



## ***Geology and geochemistry of the mid-Tertiary alkaline to calc-alkaline intrusions in the northern Hueco Mountains and adjacent areas, McGregor Range, southern Otero County, New Mexico***

Virginia T. McLemore

2002, pp. 129-139. <https://doi.org/10.56577/FFC-53.129>

*in:*  
*Geology of White Sands*, Lueth, Virgil; Giles, Katherine A.; Lucas, Spencer G.; Kues, Barry S.; Myers, Robert G.; Ulmer-Scholle, Dana; [eds.], New Mexico Geological Society 53<sup>rd</sup> Annual Fall Field Conference Guidebook, 362 p.  
<https://doi.org/10.56577/FFC-53>

---

*This is one of many related papers that were included in the 2002 NMGS Fall Field Conference Guidebook.*

---

### **Annual NMGS Fall Field Conference Guidebooks**

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual [Fall Field Conference](#) that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

#### **Free Downloads**

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

#### **Copyright Information**

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

*This page is intentionally left blank to maintain order of facing pages.*

# GEOLOGY AND GEOCHEMISTRY OF THE MID-TERTIRAY ALKALINE TO CALC-ALKALINE INTRUSIONS IN THE NORTHERN HUECO MOUNTAINS AND ADJACENT AREAS, MCGREGOR RANGE, SOUTHERN OTERO COUNTY, NEW MEXICO

VIRGINIA T. MCLEMORE

New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, NM, 87801, ginger@gis.nmt.edu

**ABSTRACT.**—Two lithologic and chemically distinct groups of igneous rocks are found in the McGregor Range, southern Otero County; syenite to trachyte and quartz monzonite and rhyolite. Alkaline and metaluminous syenite to trachyte stocks, sills, and dikes intruded Paleozoic sedimentary rocks in the northern Hueco Mountains. Calc-alkaline and metaluminous quartz monzonite is exposed in the eastern Three Buttes area of the McGregor Range. Drill holes in the Hueco geothermal field at Davis Dome, south of Three Buttes, encountered calc-alkaline and peraluminous to metaluminous rhyolite in the subsurface. In the Hueco Mountains, the igneous rocks are 34.5-34.7 Ma and are similar in age and chemical composition to those in the Cornudas Mountains. The Three Buttes pluton may be similar in age, however poor results from geochronological dating ( $36.7 \pm 9.3$  Ma), are of limited geochronological use. Geochemical compositions of the igneous rocks suggest that the magma probably originated within the lithospheric mantle and acquired a significant enrichment in lithophile-group elements during its movement through the crust. These data are consistent with either a continental rift or a subduction-related back-arc extension setting. Only small, discontinuous skarns and jasperoids that are low in precious and base metals are found adjacent to some intrusions, thereby making the mineral-resource potential low.

## INTRODUCTION

The geology of the northern Hueco Mountains and adjacent areas (Fig. 1) in southern Otero County has not been examined since the early 1940s and 1950s, before the area was withdrawn from public entry as part of the McGregor Military Range, administered by Ft. Bliss. In 1997, NMBGMR staff conducted a mineral-resource assessment for the U.S. Army (U.S. Army, 1998) and was allowed to map and examine most of the area. On the McGregor Range in southern Otero County, Tertiary intrusive rocks are exposed in the northern Hueco Mountains and in the eastern Three Buttes area. Drill holes in the Hueco geothermal field at Davis Dome south of Three Buttes, encountered rhyolite and monzonite in the subsurface. These intrusions represent the northwestern most igneous activity of the Trans-Pecos alkaline magmatic province (Fig. 1; Barker et al., 1977; Barker, 1977, 1979, 1987). The Hueco Mountains were originally mapped in the early 1940s and 1950s as homogeneous plutons or laccoliths (Hardie, 1958a,b). The Three Buttes pluton and the Davis Dome intrusions have not been recognized until now. The purpose of this paper is to 1) summarize the petrology and mineralogy of the intrusions on the McGregor Range in southern Otero County, 2) present new geochemical and geochronological data, and 3) describe the mineral resources.

## REGIONAL GEOLOGIC SETTING

The Trans-Pecos magmatic province, including the Hueco Mountains, form part of the southern portion of the North American Cordilleran alkaline igneous belt. This belt is a diffuse region of Cenozoic igneous rocks that extends along the eastern margin of the North American Cordillera from Alaska and British Columbia southward into Trans-Pecos Texas and eastern Mexico (Barker, 1977, 1979, 1987; Mutschler et al., 1985, 1991; Woolley, 1987; McLemore, 1996). The igneous intrusions in southeastern

New Mexico and west Texas are part of the Trans-Pecos magmatic province, an area defined by the Rio Grande on the west and south, the Pecos River on the east, and an east-west line approximately 30 km north of the state boundary between New Mexico and Texas (Fig. 1). The province contains more than 200 intrusive bodies, each having an outcrop area exceeding 1 km<sup>2</sup> (Barker, 1977, 1979, 1987). The Trans-Pecos magmatic province

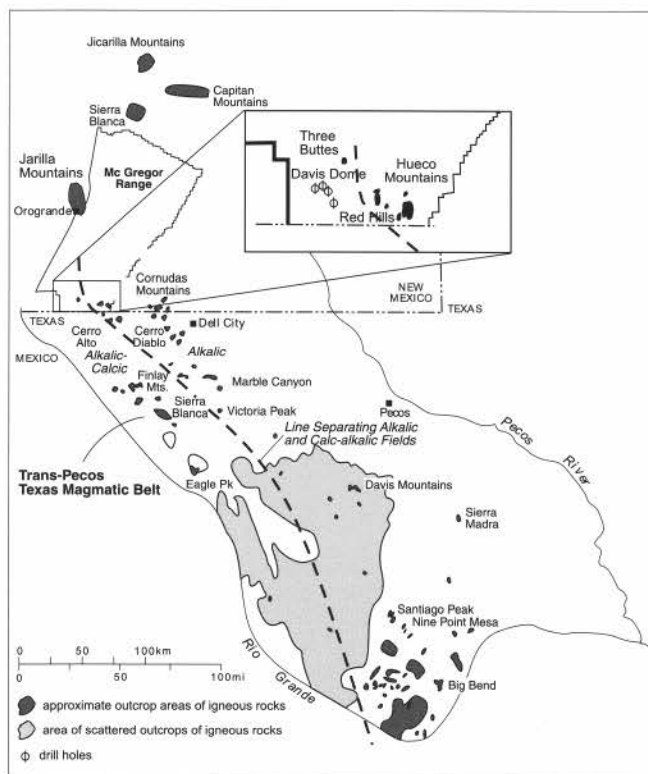


FIGURE 1. Trans-Pecos magmatic province, New Mexico and Texas (modified from Barker, 1987; Price et al., 1987).

is the eastern limit of Cenozoic magmatic activity in southwestern United States and Mexico, which occurred in the region nearly continuously from 48 to 17 Ma (Price et al., 1987). Compositions of igneous rocks vary from alkaline in the eastern portions of the province (including the Hueco and Cornudas Mountains) to calc-alkaline westward into New Mexico (including the Three Buttes and Davis Dome area) (Fig. 1; Barker et al., 1977, Barker and Hodges, 1977; Barker, 1987; Price and Henry, 1984; Cameron and Cameron, 1985; Price et al., 1987; Clark, 1989).

Early genetic interpretations suggested an analogy between the Trans-Pecos province and the Kenya portion of the East African rift (Barker, 1977). However, subsequent work has shown that much of Cenozoic faulting in Trans-Pecos Texas considered to be associated with rifting actually postdates igneous activity (Barker, 1987; Henry et al., 1991). Trans-Pecos magmatic activity began at the end of the Laramide compressional tectonic period and may be linked to progressive shallowing of the subduction of the Farallon plate beneath the North American plate with time (Coney, 1972; Sillitoe, 1972; Barker, 1987; Damon et al., 1981; Campa and Coney, 1983; Henry et al., 1991). It also is possible that some Trans-Pecos magmatic activity is related to back-arc spreading (Barker, 1987).

Ages of Trans-Pecos rocks in the New Mexico and adjacent west Texas range from 32.3 to 48.3 Ma (Table 1). In the Texas portion of the Hueco Mountains, igneous intrusions are found at Hueco Tanks, a small hill northwest of Hueco Tanks, Cerro Alto (north of Hueco Tanks), and west of Alcran Mountain (King et al., 1945; Wise, 1977). Various lithologies occur, including alkali syenite, syenite, syenodiorite, trachyte, and monzonite. The intrusions are typically fine grained, light colored, and porphyritic. Only minor skarns occur locally, all of which are less than 30 ft

thick. The skarns typically consist of calcite, hematite, silica, iron oxides, and locally epidote, garnet, and magnetite (Wise, 1977).

The Cornudas Mountains, east of the Hueco Mountains (Fig. 1), consist of ten larger sills, plugs, and laccoliths and smaller dikes and plugs that intruded relatively flat-lying limestones and other sedimentary rocks of the Hueco Limestone and Bone Spring Limestone (Permian). Lithologies vary from phonolite and nepheline syenite to syenite and quartz syenite to trachyte (Nutt et al., 1997). Wind Mountain is one of the largest intrusions with an approximate diameter of one mile and is mineralogically, texturally, and chemically zoned (McLemore et al., 1994, 1996a, b).

