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TERTIARY VOLCANICS OF THE WESTERN EAGLE MOUNTAINS, HUDSPETH COUNTY, TEXAS

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INTRODUCTION

Location and Geologic Setting

The Eagle Mountains are located in western Trans-Pecos Texas approximately 15 km southwest of Van Horn. They are bounded on the east by the Eagle Flat Bolson and to the west by the Red Light Draw Bolson (fig. 1).

The Eagle Mountains are a northwest-trending range approximately 27 km long and 10 km wide. The central part of the range is composed of Tertiary ash-flow tuffs and lavas which encircle an intrusive plug. The igneous rocks are surrounded primarily by Cretaceous clastic and carbonate rocks. Paleozoic and Precambrian rocks crop out at the northeastern margin of the range.

The range lies within a northwest-trending belt of volcanic centers in West Texas, just south of the northern Quitman cauldron. This zone of volcanic rocks is approximately coincident with the northeastern boundary of the Chihuahua Tectonic Belt. Most of these volcanic centers have been referred to as resurgent cauldrons of Oligocene age (31 to 36 m.y.) (McAnulty, 1976).

Previous and Current Work

Gillerman (1953) mapped the igneous rocks of the central Eagle Mountains and described the economic potential of the fluorspar deposits. He differentiated three volcanic units, all lava flows, and referred to them as the "lower rhyolite," "trachyte porphyry" and "upper rhyolite." Underwood (1962, 1963, 1975) mainly studied the sedimentary rocks and structure of the Eagle Mountains, and he employed Gillerman's volcanic divisions and nomenclature. Chemical data for the volcanic and intrusive rocks of the range have been reported by Tieh and others (1975).

In 1978 students from the Department of Geological Sciences, University of Texas at El Paso, began an extensive study of the volcanic geology of the Eagle Mountains. Preliminary results of the study indicate that the majority of the extrusive rocks are ash-flow tuffs and that the volcanic units can be redefined and subdivided into members based upon field relationships such as recognition of air fall, tuff and breccia units and the presence of cooling units, and petrography.

This paper summarizes the work in the western half of Eagle Mountains completed by Legett (1979) and Verrillo (1979) under the direction of J. M. Hoffer. The investigation of the volcanics in the eastern Eagles is still in progress.

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VOLCANIC STRATIGRAPHY

Introduction

The stratigraphy of the volcanic sequence exposed in the Eagle Mountains is shown in Table 1 (Legett, 1979; Verrillo, 1979).

The "lower rhyolite" has been informally renamed the Carpenter Canyon tuff after a complete section exposed in Carpenter Canyon in the northeast Eagle Mountains. The unit is composed mainly of rhyolitic ash flow tuff with minor ash fall and tuffaceous sand-

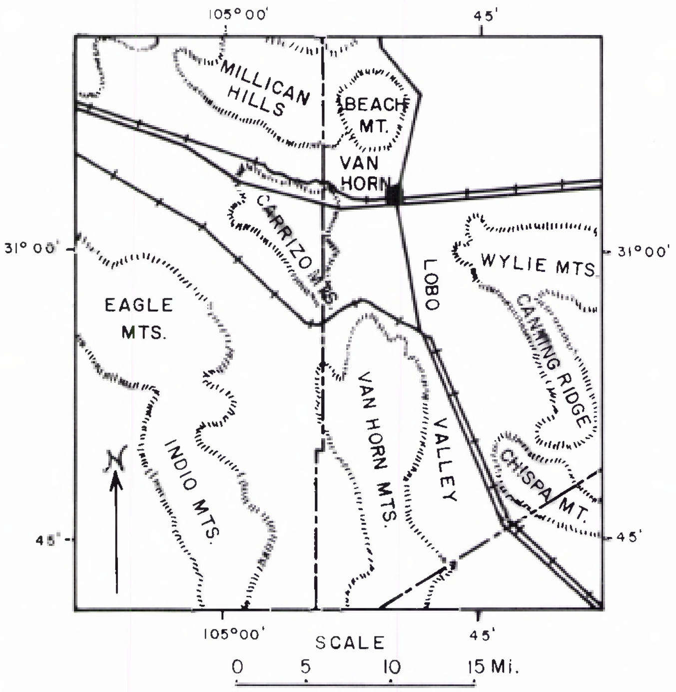

Figure 1. Index map of the Eagle Mountains.

