EXAMPLES OF INTRUSIVE ACID DYKES IN EASTERN TASMANIA[1]

by

EMYR WILLIAMS and D. I. GROVES

Geological Survey, Mines Department, Hobart, Tasmania, Australia.

(With six text figures.)

ABSTRACT

Observations of the relationship between linear or planar features on either side of dykes usually form the basis of a field determination of their mode of emplacement, although it is known that sections oblique to planar features may lead to conflicting results. In Eastern Tasmania only rarely are examples encountered where dyke wall-rock units are of use. However, dyke wall irregularities are common and a comparison of opposite walls have shown the dykes to be intrusive. Disproportionate offsets of corresponding wall irregularities due to connecting cross-dykes are general, which results in intrusive bodies resembling those of a replacement origin.

INTRODUCTION

In considering the mode of emplacement of dykes Goodspeed (1940) recognised those which dilated the host rock and others which resulted from replacement. The most important criterion noted by which the origin of a dyke may be determined is the geometrical relationship between pre-existing wall-rock linear or planar features on either side of a dyke. Offsets of such features proportional to the width of a dyke and the angle of intersection demonstrate a dilational emplacement, whereas a replacement origin is indicated when units in the wall-rock may be extrapolated across the dyke without offset (fig. 1), or, as stated by Goodspeed (p. 194), with disproportionate offset. King (1948), however, pointed out that where material is intruded along a network of fractures, offset of intersected features disproportionate to the width of the dyke may occur, although he favoured a replacement origin for examples displaying such characteristics (his figs. 4a, 10c). In an evaluation of the criteria for the forcible intrusion of magma, Noble (1952) considered that, not only is it necessary to have a knowledge of the features in all three dimensions, since planes of reference oblique to planar surfaces intersected by a dyke may give apparent displacement either greater or less than the real displacement, but that stoping or assimilation of wall-rocks and granitisation may operate concurrently with forcible intrusion leading to conflicting evidence. Another limitation on the use of offsets was shown by Noble where forcibly intrusive dykes plastically deformed the wall-rocks, which resulted in the lateral displacement of pre-existing features being confined to the zone of plastic deformation, beyond which the features maintained their undeformed position.

[1] Published by permission of the Department of Mines, Hobart, Tasmania.

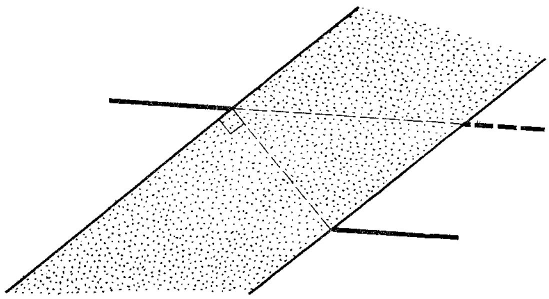

FIG. 1.—Distinctive wall-rock feature (thick line) offset by dilation dyke (stippled). With a replacement dyke position of feature in right-hand wall shown by broken thick line.

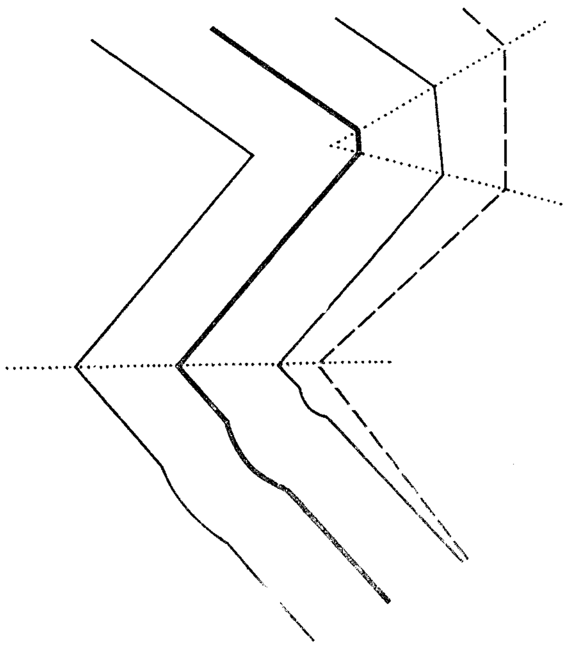

FIG. 2.—Dyke outlined by thin lines resulting from uniform replacement initiated in surface of trace represented by thick line. Note irregularities bounded by diverging angle-bisectors (dotted lines) are enlarged in replacement front. Broken line indicates right-hand wall of dyke of variable thickness.

