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MICROSTRUCTURES IN SOLIFLUCTION SEDIMENTS FROM SOUTH WALES AND NORTH NORWAY

Résumé

L'étude des microstructures de sédiments de solifluxion, prélevés en deux endroits du sud du Pays de Galles, est présentée. L'auteur décrit spécialement les recouvrements de silt et de sable fin qui se trouvent à la surface supérieure des sables grossiers et des graviers.

Ces données sont comparées avec des microstructures semblables observées dans les sédiments subissant actuellement des phénomènes de solifluxion dans la Norvége septentrionale.

Abstract

Elements of the micromorphology of solifluction sediments at two sites in South Wales are described, particularly silt and fine sand cappings which occur on the upper surfaces of the coarse sand and gravel-sized material. These are compared with similar microstructures observed in active solifluction sediments from North Norway.

INTRODUCTION

Solifluction deposits (head) form an important element in the Pleistocene drifts of South Wales (BOWEN, 1970; LEWIS, 1970). These deposits may be difficult to distinguish from locally derived till, particularly where till has been reworked by solifluction processes (HARRIS and WRIGHT, 1980). With this in mind it was decided to investigate the microstructures of solifluction deposits in South Wales in order to explore the possibility that additional diagnostic features might be identified and used to distinguish between sediments which have suffered periglacial mass movements and those which have not.

Prior to this investigation a detailed study had been made of the micromorphology of soils on a solifluction slope in the Okstindan Mountains of North Norway. Distinctive micromorphological features were observed in sediments forming turf-banked solifluction lobes. These lobes were shown to be active, with average annual surface rates of movement of around 16 mm (HARRIS, 1977).

This report presents findings of an initial study of two sites in South Wales, and compares them with micromorphological features found in the study of active solifluction sediments in Norway.

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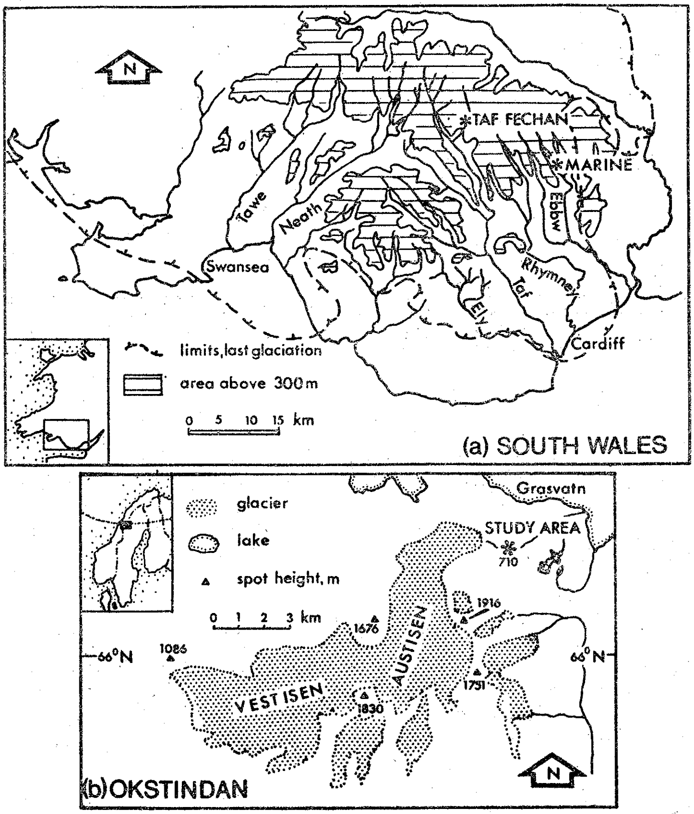


