IRISH-DUTCH

GEOHYDROLOGY AND ECOLOGY STUDY

- *O. P. W. Wildlife Service, Dublin*
- *Geological Survey of Ireland, Dublin*
- *Department of Nature Conservation, Environmental Protection and Wildlife Management, The Hague*
- *National Forest Service, Utrecht*

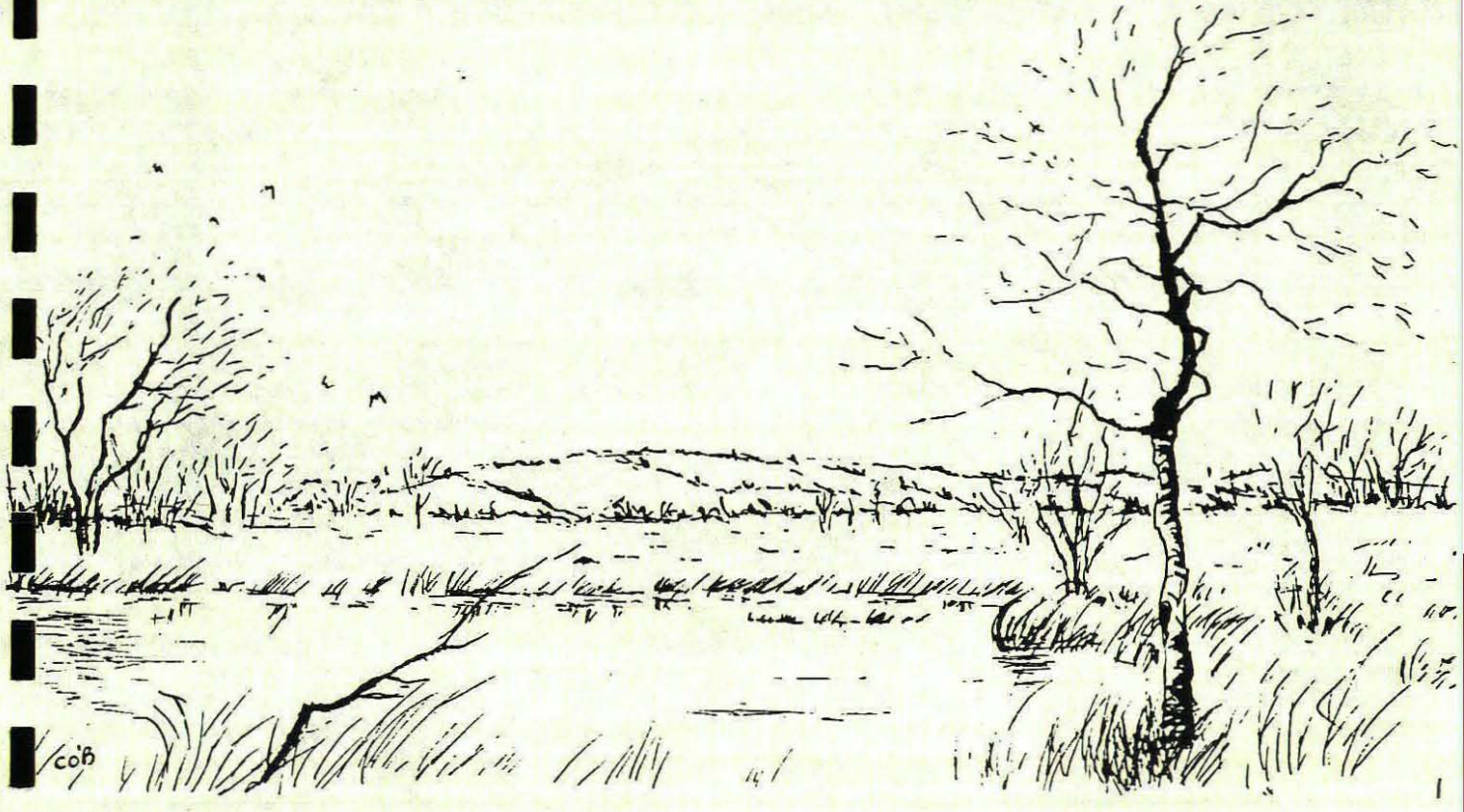
THE QUATERNARY GEOLOGY OF CLARA BOG AND RAHEENMORE,

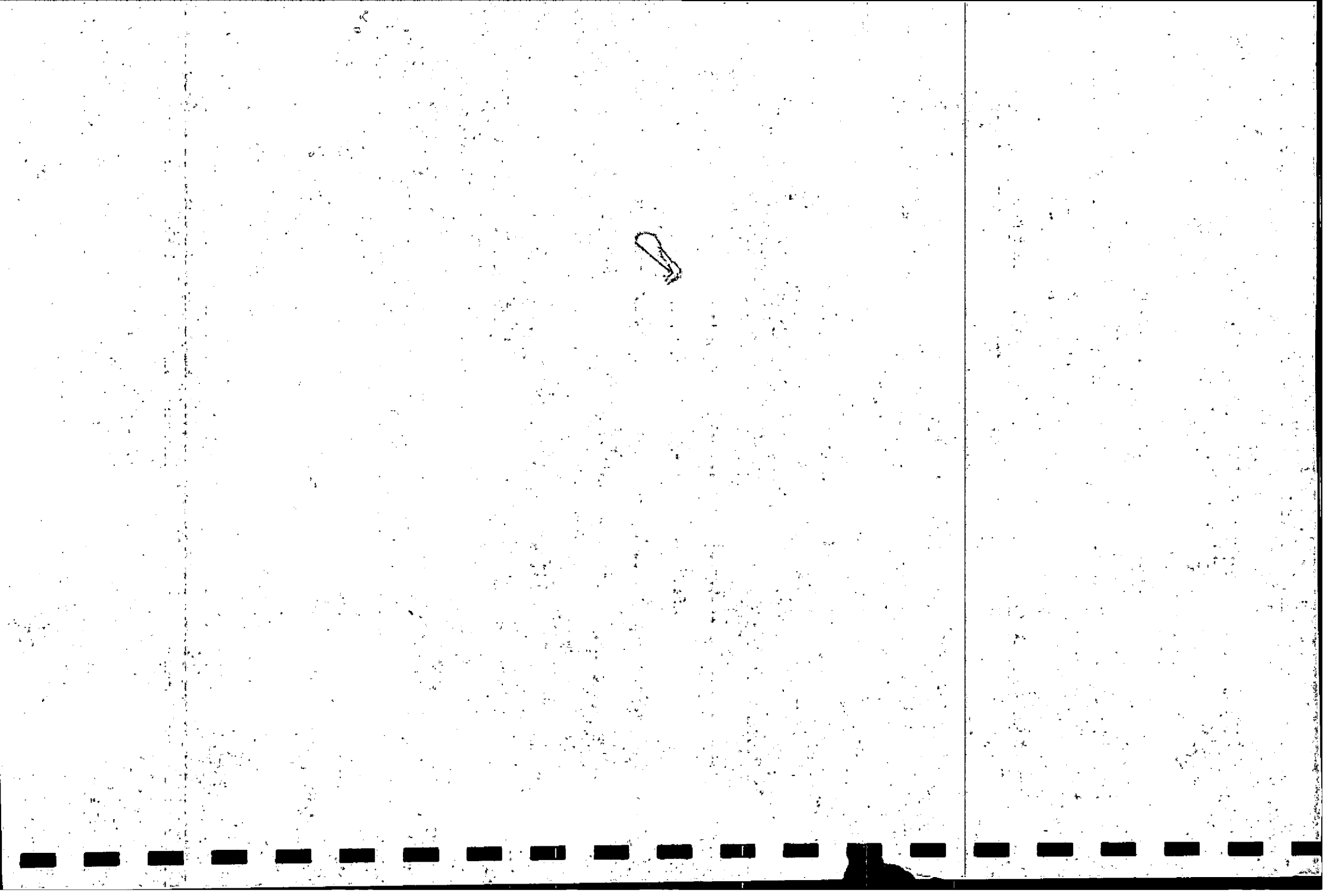
CO. OFFALY, IRELAND

PRELIMINARY MAPPING OF SURFICIAL DEPOSITS

Frank van Tatenhove & Jaap van der Meer

Fysisch Geografisch en Bodemkundig
Laboratorium
Universiteit van Amsterdam





