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PREVIEW

PETROGRAPHY OF THE WESTERN PORTION OF THE JURQUIPA STOCK,

NACUZARI, SONORA

by

Leonard C. Bolich

Thesis

Presented to the Faculty of the
DEPARTMENT OF GEOLOGICAL SCIENCES

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

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NACUZARI, SONORA

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A C K N O W L E D G E M E N T S

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A B S T R A C T

A granitic stock, Early to Middle Tertiary(?) in age, is located eighteen kilometers southeast of the town of Nacozari de Garcia in northeastern Sonora. It crops out over an area of about 30 sq km (12 sq mi) in the northeast portion of the Juriquipa Mountains. Quartz monzonite and granite make up over 80 percent of the western portion of the stock. These rocks are intruded by quartz monzonite porphyry plugs and smaller alaskite, pegmatite, and biotite dacite porphyry bodies and dikes in the study area.

Tertiary(?) volcanics are in contact nonconformably with quartz monzonite along the northern edge of the intrusive rocks. The undifferentiated volcanic sequence is composed of andesite, rhyolite, and latite flows with interbedded conglomerates. Elsewhere, the stock intrudes an 'older' (possibly Cretaceous) sequence of andesite overlain by volcanic breccias.

Rocks exposed in the study area are both hydrothermally and deuterically altered, including propylitic, argillic, siliceous, sericitic, and limonitic types of alteration. Scattered throughout the western portion of the stock are several small mines and prospects. Copper, molybdenum, and trace amounts of silver have been mined from deposits located on breccia structures adjacent to the stock, and from small pegmatite and hydrothermal vein deposits within the stock.

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I N T R O D U C T I O N

GEOGRAPHIC SETTING

The Nacozari district is located in northeastern Sonora, Mexico, about 107 km (67 mi) due south of Douglas, Arizona on the international boundary. The district embraces approximately 1,150 sq km (450 sq mi). Nacozari de Garcia (pop. 3,000) is located near the center of the district; its geographic coordinates are lat 30°21'25" N.; long 109°41'28" W.

Nacozari is connected with Agua Prieta, Sonora, and Douglas, Arizona by a railroad 123 km (76 mi) long which terminates at Nacozari, and by an unsurfaced road. Access from the south is by an unsurfaced road from Hermosillo, the state capital of Sonora, 250 km (155 mi) to the southwest (Fig. 1). Cananea, 92 km (57 mi) to the northwest is accessible by a poorly maintained unsurfaced road via the small town of Bacoachi.

The study area, 16.5 km (10.2 mi) south 30° east of Nacozari, covers approximately 10 sq km (3.9 sq mi) of the western portion of the Juriquipa Stock.* The total outcrop area of this stock is about 30 sq km (11.6 sq mi). Access to the study area from Nacozari is by two unsurfaced roads; one by way of Santo Domingo [27 km (16.8 mi)] the other, a new road by-passing Pilares [25 km (15.5 mi)] (Fig. 4).

*Named by the writer.