Fig. 1. Location maps, (a) South Wales, (b) Okstindan, North Norway

SITE DESCRIPTIONS, SOUTH WALES

MARINE COLLIERY, EBBW VALLEY

The Ebbw Valley runs roughly North-West to South-East through the Carboniferous Coalmeasures sandstones and mudstones (fig. 1). The valley is steep sided and narrow, and is floored by glacial outwash deposits and till. Just south of Marine Colliery in the western valley side, a gully provides good exposures of surface unconsolidated deposits. Here the glacial till extending up the lower valley side is covered with a layer of stony head up to 2 m thick (Fig. 2). Frost shattered sandstone fragments incorporated in the head may be traced back to severely disrupted bedrock outcropping in the bottom of the gully (Fig. 2). The clasts are angular and platy and in section lie parallel or slightly imbricate to the ground surface. Elongated clasts show a strongly developed preferred orientation parallel to the slope direction. These sandstone clasts are set in a silty sand matrix which contains less than 10% finer than 2 μ.

TAF FECHAN RESERVOIR, BRECON BEACONS

The headstreams of the River Taf rise on the dipslope of the Old Red Sandstone (Devonian), in the Brecon Beacons. Here valleys are broader than in the coalfield

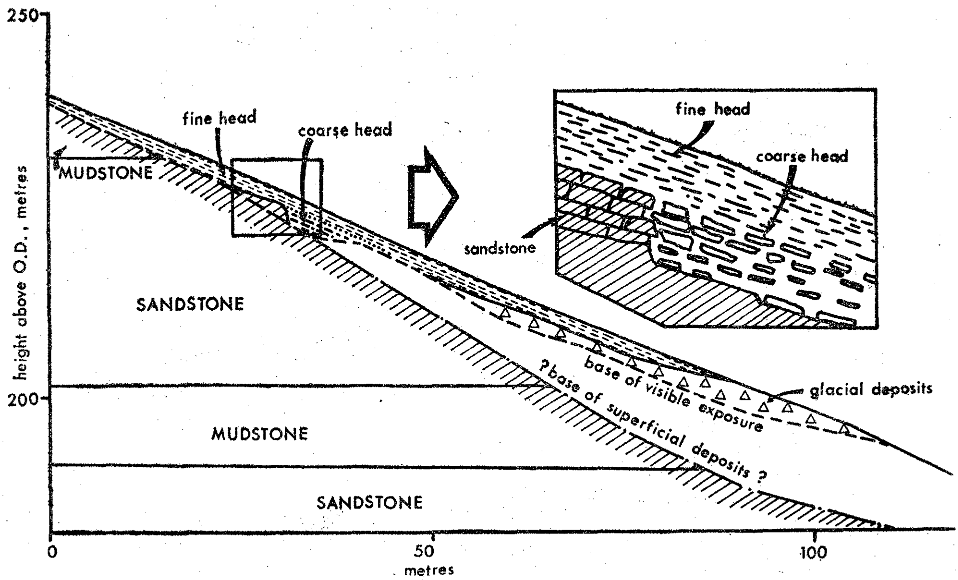


Fig. 2. Superficial deposits, Marine Colliery, Ebbw Vale

and solifluction has produced a rounded topography mantled with head deposits, described in detail by LEWIS (1966). On the western side of the Taf valley a small tributary stream has cut through the valley side head deposit and samples were taken from the stream banks in a mid-slope location. Here clasts and matrix are derived from the Old Red Sandstone, giving the deposit a reddish brown colouration. Clasts are mainly platy and angular, and show preferred orientation parallel to the slope direction and dips parallel or slightly imbricate to the ground surface. The matrix is again sandy in texture, with less than 8 % finer than 2 μ.

SAMPLING PROCEDURE

Undisturbed oriented samples were taken from 1 m below the surface at each site by carefully isolating blocks of sediment of approximate dimensions 10 cm^3, with a trowel. The blocks were then trimmed to approximately half their original size, oven dried, and impregnated with Bakelite BK191 resin, under a vacuum slowly increased to 10 cm mercury. When cured, thin sections were made taking care to transfer orientations from the sample to the microscope slide. Sections were cut in the vertical plane, with the azimuth of the section plane parallel to the direction of slope.

MICROMORPHOLOGY OF SOUTH WALES SEDIMENTS

In both sites coarse sand and gravel-sized material showed strongly developed preferred dips (Fig. 3) approximately parallel to the ground surface slope. This suggests that organisation of the macro clasts resulting from downslope mass movement also occurs in the finer grained material, down to coarse sand size.