## METHODOLOGY

This study involved the incorporation of new geologic mapping, geochemical, and geochronological data of the northern Hueco Mountains, Three Buttes, and Davis Dome areas that were obtained as part of a mineral-resource assessment of the McGregor Range (Fort Bliss; U. S. Army, 1998) with published work of these areas. The nomenclature presented by Le Maitre (1989) was used to name the igneous rocks. Fine-grained igneous rocks are designated with volcanic rock names. Medium- and coarse-grained rocks are designated with plutonic names.

Samples were sent to XRAL Laboratories for chemical analyses and were analyzed for major oxides, loss on ignition (LOI), and trace elements; sample locations and descriptions are in Appendix 1. Analytical methods included X-ray fluorescence spectrometry (XRF), instrumental neutron activation (INAA), inductively coupled plasma spectrometry (ICP), and delayed neutron counting (DCP). NMBGMR internal standards and selected samples also were analyzed at the NMGMMR X-ray laboratory

TABLE 1. Age dates of igneous rocks in south central New Mexico and west Texas. All age dates have been corrected using the decay constants of Steiger and Jager (1977).

NAME	AGE MA	REFERENCES
Sacramento Mountains		
Oliver Lee camptonite	44.01 ± 0.01 ( <sup>40</sup> Ar/ <sup>39</sup> Ar, hornblende)	NMBGMR Geochron Laboratory
Diorite sill	45.3 ± 2.2 (K/Ar)	Asquith (1974)
Jarilla Mountains (Orogrande)		
Granodiorite/quartz diorite	48.3 ± 1.8 (K/Ar, biotite)	Beane et al. (1975)
Latite porphyry (altered)	42.6 ± 2.2 (K/Ar, hornblende)	Kelley and Chapin (1997)
Copper skarn	42.8 ± 1.6 (K/Ar, phlogopite)	Unpublished report by R. K. Andrews, J. I. Lyons, and M. P. Martineau (1979)
Cornudas Mountains		
Alamo Mountain	36.8 ± 0.6 (K/Ar on biotite)	Barker et al. (1977), Henry et al. (1986)
Cornudas Mountain	34.6 ± 1.5 (K/Ar on biotite)	
Wind Mountain	36.32 ± 0.15 ( <sup>40</sup> Ar/ <sup>39</sup> Ar, hornblende)	NMBGMR Geochron Laboratory
Deer Mountain (Little Wind Mountain)	33.0 ± 1.4 (K/Ar on biotite)	Barker et al. (1977), Henry et al. (1986)
Unnamed hill	36.8 ± 0.6 (K/Ar on biotite)	
Hueco Mountains, Texas		
Cerro Alto	34.3 ± 0.5 (K/Ar on biotite)	Barker et al. (1977)
Hueco Tanks	32.3 (K/Ar, feldspar)	Henry et al. (1986)
Mayfield Valley rhyolite	34.9 ± 0.6 to 36.1 ± 0.6 (K/Ar, biotite)	Barker et al. (1977), Henry et al. (1986)
Hueco Mountains, New Mexico		
Red Hills syenite	34.48 ± 0.34 ( <sup>40</sup> Ar/ <sup>39</sup> Ar, biotite)	NMBGMR Geochron Laboratory, this report
Trachyte sill	34.67 ± 0.21 ( <sup>40</sup> Ar/ <sup>39</sup> Ar, biotite, hornblende)	NMBGMR Geochron Laboratory, this report
Eastern Three Buttes, McGregor Range	36.7 ± 9.3 ( <sup>40</sup> Ar/ <sup>39</sup> Ar, plagioclase)	NMBGMR Geochron Laboratory, this report

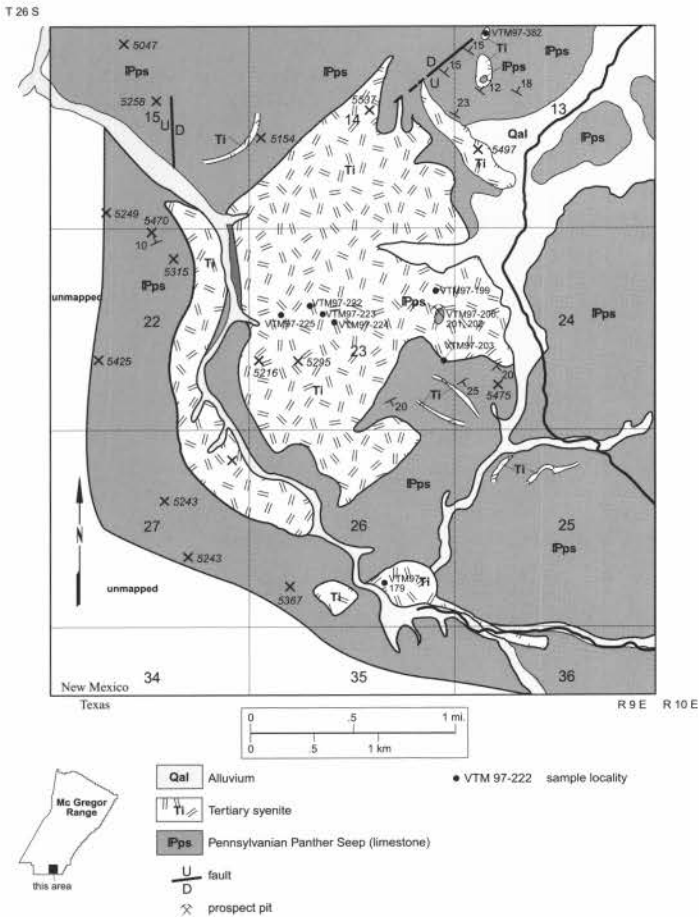


FIGURE 2. Geologic and sample location map of the Red Hills syenite, Hueco Mountains, New Mexico.

TABLE 2. Mineralogy (in percent) of igneous rocks from the McGregor Range. P—plagioclase, K—K-feldspar, M—magnetite/ilmenite, B—biotite, H—hornblende, N—nepheline, A—apatite, Ac—aeigrine, Au—augite, Hy—hypersthene. tr—trace amounts. Other minerals include sericite, clay, apatite, calcite, leucoxene, hematite, epidote/chlorite.

SAMPLE	LITHOLOGY	P	K	Q	M	B	H	Ac	Au	A	Hy	N	OTHER
VTM97-55	quartz monzonite	25	20	10	5	2	2	2	0	1	0	0	33
VTM97-330d	rhyolite	25	25	15	5	10	5	0	0	tr	0	0	15
VTM97-60	alkali-feldspar trachyte	5	65	5	5	5	10	0	5	tr	0	0	0
VTM97-63	trachyte	15	30	5	5	5	10	0	10	tr	5	0	15
VTM97-179	syenite	20	40	5	tr	5	5	0	0	tr	0	0	25
VTM97-199	syenite	25	45	3	tr	5	5	0	2	tr	0	0	15
VTM97-212	syenite	20	45	5	5	5	5	0	0	tr	0	0	15
VTM97-222	syenite (nepheline)	20	40	0	5	5	5	0	0	tr	0	tr	25
VTM97-223	syenite	20	45	5	5	5	5	0	0	tr	0	0	15
VTM97-224	syenite	20	45	10	5	5	5	0	0	tr	0	0	10
VTM97-382	syenite	20	40	5	tr	5	5	0	0	0	0	0	25
VTM97-326d	rhyolite	1	41	50	1	1	0	0	0	0	0	0	6
VTM97-327d	rhyolite	25	25	40	tr	tr	0	0	0	0	0	0	10
VTM97-329d	rhyolite	25	30	35	tr	0	0	0	0	tr	0	0	10
VTM97-350d	rhyolite	35	25	25	5	5	0	0	0	0	0	0	5
VTM97-351d	rhyolite	40	30	20	5	5	0	0	0	0	0	0	0
VTM97-352d	rhyolite	30	25	35	tr	tr	0	0	0	0	0	0	10

for comparison to results obtained by XRAL. Three certified samples were submitted to XRAL as unknowns. The results obtained by XRAL compare within error with certified values for most elements. The precision of XRAL analyses is acceptable for all samples. Details are available in U. S. Army (1998).

Samples also were submitted to the New Mexico Geochronology Research Laboratory at NMGMMR for age determinations by  $^{40}\text{Ar}/^{39}\text{Ar}$  methods. Detailed laboratory procedures for the dated samples can be found in Heizler (2002). All ages are reported at the  $2\sigma$  error and are relative to Fish Canyon Tuff sanidine with an assigned age of 27.84 Ma.

