STRUCTURAL GEOLOGY AND SEDIMENTOLOGIC ANALYSIS
(LAS VIGAS FORMATION), SIERRA SAN IGNACIO,
CHIHUAHUA, MEXICO

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STRUCTURAL GEOLOGY AND SEDIMENTOLOGIC ANALYSIS (LAS VIGAS FORMATION), SIERRA SAN IGNACIO, CHIHUAHUA, MEXICO

by

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THESIS

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ABSTRACT

Sierra San Ignacio is composed of folded and faulted Lower Cretaceous sandstones, limestones, and mudrocks. Three formations were identified within the study area: 1) Las Vigas Formation, consisting of 805 m (2641 ft) of interbedded sandstones, siltstones, and silty limestones; 2) Cuchillo Formation, composed of 724 m (2375 ft) of interbedded limestone, sandy limestone, and shale; and 3) Benigno Formation, characterized by a massive, rudistid-bearing limestone which is 55 m (180 ft) thick. The total thickness of Cretaceous rocks within the study area is 1584 m (5196 ft). Basalt to andesite dikes (Tertiary(?)), approximately vertical and trending N40°E, cross-cut the pre-existing Cretaceous rocks.

A general depositional setting dominated by lacustrine and/or shallow marine conditions is interpreted for rocks of the Las Vigas Formation. Fossil content, associated lithologies, and regional facies relations suggest that at various times both marine and non-marine conditions existed in the basin. The lower member of the Las Vigas Formation is interpreted as being deposited along a low- to moderate-energy barred coastline. The upper member represents a quieter, lower energy environment where deposition took place in deeper water or under restricted conditions.

Large, asymmetrical, overturned folds are the most striking structural feature found within Sierra San Ignacio. These Laramide age folds have accommodated 27 percent shortening across the study area. N40°E trending faults are a second major structural element found in the

range. These faults cross-cut the major folds and were probably formed in the latest stages of fold evolution or during a later NW-SE extensional event. A Basin and Range and/or Rio Grande rift related N35°W fault set is the most recent structural element expressed in the area and clearly post-dates both the folding and N40E fault set.

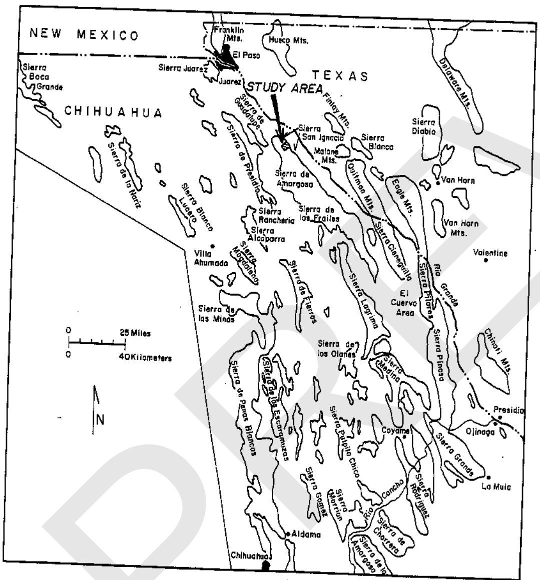
TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES



Modified after Haenggi (1966)

Figure 1 Index map of northeastern Chihuahua, Mexico.

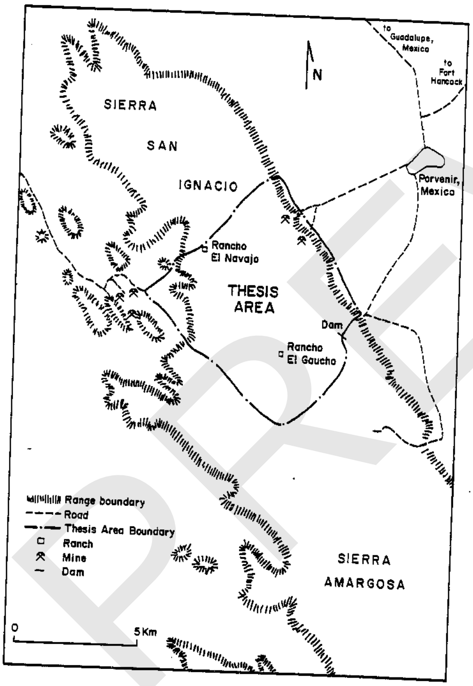


Figure 2 Location map of Sierra San Ignacio.

northeastern boundary lies about 10 kilometers (6 miles) southwest of Porvenir, Mexico (Fig. 2). The thesis area lies approximately 104 kilometers (65 miles) southeast of El Paso, Texas (Plate V).