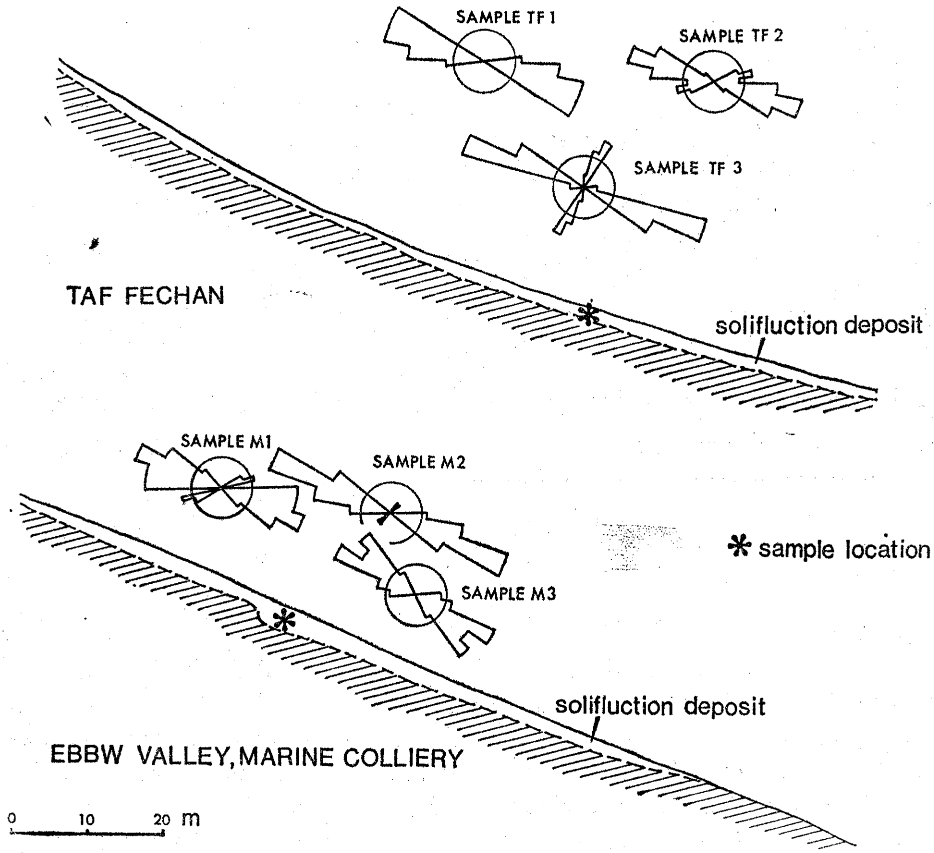
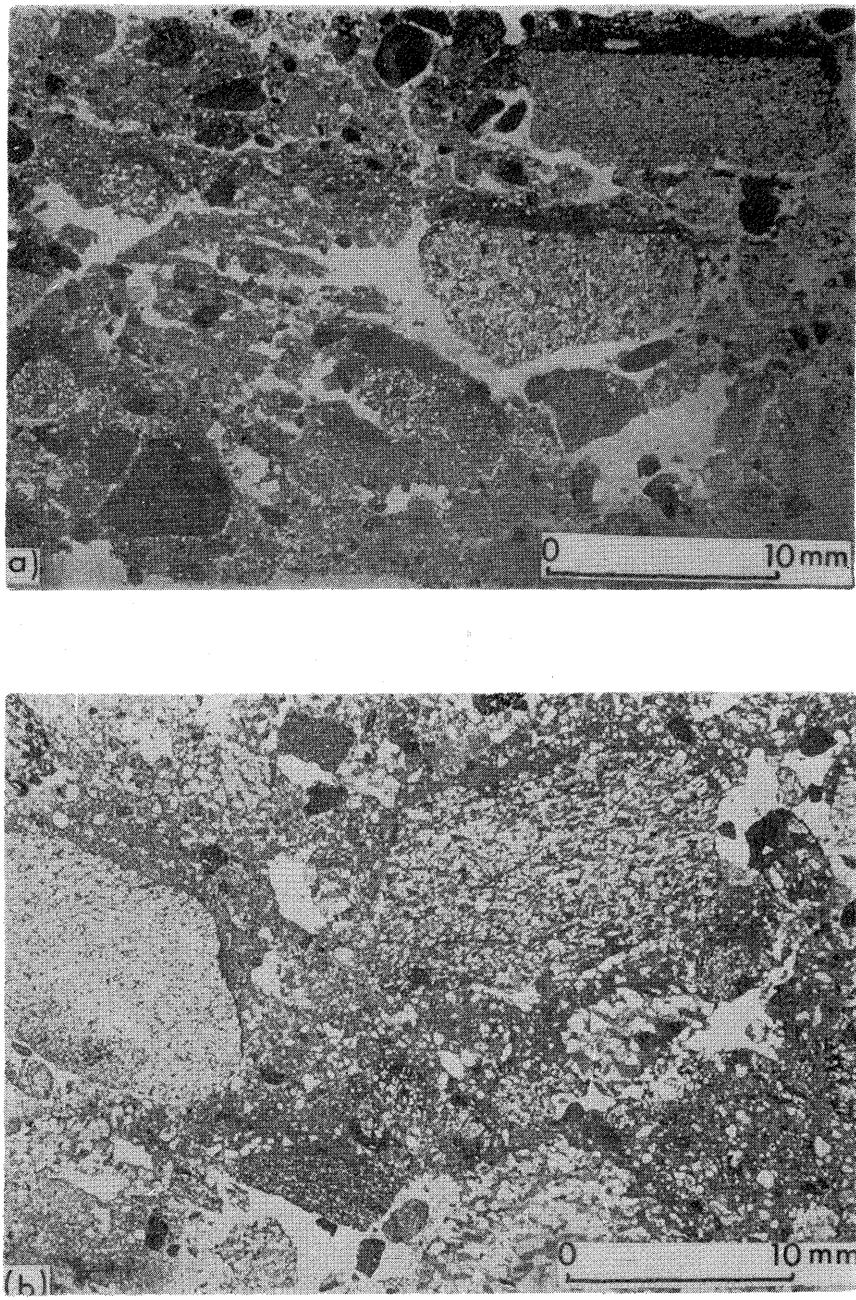


