GIANT AMYGDULES IN ANDESITE FROM THE SOUTHERN QUITMAN MOUNTAINS, TEXAS*

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ABSTRACT

The volcanic rocks of Tertiary age of the southern Quitman Mountains in Hudspeth County, Texas, contain some rather unusual amygdules. The cavity fillings are mostly varieties of silica, but one zone has much calcite, and there are minor amounts of iron and manganese oxides, montmorillonite, and saponite. The individual amygdules range in size from microscopic to some eight inches in diameter. Previously these volcanic rocks have been lumped as "rhyolitic volcanics," but more detailed study shows them to range from rhyolite and rhyolite tuff through trachyte to andesite. The amygdules are confined to the andesite. The amygdules appear to be confined to the neighborhood of highly jointed zones that provided access for later hydrothermal solutions, which altered the andesite and deposited the minerals of the amygdules.

INTRODUCTION

Location of area

The Quitman Mountains form one of the northwest-trending ranges of trans-Pecos Texas. Starting at the pass on the Southern Pacific Railroad 10 miles west of the town of Sierra Blanca, they extend in a southeasterly direction for a distance of 35 miles. Their southern end is on the Rio Grande, between Indian Hot Springs and the mouth of Quitman Arroyo. The area covered in this report is shown by diagonal lines on Figure 1.

Previous work

The northern part of the Quitman Mountains, down to Quitman Gap, has been mapped and described in detail by Huffington (1943). The southern part of the range is much less completely known. Von Steeruwitz (1890, p. 680), from the disturbed structural condition of the area and the presence of hot springs, assumed that there were igneous rocks present, but apparently he did not find them. He gave an account of the geology of much of the trans-Pecos country, but he did not prepare a geologic map.

Baker (1927) mapped the Quitman Mountains on a scale of 4 miles to the inch. His map shows two areas of "rhyolitic volcanics" on the eastern flank of the range from about 3 to 10 miles from its southern extremity. The general geologic relations shown in Figure 2 are after Baker's map.

Taff (1890, Pl. 27) shows a structure section across the southern part of the range in the neighborhood of Quitman Gap, where there are no

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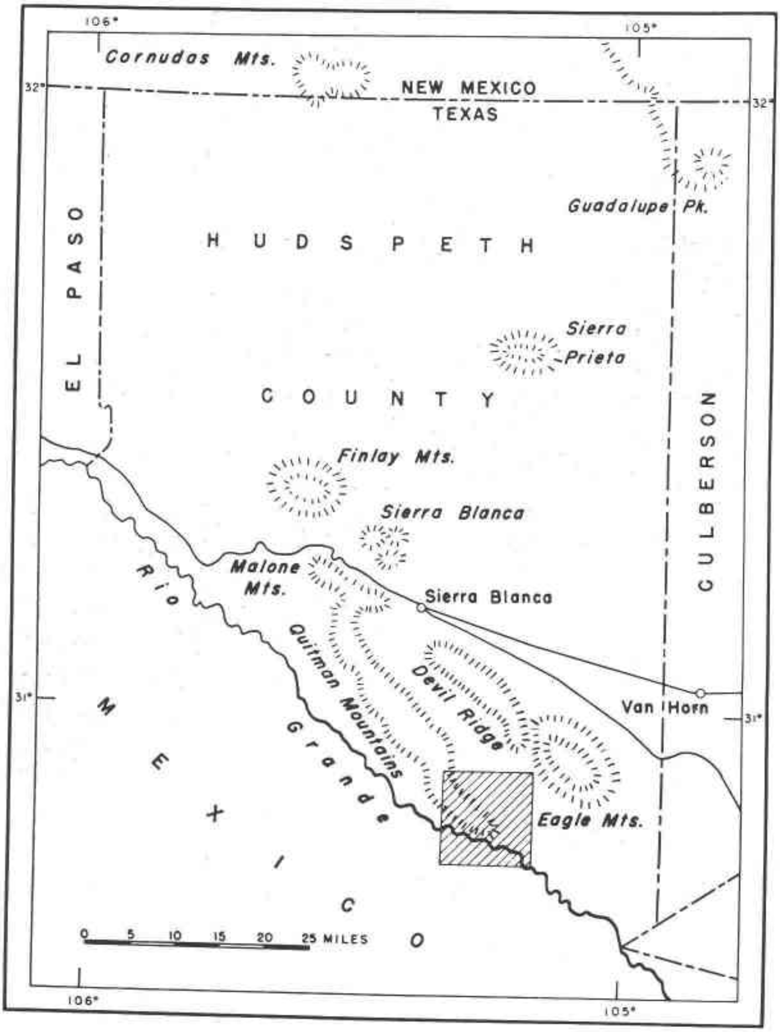

FIG. 1. Index map showing the location of the area described.

volcanics. Baker (1927, 1934) has given more details of the structure, including recognition of a thrust fault and location of the major fold axes.