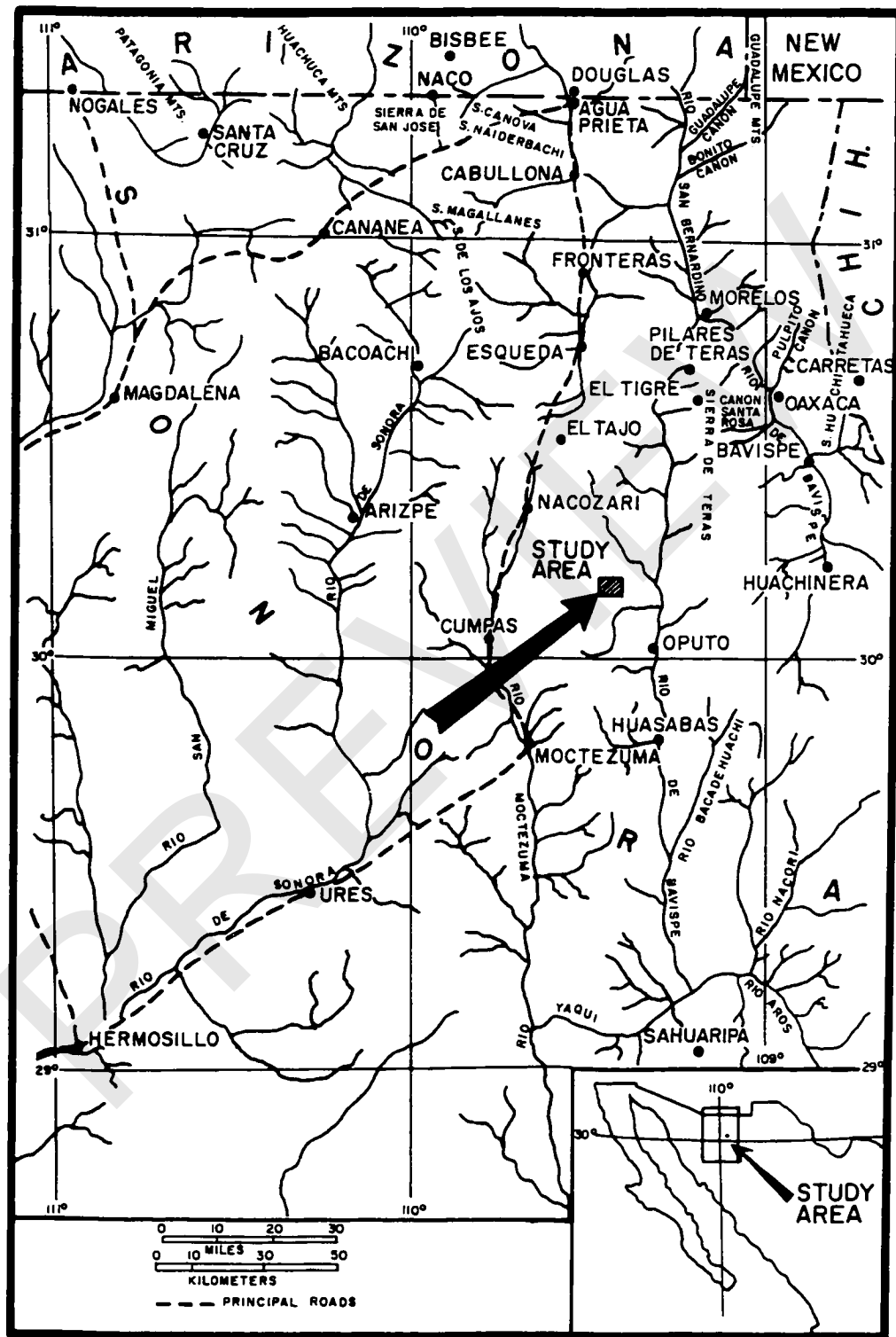


FIGURE 1.- INDEX MAP OF NORTHEASTERN SONORA SHOWING STUDY AREA.
(MODIFIED FROM R.W. IMLAY, 1939, p.1726)

PHYSIOGRAPHY

The Nacozari district lies within the physiographic province of Parallel Ranges and Valleys as defined by King, (1939) and Imlay, (1939).

This province is characterized by north-northwest trending mountain ranges separated by parallel intermontane valleys (King, 1939, p. 1635); it is 80 km (55 mi) to 120 km (75 mi) wide. The mountains are interpreted as blocks produced by normal faulting, or in some instances by high angle thrust faulting (Imlay, 1939, p. 1725). The province is bounded on the east by a nearly continuous line of west-facing escarpments located east of the towns of Huachinera, Bavispe, and Oaxaca; its western boundary roughly parallels the Sonora River Valley north of the 29° parallel (Fig. 1) (King, 1939, p. 1636 and Imlay, 1939, p. 1725). The northern limit is about 40 km (25 mi) south of the international boundary in the northern Sierra de Los Ajos (Fig. 1) (Imlay, 1939, p. 1727); it extends southward nearly to the Fuerte River, 40 km (25 mi) south of the Sonora-Sinaloa state line.

The Bavispe River, a tributary of the Yaqui River (Fig. 1), drains the area studied. Most of the streams are intermittent, although stretches of the Guadalupe and Corral de Piedras Arroyos flow most of the year. All tributary streams are youthful and occupy narrow arroyos with steep gradients. The general drainage pattern is dendritic.

All of the study area is mountainous and rugged (Plate I). The peaks and ridges in the northeastern portion of the area lack the ruggedness of those in the southwestern portion because of the differing resistance to weathering of the granitic rocks. The maximum relief in the study area is about 915 m (3,000 ft). This difference is measured

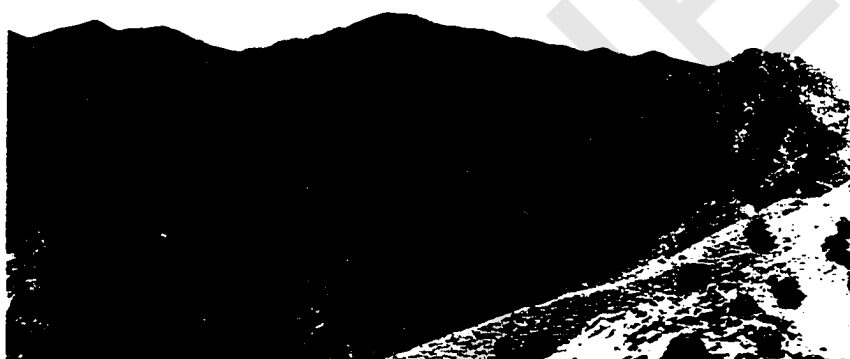


Plate I. View looking southwest across Guadalupe Arroyo into study area. Highest point on skyline is peak No. 17.

from peak No. 17, the highest point at an elevation of 1,887 m (6,190 ft) to the lowest point at the junction of the Guadalupe and Corral de Piedras Arroyos where the elevation is 975 m (3,200 ft) (Fig. 3). The average relief between the ridges and the adjacent arroyos is 300 m (1,000 ft). The highest peak in the Nacozari district, locally called 'Sierra de Juriquipa' and/or 'Cerro de Los Mantos', is located 3.2 km (2 mi) south 37° east of peak No. 17, and has an elevation of approximately 2,193 m (7,195 ft).