Table 1. Volcanic stratigraphy, western Eagle Mountains. Left column, Gillerman (1953); right column, Legett (1979) and Verrillo (1979).

Upper Rhyolite	High Mill tuff—265 to 600 m Eagle Bluff member—0 to 200 m. lithic welded tuff Cottonwood Canyon member Cottonwood Canyon tuff—265 to 400 m, densely welded tuff Silver Eagle tuff—10 to 15 m, moderately welded tuff Epiclastic unit—0 to 13 m, crystal tuff
Trachyte Porphyry	Frenchman Canyon trachyte—0 to 500 m, welded tuffs and lava flows (?), divided in the northern Eagle Mountains into: Upper unit—130 to 400 m, devitrified trachyte lavas (?) Lower unit—0 to 130 m, densely welded tuff
Lower Rhyolite	Carpenter Canyon tuff—25 to 330 m Panther Peak member—10 to 330 m, welded tuff displaying well-developed eutaxitic texture Indian Springs member—25 to 135 m, poorly welded ash flow and air fall tuffs, lithic fragments locally abundant

stone. The ash flows in the lower part of the section are moderately to densely welded and form gentle slopes. The ash flows in the upper part are more densely welded and are cliff-formers. On this basis the Carpenter Canyon tuff has been divided into two members, the lower Indian Springs member and the upper Panther Peak member. In the southern part of the area the lower member has been divided into a local basal unit which fills paleovalleys in the underlying Cretaceous strata and is overlain by a lithic welded tuff unit (Verrillo, 1979).

The "trachyte porphyry" has been renamed the Frenchman Canyon trachyte after exposures located south of Frenchman Canyon near the Hayter Ranch house in the northwest part of the range. The trachyte unit in the north can be divided into two members based upon the occurrence of an oxidized scoriaceous zone at the top of a flow unit, accompanied by a break in slope (Legett, 1979).

The "upper rhyolite" has been renamed the High Mill tuff for exposures near High Mill in the southern Eagle Mountains. The rhyolitic tuff has a densely welded lower part that grades upward into a less densely welded, more lithic upper part. The degree of welding and increased lithic fragment content form the basis for subdividing the tuff into the Cottonwood Canyon and Eagle Bluff members (Verrillo, 1979). The Eagle Bluff member does not crop out in the northern part of the range. The Cottonwood Canyon member has been subdivided into three units on the basis of welding and the presence of stratification; these units are termed the Cottonwood Canyon tuff, Silver Eagle tuff and a basal epiclastic unit (Verrillo, 1979). The intervals are described below, in ascending order.

Carpenter Canyon Tuff

Indian Springs Member

The Indian Springs member is composed of lithic rhyolitic ash flow tuff and minor ash fall and tuffaceous sandstone. The member is over 120 m thick where it has filled paleovalleys in underlying Cretaceous strata. To the north at Indian Springs, the member is made up of six ash flow units averaging 20 m in thickness (Legett, 1979). The boundaries between individual tuffs are disconformable and characterized by zones rich in lithic clasts. In the south, Verrillo (1979) has distinguished two units within the member based upon the abundance of lithic fragments.

Petrographically the tuffs of the Indian Springs member are composed of 70 to 95 percent matrix of devitrified shards, 5 to 15 percent crystals of quartz, sanidine and accessories of augite, sphene and fluorite, and 5 to 40 percent lithic fragments.

