

are known to contain blocks and small nodules of peridotite, carbonated or otherwise altered (op. cit., pp. 105, 106).

Since G. W. Tyrrell wrote the paper quoted by Messrs. Walker and Ross, the Heads of Ayr vent and the adjacent Greenan Castle tuff have been described by the Geological Survey (op. cit., pp. 54–56, and fig. 5).

The mode of intrusion of xenolithic monchiquite dykes and the origin of their included igneous fragments (peridotite and pieces of large crystals of anorthoclase, barkevikite, biotite and titanogite) are discussed in some detail in a paper published six years ago ("Problems of Carboniferous-Permian Volcanicity in Scotland", *Quart. Journ. Geol. Soc.*, civ, 1948, pp. 137–138, 149–150).

An E.-W. composite or multiple monchiquite-camptonite dyke at Loch Mojdart, Inverness-shire, is known to contain xenoliths of altered peridotite, and a neighbouring small mass of "agglomerate", with a monchiquite matrix, contains blocks of altered peridotite and of Moine country rock (op. cit., 1948, p. 138).

There are other publications, dealing with "olivine nodules" in Scottish basic rocks and vents, which are not mentioned by Messrs. Walker and Ross (for some references see "British Regional Geology: The Midland Valley of Scotland", *Mem. Geol. Surv.*, 2nd ed., 1948, p. 67).

Those who wish information on the age, distribution, and mode of occurrence of monchiquite intrusions in districts near Glenfinnan should consult the following recent publications: "Faulted Permian Dykes in the Highlands," *Geol. Mag.*, lxxxviii, 1951, pp. 60–64; "A Monchiquite Vent, Stob a' Ghrianain, Inverness-shire," op. cit., 1951, pp. 140–144; "The Camptonite-Monchiquite Suite of Loch Eil," op. cit., 1951, p. 148; "Summary of Progress of the Geological Survey of Great Britain for 1951," *Mem. Geol. Surv.*, 1953, pp. 45, 46.

A. G. MACGREGOR.

GEOLOGICAL SURVEY OFFICE,  
EDINBURGH.

20th December, 1954.

#### SUPERPOSITION OF CALEDONOID FOLDS ON AN OLDER FOLD-SYSTEM IN THE DALRADIANS OF MALIN HEAD

SIR,—I have read with interest Dr. Reynolds' and Professor Holmes' account of plasticine experiments and their application to the structure of part of Northern Donegal (*Geol. Mag.*, xci, 1954, pp. 417–444). As the latter is an area with which I am not familiar I should have refrained from comment had the authors not sought to force their theory as an explanation of the structures of South-West Donegal by dismissing without discussion one of the writer's sections of this area.

The authors do not make it clear to which of my sections they refer, but I assume from the context it is the section of Slieve League itself (text-fig. 1). Far from being drawn by the "down the plunge" method the section is derived from direct observation in an area of rugged relief amounting to nearly 2,000 feet. The shape of the outcrops, and particularly the prongs to which the authors attach so much importance, are due largely to the combined influence of topography and structure. The section is therefore drawn to explain observations on the ground, not to explain "thrusting in opposite senses". In fact, nowhere in my paper do I postulate thrust-movements in any other directions than towards the north-west or north. It is obvious, however, that if a thrust is bent sideways (i.e. rotated about a vertical axis) it will *appear* to have moved in a different direction and if it is rotated about a horizontal axis it will *appear* as a normal fault, as in text-fig. 1 of my paper (but not as a thrust in the opposite sense). Such oscillations about the vertical can be observed east of Slieve League, although they are not fully brought out on the small-scale of the map.

Similarly the minor structures at right angles shown on my map are not

the structures of two orogenies, but are due to the twisting of the north-easterly structures through  $90^\circ$ ; the gradual swing-round of these structures can also be observed in the field.

There are, it is true, two fold-phases in South-West Donegal; the evidence, however, points to the bending sideways, about roughly vertical axes, of original north-easterly structures. Far from being mechanically impossible, such distortion will take place if the direction of minimum compression is not vertical but in a horizontal direction either locally or regionally. The South-West Donegal structures can also be simulated in plasticine!

Although plasticine models prove useful qualitative methods of demonstrating possible mechanisms which have led to the evolution of complex structures, the attempt of the authors to establish a quantitative correlation with actual rock-deformation can only be described as naive. For example, the physical state of rocks undergoing a second folding after earlier folding and regional metamorphism is very different from that of sediments undergoing primary folding; no comparable change is, however, made in the physical state of the plasticine between the two foldings. The time-factor is not introduced into the scale-correlation at all although those concerned with soil mechanics will know that the rate of loading is of prime importance. The figure given for the strength of quartzite is presumably that for the crushing strength under unidirectional stress and certainly bears no relationship to its virtually unknown strength under the conditions of crustal folding and regional metamorphism, a point about which the authors themselves have apparently had some misgivings.

If the strength given for plasticine is also that under unidirectional stress, no proof is advanced that this bears a significant relationship to its strength under the stress-conditions of the experiment, which in fact are not stated. The authors, it is true, attempt to relate the varying strengths of differently coloured plasticine to the strength of different rock-types, but they offer no proof that such differences are of the same order as those between, say, psammitic, pelitic, and calcareous rocks which have undergone crustal deformation.

Those who would base structural theories on plasticine and other experiments, would do well to consider the observations of Dr. Terzaghi on standard and fundamental strengths in a discussion published in the *Quarterly Journal of the Geological Society* for 1946.

#### REFERENCES

- ANDERSON, J. G. C., 1954. The Pre-Carboniferous rocks of the Slieve League Promontory, Co. Donegal, *Quart. Journ. Geol. Soc.*, cix, 399-422.
- REYNOLDS, D. L., and A. HOLMES, 1954. The Superposition of Caledonoid Folds on an Older Fold-System in the Dalradians of Malin Head, Co. Donegal. *Geol. Mag.*, xci, 417-444.
- TERZAGHI, K., 1946. In Discussion of Papers published in previous volumes of the *Quart. Journ. Geol. Soc.*, cii, 203-204.

DEPARTMENT OF GEOLOGY,  
UNIVERSITY COLLEGE,  
NEWPORT ROAD, CARDIFF.

J. G. C. ANDERSON.

22nd December, 1954.

#### FOLDED FRACTURE CLEAVAGE IN THE SOUTHERN HIGHLANDS: PRELIMINARY NOTE

SIR,—The Ben Ledi Grits form part of an extensive outcrop of Dalradian schistose greywackes that stretches across the Scottish Highlands close to their southern border. This note draws attention to the portion of this outcrop that lies north-east of Loch Achray between Loch Katrine and