper part of the Abo Formation is of Leonardian age.

Yeso Formation

The Yeso Formation was originally named by Lee (1909) from Mesa del Yeso, Socorro County, New Mexico, and described as 1000 to 2000 feet of gray, pink, yellow, red, and purple sandstone, pink to yellow shales, earthy limestone, and massive gypsum. Needham and Bates (1943) restudied the Yeso Formation and recognized four members, three of which crop out in Cerros de Amado area. The uppermost member, the Joyita Sandstone Member, is exposed immediately north of the area studied.

No fossils have been found but the formation is considered by most geologists to be of Leonardian age (Wilpolt and Wanek, 1951).

Meseta Blanca Sandstone Member

The Meseta Blanca Sandstone Member is the lowest member of the Yeso Formation and was named and defined by Wood and Northrop (1946) as consisting of light orange or red, cross-bedded sandstone that weathers to rounded and overhanging cliffs. The type section is near Cañon, New Mexico.

The Meseta Blanca Sandstone Member conformably overlies the Abo Formation; the contact is gradational and was arbitrarily placed above the uppermost thick unit of dark red mudstone above which the sandstone beds start getting thicker than the mudstone beds, the opposite being characteristic of the Abo Formation. The contact between the Meseta Blanca Sandstone Member and the overlying Torres Member is conspicuous. It is marked by the appearance of the basal limestone of the Torres Member.

The Meseta Blanca Sandstone Member is 320 feet thick, estimated from cross-sections, and consists of thick beds of thin - to medium-bedded sandstone and siltstone separated by thinner beds of mudstone and shale.

The sandstones are cross-bedded and range from pure quartz sandstone to feldspathic and arkosic sandstones, pale reddish-brown, grayish-white, light orange, pale yellowish brown, and light greenish-gray. The sandstones are very fine-grained, subangular to subrounded and most of them are fairly well sorted. Some have calcareous cement and others have siliceous cement. Hematite and limonite stain are abundant. The sandstones commonly are orange and red and show characteristic rounded weathering.

The mudstone varies in color from pale red-purple to light blue and medium gray. It is slightly silty and bentonitic and becomes locally either a calcareous or siliceous, argillaceous, laminated shale.

Thin beds of light gray, argillaceous, nodular limestone occur occasionally near the top.

Salt casts are common in the siltstone beds near the base. Current ripple marks are abundant in the lower beds while the upper beds have wave ripple marks.

X <u>Torres Member</u>

The Torres Member was named by Wilpolt <u>et. al.</u> (1946) from exposures in a tributary to Agua Torres Canyon, on the Sevilleta Grant 7 miles due south of Black Butte, Socorro County, where the member is about 600 feet thick and consists of alternating beds of orange-red and buff sandstone and siltstone, gray limestone, and gypsum.

The Torres Member is faulted in the area mapped and has an incomplete thickness of 220 feet, estimated from the cross-sections. It consists of medium to thick beds of light gray and greenish-gray dismicrite, recrystallized dismicrite, slightly argillaceous micrite; and argillaceous, recrystallized micrite interbedded with medium to thick beds of pale red, reddish orange, and pale yellow cross-bedded feldspathic sandstone.

Cañas Gypsum Member

The Cañas Gypsum Member was named by Needham and Bates (1943) from exposures in the north end of Lomas de las Cañas, a range of hills 9 miles east of Socorro, where it is 96 feet thick and consists of thick beds of gypsum.

The Cañas Gypsum Member of the Yeso Formation in Cerros de Amado area attains a partial thickness of 40 feet, estimated from the cross-sections, and consists of thick beds (up to 7 feet) of white and bluish white gypsum (selenite) interbedded with thin - to medium-bedded, yellowish gray, pure quartz sandstone which is very fine-grained, sugangular to subrounded, and well sorted, with calcareous cement. Grayish-orange, argillaceous and gypsiferous siltsone, thick beds of yellowish gray, very calcareous mudstone, and argillaceous limestone are locally interbedded.

X Glorieta Sandstone

The name Glorieta Sandstone was first used by Keyes (1915) for the main body of Dakota Sandstone (Cretaceous). No type locality was given, presumably the sandstone was named from Glorieta Mesa in Santa Fe and San Miguel Counties, New Mexico, or from the town of Glorieta. However, Cretaceous rocks do not crop out at either of these places. Common usage has determined the Glorieta to be the prominent sandstone, well developed and exposed on Glorieta Mesa, that separates the Yeso and the San Andres Formations (Needham and Bates, 1943).

Needham and Bates (1943) designated as the type section of the Glorieta Sandstone a good exposure in Glorieta Mesa 1 mile west of the village of Rowe, San Miguel County, New Mexico, where it is 136 feet thick and consists of medium - to thick-bedded, white to gray, quartzitic sandstone and thin-bedded, buff to white, friable sandstone.

The Glorieta Sandstone is faulted in the area studied and its contact with the Yeso Formation is not exposed. Wilpolt and Wanek (1951) mapped the Glorieta Sandstone as the lower member of the San Andres Formation which lies conformably on the Yeso Formation.

It has an incomplete thickness of 110 feet, estimated from the cross-sections, and consists of thick units of thin - to medium-bedded, pure quartz sandstone, reddish orange, yellowish orange, pinkish gray, and grayish white, medium - to fine-grained, cross-bedded, subangular to sub-rounded, will sorted, occasionally bimodal, friable to very poorly silica cemented. Some beds contain abundant calcareous cement and hematite and limonite stains are common. The sandstones weather rounded and are inter-

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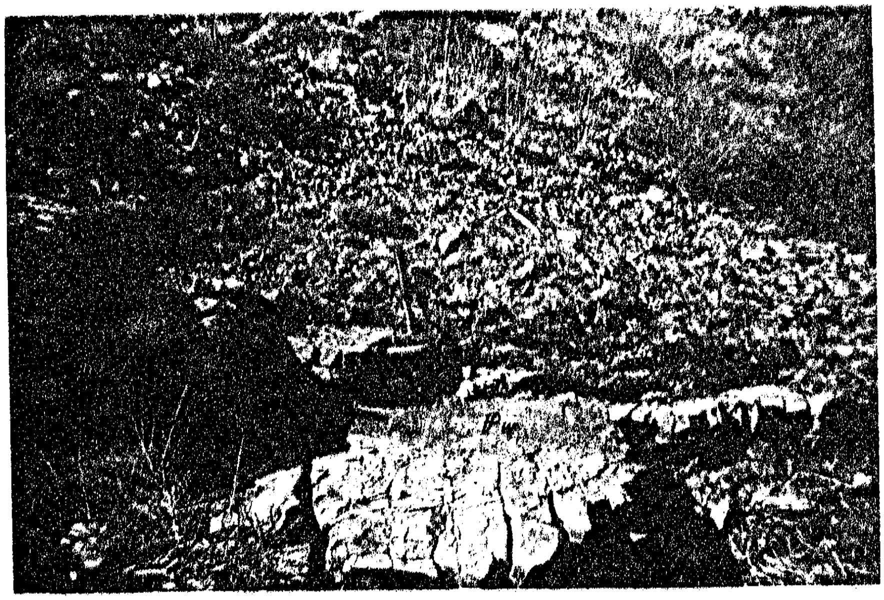

A. Angular unconformity between the Pennsylvanian (Whiskey Canyon Limestone) and the Tertiary (Baca Formation) rocks. Looking SSW, SE 1/4, NE 1/4, Sec. 34, T. 2 S., R. 1 E.

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B. The Baca Formation is unconformably overlain by the Datil Formation and both are beveled by the Santa Fe Group. Dotted lines represent bedding planes. A normal fault can be observed. Looking N. NE 1/4, Sec. 34, T. 2 S., R. 1 E.

PLATE 10

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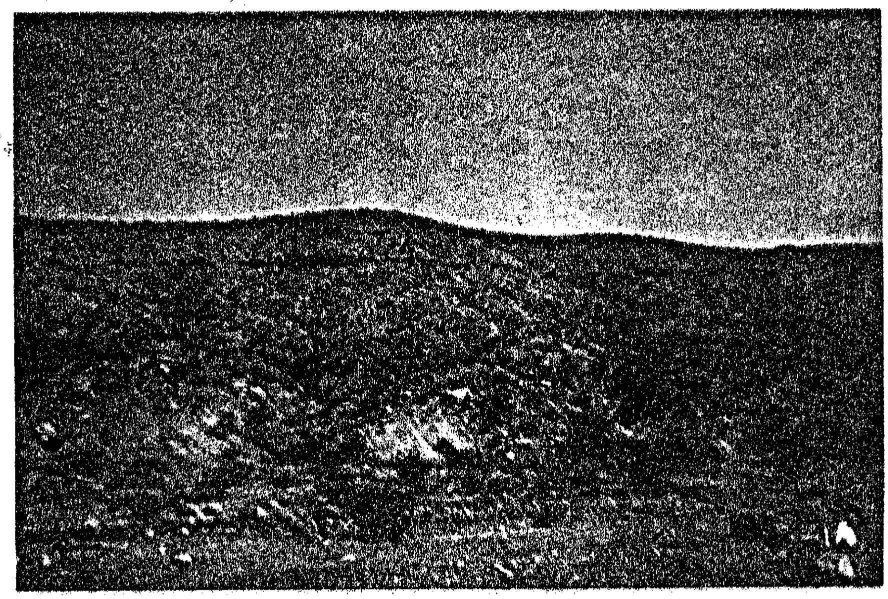

The Santa Fe Group rests with angular unconformity on the Datil Formation. Dotted line indicates bedding planes. Looking NNW, NE 1/4, Sec. 27, T. 2 S., R. 1 E.

PLATE 11

bedded with thinner covered intervals that might be mudstone.

No fossils were found in this formation. Wilpolt and Wanek (1951) say that it is considered by most geologists to be of Leonardian age.

Tertiary System

Baca Formation

The Baca Formation was named by Wilpolt et. al. (1946) from exposures in Baca Canyon, north Bear Mountains, Socorro County, where it is 694 feet thick and consists of coarse conglomerates, red and white sandstones, and red clays. It truncates all the Cretaceous formations in that area and was tentatively dated as Eocene (?).

The Baca Formation in Cerros de Amado area has a partial thickness of 320 feet, estimated from the structure sections. Its total thickness could not be determined because of faulting. It rests with an angular unconformity on the Pennsylvanian rocks (Plate 10A) and is in turn beveled by the Datil Formation. (Plate 10B)

The Baca consists of medium - to thick-bedded, light purple, red, and light yellow conglomerates and conglomeratic sandstones with graded bedding.

The lower beds contain an abundance of subangular to subrounded (a few are tabular) limestone pebbles, cobbles, and boulders which were derived from Pennsylvanian rocks, some tabular fragments derived from the Abo Formation, and a few igneous fragments. All clasts are surrounded by a pebbly arkosic matrix, angular to subangular and poorly sorted. These conglomerates are true calclithites.

The abundance of limestone fragments decreases upward while pebbles, cobbles, and boulders essentially of granite, granodiorite, quartz diorite, gneiss, and also slate, quartzite, and schist become dominant in a pebbly arkose-matrix. Most of the igneous boulders are fairly well rounded and some of them reach up to 3 feet in diameter.

The frequency of distribution of sedimentary and igneous fragments from base to top suggests that an uplifted source area was subjected to intense erosion and stripped of its sedimentary cover, thus exposing the Precambrian (?) basement complex. The products of erosion were carried by high energy streams and deposited in local basins.

In the SE 1/4, NE 1/4, Sec. 34, T. 2 S., R. 1 E., there is evidence of a very small intrusion of hypocrystalline-porphyritic andesite from the Datil Formation into the Baca Formation.

Datil Formation

The Datil Formation was named by Winchester (1920) from a sequence of tuffs, rhyolites, conglomerates, and sandstones well exposed in the north end of the Bear Mountains where it reaches a thickness of about 2000 feet. The name was derived from the Datil Mountains.

The Datil Formation constitutes a thick volcanic unit resting with angular unconformity on the Baca Formation and presumably younger rocks; it is in turn overlain by the Santa Fe Group with angular unconformity (Plate 10B and plate 11). By stratigraphic position it is considered to be Eocene (?), Oligocene (?) or Miocene(?).

It attains a partial thickness of 600 feet, estimated from the cross-sections, and consists of thick beds of pale purple and grayish-red-purple porphyritic andesite flows with feldspar phenocrysts up to 7 mm. in length, rhyolite, tuffs, and agglomerates, the latter containing abundant quartz-tonalite cobbles and boulders in an andesitic matrix.

A dike-like intrusion of hypocrystalline-porphyritic andesite was found in the Baca Formation in the SE 1/4, NE 1/4, Sec. 34, T. 2 S., R. 1 E., which indicates an intrusive nature in addition to the dominant extrusive character of the Datil Formation.

SANTA FE GROUP

Hayden (1869) originally defined the Santa Fe marls as thick deposits of gray and yellow sandstones, sands, and marls occupying the greater portion of the Rio Grande Valley. Later studies of the Santa Fe Formation led to a revision of its definition and subdivision in three members. Baldwin and Kottlowski (Baldwin, 1956) proposed that the term Santa Fe be raised to group status including the basin-filling sedimentary and volcanic rocks associated with the Rio Grande trough. It ranges in age from middle Miocene (?) to Pleistocene (?) and reaches a great thickness, probably of several thousand feet.

Geddes (1963) using the gravity method determined the Santa Fe to be 7500 feet thick near Little Pascual Mountain, south of Socorro. He refers to R. G. Anderson who in 1953 determined the Santa Fe to be 5900 feet thick a few miles north of Socorro; and to W. D. Sullivan who in 1960 determined that the Santa Fe may vary in thickness depending upon the assumptions used from 5900 to 27000 feet, near Belen. Both of these men used geophysical methods. Geddes also mentions that the Humble Oil and Refining Company in 1956 drilled a well east of Belen and encountered 9800 feet of Sanda Fe overlying Cretaceous rocks.

The exposures of the Sanda Fe Group in the area studied reach an approximate thickness of 300 feet, estimated from the cross-sections. It was not possible to determine the total thickness because most of the group is downdropped into the Rio Grande depression.

The Santa Fe beds bevel older rocks (Plate 9B, 10B, and 11) and consist of red, brownish-red, and gray, thick-bedded, partially consolidated sands, gravels, and conglomerates, and dip gently toward the Rio Grande depression (0 to 5°). The base of the group is well exposed at Ojo de Amado where a 5 foot bed of conglomerate lies with angular unconformity on the Datil Formation; the conglomerate is irregular brownish-red in color and consists of angular to subangular pebbles and cobbles (a few subrounded)of limestone, arkosic conglomerate, and sandstone in a matrix of the same material; many of the cobbles can be easily recognized as derived from the Pennsylvanian limestones, the Bursum Formation, and the Abo Formation. Clasts from the latter formation are characteristically tabular. The fragments decrease in size upward and also become better rounded.

Quaternary System

In addition to the upper part of the previously described Santa Fe Group which is considered to be Pleistocene (?) in age, Recent deposits of unconsolidated gravel, alluvium, and wind-blown sand occur scattered as a thin mantle or patches over older rocks. Little attention was paid to these deposits and their distribution as shown on the geologic map (Plate 1) does not include all the areas because of the scale used.

IGNEOUS ROCKS

Pre-Pennsylvanian Basement Complex

In addition to the volcanic rocks of the Datil Formation mentioned on page 39, the igneous rocks in the Cerros de Amado area are restricted to two small outcrops exposed by faulting; they constitute the oldest rocks in the area and are considered to form part of the pre-Pennsylvanian basement complex. Although these igneous rocks were considered to be Precambrian in age by Wilpolt and Wanek (1951), there is not enough evidence in the area studied to support such a statement and, therefore, they are here dated as pre-Pennsylvanian, possibly Precambrian.

Samples of these igneous rocks were studied with a binocular microscope and classified according to Johannsen's classification of igneous rocks (Johannsen, 1962).

The igneous rocks cropping out in the NE 1/4, Sec. 3, T. 3 S., R. 1 E., (Plate 1) consist of leucogranite, pale red to grayish red, holocrystalline, phaneritic, fine-grained (most crystals range from 0.5 to 1 mm. in size). The average composition is: 36% quartz, 52% orthoclase, 10% plagioclase, and 2% biotite. A small dike-like intrusion of gneissic granite (Plate 5A) showing flow structure and having inclusions of biotite-paraschist furnishes evidence for later igneous activity. Such an intrusion occurs very close to the base of the Pennsylvanian rocks but apparently it did not affect them. It is possible that the granite intrusion took place before the Pennsylvanian rocks were deposited. However, there is no way of proving this statement.

The other outcrop of pre-Pennsylvanian igneous rocks is located in the NE 1/4, Sec. 2, T. 3 S., R. 1 E., (Plate 1) and is composed of quartz-monzonite, grayish pink, holocrystalline, phaneritic, medium-grained (most crystals range from 1 to 2 mm. in size). Its average composition is: 39% quartz, 31% plagioclase, 25% orthoclase, and 5% biotite.

The pre-Pennsylvanian igneous rocks are nonconformably overlain by the Pennsylvanian sedimentary rocks. The depositional contact is especially well exposed at the leucogranite outcrop (Plate 5A).

Structural Geology

Structural relations in the Cerros de Amado area are complicated. Many of the minor folds and faults have been omitted from the map because the scale is too small to allow accurate plotting of all of them.

FOLDING

The pre-Pennsylvanian and Pennsylvanian rocks have undergone intense parallel folding along with a minor amount of similar folding; younger rocks have only been faulted and tilted.

The most intense folding trends in a southeasterly direction from Ojo de Amado (Plate 1) and can be traced for about 3 miles. The northern limit is a fault truncation and the southern portion is less tightly folded in the SW 1/4, Sec. 1, T. 3 S., R. 1 E. The folding may die out entirely, immediately south of the area mapped. This structure is an overturned, Z-shaped fold with its axial plane dipping from 45° to 70° to the southwest and plunging gently to the northwest. It forms a conspicuous and continuous ridge across the southwestern part of the area exposing steeply dipping, overturned beds. The "Amado Limestone" and the "Bartolo Formation" are the units involved on the western side of the Amado fault zone, and the Garcia Formation and the Whiskey Canyon Limestone are affected on the eastern side.

At the intersection of the Amado fault zone with the folded zone — north central part of Sec. 35, T. 2 S., R. 1 E. — (Plate 1) the structure is even more complex and is not well exposed. However, apparently the folded zone has not been displaced by the faulting since formations of different ages are tightly folded on both sides of the Amado fault zone. The faults are not affected by the folding. The trends of the faults are perpendicular to the axis of folding and thus parallel the direction of compression. Strike slip movement due to such compression, along the Amado fault zone could account in part for the sudden change in lithofacies across the Amado fault zone.

In the NE 1/4, Sec. 2, T. 3 S., R. 1 E. the folding becomes more intense and better exposed. The structure is well illustrated on the geologic map and in cross-section B-B (Plate 1).

Minor folds are common in the "Bartolo Formation" and in the lower beds of the Adobe-Coane undifferentiated especially on the eastern side of the Amado fault zone. Such minor folds are also Z-shaped and are so sharp that when not well exposed they are readily mistaken for faults. This is also true for the major folds. The same structural pattern occurs both on a small scale of a few feet and on a larger scale of several hundred feet.

Minor folds are also very abundant in the easterly outcrops of the Sandia Formation. The thin limestones interbedded with shales have been profusely wrinkled in a zig-zag pattern. These minor folds are considered, to be related to the major folding.

An asymmetrical anticline occurs in the "Bartolo Formation" in the SE 1/4, Sec. 24, T. 2 S., R. 1 E. It is a very local structure and is probably a drag fold due to faulting.

On the basis of the incomplete stratigraphic evidence available the deformation can not be dated closer than post-Permian and pre-Miocene.

FAULTING

The Cerrós de Amado area is located structurally on the eastern margin of the Rio Grande depression and has been completely shattered by closely spaced normal faults.

There are at least three fault systems that can be recognized (Plate 1). For convenience they are here referred to as system no. 1, system no. 2, and system no. 3.

Fault System No. 1

Fault system no. 1 includes the Amado fault zone and other subparallel faults trending approximately N. 40° E. It is very conspicuous in the area between Cerros de Amado hills and Minas del Chupadero and consists of high angle normal faults arranged in a graben and horst structure.

In the NE 1/4, Sec. 26, T. 2 S., R. 1 E., the fault running through Minas del Chupadero has a stratigraphic throw of about 800 feet, and the main fault of the Amado fault zone has a stratigraphic throw of about 1000 feet. The faults die out southward relatively rapidly. The other faults belonging to this system have stratigraphic throws of less than 400 feet which slowly decrease southward.

Branches of these faults cannot be identified in the Santa Fe group which is considered to be middle (?) Miocene to Pleistocene in age. The folding is dated as post-Permian and pre-Miocene and is considered to be younger than fault system no. 1. Consequently, this tectonic activity occurred sometime after the Permian and before the middle Miocene and prior to the folding. There is not enough stratigraphic evidence in the area mapped to date these events more closely.

Fault System No. 2

Fault system no. 2 consists of high angle normal faults trending approximately N-S.

They affect rocks as young as the Datil Formation (early Miocene?) and are covered by the Santa Fe Group (middle ? Miocene-Pleistocene). On this basis, the tectonic activity may be dated as middle (?) Miocene in age, prior to the deposition of the Santa Fe Group. This fault system is considered to be genetically related to the beginning of the formation of the Rio Grande depression.

The maximum stratigraphic throw measured is about 800 feet; however, it could be greater but the field evidence available does not permit such calculation.

Fault System No. 3

Fault system no. 3 is a set of high angle normal faults striking approximately N-S; these affect the Santa Fe Group and consequently are dated as early (?) Pleistocene in age.

This system is considered to be related to the latest stage of the formation of the Rio Grande depression.

It might represent either a strong reactivation of the system no. 2

or an entirely different set of fractures. In any case, they represent two different periods of marked tectonic activity.

The fault in Sec. 3, T. 3 S., R. 1 E. that has brought the pre-Pennsylvanian basement complex in contact with the Santa Fe Group presumably has a stratigraphic throw of several thousand feet in order to account for the great thickness of the Santa Fe Group in the Rio Grande depression. It has been hypothetically traced northward and is considered to be the main fault — or one of them — responsible for the deep down-dropping of the Santa Fe Group into the Rio Grande depression.

System no. 2 and no. 3 can be readily distinguished in the area near Ojo de Amado. Toward the east the Tertiary rocks have been eroded and there is no field evidence to differentiate the two systems. Such faults as were mapped in the eastern area probably belong to system no. 2 which is considered to be related to the beginning of the formation of the trough, which initiated deposition of the Santa Fe beds. Moderate intermittent movement continued during the deposition of the Santa Fe until a period of intense faulting, corresponding to fault system no. 3 occurred.

Although these high angle normal faults range in dip from about 60° to 80° they become less steep in places and may locally become a low angle normal fault having a dip of about 20° or even less, especially at places where they are sinuous.

A very few faults show a slight hinge effect.

Only a few low angle faults dipping about 20° or less were observed. They are considered to be low angle fractures associated with the high angle normal faults.

STRUCTURAL ANALYSIS

There is no genetic relation between the folding and the normal faulting.

On the basis of the strikes and relative movements of the faults a probable distribution of stresses can be suggested.

Fault system no. 1 was caused by uplift movements. The greatest principal stress was vertical, the medium stress was oriented at about N. 40° E. and parallel to the faults, and the least principal stress was oriented at about N. 50° W. and coincided with the direction of active tension.

Stratigraphic evidence (page 47) strongly suggests that fault system no. 1 occurred prior to the folding.

The general pattern of the folding indicates that it was produced by compressive forces acting from the southwest.

Fault system no. 2 and no. 3 can be explained as formed by tensional forces. The greatest principal stress was oriented E-W and coincided with the direction of active tension, the medium principal stress was oriented N-S parallel to the faults, and the least principal stress was vertical.

GEOLOGIC HISTORY

There is no record of unmetamorphosed sedimentary rocks prior to Pennsylvanian time in the Cerros de Amado area.

The area studied, and probably much of Central New Mexico, was emergent for a long period prior to Pennsylvanian deposition.

The granitic intrusion observed in the leucogranite (page 44) seems to represent igneous activity prior to the deposition of the Pennsylvanian sediments.

Any pre-Pennsylvanian rocks that may have been deposited in the area, were completely eroded and caused the pre-Pennsylvanian, possibly Precambrian, basement complex to be exposed.

The seas transgressed slowly from the south during Derryan time as the pre-Pennsylvanian surface was subaerially weathered to low relief. A source area to the northeast was uplifted and deposition of the Sandia Formation began. Fine and coarse clastics were transported by streams and deposited over the irregular basement surface. The lenticular, coarse, cross-bedded sandstones represent floodplain deposits. Intermittent subsidence of the region introduced shallow marine waters, presumably less than 100 feet deep, in which silty shales, siltstones, and sandy biomicrite were deposited. A brachiopod-crinoid fauna including solitary corals and scarce gastropods is associated with the limestones. The slightly lenticular character of the limestone beds probably reflects the shallowness of the water and the irregularities on the surface of deposition.

The insoluble residues (Appendix B) of several limestones of the Sandia Formation range from 5 to 20% and consist dominantly of quartz silt with minor amounts of clay. Occasionally, the insoluble residue reaches as much as 40% of the rock and consists of coarse sand and silt. There seems to be an increase in the amount of insoluble residue toward the east and also a thickening of the limestones toward the west. This suggests an easterly source of clastic sediments. A slight increase in grain size and in abundance of feldspar in the sandstones toward the west suggests a westerly source for the Sandia clastics. Although such variations in thickness, grain-size, and feldspar content could be due to the effect of local currents, it is possible that two different source areas existed at that time.

Transgression of the seas from the south continued during Desmoinesian time.

The Elephant Butte Formation was deposited in an infralittoral environment (Krumbein and Sloss, 1963) under unstable shelf conditions. Sediments associated with a brachiopod-crinoid fauna, including some solitary corals, were probably deposited at depths of less than 100 feet; they alternate with sediments associated with a fusulinid fauna which indicates deposition in slightly deeper water, probably from 100 to 200 feet deep. The limestones are poorly winnowed to unwinnowed and low in intraclasts. The presence of sporadic, local currents is indicated by occasional sparite cement, especially toward the west where two diastems were recognized. Fluctuations in the sea level combined with an influx of clastic materials caused interbeds of sandstones and shales to be formed. Thickening of the clastics toward the east suggests the approximate direction of provenance. Even during the formation of the limestones there were periods of small supply of very fine clastics as indicated by the insoluble residues (Appendix B) which range from 2.6 to 24% and consist almost entirely of quartz silt with a minor amount of clay minerals.

The fact that many of the limestones of the Elephant Butte Formation are slightly fetid suggests reducing conditions and probably restricted circulation. Since the environment was in general one of shallow and quiet marine waters subjected to the action of sporadic currents, it is possible that such an environment was somehow protected from open-sea circulation, probably by a large barrier reef.

The Missourian rocks (Appendix A) have local small reefs. It is possible that such reef building started to develop in Derryan time farther to the south on an elevation of the pre-Pennsylvanian erosion surface which served as a platform. By early Desmoinesian time such reefs might have restricted circulation in the Cerros de Amado area.

The Whiskey Canyon Limestone (Lower Des Moines) represents a long period of fairly stable shelf conditions. The abundance of fusulinids indicates water depths of about 100 to 200 feet. The almost complete absence of sparite cement reflects the lack of currents and wave action. The association of the fusulinid fauna with a brachiopod-crinoid fauna, including solitary corals, is probably due to slight lowering of the sea level to a depth where both faunas could coexist and also to the action of sporadic currents that mixed both faunas.

The land area remained fairly stable during Whiskey Canyon time. Only small amounts of shales were supplied by a low source. The shales thicken slightly to the east. A limestone containing extremely abundant fusilinids yielded about 9% of insoluble residue which consists mostly of quartz silt with a subordinate amount of bentonitic clay.

The fetid character of the Whiskey Canyon Limestone indicates reducing conditions and restricted circulation.

