Malpais maar Volcano

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MALPAIS MAAR VOLCANO

by
RICHARD 0. PAGE
Department of Geological Sciences
The University of Texas at El Paso
El Paso, Texas 79968

INTRODUCTION

Malpais maar is a Quaternary tuff ring, similar to the well-known Kilbourne, Hunts' and Potrillo maars (Reeves and De Hon, 1965) formed by phreatomagmatic eruption of alkalic olivine basalt at the southern margin of the Potrillo basalt field, southcentral New Mexico (Fig. 1). The vent penetrated shallow aquifers or water-saturated surficial sediments or both, and began eruption as a maar volcano, depositing up to 50 ft (15 m) of bedded hyaloclastic debris over the surrounding area. During eruption, water was excluded from the vent, and the style of eruption changed to lava fountaining and tephra production, constructing a cinder cone and flow complex within the crater. Late stage activity included extrusion of parasitic lava flows, intrusion of dikes into the bedded tuff sequence, and eruption of a small parasitic, maar-type vent (Fig. 2).

STRATIGRAPHY

Volcanic rocks of Malpais maar include three major lithologies, listed below (Page, 1973):

1. bedded hyaloclastic tuffs and breccias,
2. scoriaceous cinder and bombs (tephra), and
3. flows and dikes of alkalic olivine basalt.

Lithologies (1) and (2) are completely gradational as are lithologies (2) and (3), but no gradation exists between (1) and (3).

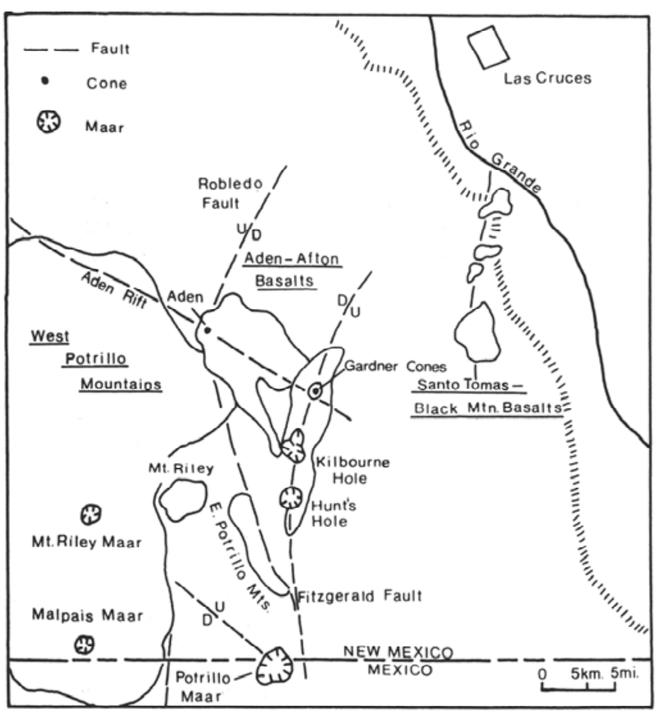

Figure 1. Index map of Potrillo basalt field and location of Malpais maar.

Tephra and flow units of Potrillo Basalt are discussed elsewhere in this paper and will not be described in this section.

Hyaloclastic units of Malpais maar were deposited from horizontally-moving, base-surge eruption clouds, which spread radially from the vent area. The eruptions covered the surrounding terrain with a coating of wet debris, extending at least 2.1 km from the vent (Fig. 2, unit T1). Moore and others (1966) describe a similar, recent occurrence at Taal Volcano in the Philippines, where base surge deposits are found in excess of 6.0 km from the vent. Thickest accumulations of tuffs at Malpais maar are located where the base surge clouds encountered raised topography (nearby cinder cones) and were forced to move upslope. The deposits wrap gently around this topography, dipping away from the peaks at 5 to 20 degrees.