## GEOLOGY

The main intrusive rock in the northern Hueco Mountains is the Red Hills syenite (Fig. 2). It is gray and black, and weathers to a dark reddish brown. The syenite is medium grained and consists of plagioclase phenocrysts (as much as 2 cm long) in a fine-grained groundmass of biotite, plagioclase, K-feldspar, pyroxene, and magnetite (Table 2, Fig. 3). Nepheline or quartz is present in small amounts locally. Syenite to trachyte dikes intruded the stock locally (Hardie, 1958a, b). These dikes are very fine-grained, are gray to brown, weather reddish brown, and consist of plagioclase, K-feldspar, iron oxides, and quartz (Table 2, Fig. 3). Syenite to trachyte dikes also are found as ring dikes partially surrounding the Red Hills syenite (Fig. 2). Locally these dikes are highly altered with liesegang banding, indicating low-temperature fluid migration. Syenite sills cut the adjacent limestone. Thin skarns are exposed at or near the contact locally. Sills or dikes also are exposed in the northwest part of the Hueco Mountains

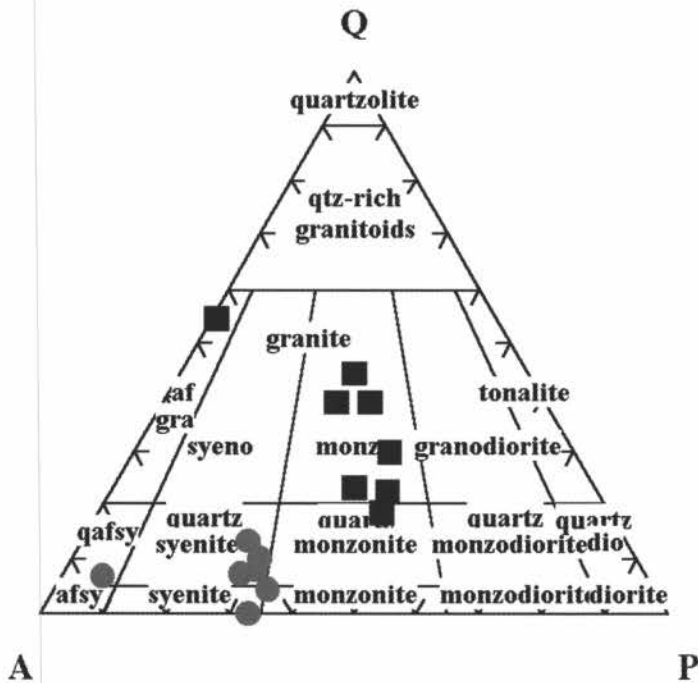


FIGURE 3. QAP (Quartz, Alkali feldspar, Plagioclase) diagram of igneous rocks collected from the McGregor Range (from LeMaitre, 1989). Mineralogy is in Table 1. Squares are rhyolites and quartz monzonite from the Davis Dome and Three Buttes, circles are syenites and trachytes from the northern Hueco Mountains. The fine-grained equivalent of granite is rhyolite and syenite is trachyte.

(Seager et al., 1987), but these sills or dikes are in remote and rugged mountains and not examined for this study.

Trachyte sills and small plugs crop out in the northeastern Hueco Mountains (#VTM97-60, sec. 24, T26S, R9E, and VTM97-212, sec. 31, T25S, R9E, Fig. 4). The trachyte is green-gray to gray and consists of K-feldspar, augite, magnetite, quartz, microcline, biotite, and hornblende (Table 2). Calcite and iron oxides veinlets along fractures are common throughout the trachyte. It is approximately 25 ft thick and intrudes Panther Seep Limestone. There is no evidence of alteration at the intrusive contact.

The easternmost hill of the Three Buttes consists of gray-brown quartz monzonite stock (Table 2, #VTM97-55). The stock is fine grained, porphyritic, and consists of quartz, plagioclase, K-feldspar, biotite, aegirine, calcite, magnetite, sericite, clay, and apatite (Table 2, Fig. 3). The phenocrysts are as much as 5 mm long. The stock is surrounded by alluvium; no intrusive contacts or xenoliths were found.

Rhyolite intruded the sedimentary sequence in drill core from geothermal test holes at Davis Dome in the southern Otero Platform (Table 3). In holes SLH 61-6, the rhyolite is overlain by Holocene basin fill; in holes SLH 46-6 and SLH 45-5, the rhyolite intruded Pennsylvanian limestone and shale. The sills range in thickness from 139 to 1272 ft (Table 3). The rhyolite sills are white to pink to brown, fine grained to very fine grained, locally porphyritic, and consist of quartz, plagioclase, K-feldspar, and iron oxides (Table 2). Minor recrystallization and hematitic to clay alteration of the adjacent limestone occurred.

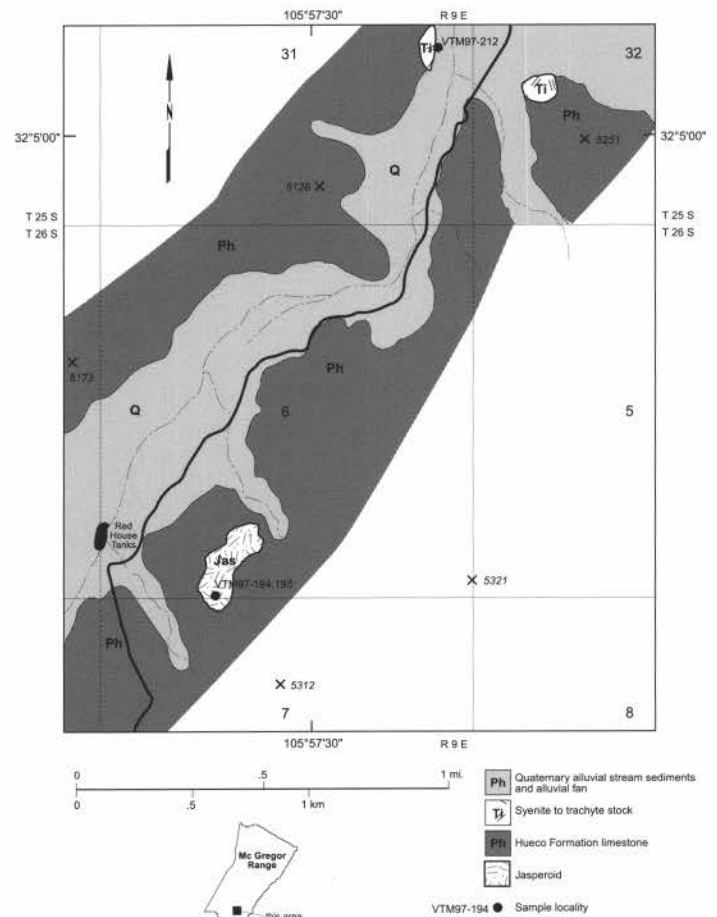


FIGURE 4. Geologic and sample location map of the jasperoid body and intrusions in northern Hueco Mountains.

## AGE OF IGNEOUS ROCKS

Three samples from the Hueco Mountains were dated by  $^{40}\text{Ar}/^{39}\text{Ar}$  methods and all of the samples provided plateau age spectra with nearly all of the heating steps yielding analytically indistinguishable apparent ages (Fig. 5). Biotite from the Red Hills syenite (VTM97-199) is  $34.48 \pm 0.34$  Ma (Fig. 5), which closely approximates the emplacement age. Hornblende and biotite from a trachyte sill (VTM97-63) yielded plateau ages of  $34.72 \pm 0.47$  and  $34.66 \pm 0.23$  Ma, respectively (Fig. 5). These ages are concordant and indicate rapid cooling from  $550^\circ\text{C}$  to  $350^\circ\text{C}$ , which suggests that their weighted mean of  $34.67 \pm 0.21$  Ma represents the intrusion age (Table 1). The low-quality plateau age of the plagioclase from the Three Buttes pluton (VTM97-55) is  $36.7 \pm 9.3$  Ma (Fig. 5). The low precision is the result of low potassium content coupled with low radiogenic yields. Only limited geochronological information can be obtained from this sample due to the high error, but it appears that this sample has a similar emplacement age as the syenite and trachyte. Because of the high error it is not possible to determine if the Three Buttes pluton is temporally distinct from the other intrusives reported here. The rhyolites from the drill holes at Davis Dome were too altered to be accurately dated.

TABLE 3. Oil and geothermal tests drilled through Tertiary igneous rocks within and adjacent to the McGregor Range, Otero County. Well locations shown in Figure 2.