CONTENTS

1. INTRODUCTION

As part of a three years research project on the hydrology of two raised bogs, Clara Bog and Raheenmore a preliminary geological inventory has been carried out. For the first reconnaisance, a three month period was available. In this reconnaisance particular attention has been paid to the sedimentological and hydrological characteristics of the deposits, their distribution, spatial variability and the contacts with the bogs.

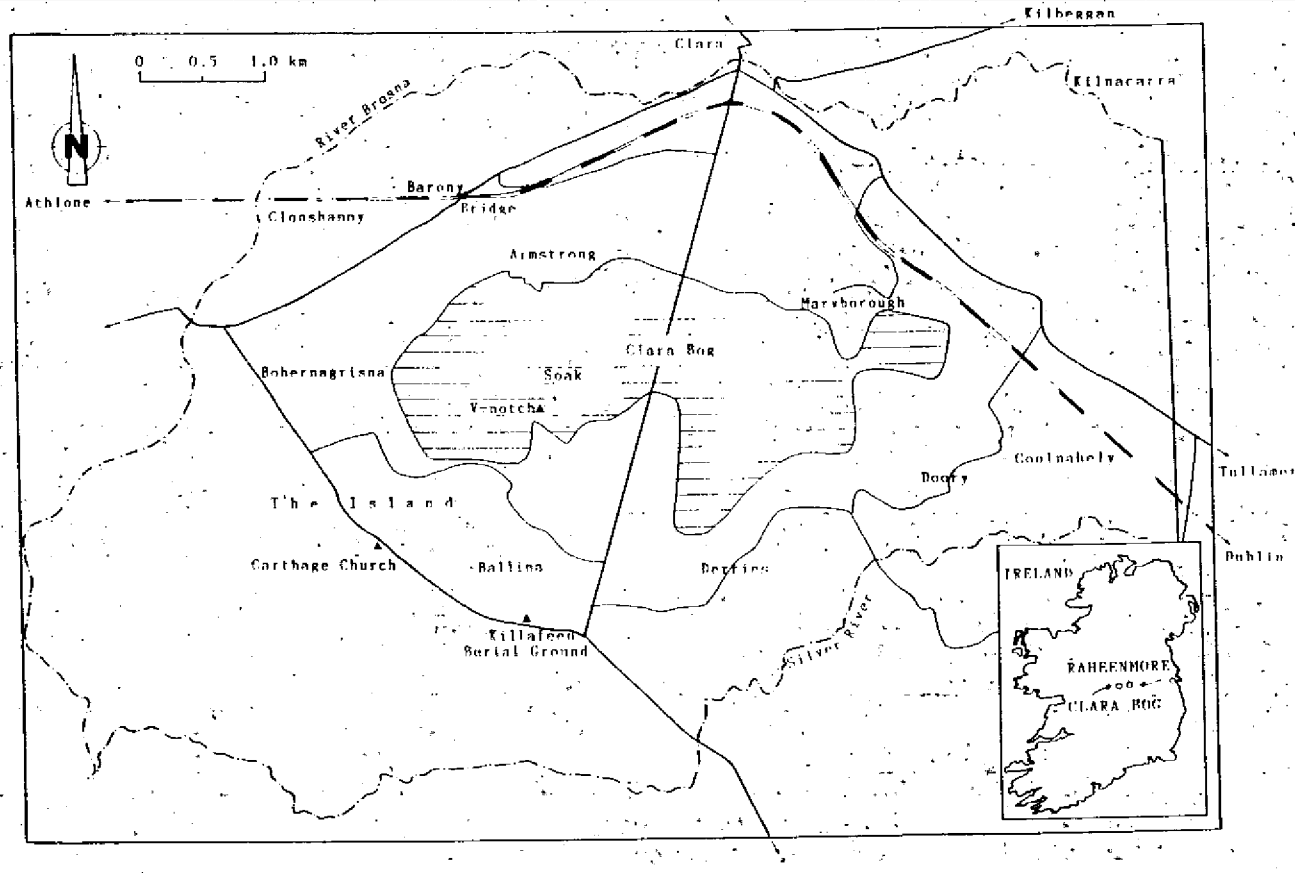


Figure 1: The location of Clara Bog with geographical names used in the text.