Sierra San Ignacio covers an area of approximately 109 square kilometers (42 square miles). The highest elevation within the range is 1805 m (5855 ft) and the highest elevation within the study area is 1710 m (5558 ft). The maximum relief within the study area is 510 m (1657 ft).

Three unimproved dirt roads provided the principal access to the area. Two of these roads run southwest from Porvenir, Mexico. The other originates near a small airport 5 kilometers southeast of Guadalupe, Mexico along Chihuahua Highway 2, and provides access to the southwestern side of the range. The Fort Hancock, Texas border crossing provides the closest access from the United States, however, the Fabens, Texas crossing was used when work was done on the southwestern side of the range.

Method of Investigation

The primary method of data collection for this thesis was field mapping on a 1:12,500 topographic base and analysis of four measured sections. Topographic maps were obtained by enlargement of 1:50,000 scale DETENAL topographic sheets of the Porvenir, Mexico quadrangle. While air photos of the region were available, their scale (1:70,000) makes them of limited value except for broad statements on regional structural trends. Stratigraphic sections were measured in the study

area using a Jacob staff and Brunton compass. These sections provided both stratigraphic guides for field mapping and data for determination of general depositional settings for formations present, particularly the Las Vigas Formation. Data such as lithology, thickness, fossil content, sedimentary structures, and bed geometry were collected during measurement and description of stratigraphic sections. Bedding thicknesses follow the classification of Ingram (1954) and 20 degrees was selected as an arbitrary cutoff between low-angle and high-angle cross-beds.

Strike and dip information was collected by use of a Brunton compass and clinometer. These data were then located and plotted on a base map. Pace and compass was the primary method of location determination since map accuracy and contour interval (20 meters) prevented the use of more accurate methods. Colors used in rock descriptions follow the GSA rock color chart (Goddard, et al.,1980).

Field work was conducted primarily in the late summer of 1983 and was completed in November of 1984.

Geologic Setting

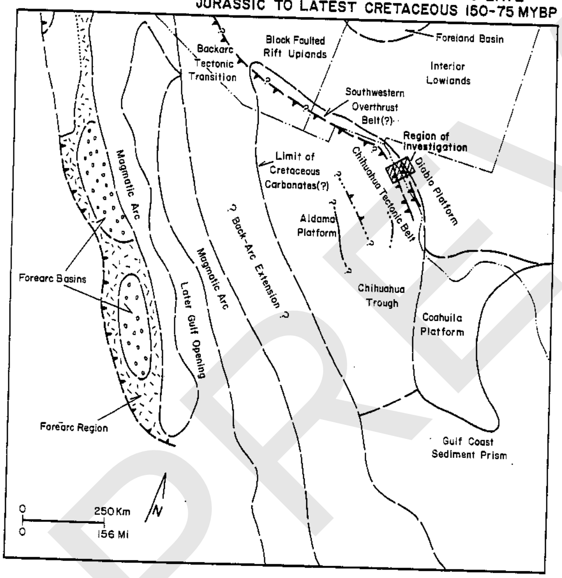
Sierra San Ignacio lies in the southeastern portion of the Basin and Range Province, along the northeastern margin of the Chihuahua Tectonic Belt (Fig. 3). The range is dominated by interbedded Cretaceous sandstones, carbonates, and mudrocks. These sedimentary rocks were deposited in a northwest-southeast trending basin called the Chihuahua Trough which may represent a Late Jurassic - Early Cretaceous

arm of the Gulf of Mexico (Dickinson, 1981). A Late Jurassic marine transgression and a Middle Cretaceous regression resulted in the deposition of 3650 - 6400 m (12,000 - 21,000 ft) of sedimentary rocks within the subsiding basin (Gries and Haenggi, 1970). This thickness is in distinct contrast to the 850 m (2800 ft) of sedimentary rock on the Diablo platform, which flanks the trough on the northeast (Gries and Haenggi, 1970). The Aldama Platform forms the southwestern boundary of the trough (Fig. 3).