NAME	LOCATION	DEPTH TO TOP ft	THICKNESS ft	LITHOLOGY
SLH 51-8	16 T26S R8E	460	200	rhyolite
SLH 46-6	6 T26S R8E	1145	139	rhyolite
SLH 45-5	5 T26S R8E	433 1857	431 1272	rhyolite
SLH 61-6	6 T26S R8E	605	825	rhyolite
Plymouth Oil Co. No. 1 Federal	15 T20S R9E	1382	404	trachyte

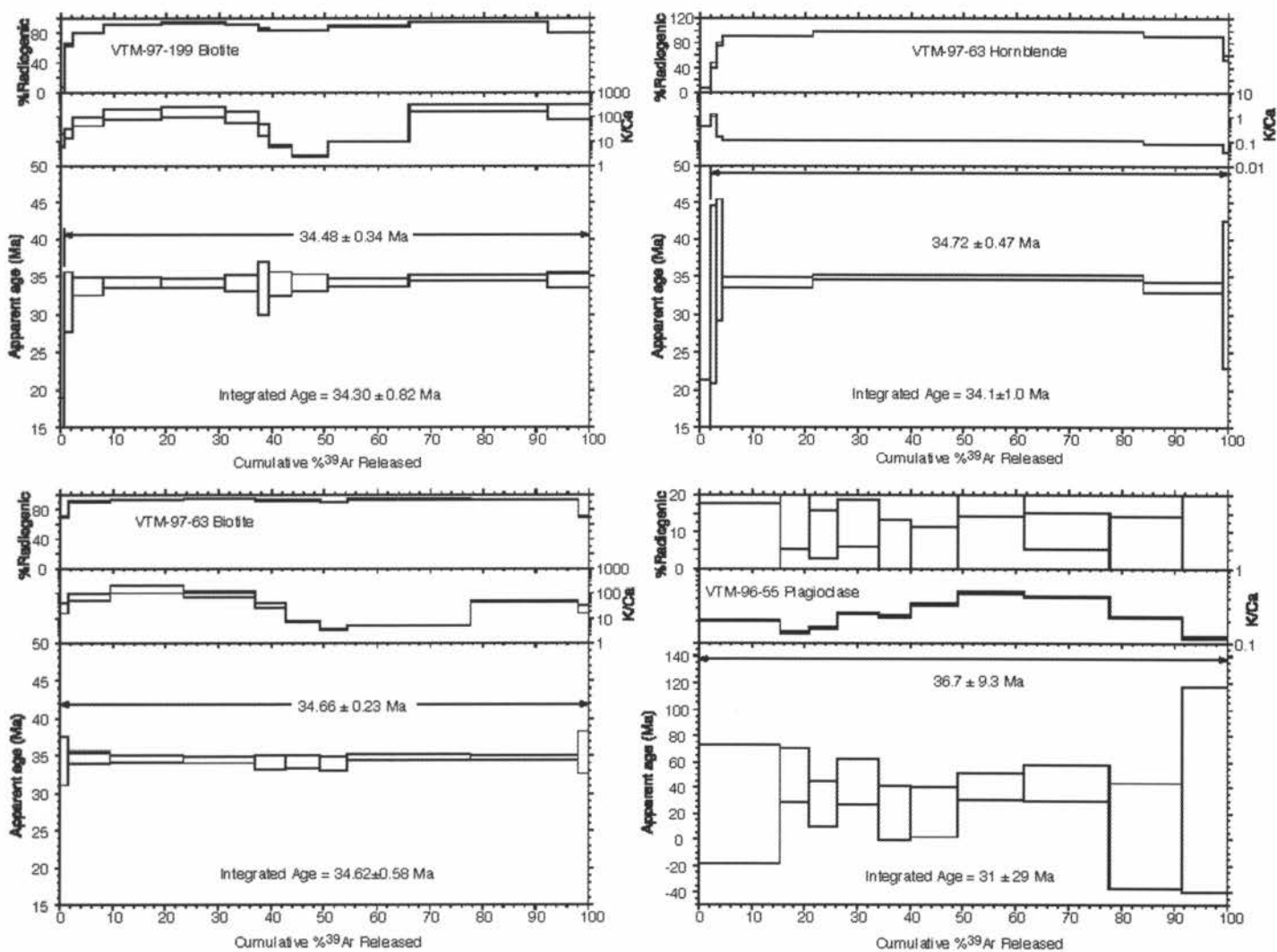


FIGURE 5. Age spectra of samples from the northern Hueco Mountains and Three Buttes.

TABLE 4. Geochemistry of Tertiary igneous rocks within the McGregor Range. All sample numbers are prefixed by VTM97. Locations and descriptions of samples are in Appendix 1. Selected samples are located on Figures 3 and 4.  $Fe_2O_3T$  is total iron calculated as  $Fe_2O_3$ . Additional chemical analyses are in U. S. Army (1998).

OXIDE %	55	60	63	179	199	212	222	223	224	382	326d	327d	329d	330d	350d	351d	352d
SiO <sub>2</sub>	64	61.9	61.2	65.8	64	63.2	60.8	63	65.3	58.71	76.6	75.2	73.4	62.3	68.8	68.3	74.5
TiO <sub>2</sub>	0.47	0.82	0.85	0.69	0.09	0.64	1.16	0.77	0.55	0.98	0.07	0.07	0.07	0.45	0.21	0.23	0.06
Al <sub>2</sub> O <sub>3</sub>	15.7	16.1	17	16.9	17.4	16.4	17.9	18.3	16.7	17.43	13.6	13.7	13.3	15.7	15.2	15.1	13.9
Fe <sub>2</sub> O <sub>3</sub> T	3.81	4.56	4.27	2.41	2.77	3.36	3.37	2.21	2.55	4.03	0.54	0.68	0.79	3.75	1.34	2.01	0.70
MnO	0.1	0.13	0.09	0.04	0.09	0.17	0.08	<0.01	0.08	0.19	0.05	0.03	0.1	0.07	<0.01	<0.01	<0.01
MgO	1.24	0.82	0.92	0.3	0.36	0.39	0.82	0.06	0.38	1.05	0.19	0.37	<0.01	0.86	0.16	0.36	0.10
CaO	3.9	1.85	2.93	0.54	1.44	2.46	3.29	0.61	1.33	2.33	<0.01	0.08	1.34	3.89	1.91	1.34	0.15
Na <sub>2</sub> O	4.41	5.91	5.62	5.86	6.1	4.82	6.39	6.77	5.72	5.20	0.13	2.18	3.35	3.71	3.96	5.78	3.42
K <sub>2</sub> O	3.63	5.43	5.12	5.38	5.81	5.48	4.65	5.14	5.64	5.85	6.82	5.23	4.98	4.53	4.24	3.49	4.61
P <sub>2</sub> O <sub>5</sub>	0.19	0.32	0.37	0.21	0.16	0.19	0.31	0.26	0.17	0.35	<0.01	<0.01	0.02	0.18	0.09	0.08	<0.01
LOI	2.65	1.15	1.45	1.15	0.2	3.05	0.55	1.1	0.4	4.27	2.1	2.25	1.65	4.55	2.15	1.95	1.20
TOTAL	100.1	98.99	99.82	99.28	98.98	100.17	99.32	98.22	98.82	100.39	100.1	99.79	99.0	99.99	98.77	98.64	98.64
TRACE ppm																	
Ba	1700	1200	1100	830	570	740	950	1500	680	1209	1300	1600	1800	1500	1500	1100	1300
Zn	37	37	65	7.2	17	54	39	19	77	297	35	19	20	59	13	19	29
Pb	10	<2	3	4	14	8	7	12	16	290	34	12	20	23	14	14	19
Rb	107	130	111	128	163	136	88	146	135	144	235	171	138	156	127	102	162
Sr	800	250	491	237	303	142	669	372	308	406	58	187	257	497	455	318	173
Nb	15	87	58	67	88	68	110	59	78	67	15	18	13	17	9	10	13
Ta	1	5	4	5	3	4	11	4	4	—	<1	<1	1	1	1	1	1
Cs	1	1	<1	<1	2	<1	<1	1	2	—	4	2	1	7	—	—	—
Y	36	62	63	66	45	74	64	41	30	30	23	24	18	36	<2	2	<2
Cu	4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	<0.5	6	<0.5	<0.5	6.3	4.6	1.4	0.6	2.2
La	42.6	99.5	85.5	80.1	43.4	90	97	79.5	60.4	—	10.5	10.7	10.5	41.7	26	28.7	6.6
Ce	80	179	154	166	91	179	197	151	113	—	17	17	17	76	43	47	11
Nd	29	70	59	64	38	77	84	60	37	—	6	5	6	30	14	15	<5
Sm	5.1	11.9	10.8	14	8	14.1	15.9	10.2	6.3	—	0.9	0.9	0.9	5.2	2.3	2.4	0.8
Eu	1.4	2.5	2.3	1.8	0.8	2.3	2.5	2.2	1.6	—	0.4	0.3	0.4	1.3	1.1	0.7	<0.2
Tb	0.6	2	1.2	1.3	0.9	1.9	2.2	0.9	0.5	—	<0.5	<0.5	<0.5	0.6	<0.5	<0.5	<0.5
Yb	2.3	4.5	4.5	5	3	5.9	4.4	2.7	3.1	—	1	1	1	2.7	1	1	0.9
Lu	0.35	0.63	0.63	0.72	0.47	0.84	0.61	0.4	0.5	—	0.17	0.18	0.17	0.44	0.17	0.16	0.17
Nb/Ba	0.009	0.07	0.05	0.08	0.15	0.09	0.12	0.04	0.11	—	0.01	0.01	0.007	0.01	0.006	0.009	0.01
Ta/Ba	0.001	0.004	0.004	0.006	0.005	0.005	0.01	0.003	0.006	—	0.001	0.001	0.001	0.001	0.001	0.001	0.001

## GEOCHEMISTRY OF IGNEOUS ROCKS

Two lithologic groups of igneous rocks occur in the southern Otero County; syenite to trachyte and quartz monzonite to rhyolite. The two groups are chemically distinct (Table 4). The syenites and trachytes from the Hueco Mountains are alkaline (Fig. 6) and metaluminous (Fig. 7). However, they are not as alkaline as the nepheline syenites from the Cornudas Mountains (Fig. 6). The syenites and trachytes from the Hueco Mountains and Cornudas Mountains are classified as Within-Plate Granites (WPG) using the classification of Pearce et al. (1984) (Fig. 8, 9). The syenites

and trachytes have relatively enriched REE patterns, typical of alkaline rocks throughout the Trans-Pecos volcanic field.