In addition to the mapping of the mainly Quaternary deposits, a simple geomorphological map has been compiled. Locally, more detailed geomorphological mapping has been carried out. In spite of this, the legend of the geomorphological map is not very detailed, because preference has been given to a legend which is applicable over the entire study area.

Natural and manmade sections are used (i.e. riverbanks, ditches, pits) for the description and mapping of the deposits. Augers have only been used occasionally, because of the preliminary character of the survey. Described sites are listed in Appendix I. Classification of slope, texture, structure and consistence are according to FAO (1968). The classification of roundness is based on Powers (1953). Stratigraphical terminology of the Quaternary is according to Warren (1985).
The location of geographical names used in the text is illustrated in figure 1.

2. CLARA BOG

2.1 Geomorphology

The geomorphological setting of Clara Bog is characterised by the hilly topography of eskers in the north-northeast and The Island, an area of undulating to hilly topography in the west-southwest (see map 1 Clara Bog: Geomorphology; appendix 2). The eskers in the Clara Bog area are classical examples.A fine example of a continuous single ridge can be seen from Ballinough Big Rock looking west. At this site it is not hard to imagine that eskers are ridges deposited in ice tunnels with a fluviatile, river-like symmetry. The width of the esker belt is at it's maximum north of the central part of Clara Bog and decreases rapidly to east and west. The height of the eskers is about 10 to 25 m above the surface of Clara Bog and therefore the esker belt is the highest elevated feature within the study area. The esker belt can be classified as a 'broad ridge with multiple crests', one of the basic esker morphologies (Banerjee and McDonald, 1975). The geomorphology of the esker belt itself is complex with broad and small, single continuous ridges, regularly spaced roughly conical hills, very irregular hummocky topography, gently sloping regular slopes and several deep depressions with an altitude comparable with the surface of Clara Bog. At the southern part of the bog the most pronounced topographical feature is Ballina Hill (þ 20 m above the surface of Clara Bog). Ballina Hill is the eastern part of 'The Island', an elevated area, which probably rightly deserves it's name, because it was used as a refuge in the time when drainage, bog development and flood control were not so advanced as at present. Typical for extensive areas of The Island is an irregular surface topography with hummocks. Superposed is less than 200 m in length a small scale microtopography as a result of partially buried big boulders. South-southeast of Clara Bog the geomorphology is characterized by the alternation of flat areas with undulating, generally medium scale hummocks (length 200-500 m).

2.2 Geology

2.2.1 Introduction

The Clara Bog area is underlain by Carboniferous limestone (O'Brien, 1962) with in the north-northwest and south west of the study area a reef lithology, and in other areas a pure fine-grained lithology (Daly and MacDermot, unpublished). Outcrops of bedrock has not been found within the study area. At site TAT/59, in the centre of Clara Bog, limestone bedrock was found at approximately 15 m below the local surface. Fenitian glacial deposits and Littletonian bog development dominate the geology and the geomorphology of the Clara Bog area.

South and west of Clara Bog different types of till have been deposited during the last glaciation, the Fenitian (see map 2. Clara Bog: Quaternary Geology; appendix 3).. Based on the textural composition, two types of till have been recognized in the present study. The third till variety is an assembly of different till facies with a limited spatial distribution or with boundaries which could not be determined in detail within the available time.

A typical till for the Clara Bog area is sandy-loamy and stony in texture, with a high content of big boulders. This unit probably underlies the southwestern part of Clara Bog. The high amount of angular light gray limestone boulders may indicate that limestone bedrock is relatively close to the surface. In this view, the till is an expression of the slight displacement of fractured

bedrock. An additional explanation for the observed deposits could be the lodgement process as described by Boulton and Paul (1976). Big boulders are preferentially lodged in clusters, because already lodged boulders provide a larger drag force at the glacier/till interface than do finer particles, and thus large boulders in traction in basal ice tend thereby to be more readily lodged against the obstacles formed by pre-existing boulders on the till surface (Boulton and Paul, 1976). If the morphology of The Island follows bedrock structures, than the deposition of the stony till took place at the lee side of the bedrock threshold (assuming an ice movement from west to east as indicated by the orientation of eskers).

A gravelly till/gravel is found in several places in the study area. These deposits are sometimes clearly related with geomorphological features. Examples are the conical hills north-northeast of Ballina Hill and the broad mediumscale hummocks near Silver River. Both can be interpreted as ice marginal deposits (kames). As gravelly tills can be expected as well in flat terrain, it is possible that large areas of the map unit "Removed Bog" are actually underlain by gravelly tills/gravel.

South-southeast of Clara Bog an 'undefined' till is found in an undulating to rolling landscape with broad mediumscale hummocks. If these till deposits underlie Clara Bog, the same type of morphology can be expected here. More work has to be done on the lithological and sedimentological characteristics of this till type before a genetic classification is possible.

Extensive fluvioglacial deposits are located north of Clara Bog. Eskers, and associated sand and gravel deposits are responsible for the most impressive geomorphological features within the study area. During the Littletonian the depressions have been filled in with lacustrine/alluvial deposits as well as peat. Because of the poorly developed drainage system at the end of the glaciation, nearly stagnant waters covered large, low lying areas and deposited finegrained sediments. A modern example of such an environment is Lough Ree in the River Shannon. Lake deposits are confined to topographical lows within the glacial landscape. Lacustrine deposits are also underlying Clara Bog. The thickness varies from 0.1 m to 2-3 m, depending on local topography and the distance the lake edge. Note that lake level was probably not constant. The lacustrine deposits gradually change into alluvial deposits near Silver River. The alluvial deposits are generally finegrained in the south and coarser in the north. Especially in the south, the boundary between alluvial and lacustrine deposits will be difficult to determine as a result of the gradual transition in the sedimentary environments involved (lake, standing water, broad low energy river, small low energy river).

