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A NOTE ON THE VOLCANIC FEATURES OF THE ADEN CRATER AREA, SOUTHCENTRAL NEW MEXICO

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INTRODUCTION

The Aden crater area is located in the northwest part of the Aden basalt field, approximately 25 mi southwest of Las Cruces, New Mexico (Fig. 1). The area is covered by thin flows of Quaternary olivine basalt of the Potrillo Basalt.

Aden crater lies astride the Aden rift; the rift strikes northwest into the north end of the West Potrillo Mountains. Southeast of Aden, along the rift, are located numerous volcanic features derived by collapse or explosive action or both.

The Robledo fault passes to the east of Aden crater. The fault can not be traced directly across the basalt, but its presence is inferred from the alignment of numerous elongate depressions and collapse depressions. It is thought that the lavas of the Aden Basalt were emplaced along fissures associated with the Robledo fault and Aden rift.

VOLCANIC FEATURES

Aden Crater

Aden crater is the most prominent feature in the area; it is classified as a shield cone by DeHon (1965). The base of the cone is approximately three to four miles in diameter and is made up of thin basaltic flows sloping from the cone with dips of 3 to 5 degrees. The rim is composed of spatter layers dipping 30 to 45 degrees inward toward the center of the crater. Within the central crater is a series of parallel lava flows representing a former lava lake. A spatter cone and collapse depression are located in the southeast portion of the crater (Figs. 2 and 3).

The formation of Aden crater involves the following series of events (Hoffer, 1973, 1975). Initially, a series of lava flows

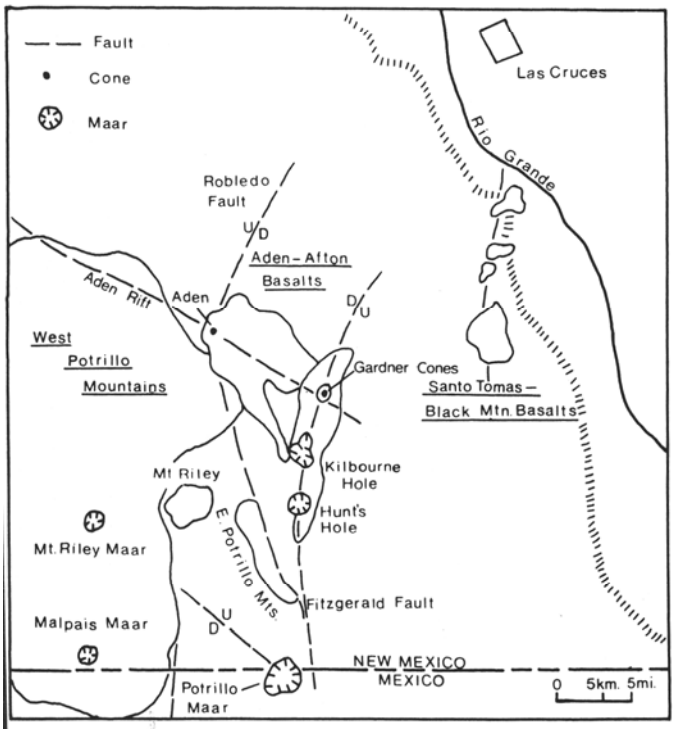

Figure 1. Index map of the Potrillo Basalt.

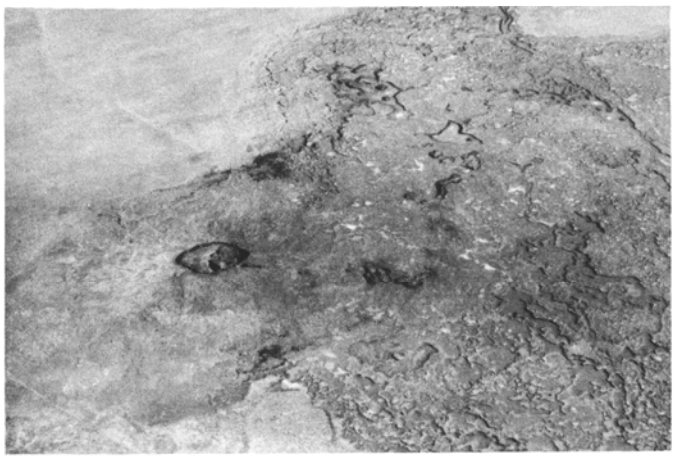

Figure 2. Oblique aerial photograph of the Aden area, view to the north. Scale is one inch equals approximately one-half mile.