A channel of pebbly feldspathic sandstone and pebbly conglomerate has scoured the Whiskey Canyon Limestone in the central part of Sec. 35, T. 2 S., R. 1 E. Its stratigraphic relationships are not clear. It possibly occurred near the end of Whiskey Canyon time. This would imply a break in the deposition of the limestones.

Uplift of the land area followed the deposition of the Whiskey Canyon Limestone. The products of erosion (shale and arkose) were deposited in a shallow marine environment as indicated by the cross-bedded arkose beds associated with sandy limestones and sandy intraclasts. These sediments constitute the lower member of the Garcia Formation. A brachiopod-crinoid fauna is associated with the limestones. Occasional occurrence of algae indicates very shallow depths (less than 30 feet). Although the environment was shallow, probably less than 100 feet deep, the scarcity of sparite cement and intraclasts indicates that it was a low energy environment only occasionally disturbed by currents. An easterly source is suggested by the thickening of the clastics toward the east and the thickening of the limestones to the west.

The upper member of the Garcia Formation consists of argillaceous micrite and micrite associated with a brachiopod-crinoid fauna that alternates with a fusulinid fauna. The absence of sparite cement indicates a very poorly winnowed to unwinnowed environment. The sediments associated with the brachiopod-crinoid fauna were probably deposited in the infralittoral zone at depths of less than 100 feet. The sediments associated with the fusulinids indicate deposition in slightly deeper water, probably from 100 to 200 feet. No marked changes in sea level occurred during the deposition of the upper member of the Garcia Formation.

Gentle uplift of the land areas followed at the end of Garcia time.

Abundant clastic products shed from nearby uplifts constitute the "Bartolo Formation". The association of calcareous shales, calcareous siltstone, and calcareous feldspathic sandstone with several sandy biomicrite beds containing a brachiopod-crinoid fauna indicates that these sediments were deposited in shallow marine waters, probably less that 100 feet deep. Occasional algae suggests even shallower depths (30 feet or less). The presence of oolites and intraclasts is proof of the existance of temporary currents strong enough to fracture the semi-consolidated limestones deposited previously.

Most of the Desmoinesian limestones are slightly fetid to fetid and unwinnowed. At the end of the Desmoinesian the influx of clastic materials ceased and the sea waters became clear, thus allowing the deposition of the "Amado Limestone". The abundance of micrite associated with a brachiopod-crinoid fauna suggests a very shallow marine environment of less than 100 feet (infralittoral zone). The total absence of sparite cement reflects deposition in very quiet water. The fetid odor of the limestones indicates the existence of reducing conditions and thus restricted circulation.

Regression of the sea waters and uplift of the source area at the beginning of the Missourian epoch, preceeded the deposition of the Adobe-Coane undifferentiated which represents an infralittoral environment less than 150 feet deep. The lithologic association (Appendix B) indicates unstable shelf conditions (Krumbein and Sloss, 1963).

West of the Amado fault zone the Adobe-Coane unit shows a slight predominance of limestones over clastic sediments. The abundance of fossiliferous micrite, biomicrite, and pelmicrite indicates a very poorly winnowed to unwinnowed environment. Very occasional sparite cement reflects the action of local, sporadic currents. The limestones are associated with a brachiopod-crinoid fauna which suggests deposition in the infraneritic zone. Occasional occurrence of algae is proof of very shallow water depth (30 feet or less). Intermittent uplift of the source area caused thick interbeds of silty shale to be formed and the influx of clastics inhibited the development of limestones. Very scattered beds of dismicrite suggest the action of burrowing organisms in a soft calcareous mud.

East of the Amado fault zone, in Cerros de Amado hills, the Adobe-Coane undifferentiated is dominantly clastic with a few thin interbeds of micrite, biomicrite, and pelmicrite. There is a marked decrease in the fauna compared to the western outcrops. No outcrops of the Adobe-Coane unit were found east of Cerros de Amado hills and it is not possible to determine how far east the clastic facies extends. However, it is probable that the outcrops represent a very local change in lithology as seems to be the case in the overlying Burrego Formation which also shows rapid lateral variations in lithology (page 25).

The sudden change in lithofacies across the Amado fault zone may result from the area of deposition being near shore and in a deltaic area. Rapid uplift and erosion of the source area produced abundant clastics which were carried by local streams toward the present site of the Cerros de Amado hills. Although the area of deposition was shallow, the mechanical energy of the near shore environment (wave action, currents, and storms) was not strong enough to sort these sediments and disperse them over a larger area.

The insoluble residues obtained (Appendix B) range from 6 to 10%. They consist mostly of quartz silt and indicate that during the deposition of the limestones the sea water was relatively clear.

In general, the environment of the Adobe-Coane unit was one of shallow marine water protected from the open sea. Presumably, a reef (page 54) served as a barrier against strong wave action and currents.

The area of deposition became progressively shallower causing the earlier formed calcareous sediments to be exposed to wave and local current action, as is indicated by the sandy intraclast bed present at the top of the Adobe-Coane unit.

Slow subsidence and clearing of the sea water allowed the deposition of the Council Spring Limestone in very shallow water.

A bioherm started to grow at the beginning of the Council Spring time when the waters were probably less than 30 feet deep. Relatively warm, of normal salinity, and well oxygenated by moderate local currents and wave action. The conditions became unfavorable and inhibited further development of the bioherm. Sinking of the area below wave base was probably the cause. The insoluble residues consist of quartz silt with a subordinate amount of clay. They range from 1 to 5% only, an amount not sufficient to inhibit the growth of the bioherm.

The presence of fossiliferous micrite, crinoidal biomicrite, and biomicrite, in the Council Spring indicates a poorly winnowed environment subjected to the action of sporadic, moderate local currents. Most of the fossils were probably washed in by occasional storms and currents since their distribution is very irregular and only the stems of the crinoids are present. Patches of dismicrite are suggestive of the action of burrowing organisms living on a soft calcareous mud bottom. In addition, the local occurrence of lithographic limestone indicates a very quiet marine environment, probably lagoonal. From the lithologic characteristics and their variations, the existence of a reef south of Cerros de Amado area can be inferred.

At the beginning of Burrego time, moderate uplift of the land areas gave rise to a supply of shale and arkose which inhibited the deposition of limestones.

Although west of the Amado fault zone the Burrego Formation consists dominantly of fine clastics, occasional clearing of the sea water caused the deposition of micrite (unwinnowed environment) associated with a scarce crinoid fauna. Local concentration of algae indicates depths of deposition of less than 30 feet and the action of moderate, local currents. A fusulinid fauna is associated with the upper limestones and indicates deposition in deeper water (100 to 200 feet). Local occurrence of dismicrite suggests the action of burrowing organism on soft micrite.

East of the Amado fault zone, immediately north-northeast of the Cerros de Amado hills, the Burrego Formation is composed of micrite, biomicrite, and pelmicrite, which reflect a poorly winnowed to unwinnowed environment. Very fine clastics occur in a minor amount. Very quiet water, probably lagoonal, is indicated by the occurrence of lithographic limestone near the base. Although the environment was one of very quiet sea water, occasional biosparite and logs of petrified wood in the clastics indicate the action of fairly strong currents. A moderate fauna consisting of crinoid stems, bryozoans, solitary corals, and gastropods, suggests shallow sea water. The occurrence of pseudomorphic limonite after pyrite and the fetid odor of some of the limestones indicate reducing conditions.

About 1 mile east of the Amado fault zone, faulted outcrops of the Burrego Formation resemble closely the outcrops west of the Amado fault zone except for the increase in grain size of the clastics toward the east and northeast which suggests the direction of provenance. It would appear that the sudden lithofacies changes in the Cerros de Amado area are of a local nature.

From the information available it follows that the Burrego Formation was deposited in a shallow and quiet marine environment (up to 200 feet deep), probably lagoonal, near a deltaic area crossed by streams that supplied the clastic sediments. Limestone deposition in the area northeast of Cerros de Amado hills was flanked to the east and the west by clastic sedimentation. Topographic barriers on the delta may have deflected the influx of clastics from that area.

Both the local lithofacies changes in the Adobe-Coane undifferentiated and in the Burrego Formation are thought to be the result of the diversion of the course of the streams in the deltaic area. The sediments were irregularly distributed in an infralittoral environment lacking strong currents that could have spread the sediments more uniformly and over a larger area.

At the end of Burrego time, moderate uplift of the source area and rapid erosion produced the abundant arkose and silty shale of the lower clastic member of the Story Formation. The dark red color of these marine sediments indicates a well drained source area and rapid burial in a sinking basin so that reduction of the hematite was prevented. The lateral gradation of the shales into siltstones and sandstones to the northeast suggests a northeasterly source.

After the deposition of the lower clastic member the sea waters cleared and favored the formation of the upper limestone member of the Story Formation. The currents were not strong enough to winnow the calcite ooze cement, except in places where some sparite cement is present, especially west of the Amado fault zone. A brachiopod-crinoid fauna with some gastropods suggests a shallow marine environment(infralittoral zone). Occasional algae indicates water depths of less than 30 feet and well oxygenated by local currents.

At the beginning of Virgilian time the source was slowly uplifted and produced an influx of shales followed by a supply of arkose due to faster uplift and erosion of the source. These sediments constitute the lower member of the Del Cuerto Formation. The sandstones are cross-bedded, fairly well sorted to poorly sorted, and subangular. They were deposited in a shore environment and in the shallower part of the infralittoral environment.

Clearing of the sea water and slow subsidence of the sea floor allowed the deposition of abundant crinoidal biosparite (middle member of the Del Cuerto Formation) in an infralittoral environment probably less than 100 feet deep, subjected to the action of moderate currents that winnowed the fine lime ooze and favored the deposition of abundant sparite cement.

A small supply of sandstone from a slowly rising land was carried into the shallow sea water and dropped on the fine lime ooze thus forming sandy micrite. As the land area continued rising, erosion progressed faster, the influx of clastics increased, and the sandy micrite graded upward into arkose. These sediments constitute the upper member of the Del Cuerto Formation. Slight cross-bedding and slump structures in the arkose beds suggest they were deposited near the edge of a delta.

When the influx of clastics ceased, the sea waters became clear and the lower member of the Moya Formation was deposited. The abundance of micrite is proof of an unwinnowed, poorly oxygenated environment. The reason for the paucity of the fauna (brachiopods and crinoid stems scattered) is not known. Deficiency in oxygen and abnormal salinity are two possible causes. The analysis of two limestones for insoluble residues (Appendix B) yielded 2.7 and 6.5% of insoluble residues which consist mostly of quartz silt. Thus, turbidity was not the reason for the paucity of the fauna. The occurrence of dismicrite suggests the action of burrowing organisms on the soft lime ooze bottom.

After the lower member of the Moya Formation attained a certain degree of consolidation, progressive shallowing of the sea caused the limestones to be exposed to the action of the waves and streams carrying sand from a rising land. Although there is no direct evidence in the area, presumably the hiatus between the lower and upper member of the Moya Formation is small. This disconformity represents the beginning of the transition from the marine Pennsylvanian environment to the continental Permian

The time interval between the end of the Permian and the beginning of the Tertiary is represented by an hiatus in the Cerros de Amado area.

Late Triassic continental deposits disconformable with Late Cretaceous rocks were mapped by Wilpolt and Wanek (1951) in areas surrounding the Cerros de Amado area. They do not report any Jurassic deposits and considered that much of central New Mexico was emergent without any deposition during Jurassic time.

It is reasonable to assume that Triassic and Cretaceous rocks were also deposited in the Cerros de Amado area. Strong uplift at the end of the Cretaceous or during the Paleocene, and consequent erosion exposed the Pennsylvanian and Permian rocks.

Fault system no. 1 (page 48) was associated with late Mesozoic or early Tertiary uplift which was followed by compressive stresses that caused the folding (page 46).

After those two periods of tectonic activity, the area (including the Cerros de Amado and surrounding areas) underwent rapid and intensive erosion that exposed the basement complex. The products of erosion were carried by streams of considerable energy and deposited in an alluvial environment filling any available local depressions. Such coarse deposits (boulder conglomerate to conglomeratic sandstone) formed the Eocene (?) Baca Formation which lies with angular unconformity on Pennsylvanian rocks in Cerros de Amado area.

At the end (?) of the Eocene, after the deposition of the Baca Formation, the area was uplifted, tilted, and subjected to erosion.

A period of volcanism followed extending into the Miocene (?) time. The volcanic debris constitute the Datil Formation that lies with angular unconformity on the Pennsylvanian and earlier Tertiary rocks in the area.

During the middle or late (?) Miocene, the area underwent a period of tectonic activity. It was uplifted, tilted, faulted, and subjected to erosion.

Fault system no. 2 (page 49) was associated with that tectonic activity which marked the beginning of the formation of the Rio Grande depression.

The products shed from the uplifts were transported by streams and deposited in the Rio Grande trough and adjacent areas. These sediments constitute the Santa Fe Group, of middle (?) Miocene to early Pleistocene age, and bevel older rocks.

Moderate tectonic movements continued through Santa Fe time concomittantly with the deposition.

During middle or late Pleistocene the tectonism reached its climax and resulted in normal faulting (fault system no. 3) that caused the Santa Fe Group to be downdropped in the Rio Grande depression.

Since then the area has remained uplifted and subjected to erosion.

There is no evidence of Recent tectonic activity in Cerros de Amado area.

Recent deposits are thin and scattered. They consist of wind-blown sand and alluvium deposited along the streams disecting the area.

ECONOMIC GEOLOGY

No mineral deposits of commercial value have been found in Cerros de Amado area.

Copper mineralization occurs in the sandstones of the Moya and Burrego Formations along the fault running through Minas del Chupadero (Plate 1). Malachite and azurite are abundant but the ore body is local and small.

Small amounts of fluorite and barite occur as open space-filling in the fault between the quartz-monzonite and the Sandia Formation, Sec. 2, T. 3 S., R. 1 E., (Plate 1).

Attempts have been made to mine these mineral deposits but they proved to be noncommercial.

Prospecting for clays has been done also without satisfactory results. Most of the Pennsylvanian shales are silty shales and some of them are true siltstones (pages 16, 124). A few argillaceous shales were found in the Garcia Formation (Appendix A) but their economical value is doubtful because of their high quartz content.

GLOSSARY

Medium-bedded:	Thickness of beds from 6 inches to 1 foot.
Protoquartzite:	A sandstone containing less than 25% of labile materials, including both feldspar and rock fragments. It approaches the composition of a pure quartz sandstone.
Sandy limestone:	A limestone (micrite, biomicrite, intraclast, etc.) containing more than 10% of sand grains.
sang.	Subangular
srnd.	Subrounded
Thick-bedded:	Thickness of beds greater than 1 foot.
Thin-bedded:	Thickness of beds from a fraction of an inch to 6 inches.

APPENDIX A

Composite stratigraphic section of the Pennsylvanian System in Cerros de Amado area, Socorro County, New Mexico.

Due to a sudden change in lithology across the Amado fault, it was necessary to measure two stratigraphic sections in the Pennsylvanian exposures, one west of the fault (section C through P) and another one east of it (section P through W). No Virgilian rocks are exposed in the area immediately east of the Amado fault. The descriptions of both sections are here presented together in order to facilitate their correlation.

The upper member of the Moya Formation was measured at two different localities (Ojo de Amado and Minas del Chupadero) in the area west of Amado fault because it shows a rapid change in lithofacies. Since no appreciable lithologic change takes place in the lower member, it was measured only at Ojo de Amado where the best exposure occurs. Bursum Formation overlies Moya Formation and remains identical at both localities.

Abbreviations

(f) = fresh

(w) = weathered

Stratigraphic section of the Sandia Formation, measured in NE 1/4 Sec. 3, T. 3 S., R. 1 E., and NW 1/4, Sec. 2, T. 3 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	PRE-PENNSYLVANIAN BASEMENT (Probably Precambrian) Leucogranite, (f) pale red 10R 5/2, (w) grayish red 10R 4/2, holocrystalline, phaneritic, fine-grained (most crystals 0.5-1 mm). Composition 36% quartz, 52% orthoclase, 10% plagioclase, 2% biotite.		
	----------------NONCONFORMITY----------------		
	DERRY - SANDIA FORMATION	580	11
1.	Arkose, (f) lt gy N7, (w) lt greenish gy, 5G 7/1; thin-bedded, 1/2-2 mm., angular. 30% strongly weathered feldspar, 67% quartz, 3% muscovite and biotite. Lower 2 inches may represent a granite wash. Roundness increases upward in the unit and the arkose grades into pure quartz ss. with only 5% of weathered feldspar, poorly silica cemented. Top of unit is quartzitic and medium-grained (1/4-1 mm) (S: 250, 250a, 250b)	3	2
2.	Sandy recrystallized micrite, (f) irregular pale yellowish brown 10YR 6/2, (w) moderate brown 5YR 3/4, thin-bedded; 10% hyaline quartz grains, 1/4-1.5 mm, subangular to subrounded. Amount of quartz increases toward the top of the unit, up to 25%. Interbedded with thin beds of laminated calcareous shale, (f-w) moderate yellowish brown 10YR 5/4. (S: 253-253a). Lower 3' contain 25% quartz grains, 1/6-1 mm, subangular to subrounded. (S:252)	5	0
3.	Chert pebble conglomerate, (f-w) dk reddish brown 10YR 3/2. Angular chert and quartz pebbles, 1/2-4 inches. Some pebbles are tabular shaped. Abundant hematite stain, thick-bedded, lenticular. Silica cemented. (S: 254a)	7	0
4.	Covered quartzite (?)	5	2
5.	Quartzite, (f) irregular medium gy N5, (w) dusky red 5R 3/4; thin-bedded, cross-bedded, 1-2 mm, fairly well sorted, subangular to subrounded. 95% quartz, 5% weathered white feldspar. Some hematite stain. (S:254)	7	8
6.	Slope covered with alluvium.	10	4

		Feet	Inches
7.	Arkose, (f-w) 5YR 7/1, thin-bedded, 1/4-1/2 mm, fairly well sorted, subangular to subrounded. 30% weathered white feldspar, 70% quartz; poorly silica cemented. Hematite and limonite stain along joints. (S: 255)	7	8
8.	Covered shale (?)	7	8
9.	Quartzitic feldspathic ss, (f) pinkish gy 5YR 7/8, (w) grayish red 5R 4/2; thick-bedded. 1/4-2 mm, poorly sorted, subangular. 88% quartz, 12% weathered white feldspar. Some hematite stain. (S: 256)	5	1
10.	Laminated calcareous shale, (f-w) pale yellowish brown 10YR 6/2. Calcareous concretions abundant; hematite and limonite stain abundant. Interbedded with thin sandy biointraclast (12% subrounded quartz grains, 1/4-2 mm) containing common crinoid stems, <u>Hustedia</u>, and productids. A thin bed of sandy crinoidal biosparite crops out near the top of the unit, it contains 15% of quartz grains, 1/2-1.5 mm, subangular to subrounded; (f-w) medium gy N5. (S: 257, 257a-258)	25	5
11.	Pure quartz quartzite, (f) lt. pinkish gy 5YR 7/1, (w) medium gy N5; thick-bedded, cross-bedded. 1/2-2 mm., poorly sorted, subangular to subrounded. (S: 260)	12	11
12.	Quartzitic feldspathic ss; (f-w) medium gy N5; thin-bedded; 1/5-2 mm, poorly sorted, subangular to subrounded, 17% weathered white feldspar, 83% quartz. Limonite stain. Interbedded with very few thin layers of laminated calcareous shale (dark reddish brown 10YR 3/4) and thin beds of biosparite (moderate yellow brown 10YR 5/4) containing abundant crinoid stems. (S: 261-a-b)	6	5
13.	Crinoidal biosparite, (f-w) medium gy N5, medium-bedded; shell fragments common. (S: 263)	10	4
14.	Crinoidal biosparite, (f-w) pale yellowish brown 10YR 6/2; thin-bedded, slightly nodular. subrounded quartz grains scarce, (1-2 mm.). (S: 264)	5	2
15.	Covered shale (?)	15	5
16.	Biogenic crinoidal ls, (f) lt brownish gy 5YR 5/1, (w) brownish gy 5YR 4/1, thin - to medium-bedded. Shell fragments scarce. (S: 264a)	15	6

		Feet	Inches
17.	Quartzitic feldspathic pebbly ss, (f-w) pinkish gy 5R 8/1 to very lt. gy N8; thick-bedded, cross-bedded. 1-26 mm., subangular to subrounded. 80% quartz, 20% weathered white feldspar. Little residual (?) calcareous cement. Some hematite stain. Grain-size and feldspar content decrease, progressively, upward in the unit. (S: 266-265)	31	0
18.	Biogenic crinoidal ls, (f-w) grayish orange 10YR 6/4, thin-bedded. 15% sparite matrix. Productids, spiriferids, and shell fragments scarce. 5% quartz grains, 1/4-1 mm., subrounded. (S: 267)	3	5
19.	Pebbly feldspathic ss, (f-w) pinkish gy 5YR 8/1, medium-bedded, cross-bedded, 1/2-4 mm, subangular to subrounded. 15% weathered white feldspar, 85% quartz. Silica cemented. (S: 267a)	10	4
20.	Recrystallized fossiliferous micrite, (f-w) lt olive gy 5Y 5/1; thin-bedded. Productids and spiriferids scarce. (S: 268)	25	10
21.	Laminated calcareous shale, (f-w) lt olive gy 5Y 5/2, 9% muscovite, silty; with thin beds of pure quartz calcareous ss, (30% calcareous matrix); (f) grayish orange 10YR 7/4, (w) dk yellowish brown 10YR 3/2. Thin beds of argillaceous biomicrite, containing common productids and spiriferids, and showing cone-in-cone structure is also interbedded with the shale. Medium grained quartzitic pure quartz ss. becomes abundant near the top. (S: 271-271a-269)	25	10
22.	Pure quartz ss, (f-w) medium lt gy N6, irregularly bedded, cross-bedded at places, 1/4-2 mm, poorly sorted, subangular; 92% quartz, 7% weathered orthoclase, 1% muscovite. It becomes better sorted and silica cemented toward the top, and weathers pale red 5R 6/2 due to hematite stain. (S: 273-272)	36	2
23.	Covered shale (?)	10	4
24.	Pure quartz ss, (f-w) pale red 5R 5/2, thin-bedded, cross-bedded; 1/10-1/5 mm, fairly well sorted, subangular; 92% quartz, 5% slightly weathered white feldspar, 3% muscovite. Silica cemented, residual (?) calcareous cement. The ss is pebbly at the base and the grain size decreases rapidly toward the top. (S: 275-274)	10	5

		Feet	Inches
25.	Covered shale (?)	10	4
26.	Pebbly quartzitic pure quartz ss, (f-w) lt brownish gy 5YR 6/1, thick-bedded, cross-bedded, 1-5 mm, poorly sorted, subangular. 7% strongly weathered white feldspar and fresh orthoclase, 93% quartz. Some hematite stain. Graded bedding, the grain size changes rhythmically from base to top of unit. The sandstone becomes arkosic near top (25% decomposed white feldspar) and has abundant calcareous cement. (S: 2780276)	40	8
27.	Covered shale (?)	12	9
28.	Crinoidal biogenic ls, (f-w) lt brownish gy 5YR 5/1, thin-bedded. <u>Composita</u> and shell and shell fragments scarce. (S: 279)	5	1
29.	Covered shale (?)	10	0
30.	Sandy biosparite, (f-w) lt olive gy 5Y 5/1, thin-bedded, nodular near base. 10% quartz grains, 1/4-2 mm., subangular. Productids, spiriferids, and shell fragments common. (S: 280)	10	4
31.	Pebbly quartzitic pure quartz ss, (f-w) lt brownish gy 5YR 5/1, thick-bedded, cross-bedded, 1/4-5 mm, subangular; 7% weathered white feldspar. Some hematite stain. (S: 281)	15	3
32.	Covered shale (?)	15	0
33.	Pebbly quartzitic pure quartz ss, (f) lt olive gy 5Y 6/1, (w) brownish gy 5YR 4/1; thick-bedded, cross-bedded; 1/4-7 mm subangular. 7% clay-sized matrix (probably decomposed feldspar) (S: 282)	10	5
34.	Laminated siliceous shale, (f-w) lt olive gy 5Y 4/2, slightly micaceous and silty. Interbedded with very thin layers of biosparite. (S: 282a)	10	2
35.	Pebbly pure quartz ss, quartzitic; (f-w) medium lt gy N6, medium-bedded, cross-bedded, 1-5 mm subangular to subrounded. (S: 282b)	10	4
36.	Recrystallized fossiliferous micrite, (f) lt olive gy 5Y 4/2, (w) pale yellowish brown 10YR 5/2; thin-bedded; crinoid stems and shell fragments scarce. (S: 283)	5	2

environment of the Abo Formation.

The transition continued during the deposition of the upper member of the Moya Formation. At least three additional disconformities were found within the upper member (page 29). Intermittent movements of the sea level and discontinuous deposition--long enough to allow the lithification of the later formed limestones--were essential factors in the formation of these disconformities.

Concurrently with the intermittent movements of the sea level there was an influx of clastic sediments (shale and arkose) carried by a local stream and deposited in shallow sea water near Minas del Chupadero and probably farther northeast and east. These clastics pass laterally into the limestones of the upper member of the Moya Formation to the west (page 29).

At the end of Virgilian time the Moya Formation was again exposed to the erosive action of waves and currents. This episode marked the end of the Pennsylvanian period.

The distribution of the Pennsylvanian sediments, their changes in thickness, and their lithologic variations strongly suggest a nearby source located east and northeast of Cerros de Amado area.

Thompson (1942) recognized three areas which remained uplifted throughout the Pennsylvanian and early Permian time in New Mexico, the Pedernal landmass the Zuni landmass, and the Uncompahgre (?) landmass.

According to Thompson's schematic paleogeographic map of Pennsylvanian time in New Mexico (1942), the western border of the Pedernal landmass was located about 50 miles east of the Cerros de Amado area and extended at least 170 miles in a north-south direction. The southeastern end of the Zuni landmass was located about 70 miles northwest of Cerros de Amado area. The south end of the Uncompahgre (?) landmass was located approximately 110 miles north of the area mapped.

The foregoing statements lead to the conclusion that the Pedernal landmass was the positive area most profoundly influencing sedimentation in the Cerros de Amado area during the Pennsylvanian. It is possible that the Zuni landmass had a certain influence in the Sandia Formation as vaguely indicated by the slight coarsening of the sandstones and their increase in feldspar content toward the west. There is no evidence of any influence of the Uncompahgre (?) landmass in the Pennsylvanian sediments of Cerros de Amado area.

Hambleton (1959) concluded that the Joyita axis (located about 11 miles north-northwest of Cerros de Amado area) was the active positive area of greatest influence in the sedimentation in north-central Socorro County during Missourian time. However, Dr. Kottlowski of the New Mexico Institute of Mining and Technology, State Bureau of Mines and Mineral Resources, (personal communication,, 1965) has found at least 290 feet of Atokan, Desmoinesian, and Missourian rocks, badly faulted, in the Joyita Hills. This definitely proves that the Joyita area was not a landmass during Pennsylvanian time.

The Pennsylvanian rocks in Cerros de Amado area show an increase in clastic content with respect to the Pennsylvanian sections described by Thompson (1942) south of Socorro, in Socorro and Sierra Counties. It is evident that the Pennsylvanian seas transgressed from a southerly direction.

At the beginning of Permian time, repeated advance and retreat of the seas continued while the Bursum Formation was being deposited. The abundance of fresh pink orthoclase in the red conglomeratic arkose and arkosic conglomerate indicates strong uplift of the source area (probably different from the Pennsylvanian source), rapid erosion, and rapid deposition in a subsiding shore environment. Occasional clearing of the water caused the deposition of micrite below wave base. Deposition was discontinuous and allowed the limestones to attain a certain degree of lithification before they were exposed on the tidal flats and torn by the waves and currents as indicated by occasional sandy intraclasts.

