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John Lemish
Iowa State College

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By JOHN LEMISH

INTRODUCTION

Pebble dikes are intrusive features associated with the forceful emplacement of magmas. Farmin (1934) and Lovering (1949), who studied pebble dikes at their type area in the Tintic District, Utah, describe them as vein- or dike-like bodies composed of rounded, sub-angular, or angular pebbles of materials derived from local formations in a matrix of finer-grained pebble material or of intrusive rock.

In the course of the field investigation of the Topia Mining district in the northwest part of Durango, Mexico, pebble dikes were observed cutting the andesite rocks of the area. These dikes at Topia were similar to the pebble dikes at Tintic which the writer has also had the opportunity to study in the field. The presence of these dikes at Topia was of great interest because they contain the only sedimentary rocks in the entire region, and shed more light on the mechanics of intrusion in the area.

DESCRIPTION

The Topia district is an old silver camp located in the highly dissected "barranca" or "canyon" country along the west slope of the Sierra Madre Occidental range which represents one of the major volcanic provinces in North America (Lemish, 1955). The oldest rocks exposed in the area are the early Tertiary andesites which are over 4,000 feet thick and whose base has not been exposed. The andesites, which have been repeatedly faulted, intruded, mineralized, and eroded, are capped unconformably by a 2,000 foot sequence of flat-lying Miocene rhyolite showing slight deformation. The pebble dikes occur individually or adjacent to diabase dikes. Field relations indicate that they are closely related or contemporaneous to the post-ore and pre-rhyolite diabase dikes which represent the last episode of intrusive activity in the district. The pebble dikes, which have the same irregular trends as the diabase dikes, average from six inches to one foot in width and are exposed for lengths up to 100 yards along the strike.

Close examination of the pebble dikes shows that they consist of sub-angular to rounded pebbles of clastic sediments, such as quartzite, siltstone, and micaceous black shale, and a few rhyolite and andesite fragments in a fine-grained, limonite-stained pulverized matrix of the

Figure 1. A pebble dike (left) and a diabase dike (right) cutting andesite tuffs at Topia, Durango, Mexico. The pick handle lies along the contact between the dikes.

same rock types (Fig. 1). The pebbles range up to two inches in diameter, but most of them average one-half inch. No one type of lithology is predominant. The sediments are all well indurated, and thin section study verifies their sedimentary origin (Figs. 2 & 3) and indicates that they are slightly metamorphosed.

A study of the pebble shapes indicates that their roundness is caused by a multiple faceting consisting of a series of small flat faces. These faceted pebbles are quite different in appearance to the smoothly rounded shapes associated with stream-worn materials. The faceting is believed to have been caused by attrition of pebble-on-pebble (Lemish, 1955). In this respect, they are identical with the quartzite pebbles studied by the writer from the dikes at Tintic. None of the pebbles at Topia showed the "onion skin" structure (Farmin, 1934; Lovering, 1949) due to concentric partings one-tenth of the diameter or less below the surface and characteristic of many pebbles at Tintic.

Mode of Emplacement

Although the pebble dikes at Topia are similar to the Tintic dikes, which are conclusively of intrusive origin, Farmin (1934) noted several alternative modes of emplacement for the Tintic dikes which should be considered with regard to the origin of the Topia pebble dikes. The pebble dikes can be considered:

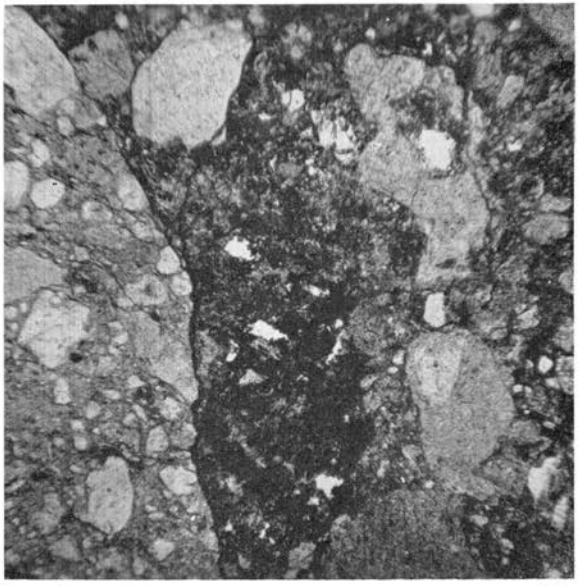

Figure 2. Photomicrograph of a pebble dike thin section. A large rounded fragment of siltstone (left) and a smaller fragment of shale (top left) occur in a finer-grained clastic groundmass of quartz and other rock material. Plane polarized light. X35.