The quartz monzonite from Three Buttes (Table 3, VTM97-55) and rhyolite from drill holes at Davis Dome in the southern Otero Platform (Table 3, VTM97-330D) are calc-alkaline and metaluminous to peraluminous and exhibit chemical trends similar to samples from the central Jarilla Mountains (Fig. 6, 7). They are classified as Volcanic Arc Granites (VAG) using the classification of Pearce et al. (1984) (Fig. 8, 9). The rhyolites from drill holes at Davis Dome (Table 3, VTM97-326d, VTM97-327d, VTM97-329d, VTM97-350d, VTM97-351d, 352d) have similar chemical

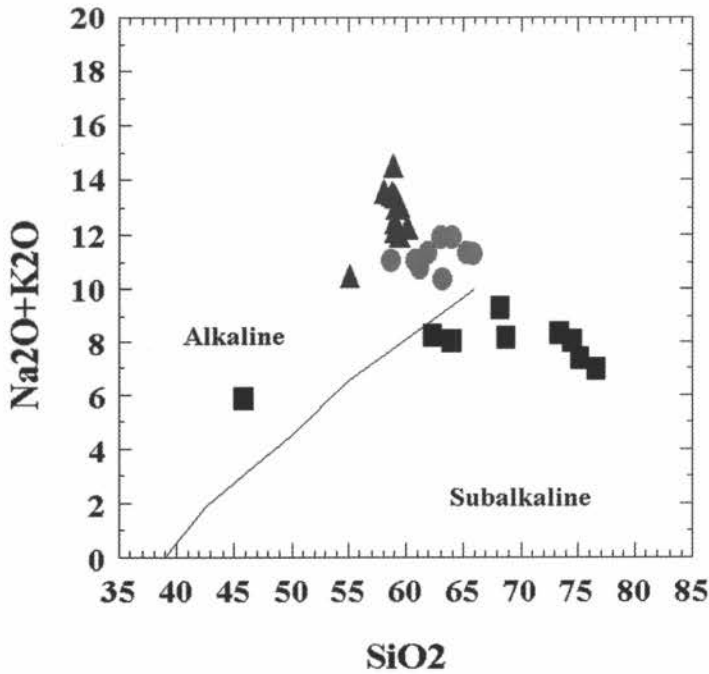


FIGURE 6. A scatter plot of total alkali elements ( $\text{Na}_2\text{O}+\text{K}_2\text{O}$ ) verses  $\text{SiO}_2$ . The line between alkaline and subalkaline is from Irvine and Baragar (1971). Squares are rhyolites and quartz monzonite from the Davis Dome and Three Buttes, circles are syenites and trachytes from the northern Hueco Mountains, and triangles are syenites from the Cornudas Mountains.

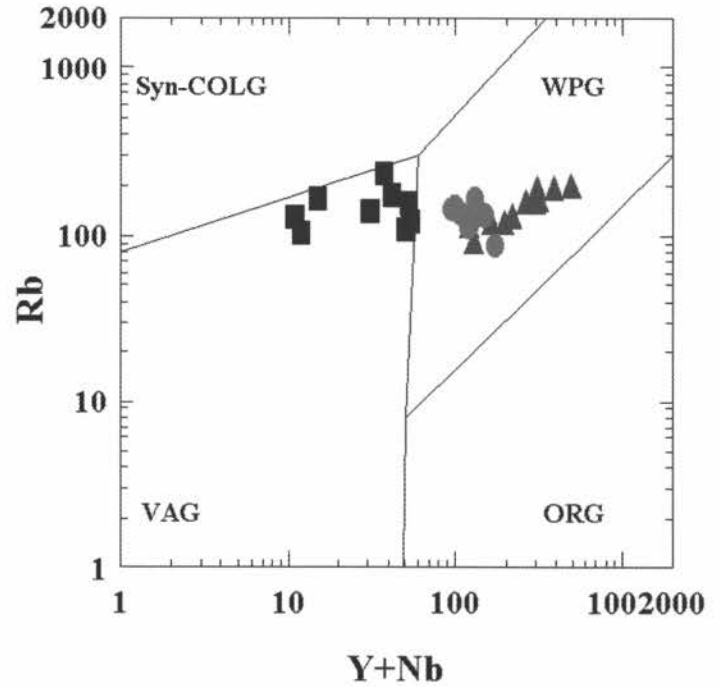


FIGURE 8. A scatter plot of Rb verses  $Y + \text{Nb}$ . Fields are from Pearce et al. (1984). WPG- within plate granites, ORG-orogenic granites, VAG-volcanic arc granites. Squares are rhyolites and quartz monzonite from the Davis Dome and Three Buttes, circles are syenites and trachytes from the northern Hueco Mountains, and triangles are syenites from the Cornudas Mountains.

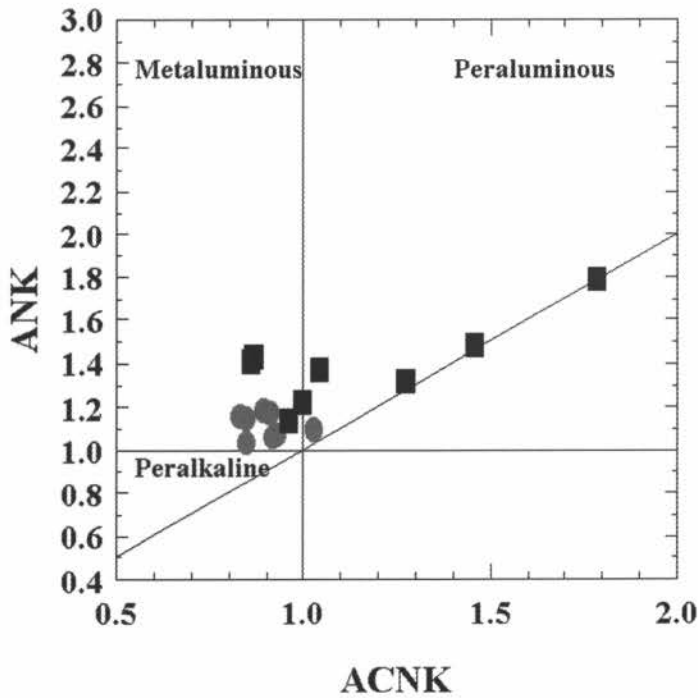


FIGURE 7. A scatter plot of ANK ( $\text{Al}_2\text{O}_3/(\text{Na}_2\text{O} + \text{K}_2\text{O})$ ) verses ACNK ( $\text{Al}_2\text{O}_3/(\text{CaO} + \text{Na}_2\text{O} + \text{K}_2\text{O})$ ). Squares are rhyolites and quartz monzonite from the Davis Dome and Three Buttes, circles are syenites and trachytes from the northern Hueco Mountains.

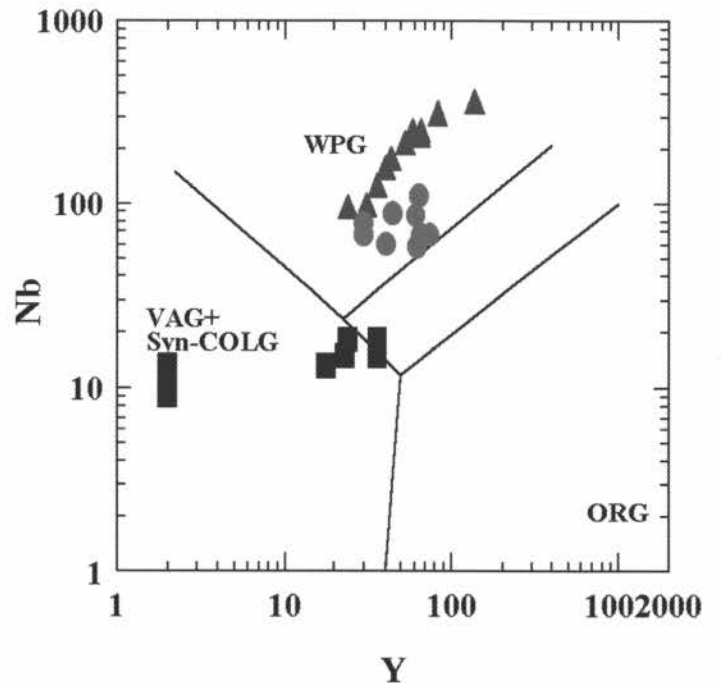


FIGURE 9. A scatter plot of Nb verses  $Y$ . Fields are from Pearce et al. (1984) and defined in Figure 8. Symbols defined in Figure 7.