Panther Peak Member

This member was named for exposures at Panther Peak in the northeastern part of the Eagle Mountains. It is composed of densely welded rhyolitic ash flow tuff ranging in thickness from 25 to 300 m. The member is characteristically a cliff-former and rests disconformably on the underlying Indian Springs member.

At Indian Springs, Legett (1979) has differentiated four ash flow units which average 27 m in thickness. Each unit is characterized by a dark, densely welded basal zone which grades upward into a lighter, less densely welded zone.

The tuffs of the Panther Peak member consist of 70 to 95 percent matrix of devitrified shards and pumice, which locally displays strong eutaxitic textures, 10 to 50 percent crystals of sanidine and quartz, and accessory augite and sphene. The member is generally free of lithic fragments except for a zone at its base, where they are abundant.

Frenchman Canyon Trachyte

The Frenchman Canyon trachyte is composed of trachyte porphyry apparently made up of both ash flows and lava flows (Legett, 1979). The trachyte varies in thickness; it is 450 m thick in the west and less than 30 m in the east. It is absent in the Rock Eagle area where it has been removed by erosion (Verrillo, 1979).

On the basis of a scoriaceous zone in the trachyte, Legett (1979) has divided it into an upper and lower member. Locally the lower member displays at its base a well-developed eutaxitic texture suggesting an ash flow origin. The upper member shows ghosts of vesicles and a trachytic texture of feldspar microlites which could indicate a possible lava flow origin.

Petrographically, the trachyte porphyry consists of a dense fine-grained groundmass of alkali feldspar (75-85%), with phenocrysts of alkali feldspar and minor quartz, plagioclase, augite and minor magnetite; no lithic fragments were found in either member (Legett, 1979).

High Mill Tuff

The High Mill tuff crops out in a circular pattern surrounding the Eagle Peak syenite intrusion. The unit consists of rhyolite welded ash flow tuff ranging in thickness from 270 to 600 m. Verrillo (1979) has divided the unit into two members, the Eagle Bluff tuff and the Cottonwood Canyon tuff.

Cottonwood Canyon Member

The Cottonwood Canyon member consists of three distinct units, a thin lower epiclastic unit, a thin moderately welded tuff, and a thick upper unit composed of densely welded tuff.

The lower epiclastic unit shows distinct stratification and lies unconformably on the surface of the Frenchman Canyon trachyte. The unit reaches a maximum thickness of 12 m and is composed of 5 percent crystals of quartz and sanidine set in a matrix of devitrified shards.

The next unit has been called the Silver Eagle tuff; it is rhyolitic welded ash flow tuff characterized by the presence of black pumice fragments (Verrillo, 1979). It averages 12 m in thickness in the southwest part of the range and thins to less than 2 m north of Eagle Peak. The tuff consists of 15 percent phenocrysts of quartz and sanidine set in a matrix of well preserved, draped shards, partly compacted pumice fragments and minor lithic fragments.

The Carpenter Canyon tuff is the youngest and thickest unit of the Carpenter Canyon member. The tuff is very densely welded and forms steep, columnar-jointed cliffs throughout the area. It is approximately 240 m thick in the west and thickens to over 360 m in the east. The tuff consists of 10 percent phenocrysts of quartz and sanidine and 10 to 20 percent flattened pumice fragments all set in a microcrystalline matrix. Shards are not visible in the tuff except near the base. No individual ash flows have been identified within the unit.

Eagle Bluff Member

The Eagle Bluff member is the youngest unit of the High Mill tuff. The Eagle Bluff forms steep, rounded bluffs with crude columnar jointing in the eastern part of the area, where it attains a thickness of up to 180 m; it is not present in the western or northern part of the area.

The tuff is a partly welded lithic rhyolite composed of 10 percent phenocrysts of quartz and sanidine and 10 percent pumice fragments set in a fine-grained devitrified matrix. Lithic clasts consisting primarily of volcanic rock and sandstone fragments, occur in amounts up to 25 percent of the tuff.