The climate of the Nacozari area is semiarid. Daytime temperatures during the summer months are commonly more than 35°C (95°F), and temperatures as low as -5°C (21°F) have been recorded in the winter months. The mean annual temperature is 25°C (72°F). The annual rainfall for the area is 460 mm (18 in), most of which falls in thundershowers in July, August, and September.

The lower mountain slopes in the area are timbered with small oak trees; at higher elevations, the Chihuahuan pine predominates. Ocotillo, maguey, sotol, beargrass, and other desert plants grow on the lower slopes and in the valleys.

PREVIOUS WORK

Only a few geological studies and investigations of mineral deposits in the Nacozari district have been published and the majority of these concern the Los Pilares mine. In 1906, S. F. Emmons described the Los Pilares mine, and the same mine was briefly described by Lindgren (1913) and by W. H. Emmons (1917). Wade and Wandtke's (1920) detailed report on the Pilares mine included a generalized geologic map of the Nacozari district. Wandtke (1925) discussed the geology and

mineral deposition of the Caridad mine. Locke (1926) discussed the formation of the Pilares ore body by mineralization stoping. R. E. King (1939) and R. W. Imlay (1939) made extensive geologic studies in southern and northeastern Sonora; Imlay's work included part of the Nacozari district. Carl Fries (1962), in his work on the Paleozoic of Sonora, briefly mentioned some Paleozoic rocks occurring near the Nacozari district. More recently, A. Chiapa (1968) and A. Nasser (1968), wrote 'professional' theses on two mines (the Bella Union and La Nueva Lily respectively) located within the Nacozari district. Several other investigations of mining properties in the district have not been published. No detailed geologic reports have been made previously in the area of the Juriquipa Stock.

PURPOSE AND SCOPE

The purpose of this investigation was to study the petrographic and petrogenetic relationships of the western portion of the Juriquipa Stock and briefly describe the small mines within the study area.

The field work, done during the summer of 1968, consisted of reconnaissance mapping on a topographic base map and collecting samples for thin sectioning. The area was covered only in a reconnaissance manner because of its size, ruggedness, and general inaccessibility. Laboratory studies were made during the winter and spring of 1969 at The University of Texas at El Paso.

Samples of igneous rocks were collected from 175 localities; 99 samples were studied in thin section. Only those samples from locations discussed in this paper are shown in Figure 3.

Zonal boundaries, mines and prospects, and sample localities were located with a Brunton Compass by triangulation methods on 8 1/2" by 11" topographic field sheets of a scale 1:4,000; these data were later transferred to an office map of the same scale. The topographic base map was made from aerial photographs by Compania Minera Nacozari in 1967.

PREVIEW

G E O L O G Y

GENERAL GEOLOGY OF THE NACOZARI DISTRICT

The Nacozari district is located in the northwestern portion of the extensive volcanic field which covers a large area in northern Mexico and southwestern United States. The dominant rock types in the district are acidic volcanic flows, tuffs, and breccias. These volcanic rocks and fragmentals are probably Late Cretaceous and Early Tertiary because similar volcanic rocks of these ages crop out in southern Arizona (Hayes and Drewes, 1968). The extrusive sequence is intruded by several plutons, many of which are probably Middle and Late Tertiary in age. Some of the intrusions are exposed throughout the district as stocks of granite, quartz-monzonite, and granodiorite. Dikes and small irregular bodies of alaskite, pegmatite, dacite, and diabase are commonly associated with the larger intrusions.

In the Sierra Coppercuin area, 3 km (2 mi) northwest of Nacozari (Fig. 4), a pre-volcanic series of siliceous limestones and dolomites with interbedded quartzite of Late Paleozoic (possibly Permian) age is present (Nasser, 1968, and W. N. McAnulty, Jr., 1969, written communication). McAnulty observed a composite pluton of predominantly quartz-monzonite intruding these sedimentary rocks. He has tentatively distinguished two series of volcanic rocks in the Coppercuin area. The older series, consisting of andesite and latite flows with associated silicified tuffs and sandstones, may possibly have a Late Cretaceous age. The younger volcanic series is Tertiary in age, and it is composed of massive basal flows of rhyolite and latite overlain by thick andesite flows with interbedded andesitic and latitic tuffs. These are in fault contact with the marine sedimentary rocks and a composite pluton.