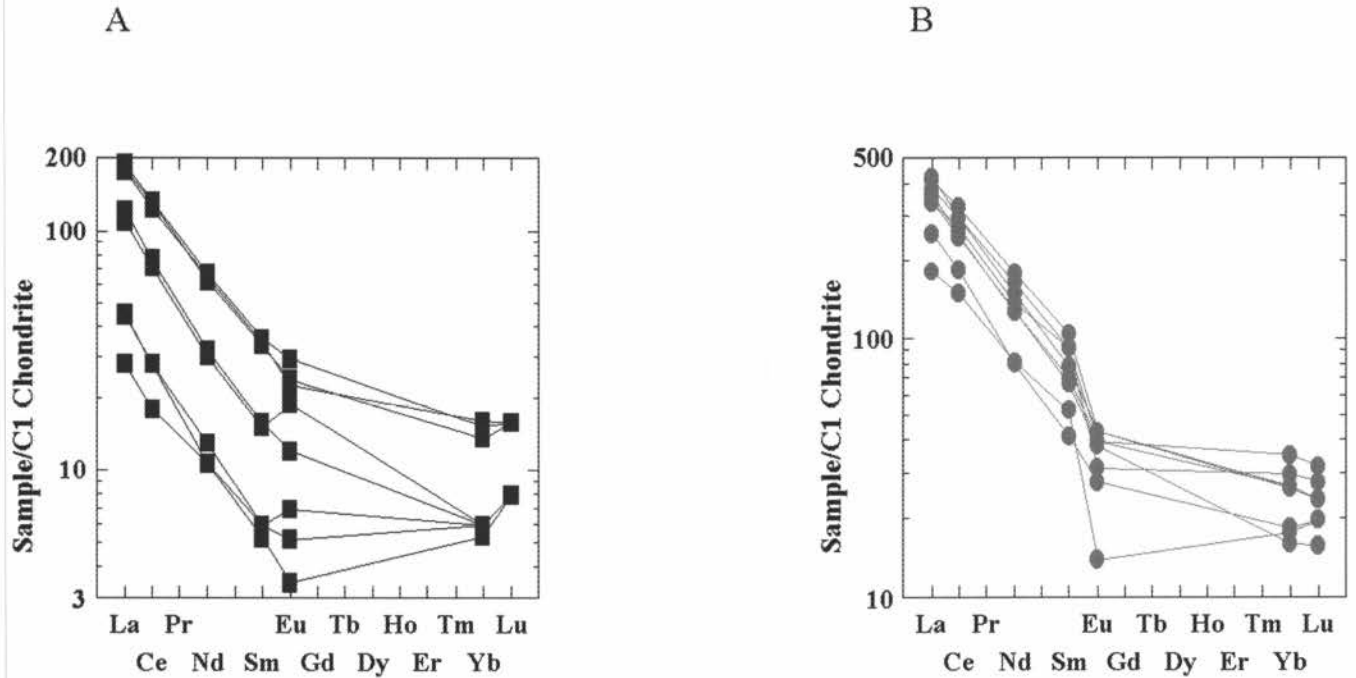


FIGURE 10. The chondrite-normalized REE contents of A) rhyolites and quartz monzonite from the Davis Dome and Three Buttes (squares) and B), syenites and trachytes from the northern Hueco Mountains (circles).

trends as quartz latites from the central Jarilla Mountains and the Sierra Blanca rhyolite; they are calc-alkalic and peraluminous (Fig. 6, 7). They are classified as Volcanic Arc Granites (VAG) using the classification of Pearce et al. (1984) (Fig. 8, 9). In addition, the Three Buttes and Davis Dome rhyolites and quartz monzonite have flat REE patterns with slightly depleted Eu anomalies and have depleted REE patterns compared to the syenites and trachytes (Fig. 10).

**DESCRIPTION OF MINERAL DEPOSITS**

There is no reported precious- or base-metal production from the northern Hueco Mountains; however, one prospect pit was found during reconnaissance in 1997. The Red Hills prospect pit is in the Hueco Mountains and is 10 ft long, 0-10 ft deep, and 6 ft wide (Fig. 3, 11). The pit exposes a hornfels and magnetite-hematite replacement body within a limestone xenolith of Pennsylvanian Panther Seep Formation in the Tertiary syenite. The hornfels is green to green-gray and consists of iron oxides, calcite, quartz, epidote, chlorite, and a trace of pyrite (Fig. 11, Table 5, #VTM97-201). The magnetite-hematite replacement body is brown to black and consists of magnetite, hematite, iron oxides, quartz, calcite, and a trace of pyrite (#VTM97-200). Samples of white to gray, silicified limestone from the waste dump contained calcite, quartz, iron oxides, and a trace of pyrite and malachite (#VTM97-202). Chemical analyses are in Table 5.

Silicified and recrystallized limestone beds of the Pennsylvanian Panther Seep Formation are found locally within several hundred to 1000 ft of the intrusive contact with the nepheline syenite. The altered zones are typically less than 1 ft thick and

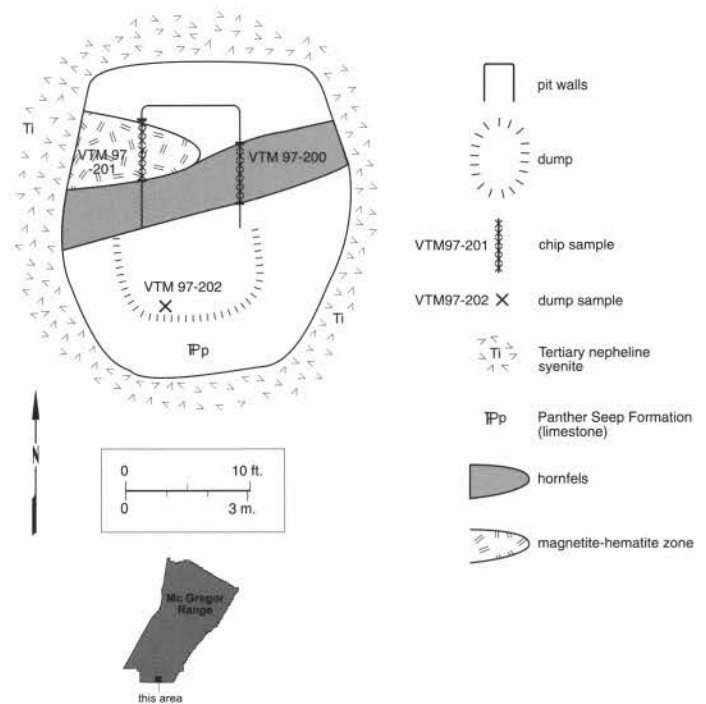


FIGURE 11. Sketch map of Red Hills prospect pit, Hueco Mountains, McGregor Range, Otero County, New Mexico.

consist of quartz, calcite, iron oxides, and locally trace amounts of pyrite (#VTM97-203, 206); chemical analyses are in Table 5. Kness (1994) also reports low geochemical analyses from these zones (#93, 94, 97, Table 5).

TABLE 5. Selected geochemical analyses of mineralized and altered samples from the Hueco Mountains area, McGregor Range. Locations and descriptions of samples are in Appendix 1. Selected sample localities are shown in Figures 3, 4, 14, and 15. Analyses are in parts per million (ppm), unless otherwise denoted. Iron is reported as total iron as  $\text{Fe}_2\text{O}_3$ . Samples 93, 94, and 97 are of mineralized limestones near the Red Hills syenite (exact locations are unknown) from Kness (1994).

SAMPLE	Fe <sub>2</sub> O <sub>3</sub> T	Ag	As	Au	Ba	Cu	Mo	Nb	Pb	Sb	Th	U	W	Zn	La
93	5.15	<5	6	<5	—	—	<2	—	—	0.9	8.8	2.5	<2	<200	31
94	5.01	<5	23	<5	—	—	4	—	—	2.7	9.4	7.4	<2	1600	41
97	2.72	<5	9	<5	—	—	41	—	—	2	8.4	2.5	11	<200	29
VTM97-59	3.21	<0.5	9	<1	70	2.4	1	12	<2	0.5	<1	1.4	38	12	6
VTM97-188F	13	<0.5	510	<1	60	3.6	9	<10	5	7.8	<1	4	170	220	3.6
VTM97-190F	19	1.4	73	2	800	4.9	73	<10	130	8.1	<1	10.3	78	2400	15.1
VTM97-248F	10	<0.5	100	<1	990	6.8	13	86	32	15	23	6.5	130	250	49.6
VTM97-249F	1.49	<0.5	3	<1	490	9.1	10	39	16	0.6	13	2.8	120	59	26.5
VTM97-184	3.04	<0.5	3	<1	2100	<0.5	5	16	9	0.5	1	3	24	13	8.3
VTM97-194	4.34	<0.5	74	<1	70	2.7	5	3	8	1.9	<1	1.2	180	67	1.4
VTM97-195	2.75	<0.5	21	<1	90	2.8	3	4	6	4.2	<1	1.6	270	37	2
VTM97-200	9.51	0.5	40	<1	450	7.5	7	17	100	2.8	7	10.9	74	500	93.3
VTM97-201	5.15	<0.5	51	1	510	25.2	5	17	190	2.2	8	6.4	60	1100	66.3
VTM97-202	4.34	<0.5	9	1	330	36.6	2	19	22	1	9	7	54	100	55.7
VTM97-203	3.3	<0.5	5	11	1200	2.6	3	27	13	0.9	11	6.5	120	37	48.8
VTM97-206	4.74	<0.5	9	<1	340	16.9	2	15	24	0.8	9	2.7	84	87	34.2
VTM97-225	2.32	<0.5	6	<1	90	8.6	3	13	5	0.2	4	6.1	22	33	22.9

A large undeveloped jasperoid body is exposed along a hillside northeast of the Red Hills syenite in section 6 and 7, T26S, R9E (Fig. 3). The jasperoid is approximately 100 ft long and up to 40 ft wide. It consists of jasper, iron oxides, quartz, and unmineralized limestone. Iron oxide and jasper cut the unmineralized limestone veins. Two samples of the jasperoid contained 85 and 92.3%  $\text{SiO}_2$  and 30 and 27 ppm Be (#VTM97-194, 195, Table 5).