Large areas of the study area are classified as "Removed Bog". Of course, this is unsatisfactory from a geological point of view. For the time being in can be stated that lacustrine deposits and all till types can be expected underneath the removed boglands.

The possible structure of the Clara Bog area is illustrated in figure 2. The two profiles are based on the distribution of surficial deposits and on theoritical considerations about their vertical distribution. Hence the two profiles are extremely speculative.

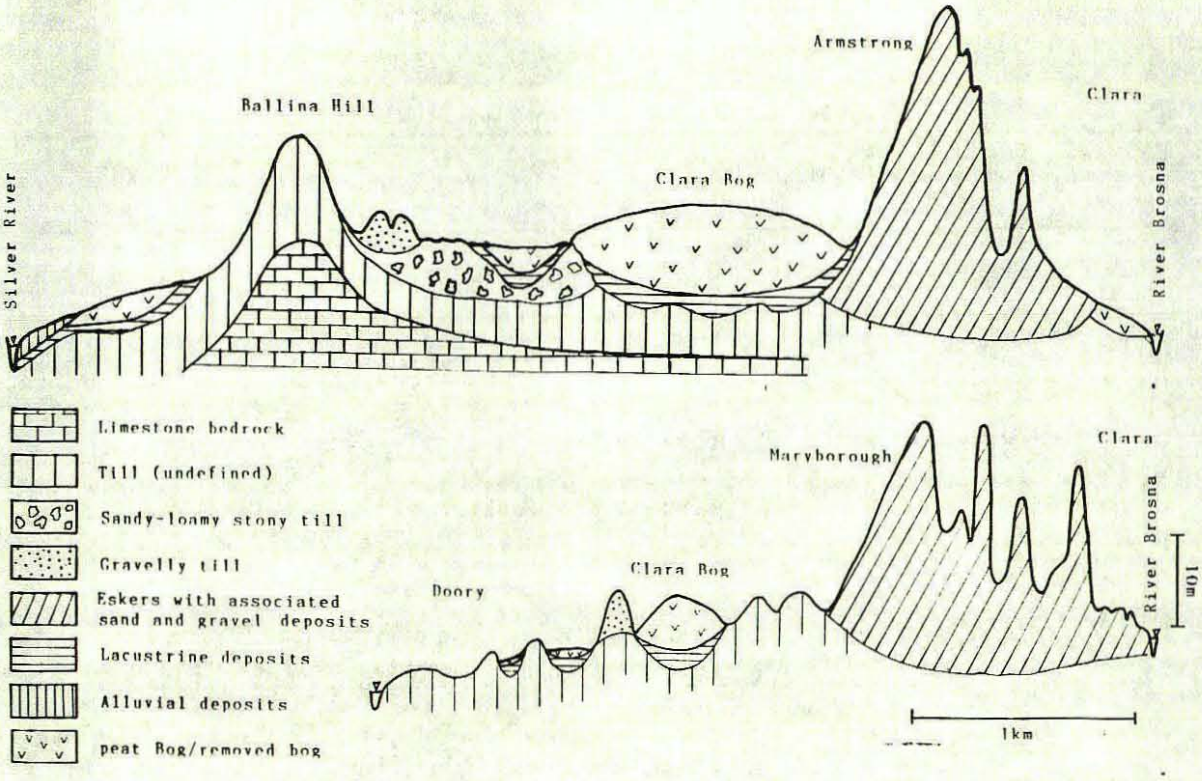


Figure 2: The possible structure of the Clara Bog area. The two schematic geological profiles are based on the distribution of surficial deposits and on theoritical considerations about their vertical distribution. Hence the two profiles are extremely speculative.

2.2.2. Description of maps units

a. Eskers [E]

Sites: TAT/64; TAT/65; TAT/66 and TAT/67.

This unit encompasses the sediments deposited in sinuous, narrow, steep-sided ridges and regularly spaced, roughly conical hills. At some places the eskers are broad with sloping or moderately steep sides (e.g. Maryborough, Armstrong). Here, the morphology of the eskers is less pronounced and the esker sediments gradually change into associated deposits. Four pits have been described to obtain an impression of the sediment types to be expected within the eskers of the study area. In table 1 observed facies types are shortly characterized (see also figure 3).
Eskers are accumulations of sand and gravel. Silt- and clay layers are common, but their thickness does not exceed a few centimeters and the horizontal extension of these layers is limited.

Facies type	Texture	Sedimentology
A	coarse gravel	massive, no sedimentary structures. At some places even bedding
B	sand and gravel	large scale trough cross bedding with moderately deep scouring. Even bedding. Length of individual sets at least 4 m.
C	sand and gravel high pebble content	large scale (height > 5 m) delta foresets.
D	sand	large scale (height > 5 m) delta foresets and pebbles rare bottomsets (length > 5 m)
E	sand	medium scale (>0.5 m; <1 m) delta foresets and trough cross bedding. Small scale cross stratification with angular ripples.
F	sandy loam	massive, but also small scale even lamination and cross lamination.
G	silt - fine sand	climbing ripples sequences.
I	gravelly loamy sand	diamicton (on top of esker deposits).

TABLE 1: Description of facies types observed in four pits in the Clara esker belt. Climbing ripples are classified according to Jopling and Walker (1968) and Allen (1973). An explanation of sedimentologica minologterminology is given in figure 8.

b. With Eskers Associated Sand and Gravel [Eg]

Sites: TAT/5; TAT/6; TAT/7; TAT/9; TAT/10; TAT/27 and TAT/58.