Hyaloclastic units may be subdivided on the basis of grain size and bed morphology (Fig. 3). In all of the tuffs, the matrix (<0.06 mm) is composed of highly altered, basaltic glass (palagonite) with subordinate amounts of fragmented lithic and mineral grains. A few glass fragments are observed as faint, relic outlines, and rarely (<0.5%) as clear, unaltered, orangish-brown glass.

Coarse ash tuffs and lapilli tuffs comprise the majority of the bedded hyaloclastic sequence. They are diverse in appearance, primarily due to the variegated coloration of the lithic fragments. This accidental ejecta forms a large percentage of the coarser tuffs, and includes:

1. at least two distinct basalt types;
2. at least eight different types of Tertiary (?) extrusive and/or hypabyssal volcanic rocks (rhyolite to andesite, crystal and vitric tuff and breccia);
3. mineral fragments, primarily of quartz and alkali feldspar, with minor plagioclase and mafics; and
4. sparse fragments from considerable depth (sedimentary, and plutonic igneous rocks).

Sedimentary structures, typical of base surge deposits (Crowe and Fisher, 1973), are present throughout the bedded tuff sequence. These structures include:

1. long wavelength, low amplitude, undulatory bedding (plane parallel lamination);
2. asymmetrical, ripple-like to dune-like bed forms;
3. small- to large-scale cross laminations; and
4. bedding sag deformation under bombs and blocks.

Unfortunately, Malpais maar tuffs are not amenable to disaggregation for sieve analysis, due to partial induration by alteration (palagonitization) and caliche cementation.

STRUCTURE

Malpais maar began activity with the eruption of base surge to vertical explosion clouds. Continued activity of this type created a crater-form depression, which was enlarged presumably by both slumping of the crater walls along ring fractures, and by active quarrying of the walls by steam explosions. Once the crater size stabilized with the eruptive energy of the vent, base surge clouds constructed a low rim of bedded ejecta