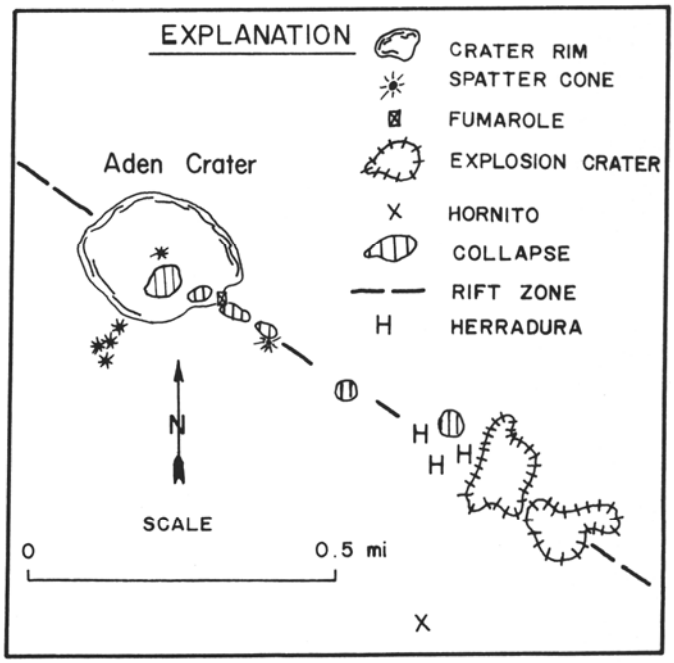

Figure 3. Volcanic features in the Aden area.

issued from a central vent and built up a gently sloping shield cone. This period of quiet activity was followed by a more explosive phase in which spatter was ejected, constructing a nearly circular rim around the orifice. At about the same time, a rift opened on the southern flank of the crater and ejection of spatter produced several small spatter cones. A less explosive phase followed in the main crater in which lava rose to the surface, was dammed by the spatter rim, and formed a lava lake. The individual flows in the crater interior average 1 to 2 ft in thickness. At several low places along the spatter rim lava overflowed, producing thin tongues and lava tubes along the flanks. The low viscosity of the lava is indicated by the fact that some of the lava tubes and tongues are only 6 to 18 in. wide and several hundred feet in length.

Late activity in the crater consisted of minor explosive action, producing a small spatter cone in the center of the crater, and a withdrawal of the lava down the primary vent, producing a collapse pit near the center of the main crater. Solidification of the lava lake produced tension cracks parallel to the spatter rim. The final activity was confined to a fumarole located on the east rim. A ground sloth *(Nothrotherium shastense)* recovered and described from the fumarole by Lull is dated at 11,000 years B.P. (Simons and Alexander, 1964) (Fig. 3).

Spatter Cones

Spatter cones or mounds are rare in the Aden basalts; their occurrence is restricted mainly to the flanks and interior of Aden crater. Four or five spatter cones are located along a fissure on the south flank of Aden crater; the mounds range in height from 4 to 8 ft and are 30 to 40 ft in diameter. Two small spatter cones exist within Aden crater itself and are located to the north of the large collapse area. A small spatter mound, approximately 5 ft high and 20 ft in diameter, can be seen on the floor of one of the explosion craters in the central part of the field.

Explosion Craters

Several major craters which show the effects of explosive activity are located approximately 0.5 mi southeast of Aden crater (Fig. 4). The craters are irregular in shape and are located on the crest of a broad ridge that can be traced southeastward from the flank of Aden crater along the Aden rift. This broad ridge is composed of thin lava flows, and, in addition to the explosive craters, several collapse craters are located along the crest. The ridge represents a major fracture or rift (Aden rift) along which lava was extruded during the formation of the Aden basalts.

Characteristic features of these explosive craters include a broad rim, 10 to 30 feet high, composed of large angular fragments of dense basalt and an interior region of thin lava flows (Fig. 4). The lava flows are nearly horizontal, or they may dip gently toward the center of the crater, with dips increasing toward the outer edges of the crater.

The origin of the explosive craters is thought to be a combination of explosive activity followed by collapse. Activity was initiated with the extrusion of thin lava flows from central vents along a rift zone. An explosive period followed in which the flows near the vents were fragmented and accumulated in a rampart encircling the vent. Renewed extrusions of basalt

Figure 4. Oblique photograph showing dark rim of angular basalt enclosing an explosive crater. To the left, note U-shaped lava ridges (herradura) flowing from near the rim of a small cone.

filled the crater with thin flows which formed a lava lake. In several craters, these extrusions were followed by central collapse, which produced a gentle sloping interior depression. In other craters, the lava lake simply cooled without subsequent collapse. Final activity built small spatter cones on the floor of several of the craters.

