CORRESPONDENCE

ULTRABASIC PILLOW LAVAS FROM CYPRUS

SIR,—Mr. R. A. M. Wilson's remarks on the Cyprus Diabase (*Geol. Mag.* 1959, xcvi, 257, following my letter of 1958), are timely. If my original explanation has been challenged, the reasons and an alternative must needs be discussed ; and I am now able to clarify some points and to add some new information.

Mr. Wilson may not have known that I had been compiling a small-scale map showing the main axes of inflection and dips for the whole Diabase region ; but the data have been utterly lost since 1953, before completion. Subject to the lapse of time, I recall that a few—at least two—major " turn-overs " on axes could be located ; but that they were extremely sharp. The change of dips from easterly to westerly across the formation is not in doubt ; and my original suggestion was that of an anticlinorium with the great plutonic intrusions in the core.

Now the Diabase is not a piece of parish geology ; it is one of the striking features of the island. It forms saw-edged ridges and precipitous canyons 3,000 feet deep ; and within the girdling ring of lavas, extends at least 35 miles from east to west across strike, with a maximum breadth of 18–20 from north to south. The peaks of Madhari and Papoutsa to the east of Mt. Troodos are very nearly as high. Everywhere the broad regional picture is the same: sheets of very uniform types of rock a few inches to a few feet thick, picked out by their different reactions to weathering ; with variable but rather high dips, sometimes resembling a hillside of Welsh slate or Arenig lavas, and generally beautifully exposed. There is no doubt that they antedate the Pillow Lava Series and the plutonic bosses, whose eroded tops, surrounded by Diabase, are at a considerable height above the highest recorded lava.

The factual picture that Mr. Wilson and his colleagues give in paras. 3, 4, and 5, of his letter, does not differ from my original findings. On passing from the Diabase to the Basal and higher group of lavas, the feeder dykes which are injected through and are concordant with the Diabase become so numerous that it is hardly possible to tell which is which or to draw an exact boundary ; for this reason this composite material, which retains the orientation of the regional Diabase structure, is given the name of " pack " on my field maps, from analogy with a pack of cards. In vertical section there is a wide transition zone between lava proper and Diabase of a fairly consistent character ; while the later lavas may sometimes be seen lying unconformably across the upturned edges of the Diabase sheets. I agree also that the low-grade regional metamorphism and epidotization of the Diabase may well be due to action from the plutonic intrusions which have also contributed some notable dykes into the Diabase near their margin. Mr. Wilson remarks that the structural pattern of the Basal Group Dykes . . . is precisely the same as that of the Diabase sheets. Of course it is ; the dykes are lit-par-lit injections, as can be seen in some beautiful exposures, and have been controlled by the pre-existing " grid ".

There are not many possible explanations for this regional structure in the Diabase. At a distance the formation resembles sedimentary beds ; it is clearly not plutonic, nor is it a " layered intrusion " ; nor can one suggest that its sheeted units have been developed by shearing, although there is in fact plenty of shearing to be seen locally. If considered as a folded series, the Diabase with its supplementary dykes (excluding feeders to the marginal lavas), must be of the order of 10,000 feet thick, which seems reasonable enough. But if I read Mr. Wilson's paragraph (8) correctly, he believes the formation to represent the original inclinations of successive (concordant) dykes. If so, into what framework were they injected ? There is no trace of any pre-existing rock. Each dyke would have to solidify before its neighbour came in alongside of it, so that some marginal chilling would occur. Is it in any way conceivable that such a process could take place, following a definitely controlled geometrical pattern, over a continuous width of 35 miles, each thin dyke coming in consecutively like the leaf of a book ? And how was the heat dissipated so as to provide sheets instead of a continuum ? Obviously the mechanism is impossible if considered on a regional scale. All that is clear is that the rock must have been emplaced in discrete sheets which were able to cool more quickly than a solid plutonic mass.

So far from there being a simple reconnaissance, several very long sections across the Diabase strike were examined in close detail. I nowhere found any intercalated sediments or a material departure from a pretty uniform character—the idea being to look for a marker horizon—and I saw no chill-margins ; but these in any case might have been indecipherable, being at the parting planes of the weathered sheets. What I did find in some sheets were little round concretions of chloritic matter like peas, which may have represented amygdales. It is possible that a bore-hole core in completely unweathered rock would show evidence of marginal chilling of the sheets. It is difficult to imagine a book of thin dykes all in perfect contact with each other over a thickness of 35 miles, and no signs of matrix or margin.