Volcanic Rocks

Baker's map shows two areas of volcanic rocks separated by alluvium and sedimentary rocks of Cretaceous age. It is possible that a cross fault is covered by the alluvium. Although there are many local irregularities in the structure, the dips in the northern area are steeper and the strikes

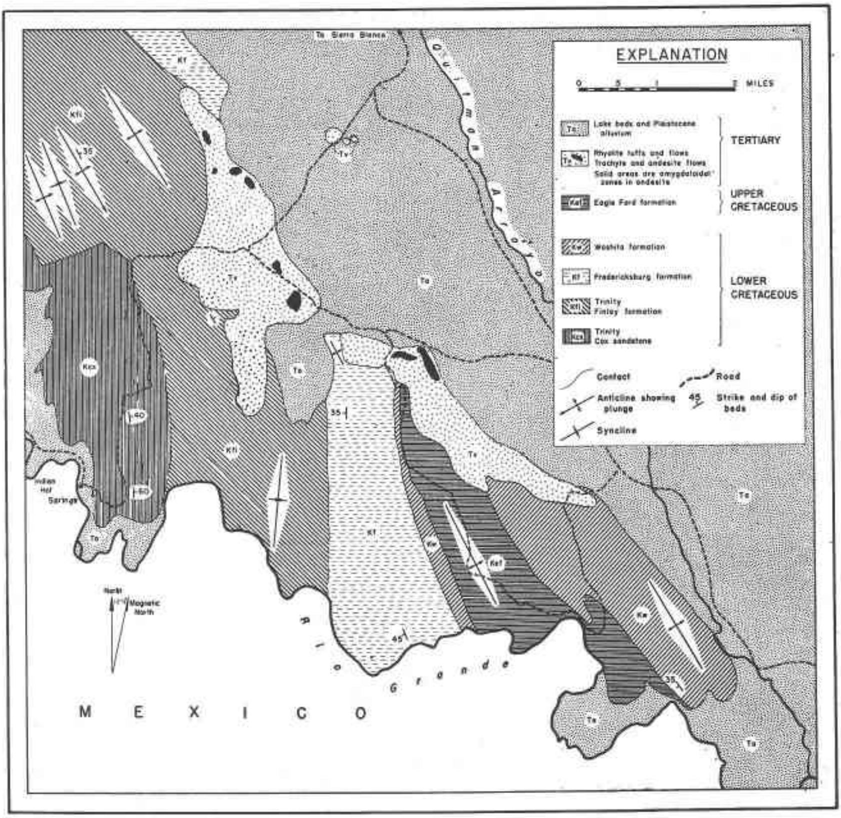

FIG. 2. Geology of the southern tip of the Quitman Mountains, adapted from Baker (1927). Distribution and structure of the sedimentary rocks after Baker (1927). Distribution of volcanic rocks modified from Baker (1927). Distribution of amygdaloidal areas (solid black) mapped by present author.

are more nearly northward than those of the southern area.

There is a third outcrop of volcanic rocks not shown on Baker's map. It is smaller than either of the other two and is located on the Sierra Blanca-Indian Hot Springs road about 1.8 miles northeast of where the road enters the northernmost of the two areas of volcanic rocks shown on Baker's map. This area is composed of red trachytic, nonamygdaloidal rocks. It may be connected with the other area(s) under the alluvial cover. The three areas of volcanic rocks and the associated sedimentary rocks are shown on the geologic map, Figure 2.

In the two areas shown by Baker, rhyolitic rocks probably predominate, although in the northernmost area trachytic to andesitic rocks are about as abundant as rhyolites. In the northern third of the southern area trachytes and andesites predominate, but the rest of the area, where a much thicker section is exposed, consists almost entirely of rhyolites and rhyolite tuff.

The entire thickness of the volcanic rocks is nowhere exposed, because the eastern edge of the areas is covered by the alluvium that laps onto the eastern flank of the mountains from Quitman Arroyo.

Amygdules in Andesite

General

For many years inhabitants of the Sierra Blanca area have collected rounded to elongate agate and quartz masses in the southern part of the Quitman Mountains. The locality is referred to as the "geode bed," and many of the specimens do resemble geodes, being cavities lined with chalcedony and quartz crystals (Fig. 4).