This unit contains sand and gravel deposits within the esker belt, but without the typical esker morphology. The morphology is undulating or hilly and locally very irregular with hummocky topography. Slopes can be steep or gentle. Due to the lack of pits, very little is known about the sedimentology of the deposits. Based on the available sections and literature about similar deposits, some tentative remarks will be made. All types of structures within a sandy-gravelly fluviatile environment are possible. Sandy gravelly diamictons will be common, because ice-collapse structures and reworking by slope processes are associated with an ice marginal depositional environment. Some sediments are similar to unit d. Gravelly Till/Gravel. The difference between the two units is the position with respect to the eskers.

Figure 3.A: Overview of north part main working face esker pit TAT/64.

Figure 3.B: Detail of facies type E.

Figure 3.C: Detail of facies type G.

c. Till (undefined) [T]

Sites: TAT/6; TAT/12; TAT/18; TAT/18b; TAT/26; TAT/32b/ TAT/33; TAT/34; TAT/47; TAT/49; TAT/50; TAT/51 and TAT/59.

This unit is an assembly of different types of diamictons, with a limited spatial distribution or with boundaries which could not be determined in detail. All tills are gravelly or stony. The texture of the matrix is highly variable: sand, silty clay, clay, loam and sandy loam. Average pebble size is in the range of 0.05 to 0.30 m. Large boulders (> 1 m) are common. Pebbles are angular to subrounded, and striae are common. The consistence is friable or firm and sometimes loose. The rock type of the pebbles is dominated by limestone. Sandstones are common.

d. Gravelly Till/Gravel [Tg]

Sites: TAT/6; TAT/12; TAT/16; TAT/41; TAT/52; TAT/58; TAT/60 and TAT/61.

In this unit all diamictons have been combined with a high gravel content (40-60%) and a sandy matrix. Gravel size is highly variable (< 1.5 m) and striated pebbles have been found at several sites. Sedimentary structures are common (even bedding, low angle cross stratification, open work gravel, clusters of pebbles with approximately the same size), and occur in patches within the sections. Pebbles are angular to rounded. Rounded pebbles are mainly found in patches with sedimentary structures. Pebble composition is limestone dominated, and sandstones are common. The consistence is generally friably to loose. South of Clara Bog the sediments of this unit are associated with little conical hills. Near the Silver River, the gravelly till ./. gravel is associated with broad medium scale hummocks. It is probable that large areas of the map unit 'till (undefined)' are actually gravelly till ./. gravels.

e. Sandy-loamy, Stony Till [Ts]

Sites: TAT/1; TAT/2; TAT/3; TAT/4; TAT/20; TAT/42 and TAT/59.

A sandy-loamy stony till can be found south-southwest of Clara Bog. A characteristic feature for this unit is the accumulation of big boulders (primarily light gray limestone, with or without fossils). Matrix texture varies from sandy to clayey with dominance of sandy-loam. All roundness classes are present, but subrounded, rounded and well rounded pebbles are rare. Pebble content is generally high (50%), and due to the large particle size this unit is classified as stony. Striations are common. The consistence is very friable to firm. The few observational sites hinder a judgement about the dominant consistence class. A typical hummocky micro-topography is created by this unit as a result of partially buried big boulders (see figure 4).

Figure 4: The typical surface topography of the sandy-loamy stony till 400 m north of St. Carthage's Church.

f. Lacustrine deposits [L]

Sites: TAT/11; TAT/14; TAT/16; TAT/17; TAT/18; TAT/18a; TAT/18b; TAT/19; TAT/28; TAT/29; TAT/30; TAT/32; TAT/32a; TAT/40; TAT/48; TAT/50; TAT/52; TAT/53; TAT/54; TAT/55; TAT/59 and TAT/60.

Lacustrine deposits are found on flat or almost flat terrain. Texture is clay. Locally, the texture is slightly coarser (sand clay loam, sandy loam, silt loam). Sand has occasionally been found as layers in a sequence with alternating sand and clay lenses (TAT/16). The thickness of the deposits varies from 0.1 m to 2-3 m, depending on local topography at the time of lacustrine deposition and the distance to the lake edge. Gravel content is always less than 5%, and is in most cases less than 1%. Pebbles are generally smaller than 2 cm. The consistence is generally firm, but can be friable or loose at sites with a more sandy texture. Shell fragments have been found at several sites.

g. Alluvial deposits [A]

Sites: TAT/17; TAT/31 and TAT/62.

Recent alluvial deposits have been descriped at three sites. The distribution of recent alluvial deposits is restricted to a strip (with a width of approximately 100-300 m) along Silver River and River Brosna. An extensive area of alluvial deposits is located west of Clara Bog. This area was outside the direct survey area, therefore it is possible that large areas are in reality lacustrine deposits. The alluvial deposits near Silver River are finegrained (clay loam) with a well sorted and rounded sandfraction. The texture indicates a fluviatile environment with low energy. The deposits near River Brosna, north of Clara Bog are different from these near Silver River. Here, gravel lenses and fining upward sequences with a gravel lag are common. The coarser deposits indicate a higher energy sedimentary environment that in the south.

h. Peat/Bog [B]

This unit is defined as (relatively) undisturbed bog. No detailed obervations on thickness and lithology have been made. In general the thickness of the bog increases towards the centre. At the margin the thickness is 1 to 4 m; in the centre approximately 10 m.

i. Peat/Removed Bog [Br]

This unit encompasses all the areas where peat has been removed, but still has a substantially peat cover of more than 1 m and no visible clastic deposits.

