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Thomas J. Frantes and Jerry M. Hoffer

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Palomas volcanic field, southern New Mexico and northern Chihuahua, Mexico

by

Thomas J. Frantes and Jerry M. Hoffer,

Department of Geological Sciences,
The University of Texas (El Paso)
El Paso, Texas

Introduction

The Palomas volcanic field (late Cenozoic) sets astride the international border in south-central Luna County, New Mexico, and northern Chihuahua, Mexico, approximately 80 mi west of El Paso, Texas (fig. 1). The field covers approximately 380 mi^2 and is bounded on the east and west by longitudes 107°35′ W. and 107°55′ W., respectively.

Lowman and Tiedemann (1968) named the volcanic rocks the Palomas volcanic field after a brief reconnaissance of the area. Balk (1962) mapped several outcrops of the volcanic rocks north of the international border. However, to date, no published data exist on the distribution and occurrence of volcanic features within the volcanic field.

Volcanic features

Rocks in the Palomas volcanic field consist primarily of olivine basalt and associated differentiates of andesite and trachyte. The field is located on the western flank of the Rio Grande rift and displays a number of differences when compared to olivine basalt occurrences previously investigated within the rift in southern New Mexico. These differences include: 1) an older age compared to the rift basalts, 2) the occurrence of more highly differentiated members, and 3) the occurrence of a number of interesting volcanic features, including "pillow" basalt structures, basalt dikes, and lava-capped cinder cones (fig. 2).

LAVA FLOWS—Olivine-rich basalt flows are the most dominant features in the field. They are moderate to highly weathered and have a partial mantle of eolian sand. The flows range in thickness from 1 to 40 ft, but average approximately 10 ft. They range from highly vesicular to extremely dense.

The olivine basalt displays typical vertical joints whereas the more highly differentiated members of andesite to trachyte composition are characterized by well-developed closely spaced platy joints (fig. 3).

Locally abundant are xenoliths of feldspar, quartz, peridotite, and orthopyroxene; these range in size from 2 mm to 4 cm.

CINDER CONES—Over 30 cinder cones have been mapped in the volcanic field (Frantes, 1981, fig. 4). The cones, ranging from 100 to 350 ft in height, show single or multiple vents. The cones are composite and consist of interbedded cinder, agglomerate, dense lava, and agglutinated spatter. They have steep slopes and the rim is typicaly breached on one or more sides where lava appears to have been extruded. Fusiform, almond-shaped, cylindrical ribbon, and cow-dung bombs are locally abundant around the base of many of the cinder cones.

A number of cinder cones display a basal section of pyroclastic materials capped by dense flow rock. These cones are interpreted as the result of lava welling up through a cinder-spatter cone and ponding in the central vent. Subsequent erosion has removed the encircling pyroclastic materials while removing very little of the more resistant dense flow rock (fig. 5). In addition, several cinder cones have been mapped that contain concentrically oriented dikes at the top of the cone.

DIKES—A number of basaltic dikes are exposed in the Palomas field. The dikes are of olivine basalt and are primarily associated with cinder cones. The dikes dip nearly vertical, are several feet in width, and average 400 ft in length (figs. 6 and 7). Several of the cinder cones are located at the intersection of two or more dike trends.

The dikes display two different orientations. One group are linear and strike in a generally north direction. These dikes are 1-15 ft wide and extend for distances of up to a maximum of 2,000 ft. Approximately 80% of the mapped dikes are linear. The second group occur as curving ring dikes near the top of several of the cinder cones; these dikes dip