In 1958 I drew attention to a possible analogy in Fuerteventura (Canary Islands), which has been insufficiently studied. Another comparison is now available with the far greater and more widely spread Ventersdorp System of basic lavas in South Africa. The later Ongeluk lavas are similar but much smaller. The Ventersdorp lavas may attain a thickness up to 15,000 feet, and are much less altered than the Cyprus Diabase ; unlike the latter, they are not deeply dissected and exposed. There are very rare instances of intercalated sediment in this great formation ; normally there are no markers, but some parts are highly amygdaloidal and others not so. There are, however, appreciable regional dips, while around the Vredefort Ring the whole formation has been inverted and overturned. Excellent examples of chill-margining at the interfaces of flows have been obtained in shaft-sinking ; but these zones may be only an inch or less wide. At surface individual flows weather out to make little scarplets with visible partings that look rather like shears but which do reflect the dip of the rocks. The surfaces of a flow will hardly ever be identified on a weathered outcrop ; but a succession of tilted flows gives a diagnostic topography. It is quite unnecessary in many lava systems that the characteristics mentioned in Mr. Wilson's paragraph 6 should invariably be present, particularly with basic material. I agree that the strain-slip type of small shear seems to be lacking in the Diabase ; but the surfaces between the narrow sheets may have allowed enough slip to permit bending of such a rigid rock, like the leaves of a spring. While the dips are high, the amplitude of the " folds " is large ; the term " highly folded " could apply to major structures but not to minor phenomena within those structures. It is, as Mr. Wilson observes, a very competent rock ; and liable to break rather than bend.

In summary, I can find no strong reason for discarding the idea that the bulk of the Diabase, which amounts to some hundreds of cubic miles, is made up of ancient flows now showing high angles of dip, with a regional strike that is dominantly north and south. The only alternative so far suggested is that it is a pack or book of thin successive dykes or sheets which conform to a geometrical pattern resembling systematic folding. This seems impossible owing to the enormous extent of the phenomenon and the absence of any framework of rock into or through which they could have been injected. If a large proportion of the formation is an intrusive rock, into what is it intruded ? The very restricted width of these sheets—over a minimum width of 35 miles—suggests a rapid succession of effusive lavas. In a tremendous system of tens of thousands of successive *dykes* some would have been much wider than a few feet and of coarser texture. The problem of heat dissipation in such a mass would have led to plutonic conditions. The comparison with the Ventersdorp lavas of South Africa certainly suggests that there is nothing unreasonable in the view that the Cyprus Diabase is a system of sharply folded ancient lavas which have been intruded and metamorphosed by plutons and their related dykes, and again pierced round the rim by later lavas and covered by their flows. The view that the whole of the Diabase is a " book " of oriented intrusive dykes seems to me to provide insuperable difficulties, but such possibilities must be considered. However, since the formation is dissected vertically for several thousand feet, the thin Diabase sheets, if they are intrusive, might well show systematic differences in texture between points 1,000 feet and 5,000 feet above sea-level. It does seem important to record and analyse the structures so generously presented by Nature, before venturing farther. The network of motor-roads now available would make the recovery of this information a not-too-troublesome task. In the meantime I believe that my original description of " Folded Diabase " should be retained until there is stronger evidence against it.

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16th August, 1959.

CARBONIFEROUS LIMESTONE–NAMURIAN JUNCTION IN IRELAND

SIR,—The nature and extent of the non-sequence between the Carboniferous Limestone and the overlying Namurian in Ireland is rapidly being evaluated by many workers, so that a complete synthesis of the phenomenon may shortly be expected. I think, therefore, that it may be worth while to record relevant results derived from a preliminary survey of the Taur-Meelin anticline near the Co. Limerick–Co. Cork border, recently carried out.

In this region the top of the Carboniferous Limestone, seen in a series of dome-like outcrops between Taur and Meelin, is cherty to a depth of about 6 feet below the Namurian junction. Immediately above the limestone occur 60 feet of shales, corresponding to the Clare Shales of Co. Clare and Co. Limerick, above which the facies changes and sandstones and siltstones appear in the succession. West of the village of Taur, poorly preserved *Homoceras* sp. has been collected from the shales 20 feet above the top of the Carboniferous Limestone. It is clear, therefore, that lower beds in these shales are of *Homoceras* age so that the *Eumorphoceras* zones are probably absent here.

Above the Carboniferous Limestone there occur beds of thickness of the order of 1,750 feet, which include coal seam(s?) near the top. Spoil heaps from the old collieries yield shales with impressions of *Reticuloceras bilingue* showing that the succession ranges up into the R_{2b} subzone.

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THE BUGLE PIT, HARTWELL, NEAR AYLESBURY, BUCKS SP(42)793121

SIR,—The Bugle Quarry used to be the type section of the Portland and Purbeck Beds of the Aylesbury neighbourhood (Arkell, 1947, p. 126) and has been regularly visited by geologists since at least as early as 1854. It has long been out of work and has slowly become more and more obscured. Up to about three years ago, quite a good section of the Purbeck Beds could be seen. In 1958 an unexpected *coup-de-grâce* was given by tipping the spoil from extensive main road improvements over the face, which completely hid all

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