LETTERS TO THE EDITOR

Lithostratigraphy of the Peel Sandstones, Isle of Man

16th May, 1985

Dear Sir,

In a recent account of the Society's field excursion to the Isle of Man Dr. T.D. Ford very briefly outlined several problematical aspects regarding the outcrop stratigraphy and age of the Peel Sandstones. Both problems have resulted in some disagreement in the published literature (see review by Ford, 1971). The age of the succession has proved to be particularly enigmatic in the absence of a dateable contemporaneous fauna or flora and has lead to a variety of assumed dates of sedimentation, ranging from Old Red Sandstone (ORS) to Carboniferous and Permo-Triassic. In view of the Society's recent interest in the Peel Sandstones the aim is to briefly examine published data and new evidence which may help to resolve these problems.

Outcrop Sratigraphy

The Peel Sandstones, outcropping on the northwest coast of the Isle of Man (see Fig.1), were originally described by Boyd Dawkins (1902) and Lamplugh (1903). In his paper, Boyd Dawkins (1902) erected an outcrop stratigraphy and proposed the occurrence of a total stratigraphic thickness of approximately 500 m (including an inferred unexposed sequence of approximately 150 m projected inland). A cross section illustrating the outcrop stratigraphy suggested that the coastal exposure represented the fault repetition of the succession, based on observed gross lithological similarities between the rocks exposed either side of Traie Fogog bay and those exposed further north at Whitestrand. Ford (1984), however, pointed out that the Whitestrand succession, although lithologically similar, is "a repetition of depositional facies rather than a faulted recurrence of the same beds in Traie Fogog" and that the succession has, therefore, not been fault repeated to any significant extent. This assertion may be confirmed by:

1. Examination of clast petrography and identification of derived fossils (see also Gill, 1903; Lewis, 1934) has established that the younger the conglomerate the older are its clasts. This well developed inverted clast stratigraphy, most obviously defined by the restricted occurrence of Wenlock faunas to The Stack conglomerates (supported by the work of Lewis, 1934 and my own recent collection of approximately 70 fossiliferous clasts examined by Dr. C.T. Scrutton) and Ashgillian faunas to the Whitestrand conglomerates (supported by Gill, 1903; Lewis, 1934) and the presence of Ordovician related crinoid ossicles identified in one derived limestone clast by Dr. S.K. Donovan). This strongly suggests that the conglomerates exposed at Whitestrand are stratigraphically younger than those exposed at The Stack. Segregation of a wide range of clast types further supports this argument, particularly noteable is the restricted occurrence, in The Stack conglomerates, of numerous clasts of relatively unaltered acid lavas, pyroclastics and the presence of similar pyroclastic material in some derived Wenlock limestone clasts, whilst the Whitestrand conglomerates do not contain any clasts of this type, but do contain an abundance of intensely altered (?) volcanoclastic detritus of a type not recognised in The Stack conglomerates. Further distinct variations in clast composition also exists between the two units described above and the exotic conglomeratic clasts which contribute to the thin gravel bases of fluvial channel sandstone bodies exposed towards the base of the succession.
2. Although the succession is intensely dissected by fractures and small faults the thickness of The Stack conglomerate is approximately an order of magnitude greater than the conglomeratic unit exposed at Whitestrand.
3. The occurrence of distinct variations in profile type, degree of profile development and thickness of the pedogenic carbonates between the two conglomeratic units.

Further differences, in the form of minor facies variations (as suggested by Ford, 1984), also support the argument for an outcrop pattern not repeated by faulting, but the evidence is less immediately conclusive than that outlined above.

Therefore, despite a moderate degree of deformation, it appears that the present Peel Sandstone exposure represents a sediment package of the order of 1000 m, approximately twice that originally suggested by Boyd

Dawkins (1902). Furthermore, since no outcrop evidence exists defining the base and top of the Peel Sandstones the complete succession may originally have been substantially thicker, the present exposure existing at a remnant of a once significant clastic wedge.