## DISCUSSION AND CONCLUSIONS

The igneous rocks in southern Otero County are Eocene to Oligocene in age (Table 1). The oldest rocks are dikes and sills exposed in the Sacramento Mountains and stocks in the Jarilla Mountains. In the Hueco Mountains, the alkaline igneous rocks are 34.5–34.7 Ma (Table 1), younger than those in the Jarilla Mountains, and similar in age to those in the Cornudas Mountains (Table 1). The  $36.7 \pm 9.3$  Ma age determined for the Three Buttes pluton may indicate that it is of similar age to the well-dated 34.5–34.7 Ma alkaline rocks, but the large uncertainty precludes using the geochronology in a precise fashion. If the calc-alkaline Three Buttes pluton were of similar age to the alkaline rocks, it would suggest a narrow time span for two different magmas to be emplaced in the same area. However, based on the poor geochronology, the magmas could be discordant by as much as 7 to 12 Ma at the 95% confidence level. Apatite cooling ages of rocks in the Sacramento Mountains suggest it was uplifted during the same time period, 35–41 Ma (Kelley and Chapin, 1997).

Geochemical compositions of the igneous rocks, especially low Nb/Ba and Ta/La ratios (Table 4), suggests that the magma probably originated within the lithospheric mantle (Kempton et

al., 1991; McMillan, 1998; Potter, 1996) and acquired a significant enrichment in lithophile-group elements during its movement through the crust. The geochemical data are consistent with either a continental rift or a subduction-related back-arc extension setting (Fig. 8, 9). The alkaline and calc-alkaline rocks were erupted at nearly the same time and the compositional differences between them probably reflect differences in source reservoirs and conditions of melting (Barker, 1980, 1987; Potter, 1996). Isotopic data are required to confirm the sources of the magmas. The northern Hueco Mountains and adjacent area exhibits the compositional gradient from alkaline (northern Hueco Mountains) to the east and calc-alkaline to the west (Three Buttes and Davis Dome) described by Barker (1987), and is additional evidence supporting the theory that these rocks are related to the subduction of the Farallon plate and not part of the Rio Grande continental rift (Potter, 1996).

## ACKNOWLEDGMENTS

This report is part of on-going studies of igneous intrusions and mineral resources in New Mexico, supported by the New Mexico Bureau of Geology and Mineral Resources, Peter Scholle, Director and State Geologist. I would like to thank Matt Heizler, Nelia Dunbar, and Nancy McMillan for reviewing an earlier version of this manuscript; their comments are appreciated. Phil Kyle and Chris McKee (NMGMMR) analyzed some samples by X-ray-fluorescence using the Phillips PW 2400 instrument purchased with funds from NSF grant EAR-9316467. Matt Heizler, Lisa Peters, and Rich Esser carried out mineral separations and  $^{40}\text{Ar}/^{39}\text{Ar}$  age determinations at the New Mexico Geochronology Laboratory at the New Mexico Bureau of Geology and Mineral Resources. The

New Mexico Bureau of Geology and Mineral Resources Cartography Department drafted the figures. This paper was approved for public release by White Sands Missile Range; distribution unlimited. OPSEC review completed on March 25, 2002.

