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# Llan-non

## Highlights

This site demonstrates the complexities of glacial and periglacial events in western Mid Wales, showing Irish Sea and Welsh tills and some of the best multi-generation periglacial features in Britain. The site provides outstanding evidence for migrating ice fronts and polar desert during the Devensian Stage.

## Introduction

The coastal sections at Llan-non display evidence for glacial and periglacial events and processes. The site is regarded as one of the finest exposures exhibiting periglacial involutions (festoons) and vertical stone structures in Great Britain (Watson and Watson 1971). Additional interest is provided by what some regard as a zone of interglacial weathering, the Llansantffraid Soil. The site was first noted by Williams (1927) and Mitchell (1960, 1962, 1972). The most detailed studies of the stratigraphy and periglacial structures were by Watson (1965b, 1970, 1976, 1977a, 1977b) and Watson and Watson (1971).

## Description

The principal sections at Llan-non occur between the rivers Peris and Clydan, which flow west and dissect a low coastal terrace. The sections comprise a low cliff 3.5–4.5m high, almost entirely composed of alluvial gravels. Till deposits crop out to the north of the Peris and south of the Clydan, and the alluvial gravels occupy what is believed to be a fluvially excavated depression in the surface of the till. The following succession was recognised by Watson (1965b, 1976, 1977a):

4 Fine gravels, sands and silts

3 Torrential alluvial boulder gravels

2 Irish Sea till

1 Welsh till

The sequence shows multi-generation periglacial involutions.

## Interpretation

Williams (1927) noted that the drift deposits in the Llan-non area were banked up against what he interpreted as a fossil cliff of 'pre-glacial' age. Wood (1959) likewise described the relationship between the superficial deposits and the fossil cliff, and noted that the drift platform at Llan-non had resulted from the infilling of hollows on a till surface by water-washed, probably solifluction, debris.

Mitchell (1960, 1962, 1972) noted that the base of the exposures north of the Peris river (termed by him the "Llansantffraid sections") comprised a much cryoturbated stony till, which passed laterally southwards into a coarse gravel. The surface of the till and gravels was deeply weathered, frost-heaved and penetrated by vertical weathering cracks. This weathered surface was truncated and overlain by a younger series of gravels, also subsequently slightly disturbed by frost-heaving. The zone of weathering between the two gravels was termed by Mitchell the Llansantffraid Interglacial Soil, and was believed by him to have formed during the Ipswichian Stage. The underlying till was thus ascribed to the Gippingian glaciation (Saalian Stage), and the overlying gravels and subsequent phase of frost disturbance were ascribed to the Devensian. This evidence was used by Mitchell (1960, 1962, 1972) to support his concept of restricted glaciation in Wales in Late Devensian times, with much of the west Wales coast remaining ice-free.

Taylor (1973) noted that a deposit similar to the Llansantffraid Soil occurred to the south, along the coast at Aberaeron. There it contained a pollen assemblage with *Abies*, which he noted was otherwise rarely recorded in British Devensian late-glacial and Holocene pollen diagrams; he further considered that it supported Mitchell's view that the Llansantffraid bed was indeed an interglacial soil of pre-Holocene age. Other workers (Stewart 1961; Rudeforth 1970; Clayden 1977b) disputed that the bed was a soil at all, and doubted its inferred chronological significance. Stewart and Rudeforth suggested that the whole sequence could have resulted from fluctuating environmental conditions during the Devensian Stage, with the 'soil' simply representing a relict permafrost feature. Bowen (1973a, 1974) agreed, and classified it as part of the sequence of Devensian age.

From evidence in the coastal sections between Llan-non and Llansantffraid, Watson (1976, 1977a) proposed the following sequence of events. First, till was deposited by local Welsh glaciers, and subsequently by Irish Sea ice moving southwards. Precursors of the Peris and Clydan rivers then dissected the resulting till surface, first truncating it and secondly, depositing coarse alluvial gravels in a large fan. Where undisturbed, the imbrication of the gravels shows that they were deposited by water moving from east to west. A period of intense cryoturbation under periglacial conditions led to the striking development of vertical stones and involutions in the gravels and in the upper horizons of the till. The lower limit of cryoturbation was interpreted by Watson as a fossil permafrost table, with intense freeze-thaw processes having occurred only in the active layer. A second period of erosion by the two rivers then removed part of the cryoturbated gravels and deposited beds of finer gravels, sands and silts. A renewed phase of cryoturbation, less intense than the first, produced smaller involutions in the later beds; Watson considered that this later episode could in fact be divided into two separate phases of fluvial deposition and cryoturbation. In view of the depth of weathering in the till and lower gravels, Watson (1976, 1977a), like Mitchell (1960, 1962, 1972), argued that they were probably Saalian in age, and attributed the upper alluvial gravels and frost structures to periglacial conditions in the Devensian Stage, when much of the west Wales coast was thought to have been free from glacier ice.

Although Watson provided the most detailed description and interpretation of the beds and structures at Llan-non, his classification has not been accepted by others. Bowen (1974, 1976), for example, argued that the till at Llan-non and Llansantffraid was the product of coeval Welsh and Irish Sea ice in the Late Devensian. Such a view is also supported by the work of Garrard and Dobson (1974) who showed that extensive Late Devensian glacial deposits occur offshore in Cardigan Bay. As such, Llan-non shows contrasting evidence to Morfa-bychan farther north where the deposits suggest the presence of Welsh ice only, and Traeth-y-Mwnt to the south, which clearly demonstrates the incursion of the Irish Sea ice-sheet into south-west Dyfed. Collectively, therefore, these sites demonstrate the complex interaction of the Welsh and Irish Sea ice masses along the west coast of Wales during the Late Pleistocene.

Although involutions and vertical stone structures can be seen at many sites along the Cardigan Bay coast, they are best developed between Llan-non and Llansantffraid; and they were probably formed in the active layer of former permafrost. The cryoturbated gravels and till at Llan-non provide exceptionally detailed evidence for a number of distinct periglacial phases, which have yet to be dated.

Llan-non is a rare exposure through a periglacial alluvial fan. The succession of till, alluvial gravels and associated periglacial structures has been used to reconstruct a sequence of Late Pleistocene events. The interpretation of one bed, the Llansantffraid Soil, however, has proved controversial. The multi-generation periglacial structures at the site, are unparalleled in Wales, and they are amongst the finest of their kind in Britain. Glacial sediments at Llan-non are important for interpreting the complex interaction of the Irish Sea and Welsh ice masses along the west Wales coast during the Late Pleistocene.

## Conclusions

The alluvial fan gravels at Llan-non are unique in Wales. They were deposited by the Peris and Clydan streams towards the end of the ice age. What makes the gravels exceptional, even by international standards, is the way in which they have been disturbed and arranged into distinctive structures by the former development of large ice lenses in the sub-soil. These have been used as examples in text-books.

## [References](#)