CORRESPONDENCE

A NOTE ON CLIFF EROSION IN SOUTHERN LLEYN

SIR,—The southern coast of the Lleyn peninsula, Caernarvonshire, is scalloped by a number of small bays which are separated by minor headlands invariably composed of small igneous masses. The formation of shingle beaches banked up against the western side of certain of these headlands has been attributed by Steers (1939) to eastward-moving longshore drift. It is apparent, however, that such accumulations are matched by erosion on the other side of the headlands, in what is generally unconsolidated glacial drift and/or alluvial material.

Discussion with members of the Lleyn, Criccieth, and Portmadoc Councils, the Manager of Butlin's Holiday Camp, Pwllheli, and subsequent correspondence with Mr. J. Lewis of Lewis and Duvivier, Consulting Engineers, has revealed that present erosion of the cliff-line is considerable. Comparison of the latest Ordnance Survey 6-inch maps with those of the first edition some seventy years ago, had indicated that the average annual recession rate is approximately 6 inches at Criccieth, 18 inches near Pwllheli, up to 24 inches south of Abersoch, and 24 inches to the east of Pen-y-Chain Pt., in cliffs which range from 5 to 30 feet in height, while frontages so affected include one of 2,500 feet south of Abersoch and 1,200 feet north of Careg-y-Defaid.

It is notable that this erosion is concentrated in what, considering the prevailing south-westerly wind, is in the most sheltered part of each bay unit, and that the majority of the erosion sites face east or south-east—a direction from which there can only be a limited fetch (Text-fig. 1).

Silvester (1962) drew attention to this phenomenon on a world-wide scale, and concluded, on the basis of model studies, that this " half-heart " shape, with the curved portion upcoast and the tangent section downcoast of a bay unit, was the equilibrium shape for a coastline affected by oblique swell, but he did not discuss the mechanism responsible for this development. That the erosion in the Lleyn could have been produced solely by waves approaching from an easterly direction is possible, but Silvester's experiments suggest that erosion proceeds even when the prevailing south-westerly winds are dominant. An analogous situation may be seen to exist, on a smaller scale, around beach groynes, where accumulation on the updrift side is frequently matched by removal of material immediately on the downdrift side.

Within the area under consideration, wave refraction must play an important part in determining the course of the erosion, but it is difficult to assess whether this alone can account for the apparent concentration of erosive processes in the shelter of the headlands. Tracer experiments by Ingle (1966) have shown that there is shoreward transport of sand grains by an eddy current immediately to the lee side of a beach groyne, and such a current, perhaps coupled with local changes in direction of the longshore drift, may be a contributory factor.

At present there are no plans for a fuller investigation into this problem, and this note is inserted in the hope that other workers may be interested in conducting a detailed study.

I am indebted to the abovementioned members of various Councils for giving up their time to discuss this matter, and also to Mr. J. Lewis of Lewis and Duvivier, who originally prepared reports on the erosion problem on behalf of clients, and who kindly commented at length on the present state of the coastline in N. Cardigan Bay. It must be stressed, however, that the author alone is responsible for inferences based upon this data. The observations were made during the tenure of a D.S.I.R./S.R.C. Research Studentship in the Department of Geology, University College of Wales, Aberystwyth.