Age of the Peel Sandstones

Available lithostratigraphic and structural evidence indicates that the Peel Sandstones were deposited:

1. Later than the derived Wenlock limestone clasts contained within The Stack conglomerates.
2. Prior to the tectonic uplift of the Cambro-Ordovician Manx Carboniferous (Arundian) basal, red bed conglomerates exposed at Langness and their complete absence from the Peel Sandstone conglomerates.
3. Prior to the tectonic deformation of the Manx Carboniferous (Arundian-Brigantian) succession, as evidenced by the significantly greater degree of tectonic deformation (with dips in the Peel Sandstone exceeding those in the Manx Carboniferous by up to 30°-40°) suffered by the Peel Sandstones.

The age of the Peel Sandstones, therefore, falls into a time slot between the Upper Silurian and Lower Carboniferous and can therefore be considered ORS in age as defined by Allen (1977, pg 40-42).

Clearly the date of the earliest phase of deformation to affect the Peel Sandstone becomes critical in defining the age of the rocks more precisely. Examination of the regional deformation history of the British Isles between the Upper Silurian-Lower Carboniferous (e.g. Allen, 1974; Bluck, 1984; Powell & Phillips, 1985) suggests that the Peel Sandstones could have been affected by either or both of two potential tectonic events, the first of these occurring during the end Silurian (Downtonian) to Lower Devonian (Gedinnian-Siegenian ?) and the second during the Middle to Upper Devonian (late Emsian to Famennian). The degree of structural deformation of the Peel Sandstones suggests that the succession was unlikely to have been deposited prior to the end Silurian-Lower Devonian event since rocks as young as Lower Downtonian in the Lake District zone are observed to have been overprinted by an end Caledonian cleavage event (Ingham et al. 1978), an effect not recorded in the Peel Sandstones. Evidence provided by the structural and stratigraphic relationships of the Shap Granite (Boulter & Soper, 1973; Wadge *et al*, 1978) suggests that this phase of deformation had been completed by earliest Devonian times. A more likely scenario is that the Peel Sandstones were deposited after the phase of end Caledonian deformation and later deformed by a mild regional tectonic event during the Middle and early Upper Devonian. The period was represented by a major hiatus in sedimentation over much of northern and central Britain, prior to the deposition of an Upper Devonian or Lower Carboniferous uncomformable cover on previously deformed Lower ORS. This view, although equivocal, of the occurrence of Lower Devonian, post orogenic clastic successions, within the paratectonic Caledonian zone, deformed during the Middle Devonian is supported by, and in agreement with, the observations of Capewell (1955) (see also Boulter & Soper, 1973, table 1) on the supposed Lower Devonian Mell Fell Conglomerate of the Lake District.

The assertion that the Peel Sandstones are of Lower Devonian age may be further supported by recourse to the petrological evidence. The variable, but high detrital, garnet content of the sandstones (as noted by Lewis, 1930 and confirmed by Crowley, 1981) originally lead to the speculation (Crowley, 1981) that the Peel Sandstones formed part of a southerly flowing (supported by palaeocurrent data, Crowley, 1981) regional (extending from present-day N. Ireland to S. Wales) early Lower ORS (Downtonian-early Gedinnian) fluvial dispersal system described by Allen (1974), Allen & Crowley (1983) and Simon & Bluck (1982), which consisted of sandstones and conglomerates characterised by a high content of metamorphic detritus dervied from high grade rocks of the orthotectonic Calendonides of (?) northern Britain. This suggestion is now, however, considered to be incorrent for the following reasons:

1. The relative absence in both the sandstones and conglomerates of detrital metamorphic debris other than garnet.
2. The relatively short distance of sediment transport (approximately 5-10 km) inferred from the angularity and coarseness of much of the conglomeratic debris.
3. The inferred alluvial fan-alluvial plain type sedimentology which suggests that the Peel Sandstones did not form part of a major trunk distributary system.