Lava Flows

The lavas of the Aden flows are alkaline olivine basalts. The individual flows or flow units are thin, ranging from a few inches to 17 ft in thickness; they average approximately 10 ft. Typically, the flows are highly vesicular with vesicules concentrated near the top and bottom of the flow; zones of elongate vesicules are common near the top of many flows. Columnar jointing is poorly developed, consisting of irregular and sometimes discontinuous vertical joints outlining very irregular columns 1 to 2 ft in diameter. The surface of most flows is relatively smooth, with occasional development of ropes; they are classed as pahoehoe flows. Northeast of Aden crater lies a small portion of one of the flows; it is composed of broken, irregular, and spinose blocks of lava typical of aa.

Flow Features

Associated with the Aden flows are several features which include pressure ridges, lava tubes, horseshoe-shaped lava ridges (herradura) and several hornitos ("rootless" volcanoes).

Pressure ridges are relatively common, but are generally located near the margins of the field. They range from less than 3 ft to over 30 ft in height. The pressure ridges possess a typical medial crack, which narrows downward, and are elongated parallel to the edge of flows.

Lava tubes and thin tongues of basalt are common on the flanks of Aden crater. The extremely low viscosity of the lava is evident by the fact that some of the lava tubes are less than 1 ft across but extend for several hundred feet. Cross-sections of numerous small lava tubes are exposed in the walls of several collapse craters southeast of Aden crater. Several large lava tongues, 5 to 6 ft across, are present on the flanks of the cone. They possess marginal ridges or levees of lava.

Herraduras or horseshoe-shaped lava ridges are common on the flanks of one of the collapse craters located about 0.5 mi southeast of Aden crater, and several similar structures are present on the eastern and western margins of Aden crater (Hoffer, 1971). The ridges are generally U-shaped with the open end pointing downslope. They are composed of thin-layered flow units of vesicular and ropy basalt. The layering dips steeply upslope at the closed end of the structure, but is nearly horizontal or nonexistent on the flanks or "horns" of the herradura (Figs. 4 and 5). The herraduras are 1 to 3 ft in height, 30 to 150 ft in length, and 7 to 50 ft in width across the horseshoe. Width of the individual ridges is about 4 ft, but some extend up to 8 ft. The marginal ridges or "horns" tend to converge downslope, but never merge; several, however, bifurcate into smaller ridges downslope. Nesting of three to four such structures in a group is common. The herraduras appear isolated with no direct connection between them and the underlying flows. However, observations show that the surface of the underlying flow grades gently upward and merges with the lower portion of the closed end of the herradura. This suggests that the lava of the herradura was extruded through the surface of the underlying flow. In one locality, a bifurcating lava tongue has formed a herradura; the