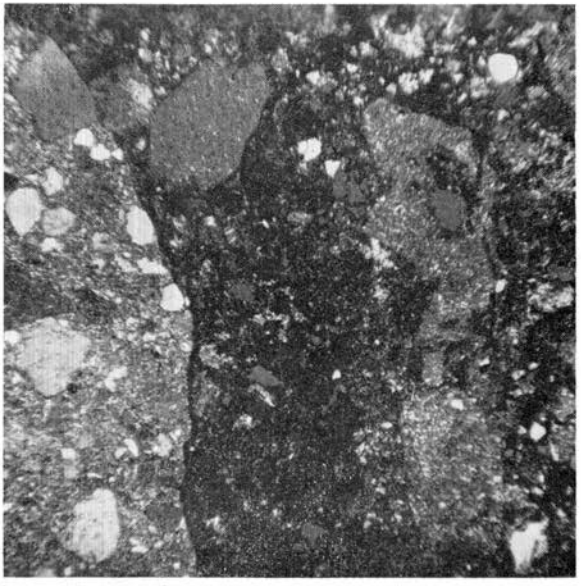

Figure 3. Same as figure 2. Crossed nicols. X35.

1) to represent fracture filling of material from above, as is the case in many other areas where "clastic" dikes of sedimentary origin have been described.

2) to represent a tectonic breccia caused by faulting or intruded upward by pressures caused by faulting (Ransome, 1901).

3) to represent an intrusion phenomenon of material derived from below in association with emplacement of magmatic bodies.

The Topia pebble dikes are considered to be a manifestation of intrusive igneous activity (point 3, above), for the reasons listed below.

A. The multiple faceting of the pebbles indicates that the attrition causing the roundness is due to movement under great pressure or a strong driving force.

B. Their close association in space and time to the diabase dikes.

C. The dikes are the sole source of sedimentary rocks, not only in the district, but the entire surrounding area. Examination of the Tertiary gravels in the area, as well as the regolithic materials along the andesite-rhyolite unconformity, shows no evidence of sedimentary rocks. The history of the area also makes it very difficult to postulate a gravel source from above. The region has a history of volcanic accumulation alternating with cycles of erosion. No surrounding region high enough to serve as a local source for sedimentary gravels is known to have existed in Tertiary time. The region served as a source area for volcanic gravels transported elsewhere.

D. Both the pebble dikes and diabase dikes with which they are so closely related in space and time show no consistent pattern with respect to the three fault systems in existence at the time of intrusion. In a few places either type of dike is structurally controlled for a short distance along the strike of a fault or vein. In these instances the fractures are of known, but low, displacement which is not great enough to have carried or forced sediments from below or down from above.

E. The presence of xenoliths of large cobbles and pebbles of similar sedimentary rocks in the border zones of one of the largest diabase dikes indicates a sedimentary source from below.

On the basis of the evidence enumerated above, the pebble dikes at Topia are considered to be intrusive phenomena associated with the forceful intrusion of diabase. The lack of a definite relationship to the structural pattern suggests that, for the most part, the diabase and pebble dikes open their own fissures rather than take advantage of pre-existing fractures. The details of intrusion, or mode of emplacement, is considered to be the same as that for the pebble dikes at Tintic which were most recently studied in great detail by Lovering (1949, pp. 11-13), and whose observations are pertinent with regard

to the origin of the dikes. Lovering notes that the fragments in the dikes represent material from rocks occurring below or adjacent to the area of the dike under observation. In the majority of dikes, the pebbles which are elongated or flattened in shape are horizontally oriented and normal to the direction of intrusion. He believes that the majority of dikes represent material riding on top of monzonite dikes or dragged along the edge of viscous monzonite bodies. Both