A more likely picture capable of accounting for the association of detrital garnet and the relative absence of other related metamorphic detritus is one in which the earlier regional fluvial dispersal system was segmented and locally uplifted in response to the gradual tectonic evolution of the Caledonides (see Allen, 1974; Allen & Crowley, 1983), resulting in the reworking of earlier, metamorphic-rich Lower ORS sequences along with Lower Palaeozoic upper crustal lithologies. A similar situation is envisaged by Allen (1974) to account for the composition of the later Lower ORS (late Gedinnian-early Emsian) in the Welsh Borders.

In summary it is suggested that the Peel Sandstones represent a fragment of an originally substantial package of sediments deposited during the late Lower Devonian (Seigenian-Emsian) as a series of coalescing alluvial fans and adjacent alluvial plains. Contrary to popular belief regarding Ordovician and Silurian palaeogeographies the Peel Sandstones were derived from a thick, upper level crustal succession of Lower Palaeozoic shallow marine carbonates, volcanics (lavas, pyroclastics and volcanoclastics) and coarse grained clastic lithologies (probably including metamorphic-rich earlier Lower ORS sediments) lying to the NW of the Isle of Man, the resultant detritus being deposited in a (?) simple, isolated intractratonic sag basin possibly initiated in response to marginal uplift induced by the intrustion of the c. 400 Ma granites into the surrounding crust.

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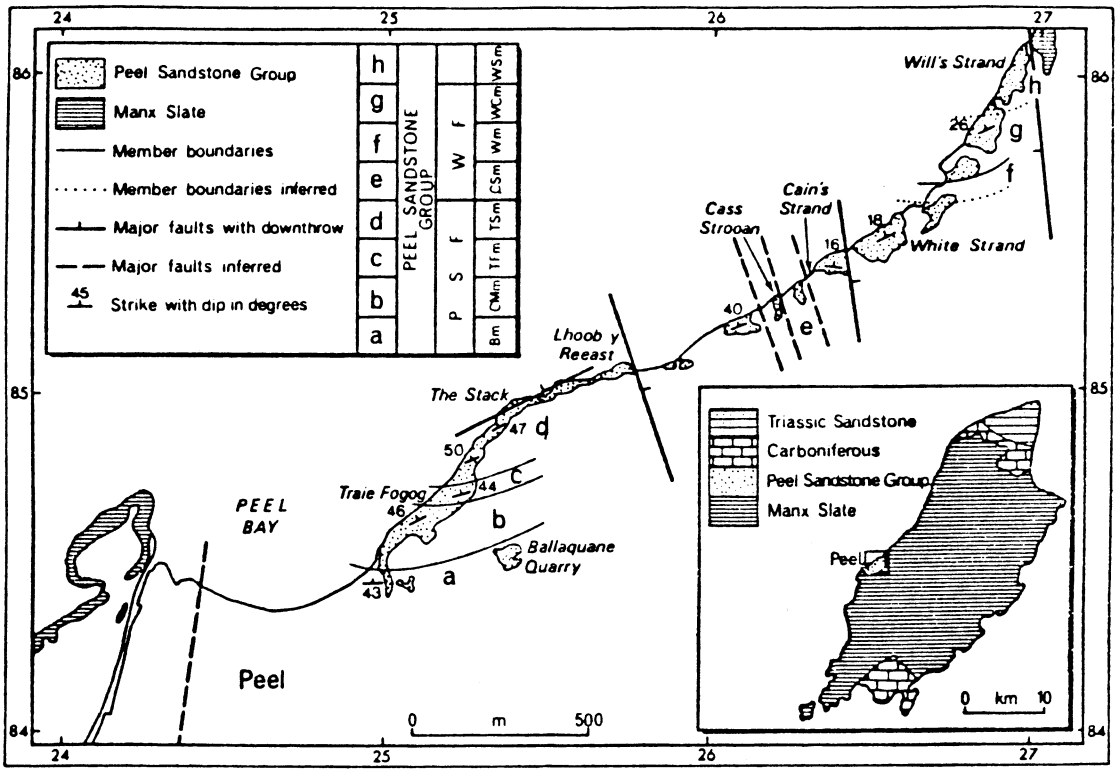

Fig.1. Outcrop and simplified structural map of the Peel Sandstones showing provisional lithostratigraphy.