Progressive withdrawal of the seas toward the south caused the upper arkosic beds of the Bursum Formation to be essentially fluviatile deposits. This marked the end of the environmental transition between the Pennsylvanian and Permian periods.

The Abo Formation represents a long period of continental deposition in an alluvial environment (page 33). Floodplains were criss-crossed by streams carrying abundant fine sediments from a distant northerly source. The dark red color of the sediments suggests a well drained source area and a hot and humid climate.

Seas from the south again invaded the area in middle Permian time, depositing the Meseta Blanca Sandstone Member of the Yeso Formation. A shore environment of deposition is suggested by the cross-bedding, current ripple marks, and wave ripple marks in the sandstone beds. Casts of salt crystals in the lower beds of this member are proof of very shallow seas advancing over a fairly flat surface. The dominant red color of the sediments suggests deposition in an oxidizing environment.

Intermittent variation of the sea level and slight clearing of the water allowed the deposition of argillaceous micrite interbedded with sandstones which constitute the Torres Member of the Yeso Formation. The sandstones are cross-bedded, fairly well sorted, and non-lenticular. They were deposited in a shore environment. The limestones were deposited in quiet slightly deeper water in the infralittoral environment. The environmental conditions (presumably high salinity and turbidity) did not favor the development of a fauna with the exception of scarce coiled nautiloids and burrowing organisms that disturbed the fine lime ooze.

The abundance of gypsum in the Cañas Member of the Yeso Formation is proof of evaporation conditions. The interbedded limestones are argillaceous micrite and grade upward into calcareous mudstone and siltstone. The sediments are barren of any fauna. Although only a very small outcrop of this member is present in the area (Plate 1), it is possible to postulate for it a very shallow, locally restricted marine environment, with warm waters, high salinity, and high turbidity.

The Joyita Sandstone Member of the Permian Yeso Formation does not crop out in the area mapped.

In general, the Yeso Formation represents alternate advances of the seas to the north and retreats to the south.

The well sorted, subangular to subrounded, and cross-bedded pure quartz sandstones of the middle Permian Glorieta Sandstone represent stream sediments deposited in a shore environment of strong mechanical energy. The outcrop of this formation is very small (Plate 1) and therefore the information is incomplete.

Permian rocks younger than the Glorieta Sandstone are not present in the area mapped but occur immediately to the north and east.

		Feet	Inches
37.	Recrystallized micrite, (f-w) medium gy N5, thin-bedded, slightly nodular, very little cherty. (S: 283a)	10	5
38.	Covered shale (?) interbedded with thin layers of slightly nodular recrystallized micrite, (f) dk gy N3, (w) lt olive gy 5Y 5/1. (S: 284)	25	5
39.-	Pebbly pure quartz ss, (f-w) medium lt gy N6, medium-bedded, 1-6 mm, subangular to subrounded, slightly cross-bedded. (S: 284a)	5	1
40.	Recrystallized fossiliferous micrite, (f-w) medium lt gy N6; medium - to thick-bedded, very slightly cherty, (lt brown 5YR 6/4). Crinoid stems and large solitary corals scarce. Interbedded with medium beds of covered shale (?). (S: 285a)	28	0
41.	Covered shale (?)	5	1
42.	Pebbly quartzitic ss, (f) lt gy N7, (w) pale red 5R 5/2, medium-bedded, 1-25.7 mm, subrounded; some hematite stain. (S: 285b)	7	7
43.	Covered shale (?)	5	1
44.	Recrystallized fossiliferous micrite, (f) dk gy N7, (w) irregular medium gy N5 to lt brown 5YR 5/6. Crinoid stems scarce. (S: 285c)	5	0
45.	Covered shale (?)	7	8
46.	Recrystallized micrite, (f) medium dk gy N4, (w) mottled medium gy N5 to lt brown 5YR 5/4. Slightly cherty. (S: 285d)	7	7
47.	Covered shale (?)	5	1
48.	Pebbly feldspathic ss, (f) very lt gy N8, (w) yellowish gy 5Y 8/1, medium-bedded, 1/4-4 mm, poorly sorted, subangular. 15% weathered plagioclase and orthoclase, 85% quartz. Calcareous cement, slightly silicified. (S: 285e)	10	2

----------------CONFORMITY----------------

DES MOINES - ELEPHANT BUTTE FORMATION

Stratigraphic section of the Sandia Formation, measured in NE 1/4 Sec. 2, T. 3 S., R. 1 E. (Eastern section)

Unit No.	Description	Thickness Feet	Thickness Inches
	PRE-PENNSYLVANIAN - BASEMENT (Probably Precambrian) Quartz-monzonite, (f-w) grayish pink 5R 8/2, holocrystalline, phaneritic, medium-grained (most crystals 1-2 mm). Composition: 39% quartz, 31% plagioclase, 25% orthoclase, 5% biotite.		
	----------------NONCONFORMITY----------------		
	DERRY - SANDIA FORMATION	445	8
1.	Sandy micrite, (f) pale yellowish brown 10YR 5/2, (w) dk yellowish brown 10YR 3/2, very lenticular (maximum thickness: 6'), 10% hyaline quartz grains, 1/12-1/8 mm, subrounded, coarser quartz grains scarce (up to 1 mm.) It is overlain by a sandy siliceous shale, (f) lt olive gy, 5Y 4/2, (w) irregular grayish brown 5YR 3/2; very lenticular (maximum thickness 1'10") 20% hyaline quartz grains, 1/5-1 mm, subrounded. Some hematite stain. (S: 540-539) This unit lies nonconformable on the uneven weathered-surface of pre-Pennsylvanian granite.	3	6
2.	Laminated argillaceous (?) shale, (f) lt olive gy 5Y 5/2, (w) dusky yellow 5Y 6/4, 6% muscovite, slightly silty, interbedded with few thin layers of quartzitic pure quartz ss, containing 30% of argillaceous matrix; 1/4-1/2 mm. subrounded quartz grains; some hematite and limonite stain. (S: 542a-542)	22	0
3.	Pebbly feldspathic ss, (f-w) lt gy N7, irregularly bedded, very lenticular, cross-bedded, 1 to 10 mm, subangular to subrounded; 85% quartz, 15% fresh orthoclase and plagioclase. (S: 543)	5	0
4.	Laminated argillaceous (?) shale, (f) lt olive gy 5Y 5/2, (w) dusky yellow 5Y 5/4; 5% muscovite. In the upper 40 ft [illegible] shale becomes slightly siliceous, (f-[illegible]) olive gy 5Y 4/2; and contains traces of carbonaceous organic matter. Slightly silty throughout the unit. (S: 543a-543b)	70	0

5.	Biomicrite, (f) pale yellowish brown 10YR 5/2, (w) dk yellowish brown 10YR 4/2; thin-bedded. Crinoid stems and shell fragments abundant; productid and spiriferid common. Subrounded quartz grains scarce (1/4-1 mm.) (S: 544)	4	0	1.
6.	Covered shale (?)	24	0	1.
7.	Pure quartz ss, (f-w) grayish pink 5R 7/2, medium - to thick-bedded, cross-bedded, 1/4-1/2 mm, poorly sorted, subangular, coarser quartz grains up to 5mm. scattered. 95% quartz, 5% weathered white feldspar. Some hematite stain. Silica cemented. (S: 545)	22	10	7
8.	Sandy biomicrite, (f-w) dk yellowish brown 10YR 3/2, medium-bedded; shell fragments abundant. 7% hyaline quartz 1/4-1 mm, subangular. (S: 546)	5	2	1.6
9.	Covered shale (?)	9	0	2.
10.	Quartzitic pure quartz pebbly ss, (f) pale red 10R 5/2, (w) grayish red 5R 4/2, medium-bedded, cross-bedded; 1/4-3 mm, poorly sorted, subangular; 98% quartz, 2% weathered white feldspar, silica cemented. Abundant hematite stain. (S: 548)	10	0	3.
11.	Sandy biomicrite, (f) grayish orange 10YR 6/4, (w) dk yellowish brown 10YR 4/2, thin - to medium-bedded. Crinoid stems abundant; <u>Composita</u> and shell fragments common. (S: 547)	8	0	2.
12.	Quartzitic pure quartz ss, (f-w) lt brownish gy 5YR 6/1; thin-bedded, cross-bedded; 1/4-1/2 mm, subangular, poorly sorted. 98% quartz, 2% weathered white feldspar. Some hematite stain. It becomes medium-bedded and pebbly (up to 4 mm) toward the top. A 2-foot bed of sandy biomicrite crops out at the middle of the unit, (f-w) grayish orange 10YR 6/4, with abundant crinoid stems and shell fragments, and 15% hyaline quarts grains, 1/4-2 mm, subangular. (S: 550-549)	40	0	12.2
13.	Protoquartzite, (f) irregul[illegible] [illegible]e yellowish brown, 10YR 6/2, (w) dk yel[illegible] [illegible]h brown 10YR 3/2, thin-bedded, cross-bedded, 1/8 to 1/4 mm, subangular, fairly well sorted. 75% quartz, up to 15% muscovite. Interbedded with few thin beds of laminated argillaceous shale, (f-w) lt olive gy 5Y 4/2 containing			

		Feet	Inches	m
	scarce quartz grains, 1 mm, subrounded. (S: 551a-551)	15	0	4.6
14.	Feldspathic ss, (f) pale yellowish brown 10YR 6/2, (w) pale brown 5YR 6/2; thick-bedded, cross-bedded. 1/10-1/4 mm, subangular to subrounded, fairly well sorted. 70% quartz, 17% weathered white feldspar, 8% clayey matrix, 5% muscovite. Silica cemented. (S: 252)	18	0	5.5
15.	Covered shale (?)	6	0	1.8
16.	Feldspathic ss, (f) pale brown 5YR 6/2, (w) pale yellowish brown 10YR 6/2; thick-bedded, cross-bedded; 1/8-1/4 mm, subangular, fairly well sorted. 73% quartz, 15% weathered white feldspar, 5% muscovite, 7% clayey matrix. Silica cemented. (S: 552a)	6	0	1.8
17.	Quartzitic pure quartz ss, (f) lt brownish gy 5YR 7/1, (w) pale brown 5YR 4/2, medium-bedded; 1/8 to 1/4 mm, fairly well sorted, subrounded. Calcareous matrix (15%) (S: 553)	6	0	1.8
18.	Quartzose shale, silty, (f) lt olive gy 5Y 4/2, (w) lt olive gy 5Y 5/6, thinly laminated, slightly micaceous. X-ray analysis has shown it consists mostly of quartz, with small amounts of kaolinite and traces of k-bentonite (montmonillinoid). A 1-foot bed of sandy biomicrite crops out at the middle of the unit, (f-w) dk yellowish brown 10YR 3/2, with abundant spiriferids, productids, and shell fragments; 40% subangular to subrounded quartz grains (1/4-2 mm). (S: 555-554)	44	0	13.4
19.	A calcareous ss., (1/6-2 mm, subangular to subrounded) containing 40% micrite matrix grades into sandy brachiopodal biosparite, (f-w) moderate yellowish brown 10YR 6/4; spiriferids, productids, and <u>Composita</u> abundant; crinoid stems common, and gastropod scarce. It shows cone-in-cone structure and forms yellow-colored slopes. (S: 556b-556)	4	0	1.2
20.	Brachiopodal biosparite, (f) moderate yellowish brown 10YR 5/4, (w) dk yellowish brown 10YR 4/2; medium-bedded. Productid, spirifer, and <u>Composita</u> abundant, crinoid stems scattered. (S: 256a)	7	8	2.3

		Feet	Inches	m
21.	Laminated calcareous shale, (f) olive gy 5Y 3/1, (w) lt. olive gy. 5Y 5/1, slightly micaceous, slightly silty. (S: 557)	30	0	9.1
22,	Sandy biomicrite, (f) medium dk. gy. N4, (w) pale yellowish brown 10YR 5/2. Thin - to medium-bedded. Small productids and spiriferids abundant, <u>Composita</u> common. 30% quartz grains, 1/4-2 mm. subangular. It grades upward into biogenic brachiopodal ls. containing abundant spiriferids and productids, common <u>Composita</u>, and scarce gastropod. (S: 558b-558)	9	0	2.7
23.	Laminated calcareous shale, (f) olive gy 5Y 3/1, (w) lt. olive gy. 5Y 5/1, micaceous, slightly silty. (S: 558a)	23	0	7.0
24.	Pebbly feldspathic ss, (f-w) lt. gy. N7, thick-bedded, cross-bedded; 1/4-15 mm, subangular (coarser pebbles are subrounded). 20% weathered white feldspar, 78% quartz, 2% ls. pebbles (1.5 cm). Crinoid stems scarce. Some hematite stain near top. (S: 559)	10	0	3.0
25.	Laminated calcareous shale, (f-w) olive gy. 5Y 4/1, interbedded with thin layers of biomicrite (shell fragments abundant, algae and spirifers common, planispira; gastropod scarce) and fossiliferous micrite; (f) dk. gy. N4, (w) pale yellowish brown 10YR 5/2 and medium gy. N5. A very lenticular feldspathic pebbly ss. crops out at top of unit; (f-w) pinkish gy. 5YR 7/1; thick-bedded, cross-bedded, maximum thickness 17 feet. 1/2-6 mm, subangular, calcareous cement; it weathers rounded. A normal fault runs immediately below the lenticular ss and has cut about 135 feet of the Sandia Formation; its stratigraphic throw increases northwest. (S: 559a, 559b, 559c)	43	6	13.3

------------------CONFORMITY-------------------

DES MOINES - ELEPHANT BUTTE FORMATION

Stratigraphic section of the Elephant Butte Formation measured in SW 1/4, SW 1/4, Sec. 35, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	DES MOINES-ELEPHANT BUTTE FORMATION	127	8
1.	Covered shales (?) with a 5' thick crinoidal biosparite 5' above the base, (f) lt. brownish gy. 5YR 5/1, (w) moderate yellowish brown 10YR 5/4, thin - to medium-bedded, containing common shell fragments and scarce poorly preserved brachiopod shells. Few thin beds of nodular recrystallized biomicrite crop out near the top, (f) medium dk. gy. N4, (w) lt. gy. N7, containing common crinoid stems and scarce brachiopod shells. (S: 286c-e).	28	0
2.	Recrystallized micrite, (f) medium dk. gy. N4, (w) mottled lt. brown 5YR 5/4 to medium gy. N5, thick-bedded; very little cherty; slightly nodular near the base. A lenticular pebbly pure quartz ss. crops out at the base of the unit, (f-w) pinkish gy. 5YR 8/1, 1/4-13 mm., subangular, (larger pebbles are subrounded), poorly sorted, quartzitic, containing 8% of fresh plagioclase and subrounded ls. pebbles (S: 286a-286b).	8	0
3.	Covered shale (?)	4	0
4.	Recrystallized micrite, (f) lt. greenish gy., 5GY 7/1, (w) irregular lt. greenish gy. 5GY 7/1 giving a mottled appearance, thick-bedded. Lower 2' are thin-bedded and nodular. (S: 287-287a)	7	0
5.	Pebbly quartzitic feldspathic ss., (f-w) pale red 5R 5/2, lenticular, 1/4-15 mm., subangular to subrounded. 12% orthoclase and plagioclase; 88% quartz. Residual (?) calcareous cement. Lower 3" consist of sandy intraclast. (S: 288)	1	0
	-------------------Diastem-------------------		
6.	Recrystallized fossiliferous micrite, (f) dk. gy. N3, (w) medium gy. N5, thin-bedded, nodular. Productids, spiriferids, and fusulinids scarce. (S: 289)	2	0
7.	Biointraclast, (f) lt. gy. N7, (w) medium lt. gy. N6, medium-bedded, slightly cherty near top. Crinoid stems and shell fragments abundant. (S: 290)	1	3
	-------------------Diastem-------------------		

		Feet	Inches
8.	Covered shale (?)	5	2
9.	Recrystallized biomicrite, (F) dk. gy. N3, (w) yellowish brown 10YR 5/4, thin-bedded, fetid, crinoid stems and bryozoans common, minute unrecognizable shells scarce. (S: 492-491)	5	3
10.	Laminated calcareous shale, (f-w) lt. olive gy. 5Y 4/2; Composita and spiriferids scattered; traces of carbonaceous organic matter, it becomes slightly bentonitic near top and contains abundant bryozoan and common shell casts. Thin beds of crinoidal biosparite, (f) medium gy. N4, (w) grayish orange 10YR 6/4 containing abundant crinoid stems, common shell fragments, and scarce Composita and Hustedia appear interbedded with the shale throughout the unit. (S: 296-293)	16	9
11.	Crinoidal biosparite, (f) medium dk. gy. N4, (w) grayish orange 10YR 6/4, irregularly bedded, fetid. Crinoid stems abundant, bryozoan, spiriferids, productids, Composita, Hustedia, and shell fragments common. (S: 301-297)	7	6
12.	Covered shale (?)	5	3
13.	Crinoidal biosparite, (f-w) medium gy. N5, thin-bedded, grades upward into biomicrite containing common silicified Composita, crinoid stems, and shell fragments, unit is slightly fetid. (S: 304-302)	4	6
14.	Biosparite, (f-w) medium dk. gy. N4, thin-bedded, little cherty, (moderate brown 5YR 3/4), slightly fetid. Bryozoans abundant, spiriferids, Composita, and shell fragments common, crinoid stems, and solitary corals scarce. The lithology changes upward to fossiliferous micrite (f) grayish black N2, (w) pale yellowish brown 5YR 6/2, slightly fetid; a fish jaw was found in this horizon. (S: 308-305)	15	6
15.	Recrystallized argillaceous micrite,(f) olive gy. 5Y 3/1 to dk. gy. N3, (w) grayish orange 10YR 7/4; laminated, slightly nodular, fetid. Interbedded with laminated calcareous shale, (f-w) lt. olive gy. 5Y 6/1, containing scarce productid shell casts. (S: 312-309)	16	6

-----------------CONFORMITY-----------------

DES MOINES - WHISKEY CANYON LIMESTONE

Stratigraphic section of the Elephant Butte Formation measured in SE 1/4, NE 1/4, Sec. 2, T. 3 S., R. 1 E., and NW 1/4, NW 1/4, Sec 1, T. 3 S., R. 1 E.. (Eastern section)

Unit No.	Description	Thickness Feet	Inches
	DES MOINES - ELEPHANT BUTTE FORMATION	186	11
1.	Biomicrite, (f) medium dk. gy. N4, (w) irregular lt. gy. N7, thin-bedded, slightly nodular, Crinoid stems and shell fragments abundant; Composita and bryozoan common, solitary corals scarce. (S: 560)	2	0
2.	Fossiliferous micrite, (f) lt. gy. N7, (w) medium lt. gy. N6, thick-bedded, cliff-forming, lenticular, with prominent vertical joints, crinoid stems common (up to 1.5 cm. in diameter); Composita scarce. (S: 561)	12	0
3.	Laminated calcareous shale, (f) medium dk. gy. N4, (w) lt. olive gy. 5Y 6/1, 5% muscovite; solitary corals and bryozoans scarce. Interbedded with thin, dk. gy. N3 micrite containing common bryozoans and scarce solitary corals. (S: 562-562a)	10	10
4.	Biomicrite, (f) dk. gy. N3, (w) yellowish gy. 5Y 7/1, medium-bedded. Crinoid stems abundant; bryozoans, productids, and shell fragments common. Slightly cherty (pale red 10R 5/2) at the base. It becomes a biosparite toward the top. (S: 563)	7	10
5.	Quartzitic pure quartz ss., (f-w) pinkish gy. 5YR 7/1, thick-bedded, cross-bedded, 1/2-2 mm., subangular, poorly sorted; pebbly at the base, 7% white decomposed feldspar. Some hematite and limonite stain. Residual (?) calcareous cement. (S: 564)	11	6
6.	Covered.	2	0
7.	Pure quartz ss. with $CaCO_3$ matrix (10%), (f-w) pinkish gy. 5YR 7/1; thick-bedded, cross-bedded, 1/5-2 mm., poorly sorted, subangular. (S: 565)	3	0
8.	Covered shale (?)	3	0
9.	Recrystallized biomicrite, (f) medium dk. gy. N4, (w) irregular pale yellowish brown 10YR 6/2, medium-bedded, slightly fetid. Crinoid stems abundant, bryozoans common, Composita scarce. (S: 566)	6	3

		Feet	Inches
10.	Biomicrite, (f) medium gy. N5, (w) medium dk. gy. N4, irregularly bedded, slightly fetid and cherty; crinoid stems common, shell fragments scarce. Some of the fossils are silicified. (S: 567)	3	6
11.	Covered shale (?)	11	6
12.	Pebbly quartzitic pure quartz ss., (f-w) pinkish gy. 5YR 8/1, cross-bedded, 1/2-3 mm., subangular. 5% white strongly weathered feldspar. Residual (?) calcareous cement; some hematite stain near top. (S: 569-568)	5	3
13.	Recrystallized fossiliferous micrite, (f) medium dk. gy. N4, (w) medium gy. N5, thin-bedded. Fusulinids and large solitary corals scarce. (S: 570)	5	3
14.	Covered shale (?)	5	2
15.	Recrystallized fossiliferous micrite, (f) medium dk. gy. N4, (w) medium lt. gy. N6, thin-bedded, crinoid stems and shell fragments scarce. (S: 572-571)	5	2
16.	Biomicrosparite, (20% micrite, 15% sparite), (f-w) medium lt. gy. N6, thin-bedded. *Composita* and crinoid stems abundant, productid, shell fragments, common, and solitary corals scarce. (S: 573)	2	0
17.	Biomicrosparite, (20% sparite, 20% micrite), (f) dk. gy. N3, (w) grayish orange 10YR 6/4 and medium dk. gy. N4, thin-bedded, slightly fetid. Spiriferids, productids, bryozoans, and crinoid stems common. (S: 573)	6	3
18.	Biomicrite, (f) dk. gy. N3, (w) medium gy. N5; medium-bedded. Crinoid stems common, solitary corals and shell fragments scarce. (S: 575)	3	0
19.	Biomicrosparite, (f) medium dk. gy. N4, (w) irregular grayish orange 10YR 7/4; thin-bedded. Crinoid stems abundant, shell fragments common, large solitary corals scarce. (S: 576)	5	3
20.	Biomicrite, (f) medium gy. N5, (w) irregular pale yellowish brown 10YR 7/2, thick-bedded; *Fusulina* abundant, crinoid stems scattered. (S: 577)	1	6
21.	Covered shale (?)	5	1

22.	Recrystallized fossiliferous micrite, (f) medium dk. gy. N4, (w) mottled lt. brown 5YR 6/6 to medium dk. gy. N4. Productids and large solitary corals scattered.	5	2
23.	Fossiliferous dismicrite, (f-w) medium lt. gy. N6, thick-bedded, slightly cherty (irregular). Large crinoid stems and poorly preserved brachiopods <u>Composita</u> (?) shells scattered. (S: 578)	10	6
24.	Covered shale (?)	5	3
25.	Micrite, (f-w) medium lt. gy. N6, thin-bedded, very little cherty, (irregular). Lower 2 feet are very nodular. (S: 579)	4	6
26.	Laminated argillaceous shale, (f-w) lt. olive gy. 5Y 5/1 5% muscovite, slightly bentonitic; interbedded with thin beds of biomicrosparite and biomicrite, (f) lt. gy. N3, (w) lt. olive gy. 5Y 5/1, containing abundant fusulinids and crinoid stems and shell fragments scarce. Upper 20 feet consist of thin-bedded nodular recrystallized micrite (f) medium dk. gy. N4, (w) lt. gy. N7 interbedded with laminated calcareous shale, (f) medium dk. gy. N4, (w) lt. gy. N7. A thin 6" bed of lt. olive gy. (5Y 5/2) siliceous shale crops out near the top of the unit and forms a green rubble-covered slope. (S: 580-584)	44	0

-----------------CONFORMITY-----------------

DES MOINES - WHISKEY CANYON LIMESTONE

Stratigraphic section of the Whiskey Canyon Limestone measured in: SW 1/4, Sec. 35, T. 2 S., R. 1 E. . (Western section)

Unit No.	Description	Thickness Feet	Thickness Inches
	DES MOINES - WHISKEY CANYON LIMESTONE	99	1
1.	Pelmicrite, (f-w) medium dk. gy. N4, medium- to thick-bedded, cherty (moderate brown 5YR 4/4). Large productids common, solitary corals scarce, specially near the base; top becomes slightly crinoidal. (S: 461-560)	5	2
2.	Crinoidal biomicrite, (f-w) lt. gy. N7, medium-bedded, slightly cherty (moderate brown 5YR 4/4; productids common near the base of the unit. (S: 464-462)	5	3
3.	Covered shale (?)	2	0
4.	Recrystallized fossiliferous micrite, (f) pale red pruple 5RP 5/2, (w) pale yellowish brown 10YR 6/2, thick-bedded, crinoid stems scarce. (S: 465)	2	0
5.	Recrystallized fossiliferous micrite, (f) medium gy. N5, (w) mottled medium gy. N5 to very pale orange 10YR 7/2, thick-bedded; solitary corals scarce. (S: 466)	2	0
6.	Lower 1' is a micrite grading upward into crinoidal biomicrite, (f-w) medium gy. N5, containing scarce Composita. (S: 467)	3	0
7.	Crinoidal biomicrite, (f) medium lt. gy. N6, lt. gy. N7, containing scarce Composita and productids grades upward into crinoidal biosparite, (f) pale yellowish brown, 10YR 5/2, (w) moderate yellowish brown 10YR 5/4 having 6% subrounded quartz grains (1/5 mm.). Unit is fetid and slightly nodular. (S: 470-468)	6	0
8.	Recrystallized fossiliferous micrite, (f) dk. gy. N3, (w) pale blue 5PB 6/2, thin-bedded, nodular, slightly fetid, crinoid stems very scarce. (S: 471)	13	0
9.	Fossiliferous micrite (f-w) irregular medium gy. N5, medium-bedded little cherty (irregular and very thin-bedded, lt. brown 5YR 5/6); crinoid stems scarce. (S: 472)	5	3

		Feet	Inches
10.	Crinoidal biomicrite, (f) medium gy. N5, (w) grayish orange 10YR 6/4, thin - to medium-bedded; Fusulina and Wedekindellina and Composita common, productids scarce. (S: 474-473)	5	3
11.	Recrystallized fossiliferous micrite, slightly argillaceous, (f) dk. gy. N3, (w) grayish orange 10YR 8/4, thin-bedded, very slightly nodular, very slightly fetid, slightly cherty. Large productids (up to 2" long) scarce. Interbedded with thin layers of laminated very calcareous shale, (f) dk. gy. N3, (w) irregular medium lt. gy. N6 to lt. olive gy. 5Y 6/1. (S: 477-475)	10	6
12.	Fossiliferous micrite, (f) medium gy. N5, (w) medium lt. gy. N6, medium-bedded, very thin-bedded chert (moderate brown 5YR 4/4) large solitary corals and crinoid stems scattered. (S: 478)	3	0
13.	Recrystallized biomicrite, (f) medium dk. gy. N4, (w) grayish orange 10YR 8/4; medium-bedded, abundant thin-bedded chert (moderate brown 5YR 4/4); crinoid stems abundant (up to 3/4" in diameter); productids scarce. The fauna increases upward in the unit. Upper 4' of recrystallized biomicrite are thin - to medium-bedded, (f) grayish red purple 5R 3/2, (w) irregular lt. gy. N7, noncherty. (S: 481-479)	25	10
14.	Biomicrite, (f) medium gy. N5, (w) lt. gy. N7, thin-bedded, slightly nodular; Fusulina and Wedekindellina abundant; crinoid stems and bryozoans common, Composita and productids scattered. Abundance of fossils decreases upward rapidly. (S: 482-482a)	7	4
15.	Crinoidal biomicrite, (f) medium lt. gy. N7, (w) irregular lt. brownish gy. 5YR 6/1; thin - to medium-bedded; 2% muscovite. Spiriferids and shell fragments scattered. (S: 483)	3	6

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DES MOINES - GARCIA FORMATION

Stratigraphic section of the Whiskey Canyon Limestone measured in NW 1/4, NW 1/4, Sec. 1, T. 3 S., R. 1 E. (Eastern section).