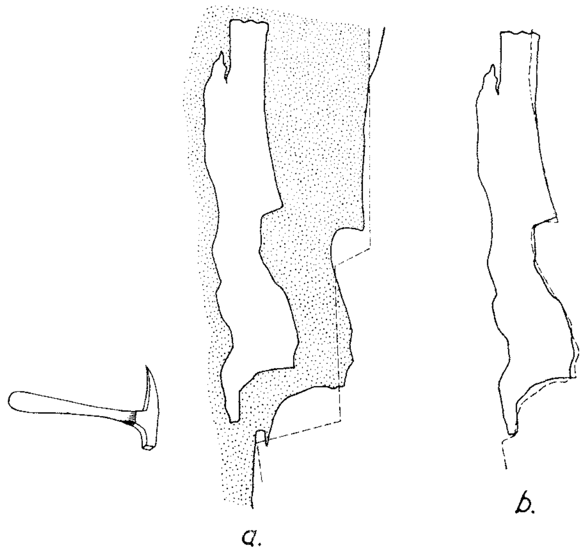

FIG. 3.

a. Tracing of photograph of red micro-adamellite (stippled), with walls vertical to reference plane in grey adamellite at Bluestone Bay. Irregularities correspond at right angles to walls. Broken line is trace of calculated right-hand wall if dyke is of replacement origin, and is quite unlike the actual trace.

b. Right-hand wall (broken line) superimposed on opposite wall indicates close fit demonstrating red micro-adamellite of intrusive origin.

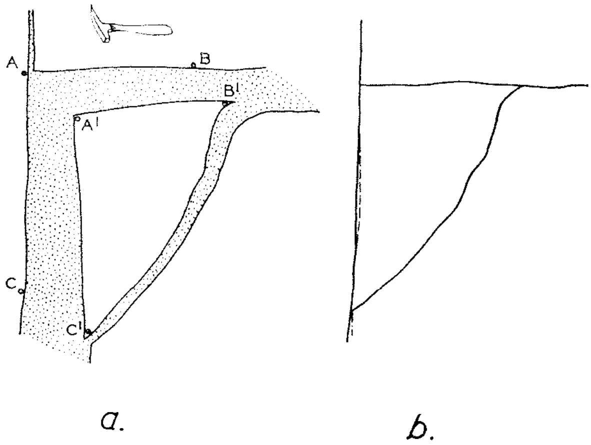

FIG. 4.

a. Tracing of a photograph of muscovite granite (stippled), with walls vertical to reference plane, in porphyritic biotite granodiorite at St. Helens Head. Note offset of points AA', BB' and CC'.

b. Remarkable fit of fragments of porphyritic biotite granodiorite can only be attained if muscovite granite is of intrusive origin. Broken line indicates overlap.

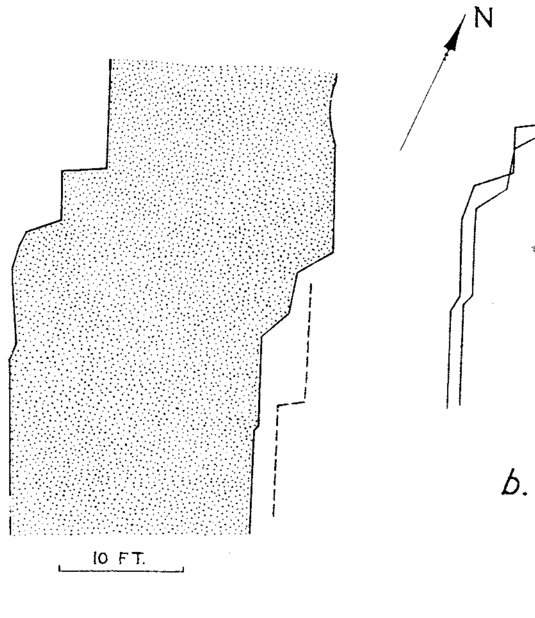

FIG. 5.

a. Mapped example of a cluster of irregularities at a locality along the length of a vertical dyke of quartz-feldspar porphyry (stippled) in red adamellite on the Coles Bay foreshore. Broken line is trace of calculated right-hand wall of dyke of replacement origin, which is quite unlike actual trace.

b. Close fit of margins indicate dilational nature of emplacement of quartz-feldspar porphyry with concomitant lateral displacement of some 7 feet.

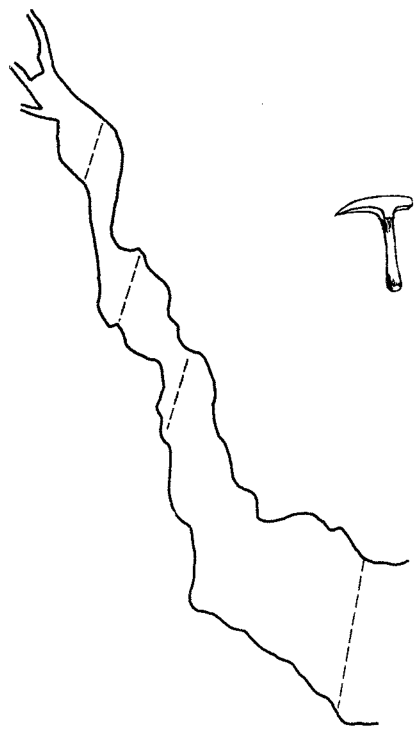

FIG. 6.—Tracing of photograph (bottom nearest camera) of an approximately vertical dyke of biotite granodiorite with diffuse margins against hornfelsed sedimentary rocks at Piccaninny Point. Foliation of dyke material, indicated by broken lines, in direction of like irregularities of opposite walls, the similarity of which only accounted for by a dilational mode of emplacement.