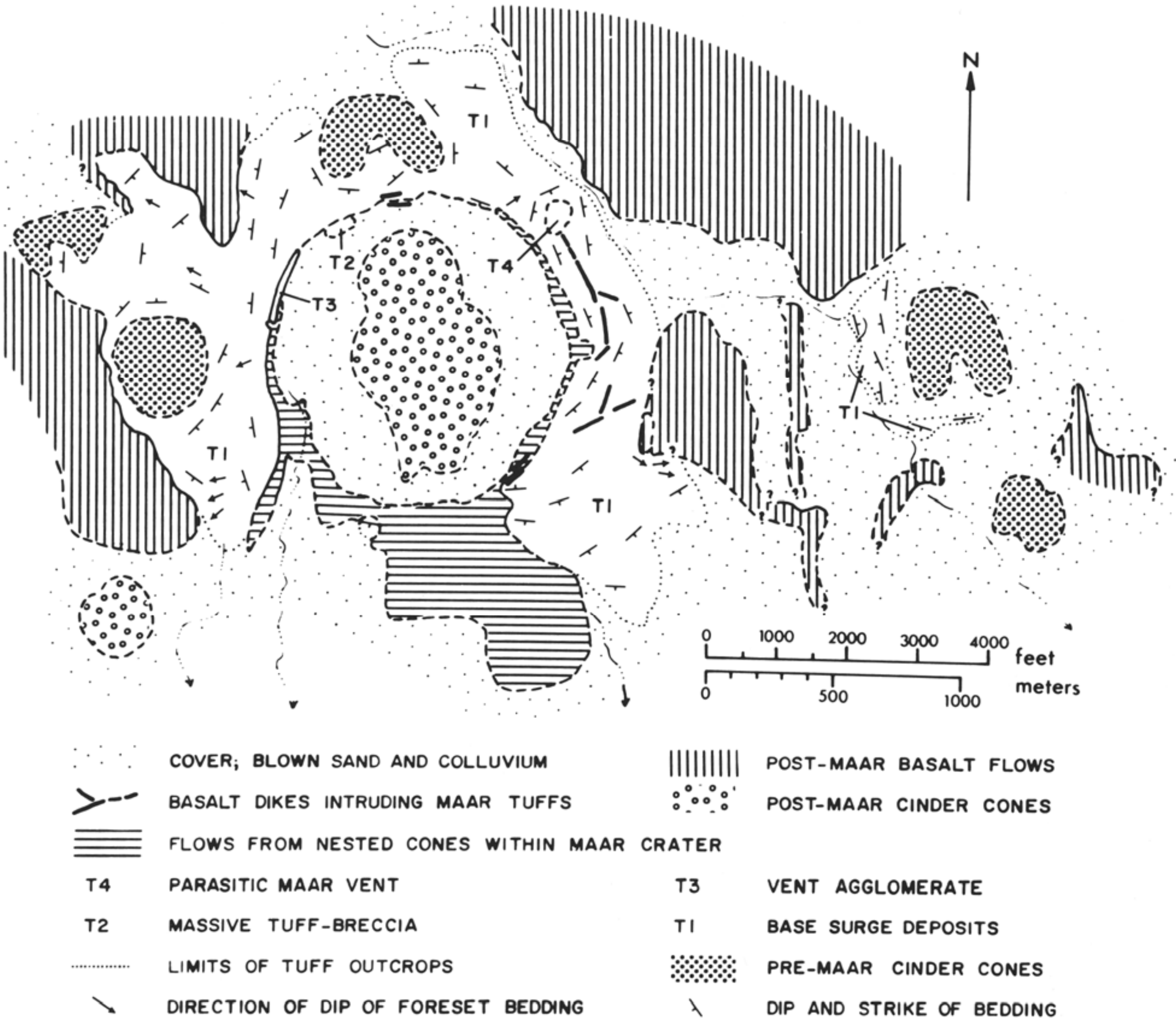

Figure 2. Generalized geologic map of Malpais maar.

around the crater. The maar rim is nearly circular, approximately 1,250 m in diameter, and is perhaps 10 to 15 m in height, although the lower contact is not exposed.

Inward-dipping beds are exposed at three locations along the maar rim, dipping 30 to 35 degrees towards the center of the crater. Outer flank beds near the rim dip 5 to 20 degrees away from the vent. Farther from the rim, bedding in the tuffs generally conforms to subdued pre-tuff topography, although cross laminations in ripple and dune bedforms indicate a consistent, radial transport for the base surge clouds.

When water ceased to have access to the vent, the eruption changed from predominately base surge to lava fountaining and tephra production. Lava ponding within the maar crater, evidenced by numerous, thin, sub-horizontal flows, also occurred during this second eruptive phase. However, the precise relationship of the lava ponding to the multiple-vent, cone complex (also within the crater) is obscured by colluvial and alluvial deposits. A few of the lava flows within the crater overtopped the maar rim, flowing out over the tuff surface for short distances.

Late stage activity of the vent area, possibly coeval with parasitic flows originating from the cone complex, was restricted to dike intrusion into the bedded tuff sequence. The dikes are concentrated along the maar rim, and appear to have reached the surface in at least one location. A small, maar-type vent is found along the strike continuation of one of the dikes, where it presumably penetrated water-saturated alluvium or bedded hyaloclastic debris or both.

ACKNOWLEDGMENTS

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lithology	bed morphology
fine ash tuff (airfall)	thin bedded to finely laminated; plane parallel bedding with no cross lamination; rare accretionary lapilli
fine ash tuff (base surge)	thin bedded to finely laminated; plane parallel to rippled bedding, with very low-angle, small-scale cross lamination
coarse ash tuff (base surge)	thin to medium bedded; plane parallel to rippled to duned bedding, with small- to large-scale cross lamination (preservation of both stoss and lee side laminae)
lapilli tuff (base surege	medium bedded; plane parallel to duned bedding; massive to cross laminated
bedded tuff-breccia (base surge)	medium to thick bedded, generally massive with rare internal stratification; low matrix content
massive tuff-breccia (vent plug?)	massive and unjointed; high matrix content; location within maar rim

Grain size classification follows: Fisher (1966)

Figure 3. Bed morphology of hyaloclastic lithologies, Malpais maar.

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