Unit No.	Description	Thickness Feet	Inches
DES MOINES - WHISKEY CANYON FORMATION		108	5
1.	Biomicrite, (f) medium dk. gy. N4, (w) medium gy. N5, thin-bedded; 1" beds of chert (pale yellowish brown 10R 6/2 and grayish red 10R 4/2) slightly fetid. Large solitary corals and small *Composita* scarce, shell fragments common. (S: 586-585)	5	6
2.	Biomicrosparite, (f) medium dk. gy. N4, (w) medium gy. N5, thin - to medium-bedded. Crinoid stems abundant, fusulinids common, spiriferids scarce. Lower 2 feet consist of recrystallized biomicrite containing common productids and *Composita*. (S: 588-587)	10	0
3.	Recrystallized biomicrite, (f) dk. gy. N3, (w) irregular medium gy. N5 to very pale orange 10YR 7/2; thin -bedded; bedded chert (up to 3" thick) lt. brown 2YR 5/4. Spiriferids and crinoid stems common; productids, larg solitary corals, and bryozoans scarce. *Fusulina* and *Wedekindellina* abundant near top of unit. (S: 589-589a)	5	0
4.	Biomicrite, (f-w) medium gy N5, medium-bedded, large solitary corals common (up to 2" in diameter), productids scarce. (S: 590)	4	0
5.	Recrystallized fossiliferous micrite, (f-w) medium gy. N4; medium - to thick-bedded. Crinoid stems scarce. Thin beds of chert (moderate brown 5YR 3/4) (S: 592-591)	36	8
6.	Covered shale (?)	15	9
7.	Recrystallized fossiliferous micrite,, (f) medium gy. N5, (w) lt. gy. N7; thick-bedded; thin-bedded chert (moderate brown 5YR 4/4). Large white crinoid stems (up to 1 cm. in diameter), solitary corals, and productids scarce. (S: 593-593a-593b-593c)	31	6

----------------CONFORMITY----------------

DES MOINES - GARCIA FORMATION

Stratigraphic section of the Garcia Formation measured in NW 1/4, NW 1/4, Sec. 35, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	DES MOINES - GARCIA FORMATION	196	0
	Lower Member	120	3
1.	Very thinly laminated (fissile) carbonaceous shale, (f-w) dk. gy. N3, micaceous, very slightly bentonitic. (S: 484)	1	6
2.	A thin bed of calcareous sandstone, (f) irregular medium dk. gy. N4, (w) irregular pale yellowish brown 10YR 6/2; 55% quartz, 1/5-2 mm., 45% sparite matrix, with some hematite stain, grades upward into biomicrite, (f) medium dk. gy. N4, (w) grayish orange 10YR 7/4, thin-bedded, slightly fetid, containing abundant crinoid stems, spiriferids, and productids, Composita, fusulinids, bryozoans, and solitary corals scattered. It becomes more fetid toward the top where the abundance of fossils decreases. (S: 486-485)	5	0
3.	Micrite, (f) dk. gy. N3, (w) medium lt. gy. N6, thin-bedded, highly nodular at top, fetid; interbedded with thin dk. gy. N3 laminated calcareous shales. (S: 488-487)	12	6
4.	A sandy sparite ls, (f) pinkish gy. 5YR 7/1, (w) pale yellowish brown 10YR 5/2, containing 30% quartz grains, 1/4-2 mm., subangular, grades upward into a sandy biointraclast, (f) medium dk. gy. N4, (w) lt. brownish gy. 5YR 5/1; 15% quartz grains, 1/4-1 mm., subangular, containing common crinoid stems, scattered spiriferids, productids, and Hustedia. (S: 490-489)	2	0
	------------------Diastem(?)------------------		
5.	Covered shale (?) with thin beds of micrite, (f-w) medium dk. gy. N4, nodular. (S: 491)	5	2
6.	Lower 7 feet consist of biosparite, (f) medium dk. gy. N4, (w) pale yellowish brown 10YR 6/2, thin - to medium-bedded; with interbedded laminated calcareous shale, (f-w) dk. gy. N3. Crinoid stems (up to 1.7 cm. in diameter) and coral cones (up to 5 cm. in diameter) common, spiriferids, Composita, and bryozoans common. The rest of the unit consists of cri-		

		Feet	Inches
	noidal biomicrite, (f) medium gy. N5, (w) irregular lt. olive gy. 5Y 6/1, thin - to medium-bedded, fetid; with interbedded thin laminated calcareous shale (dk. gy. N3). Algae nuclei scarce. (S: 486-492)	15	6
7.	Quartzitic feldspathic ss, (f) pinkish gy. 5YR 7/1, (w) lt brownish gy. 5YR 5/1; thick-bedded, slightly cross-bedded, 1/4-2 mm., subangular, poorly sorted; 80% quartz, 20% weathered orthoclase and plagioclase. Residual (?) calcareous cement. (S: 497)	5	2
8.	Sandy biomicrite, (f) medium gy N5, (w) irregular medium lt. gy. N6, thin - to medium-bedded; bryozoans common; fusulinids, _Hustedia_, spiriferids, and productids scattered; 15% quartz grains; 1/4-2 mm., subangular. Interbedded with laminated calcareous sandstone, 1/10-1/8 mm., subrounded, 30% sand-sized ls. grains; and with laminated calcareous shale, (f-w) lt. olive gy., 5Y 5/1, micaceous (muscovite) slightly silty, traces of carbonaceous organic matter. (S: 500-498)	7	9
9.	Laminated calcareous shale, (f) dk. gy. N3, (w) olive gy. 5Y 4/1, slightly micaceous (muscovite), slightly silty. (S: 501)	4	3
10.	Arkose, (f) lt. gy. N7, (w) lt. brownish gy. 5YR 6/1, thin - to medium-bedded, lenticular, cross-bedded; 1/2-1/5 mm., sugangular, poorly sorted. 40% fresh orthoclase and plagioclase, 60% quartz. Some hematite stain. Quartzitic, residual (?) calcareous cement. Quartz grains become coarser (1/4-1 mm.) subangular to subrounded. (S: 503-502)	9	0
11.	Recrystallized micrite, (f) medium gy. N5, (w) grayish orange 10YR 7/4 irregularly bedded. Upper 2 feet consist of argillaceous recrystallized micrite, (f) medium dk. gy. N4, (w) banded medium dk. gy. N4 and medium lt. gy. N6, laminated, interbedded with medium dk. gy. N4 laminated calcareous shale near top of unit. (S: 505-504)	26	3
12.	Laminated calcareous shale, (f-w) dk. gy. N3; with thin bed of recrystallized biomicrite, (f) grayish black N2, (w) olive gy. 5Y 3/1, slightly nodular and fetid. Crinoid stems common, productids and _Composita_ scattered. A		

		Feet	Inches
	thin bed of calcareous quartzitic feldspathic ss. crops out 2' abouve the base of the unit, (f-w) irregular medium dk. gy. N4, 1/2-2 mm., subrounded, poorly sorted; feldspar grains up to 5 mm. 45% quartz, 17% slightly weathered white feldspar, 38% sparite matrix. Silica cemented. It grades upward into sandy ls. and then into recrystallized biomicrite. (S: 509-506)	15	9
13.	Recrystallized fossiliferous micrite, (f) dk. gy. N3, (w) olive gy. 5Y 3/1, thin-bedded, slightly nodular, slightly fetid. Productids (up to 1.5" long) scattered; crinoid stems scattered near top of unit. (S: 510)	5	3
14.	Recrystallized biomicrite, (f) medium dk. gy. N4, (s) irregular grayish orange 10YR 6/4, thin - to mediump bedded. Crinoid stems abundant, speriferids and productids common. 5% subrounded quartz grains (1/4-1 mm.) It grades upward into calcareous pebbly quartzitic arkose, (f) medium gy. N5, with white N9 spots, (w) irregular lt. brownish gy. 5YR 5/1, medium-bedded, 1/2-3 mm., subangular to subrounded, 55% quartz, 35% slightly weathered white feldspar, 10% CO_3Ca matrix (micrite). Few quartz grains up to 5 mm. (S: 512-511)	5	4
	Upper Member	75	9
1.	Recrystallized micrite, (f) dk. gy. N3, (w) medium lt. gy. N6, thin-bedded, nodular, with interbedded laminated calcareous shale (f-w) olive gy. 5Y 3/1, bentonitic, slightly silty. (S: 513)	15	9
2.	Recrystallized micrite, (f) dk. gy. N3 to medium dk. gy. N4, (w) grayish orange 10YR 6/4 to grayish orange 10YR 7/4, laminated, occurs at the lower 10 feet of the unit. The rest consists of recrystallized biomicrite, (f) dk. gy. N3, (w) irregular lt. gy. N7; irregularly bedded; crinoid stems, bryozoans, and productids scattered; Fusulina and Wedekindellina abundant; Fusulinella-Fusulina common. (S: 517-515). Upper 2 feet are lighter in color (medium lt. gy. N5) and very little cherty (moderate yellowish brown 10YR 5/4. (S: 514)	39	3

		Feet	Inches
3.	Recrystallized biomicrite, (f) dk. gy. N3, (w) banded: dk. gy. N3 and pale yellowish brown 10YR 6/21 light-colored bands have coarser calcite crystals than the dark-colored bands. Penecontemporaneous deformation (folding and faulting). Shell fragments abundant; crinoid stems and bryozoans scattered. (S: 520). Lower 12 feet consist of recrystallized dismicrite (f) medium dk. gy. N4, (w) medium gy N5, thin-bedded slightly nodular, with interbedded dk. gy. N3, laminated calcareous shale weathering yellowish gray 5Y 8/1. (S: 519-518)	15	9
4.	Biomicrite, (f) olive gy. 5Y 4/1 to medium dk. gy. N4, (w) irregular moderate yellowish brown 10YR 5/4; thin - to medium-bedded, slightly nodular, slightly fetid. Productids, Composita, spiriferids abundant; crinoid stems common; bryozoans scattered. (S: 521)	5	0

-----------------CONFORMITY-----------------

DES MOINES - "BARTOLO FORMATION"

Stratigraphic section of the Garcia Formation measured in NE 1/4, Sec. 35, T. 2 S., R. 1 E. (Eastern section).

Unit No.	Description	Thickness Feet	Inches
	DES MOINES - GARCIA FORMATION	201	6
	Lower Member	124	3
1.	Laminated argillaceous shale, (f-w) lt. olive gy. 5Y 4/1, slightly bentonitic, 5% muscovite. It looks like kaolinite. (S: 594)	35	0
2.	Biomicrite, (f) medium gy. N5, (w) yellowish gy. 5Y 7/1, productids (up to 2.5" long) and crinoid stems abundant; Composita and large solitary corals common; spiriferids scarce. (S: 596-595)	0	6
	--------------------Diastem--------------------		
3.	Argillaceous biointrasparite, (f-w) lt. olive gy. 5Y 5/1, thin-bedded; crinoid stems and shell fragments common; 4% muscovite. (S: 597)	1	0
4.	Argillaceous micrite, (f-w) lt. brownish gy. 5YR 6/1, thin-bedded, nodular; Composita, crinoid stems, and bryozoans scarce. Upper 1 foot becomes less nodular and it is no argillaceous, slightly fetid. (S: 599-598)	2	2
5.	Laminated calcareous shale, (f) pale yellowish brown 10YR 7/2, (w) pale yellowish brown 10YR 5/2; slightly silty; with thin beds of nodular micrite, (f) dk. gy. N3, (w) medium lt. gy. N6. (S: 600)	3	0
6.	Crinoidal biomicrite grades upward into biomicrite containing abundant crinoid stems and spiriferids; Composita and productids scarce; (f) medium dk. gy. N4, (w) irregular medium gy. N5 and lt. brown 5YR 6/6; thin - to medium-bedded. (S: 601-601a)	4	0
7.	Laminated calcareous shale (f) lt. olive gy. 5Y 5/1, (w) yellowish gy. 5Y 7/1, 5% muscovite; with few thin beds of biomicrite, (f-w) medium dk. gy. N4 containing abundant crinoid stems, and common productids and spiriferids. (S: 602-602a)	12	0
	--------------------Diastem--------------------		

		Feet	Inches
8.	Calcareous arkose, (f-w) lt. brownish gy. 5YR 6/1, 1/4-1 mm., 59% quartz, subrounded; 30% fresh white feldspar, 4% ls. fragments, 7% sparite matrix; slightly quartzitic. Feldspar grains show hematite stain. It grades into feldspathic pebbly ss, (f-w) medium lt. gy. N6; 1-4 mm., subangular; few quartz grains reach up to 7 mm. Unit is cross-bedded, and has graded bedding, there is a rhythmic variation in grain size from base to top. A 6-inch bed of sandy biointrasparite, (f-w) medium gy. N5 is present at the base of unit and grades upward into feldspathic ss.; it contains 10% quartz grains, 1/4-6 mm., subangular, the coarser grains are subrounded; 5% fresh orthoclase, 1/4-7 mm.; shell fragments and crinoid stems (up to 6 mm. in diameter) common; spiriferids scattered; 30% subangular ls. pebbles (1/4-7 mm.) in sparite matrix (30%) (S: 602-603)	16	0
9.	Micrite, (f) dk. gy. N3, (w) lt. olive gy. 5Y 5/1, thin-bedded, (S: 610)	10	0
10.	Biosparite, (f) lt. gy. N7, (w) irregular pale brown 5YR 5/2, medium - to thick-bedded; crinoid stems extremely abundant; Composita abundant, spiriferids common. (S: 611)	6	7
11.	Biomicrite, (f) dk. gy. N3, (w) lt. gy. N7 to pale yellowish brown 10YR 7/2, thin-bedded, slightly nodular; crinoid stems (up to 5 mm. in diameter), Composita, productids, and spiriferids abundant, especially near the top of the unit; bryozoans scattered. (S: 614-612)	5	0
12.	Laminated very calcareous shale (f) lt. olive gy. 5Y 5/1, (w) dusky yellow 5Y 5/4; speriferids, productids and Composita scattered. A thin bed of biomicrosparite, (f) medium gy. N5, (w) lt. olive gy. 5Y 5/1, containing abundant Composita crops out 7' above the base of the unit, and a thin bed of biomicrite, (f) medium dk. gy., (w) grayish orange 10YR 6/4 containing abundant algae and common crinoid stems grades into biointraclast ls. (f-w) lt. gy. N7, and caps the unit. The biointraclast ls. is composed of 42% shell fragments, 30% ls. grains (1/4-2 mm) subangular, 5% crinoid stems, 2% gastropod shells, 1% subangular quartz grains (2 mm.), and 20% calcareous mud matrix. (S:		

		Feet	Inches
	617-617a-615)	20	0
	---------------------Diastem---------------------		
13.	Quartzitic arkose, (f) pinkish gy. 5YR 7/1, (w) lt. brownish gy. 5YR 5/1, irregularly bedded, highly cross-bedded, 1/4 to 2 mm., subangular to subrounded; residual (?) calcareous cement. 30% white slightly weathered feldspar, 70% quartz. A calcareous feldspathic ss. is present near top, and grades into sandy intraclast, (f) medium lt. gy. N6, (w) pale brown 5YR 5/2, 25% subangular quartz grains (1/2-2 mm.), 10% white slightly weathered feldspar, 50% subangular to subrounded ls. grains (1/4-2 mm.), 10% sparite, 5% micrite; scattered brachiopod shells. (S: 620-618)	9	0
	---------------------Diastem (?)---------------		
	Upper Member	77	3
1.	Biomicrosparite, (f-w) medium gy. N5, thin-bedded, slightly fetid, containing scattered subrounded quartz grains (2-3 mm.), grades upward into biomicrite, (f) medium dk. gy. N4, (w) medium gy. N5. Unit contains abundant <u>Composita</u>, and spiriferids, crinoid stems common, productids and bryozoans scattered. Interbedded thin covered shales (?). (S: 622-621)	5	0
2.	Recrystallized micrite, (f) dk. gy. N3, (w) irregular medium gy. N5 and very pale orange 10YR 7/2; thin-bedded, slightly nodular, slightly fetid; interbedded with thin layers of slightly laminated calcareous shale, (f) dk. yellowish brown 10YR 4/2, (w) pale yellowish brown 10YR 6/2; bentonitic, slightly silty. (S: 624-623)	15	6
3.	Biomicrite, (f) medium gy. N5, (w) irregular medium gy. N5 and lt. brown 5YR 5/4, containing abundant crinoid stems, <u>Composita</u> and spiriferids scattered; it grades upward into crinoidal biomicrosparite of same color. Unit is medium-bedded, slightly fetid, cherty (irregular to bedded), lt. brown 5YR 5/4. (S: 627-625)	6	0

		Feet	Inches
4.	Argillaceous micrite, (f) pale yellowish brown 10YR 6/2, (w) very pale orange 10YR 7/2, thin-bedded). (S: 628)	3	3
5.	Recrystallized biomicrite, (f) medium gy. N5, (w) medium lt. gy. N6, medium,- to thick-bedded, fetid, slightly cherty, (irregular to bedded). Crinoid stems and _Composita_ abundant. Lower 2 feet (w) moderate orange pink 5YR 7/4. Some crinoid stems are silicified. (S: 429-429a-429b)	14	6
6.	Argillaceous biomicrite, (f-w) medium lt. gy. N6, medium - to thick-bedded, fetid, very little cherty. Bryozoan abundant, crinoid stems common, _Composita_ scattered. (S: 630)	4	3
7.	Biomicrite, (f) medium gy. N4, (w) medium lt. gy. N6, thin-bedded, fetid. _Fusulina_ and crinoid stems abundant, productids, spiriferids, and _Composita_ common. (S: 633-631)	12	6
8.	Laminated calcareous shale, (f) medium dk. gy. N4, (w) lt. olive gy. 5Y 5/1, micaceous (10% muscovite), slightly bentonitic; capped by a thin bed of biomicrite (f-w) medium gy. N5, containing common _Composita_, productids, spiriferids, and crinoid stems. (S: 635-634)	5	0
9.	Recrystallized fossiliferous micrite, (f) medium dk. gy. N4, (w) medium lt. gy. N6 with pale yellowish orange (10YR 7/6) spots; thin-bedded, slightly fetid. Productids, _Composita_, crinoid stems, and shell fragments scattered. (S: 636)	5	0
10.	Recrystallized micrite, (f) dk. gy. N3, (w) pale yellowish brown 10YR 6/2, thin-bedded. Upper 1 foot consists of brachiopod biomicrosparite, (f) lt. brownish gy. 5YR 6/1 (w) moderate orange pink 5YR 7/4, thin-bedded, containing extremely abundant _Composita_ and common bryozoans; 25% micrite, 5%sparite cement. (S: 638-637)	6	3

DES MOINES - "BARTOLO FORMATION"

Stratigraphic section of the "Bartolo Formation" measured in NW 1/4, NW 1/4, Sec. 35, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Inches
	DES MOINES - "BARTOLO FORMATION"		
	Thickness: 188' 0" + ~ 30'		
1.	Laminated calcareous shale, (f-w) lt. olive gy. 5Y 4/2, very little muscovite. (S: 522) about 30 feet of shale have been squeezed out due to folding.	40	0
2.	Arkose, (f) grayish pink 5R 8/2, (w) grayish red 10R 4/2, medium-bedded, cross-bedded 1/2-2 mm, subangular, poorly sorted; 30% white weathered feldspar, 70% quartz, some hematite stain, and pyrolusita impregnation; slightly quartzitic, residual (?) calcareous cement. (S: 523)	5	8
3.	Laminated calcareous shale, (f-w) lt. olive gy. 5Y 4/2, very little muscovite. (S: 524)	58	4
	----------------Diastem (?)----------------		
4.	Lower two feet consist of arkosic pebble conglomerate (f-w) grayish pink 5R 7/2; medium-bedded, 1/2 to 50 mm., subangular, 5% subrounded ls. pebbles; slightly quartzitic and with some residual (?) calcareous cement. Overlain by feldspathic pebbly ss, (f) lt. gy. N7, (w) irregular lt. brownish gray 5YR 6/1 to medium lt. gy. N6; medium-bedded, cross-bedded; 1/4-3 mm, subangular, poorly sorted, slightly quartzitic. 20% fresh pink feldspar, 78% quartz, 2% sand-size ls grains, calcareous cement. It grades upward into pebbly arkose, (f-w) lt. brownish gy. 5YR 6/1, medium-bedded, cross-bedded, 1/4-2 mm., subangular to subrounded. 30% fresh pinkish white feldspar (1/4-5 mm.), 70% quartz; slightly quartzitic, residual (?) calcareous cement. (S: 527-525). The base of this unit probably represents a diastem.	15	0
5.	Recrystallized fossiliferous micrite, (f-w) pale yellowish brown 10YR 5/2, medium-bedded. Shell fragments common, productids and spiriferids scarce.	5	0
6.	Laminated calcareous shale, (f-w) lt. olive gy. 5Y 4/2, slightly micaceous. (S:529)	15	0

		Feet	Inches
7.	Sandy oolitic intraclast, (f) irregular lt. brownish gy. 5R 6/1, (w) irregular pale brown 5YR 5/2, medium-bedded; 35% oolites (1/4-1.5 mm.); 10% quartz grains, (1-3 mm.) subrounded; 10% crinoid stems; 30% ls. pebbles (1/2-6 mm.) subangular, 15% sparite matrix; gastropods scattered. (S: 530)	5	0
	------------------Diastem--------------------		
8.	Fossiliferous Micrite, (f) medium gy N5, (w) medium lt. gy. N6, medium-bedded, recrystallized brachiopod shells scattered. (S: 531)	5	0
9.	Laminated calcareous shale, (f-w) lt. olive gy. 5Y 5/1, traces of carbonaceous organic matter, traces of muscovite; interbedded with thin biomicrite, (f) lt. brownish gy. 5YR 5/1 (w) pale yellowish brown 10YR 5/2, shell fragments and crinoid stems common, tendency to oolitic; scattered quartz grains (1/4 mm) subrounded. A thin bed of biomicrite, (f) medium dk. gy. N4, (w) medium gy. N5, containing common shell fragments and scattered algal nuclei is present near top of unit. (S: 533-531a)	34	0

-----------------CONFORMITY-----------------

DES MOINES - "AMADO LIMESTONE"

Type section of the "Bartolo Formation" measured in NE 1/4, Sec. 35, T. 2 S., R. 1 E.; 3200 feet northeast of the most northeasterly head water of the Arroyo de Tio Bartolo (Eastern section).

Unit No.	Description	Thickness Feet	Thickness Inches
DES MOINES - "BARTOLO FORMATION"		219	8
1.	Covered shale (?)	9	2
2.	Laminated calcareous shale, (f-w) olive gy. 5Y 3/1, slightly silty, 7% muscovite, traces of carbonaceous organic matter (S: 415a)	30	2
3.	Feldspathic calcareous ss., (f) lt. brownish gy. 5YR 5/1, (w) pale brown 5YR 4/2, thin-bedded, cross-bedded, 60% quartz, 1/8-1/4 mm., subangular to subrounded, fairly well sorted; 15% slightly weathered white feldspar; 5% muscovite, 20% CO_3Ca matrix. Some hematite stain. (S: 415)	5	0
4.	Quartzose shale (?) (f-w) lt. olive gy. 5Y 5/1, slightly silty, 7% muscovite, traces of carbonaceous organic matter. With few thin beds of very fine-grained micaceous feldspathic ss., (f-w) pale brown 5YR 5/2, near top. (S: 416-416a)	46	6
5.	Calcareous pure quartz ss., (f) medium lt. gy. N6, (w) pale brown 5YR 4/2, thin-bedded, cross-bedded, 1/15-1/30 mm. subangular to subrounded, fairly well sorted; 77% quartz, 10% CO_3Ca matrix, 3% weathered white feldspar. Interbedded with olive gy. 5Y 3/1 laminated calcareous sh. (S: 417-417a)	26	3
6.	Pure quartz ss., (f-w) lt. greenish gy. 5GY 7/1, laminated, slightly cross-bedded, 1/4-1/12 mm., subangular, poorly sorted; calcareous cement, friable, micaceous 10% muscovite. (S: 418)	15	9
7.	Feldspathic pebbly calcareous ss, (f-w) lt. gy. N7, thin - to medium-bedded, 1/4-3 mm., subangular to subrounded; 20% fresh white feldspar, 70% quartz, 10% subrounded ls. grains, 1/2 to 1 mm. Slightly quartzitic, residual (?) calcareous cement. It grades upward into quartzitic calcareous arkose (f-w) lt. gy. N7, 30% fresh white feldspar (1/4-1 mm.), 60% quartz (1/8-1/4 mm) subrounded, fairly well sorted; 10% subangular ls. grains		

Unit	Description	Feet	Inches
	(1/4 mm.) (S: 421-419)	10	6
	----------------Diastem (?)----------------		
8.	Calcareous pebble conglomerate, (f) irregular medium gy. N5, (w) pale brown 5YR 5/2, medium-bedded. 60% quartz, 1-9 mm., subrounded to rounded, 10% subangular intraclast fragments 1-3 mm; 8% fresh white feldspar, 22% calcareous matrix. It grades into unit 9 and probably represents a diastem. (S: 422)	4	0
9.	Algal biomicrite, (f-w) medium dk. gy. N4 to medium gy. N5, thin-bedded, algae nuclei, and crinoid stems abundant, high-spired snails common. Upper 2' become a crinoidal biomicrosparite, (f) medium dk. gy. N4, (w) pale yellowish brown 10YR 6/2; 10% sparite, 5% micrite, shell fragments scattered. (S: 425-423)	10	6
10.	Covered shale (?)	10	7
11.	Sandy crinoidal biomicrite, (f) medium gray N4, (w) dk yellowish brown 10YR 3/2; 12% subangular quartz grains (1/4-1.5 mm.). Composita and spiriferids scattered; gastropods, very scattered. Quartz grains become coarser (up to 2 mm.) and less abundant toward top. (S: 427-426)	3	0
12.	Laminated calcareous shale, (f-w) lt. olive gy. 5Y 5/1, 7% muscovite, slightly silty, with scattered thin beds of very fine grained micaceous feldspathic ss. (pale brown 5YR 5/2) near top. Traces of carbonaceous organic matter. (S: 428)	11	6
13.	Sandy biomicrite, (f) lt. gy. N7, (w) lt. gy. 5YR 5/1, medium - to thick-bedded, cross-bedded; 25% quartz grains, (1/4 to 6 mm.) subangular to subrounded; 5% fresh white feldspar (1 to 8 mm.). Crinoid stems abundant, shell fragments common, Composita and spiriferids scattered. (S: 429)	5	3
14.	Laminated calcareous shale, (f-w) olive gy. 5Y 3/1, 7% muscovite, slightly silty in part, traces of carbonaceous organic matter (S: 430)	31	6

----------------CONFORMITY----------------

DES MOINES - "AMADO LIMESTONE"

Stratigraphic section of the "Amado Limestone", measured in NW 1/4, NW 1/4, Sec. 35, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	DES MOINESIAN - "AMADO LIMESTONE"	35	0
1.	Biomicrite, (f) medium gy. N5, (w) grayish orange 10YR 7/4, thin-bedded, crinoid stems common. (S:535a)	2	2
2.	Fossiliferous micrite, (f) irregular medium dk. gy. N4, (w) pale yellowish brown 10YR 6/2, thin-bedded, little cherty, scattered shell fragments, slightly fetid, (S: 535)	8	4
3.	Recrystallized biomicrite, (f) dk. gy. N3, (w) medium lt. gy. N6, thin - to medium-bedded; bedded chert up to 4" thick (moderate brown 5YR 3/4 to 4/4) slightly fetid; bryozoans, and productids, (up to 3" long) abundant, <u>Composita</u> common. (S: 536)	15	6
4.	Recrystallized fossiliferous micrite, (f) medium dk. gy. N4 (w) grayish-orange 10YR 8/4, little cherty (irregular), thin - to medium-bedded; crinoid stems scattered (S: 538). Upper 5 feet of unit consist of crinoidal biomicrite, (f) medium lt. gy. N6, (w) medium gy. N5, thin-bedded, cherty (irregular and slightly bedded) moderate brown 5YR 4/4 (S:537)	9	0