Fig. 3. Dips of elongate sand grains, South Wales samples. Circles equal 10%

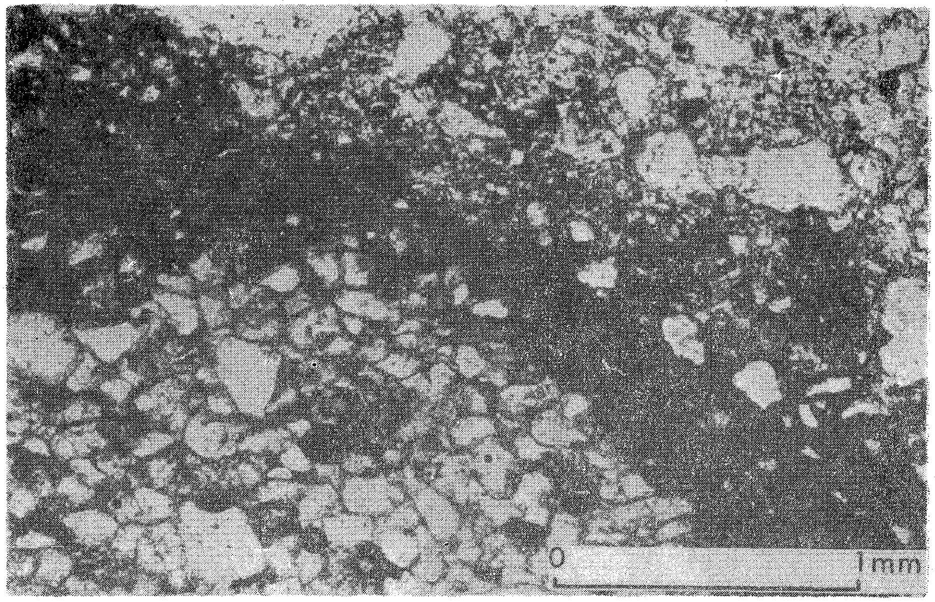
A second element of the micromorphology of these sediments was the distribution of fine grained matrix material relative to the coarse sand and gravel sized rock fragments. In both sites, despite the differing bedrocks and consequent lithology of the head deposits, silt and fine sand was observed forming distinct coatings on the upper surfaces of gravel and coarse sand-sized grains. These coatings were visible in the thin sections with no magnification (Pl. 1) and their high density and relatively fine grained nature was clearly seen under the microscope (Pl. 2). The outer boundary of these coatings was generally indistinct, merging into the coarser less dense matrix. The thickness of these coatings was up to 1 mm and they were more clearly developed in the Taf Fechan samples than in those from the site at Marine Colliery (Pl. 1).