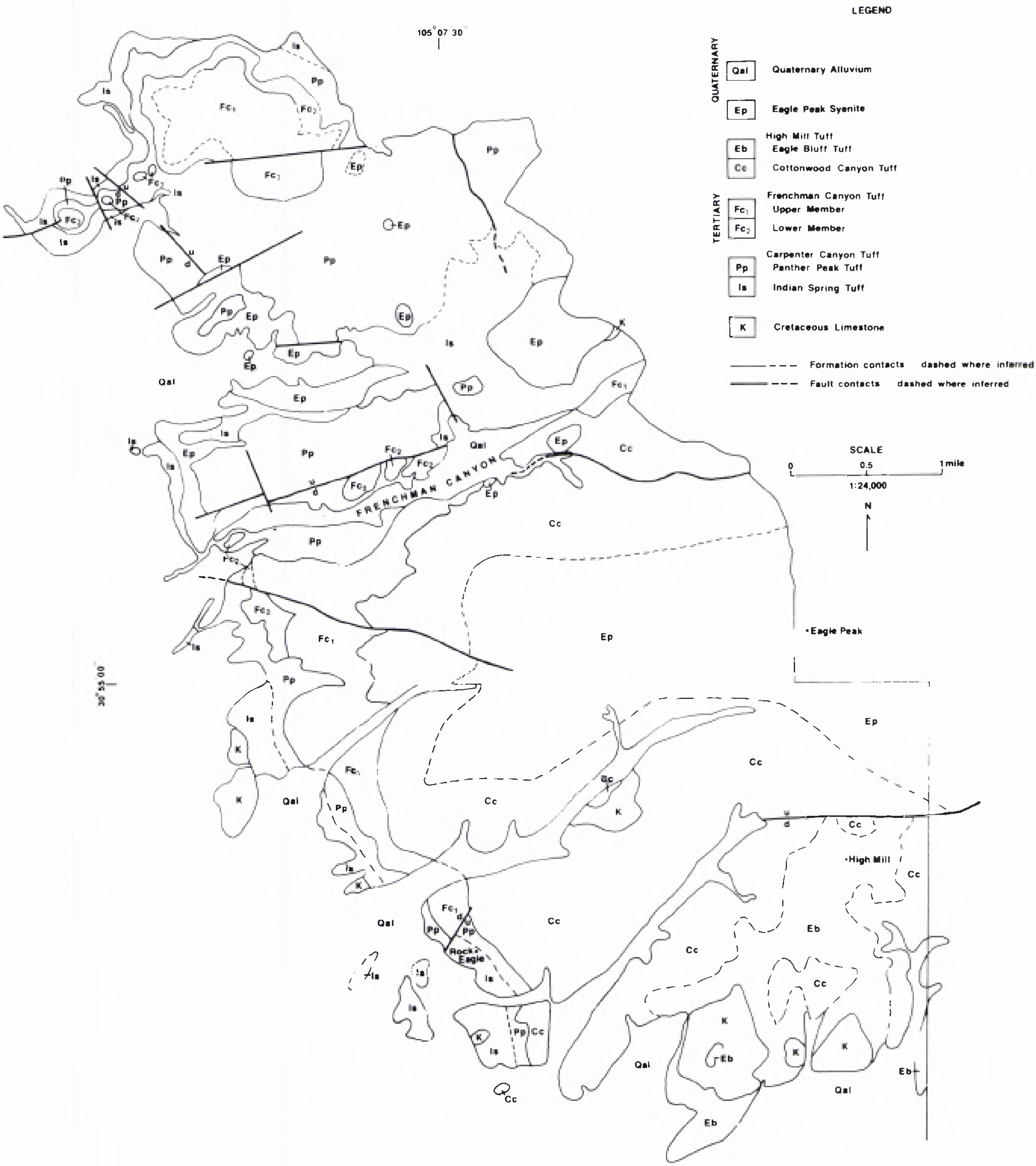

Figure 2. Geologic map of the western Eagle Mountains

Shard structures, not visible at the base of the tuff, become more apparent upward in the section as the degree of welding decreases.