-----------------CONFORMITY-----------------

DES MOINES - ADOBE-COANE UNDIFFERENTIATED

Type section of the "Amado Limestone", measured in NE 1/4, NE 1/4, Sec. 35, T. 2 S., R. 1 E.; 1600 feet southwest of the top of Cerros de Amado. (Eastern section)

Unit No.	Description	Thickness Feet	Thickness Inches
	DES MOINESIAN - "AMADO LIMESTONE"	34	3
1.	Recrystallized micrite, (f-w) medium gy. N5, thin-bedded, slightly nodular. (S: 431)	2	0
2.	Recrystallized biomicrite, (f) dk. gy. N3, (w) medium dk. gy. N4, thin-bedded, medium-bedded; bedded chert up to 4" thick (moderate brown 5YR 3/4). Productids (up to 3.5" long) abundant, large spiriferids; crinoid stems (up to 017"in diameter), and Composita common. Fetid. (S: 433-432)	8	0
3.	Recrystallized biomicrite, (f) dk. gy. N3, (w) medium gy. N5, medium-bedded; cherty (irregular to slightly bedded); with thin covered intervals representing probably shale. Composita abundant (some are silicified), productids, crinoid stems, and bryozoans common, speriferids scattered. Amount of chert and fossils decreases toward top of unit. Slightly fetid. (S: 435-434)	20	3
4.	Fossiliferous micrite, (f-w) medium dk. gy. N4, thin-bedded, crinoid stems and Composita scattered, a few of them are silicified. Upper 1' consists of dismicrite (f) medium dk. gy. N4, (w) medium lt. gy. N6. (S: 437-436)	4	0

-----------------CONFORMITY-----------------

DES MOINES - ADOBE-COANE UNDIFFERENTIATED

Stratigraphic section of the Adobe-Coane undifferentiated measured in NW 1/4, NW 1/4, Sec. 35, T. 2 S., R. 1 E., and SW 1/4, Sec. 26, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Inches
	MISSOURIAN - ADOBE-COANE UNDIFFERENTIATED	299	6
1.	Laminated calcareous sh, (f-w) medium dk. gy. N4, interbedded with thin-bedded micrite, (f) grayish black N2, (w) pinkish gy. 5YR 8/1, fetid. (S: 316-315)	10	1
2.	Recrystallized micrite, (f) dk. gy. N3, (w) lt. olive gy. 5Y 5/1, thin-bedded, slightly fetid, with thin laminae of reddish sh. (S: 317)	10	2
3.	Laminated calcareous sh., (f) lt. gy. N7, (w) very lt. gy. N8, 7% muscovite, interbedded with: sandy fossiliferous micrite, (f) medium gy. N5, (w) medium lt. gy. N6, 15% quartz grains, 1-4 mm, subangular to subrounded, poorly sorted; crinoid stems and oolites scarce; some calcite grains show hematite stain, they might represent recrystallized fossils. (S: 319-318)	10	2
4.	Micrite, (f) brownish gy. 5YR 5/1, (w) lt. brown 5YR 5/4, thick-bedded, dolomitic. (S: 320)	3	0
5.	Micrite, (f-w) grayish black N2, thin-bedded (S: 321)	12	0
6.	Algal biomicrosparite (10% micrite, 10% sparite), (f) medium dk. gy. N4, (w) irregular lt. brownish gy 5YR 6/1, medium-bedded, abundant algal nuclei; scattered subangular, medium, hyaline quartz grains; fetid. (S: 322)	0	10
7.	Covered buff-weathered sh. (?)	15	0
8.	Recrystallized micrite, (f) dk. gy. N3, (w) banded lt. brownish gy. 5YR 5/1 and medium dk. gy. N4, laminated; laminae consist of alternated coarser and finer calcite crystals. It shows evidence for penecontemporaneous deformation (folding and faulting), slightly fetid, (S: 325-323)	34	9
9.	Recrystallized biomicrite, (f) medium dk. gy. N4, (w) medium lt. gy. N6, thin-bedded; spiriferid shells common, productid shells scattered, crinoid stems up to 3 cm. in diameter		

		Feet	Inches
	scattered. (S: 326)	2	0
10.	Laminated calcareous sh, (f) lt. olive gy. 5Y 5/1, (w) lt. brownish gy. 5YR 7/1 with interbedded laminated to thin dk. gy. recrystallized biomicrite containing scattered crinoid stems, productids, and spirifered shells. (S: 328-327)	18	4
11.	Recrystallized fossiliferous micrite, (f) medium dk. gy. N4, (w) very pale orange 10YR 7/2, thin-bedded, slightly nodular; productid shells scarce. (S: 329)	20	8
12.	Biogenic algal ls, (f) medium gy. N5, (w) medium lt. gy. N6, medium - to thick-bedded. (S: 330)	10	4
13.	Micrite, (f) pale yellowish brown 10YR 6/2, (w) lt. brown 5YR 6/4, dolomitic, some hematite stain, abundant black, soft irregular, grains. (S: 331)	3	0
14.	Pelmicrite (10% micrite), (f) medium lt. gy. N6, (w) pale yellowish brown 10YR 6/2, scattered algal pellets, some limonite stain. (S: 332)	2	0
15.	Recrystallized micrite, (f) pale red 5R 6/2, (w) pale yellowish red 10YR 6/2, some limonite stain, scattered fine to medium, rounded quartz grains (S: 333)	2	8
16.	Laminated calcareous sh., (f) olive gy. 5Y 4/1, (w) lt. olive gy. 5Y 6/1, (S: 334)	26	0
17.	Crinoidal micrite, (f) medium gy. N5, (w) greenish orange 10YR 6/4, slightly fetid, productid shells (up to 1" long) and shell fragments scarce. (S: 335)	1	0
18.	Biomicrite, (f) pale red 5R 6/2, (w) grayish orange 10YR 6/4, medium-bedded; *Composita*, spiriferid shells, and shell fragments common, crinoid stems scarce, slightly recrystallized. (S: 336)	8	0
19.	Pelmicrite, (f) medium lt. gy. N6, (w) moderate yellow brown 10YR 5/4, medium-bedded, slightly dolomitic. (S: 337)	2	5
20.	Micrite, (f) olive gy. 5Y 3/1, (w) lt. olive gy., 5Y 6/1, thin-bedded, nod, with interbedded thin buff-weathering sh. (S: 338)	21	8

		Feet	Inches
21.	Dismicrite, (f) medium gy. N5, (w) lt. gy. N7, medium-bedded; with a thin bed of micrite at the base, (f) grayish red 5R 4/2, (w) lt. brown 5R 6/4. (S: 340-339)	3	0
22.	Laminated calcareous sh., (f) olive gy. 5Y 4/1, (w) very lt. gy. N8, with thin - to medium-bedded layers of dk. gy. N3 nod, micrite. (S: 342-341)	31	0
23.	Micrite, (f) medium dk. gy. N4, (w) lt. gy. N7, thin-bedded. (S: 343)	2	0
24.	Laminated calcareous sh., (f) olive gy. 5Y 4/1, (w) lt. olive gy. 5Y 6/1, 7% muscovite; interbedded with thin, slightly nodular recrystallized fossiliferous micrite, (f) medium gy. N5, (w) medium lt. gy. N6. Productid and spiriferid shells scattered. (S: 345-344)	5	2
25.	Laminated calcareous sh, (f) dk. gy. N3, (w) lt. olive gy. 5Y 6/1; with dk. greenish gy. 5GY 4/1 sh. at the base and with dusky blue 5PB 3/2 sh. near top. (S: 348-346)	10	4
26.	Recrystallized biomicrite, (f) lt. olive gy. 5Y 5/1, (w) lt. olive gy. 5Y 6/1, grades upward into biosparite containing abundant crinoid stems, productid shells up to 1.5" long common. (S: 350-349)	10	5
27.	Recrystallized micrite, (f) dk. gy. N3, (w) grayish orange 10YR 6/4, thin-bedded, nod., interbedded with laminated ca. sh., (f) medium dk. gy. N4, (w) lt. olive gy. 5Y 6/1 (S: 352-351)	10	4
28.	Laminated calcareous sh., (f) olive gy 5Y 4/1, (w) lt. olive gy. 5Y 6/1, interbedded with thin-bedded recrystallized micrite ls., (f) medium dk. gy. N4, (w) olive gy. 5Y 4/1 (S: 354-351)	6	2

-----------------CONFORMITY-----------------

MISSOURI - COUNCIL SPRING LIMESTONE

Stratigraphic section of the Adobe-Coane undifferentiated measured at Cerros de Amado in NE 1/4, NE 1/4, Sec. 35, T. 2 S., R. 1 E., and SW 1/4, Sec. 25, T. 2 S., R. 1 E. (Eastern section).

Unit No.	Description	Thickness Feet	Inches
	MISSOURI - ADOBE-COANE UNDIFFERENTIATED	258	2
1.	Covered shale (?)	5	3
2.	Fossiliferous micrite, (f) medium dk. gy. N4, (w) lt. gy. N7; thin-bedded. Bedded chert (up to 2" thick) moderate brown 5YR 3/4. Crinoid stems common at places, Composita scarce. Some of the fossils are silicified. (S: 640)	2	7
3.	Covered shale (?) with 2 thin beds of recrystallized argillaceous micrite, (f) pinkish gy. 5YR 7/1 and grayish black N2, (w) lt. brown 5YR 5/5 and medium gy. N5, respectively. Thin-bedded to laminated, fetid, nodular; plant remains scarce. (S: 642-641)	6	11
4.	Covered shale (?)	2	7
5.	Recrystallized biomicrite, (f) dk. gy. N3, (w) medium gy. N5, thin-bedded, nodules; Composita, crinoid stems, shell fragments, and algae scattered. 3% subangular to subrounded quartz grains (1/5 to 2 mm.), (S: 643)	2	0
6.	Laminated calcareous shale, (f) dk. gy. N3, (w) medium dk. gy. N4, 5% muscovite, with thin dk. gy. (N3) micrite beds and a thick lenticular gypsum bed. The shale at the base of the unit is olive gy. 5Y 3/1 (f-w) (S: 646-644)	5	5
7.	Laminated calcareous shale, (f-w) medium dk. gy. N4, 5% muscovite. Interbedded with thin beds of slightly argillaceous micrite, (f) dk. gy. N3, (w) medium gy. N5, laminated and fetid. A 6-inch bed of slightly nodular and slightly fetid micrite weathering very pale orange (10 YR 7/2) occurs at the base of the unit. (S: 650-647)	8	4
8.	Pelmicrite, (f-w) medium lt. gy. N6, laminated, slightly fetid, slightly cherty. Algal pellets scattered. 10% micrite. (S: 651)	1	6

		Feet	Inches
9.	Laminated calcareous shale, (f-w) olive gy. 5Y 4/1; 5% muscovite; abundant siliceous concretions (f) dk. gy. N3, (w) dusky yellow 5Y 6/4. Interbedded with thin argillaceous micrite beds, (f-w) medium gy. N4. (S: 653-652)	56	3
10.	Micrite, (f) medium dk. gy. N4, (w) lt. gy. N7, slightly fetid is overlain by medium gy. (N5) biomicrite containing abundance <u>Composita</u> and scattered spiriferids which in turn is overlain by slightly nodular fossiliferous dismicrite, (f) medium gy N5, (w) yellowish gy 5Y 7/1 containing scarce <u>Composita</u>. Upper 1' consists of argillaceous micrite, (f) dk. gy. N3, (w) banded medium gy N5 and pale yellowish brown 10YR 6/2; laminated (coarse and fine calcite crystals), showing penecontemporaneous deformation (folding and faulting); underlain by 2' of pelmicrite. Unit is mostly medium-bedded becoming thin-bedded to laminated near the top. (S: 658- 653)	15	9
11.	Quartzose shale (?), (f) olive gy. 5Y 4/1, (w) lt. olive gy. 5Y 5/1, slightly silty, 7% muscovite, carbonaceous organic remains common. A 1-foot bed of dismicrite, (f) dk. gy. N3, (w) grayish orange 10YR 6/4, crops out 18' above the base; and a 1-foot bed of slightly nodular micrite, (f) lt. olive gy. 4/2, (w) grayish yellow 5Y 7/4 crops out 10' above the base of the unit. Laminated calcareous shale, (f-w) dk. gy. N3, carbonaceous organic remains common, 5% muscovite, occurs at the base and the top of the unit. (S: 662-659)	52	6
12.	Calcareous protoquartzite, (f) lt. olive gy. 5Y 5/1, (w) lt. brownish gy. 5 YR 5/1, thin-bedded, 1/25-1/16 mm., fairly well sorted, subrounded. 70% quartz, up to 10% muscovite, 5% carbonaceous organic remains; 15% calcareous matrix. Interbedded with olive gy. laminated calcareous shale. (S:664-663)	5	3
13.	Calcareous arkose, (f) yellowish gy. 5Y 8/1 and very pale orange 10YR 7/2, (w) pale yellowish brown 10YR 6/2, thick-bedded, cross-bedded. Grain size: 1/5-1/2 mm. with quartz grains up to 3 mm. (at the base) scarce; 1/5-1.5 mm. (at the middle); 1/5-1 mm (at the top of the unit). Subangular, poorly sorted. Unit		

		Feet	Inches
	has graded bedding. Content of fresh white feldspar increases from base (27%)to top (32%); 3% muscovite; 2% subrounded ls. grains (2 mm.); remainder is quartz. Calcareous cement abundant. (S: 667-665)	15	3
14.	Feldspathic ss, (f-w) pale greenish yellow 10Y 7/2, laminated, cross-bedded; 1/8-1/12 mm, poorly sorted, subangular. 81% quartz, 15% fresh white feldspar (1/8-1/2 mm), 3% muscovite, 1% biotite. Abundant calcareous cement. Interbedded with thin layers of lt. olive gy. (5Y 5/2) silty shale. (S: 669-668)	11	6
15.	Micrite, (f) lt. olive gy. 5Y 5/1, (w) moderate yellowish brown 10YR 5/4 is overlain by intrasparite. (f-w) pale yellowish orange 10YR 7/6 containing subangular ls. pebbles up to 8 mm. in size. (?) Unit is medium-bedded; slightly nodular at top. (S: 672-670)	5	3
	-------------------Diastem-------------------		
16.	Covered shale (?)	10	0
17.	Feldspathic ss., (f-w) greenish gy. 5GY 6/1, laminated to medium-bedded, cross-bedded, 1/16 to 1/8, subangular to subrounded, fairly well sorted. 76% quartz, 16% fresh plagioclase and orthoclase, 8% muscovite. Some hematite stain. Abundant calcareous cement. (S: 673)	5	9
18.	Covered shale (?) showing two ledges of ls: Dismicrite, (f) medium gy. N5, (w) lt. olive gy. 5Y 5/1, 3' thick, medium-bedded, It crops out at 25' above the base of the unit. (S: 675) Fossiliferous micrite, (f-w) medium dk. gy. N4, 2' thick; medium-bedded. Productids, crinoid stems (up to 5 mm. in diameter), and bryozoan scarce. (S: 674)	44	6
19.	Sandy intraclast, (f-w) medium gy. N5, thick-bedded. 55% subangular to subrounded ls. pebbles (1/2-60 mm.); 30% subangular to subrounded quartz grains, (1/4-3 mm.), 10% fresh orthoclase with a subordinate amount of plagioclase (1/4-4 mm.); 5% sparite matrix with crinoid stems scarce. (S: 676)	1	7
	-------------------Diastem-------------------		

----------------DISCONFORMITY----------------

MISSOURI - COUNCIL SPRING LIMESTONE

Stratigraphic section of the Council Spring Limestone measured in NE 1/4, SE 1/4, Sec. 27, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Inches
	MISSOURI - COUNCIL SPRING LIMESTONE	19	7
1.	Micrite, (f) dk. gy. N3, (w) medium dk. gy. N4, thin - to medium-bedded, slightly nod. at places, slightly fetid, scattered productid shells (up to 1" long). (S: 357-376)	9	5
	A recrystallized biohermite, (f) lt. gy. N7, (w) yellowish gy 5Y 7/1 is locally present between units 1 and 2. It attains a maximum thickness of 6' 6" and an approximate length of 80'. The ls. layers immediately above and below the bioherm are arched. (S: 355) The whole formation is a cliff-forming unit showing vertical joints that produce a columnar appearance.		
2.	Micrite, (f-w) medium gy. N5, thin - to medium-bedded, (S: 361-358)	10	2

----------------CONFORMITY----------------

MISSOURI - BURREGO FORMATION

Stratigraphic section of the Council Spring Limestone, measured in SW 1/4, Sec. 25, T. 2 S., R. 1 E. (Eastern section).

Unit No.	Description	Thickness Feet	Thickness Inches
	MISSOURI - COUNCIL SPRING LIMESTONE	18	0
1.	Crinoidal biomicrosparite, (f-w) medium gy. N5, thin-bedded; 40% micrite, 10% sparite. Crinoid stems abundant (up to 10 mm. in diameter), bryozoan and Composita scarce. (S: 677)	1	6
2.	Crinoidal micrite, (f-w) medium lt. gy. N6, medium-bedded at the base of unit, becomes thin-bedded upward. Large crinoid stems common, Composita scarce. Upper 2' consist of fossiliferous dismicrite. Cliff-forming unit with prominent vertical joints giving a columnar appearance. (S: 679-678)	16	6

-----------------CONFORMITY-----------------

MISSOURI - BURREGO FORMATION

Stratigraphic section of the Burrego Formation measured in NW 1/4, SW 1/4, Sec 26. T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	MISSOURIAN - BURREGO FORMATION	85	2
1.	Laminated calcareous sh., (f) olive gy. 5Y 4/1, (w) lt. olive gy. 5Y 5/1, 5% muscovite, with thin beds of olive gy. 5Y 4/1 calcareous feldspathic siltstone, and thin beds of re-crystallized micrite, (f-w) pale yellowish brown 10YR 5/2 (S: 364-362)	18	0
2.	Dismicrite, (f) medium dk. gy. N4, (w) lt. brown 5Y 5/6, thin-bedded, slightly nod., scattered algal pellets near base of unit, scattered limonite spots; interbedded with thin laminated calcareous sh, (f) olive gy. 5Y 4/1, (w) lt. olive gy. 5Y 5/1, 5% mus-covite, (S: 367-365)	12	10
3.	Micrite, (f) medium dk. gy. N4, (w) medium gy N5, thin-bedded, scattered rounded quartz grains (1/4-2 mm) (S: 368)	1	0
4.	Arkose, (f-w) irregular lt. gy. N7, thick-bedded, 1/2-2 mm., poorly sorted, subangular 30% f. white feld. 69% quartz, 1% muscovite, si. cem., residual (?) ca. cem. (S:369)	5	2
5.	Arkosic quartzite, (f) dk greenish gy 5GY 4/1, (w) brownish black 5YR 2/1, thin-bedded, 1/4 to 1 mm., poorly sorted, subangular, 30% fresh orthoclase, 70% quartz, residual (?) ca. cem. the uppermost 2' consist of arkosic ss., 1/2 to 3 mm., poorly sorted, subangular 23% fresh orthoclase, 71% quartz, 3% black rock fragment, 1% muscovite and biotite, ca. cement. (S: 372-370)	5	3
6.	Covered shale (?)	5	0
	Arkose, (f) brownish gy, 5YR 3/1, (w) pale brown 5YR 4/2, laminated, cross-bedded, mic-aceous, 1/3-1/2 mm., fairly well sorted, sub-angular 27% f. orthoclase, 68% quartz, 5% biotite with muscovite tr. (S: 373)	6	2
7.	Dismicrite, (f) medium lt. gy. N6, (w) lt. gy. N7, medium-bedded, (S: 375)	2	6
	Micrite, (f) dk. gy. N3, (w) medium lt. gy. N6, thin-bedded, nod, (S:374)	3	0

		Feet	Inches
8.	Recrystallized micrite, (f) medium lt. gy. N6, (w) lt. olive gy 5Y 6/1, thin-bedded, nod. (S: 376)	5	2
9.	Laminated micaceous sh, (f-w) brownish gy. 5R 4/1, silty; with thin beds of recrystallized micrite, (f) medium gy. N5, (w) pale yellowish brown 10YR 6/2, nod. (S: 378-377)	15	6
10.	Micrite, (f-w) medium lt. gy. N6, thin-bedded, nod., (S: 379)	2	7
11.	Dismicrite, (f) medium gy. N5, (w) lt. olive gy. 5Y 5/1, thin-bedded, some fusulinids. (S: 380)	5	0

-----------------CONFORMITY-----------------

MISSOURI - STORY FORMATION

Stratigraphic section of the Burrego Formation, measured in NE 1/4, SW 1/4, Sec. 25, T. 2 S., R. 1 E. (Eastern section).

Unit No.	Description	Thickness Feet	Thickness Inches
	MISSOURI - BURREGO FORMATION	36	9
1.	Gentle slopes covered with ls. rubble and showing three ledges (2' thick) of medium-bedded ls. From base to top: - Recrystallized pelmicrite, (f-w) medium gy. N5. (S:680) - Crinoidal biomicrite, (f-w) medium lt. gy. N6, containing up to 85% crinoid stems (up to 5 mm. in diameter). Slightly fetid. (S: 682-681) - Dismicrite, (f-w) medium lt. gy. N6 grades upward into micrite (lithographic ls.), greenish gy. 5GY 5/1. (S: 683-683a). Thickness of unit:	15	8
2.	Crinoidal biomicrosparite, (f-w) lt. gy. N7, (10% micrite, 10% sparite); thin-bedded, high spired gastropods ans shell fragments scarce. It grades upward into crinoidal biosparite and into fossiliferous micrite, lt. olive gy. 5Y 5/1 containing scarce crinoid stems (some of them are silicified). (S: 686-684)	10	7
3.	Covered shale (?) with three thin ledges of: (from base to top) - Argillaceous fossiliferous micrite, (f) mederate red orange 10R 5/6, (w) lt. brown 5YR 5/6. Crinoid stems scarce and shell fragments, high spired gastropods very scarce; all fossils are silicified (S: 687) -Pelmicrite (10% micrite), (f) medium dk. gy. N4, (w) lt. olive gy. 5Y 6/1. (S:688) - Fossiliferous dismicrite, (f-w) medium lt. gy. N6, scattered crinoid stems. (S: 689)	10	6

-----------------CONFORMITY-----------------

MISSOURI - STORY FORMATION

Stratigraphic section of the Story Formation measured in NW 1/4, SW 1/4, Sec. 26, T. 2 S., R 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	MISSOURIAN - STORY FORMATION	39	8
	Lower Clastic Member	23	4
1.	Arkose, (f) lt. gy. N7, (w) pale brown 5YR 5/2, thin-bedded, 1/4 to 1/2 mm., fairly well sorted, subangular, 40% fresh orthoclase, 57% quartz, 2-5% muscovite with little biotite, 1% fn, dk. rock frag., ca. cem., slightly quartzitic. (S: 381)	1	0
2.	Arkose, (f) brownish gy. 5YR 4/1, (w) moderate brown 5YR 3/4, laminated, cross-bed, 1/16 to 1/4 mm., subangular poorly sorted, 27% fresh orthoclase. 15% mica (abundant muscovite, some biotite), 57% quartz, 1% very fine dk. rock frag, no cem. (S:382)	6	10
3.	Laminated slightly calcareous sh, (f-w) grayish red 10R 4/2, highly micaceous (abundant muscovite, little biotite), silty; it becomes coarser-grained toward the northeast. (S: 383)	5	2
4.	Covered sh(?) with a lenticular arkose containing scattered ls. pebbles and fresh orthoclase, and a thin recrystallized pelmicrite containing scattered muscovite flakes and shell fragments crop out near the top of the unit. (S: 385-384)		
	Upper Limestone Member	16	4
1.	Crinoidal biosparite, (f) medium dk. gy. N4, (w) lt. gy. N7, thin-bedded, fetid, abundance of crinoids decreases upward, some reach 1 cm. in diameter. (S: 386)	2	6
2.	Crinoidal biomicrite, (f-w) lt. gy. N7, thin - to medium-bedded, silicified crinoid stems common, (w) lt. red 5R 6/6, some of them up to 1 cm. in diameter, (w) in high relief. (S: 387)	3	6
3.	Biomicrosparite (10% sparite, 20% micrite), (f) very lt. gy. N8, (w) pinkish gy. 5YR 7/1, thin - to thick-bedded, abundant white calcareous crinoids, some up to 1.5 cm. in diameter, small Composita shells scarce. (S: 388)	10	4

-----------------CONFORMITY-----------------

VIRGIL - DEL CUERTO FORMATION

Stratigraphic section of the Story Formation measured in NE 1/4, SW 1/4, Sec. 25, T. 2 S., R 1 E. (Eastern section).