COMPARISON WITH NORWEGIAN SOLIFLUCTION SEDIMENTS

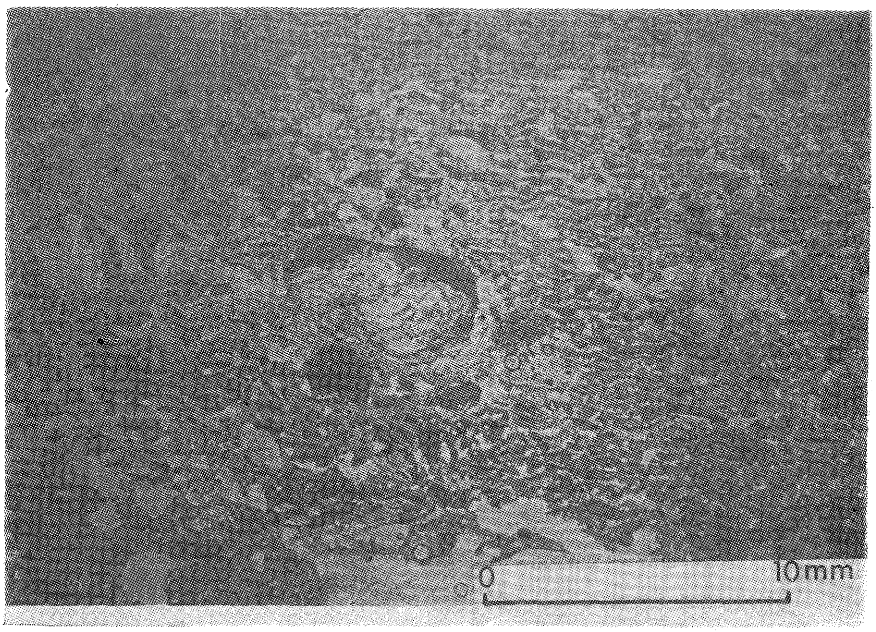
Three profiles were examined in Okstindan, North Norway (Harris and Ellis, 1980), in soliflucted silty sand till. The Norwegian sediments were finer textured than those examined in South Wales. Figure 4 shows dips of sand grains recorded in thin sections from Okstindan. The similarity between these fabrics and those



Pl. 1. Silt cappings coating upper surfaces of gravel and coarse sand
(a) Taf Fechan site, (b) Marine Colliery site



Pl. 2. Photo micrograph of silt capping on upper surface of gravel-sized grain, Taf Fechan site