In Late Cretaceous, and continuing into the Middle Tertiary, contractual deformation "swept" across the southern Cordillera (Dickinson, 1981). This Laramide age deformation included large scale west and northwest trending thrust faults, complex folding, and arc magmatism. This deformation is thought to be the result of subduction of the Farallon plate along the west coast of North America. Changes in the subduction angle has been used to account for the differences in timing of these events in western North America (Coney and Reynolds, 1977; Coney, 1978; Dickinson and Snyder, 1979). The structural style of this deformation is still, however, controversial. Drewes (1978) feels the thrusting is regional in nature and is a type of "thin skin" tectonics. Transport distances on the order of 100-200 km (63-125 mi) are postulated on a regional decollment between Precambrian basement and overlying rock of Paleozoic and Mesozoic age. Davis (1979), on the other hand, suggests that many of the thrusts found in southeastern Arizona and southwestern New Mexico are associated with basement-cored uplifts. In this case, the vergence and timing of the thrust faults would be controlled by local uplift rather than a regional detachment surface.

Figure 3

TECTONIC SETTING FROM MIDDLE TO LATE JURASSIC TO LATEST CRETACEOUS 150-75 MYBP



Modified after Dickinson (1981)

Based on work in southern Arizona, Dickinson (1984) has cast some doubt on the regional applicability of a "thin skin" hypothesis. Drewes (1978) points out, however, that post-orogenic tectonic events cause many problems in a regional synthesis. If the thrust belt of western North America can be carried across southern Arizona and New Mexico, then Sierra San Ignacio falls on the southeastward continuation of the North American Cordillera postulated by Drewes (1978).

From Oligocene to Recent the region has been subjected to Basin and Range type extensional faulting which has overprinted many of the pre-existing Mesozoic structures, and probably accounts for the present topography of the region. An escarpment along the eastern side of Sierra San Ignacio offsets Quaternary(?) gravels approximately 5 m (16 ft) which substantiates that faulting is still active. Tertiary age basalt-andesite dikes are also present near and within the study area and crosscut the preexisting Laramide age structures.

In late Pliocene to late Pleistocene, alluvial and lacustrine terraces were developed along the margins of the present day Rio Grande drainage. A variety of depositional environments characterize these deposits, ranging from braided-meandering systems to lacustrine facies (Riley, 1984).

The most recent geologic events in the area are the continued fill of the Hueco Bolson to the east of Sierra San Ignacio, and the active downcutting and erosion by the Rio Grande river.

Previous Work

Previous work in the immediate vicinity of Sierra San Ignacio is sparse and limited to one stratigraphic study by Caire (1966). His work consisted of seven measured sections encompassing each of the seven Cretaceous formations cropping out within the area. However, due to the great thickness of the exposed section (2300+ m), the detail presented is quite limited. His report also contains a brief statement on the structural geology and depositional environments of formations present. PEMEX (Petroleos Mexicanos) geologists have also reportedly measured several sections within the range, but the data is unpublished at this time.

A regional map compiled by Navarro and Tovar (1975) includes Sierra San Ignacio, but the scale (1:350,000) offers no significant detail. The map does, however, reveal the presence of Cretaceous strata and delineates several of the major folds axes in the area.

While only limited work has been conducted in the immediate vicinity of Sierra San Ignacio, other studies in the surrounding ranges have proved helpful, especially in regards to identifying stratigraphic relationships and structural styles. Table 1 presents several of the more pertinent investigations in Trans-Pecos Texas and northern Chihuahua.

Table 1 Previous Work in the Vicinity of Sierra San
Sierra San Ignacio, Chihuahua, Mexico

Location and Author		Type of Work
Eagle Mountains		
	Underwood (1962)	Structural and Stratigraphic
	Reaser and Underwood (1975)	Structural
El Cuervo Area		
	Haenggi (1966)	Structural and Stratigraphic
Hueco Bolson		
	Uphoff (1978)	Structural and Geophysical
Malone Mountains		
	Berge (1984)	Structural and Geophysical
Quitman Mountains		
	Campbell (1968, 1970, 1980)	Petrology and Depositional Environments
	Jones (1968)	General Geology
	Jones and Reaser (1970)	General Geology
	Reaser (1982)	Structure
Sierra Blanca Area		
	Albritton and Smith (1965)	General Geology
Sierra Juarez		
	Cordoba (1968)	Structural and Stratigraphic
	Wacker (1972)	Structural and Stratigraphic
	Swift (1972)	Stratigraphic
	Campuzano (1973)	Structural and Stratigraphic
	Wagner (1975)	Stratigraphic
	Nodeland (1977)	Structural
	Lovejoy (1980)	Structural and Stratigraphic
Sierra Presidio		
	Haulenbeek (1970)	Structural and Stratigraphic