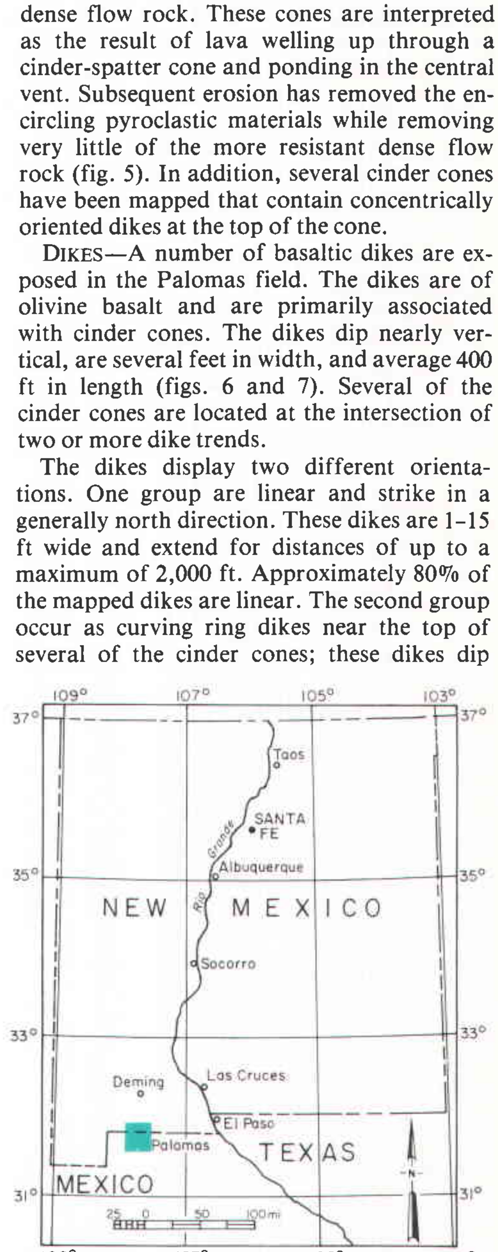

FIGURE 1—INDEX MAP SHOWING PALOMAS VOLCANIC FIELD.

almost vertically and partially encircle the vent area.

CONCENTRIC BASALT STRUCTURES—In a roadcut approximately 16 mi south of Palomas along Mexico Highway 25 are exposed oval to circular structures of dense basalt with interbedded hydroclastic materials. The structures range from 5 to over 25 ft in diameter and display concentric jointing patterns (fig. 8). They display an outer rim of very glassy basalt grading inward to fine-grained dense basalt.

The above structures, seen only in two dimensions, represent pillow basalts or large lava toes. The presence of interbedded hydroclastic materials, which are stratified with graded bedding present locally, indicates extrusion of basalt into a hydrous environment (fig. 9). The basalt flows may have flowed into a shallow lake where they broke up and partially sank while squeezing soft sediment between and around what are now seen as spherical pillowlike structures.

Composition of basalts

The mineralogy and chemistry of the Palomas volcanic rocks are summarized in table 1. Based upon their composition, three major rock types are represented: olivine basalt, andesite, and trachyte. ☞