3. RAHEENMORE

3.1 Geomorphology

Raheenmore is situated in a shallow depression between two hills in the north (Mullagharush Hill, 140 m and Clonagh Hill, 123 m) and several broad hummocks to the south, west and east (see map 1. Raheenmore: Geomorphology; appendix 4). Limestone bedrock is found at two locations on Mullagharush Hill. On Clonagh Hill no bedrock has been found during the present survey. The regular slopes on top of

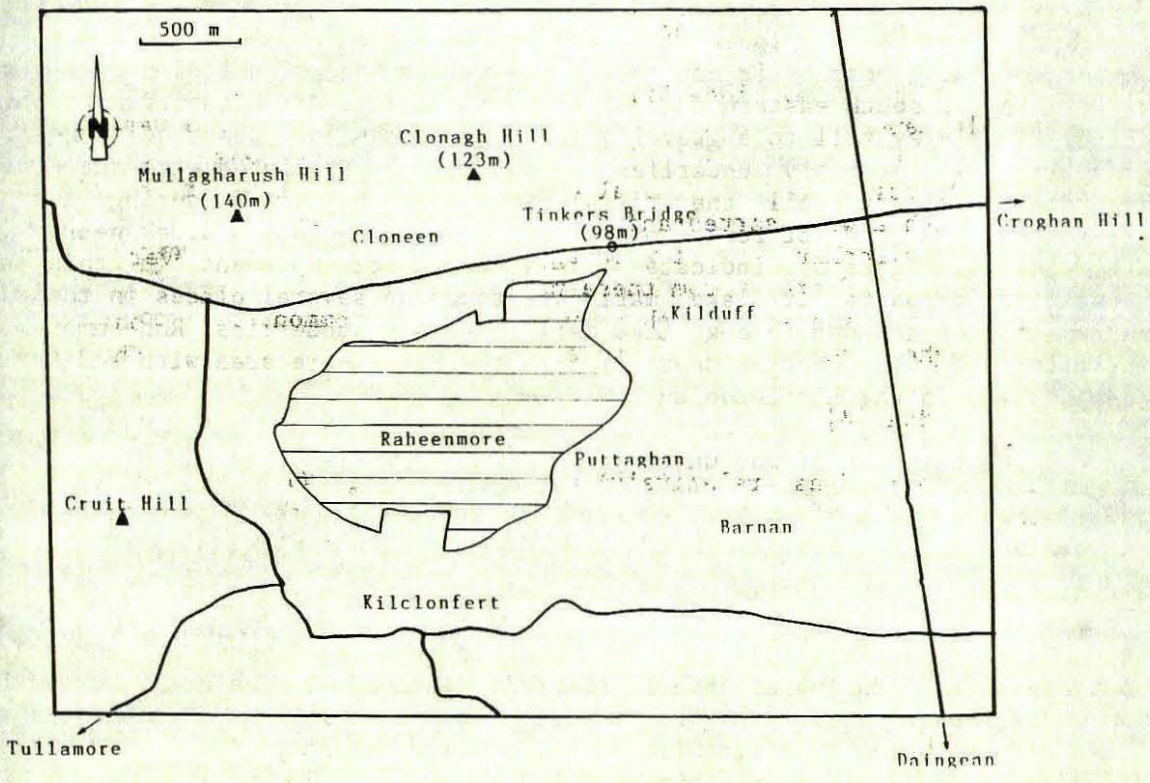


Figure 5: The location of Raheenmore with geographical names used in the text.

Mullagharush Hill and Clonagh Hill are interpreted as dip slopes (i.e. a surface slope conbedrock structure). The same applies for Cruit Hill, west of Raheenmore.
East of Raheenmore a circular, relatively low (compared to Mullagharush Hill), conical hill is found, named Kilduff. Characteristic for Kilduff are niches (approximately horseshoe-shaped depressions located on a slope) with in the north several circular, closed depressions. Also the locally irregular topography with moderately steep slopes, differentiates Kilduff from the broad hummocks in the south. The latter have a 'plateau'- like appearance, with a broad, flat or almost flat top level and gently slopes.

3.2 Geology

3.2.1 Introduction

The limestone found in Mullagharush and Cruit Hill is of Carboniferous age (O'Brien, 1962). The limestone is bedded and macro-fossils are absent or rare. Locally, the limestone is rich in chert. Mullagharush Hill, Clonagh Hill and Cruit Hill consist of limestone with a till cover of variable thickness (see map 2: Raheenmore: Quaternary Geology; appendix 5). The interpretation of the type of deposits occurring at Kilduff is difficult because of a lack of sections. Based on the geomorphology (niches, closed depressions, irregular topography) and two sections at the base of Kilduff, the deposits in this area are interpreted as a gravelly till/gravel. Till is the most widespread deposit the Raheenmore area. South and east of Raheenmore a firm, gravelly clay till is dominant. Patches of loose, gravelly sandy till are common. The distribution pattern of these patches is unclear. A significant occurrence of gravelly sandy till is on the south eastern edge of Raheenmore. In a ditch the transition from a gravelly clayey till to a gravelly sandy till can be observed. The sandy gravelly till probably underlies Raheenmore, and is linked with the gravelly deposits of Kilduff. All the tills have been deposited during the last glaciation and are of Fenitian age. Striae on limestone bedrock nearby Cruit Hill (TAT/35, figure 5), indicate a west-east ice movement in this area. Lacustrine deposits or lake marl are found on several places in the direct surrounding of Raheenmore bog. Lake marl probably underlies Raheenmore. The infilling of the central depression in the Raheenmore area with sediment and peat started in the Littletonian.

3.2.2. Description of map units

a. Carboniferous limestone [Cl]

Sites: TAT/22; TAT/35; TAT/36.

Bedded dark gray-black limestone can be found in an old limestone quarry in the southern base of Mullagharush Hill (TAT/22). Individual beds are 5-30 cm thick. Macro-fossils are absent or very rare. At site TAT/35 (Cruit Hill) the limestone is rich in chert. Limestone beds are slightly silted (4 to 11) and dip to west (TAT/22) and northwest (TAT/36).

b. Till (undefined) [T]

Sites: TAT/21; TAT/23; TAT/24; TAT/25b; TAT/35; TAT/37a; TAT/38; TAT/39; TAT/43; TAT/44; TAT/57 and TAT/63.