Pl. 3. Silt coatings of larger detrital grains, Norwegian solifluction sediment

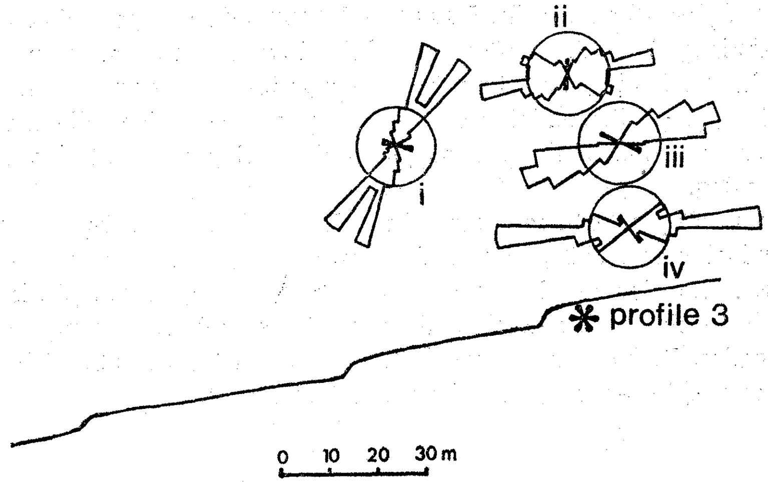


Fig. 4. Dips of elongate sand grains, Okstindan. Circles equal 10%

recorded from South Wales is apparent. Harris and Ellis (1980) suggest that the saturated flow of the soliflucted sediment leads to shearing within the sediment mass and consequent orientation of elongate grains.

The silt and fine sand forming coatings on the upper surfaces of coarser grains observed in the South Wales sediments also resembled matrix coatings on detrital grains in the Norwegian sediments (Pl. 3). In these solifluction lobe sediments coatings were often smooth and streamlined, and consisted of dense accumulations of silt. The silt flakes were generally oriented around the sand grain surface (Harris and Ellis, 1980).

Accumulations of fine textured material on the upper surfaces of larger grains have been widely reported in soils from cold environments (see Harris and Ellis, 1980 for details). Fitz Patrick (1971) has explained the formation of these coatings as being due to melting of ice sheaths around mineral grains, leaving spaces above the grains into which is washed fine material. Such ice sheaths would presumably develop in sediments which are fine enough to retain sufficient moisture for segregation ice growth, and have a texture which is frost susceptible. The soliflucted sediments investigated in Okstindan were frost heaved in winter (Harris, 1972) and therefore (Fitz Patrick's mechanism for the development of silt coatings on sand grains might operate there. However, these much coarser sandy gravel head deposits in South Wales are only marginally frost susceptible when compared with Beskow's limits (Beskow, 1935). It would therefore seem less likely that ice sheaths developed around the coarser grains during freezing of this material.

In his study of the solifluction site in Okstindan Harris (1972) has shown that the soil is frozen to a depth of 1 to 2 m in winter. During the spring and summer thaw drainage on the solifluction slope is impeded by a frozen subsoil and solifluction is active until thawing of the ground from the surface reaches the depth of penetration of frost during the previous winter. Clearance of ground ice then leads to rapid drainage of the saturated soils. HARRIS and ELLIS (1980) suggest that this rapid vertical drainage leads to translocation of the finer matrix down the profile. This silt and fine sand is intercepted by the coarser grains and accumulates to form the observed cappings. Streamlining of these cappings results from differential rates of flow and rotation of the sand/capping units during saturated downslope soil flow in spring.

The coarse open textured nature of the South Wales head deposits, and their relatively high permeability, suggests that downwashing of fines perhaps as a result of the clearance of ground ice, as described in the Norwegian example, is the most likely cause of the coatings of silt and fine sand observed on the upper surfaces of coarser grains. It should be stressed that sampling of these South Wales deposits took place well below the depth of modern pedogenesis.

CONCLUSIONS

A preliminary study of microstructures in solifluction deposits in South Wales has revealed marked similarities with microstructures observed in sediments from a modern solifluction environment, in Okstindan Norway. In particular the preferred dips of sand grains were similar, suggesting a similar mode of mass movement. In addition a prominent feature of the micromorphologies in South Wales and Norway was the presence of silt and fine sand coating the upper surfaces of coarser grains. This was thought to result from downwashing of fines during soil drainage following clearance of ground ice in summer. This investigation suggests that it may be possible to identify micromorphological elements characteristic of solifluction deposits. A more detailed study, including many more sites is now in progress in South Wales in an attempt to test this suggestion.

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