PSF– Peel Sandstone Formation; WF– Whitestrand Formation; Bm– Ballaquane member (conglomerate and sandstone dominated low sinuosity channels; sheet flood sandstones); CMm– Creg Malin Member (stacked fining upwards cycles– active low sinuosity streams); TFm– Traie Fogog Member– (distal to medial alluvial fan conglomerates, sandstones and siltstones/mudstones; abundant dessication features, sparse pedogenic carbonate profiles); TSm– The Stack Member (medial alluvial fan conglomerates, pebbly sandstones and sandstones; abundant pedogenic carbonate profiles); CSm– Cain's Strand Member (sandstone dominated low sinuosity streams); Wm– Whitestrand Member (distal alluvial fan conglomerates, sandstones and siltstones; abundant dessication features, sparse pedogenic profiles); WCm– Whitestrand Conglomerate Member (distal alluvial fan conglomerates and pebbly sandstones); WSm– Will's Strand Member (sandstone dominated low sinuosity streams; intense structural deformation).

Inset. Simplified geological map of the Isle of Man (after Taylor *et al.*, 1971).

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29th May, 1985

Dear Sir,

Having introduced Mr. Crowley to the Peel Sandstone on a student field course several years ago, I welcome this expansion of knowledge concerning these exposures of the Old Red Sandstone. I fully support his deductions concerning the stratigraphic succession and thickness. He has raised an important point concerning the source of the fossiliferous Ordovician and Silurian clasts in the conglomerates: he suggests the possible presence of a Lower Palaeozoic carbonate platform "5 to 10 km N.W. of the Isle of Man". This would require revision of current ideas of contemporary palaeogeography, and I can only hope that Mr Crowley will soon publish the evidence on which his deductions are based in full.

Yours sincerely,

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ERRATA

1. Due to an oversight which resulted in the author not receiving proofs, a number of printing errors crept into the letter to the editor entitled *Lithostratigraphy of the Peel Sandstones* in Vol. 10, No. 1, pp. 73–76 by S.F. Crowley (Dept. of Geology, University of Liverpool). The editor offers his apologies for these errors, the corrected versions of which, as supplied by the author, are given below.

Page 73. Line 24–29. This well developed inverted clast stratigraphy is most obviously defined by the restricted occurrence of Wenlock faunas to The Stack conglomerates (supported by the work of Lewis, 1934 and my own recent collection of approximately 70 fossiliferous clasts, a small number of which were examined by Dr. C.T. Scrutton) and Ashgillian faunas to the Whitestrand conglomerates (supported by Gill, 1903; Lewis, 1934 and the presence of Ordovician related crinoid ossicles identified in one derived limestone clast by Dr. S.K. Donovan).

Page 74. Line 7–8. 2. Prior to the uplift and erosion of the Cambro-Ordovician Manx Massif, as defined by the predominance of Manx Slate clasts in the Manx Carboniferous (Arundian) basal, red bed conglomerates exposed at Langness (south IOM) and their complete absence from the Peel Sandstone conglomerates.

Page 75. Line 18. Ford, T.D., 1984. Field excursion to the Isle of Man. *Mercian Geol.* 9. 243–244.

2. In Vol. 10, No. 2 Table 1, p. 116 in the paper by *M.A. Moss* the analyses for Acid Leach (1b) and Residue Calculations (1c) for BD2 and BD3 were inadvertently transposed by the author when preparing this table. The resulting descrepancy between Fig. 5 b and c and Table 1 was unfortunately not detected until after the journal had gone to press. The editor and author apologise to those readers who attempted to correlate Table 1 with Fig. 5.

In this same paper there are, in spite of proof reading by both the author and editor, different spellings of Sprotbrough. The spelling favoured by the Ordnance Survey and used by geologists for stratigraphical purposes is 'Sprotbrough'.