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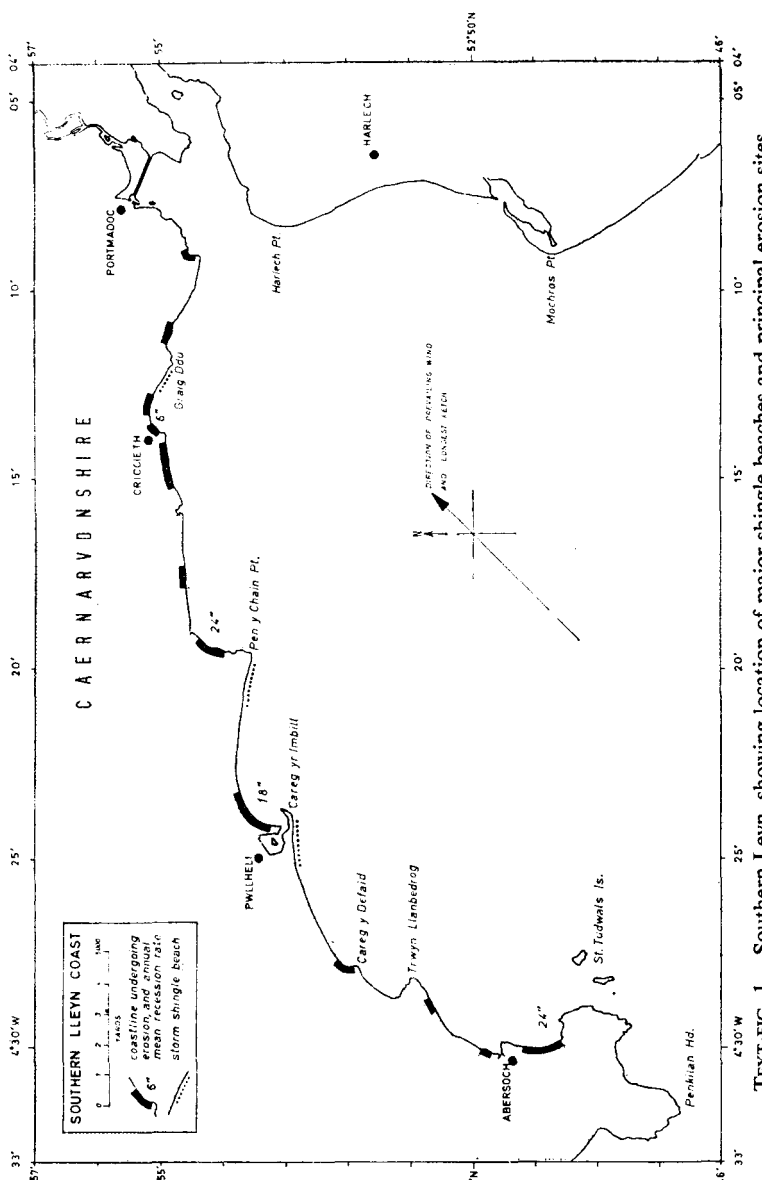

TEXT-FIG. 1.—Southern Leyn, showing location of major shingle beaches and principal erosion sites.

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THE POSITION OF THE WENLOCK/LUDLOW BOUNDARY IN THE SILURIAN GRAPTOLITE SEQUENCE

SIR,—We are currently preparing a detailed account of the faunal stratigraphy of the Wenlock/Ludlow passage beds of Wenlock Edge and Hopedale, Shropshire. Our communication is prompted by the letter of Warren, Rickards, and Holland in this *Magazine* (1966, **103**, p. 466–7). The comments of these authors pertinent to our study involve the assignment of the Wenlock Limestone to the graptolite zone of *Pristiograptus ludensis* (= *vulgaris*) and the reference of this zone to the Wenlockian.

We concede that the base of the Ludlovian Series as defined by Wood (1900, p. 422) at the base of the *P. ludensis* (*M. vulgaris*) zone is no longer tenable following the report by Warren, Rickards, and Holland that species indicative of this zone occur below and within the Wenlock Limestone of the Ludlow area. We fail, however, to agree with their statement (p. 467) that the base of the Ludlovian as currently defined at Ludlow by Holland, Lawson, and Walmsley (1963, p. 139) " would appear to lie more or less at the base of the *Pristiograptus nilsonni* zone ". The Wenlock/Ludlow junction in fact occurs at the base of the " Barren " beds of Alexander (1936) (= Lower Elton Beds), from which graptolites have not yet been recorded at Ludlow.

In our study of the passage beds between the limestone facies of the Wenlock Limestone and the Lower Elton Beds of Wenlock Edge we have found no evidence to suggest that the latter beds (which are the direct correlatives of the lower Elton Beds at Ludlow) lie within the zone of *P. nilsonni*. In fact there is evidence to the contrary from the report of Das Gupta (1932, p. 351–2) who identified the graptolite species *Monograptus vulgaris* (= *Pristiograptus ludensis*), *M. colonus* var. *ludensis*? (= *P. ludensis*) and *M. dubius* (= *P. dubius*) from an horizon within the Lower Ludlow Shales 100 feet above the Wenlock Limestone at Millichope. One of us (J. H. S.) has determined Das Gupta's horizon to lie within the lithological transition from Lower to Middle Eltonian and immediately below beds with a *P. nilssoni* zone graptolitic assemblage. The Middle Elton Beds at Ludlow have yielded a similar *P. nilssoni* zone assemblage. (Holland, Lawson, and Walmsley, 1963, p. 107.)

This evidence leads us to believe that the Lower Elton Beds represent a dominantly shelly lateral equivalence of the uppermost *P. ludensis* zone as it occurs in the basin facies, and that the Wenlock/Ludlow boundary as defined by Holland, Lawson, and Walmsley lies within this zone. If, as Warren, Rickards, and Holland suggest, the base of the *P. nilssoni* zone is accepted as the base of the Ludlovian, we consider that the shales (Lower Elton Beds) immediately overlying the Wenlockian limestone facies should then be regarded as the highest division of the Wenlockian, in which conclusion we voice the opinions of Ketley (1865) and Davidson and Maw (1881).

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