In the surveying of granitic rocks in areas of Eastern Tasmania, numerous outcrops of dykes have been found but only occasionally have the dykes investigated been observed to intersect pre-existing features of the host rock, and only rarely have rock exposures been discovered where sufficient evidence is available not to lead to conflicting conclusions. However, dyke wall irregularities are fairly common and a comparison of such features between the walls of dykes proved profitable even in examples where the nature of the surfaces in all three dimensions was not evident.

MATCHING IRREGULAR DYKE WALLS AS A A GUIDE TO ORIGIN

Although it is obvious that marked wall irregularities can match perfectly across only a dilational dyke it is instructive to consider how good a match may develop by replacement. It appears that the most favourable conditions under which a replacement dyke may develop closely matching walls are where irregularities are inherited from a pre-existing surface whom which a replacement front proceeded. Figure 2 illustrates the form of a replacement dyke that may develop from an irregular initial surface, and the diminution of irregularities of the original surface in the replacement front where bisectors of the angles in the irregularities converge. It is evident in figure 2 that the irregularities that may develop in a replacement dyke wall may be determined from the observed trace of the opposite wall providing the dyke thickness is known, although it may vary along its length. It may also be noted that replacement dykes cannot have perfectly matching irregular walls.

At Bluestone Bay on the east coast of the Freycinet Peninsula red micro-adamellite is emplaced in grey adamellite (Groves, in press). Figure 3 is of one of a number of examples at this locality where the irregularities in opposite vertical walls correspond at right angles to the length of the micro-adamellite bodies, and where the close fit of the walls clearly shows that the dyke material intruded the coarser grained grey adamellite.

Displacement of wall irregularities at right angles to the length of dykes are not common in Eastern Tasmania because of the presence of connecting cross-intrusions, as is demonstrated in the example from St. Helens Head in figure 4. However, on a larger scale lateral offsets may be even greater than the dimensions of the outcrop exposed. This has been encountered at Coles Bay on the western shore of Freycinet Peninsula where three NNW trending dykes of quartz-feldspar porphyry occur within red adamellite. The eastern dyke exhibits corresponding wall irregularities displaced at right angles to the length of the intruding body, whereas the middle dilation dyke (fig. 5) shows a lateral displacement of corresponding wall irregularities of some seven feet. The characteristics of the walls of the western dyke at Coles Bay, some 300 yards from the eastern dyke, cannot be matched along a exposed length of some 200 feet. Such results, however, are to be expected in this region where connecting east trending cross-dykes are known.

Finally, it should be noted that lateral displacements of irregular walls by the intrusion of material along a network of fractures may result in dykes which at first sight may appear to be of replacement origin. At Piccaninny Point (fig. 6) dykes of foliated biotite granodiorite have very variable widths, which culminate in pinches and swells, and diffuse boundaries against hornfelsed sandstones and mudstones. Such characteristics are generally believed to be those of a replacement dyke. However, the foliation of the dyke material is actually in the direction linking similar irregularities in opposite walls, which show a correspondence that although it is readily accounted for by a dilation mechanism it could not be explained if the dyke was attributed to replacement.

CONCLUSIONS

To those Survey workers engaged in studies of igneous complexes and gneissic terranes, observations of dilational and non-dilational characteristics of the rock-types are essential in order to determine their origin, all the more so since the necessary microscope examination of the rocks encountered often lags well behind mapping. Goodspeed and King introduced to many the significance of offsets, or lack of offsets, of wall rock units by veins and dykes, but neither considered the use of dyke wall irregularities in determining the nature of emplacement. Irregularities of the walls of dykes examined in Eastern Tasmania have proved not only more common than intersected wall-rock units, but have given a more conclusive guide to the origin of the dykes. Matching irregular dyke walls, even when only approximate, can only result from dilation, since even where replacement behaves in the most ideal way dyke walls must differ unless they are perfectly planar.

Goodspeed, King and Noble considered determination of offsets of wall features of prime importance, but it has proved of little value in Eastern Tasmania where disproportionate offsets of wall-rock irregularities of the dilational bodies have resulted from connecting cross-dykes. In conclusion it may be noted that unless due regard is given to the possibility of disproportionate offset along intruded masses with irregular walls, erroneous results may be obtained.

REFERENCES

GOODSPEED, G. E., 1940.—Dilation and Replacement Dykes. *J. Geol.*, 48, 175-195.

GROVES, D. I. (in press).—Granites of the Coles Bay Area. *Tech. Rep. Dep. Min. Tas.*, 10.

KING, B. C., 1948.—The Form and Structural Features of Aplite and Pegmatite Dykes and Veins in the Osi Area of the Northern Province of Nigeria and the Criteria that Indicate a Nondilational Mode of Emplacement. *J. Geol.*, 56, 459-475.

NOBLE, J. A., 1952.—Evaluation of Criteria for the Forcible Intrusion of Magma. *J. Geol.*, 60, 34-57.