Unit No.	Description	Thickness Feet	Thickness Inches
	MISSOURI - STORY FORMATION	28 (?)	9
	Lower Clastic Member	10	6
1.	Feldspathic micaceous ss., (f) pale red purple 5RP 5/2, (w) grayish red 10R 4/2; laminated to thin-bedded. 1/8-1/25 mm, subangular, poorly sorted. 79% quartz, 10% fresh white feldspar, 7? muscovite, 4% biotite. Abundant calcareous cement. (S: 690)	10	6
	Upper Limestone Member	+18	3
1.	Biomicrite, (f) medium dk. gy. N4, (w) greenish gy. 5GY 5/1. Brachiopods, snails, and and algae scarce. Upper part becomes a dismicrite (f-w) medium gy. N4. (S: 692-691)	5	3
2.	Biodismicrite, (f-w) lt. gy. N7: thin - to medium-bedded; crinoid stems (up to 1.5 cm in diameter) common, brachiopod shells scarce. Upper part becomes a micrite. (S: 693). The thickness of this unit is uncertain since the Virgilian rocks have been removed by erosion at this locality. Unit 1 and 2 are cliff-forming.	13 (?)	0
	Total measured thickness (East of Amado fault)	1538	1

VIRGIL - REMOVED BY EROSION

Stratigraphic section of the Del Cuerto Formation measured south-southwest of Minas del Chupadero in SW 1/4, NE 1/4, Sec. 26, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	VIRGILIAN-DEL CUERTO FORMATION	56	7
	Lower Member	15	8
1.	Covered shale (?)	10	5
2.	Sandy sparite, (f) medium lt. gy. (w) lt. brownish gy. 5YR 6/1, 30% hyaline quartz grains, 1/16-2 mm., subangular to subrounded It grades into unit 3. (S: 389)		
3.	Quartzitic calcareous arkose, (f) lt. gy. N7, (w) pale yellowish brown 10YR 6/2, thin-bedded, 1/4 to 1/2 mm., fairly well sorted; 40% white, w. feld., 55% quartz, 5% calcite grains; ca cem. It grades upward into a calcareous feldespathic ss., (f) very lt. gy. N8, (w) pale yellowish brown 10YR 6/2, 1/16-2 mm., subangular, poorly sorted, 20% w. white feld., 20% ls. grains, 60% hyaline quartz, ca. cem., quartzitic near top. (S: 392-390)	0	6
		4	9
	Middle Member	20	0
1.	Crinoidal biosparite, (f-w) lt. gy. N7, medium-bedded, (S: 394-393)	16	0
2.	Dismicrite, (f) lt. gy. N7, (w) lt. brownish gy 5YR 6/1, little cherty (irregular) moderate brown 5YR 3/4, Crinoid stems scarce, some of them are silicified and (w) lt. red 5R 6/6. (S: 395)	4	0
	Upper Member	20	11
1.	A thin bed of micrite (f-w) medium lt. gy. N6, nod. grades upward into arkose, (f) lt. gy. N8, (w) lt. brownish gy 5YR 6/1, thin-bedded, 1/8-1/2 mm., poorly sorted, sub-angular 27% fresh white feld., 60% quartz, 4% biotite, 9% ca. matrix, (S: 397-396)	7	5
2.	Arkose, (f) pale purple 5P 7/2, (w) lt. brown 5YR 6/4. laminated to thin-bedded, cross-bedded, 1/4-1/2 mm., poorly sorted, subangular, 30% white, fresh feld., 63%		

	Feet	Inches
quartz, 5% biotite and muscovite, 2% dark rock fragments; ca. cem., scattered limonite spots. (S: 400). The ss. grades laterally toward the southwest into laminated ca. sh. (f-w) grayish red 5R 4/2, slightly micaceous, and laminated ca. sh. (f-w) grayish red pruple 5RP 3/2, slightly siliceous. (S: 399-398)	13	6

-----------------CONFORMITY-----------------

VIRGIL - MOYA FORMATION

Stratigraphic section of the Moya Formation, measured at Minas del Chupadero, in SW 1/4, NE 1/4, Sec. 26, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Thickness Inches
	VIRGIL - MOYA FORMATION		
	Lower Member Similar to the lower member, measured at Ojo de Amado and described on page 122.		
	---------------DISCONFORMITY---------------		
	VIRGIL - MOYA FORMATION	77	9
	Upper Member	38	5
1.	Sandy intraclast containing subangular ls. cobbles up to 9 cm., (medium lt. gy. N6) with crinoid stems common in matrix (30%) of conglomeratic arkosic ss., grayish red purple, 5RP 4/2, slightly quartzitic, subrounded quartz grains. It grades upward into unit 6. (S:695)	1	0
2.	Laminated carbonaceous shale, (f-w) medium gy. N5, slightly micaceous (7% muscovite). It shows alternation of very thin laminae of silty and finer material. Interbedded with laminated carbonaceous shale, (f-w) dk. gy. N3, silty, 5% muscovite; and with laminated calcareous shale, (f) olive gy 5Y 4/1, (w) lt. olive gy. 5Y 5/1, 5% muscovite, traces of carbonaceous organic matter, slightly silty (S: 702-699) The shales contain lenses of: -quartzitic arkose, (f) very pale orange 10YR 4/2, (w) pale brown 5YR 5/2, thin-bedded, 1/6-1/2 mm., poorly sorted, subangular to subrounded, 35% weathered white feld., 62% hyaline quartz, 3% dark rock fragments, silica cem., some limonite stain, some malachite and azurite. (S:698). Thickness: -arkose, (f) yellowish gy. 5YR 7/2, (w) pale yellowish brown 10YR 6/2, thin-bedded, 1/5 to 1/2 mm., fairly well sorted, subangular to subrounded, 44% strongly weathered yellowish white	8	10

		Feet	Inches
	feld., 55% hyaline quartz, 1% muscovite; silica cem. little malachite stain. (S: 697)		
	Thickness:	5	6
	-arkosic quartzite, (f-w) grayish brown 5YR 3/2, thin-bedded, 1/2 to 2 mm., subangular, poorly sorted, 25% weathered white feld., 73% byaline quartz, 2% dark rock frag., little ca. can., abundant hematite stain. (S: 696)		
	Thickness:	4	
	Total thickness of shale and interbedded lenses:	18	4
3.	Fossiliferous micrite, (f-w) lt. gy. N7, thin-bedded, slightly mottled at the base, probably due to algae, crinoid stems scarce. Uppermost 3 inches contain abundant crinoids. (S: 703)	2	0
4.	Covered	3	
5.	Micrite, (f-w) lt. gy. N7, thin-bedded, irregular cherty (moderate brown 5YR 3/4) (S: 704)	3	6
6.	Dismicrite, (f-w) lt. gy. N7 with pale red purple 5RP 6/2 spots, medium-bedded. (S: 705)	5	3
7.	Recrystallized micrite, (f-w) lt. gy. N7, thin-bedded, slightly cherty (brownish gy. 5YR 3/1). (S: 706)	5	4
	Total measured thickness (West of Amado fault):	1804	11

---------------DISCONFIRMITY----------------

PERMIAN - BURSUM FORMATION

	Feet	Inches
Interbedded grayish red pebbly arkosic quartzitic, arkosic pebble conglomerate, and dark red shale, with few thin beds of light gray recrystallized micrite and sandy intraclast.	200	0

Stratigraphic section of the Moya Formation measured at Ojo de Amado in SE 1/4, NE 1/4 Sec. 27, T. 2 S., R. 1 E. (Western section).

Unit No.	Description	Thickness Feet	Inches
	VIRGIL - MOYA FORMATION	77	9
	Lower Member	39	4
1.	Micrite, (f-w) very pale blue 5B 7/2, thin-bedded, very nodular (S: 402-401)	6	10
2.	Recrystallized micrite, (f-w) medium lt. gy. N6, it becomes slightly nodular at top of unit, (f) lt. gy. N7, (w) lt. brown 5YR 5/4. Irregular bedded, prominent cliff-forming unit, vertical joints give a columnar appearance. White crinoid stems up to 2 cm. in diameter scarce, near top of unit. Locally dismicrite. (S: 405-403)	32	6
	---------------DISCONFORMITY----------------		
	Upper Member	38	0
1.	Sandy intraclast containing ls. pebbles up to 3 cm., with crinoid stems common, in a matrix (20%) of conglomeratic arkosic ss. (f-w) medium lt. gy. N6. (S: 406)	0	6
2.	Recrystallized micrite, (f-w) lt. gy. N7, thin-bedded, nod., (S: 407)	5	1
3.	Recrystallized micrite, (f-w) lt. gy. N7, medium-bedded, (S: 408)	1	7
4.	Recrystallized micrite, (f-w) lt. gy. N7, thin-bedded, nod., (S: 409)	7	7
5.	Recrystallized micrite, (f) medium gr. N5, (w) medium dk. gy. N4, medium-bedded (S: 410)	2	0
6.	Recrystallized fossiliferous micrite, (f-w) lt gy N7, thin-bedded, nod., crinoid stems and brachiopod shells scarce; some of them are silicified and lt. red-colored 5R 6/6. (S: 411)	12	2
7.	Dismicrite, (s-w) lt. gy. N7, medium - to thick-bedded, nod. near top. (S: 412)	5	1
8.	Recrystallized fossiliferous micrite, (f-w) irregular grayish purple 5P 4/2 to medium lt. gy. N6, thin-bedded, nod.; crinoid stems scarce. (S: 413)	4	0

	Feet	Inches
Total measured thickness (West of Amado fault):	1804	11

---------------DISCONFORMITY-----------------

PERMIAN - BURSUM FORMATION

Interbedded grayish red pebbly arkosic quartzite, arkosic pebbly conglomerate, and dark red shale, with few thin beds of light gray nodular recrystallized micrite and sandy intraclast.

Thickness: 200' 00"

APPENDIX B

Insoluble residues of limestones.

(E) and (W) indicate eastern and western sections respectively

Formation	Unit	Sample	Insoluble residue (%)	Description
Sandia	19	555 (E)	39.55	Sand, 1/20-2 mm., ang., poorly sorted; silt (c).
	19	556a(E)	5.09	qtz. silt; clay minerals (c).
	25	559a(E)	19.54	qtz. silt; and fine sand; clay minerals (tr).
	21	271a(W)	11.98	qtz. silt; clay minerals (a); muscovite (tr); shell frag. (tr).
Elephant Butte	2	561 (E)	2.63	qtz. silt; clay minerals (tr).
	9	566 (E)	15.01	qtz. silt; clay minerals (tr); shell frag. (tr).
	11	297 (W)	24.28	qtz. silt; clay minerals (tr).
Whiskey Canyon	14	482 (W)	9.35	qtz. silt; bentonitic clay (a).
"Bartolo"	7	530 (W)	10.23	sand, up to 2 mm., sang. to srnd; silt (a); clay minerals (tr), fossils frag. (c).
Adobe-Coane	8	324 (W)	10.43	qtz. silt; clay minerals (tr).
	12	330 (W)	6.68	qtz. silt; muscovite (c), clay minerals (tr).
	10	656 (E)	7.52	qtz. silt; sand (tr), fine, sang; clay minerals (tr).
	13	667 (E)	29.20	qtz. silt; muscovite (tr), clay minerals (tr).
Council Spring	1	677 (E)	2.35	qtz. silt; clay minerals (c); muscovite (c).

Formation	Unit	Sample	Insoluble residue (%)	Description
	2	679 (E)	1.38	qtz. silt; clay minerals (c); muscovite (c).
	1	355 (W)	2.32	qtz. silt; muscovite (tr.).
	1	356 (W)	4.87	qtz. silt; clay minerals (a); muscovite (t
	2	361 (W)	2.56	qtz. silt; clay minerals (a); muscovite (c

APPENDIX C

X-ray analyses of shales

Three samples from thick units of shale, east of the Amado fault zone, were taken in order to determine their clay mineral content.

Formation	Unit	Description
Sandia	18	Mostly quartz with small amounts of kaolinite and traces of montmorillinoid.
"Bartolo"	4	Mostly quartz with some calcite and minor amounts of kaolinite and illite.
Adobe-Coane	11	Mostly quartz with some calcite, small amounts of kaolinite, and traces of illite and montmorillinoid.

The results of the X-ray analysis combined with the results of the mechanical analysis (p. 16) of the sample from the Sandia Formation proved the sample is a silty quartzose shale. Although no mechanical analysis of the other two samples was made it is very probable that they are similar to the sample from the Sandia Formation and therefore they are here called silty quartzose (?) shale.

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Date: September 2, 1965

Thesis
R279
1965
C.2

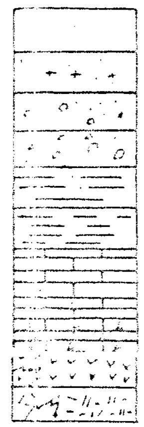
PLATE 2

GENERALIZED COMPOSITE STRATIGRAPHIC SECTION

CERROS DE AMADO AREA, SOCORRO, N.M.

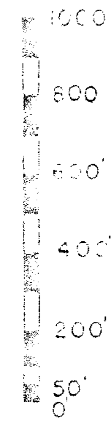
by
Angel Rejas
1965

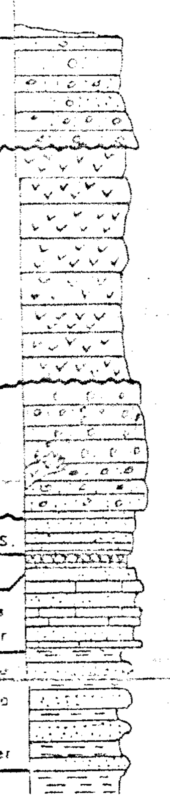
Explanation

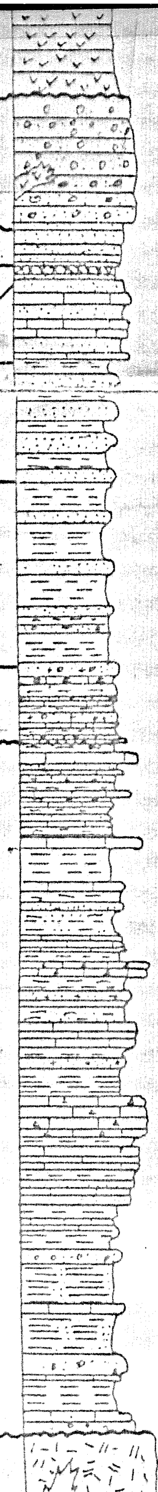


Sandstone
Arkose
Conglomeratic Ss
Conglomerate
Siltstone
Shale
Limestone
Sandy Ls
Cherty Ls
Volcanic rocks
Basement complex

Scale 1" = 500'



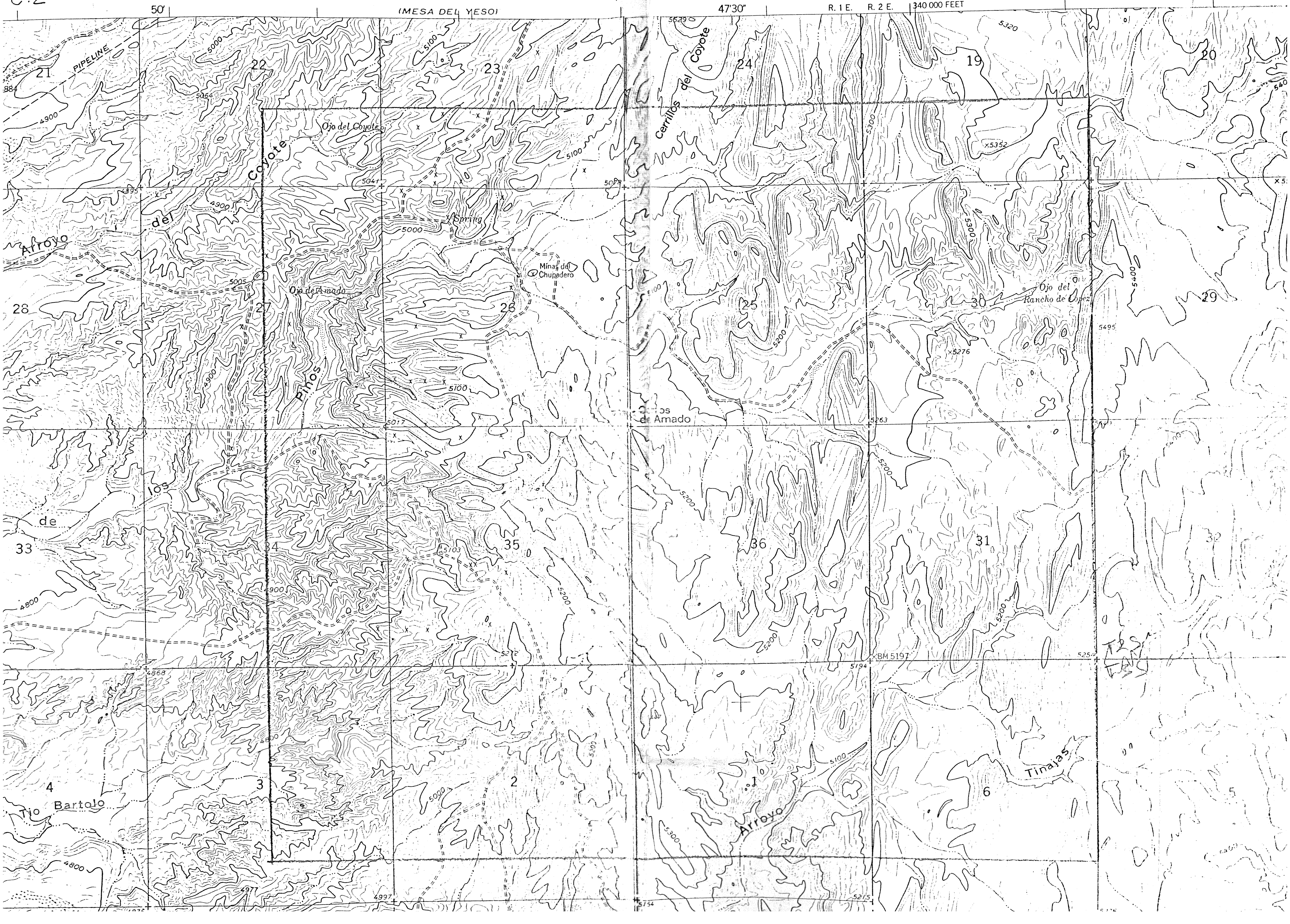
SYSTEM	SERIES	FORMATION	COLUMNAR SECTION	THICKNESS	DESCRIPTION
QUATERNARY	RECENT				
QUATERNARY	PLEISTOCENE			10'	Alluvium, gravel, wind-blown sand.
TERTIARY	PLIOCENE	Santa Fe Group		300'	Thick-bedded, partially consolidated sands, gravels, and conglomerates; red, grayish red, and gray.
					angular unconformity
TERTIARY	MIOCENE (?)	Datil		600'	Thick beds of pale purple and grayish red purple porphyritic andesite, rhyolite, tuffs, and agglomerate.
					angular unconformity
TERTIARY	EOCENE (?)	Baca		320'	Medium- to thick-bedded, light purple, red, and light yellow conglomerates and conglomeratic sandstone.
					angular unconformity
		Glorieta Ss.		110'	Thin- to medium-bedded pure quartz sandstone, yellowish orange.
PERMIAN	LEONARD	Yeso: Cañas Gypsum		40'	Thick beds of white gypsum with thin interbeds of limestone, sandstone, and siltstone.
PERMIAN	LEONARD	Yeso: Torres Member		220'	Medium to thick beds of lt. gy. and greenish gy. argillaceous micrite and dismicrite, interbedded with reddish orange feldspathic sandstone.
PERMIAN	LEONARD	Yeso: Meseta Blanca Ss Member		320'	Thin to medium-bedded, orange and red cross-bedded sandstone, interbedded with red, purple, lt. blue, and medium gy. siltstone and shale.
					Thick beds of dark red [illegible] mudstone and shale interbedded with thinner [illegible]

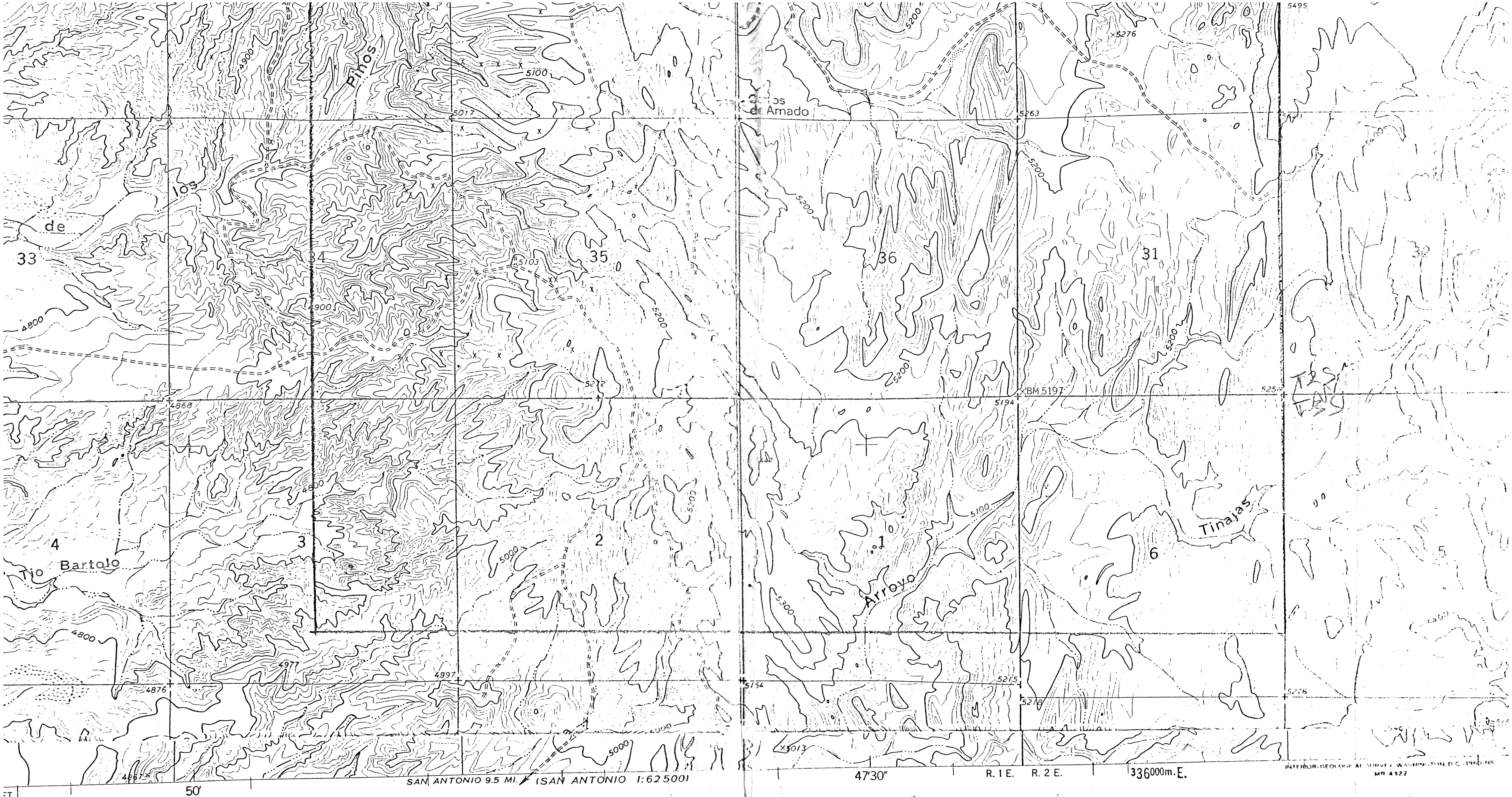


TERTI[ARY]	MIOCE[NE]			
				angular unconformity
TERTI[ARY]	EOCENE (?)	Baca	320'	Medium- to thick-bedded, light purple, red, and light yellow conglomerates and conglo - meratic sandstone.
				angular unconformity
PERMIAN	LEONARD	Glorieta Ss.	110'	Thin- to medium-bedded pure quartz sandstone, yellowish orange.
PERMIAN	LEONARD	Yeso: Cañas Gypsum	40'	Thick beds of white gypsum with thin interbeds of limestone, sandstone, and siltstone.
PERMIAN	LEONARD	Yeso: Torres Member	220'	Medium to thick beds of lt.gy. and greenish gy. argillaceous micrite and dismicrite, interbedded with reddish orange feldspathic sandstone.
PERMIAN	LEONARD	Yeso: Meseta Blanca Ss. Member	320'	Thin to medium-bedded, orange and red cross-bedded sandstone; interbedded with red purple lt. blue, and medium gy. siltstone and shale.
PERMIAN	WOLFCAMP	Abo	460'	Thick beds of dark red calcareous mudstone and shale interbedded with thinner beds of pure quartz and feldspathic sandstone and siltstone. Occasional medium beds of cal - clithite near the base.
PERMIAN	WOLFCAMP	Bursum	200'	Interbedded grayish red pebbly arkose, quartzitic arkosic pebbly conglomerate, and dk. red sh. with few thin beds of lt. gy. nodular micrite and sandy intraclast.
				disconformity
PENNSYLVANIAN	VIRGIL	(See plates 3 and 4)	133'	Lt. gy. recrystallized micrite and crinoidal biosparite
PENNSYLVANIAN	MISSOURI		444'	Medium lt. gy. crinoidal biomicrite, and dismicrite. Olive gy. laminated calcareous sh. Yellowish gy. to greenish gy. arkose Olive gy. laminated calcareous sh. and siltstone Dk. gy. micrite, biomicrite, and pelmicrite
PENNSYLVANIAN	DES MOINES		645'	Medium to dk. gy. recrystallized biomicrite and micrite Olive gy. laminated calcareous sh. and siltstone Medium gy. recrystallized biomicrite and micrite Olive gy. laminated calcareous sh. Medium gy. recrystallized fossiliferous micrite. Medium gy. crinoidal biosparite and dusky yellow biomicrite and micrite
PENNSYLVANIAN	DERRY		581'	Lt. olive gy. laminated argillaceous(?) sh., laminated calcareous sh., laminated calcareous siltstone, interbedded with medium to thick-bedded brownish gy. pebbly feldspathic sandstone, pebbly pure quartz sandstone, and few beds of yellowish brown and medium gy. sandy biomicrite.
				nonconformity
PRE PENN				Quartz-monzonite, leucogranite, intrusion of gneissic granite.

R2799
1965
C.2

7.5 MINUTE SERIES (TOPOGRAPHIC)
SE/4 SOCORRO 15' QUADRANGLE





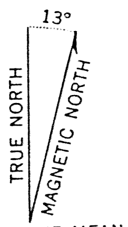
SCALE 1:24 000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

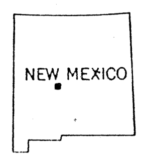
1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL



APPROXIMATE MEAN
DECLINATION, 1959

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER 25, COLORADO OR WASHINGTON 25, D.C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



QUADRANGLE LOCATION

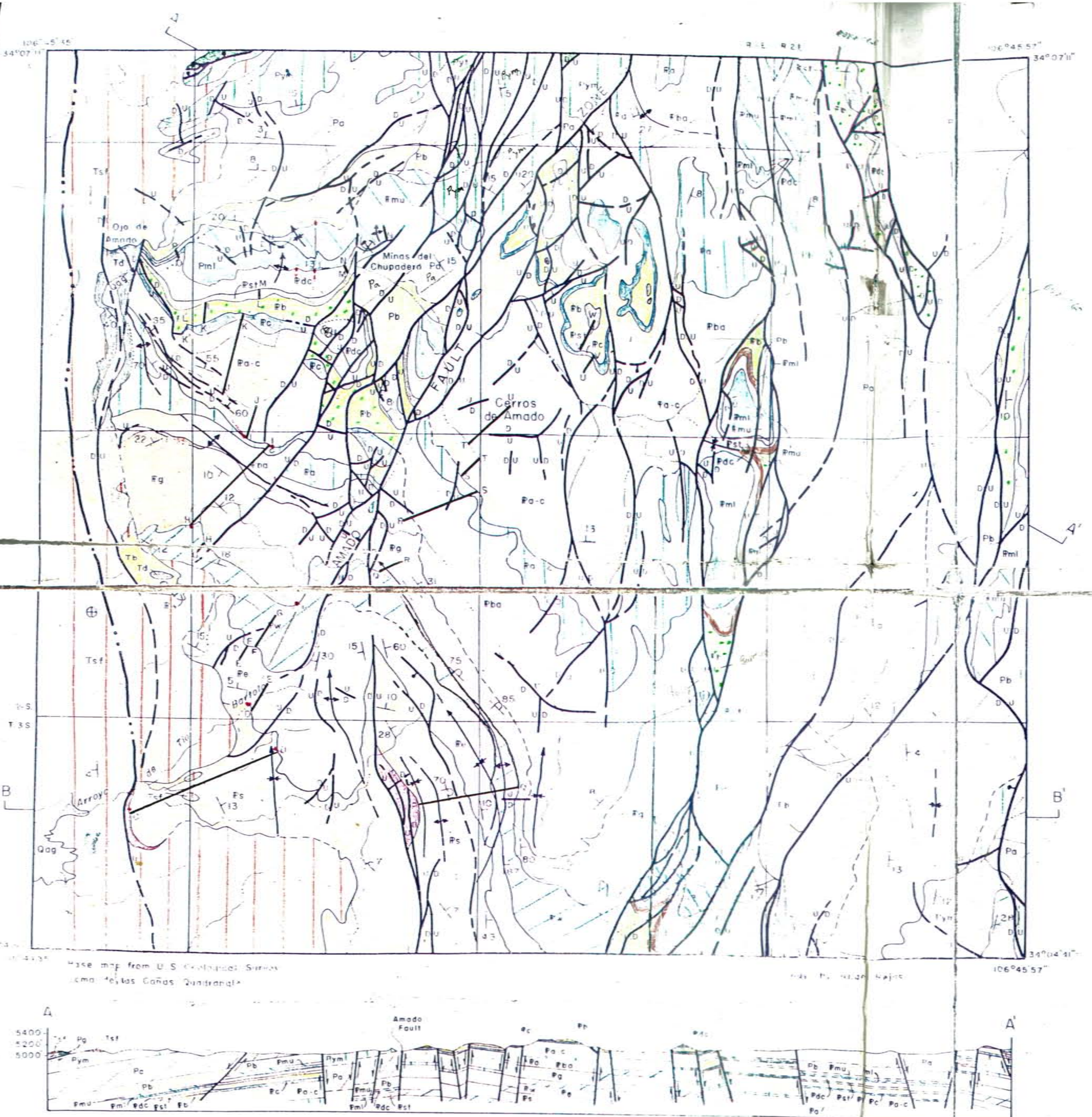
ROAD CLASSIFICAT

Unimproved dirt

LOMA DE LAS CAÑAS, N. M.
SE/4 SOCORRO 15' QUADRANGLE
N3400—W10645/7.5

1959

Fig. 2



EXPLANATION

PLIOC-PLEIST

Qag — Recent alluvium, gravel, etc.

MIOCENE(?)

Tsf — Santa Fe Group

Angular unconformity

Td — Datil Formation

Angular unconformity

EOCENE(?)