## REFERENCES

- Asquith, G. B., 1974, Petrography and petrogenesis of Tertiary camptonites and diorites, Sacramento Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Circular 141, 6 p.
- Barker, D. S., 1977, Northern Trans-Pecos Magmatic province: Introduction and comparison with the Kenya rift: Geological Society of America Bulletin, v. 88, p. 1421-1427.
- Barker, D. S., 1979, Cenozoic magmatism in the Trans-Pecos province: Relation to Rio Grande rift; in Riecker, R. E., editor, Rio Grande Rift: Tectonics and magmatism: American Geophysical Union, p. 382-392.
- Barker, D. S., 1980, Cenozoic igneous rocks, Sierra Blanca area, Texas: New Mexico Geological Society, 31<sup>st</sup> Field Conference, Guidebook, p. 219-223.
- Barker, D. S., 1987, Tertiary alkaline magmatism in Trans-Pecos Texas; in Fitton, J. G. and Upton, B. G. J., eds., Alkaline igneous rocks: Geological Society, Special Publication 30, p. 415-431.
- Barker, D. S., and Hodges, F. N., 1977, Mineralogy of intrusions in the Diablo Plateau, northern Trans-Pecos magmatic province, Texas and New Mexico: Geological Society of America Bulletin, v. 88, p. 1428-1436.
- Barker, D. S., Long, L. E., Hoops, C. K., and Hodges, F. N., 1977, Petrology and Rb-Sr isotope geochemistry of intrusions in the Diablo Plateau, northern Trans-Pecos magmatic province, Texas and New Mexico: Geological Society of America Bulletin, v. 88, p. 1437-1446.
- Beane, R. E., Jaramillo C., L. E., and Bloom, M. S., 1975, Geology and base metal mineralization of the southern Jarilla Mountains, Otero County, New Mexico: New Mexico Geological Society, 26<sup>th</sup> Field Conference, Guidebook, p. 151-161.
- Cameron, K. L., and Cameron, M., 1985, Rare-earth elements, Sr<sup>86</sup>Sr and <sup>143</sup>Nd/<sup>144</sup>Nd compositions of Cenozoic orogenic dacites from Baja California, north-western Mexico and adjacent west Texas: evidence for the predominance of a subcrustal component: Contributions to Mineralogy and Petrology, v. 91, p. 1-11.
- Campa, M. F. and Coney, P. J., 1983, Tectono-stratigraphic terranes and mineral resource distributions in Mexico: Canadian Journal of Earth Sciences, v. 20, p. 1040-1051.
- Clark, K. F., 1989, Metallogenic provinces and epochs in Mexico: 28th International Geological Congress, Abstracts, v. 1, p. 300.
- Coney, P. J., 1972, Cordilleran tectonics and North American plate motions: American Journal of Science, V. 272, p. 603-628.
- Damon, P. E., Shafiqullah, M. and Clark, K. F., 1981, Age trends of igneous activity in relation to metallogenesis in the southern Cordillera: Arizona Geological Society Digest, v. 14, p. 137-154.
- Hardie, C. H., 1958a, The geology of part of the Hueco Mountains, Otero County, New Mexico [M. S. thesis]: University of Illinois, 46 p.
- Hardie, C. H., 1958b, The Pennsylvanian rocks of the northern Hueco Mountains; in 1958 Field trip Franklin and Hueco Mountains, Texas: West Texas Geological Society Guidebook, p. 43-45.
- Heizler, M. T., 2002, <sup>40</sup>Ar/<sup>39</sup>Ar results from intrusives in the McGregor Range, southern Otero County, New Mexico Bureau of Geology and Mineral Resources, Open File Report.
- Henry, C. D., McDowell, F. W., Price, J. G., and Smyth, R. C., 1986, Compilation of potassium-argon ages of Tertiary igneous rocks, Trans-Pecos Texas: Texas Bureau of Economic Geology, Geological Circular 86-2, p. 34.
- Henry, C. D., Price, J. G., and James, E. W., 1991, Mid-Cenozoic stress evolution and magmatism in the southern Cordillera, Texas and Mexico: Transition from continental arc to intraplate extension: Journal of Geophysical Research, v. 96, no. B8, p. 13,545-13,560.
- Irvine, T. N. and Baragar, W. R. A., 1971, A guide to the chemical classification of the common volcanic rocks: Canadian Journal of Earth Sciences, v. 8, p. 523-548.
- Kelley, S. A. and Chapin, C. E., 1997, Cooling histories of mountain ranges in the southern Rio Grande Rift based on apatite fission-track analysis—a reconnaissance study: New Mexico Geology, v. 19, p. 1-14.
- Kempton, P. D., Fitton, J. G., Hawkesworth, C. J., and Ormerod, D. S., 1991, Isotopic and trace element constraints on the composition and evolution of the lithosphere beneath the southwestern United States: Journal of Geophysical Research, v. 96, p. 13,713-13,735.
- King, P. B., King, R. E., and Knight, J. B., 1945, Geology of Hueco Mountains, El Paso and Hudspeth Counties, Texas: U. S. Geological Survey, Oil and Gas Investigations Map OM-36, 1 sheet.
- Kness, R. F., 1994, Mineral resource investigation of part of the Fort Bliss military Reservation (McGregor Range), Caballo Resource Area, Otero County, New Mexico: U. S. Bureau of Mines, Mineral Land Assessment Report MLA-19-94, 46 p.
- LeMaitre, R. W., 1989, ed., A classification of igneous rocks and glossary of terms: Blackwell Scientific Publications, Oxford, England, 193 p.
- McMillan, N. J., 1998, Temporal and spatial magmatic evolution of the Rio Grande rift: New Mexico Geological Society, 49<sup>th</sup> Field Conference, Guidebook, p. 107-116.
- McLemore, V. T., 1996, Great Plains Margin (alkalic-related) gold deposits in New Mexico; in Cyner, A. R. and Fahey, P. L., eds., Geology and ore deposits of the American Cordillera: Geological Society of Nevada Symposium Proceedings, Reno/Sparks, Nevada, April 1995, p. 935-950.
- McLemore, V. T., Guilinger, J. R., and Oumiette, M. A., 1994, Geology of the Wind Mountain nepheline syenite deposit, Cornudas Mountains, Otero County, New Mexico: Society Mining, Metallurgy, and Exploration, Preprint 94-63, 10 p.
- McLemore, V. T., Lueth, V. W., Guilinger, J. R., and Pease, T. C., 1996a, Geology, mineral resources, and marketing of the Wind Mountain nepheline-syenite porphyry, Cornudas Mountains, New Mexico and Texas; in Austin, G. S., Barker, J. M., Hoffman, G., Gilson, N., and Zidec, J., eds., Proceedings of the 31st Forum on the Geology of Industrial Minerals, Borderland Forum: New Mexico Bureau of Mines and Mineral Resources, Bulletin 154, p. 127-136.
- McLemore, V. T., Lueth, V. W., Pease, T. C., and Guilinger, J. R., 1996b, Petrology and mineral resources of the Wind Mountain laccolith, Cornudas Mountains, New Mexico and Texas: Canadian Mineralogist, v. 34, pt. 2, p. 335-347.
- Mutschler, F. E., Griffin, M. E., Stevens, D. S. and Shannon, S. S., Jr., 1985, Precious metal deposits related to alkaline rocks in the North American Cordillera—an interpretive review: Transactions Geological Society of South America, v. 88, p. 355-377.
- Mutschler, F. E., Mooney, T. C., and Johnson, D. C., 1991, Precious metal deposits related to alkaline igneous rocks—a space-time trip through the Cordillera: Mining Engineering, v. 43, p. 304-309.
- Nutt, C. J., O'Neill, J. M., Kleinkopf, M. D., Klein, D. P., Miller, W. R., Rodriguez, B. D., and McLemore, V. T., 1997, Geology and mineral resources of the Cornudas Mountains, New Mexico: U. S. Geological Survey, Open-file Report 97-282, 46 p.
- Pearce, J. N., Harris, N. B. W., and Tindle, A. G., 1984, Trace element discrimination diagrams for the tectonic interpretation of granitic rocks: Journal of Petrology, v. 25, p. 956-983.
- Potter, L. S., 1996, Chemical variation along strike in feldspathoidal rocks of the eastern alkalic belt, Trans-Pecos magmatic province, Texas and New Mexico: Canadian Mineralogist, v. 34, p. 241-263.
- Price, J. G. and Henry, C. D., 1984, Stress orientations during Oligocene volcanism in Trans-Pecos Texas: timing the transition from Laramide compression to Basin and Range tension, Geology, v. 12, p. 238-241.
- Price, J. G., Henry, C. D., Barker, D. S., and Parker, D. F., 1987, Alkalic rocks of contrasting tectonic settings in Trans-Pecos Texas; in Mantle metasomatism and alkaline magmatism: Geological Society of America, Special Paper 215, p. 335-346.
- Seager, W. R., Hawley, J. W., Kottowski, F. E., and Kelley, S. A., 1987, Geology of east half of Las Cruces and northeast El Paso 1° by 2° sheets, New Mexico: New Mexico Bureau of Mines and Mineral Resources, Geologic Map 57, scale 1:250,000.
- Sillitoe, R. H., 1972, Relation of metal provinces in western America to subduction of oceanic lithosphere: Geological Society of America, Bulletin, v. 83, p. 813-818.
- Steiger, R. H. and Jager, E., 1977, Subcommittee on geochronology: Convention on the use of decay constants in geo- and cosmochronology: Earth and Planetary Science Letters, v. 36, p. 359-362.
- U. S. Army, 1998, Mineral and energy resource assessment of the McGregor Range: U. S. Army report, New Mexico Bureau of Geology and Mineral

Resources, OF 458, 543 p.  
 Wise, H. M., 1977, Geology and petrology of igneous intrusions of northern Hueco Mountains, El Paso and Hudspeth Counties, Texas: M. S. thesis, University of Texas at El Paso, 78 p.

Woolley, A. R., 1987, Alkaline rocks and carbonatites of the world, part 1: North and South America: University of Texas Press, Austin, and British Museum of Natural History, Cambridge, England, 216 p.

## APPENDIX 1. Sample location and description.

SAMPLE	LITHOLOGY	LATITUDE	LONGITUDE	COMMENTS
VTM97-55	quartz monzonite	32° 8' 22"	106° 8' 20"	outcrop
VTM97-60	alkali-feldspar trachyte sill	32° 1' 39"	105° 58' 37"	Outcrop
VTM97-63	trachyte	32° 5' 20"	105° 55' 5"	Outcrop
VTM97-179	syenite	32° 00' 31"	105° 59' 10"	Outcrop
VTM97-199	syenite	32° 1' 46"	105° 58' 52"	Outcrop
VTM97-212	syenite	32° 6' 3"	105° 56' 53"	Outcrop
VTM97-222	nepheline syenite	32° 1' 36"	105° 59' 39"	Outcrop
VTM97-223	syenite dike	32° 1' 36"	105° 59' 34"	Outcrop
VTM97-224	syenite	32° 1' 38"	105° 59' 29"	Outcrop
VTM97-326d	rhyolite	32° 4' 8"	106° 9' 52"	Drill core hole 46-6, box 65, depth 1284-1288 ft
VTM97-327d	rhyolite	32° 4' 23"	106° 8' 54"	drill core hole 45-5, 436.1 ft
VTM97-329d	rhyolite	32° 4' 42"	106° 9' 45"	drill core hole 61-6, 6795.8 ft
VTM97-330d	rhyolite	32° 3' 2"	106° 7' 58"	drill core hole 51-8, 570 ft
VTM97-331d	altered rhyolite	32° 3' 2"	106° 7' 58"	drill core 5198, 627 ft
VTM97-350d	rhyolite	32° 4' 20"	106° 8' 54"	Drill core hole 45-5, 1890 ft depth
VTM97-351d	rhyolite	32° 4' 20"	106° 8' 54"	Drill core hole 45-5, 2500 ft depth
VTM97-352d	rhyolite	32° 4' 42"	106° 9' 45"	Drill core hole 61-6, 1600 ft depth
VTM97-382	syenite	32° 3' 00"	105° 59' 00"	outcrop
VTM97-59	vein	32° 1' 48"	105° 58' 48"	Calcite veins in dolomite
VTM97-188F	float chip	32° 2' 20"	105° 55' 40"	Float sample of jasperoid
VTM97-190F	float chip	32° 00' 4"	105° 57' 47"	Float sample of altered limestone
VTM97-248F	float chip	32° 5' 9"	106° 4' 28"	Jasperoid
VTM97-249F	float chip	32° 5' 9"	106° 4' 28"	Jasperoid
VTM97-184	outcrop	32° 00' 16"	105° 58' 17"	Altered limestone
VTM97-195	Outcrop	32° 3' 44"	105° 57' 28"	Jasperoid
VTM97-200	Outcrop	32° 1' 39"	105° 58' 52"	Magnetite-hematite skarn
VTM97-201	Outcrop	32° 1' 39"	105° 58' 52"	Skarn
VTM97-202	Dump	32° 1' 39"	105° 58' 52"	Skarn
VTM97-203	6 inch chip	32° 1' 29"	105° 58' 55"	Skarn
VTM97-206	outcrop	32° 1' 23"	105° 58' 48"	Hornfels
VTM97-225	outcrop	32° 1' 37"	105° 59' 44"	Skarn



“A road through time.” Range Road 9 as it passes around the southern most lobe of the Carrizozo lava flow. The San Andres Mountains rise in the background juxtaposing the Proterozoic granites at the base of the range with one of the most recent igneous events in New Mexico. Paleozoic rocks cap the range.