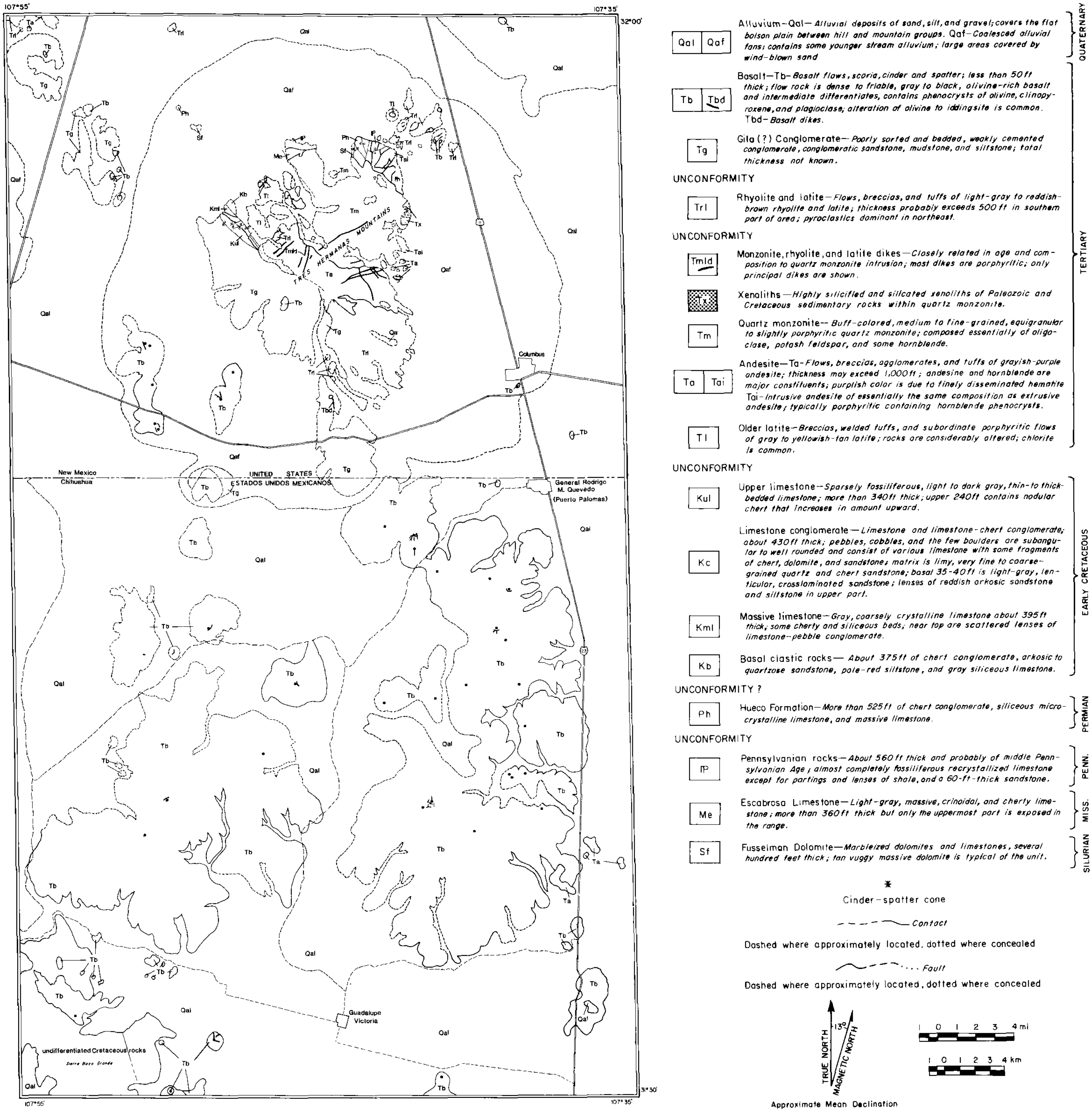

FIGURE 2—GEOLOGIC MAP OF PALOMAS VOLCANIC FIELD; Tres Hermanas Mountains mapped by Balk (1962) and Sierra Boca Grande mapped by Robinson and Clark (1981).

TABLE 1—Chemical composition and mineralogy of volcanic rocks, Palomas field (1 = number of analyzed samples, * = total Fe reported as Fe_2O_3).

Chemical Oxides	Olivine Basalt (37[1])	Andesite (7[1])	Trachyte (8[1])
SiO_2	45.26	52.63	57.95
TiO_2	2.38	1.66	1.40
Al_2O_3	14.57	15.25	15.37
Fe_2O_3*	11.83	9.93	7.03
MnO	0.16	0.15	0.12
MgO	10.59	3.96	1.45
CaO	9.09	7.15	5.03
Na_2O	2.93	4.58	5.12
K_2O	1.16	3.72	3.00
P_2O_5	0.54	0.63	0.63
	98.51%	99.66%	97.10%

Mineralogy	Olivine basalt	Andesite-Trachyte
Plagioclase	33 (An_{59})	60 (An_{49})
Clinopyroxene	20	11
Olivine + Iddingsite	18	4
Biotite	0	8
Magnetite	9	9
Glass	20	8
	100%	100%

FIGURE 3—Closely spaced platy jointing in basalt flow located approximately 16 mi south of Palomas on Mexico Highway 25.

FIGURE 4—Cinder-spatter cones, in background, at north end of volcanic field.