Tb — Baca Formation

Angular unconformity

LEONARD

Pg — Glorieta Sandstone

Yeso Formation:

- Not exposed in the area — Joyita Sandstone Member
- Pyc — Cañas gypsum Member
- Pyt — Torres Member
- Pym — Meseta Blanca Sandstone Member

WOLFCAMP

Pa — Abo Formation

Pb — Bursum Formation

VIRGIL

Moya Formation:

- Pmu — Upper Member
- DISCONFORMITY
- Pml — Lower Member

Pdc — Del Cuerto Formation

Upper, Middle, and Lower Members mapped together

MISSOURI

Pst — Story Formation

Upper Limestone Member and Lower Clastic Member mapped together

Pb — Burrego Formation

Pc — Council Spring Limestone

Pa-c — Adobe-Coane Undifferentiated

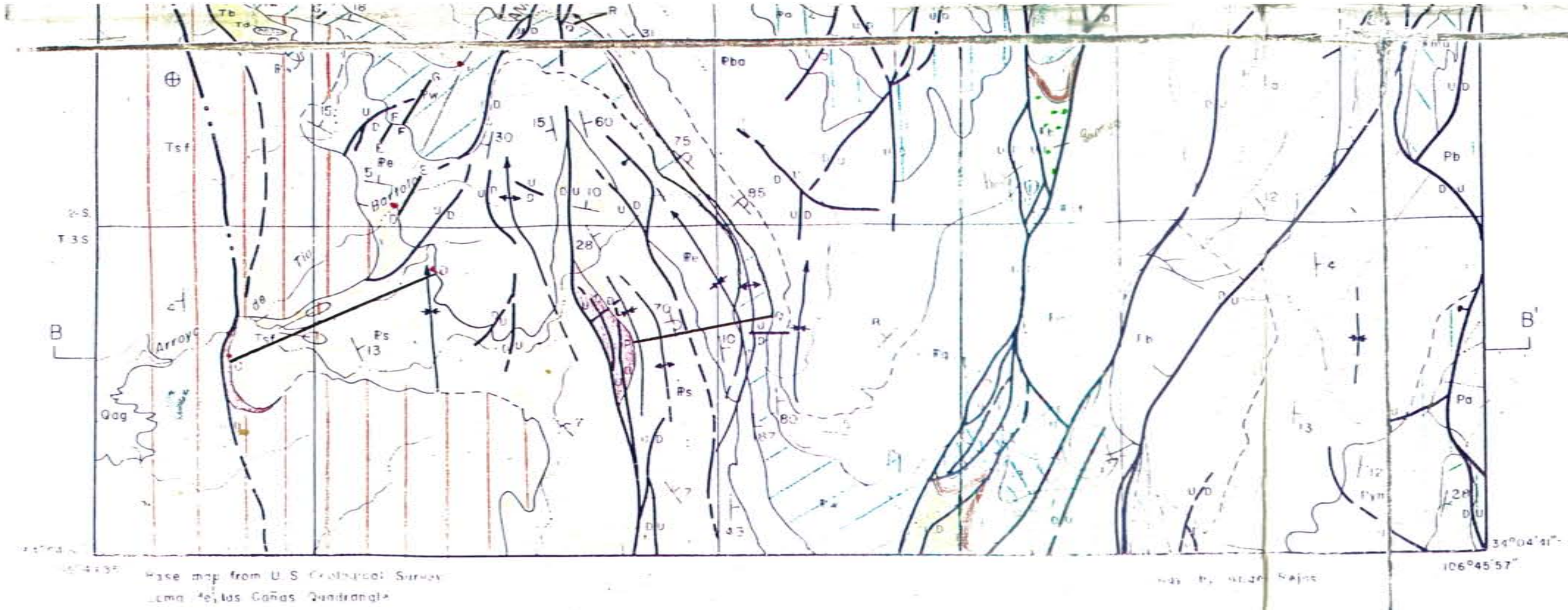
DES MOINES

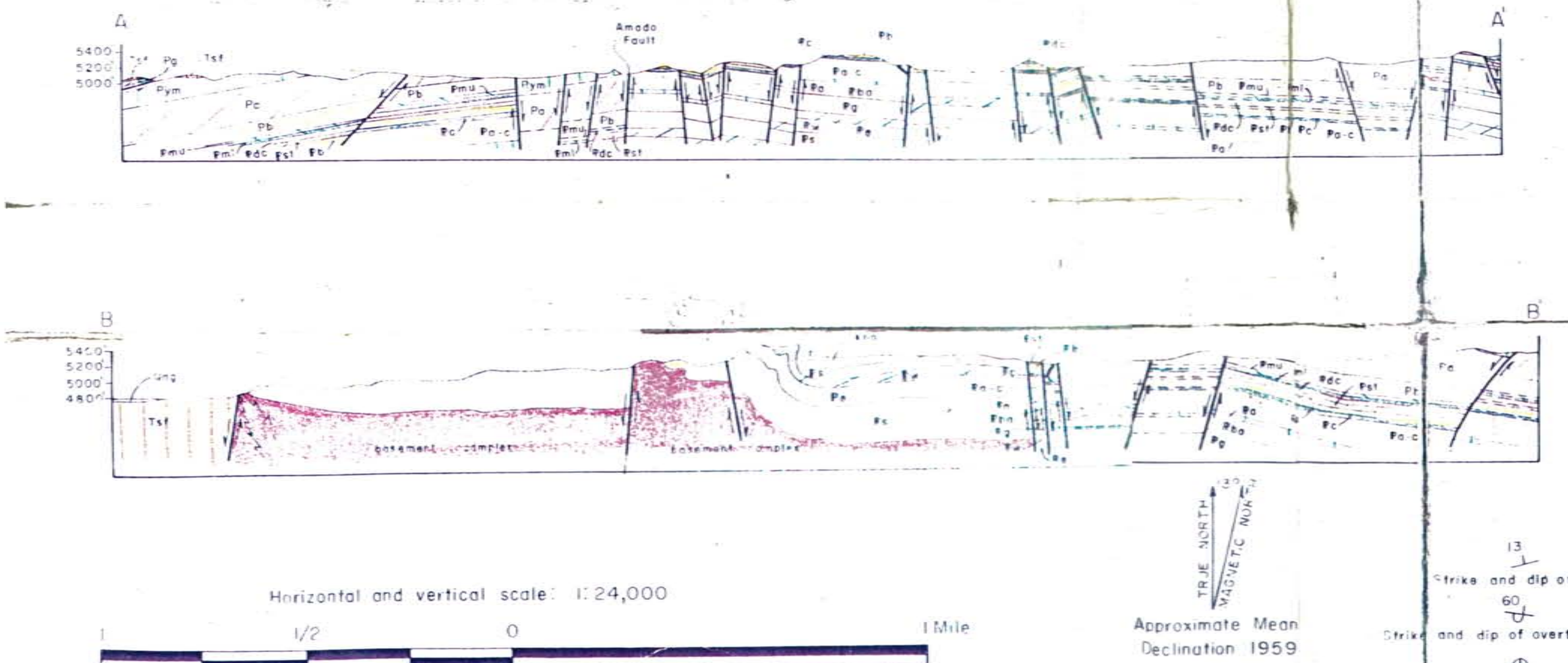
Pa — Amado Limestone

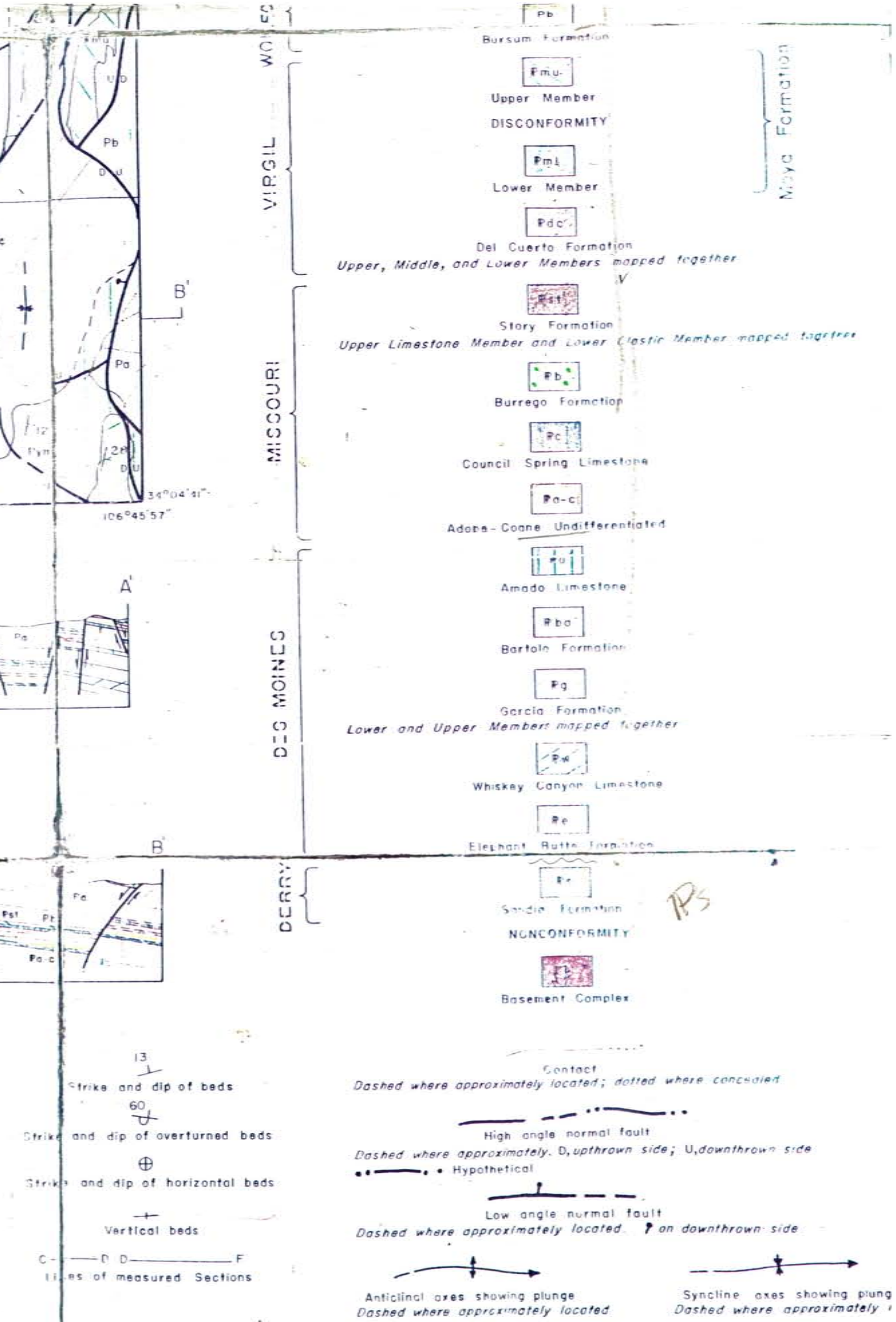
Pba — Bartolo Formation

Pg — Garcia Formation

Lower and Upper Members mapped together







GEOLOGIC MAP AND CROSS-SECTIONS OF CERROS DE AMADO AREA, SOCORRO COUNTY, NEW MEXICO

PLATE 4

PENNSYLVANIAN STRATIGRAPHIC SECTION

SOCORRO, NEW MEXICO

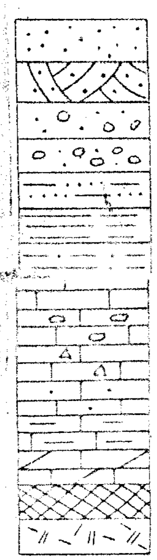
(Measured on the eastern side of the Amado fault zone, from P to W)

by

Angel Rejas

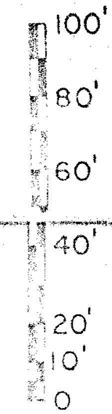
1965

EXPLANATION



Sandstone
Cross-bedded Ss.
Conglomeratic Ss.
Conglomerate
Siltstone
Shale
Silty Sh.
Limestone
Nodular Ls.
Cherty Ls.
Sandy Ls.
Argillaceous Ls.
Dolomitic Ls.
Gypsum
Quartz-monzonite

Scale: 1" = 50'

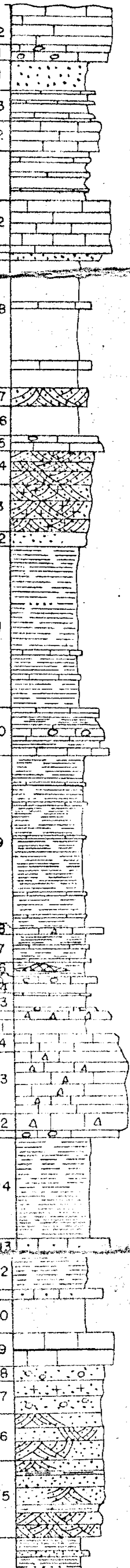


(f) = fresh

(w) = weathered

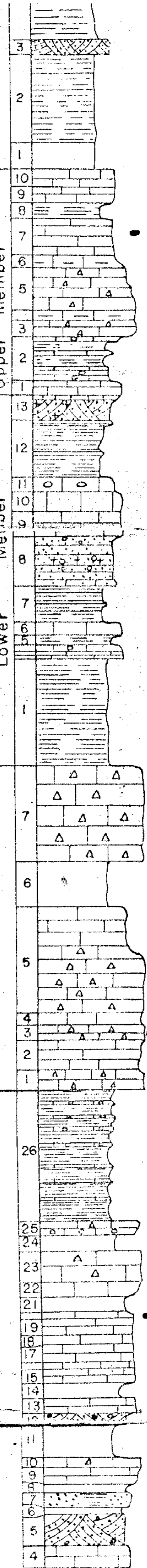
position of fusulinid collections

SYS-	SERIES	FORMA	T	COLUMNAR	THICK	LITHOLOGY	PALEONTOLOGY



Series	Formation / Member	Unit	Thickness	Description	Fossils
V	Not present in this area				
	STORY, Upper Member	2	28'	Biodismicrite (f-w) lt. gy.	Crinoid stems(c),brachiopods(r), gastropods(r),algae(r)
		1		Biomicrite (f)medium dk. gy.,(w)greenish gy.	
	STORY, Low. Member	1		Feldspathic ss.(f)pale red purple,(w)grayish red.	
	BURREGO	3	36'	Covered sh.(?) with thin-bedded micrite and pelmicrite	Crinoid stems(r),gastropods(r)
		2		Crinoidal biosparite (f-w) lt. gy.	Crinoid stems(a)
		1		Lt.rubble-covered slope with three ledges of medium-bedded pelmicrite and crinoidal biomicrite.	Bryozoan(c),solitary corals(r), crinoid stems(a)
	COUNCIL SPRING	2	18	Dismicrite (f-w)medium lt. gy. Crinoidal biomicrosparite (f-w)medium lt. gy. Sandy intraclast (f-w) medium gy. Diastem.	Crinoid stems(c),Composita(r)
MISSOURI	ADOBE - COANE UNDIFFERENTIATED	18	258'	[illegible] lt. olive gy., and a 2 foot-ledge of fossiliferous micrite (f-w) medium dk. gy.	Productids (r), crinoid stems (r),bryozoan (r)
		17		Feldspathic ss. (f-w) greenish gy.	
		16		Covered sh.(?)	
		15		Micrite (f) lt. olive gy, (w) moderate yellowish brown. Intrasparite	
		14		Diastem.	
		13		Calcareous arkose (f-w)yellowish gy.,grades upward into feldspathic ss. (f-w) pale greenish yellow.	
		12, 11		Silty quartzose sh. (f)olive gy.,(w)lt. olive gy. with thin beds of micrite (f) lt. olive gy.,(w) grayish yellow, and dismicrite (f) dk. gy., (w) grayish orange. Laminated calcareous sh. (f-w) dk. gy. at top and base of unit.	
		10		Micrite,pelmicrite,dismicrite,biomicrite, and micrite,(from top to base of unit),(f) medium gy.,(w)pale yellowish brown. Contemporaneous deformation at top.	Composita(a), spiriferids(r)
		9		Laminated calcareous sh. (f-w) olive gy.; si. conc. (a)	
		8		Pelmicrite (f-w) medium lt. gy.	Algae (r)
		7		Laminated calcareous sh. (f-w)medium dk. gy. with a gypsum bed.	
		6–2		Covered sh.(?) with thin micrite and fossiliferous micrite beds.	Composita(r),crinoid stems (r), algae(r).
		1		Covered sh.(?)	
	AMADO LS.	4, 3	34'	Recrystallized biomicrite (f)dk. gy.,(w)medium gy.	Productids(c),crinoid stems (c), bryozoan(c),spiriferids(r).
		2		Recrystallized micrite (f)dk.gy.,(w)medium gy. Layered chert.	Large productids (a).
	BARTOLO	14	219'	Laminated calcareous sh. (f-w) olive gy.	
		13		Sandy biomicrite (f)lt. gy.,(w)lt. brownish gy.	Crinoid stems(a),shell frag.(c), Composita(r), spiriferids(r)
		12		[illegible] calcareous sh. (f-w) lt. olive gy.	
		11		Sandy biomicrite(f)medium dk. gy.,(w)dk. yellowish brown	Composita(r), spiriferids(r)
		10		Covered sh.(?)	
		9		Algal biomicrite (f-w) medium dk. gy.	Algae (a),crinoid stems (a)
		8		Calcareous qtz. pebble conglomerate;10% intraclast pebbles.Diastem.	
		7		Qtzitic calcareous arkose (f-w) lt. gy.	
		6		Pure qtz. ss. (f-w) lt. greenish gy.	
		5		Pure qtz. ss. (f)medium lt. gy.,(w)pale brown, with interbedded greenish gy. sh.	
				Silty quartzose sh.(f-w)lt. olive gy., with thin-bedded feldspathic	

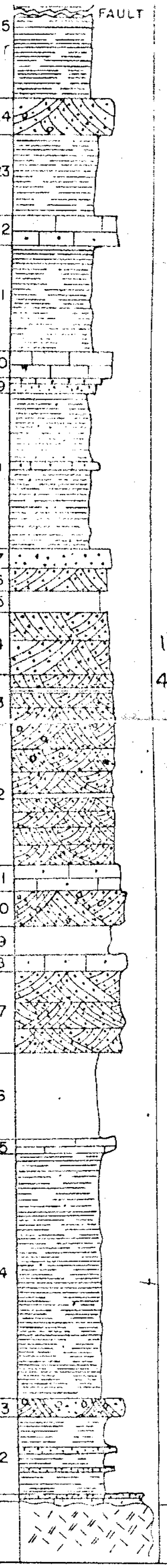
ENNSYLVANIAN — DES MOINES



	Feldspathic ss.(f)lt. brownish gy.,(w)pale brown.	
	Laminated calcareous sh. (f-w) olive gy.	
	Covered sh. (?)	
GARCIA — Upper Member		
	Brachiopod-biomicrosparite (f)lt. brownish gy.,(w)moderate orange pink.	Composita(a),productids(a), spiriferids(a),crinoid stems(c)
	Recrystallized fossiliferous micrite(f)medium dk. gy.,(w)medium gy.	Fusulina(a)
	Recrystallized biomicrite (f-w) medium gy.	Composita(a),crinoid stems (a)
	Argillaceous biomicrite (f)medium gy.,(w)medium lt. gy.	
	Biomicrite (f-w) lt. brown	Composita(a), spiriferids (a), crinoid stems (c), algae (a)
	Recrystallized micrite with interbedded slightly laminated ca. sh.	
GARCIA — Lower Member		
	Biomicrosparite (f-w) medium gy.	Composita(a),spiriferids(a)
	Arkose grades upward into sandy intraclast	
201'	Laminated calcareous sh.(f)lt. olive gy.,(w)dusky yellow, with thin-bedded biomicrite	Composita(a),spiriferids (a), productids(a),crinoid stems(a)
	Biomicrite (f) dk. gy., (w) lt. gy.	
	Biosparite (f) lt. ..., (w) pale brown	Composita(a), spiriferids (a), productids (a),crinoid stems (a)
	Micrite (f) dk. gy., (w) lt. olive gy.	
	Feldspathic ss. and arkose. Graded bedding.	
	Laminated calcareous sh.(f)lt. olive gy.,(w)yellowish gy.	
	Crinoidal biomicrite (f-w) medium dk. gy.	Crinoid stems(a),productids(a), spiriferids(a), Composita (c), solitary corals (c)
	Argillaceous micrite (f-w) lt. brownish gy.	
	Argillaceous laminated sh. (f-w) lt. olive gy.; slightly bentonitic.	
WHISKEY CANYON LS.		
	Recrystallized fossiliferous micrite (f) medium gy., (w)lt. gy.; abundant bedded chert (moderate brown).	Crinoid stems (r)
	Covered sh. (?)	
108'	Recrystallized fossiliferous micrite (f-w) medium gy.; abundant bedded chert (up to 2" thick)	Crinoid stems (r)
	Biomicrosparite (f) medium dk. gy., (w) irregular medium gy. to very pale orange	Fusulina (a), Wedekindellina (a) spiriferids(c),solitary corals(c) Composita(c),productids(c)
BUTTE		
	Laminated argillaceous sh. (f-w) lt. olive gy.; slightly bentonitic; with thin beds of biomicrosparite and micrite (f) dk. gy., (w) lt. olive gy.	
	Micrite (f-w) medium lt. gy.	
	Covered sh. (?)	
	Fossiliferous dismicrite (f-w) medium lt. gy.	Crinoid stems(r),Composita (r), productids (r)
	Covered sh. (?).	
186'	Biomicrosparite (f) medium dk. gy., (w) grayish orange to medium gy.	Fusulina(a),spiriferids (c), crinoid stems(c), solitary corals (c),productids (c)
	Covered sh. (?).	
	Recrystallized micrite (f)medium gy., (w) medium lt. gy.	
EPHANT		
	Pure qtz. ss. (f-w) pinkish gy.	
	Covered sh. (?)	
	Biomicrite (f) medium dk. gy., (w)pale yellowish brown	Crinoid stems(a), bryozoan (c), Composita(r),solitary corals(r)
	Calcareous pure qtz. ss. (f-w) pinkish gy.	
	Qtztic. pure qtz. ss. (f-w) pinkish gy.	
	Biomicrite (f)dk. gy.,(w) yellowish gy.	Crinoid stems(a),productids(c), solitary corals(c),bryozoan(c).
	Laminated calcareous sh.(f)medium dk. gy.(w)lt. olive gy.	

DERRY

SANDIA



Unit	Description	Fossils
25	Laminated calcareous sh. (f-w) olive gy. with thin beds of biomicrite.	Shell frag.(a),spiriferids(c), gastropods(r), algae(c).
24	Pebbly feldspathic ss. (f-w) lt. gy.	
23	Laminated calcareous sh. (f) olive gy., (w) lt. olive gy.	
22	Sandy biomicrite (f)medium dk. gy.,(w)pale yellowish brown. It grades into a brachiopodal biomicrite.	Productids(a),spiriferids (a), Composita(a),crinoid stems(c), gastropods(r).
21	Laminated calcareous sh. (f) olive gy. ,(w) lt. olive gy., slightly silty.	
20	Biosparite (f-w) moderate yellowish brown	
19	Calcareous ss. grades upward into sandy biomicrosparite showing cone-in-cone structure.	Spiriferids(a), productids (a), Composita(a), Crinoid stems(c), gastropods (r).
18	Silty quartzose sh. (f)lt. olive gy.,(w)lt. olive brown, with a thin bed of sandy biomicrite.	Productids(a),spiriferids(a).
17	Qtztic. pure qtz. ss.(f)lt. brownish gy.,(w)pale brown.	
16	Feldspathic ss.(f)pale brown,(w)pale yellowish brown.	
15	Covered sh. (?).	
14	Feldspathic ss. (f) pale brown, (w) pale yellowish brown.	
13	Protoquartzite (f) pale yellowish brown,(w)dk. yellowish brown, with thin beds of laminated argillaceous sh.	
12	Qtztic. pure qtz. ss. (f) lt. brownish gy., (w) pale red. It becomes pebbly near top.	
11	Sandy biomicrite (f) grayish orange,(w) dk. yellowish brown.	Composita(c),crinoid stems (a), shell frag. (c)
10	Pebbly qtztic. pure qtz. ss. (f)pale red,(w) grayish red.	
9	Covered sh. (?).	
8	Sandy biomicrite (f-w) dk. yellowish brown	Shell frag. (a).
7	Pure qtz. ss. (f-w) grayish pink.	
6	Covered sh. (?).	
5	Sandy biomicrite (f)pale yellowish gy.,(w)dk. yellowish brown.	Crinoid stems(a), productids(c), spiriferids(c),
4	Laminated argillaceous (?) sh. (f) lt. olive gy., (w) dusky yellow	
3	Pebbly feldpathic ss. (f-w) lt. gy.	
2	Laminated argillaceous (?) sh. (f)lt. olive gy.,(w) dusky yellow, with thin beds of qtztic. pure qtz. ss.	
1	Sandy micrite, silty sh., and qtztic. pure qtz. ss.; lenticular.	
	Quartz-monzonite.	