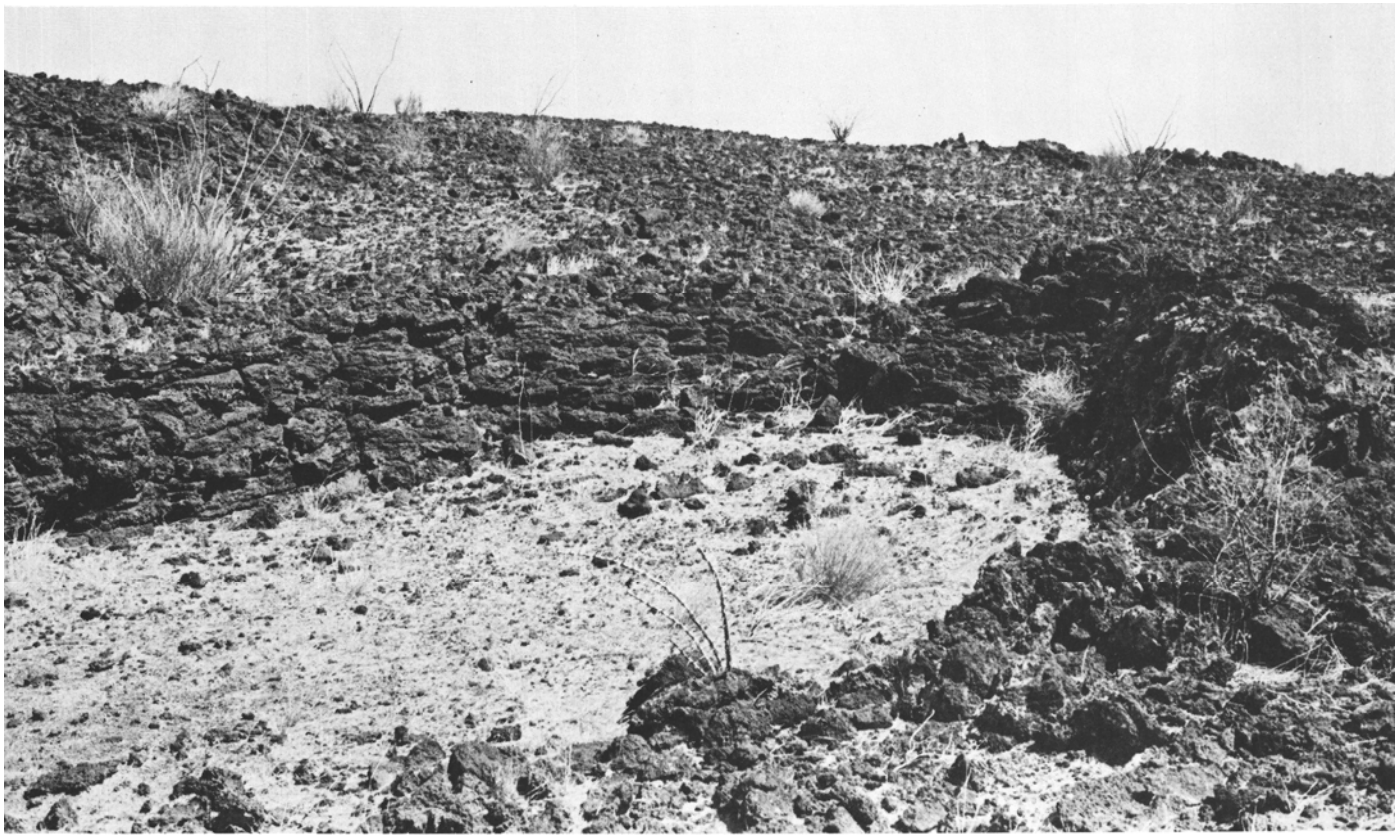

Figure 5. View of a herradura, closed-end to the upper right with open-end (downstream) to the lower left.

single lava ridge, before it splits, can be traced several feet upslope where it disappears into an underlying flow. Almost vertically oriented layering is displayed in blocks and fragments inside the curved head of the structure indicating the presence of a buried obstacle that caused the lava stream to bifurcate.

Various stages in the development of these structures can be seen on the flanks and crest of a collapse crater approximately one-third of a mile southeast of Aden crater. The initial stage shows a small area of surface irregularities consisting of almost vertical layered thin flow units bulging from the crest of an individual flow with no "horns" or marginal ridges. A more advanced stage is represented by small herraduras with short "horns" only 3 to 10 ft in length. Maximum development consists of U-shaped lava ridges measuring 150 ft in total length.

Most of the herraduras are located at or near the crest of a broad dome or swell at the top of an underlying flow. The flow units at the head of each herradura are composed of lava ropes oriented tangent to the line of curvature at the head of the structure; the ropes can be traced into lava tubes on the flanks or "horns" of the herraduras. Small lava tubes are also abundant in the upstream portion of the herraduras; the floors of the tubes dip downward and upslope indicating flowage from a source beneath the surface.

The herraduras have formed by the extrusion of lava through the crust of an underlying flow. Basaltic lava flows of this type are commonly inflated with gas as they travel; the former high gas content is indicated by the high degree of vesicularity seen in the flows and flow units of the area. The broad domes present below most of the herraduras undoubtedly represent an accumulated pocket of gas that caused the thin flow crust to bulge up. A buckling of the crust at the top of the dome, along with differential collapse of the flow top, would have produced a crack or series of fractures which allowed molten lava to ooze out onto the surface of the flow.

The resulting lava ridges could be explained easily if the major fracture is oriented tangent to the U-shaped end of the structure. Small gushes of lava followed after the initial fracturing of the dome, oozing up and along the length of this crack. After this initial extrusion, the lava would flow down the sides of the dome and produce the "horns" or marginal ridges of the herradura. The crest of the dome would act as a barrier to the flow and the lava oozes would simply pile up producing the characteristic layering observed at the upstream portion of the herraduras.

REFERENCES

DeHon, R., 1965, The Aden Crater lava cone: Compass, v. 43, p. 34-40.

Hoffer, J. M., 1971, Herradura: A new lava flow feature, Geol. Soc. America Bull., v. 82, p. 2949-2954.

Hoffer, J. M., 1973, Summary of the Cenozoic geology of southern Dona Ana County, New Mexico: El Paso Geol. Soc., 7th Annual Fieldguide, p. 12-15.

Hoffer, J. M., 1975, The Aden-Afton basalt field, southcentral New Mexico: Texas Jour. Sci., (in press).

Simons, E. L., and Alexander, H. L., 1964, Age of the Shasta ground sloth from Aden Crater, New Mexico: Am. Antiquity, v. 29, p. 390-391.