FIGURE 5—Cinder-spatter cone (lower slopes of cinder) capped by dense lava flows (cliffs); Tres Hermanas Mountains in background.

FIGURE 6—Basalt dike outcrop, southwest of Palomas.

FIGURE 7—Closeup of basalt dike shown in fig. 6; note dense nature of basalt and vertical jointing.

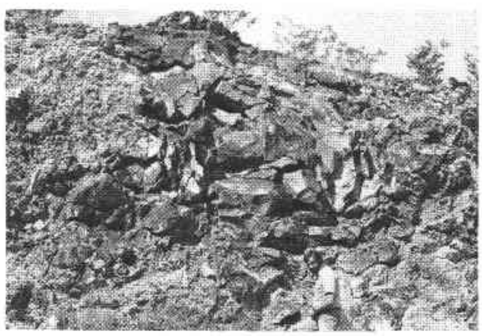

FIGURE 8—Dense, concentrically oriented jointing in basalt toe or pillow structure, exposed in roadcut approximately 15 mi south of Palomas, Mexico. Lighter colored materials are primarily clay and silt.

FIGURE 9—Parallel-bedded hydroclastic materials overlain by dense basalt; roadcut approximately 15 mi south of Palomas, Mexico.

The olivine basalts are fine-grained to glassy and contain abundant olivine and pyroxene. Chemically, they have low SiO_2, Na_2O, and K_2O concentrations and high MgO concentrations. In the field, the basalts are typically dark gray to black and dense.

The andesites and trachytes are more coarse grained and contain more plagioclase than the basalts. Chemically, they contain more SiO_2, Na_2O, and K_2O and less MgO, Fe_2O_3, and CaO than the basalts. The andesites and trachytes are generally light to brown in color and display platy jointing.

Basalt ages and origin

Field relationships show that the olivine basalts are younger than the andesites and trachytes (Frantes, 1981). Three occurrences of olivine basalt have been dated (K-Ar) from southern Luna County, New Mexico, giving dates of 2.96 ± 0.07, 3.91 ± 0.18, and 5.17 ± 0.11 m.y. (Hawley, 1981). The Palomas volcanic rocks are therefore at least Pliocene in age.

The rocks of the Palomas field are clearly differentiated, and it is suggested that the differentiation is because of fractionation in the magma close to the earth's surface.

Solidification indexes (SI) of the Palomas volcanic rocks were calculated (after Kuno and others, 1957) and found to range from 57.1 in an olivine basalt sample to 4.9 in a trachyte. Many of the olivine basalts and all of the intermediate rocks in the Palomas volcanic field have SI values less than 35. Renault (1970) reports that SI values less than 35 are thought to result from differentiation of basaltic magma within the crust. Several olivine basalt samples have values of SI greater than 35 which implies little or no differentiation. The lack of differentiation in some of the olivine basalts suggests that they were transported from the mantle in a relatively short period of time, whereas the other olivine basalts and intermediate rocks previously mentioned probably resided in a magma chamber in the crust long enough for significant differentiation to occur.

The presence of high-pressure phase xenocrysts such as enstatite and feldspar are further evidence that some of the basalts were brought to the surface from the mantle in a short period of time.

The plagioclase-rich rocks (andesites and trachytes) are older than the olivine basalts and therefore were emplaced first. These rocks represent successive tapping of a differentiated magma reservoir. This type of activity has been suggested for the basalts in the nearby West Potrillo Mountains by Hoffer (1976). The intermediate rocks represent eruptions from the top of the magma chamber, where plagioclase and biotite, being less dense than the magma, concentrated. Later eruptions were from the lower part of the reservoir where clinopyroxene, olivine, and dense mafic xenoliths concentrated. This explains the occurrence of the more differentiated flows underlying the olivine and clinopyroxene phenocrysts, lack of peridotite xenoliths,

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Palomas volcanic field

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significantly lower MgO concentration, total Fe content, and higher SiO_2 and alkali content of the andesites and trachytes relative to the olivine basalts.

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