NON-CONFORMITY

PRE-PENN

PENNSYLVANIAN STRATIGRAPHIC SECTION
SOCORRO, NEW MEXICO

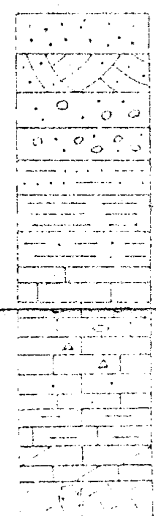
(Measured on the western side of the Amado fault zone, from C to P)

by

Angel Rejas

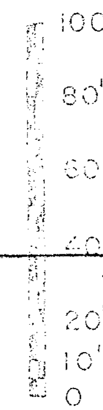
1965

EXPLANATION

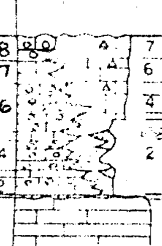


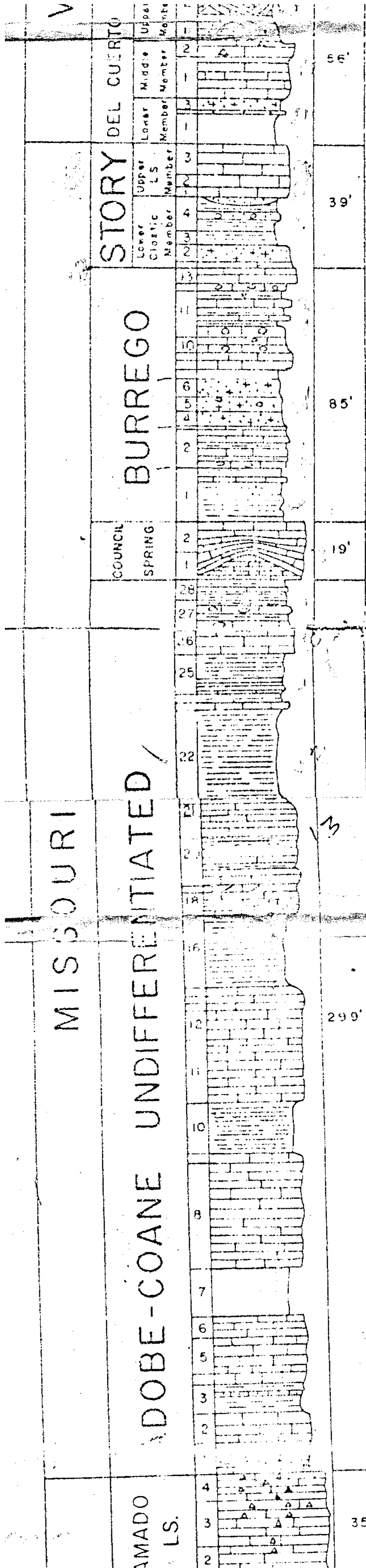
Sandstone
Cross-bedded Ss
Conglomeratic Ss.
Conglomerate
Siltstone
Shale
Silty Sh.
Limestone
Nodular Ls
Cherty Ls.
Sandy Ls.
Argillaceous Ls.
Dolomitic Ls
Leucogranite

Scale: 1" = 50'



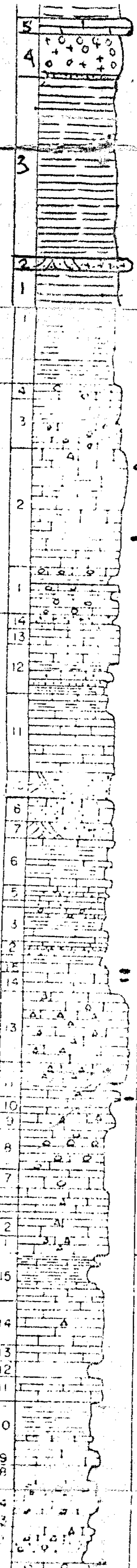
(F) = fresh
(w) = weathered
position of fusulinid collections

YS-EM	SERIES	FORMATION.	UNIT	COLUMNAR SECTION	THICKNESS	LITHOLOGY	PALEONTOLOGY
ER-IAN	WOLF CAMP	BURSUM					
						Disconformity	
IL		MOYA	8, 7, 6, 4, 2			Recrystallized fossiliferous micrite, (f-w) lt. gy. Laminated carbonaceous and calcareous sh grade laterally into re-crystallized nodular micrite.	Crinoid stems (r), productids (r) Composita (r).
					77'	Disconformity	
						Recrystallized micrite, locally dismicrite, (f-w) lt. gy.	Crinoid stems up to 2cm. in



Arkose,(f)pale ... (w)lt. brown. Slump structure.	
Sandy micrite grading upwards into arkose.	
Crinoidal biosparite,(f-w) lt. gy. to lt. brownish gy.	Crinoid stems (a), shell frag. (r).
Calcareous arkose,(f)lt. gy.,(w) moderate brown.	
Covered sh (?)	
Biomicrosparite,(f)very lt. gy.,(w)pinkish gy.	Silicified crinoid stems (a), Composita (r).
Crinoidal biomicrite,(f)medium dk. gy.,(w) lt. gy.	
Laminated calcareous sh,(f-w) greyish red.	
Arkose,(f) lt. gy.,(w) pale brown.	
Fossiliferous dismicrite,(f)medium gy.,(w) lt. olive gy.	Fusulinids (r), crinoid stems(r)
Recrystallized micrite interbedded with thin beds of laminated argillaceous sh (f-w) brown, higly micaceous.	
Dismicrite,(f) medium dk. gy.,(w) lt. gy.	
Covered sh (?).	
Arkose,(f) greenish gy.,(w)lt. brownish gy.	
Fossiliferous micrite,(f) medium dk. gy.,(w)moderate yellowish brown.	Algae (r).
Laminated calcareous sh interbedded with thin calcareous siltstone and micrite beds.	
Fossiliferous micrite,(f-w) medium gy.;local biohermite.	
Laminated calcareous sh with thin recrystallized micrite beds.	
Recrystallized micrite with laminated calcareous sh.	
Recrystallized biomicrite,(f-w) lt. olive gy.	Crinoid stems(a), large productids (c), spiriferids (r).
Laminated calcareous sh,(f-w)olive gy.,with thin micrite beds.	
Micrite,(f) medium dk. gy.,(w) lt. gy.	
Laminated calcareous sh,(f) olive gy.,(w) very lt. gy., with a few thin beds of dk. gy. nodular micrite.	
Dismicrite, (f) medium gy., (w) lt. gy.	
Micrite, (f) olive gy.,(w) lt. olive gy.	
Pelmicrite, (f)medium lt. gy.,(w)moderate yellowish brown.	
Crinoidal biomicrite interbedded with biomicrite.	Composita (c),crinoid stems(a), spiriferids (c).
Laminated calcareous sh, (f)olive gy.,(w) lt. olive gy.	
Pelmicrite interbedded with micrite.	
Algal biogenic ls, (f-w) medium gy.	Algae (a).
Recrystallized fossiliferous micrite,(f)medium dk. gy.,(w) very pale orange.	Productids (r).
Laminated calcareous sh,(f)lt. olive gy.,(w)lt. brownish gy.	
Recrystallized micrite,laminated,(w) banded lt. brownish gy. and dk. gy.,slightly fetid; penecontemporaneous deformation. A thin recrystallized biomicrite bed at top.	Spiriferids (c),productids(c), crinoid stems (r).
Covered sh (?).	
Algal biomicrosparite, (f-w) medium gy.	Algae nuclei (a).
Micrite,(f-w) grayish black.	
Laminated calcareous sh with interbedded sandy fossiliferous micrite	Crinoid stems (r).
Recrystallized micrite with thin laminae of reddish sh.	
laminated calcareous sh,(f-w) medium dk. gy. with thin-bedded micrite, fetid.	
Recrystallized biomicrite,(f)medium dk. gy.,(w) grayish orange.	Crinoid stems (a),bryozoans(a), productids(a).
Crinoidal biomicrite,(f)medium lt. gy.,(w)medium gy.	Composita (c).
Recrystallized biomicrite,(f)dk. gy.,(w)medium lt. gy.;medium-bed-	
... sh (f-w) lt. olive gy., carb. tr. interbedded	

BARTOLO



Laminated calcareous sh,(f-w) lt. olive gy.
Recrystallized biomicrite, (f-w) pale yellowish brown.
Pebbly arkose,(f-w) grayish pink. Lowest 1 foot is a sandy, pebbly intraclast. Diastem.

Productids (r), spiriferids (r), shell frag. (c).

188' + ~30'

Laminated calcareous sh,(f-w) lt. olive gy., very slightly micaceous.

Arkose, (f) grayish pink, (w) grayish red.

DES MOINESIAN

GARCIA

Upper Member

Laminated calcareous sh, (f-w) lt. olive gy.
Approximately 30 ft. of sh were squeezed out due to folding.

Recrystallized biomicrite, (f) dk. gy., (w) medium gy. to pale yellowish brown; fetid

Composita (a), spiriferids (a), productids (a), crinoid stems (c), bryozoans (r).

Recrystallized biomicrite, (f) dk. gy., (w) medium lt. gy to grayish orange.

Fusulina (a), Fusulinella-Fusulina (?), crinoid stems (r), bryozoans (r), productids (r).

Laminated calcareous sh, bentonitic, (f-w) olive gy.; interbedded with thin recrystallized micrite beds.

Fusulina (a), Wedekindellina (a).

Lower Member

196'

Recrystallized biomicrite grades upward into calcareous arkose.
Laminated calcareous sh, (f-w) dk. gy. with thin beds of recrystallized micrite and feldspathic ss.

Crinoid stems (a), productids (c), spiriferids (c).

Argillaceous recrystallized micrite, laminated, with laminated calcareous sh near top.

Arkose light gy., (w) lt. ? gy.
Sandy crinoidal biomicrite, (f-w) medium gy.
Qtzic. feldspathic ss, (f) pinkish gy., (w) brownish gy.
Biosparite interbedded with dk. gy., laminated calcareous sh.

Crinoid stems (a).

Crinoid stems (c), spiriferids (r), productids (r), Hustedia (r).

Sandy micrite and sandy biointraclast.
Laminated calcareous sh, (f-w) dk. gy.
Calcareous ss grade upward into biomicrite.

WHISKEY CANYON LS.

Crinoidal biomicrite, (f-w) medium gy., fetid.

Recrystallized biomicrite, (f) medium dk gy., (w) grayish orange; fetid.

Fusulina (a), Wedekindellina (a), crinoid stems (a), spiriferids (r), Composita (r), solitary corals (r), bryozoans (r).

99'

Recrystallized fossiliferous micrite with laminated calcareous sh.
Crinoidal biomicrite, (f) medium gy, (w) grayish orange.

Fusulina (c), Wedekindellina (c), Composita (c), crinoid stems (c).

Recrystallized fossiliferous micrite, (f-w) medium gy.
Crinoidal biomicrite, (f-w) medium gy.
Biomicrite, (f-w) lt. gy.
Pelmicrite, (f-w) medium dk. gy.

Crinoid stems (a), Composita (r), productids (c), solitary corals (r).

ELEPHANT BUTTE

Recrystallized argillaceous micrite with interbedded laminated calcareous sh.
biosparite, (f-w) medium dk.
Crinoidal biosparite, (f-w) medium gy.; fetid.
Covered sh (?).

Composita (a), spiriferids (a), bryozoans (a), solitary corals (r).

Crinoidal biosparite, (f) medium dk. gy., (w) grayish orange.

127'

Laminated calcareous sh, (f-w) lt. olive gy.
Recrystallized biomicrite, (f) dusky yellow, (w) grayish orange; fetid.
Covered sh (?).

Crinoid stems (a), Composita (c), Hustedia (c), productids (r), bryozoans (c).

Recrystallized micrite with fossiliferous micrite and intraclast ls.

Productids (r), spiriferids (r), fusulinids (r).

Pebbly pure qtz. ss, (f-w) pinkish gy.
Covered sh (?) with thin beds of crinoidal biosparite, (f) lt. brown-

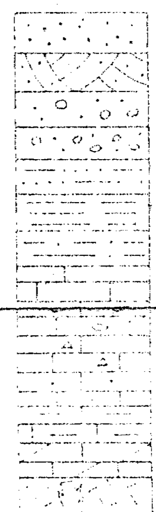
Crinoid stems (.)

PENNSYLVANIAN STRATIGRAPHIC SECTION
SOCORRO, NEW MEXICO

(Measured on the western side of the Amado fault zone, from C to P)

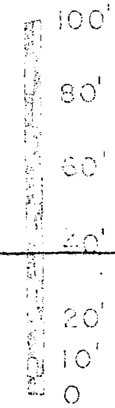
by
Angel Rejas
1965

EXPLANATION

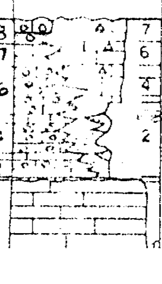


Sandstone
Cross-bedded Ss
Conglomeratic Ss.
Conglomerate
Siltstone
Shale
Silty Sh.
Limestone
Nodular Ls
Cherty Ls.
Sandy Ls.
Argillaceous Ls.
Dolomitic Ls
Leucogranite

Scale: 1" = 50'



(f) = fresh
(w) = weathered
position of fusulinid collections

SYSTEM	SERIES	FORMATION	UNIT	COLUMNAR SECTION	THICKNESS	LITHOLOGY	PALEONTOLOGY
PERMIAN	WOLFCAMP	BURSUM					
						Disconformity	
		MOYA	Upper Member 8 7 6 4 2		7 6 4 2	Recrystallized fossiliferous micrite, (f-w) lt. gy.	Crinoid stems (r), productids (r) *Composita* (r).
						Laminated carbonaceous and calcareous sh grade laterally into recrystallized nodular micrite.	
					77'	Disconformity	
	IL		Member 2			Recrystallized micrite, locally dismicrite, (f-w) lt. gy.	Crinoid stems up to 2cm. in

V
MISSOURI

STORY

DEL CUERTO
Upper Member
Middle Member
Lower Member

Arkose,(f)pale ..., (w)lt. brown. Slump structure.
Sandy micrite grading upwards into arkose.

56'

Crinoidal biosparite,(f-w) lt. gy. to lt. brownish gy.
Calcareous arkose,(f)lt. gy.,(w) moderate brown.
Covered sh (?)

Crinoid stems (a), shell frag. (r).

Upper LS Member
Lower Clastic Member

Biomicrosparite,(f)very lt. gy.,(w)pinkish gy.
Crinoidal biomicrite,(f)medium dk. gy.,(w) lt. gy.
Laminated calcareous sh,(f-w) grayish red.

39'

Silicified crinoid stems (a), Composita (r).

Arkose,(f) lt. gy.,(w) pale brown.

BURREGO

Fossiliferous dismicrite,(f)medium gy.,(w) lt. olive gy.
Recrystallized micrite interbedded with thin beds of laminated argillaceous sh (f-w) brown, higly micaceous.
Dismicrite,(f) medium dk. gy.,(w) lt. gy.
Covered sh (?).
Arkose,(f) greenish gy.,(w)lt. brownish gy.

85'

Fusulinids (r), crinoid stems(r)

Fossiliferous micrite,(f) medium dk. gy.,(w)moderate yellowish brown.
Laminated calcareous sh interbedded with thin calcareous siltstone and micrite beds.

Algae (r).

COUNCIL SPRING

Fossiliferous micrite,(f-w) medium gy.;local biohermite.
Laminated calcareous sh with thin recrystallized micrite beds.

19'

ADOBE-COANE UNDIFFERENTIATED

Recrystallized micrite with laminated calcareous sh.
Recrystallized biomicrite,(f-w) lt. olive gy.

Crinoid stems (a), large productids (c), spiriferids (r).

Laminated calcareous sh,(f-w)olive gy.,with thin micrite beds.
Micrite,(f) medium dk. gy.,(w) lt. gy.

Laminated calcareous sh,(f) olive gy.,(w) very lt. gy., with a few thin beds of dk. gy. nodular micrite.

Dismicrite, (f) medium gy., (w) lt. gy.
Micrite, (f) olive gy.,(w) lt. olive gy.
Pelmicrite, (f)medium lt. gy.,(w)moderate yellowish brown.
Crinoidal biomicrite interbedded with biomicrite...

Composita (c),crinoid stems(a), spiriferids (c).

Laminated calcareous sh, (f)olive gy.,(w) lt. olive gy.

Pelmicrite interbedded with micrite.
Algal biogenic ls, (f-w) medium gy.

299'

Algae (a).

Recrystallized fossiliferous micrite,(f)medium dk. gy.,(w) very pale orange.

Productids (r).

Laminated calcareous sh,(f)lt. olive gy.,(w)lt. brownish gy.

Recrystallized micrite,laminated,(w) banded lt. brownish gy. and dk. gy.,slightly fetid; penecontemporaneous deformation. A thin recrystallized biomicrite bed at top.

Spiriferids (c),productids(c), crinoid stems (r).

Covered sh (?).
Algal biomicrosparite, (f-w) medium gy.

Algae nuclei (a).

Micrite,(f-w) grayish black.
Laminated calcareous sh with interbedded sandy fossiliferous micrite

Crinoid stems (r).

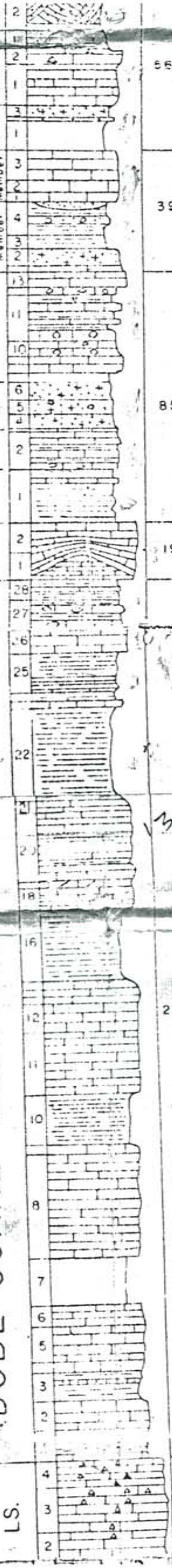
Recrystallized micrite with thin laminae of reddish sh.
Laminated calcareous sh,(f-w) medium dk. gy. with thin-bedded micrite, fetid.

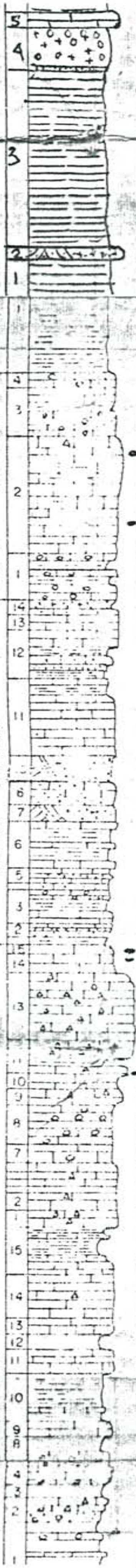
AMADO LS.

Recrystallized biomicrite,(f)medium dk. gy.,(w) grayish orange.
Crinoidal biomicrite,(f)medium lt. gy.,(w)medium gy.
Recrystallized biomicrite,(f)dk. gy.,(w)medium lt. gy.;medium-bed-

35'

Crinoid stems (a),bryozoans(a), productids(a).
Composita (c).

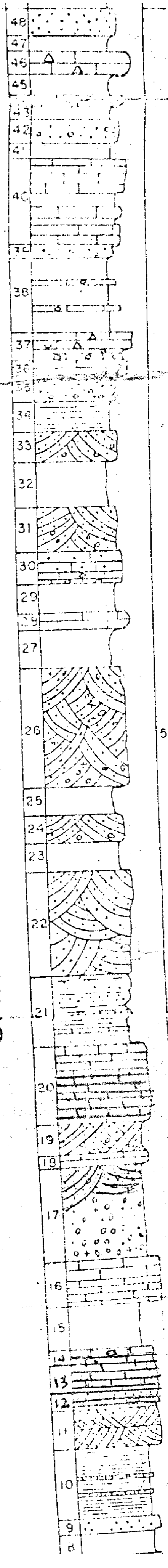




PENNSYLVANIAN, BARTOLO		Recrystallized biomicrite, (f-w) pale yellowish brown.	Productids (r), spiriferids (r), shell frag. (c).
	188'	Pebbly arkose, (f-w) grayish pink. Lowest 1 foot is a sandy, pebbly intraclast. Diastem.	
	130'	Laminated calcareous sh, (f-w) lt. olive gy., very slightly micaceous.	
		Arkose, (f) grayish pink, (w) grayish red.	
DES MOINES, GARCIA		Laminated calcareous sh, (f-w) lt. olive gy. Approximately 30 ft. of sh were squeezed out due to folding.	
GARCIA, Upper Member		Recrystallized biomicrite, (f) dk. gy., (w) medium gy. to pale yellowish brown; fetid	[illegible]mposita (a), spiriferids (a), [illegible]r[illegible]ucti[illegible]s (a), crinoid stems (c), bryozoans (r).
		Recrystallized biomicrite, (f) dk. gy., (w) medium lt. gy. to grayish orange.	[illegible]usulina (a), Fusulinella-Fusulina (?), crinoid stems (r), bryozoans (r), productids (r). Fusulina (a), Wedekindellina (a).
		Laminated calcareous sh, bentonitic, (f-w) olive gy.; interbedded with thin recrystallized micrite beds.	
GARCIA, Lower Member		Recrystallized biomicrite grades upward into calcareous arkose.	Crinoid stems (a), productids (c), spiriferids (c).
	196'	Laminated calcareous sh, (f-w) dk. gy. with thin beds of recrystallized micrite and feldspathic ss.	
		Argillaceous recrystallized micrite, laminated, with laminated calcareous sh near top.	
		Arkose light gy., (w) lt. ? gy.	
		Sandy crinoidal biomicrite, (f-w) medium gy.	Crinoid stems (a).
		Qtzic. feldspathic ss, (f) pinkish gy., (w) brownish gy.	
		Biosparite interbedded with dk. gy., laminated calcareous sh.	Crinoid stems (c), spiriferids (r), productids (r), Hustedia (r).
		Sandy micrite and sandy biointraclast.	
		Laminated calcareous sh, (f-w) dk. gy.	
		Calcareous ss grade upward into bio micrite.	
WHISKEY CANYON LS.		Crinoidal biomicrite, (f-w) medium gy.; fetid.	Fusulina (a), Wedekindellina (a), crinoid stems (a), spiriferids (r), Composita (r), solitary corals (r), bryozoans (r).
		Recrystallized biomicrite, (f) medium dk gy., (w) grayish orange; fetid.	
	99'	Recrystallized fossiliferous micrite with laminated calcareous sh.	
		Crinoidal biomicrite, (f) medium gy, (w) grayish orange.	Fusulina (c), Wedekindellina (c), Composita (c), crinoid stems (c).
		Recrystallized fossiliferous micrite, (f-w) medium gy.	
		Crinoidal biomicrite, (f-w) medium gy.	Crinoid stems (a), Composita (r), productids (c), solitary corals (r).
		Biomicrite, (f-w) lt. gy.	
		Pelmicrite, (f-w) medium dk. gy.	
ELEPHANT BUTTE		Recrystallized argillaceous micrite with interbedded laminated calcareous sh.	
		biosparite, (f-w) medium dk.	Composita (a), spiriferids (a), bryozoans (a), solitary corals (r).
		Crinoidal biosparite, (f-w) medium gy.; fetid.	
		Covered sh (?).	
		Crinoidal biosparite, (f) medium dk. gy., (w) grayish orange.	Crinoid stems (a), Composita (c), Hustedia (c), productids (r), bryozoans (c).
		Laminated calcareous sh, (f-w) lt. olive gy.	
	127'	Recrystallized biomicrite, (f) dusky yellow, (w) grayish orange; fetid.	
		Covered sh (?).	
		Recrystallized micrite with fossiliferous micrite and intraclast ls.	Productids (r), spiriferids (r), fusulinids (r).
		Pebbly pure qtz. ss, (f-w) pinkish gy.	
		Covered sh (?) with thin beds of crinoidal biosparite, (f) lt. brownish gy., (w) moderate yellow brown.	Crinoid stems (a).

DERRY

SANDIA



Feldspathic ss, (f) very lt. gy., (w) yellowish gy.
Covered sh (?).
Recrystallized micrite, (f) medium dk. gy., (w) medium gy.
?—sh (?).
Recrystallized fossiliferous micrite, (f-w) medium gy. — Crinoid stems (r).
Pure qtz. qtztic ss, (f) lt. gy., (w) pale red; pebbly.
Recrystallized fossiliferous micrite, (f-w) medium lt. gy. — Large solitary corals (r), crinoid stems (r).

Recrystallized fossiliferous micrite, (f-w) medium lt. gy.
Pebbly pure qtz. ss, (f-w) medium lt. gy.

Covered sh (?) with thin beds of recrystallized micrite.

Recrystallized micrite, (f-w) medium lt. gy.
Recrystallized fossiliferous micrite, (f-w) medium gy. — Crinoid stems (r), shell frag.
Pebbly pure qtz. ss, (f-w) medium lt. gy.
Laminated siliceous sh, (f-w) lt. olive gy.
Pure qtz. qtztic. ss, (f) lt. olive gy., (w) brownish gy.; pebbly.

Covered sh (?).

Pebbly pure qtz. ss, (f-w) lt. brownish gy.
Sandy biosparite, (f-w) lt. olive gy. — Crinoid stems (a), *Composita* (c)
Covered sh (?).
Crinoidal biogenic ls, (f-w) lt. brownish gy. — Crinoid stems (a), *Composita* (r), shell frag. (r).

Covered sh (?).
Pure qtz. ss, (f-w) medium lt. gy.

580' Qtztic. arkose, (f-w) pale brown. Graded bedding. Pebbly.
Pebbly pure qtz. ss, (f-w) lt. brownish gy.
Covered sh (?).

Pebbly pure qtz. ss, (f-w) pale red.
Covered sh (?).

Pure qtz. qtztic. ss. (f-w) medium lt. gy.

Laminated calcareous sh, (f-w) lt. olive gy., with interbedded pure qtz. qtztic. ss and argillaceous biomicrite showing cone-in-cone structure. — Productids (c), crinoid stems (s)

Fossiliferous recrystallized micrite, (f-w) lt. olive gy. — Productids (r), spiriferids (r).

Pebbly feldspathic ss, (f-w) pinkish gy. — Crinoid stems (a).
Crinoidal biogenic ls, (f-w) grayish orange.

Qtztic. feldspathic ss, (f-w) pinkish gy.; pebbly.
Feldspathic cobble conglomerate, (f-w) pinkish gy. — Crinoid stems (a), productids (r), spiriferids (r), shell frag. (r).

Crinoidal biogenic ls. (f-w) lt. brownish gy.

Covered sh (?). — Crinoid stems (a), shell frag. (c)

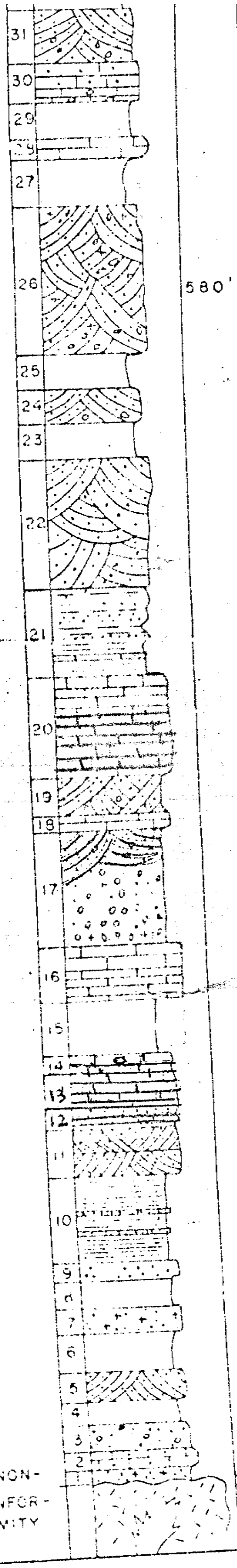
Crinoidal biosparite, (f-w) pale yellowish brown.
Qtztic. feldspatic ss, (f-w) medium gy.
Quartzite, (f) lt. pinkish gy, (w) medium gy.

Laminated calcareous sh (f-w) pale yellowish brown, with thin beds of sandy biointraclast. — Crinoid stems (a), *Hustedia* (c), productids (c).
Feldspathic ss, (f) pinkish gy., (w) grayish red.
Covered sh (?).
... (f-w) pinkish gy.

DERRY

SANDIA

580'



Pebbly pure qtz. ss, (f-w) lt. brownish gy.
Sandy biosparite, (f-w) lt. olive gy. — Crinoid stems (a), Composita (c)
Covered sh (?).
Crinoidal biogenic ls, (f-w) lt. brownish gy. — Crinoid stems (a), Composita (r), shell frag. (r).

Covered sh (?).
Pure qtz. ss, (f-w) medium lt. gy.

Qtztic. arkose, (f-w) pale brown. Graded bedding. Pebbly.
Pebbly pure qtz. ss, (f-w) lt. brownish gy.
Covered sh (?).

Pebbly pure qtz. ss, (f-w) pale red.
Covered sh (?).

Pure qtz. qtztic. ss. (f-w) medium lt. gy.

Laminated calcareous sh, (f-w) lt. olive gy., with interbedded pure qtz. qtztic. ss and argillaceous biomicrite showing cone-in-cone structure. — Productids (c), crinoid stems (s)

Fossiliferous recrystallized micrite, (f-w) lt. olive gy. — Productids (r), spiriferids (r).

Pebbly feldspathic ss, (f-w) pinkish gy.
Crinoidal biogenic ls, (f-w) grayish orange. — Crinoid stems (a).

Qtztic. feldspathic ss, (f-w) pinkish gy.; pebbly.
Feldspathic cobble conglomerate, (f-w) pinkish gy. — Crinoid stems (a), productids (r), spiriferids (r), shell frag. (r).

Crinoidal biogenic ls. (f-w) lt. brownish gy.

Covered sh (?).

Crinoidal biosparite, (f-w) pale yellowish brown. — Crinoid stems (a), shell frag. (c)
Qtztic. feldspathic ss, (f-w) medium gy.
Quartzite, (f) lt. pinkish gy, (w) medium gy.

Laminated calcareous sh (f-w) pale yellowish brown, with thin beds of sandy biointraclast. — Crinoid stems (a), Hustedia (c), productids (c).
Feldspathic ss, (f) pinkish gy., (w) grayish red.
Covered sh (?).
Arkose, (f-w) pinkish gy.
Slope covered with alluvium.
Quartzite, (f) medium gy, (w) dusky red.
Covered quartzite (?).
Chert conglomerate, (f-w) dk. brownish red. Sandy micrite. Arkose.

NON-CONFORMITY — Nonconformity.

PRE-PENN

Leucogranite.