In the fall of 1951 the writer spent several days in the area. The "geodes" turned out to be amygdules, some of remarkable size, in reddish andesite. Plate I A and Figure 3, top-center, show the manner of occurrence in the andesite. In the short time available it was not possible to do more than map the zone in which they occur and to collect speci-

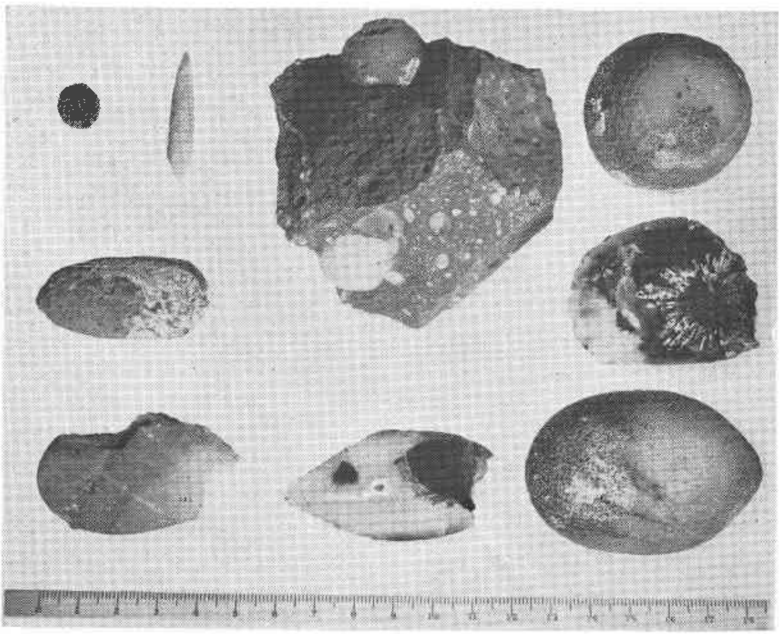

Fig. 3. Group of amygdules showing variations in size and shape. Note zeolite-like mineral in right center specimen. Scale is in centimeters.

PLATE I A. Color photo showing manner of occurrence of the amygdules in andesite. Scale is in centimeters.

PLATE I B. Color photo showing cross section of typical amygdule with agate banding around the periphery and quartz crystals in the interior.

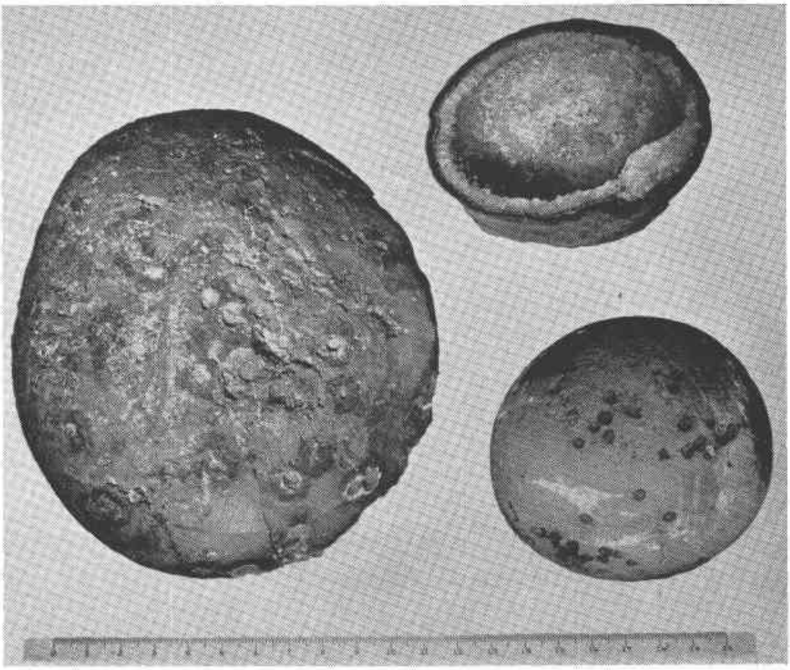

FIG. 4. Two larger amygdules showing near-spherical shape of those in this size range. Scale is in centimeters.

mens of the amygdules, the andesite that contains them, and the associated volcanic rocks.

Figure 2 shows the areas (solid black) in which the amygdules were found. These areas are zones in andesite; no amygdules were found in the associated rhyolites or trachytes. There are also areas in the andesite where the vesicles are not filled. The amygdules appear to be related to cross faults or highly jointed zones.

Size

The amygdules range in size from microscopic up to several inches in diameter. The largest one found thus far is almost 8 inches in diameter; sizes up to 3 inches are common.

Shape

The largest amygdules are all more or less spheroidal, probably because large gas cavities are unstable under differential motion of the containing lava. The smaller ones range from spherical to highly elongate and flattened, depending on the shapes of the vesicles at the time the lava ceased its motion. The most highly elongate one collected measures 35×6×4 mm. Figures 3 and 4 show something of the range in size and shape.