This unit is an assembly of different types of diamictons, with a limited spatial distribution or with boundaries which could not be determined in detail. A gravelly clay till with a gravel content varying from 20 to 50% (see figure 5) is dominant. Gravel size is generally smaller than 40 cm. Large boulders are rare. In most of the sections striae are common, but sometimes lacking. All roundness classes are present, but very angular, rounded and well rounded pebbles are rare. The majority of the pebbles are subangular to subrounded. Pebbles composition is limestone dominated. Sandstones are common. At one site (TAT/25a) a pebble of volcanic origin has been found. The consistence of the gravelly clay till is generally firm to very firm.

Figure 6:

Gravelly clay till on top of striated limestone bedrock. Striae indicate a west to east ice movement. For more details see Appendix I, TAT/45.

c. Gravelly till ./. Gravel [Tg]

Sites: TAT/13; TAT/39; TAT/45 (figure 6); TAT/56 and TAT/57.

In this unit all diamictons are with a high gravel content (40-60%) and a sandy matrix have been combined. Gravel size is probably highly variable, but big boulders (> 1 m) are rare. Pebbles are limestone dominated with some sandstones. Striae are common. The consistence varies from very friable to firm. The few observational sites hinder a judgement about the dominant consistence class.

d. Lacustrine deposits [L]

Sites: TAT/30 and TAT/56.

Generally, the texture of the lacustrine deposits is silty, clay loam or clay. The percentage of sand is less than 50%. At some places the deposits are slightly gravelly. Most pebbles are small (< 2 cm), but locally (TAT/56) larger pebbles occur (< 10 cm). Pebble size probably depends on the distance to the sediment source. Roundness varies from angular to subrounded. No striated pebbles are found. Pebbles are limestone dominated with few sandstones. Most deposits are massive, or have lost their sedimentary structures due to biological activity. Sedimentary structures are found at site TAT/56: alternating layers of medium fine sand and clay. Consistence is very friable to firm and depends on texture (sand-friable, clay-firm).

e. Alluvial deposits [A]

In the northwestern part of the study area small sections of silty loam underlain by bedded gravels are observed. They are interpreted as Littletonian alluvial deposits.

Figure 7: An example of a sandy gravelly till (site TAT/45).

f. Peat/Bog [B]

This unit is defined as (relatively) undisturbed bog. No detailed obervations on thickness and lithology have been made. In general the thickness of the bog increases towards the centre. At the margin the thickness is to 4 m; in the centre approximately 10 m.

g. Removed Bog [Br]

This unit encompasses all the areas where peat has been removed, but still has a substantially peat cover of more than 1 m and no visible clastic deposits.

4. HYDROLOGICAL ASPECTS

A few general remarks can be made about hydrological aspects of the sediments in the Clara Bog and Raheenmore area.

(1) The permeability of tills is in the range of 10^{-6} to 10^{-12} m/s (Freeze and Cherry, 1979) and seems to be relatively unaffected by weathering (Lloyd, 1983). However, fissures and fractures can increase the permeability with magnitudes two to three (Hendry, 1982; Lloyd, 1983). The permeability of the sandy loamy, stony till described in this study is probably comparable with the "variable till" of Lloyd (1983), i.e. in the order of 10^{-6} to 10^{-10} m/s. Hanrahan (1977) reports a remarkable high permeability for in a silty clay matrix with boulders (10^{-4} m/s). The permeability of gravelly till ./. gravel could be in the range of 10^{-4} (permeability of kames; Daly, 1985) to 10^{-8} m/s (arithmetical mean of "variable till"). According to Daly (1985) the permeability of eskers is in the range of 10^{-3} to 10^{-4} m/s.

(2) Clara Bog and Raheenmore are underlain by clayey lacustrine deposits. These deposits have a very low permeability and therefore they act as a 'caprock'. Due to the textural variability of the lacustrine deposits, the overall permeabilty will be in de range of 10^{-6} to 10^{-10} m/s.

(3) The aquifer found at the drilling site on Clara Bog (TAT/59, CL1) is underneath the lacustrine clay, in a layer with stony clay, stony-gravelly diamicton and angular limestone fragments.

(4) The topography of till deposits underlying Clara Bog is probably comparable with deposits south of Clara Bog. Hummocks standing out above lacustrine deposits must not be ruled out beforehand. This would imply that locally lacustrine deposits do not close off the bog [Zrt].
Here, deposits with a higher permeability can be in direct contact with the bog.

(5) The gravelly till/gravel deposits which are probably underlying the east part of Raheenmore could be in direct contact with the bog, especially at southeastern margin of the bog and at places with a thin cover of lacustrine deposits.

5. ACKNOWLEDGEMENT

The first author likes to express his gratitude to Willy Warren, his visits to Clara were not only informative, but very pleasant aswell. Eric Gloudemans toke my presence in the house without faltering and made the period in Clara to a very agreable one. The Dolan's are not only thanked for serving beers and spirits, but also for their kindness, hospitality and interest in the project. Finally, I thank all the servants of Wildlife Service and Staatsbosbeheer who tried to provide "the workers in the field" with everything they needed.

