CORRESPONDENCE

THE LUXEMBOURG COLLOQUIUM—A REPLY

SIR,—I fear Dr. Miller has misunderstood the purpose of my paper which was to report on the Luxembourg deliberations and to compare the basis of classification with schemes such as those proposed by Arkell (1946) and the Copenhagen Sub-committee (1961). Many of the points to which he takes exception are either quotations or paraphrases of material from one or other of these sources. My intention was to present an objective appraisal, though a certain personal bias was inevitable from one who has been concerned with these problems for many years.

In accepting these limitations I was denied the freedom that Dr. Miller claimed when he " prefer(red) . . . to disregard the Copenhagen Rules ", but this was no bad thing. The virtue of the Luxembourg Colloquium lay in the opportunity it gave for re-assessing our ideas on the Jurassic in an international environment, for clearing away dead wood from the past and for seeking compromise solutions in the light of present knowledge. This background rather than my own opinions was the subject of my paper.

As for the Uppermost Jurassic problem, I went to Luxembourg believing that the situation described by Arkell in 1956 still obtained—that is, that no trans-European objective correlation could be made above the horizon of the *Gravesia* Zone. At the colloquium I was told by Drs. Barthel and Zeiss of Erlangen that correlation between England, parts of France, and Bavaria was possible at the level of the *Albani* Zone, suggesting that the base of the Portlandian (*sensu anglico*) was an important datum. However, with Casey's work on the British faunas assignable to both Volgian stages and particularly his recognition of a common base to the Cretaceous in England and Russia, there is no longer a case for dual standards. Whatever its name we should now be prepared to recognize in this country a unit (or units) of post-*Autissiodorensis* Zone–pre-Cinder Bed age.

Finally, Dr. Miller's dicta on the concept of zones (with which I disagree) have caused me to clarify my own ideas on the subject. I look forward to reading his full account.

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THE MALVERN LINE

Sir,—In their recent paper Phipps and Reeves (1964) reopen discussion on the Malvern line. In it they are particularly critical of the conclusions drawn by Reading and Poole (1961 and 1962) from an exposure in the Gullet Quarry, where the contact between the Upper Llandovery and Pre-Cambrian is interpreted by the latter authors as an unconformity. Another exposure at the " sycamore tree locality " is interpreted similarly. Phipps and Reeves contend that the junction is a tectonic one; a conclusion supported by Whitworth (1962). Among the arguments presented by Phipps and Reeves in support of their conclusions, they discuss the sedimentary environment of the period in that area, concluding that current velocities were insufficient to transport the large boulders found at the contact. Ziegler (1964), however, adds supporting palaeontological evidence to Reading and Poole's thesis and demonstrates that the Upper Llandovery deposits of the Gullet are younger than those immediately to the west of the Malvern Range. He further suggests that a fault-controlled scarp was transgressed by the late Upper Llandovery sea causing these deposits to rest directly upon Malvernian, and that these controlling faults, trending north–south, are early manifestations of the Malvern axis.

One of the difficulties of mapping in the Welsh Borderlands is the lack of exposure, but if one considers the regional environment, both sedimentary and structural, one can assess the value of the limited available evidence more satisfactorily. I am able to accept the relationship at the Gullet Quarry as being a sedimentary contact. In 1963 I had the opportunity to visit this exposure at a period when the overburden of Llandovery Beds had been further stripped and then one could readily identify the base of the sea stacks pushing upwards into the Llandoverian beds, with the large boulders in close proximity to the stacks (see Reading and Poole, 1961): these sea stacks explain the boulders within the conglomerate. However, because Upper Llandoverian beds rest unconformably upon Malvernian high up on the flanks of the Malvern Range at an altitude of over 600 feet O.D. the presence of the Western Boundary Fault is neither proved nor disproved. Over the complete length of the Malvern line, including the northward extension towards the Abberley Hills, field relationships suggest the existence of fault lines delimiting the western margin of the major structural units. Asymmetrical anticlinal structures with steeper, sometimes even overturned, western limbs exist within the Silurian beds of the Ledbury, Stuckley, and Woodbury areas. North-east of Stuckley the Upper Ludlow Beds are overturned where they are faulted up on the eastern side of Downtonian red marls. Similar faults bound the western margins of the Silurian inliers of Woolhope and Mayhill to the west of the Malvern line. There is no real reason to discount the presence of the fault along much of the western margin of the Malvernian outcrop. This fault line, however, generally follows a distinct break in slope which is at a lower level than and to the west of the Gullet Quarry and " sycamore tree " exposures, where remnants of Upper Llandovery beds are preserved in embayments which existed in the now upfaulted Pre-Cambrian land mass.

One further point must be discussed. In his contribution Ziegler refers to vertical movements along the Malvern line in pre-Upper Llandovery times, and claims that the line is sub-parallel with the Church Stretton line and like it seems to have controlled sedimentary patterns from time to time. An unwarranted and somewhat misleading simile is drawn here. The Malvern line is far from being sub-parallel to the Church Stretton line and it is readily obvious from a geological map that the two lines converge rapidly northwards. The Church Stretton fault, with its Caledonoid trend, is one of many such structures which controlled sedimentation in Lower Palaeozoic times throughout Wales and the Welsh Borderland, but there is little evidence that the north–south trending Malvern line influenced sedimentation until at least Avonian times when the Drybrook Sandstone accumulated over the northern part of the Forest of Dean. Evidence points to the fact that even here the structures which controlled sedimentation in Lower Palaeozoic times still retained a true Caledonoid trend. Except for the further transgression of the Upper Llandovery sea on to the Malvern land mass (or chain of islands) the Silurian sediments, particularly those in the upper part, become coarser, include thicker conglomerates, are more discontinuous, and generally show signs of having accumulated in shallower water as one moves southwards in both the Ledbury area and the Woolhope area to the west. There is no indication of any marked change in sedimentary environment along a west to east line as would be anticipated if the Malvernoid axis was active at this time. The Caledonoid axis, whose activity interrupted sedimentation, existed near Gorsley and the eastward extension of this positive zone readily accounts for the changes seen in the sediments in the vicinity of the Malvern range. A parallel active zone also controlled sedimentation some distance to the south along the line of the Lower Severn Valley. This Lower Severn axis was the cause of the conglomerates and breaks in sedimentation that exist within the Silurian beds around Newnham and Purton Passage. It seems unlikely that the Malvernoid axis, trending almost normal to the Lower Severn and Gorsley axes, could have been particularly active at this time. Silurian faulting in the Malvern Range (and such faulting may well have locally

controlled the Upper Llandoverian transgression as suggested by Ziegler) is more likely to have been along lines at least sub-parallel to the Caledonoid line of Gorsley. The transverse faulting through the Malverns may have been much more important at this time than the major north–south fault which now exists there and it may be significant that such a fault is known to pass through the Gullet, whilst at the northern end of the Malvern Range, close to the " sycamore tree locality ", the Malvernian rocks appear at structurally lower levels before finally disappearing beneath the cover of Lower Palaeozoic sediments. Although erosion undoubtedly preceded the final burial of these Malvernian " islands " contemporaneous faulting may well have facilitated their submergence.

There is little evidence for movement along the Malvernoid structure until Avonian times and the Malvern line as a whole is fundamentally a Hercynian structure.

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