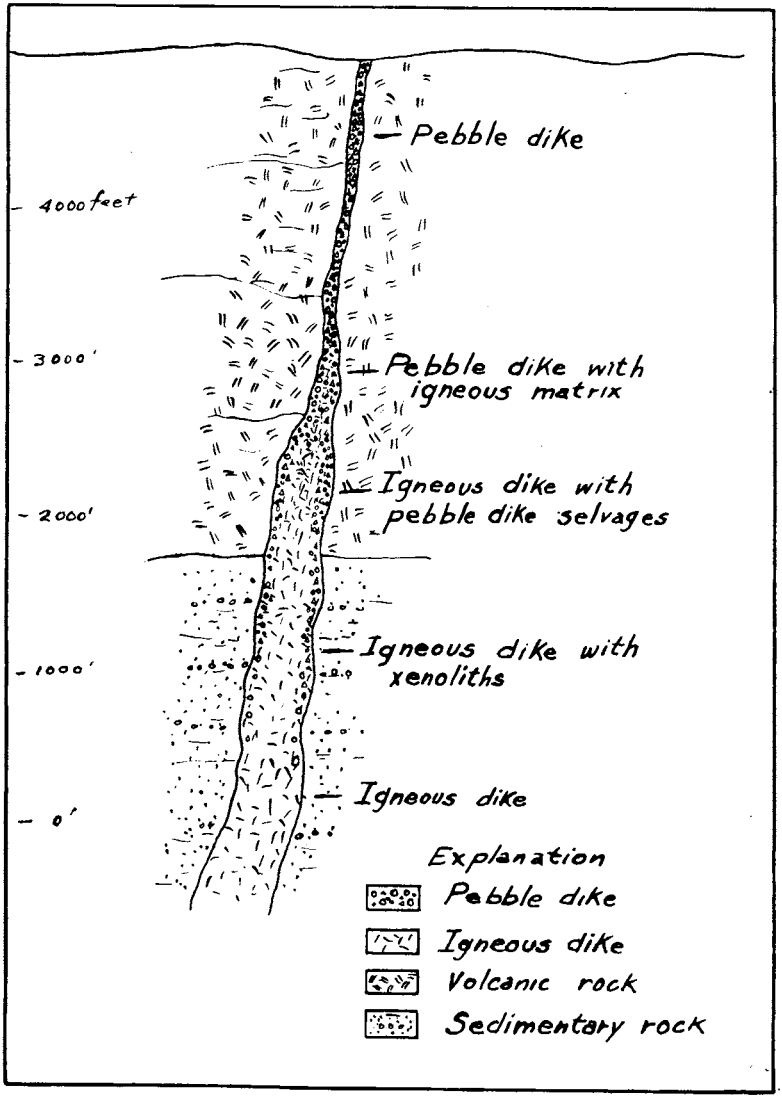

Figure 4. A hypothetical intrusion based on a composite of field evidence showing the intrusive relationship of pebble dikes to an igneous body over a large but indefinite vertical range.

Lovering and Farmin (1934) believe that some dikes represent explosion bodies injected upward with great violence when the fissure opened suddenly, allowing steam to inject material abraded from the walls traversed.

Discussion

The occurrence of the pebble dikes at Topia and Tintic afford an insight into the mechanics of forceful intrusion. The pebble dikes are considered a variety of intrusive breccia in which constituent materials have been rounded by attrition. The presence of rounded shapes indicates that such materials have been driven upward by a force great enough to cause appreciable movement and attrition. This emphasizes the forceful or explosive nature of some intrusions. Not all intrusions are as violent and probably all degrees of activity actually occur. The typical intrusion breccias or shattered rock zones present in many volcanic areas have angular shapes which may be due to less movement because of a weaker driving force from below. Such variables as the width between the walls, nature of the rocks traversed, and depth below the surface, cannot be properly evaluated at this time.

In an attempt to review the various observations regarding the origin of the pebble dikes, a sketch of a hypothetical dike is presented in Figure 4, based on composite field evidence from Topia and Tintic showing the relationship of the pebble dikes to an igneous body over a large but indefinite vertical range. Vertical continuity of all related features is assumed. The pebble dike grades downward into an igneous dike with a pebble dike selvage. At depth it grades from an igneous dike with xenoliths to a true dike. Different levels of erosion would expose various parts of the composite. The pebble dikes (or intrusive breccias) are more common in areas of Tertiary volcanic activity where erosion has not been sufficient to remove pebble dikes and related features.

The great value of the pebble dikes at Topia is that they present evidence of sedimentary strata beneath the andesites whose base is not exposed. They serve the purpose of diamond drill holes for sub-surface study. They do not, however, give any indication of the depth at which the sediments occur. In other districts where pebbles are present, the observer is cautioned to ascertain the intrusive origin of the pebble dike before utilizing them for sub-surface data. When pebble dikes occur in volcanic areas, the writer believes that an intrusive origin for them should be seriously entertained.

Literature Cited

Farmin, R. 1934. "Pebble Dikes" and Associated Mineralization at Tintic, Utah. Econ. Geol., vol. 29, pp. 356-370.

Lemish, J. 1955. The Geology of the Topia Mining District, Topia, Durango, Mexico. Unpublished Ph.D. thesis manuscript, University of Michigan.

Lovering, T. S., et al. 1949. Rock Alteration as a Guide to Ore—East Tintic District, Utah. Econ. Geol., Monograph 1, pp. 1-64.

Ransome, F. L. 1901. A Peculiar Clastic Dike Near Ouray, Colorado, and its Associated Deposit of Silver. A.I.M.E. Trans., vol. 30, pp. 227-236.

DEPARTMENT OF GEOLOGY
IOWA STATE COLLEGE
AMES, IOWA