GEOCHEMISTRY

Introduction

Tieh and others (1975) have reported the results of 21 chemical analyses from the four major igneous rock units (three volcanic units and the intrusive Eagle Peak syenite stock) in the Eagle Mountains. Their results indicate that the igneous rocks were emplaced during two eruptive cycles. The first cycle includes the Carpenter Canyon tuff and the Frenchman Canyon trachyte; the first extrusive rocks contained abundant silica (75%) whereas the last volcanic units contain less (68%). The second cycle began with the extrusion of the High Mill tuff (silica content of 73%) and ended with the intrusion of the Eagle Peak syenite (silica content of 66%).

An additional 37 igneous rock samples from measured sections in the northwest Eagle Mountains have been chemically analyzed. Major oxides were determined with an ORTEC 6110 Tefa system and percentages are reported in Table 2.

Results

All the volcanic rocks analyzed from the Eagle Mountains are silicic and contain more than 66 percent SiO_2. Based upon the ratios of oxides of aluminum and alkalis, the Carpenter Canyon tuff and lower part of the High Mill tuff are metaluminous whereas the Frenchman Canyon trachyte and upper part of the High Mill tuff are peraluminous.

Table 2. Average chemical composition of the igneous rocks units of the northwest Eagle Mountains. ISM = Indian Springs member, PPM = Panther Peak member, lm = lower member, um = upper member, and all = all three members of the High Mill tuff.

	Carpenter Canyon tuff		Frenchman Canyon trachyte		High Mill tuff	Eagle Peak syenite
	ISM	PPM	lm	um	all	
Number of Analyses	5	9	5	9	8	1
SiO_2	73.32	72.29	66.60	67.65	72.71	66.72
TiO_2	0.06	0.09	0.23	0.29	0.15	0.30
Al_2O_3	13.69	13.53	16.85	16.27	13.40	15.68
*Fe_2O_3	2.48	3.45	5.99	4.93	3.68	6.75
MnO	0.04	0.06	0.08	0.09	0.06	0.07
MgO	0.13	0.31	0.48	0.59	0.29	0.44
CaO	0.59	0.61	0.56	1.16	0.38	0.08
Na_2O	4.63	3.87	3.00	3.98	3.39	3.38
K_2O	5.36	5.83	7.16	5.59	5.83	6.32
P_2O_5	0.01	0.02	0.09	0.12	0.03	0.16
	100.31	100.06	101.04	100.67	99.92	99.90

*total iron reported as Fe_2O_3; chemical analyses by J. M. Hoffer

As first noted by Tieh and others (1975) the chemical analyses support the theory that the igneous rocks of the Eagle Mountains were emplaced during two periods of eruption. The rocks of each period display a systematic chemical variation as well as variations in mineralogy. Crystal-poor rhyolites (73% SiO_2, 5% phenocrysts) formed during the first period and grade upward into trachyte (67% SiO_2; 24% phenocrysts). This sequence is followed by crystal-poor rhyolites of the High Mill tuff (73% SiO_2; 7% phenocrysts) that grade upward into more crystal-rich tuffs (70% SiO_2; 11% phenocrysts) (Legett, 1979).

CALDERA MODEL

McAnulty (1976) has referred to the Eagle Mountains as a resurgent cauldron. Although field mapping has not yet been completed in the eastern part of the Eagle Mountains, it appears that they do represent a volcanic cauldron. Evidence for a resurgent cauldron is based upon the following observations:

1. The roughly circular outcrop patterns of volcanic rocks,
2. The presence of a thick section of intracaldera welded tuffs which are not correlative with volcanic rocks outside the Eagle Mountains,
3. A cauldron boundary fault (exposed in southeast sector) and evidence of subsidence, and
4. A central intrusive stock (Eagle Peak syenite) and uplift.

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