Structure

Typically the vesicles are filled more or less completely with silica. In general the larger ones are less completely filled than the smaller ones, although a few as much as 4 inches in diameter are completely filled, and some hollow ones only a few millimeters in diameter have been found. Commonly there is a banded rim around the outside, and the interiors are filled to varying degrees with quartz. The thickness of the banded rim may be only a few per cent of the diameter of the cavity, or may constitute almost the entire filling. Plate I B shows a typical amygdule of medium size with agate around the periphery and quartz crystals projecting into a central cavity.

Mineralogy

The mineralogy of most of the amygdules is very simple. The banded rim is "agate," chalcedony with or without intercalated layers of opal and/or quartz.

The quartz of the central cavities varies from paper-thin layers of very fine crystals to massive fillings with the largest crystals up to half an inch long and an eighth of an inch in diameter. The quartz crystals are roughly proportional in size to the size of the cavity or amygdule that contains them. They tend to grow with their *c*-axes normal to the cavity walls.

Many of the amygdules contain rounded black masses embedded in the siliceous filling. (See Pl. I B and Fig. 3.) They are, for the most part, so thoroughly impregnated (partly replaced) by silica that optical and *x*-ray methods fail to differentiate their substance from the matrix. In cavities where the material is still partly friable it consists of a mixture of manganese and iron oxides.

In some of the amygdules there are radiating masses that very much resemble zeolites in structure and cross section of individual blades (Fig. 3, right-center). They are so thoroughly impregnated and replaced with silica, however, that no mineral other than silica can now be identified.

Near the northwest tip of the more northwesterly of the two areas of amygdules in the southern patch of volcanics, there is a zone in which the mineralogy of the amygdules is quite different. In this zone most of the amydules are filled with coarse-grained calcite; a few cavities are entirely filled by a single anhedron.

Montmorillonitic and saponitic clay is associated with the calcite, as cavity linings outside of the calcite, as rounded masses enclosed by carbonate, and as irregular intergrowths with the calcite. The montmorillonite is flesh colored to pink, and the saponite is yellowish green.

There are also silica-filled amygdules in and near this zone. Many of them are coated and/or intergrown with saponite, and a few were found in which calcite crystals rest on the quartz lining.

Origin

All of the areas of amygdules appear to be associated with cross faults or zones of shearing where the rock is highly jointed. This is particularly true of the area where the fillings are largely of calcite. Here the structure of the andesite strikes approximately eastward and dips some 25° N. The calcite-clay amygdules are related to a prominent zone of closely spaced cross joints that strikes N. 25° E. and is almost vertical. In addition to the amygdules there are abundant joint fillings and coatings and irregular masses of calcite at intersections of joints.

The vesicles were probably filled under near-surface conditions by means of low temperature hydrothermal solutions. The association of saponite, montmorillonite, calcite, opal, chalcedony, zeolites(?), and low-temperature quartz suggests temperatures not much in excess of 100° C. There is a possibility that much of the deposition was accomplished below 100° C. Several samples of the largest quartz crystals were studied carefully for liquid inclusions, but none could be identified with certainty. Some of the crystals contain planes of very small inclusions with about the right index of refraction for aqueous solutions, but no vapor bubbles could be identified even with a high-power objective. If these inclusions are liquid this observation is consistent with a low temperature of formation.

It is probable that these rocks have never been buried to depths of more than several hundred to a few thousand feet. Skees (1953) gives a column of volcanic rocks of Tertiary age in the Chinati Mountains (80 miles to the southeast of this area) totaling about 2400 feet in thickness. In that area, where the rocks are much less disturbed, and the sequence can be determined readily, the youngest rock is a basalt flow some 300 feet thick. There is evidence that a similar basalt flow capped the series in the southern Quitman Mountains; there is a great deal of basalt float, but none was found in place. It has either been completely removed or the remnants are buried under the alluvium to the east.

It is very unlikely that the solutions that deposited the fillings of the vesicles were derived from any of the volcanic rocks, because great quantities of silica have been transported and deposited and large volumes of andesite altered. There was probably an intrusion of silica-rich magma whose crystallization produced the effective solutions. The pluton of the northern Quitman Mountains (Huffington, 1943) has given rise to numerous quartz veins, and solutions from it have produced large amounts of silicate minerals in the contact zone.

Three components comprise practically all of the material deposited in the vesicles: 1) silica, 2) calcium carbonate, and 3) manganese and iron oxides. The silica was probably derived from a crystallizing subjacent pluton. The solutions almost certainly had to traverse limestone areas on the way up and could have picked up the calcium carbonate from them. The ferromagnesian minerals of the andesite in the amygdaloidal zones have been almost completely altered, probably by the solutions that filled the vesicles. This would provide a logical and sufficient source for the iron and manganese oxides.

Acknowledgments

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