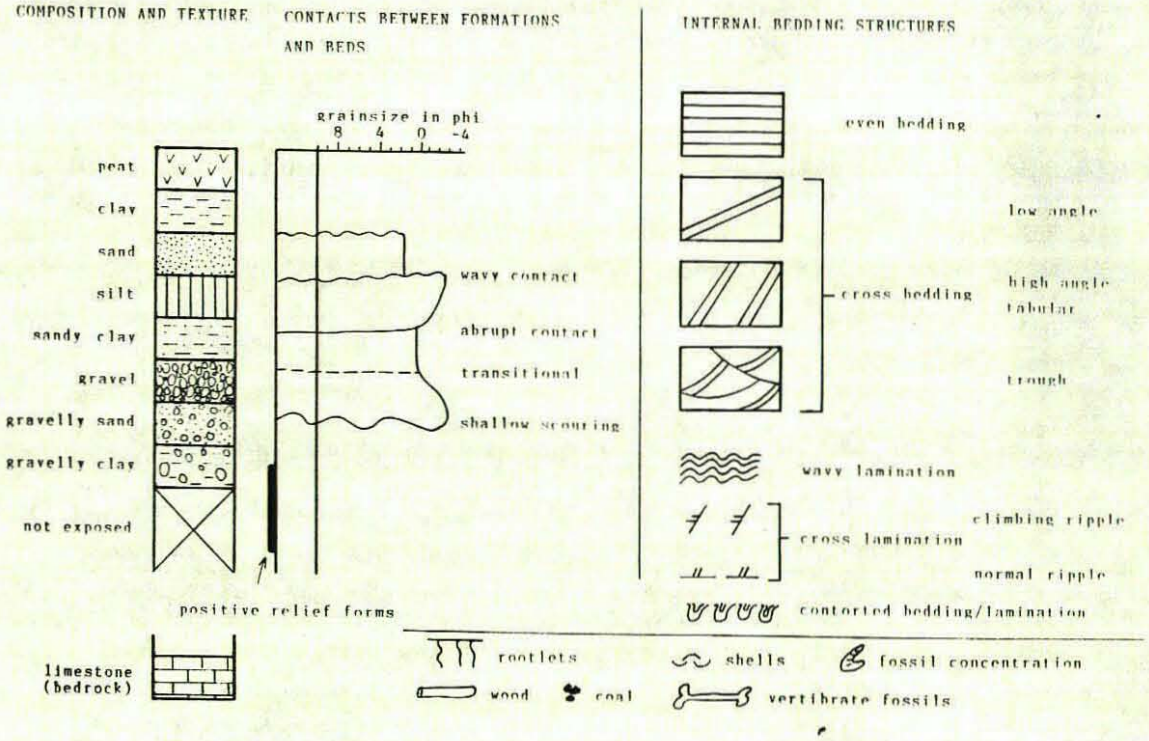


Figure 8: Symbols used for the description of texture, composition and sedimentary structures.

6. REFERENCES

ALLEN, J.R.L., 1973: A classification of climbing-ripple cross lamination. Journal Geol. Soc. London 129, pp. 537-541.

BANERJEE, I. and B.C. MCDONALD, 1975: Nature of esker sedimentation. In Jopling, A.V. and B.C. McDonald (eds): Glaciofluvial and glaciolacustrine sedimentation. Soc. of Econ. Paleont. & Mineral. Special Publ. No. 23, pp. 132-154.

BOULTON, G.S. and M.A. PAUL, 1976: The influence of genetic processes on some geotechnical properties of glacial tills. Q. Jl. Engng. Geol., Vol. 9, pp. 159-194.

DALY, E.P., 1985: Hydrogeology. In K.J. Edwards and W.P. Warren, (eds): The Quaternary history of Ireland, pp. 331-334.

DALY, D. and C.V. MACDERMONT, Unpublished: A preliminary map of bedrock lithologies in Co. Offaly. Geological Survey of Ireland.

FAO, 1968: Guidelines for soil profile description. Rome, 53 pp.

FREEZE, R.A. and J.A. CHERRY, 1979: Groundwater. Prentice-Hall, 604 pp.

HANRAHAN, E.T., 1977: Irish glacial till: Origin and characteristics. RC 164, An Foras Forbartha, Dublin.

HENDRY, M.J., 1982: Hydraulic conductivity of a glacial till in Alberta. Groundwater, Vol. 20, No. 2, pp. 162-169.

JOPLING, A.V. and R.G. WALKER, 1968: Morphology and origin of ripple-drift cross-lamination, with examples from the Pleistocene of Massachusetts. Journal of Sedimentary Petrology 38, pp. 971-984.

LLOYD, J.W., 1983: Hydrogeological investigations in glaciated terrains. In Eyles, N. (ed): Glacial Geology, pp. 349-368.

O'BRIEN, M.V., 1962: Geological map of Ireland, 3rd Edition. 1:750,000. Geological Survey of Ireland.

POWERS, M.C., 1953: A new roundness scale for sedimentary particles. Journal of Sedimentary Petrology 23, pp. 117-119.

SOLLAS, W.J., 1896: A map to show the distribution of eskers in Ireland. The Scientific Transactions of the Royal Dublin Society, Vol. V, Ser. II, pp. 785-822.

WARREN, W.P., 1985: Stratigraphy. In K.J. Edwards and W.P. Warren, (eds): The Quaternary history of Ireland, pp. 39-65.

7. MAPS AND AERIAL PHOTOGRAPHS

7.1 Maps

DALY, D. and C.V. MACDERMONT, Unpublished: A preliminary map of bedrock lithologies in Co. Offaly. Geological Survey of Ireland.

O'BRIEN, M.V., 1962: Geological map of Ireland, 3rd Edition. 1:750,000. Geological Survey of Ireland.

WARREN, W.P., (ed), Unpublished: A preliminary map of the Quaternary deposits in Co. Offaly. Several sheets. Scale 1:25,000. Geological Survey of Ireland.

7.2 Aerial photographs

GSI IRK, 1/300 6-73 ± 4750 m
No. 547 - 551
No. 554 - 558
No. 531 - 535

APPENDIX I

DESCRIPTION OF SITES

Number: TAT/1
Location: S of Clara Bog, E side of The Island
Topography: small hummocks
Vegetation/land use: grassland
Section orientation: ± N-S
length: 2-3 m
height: 0.5 m
Moisture condition: moist
General description: Gravelly be stony diamicton with vague bedding. Large limestone boulders (finegrained light gray). Pebbles in all roundness classes. Matrix sandy (mode: 105-150 μm).

Interpretation: Till with large boulders associated with melt-out features. Sandy-loamy stony till.

Number: TAT/2
Location: Clara Bog; SW of Carthage Church; The Island
Topography: broad hummock (ringfort on map has been destroyed)
Vegetation/land use: grassland
General description: Large limestone boulders cropout on field and surrounding fields. At the edge of the field accumulation of giant boulders.

Interpretation: Probably Till with large boulders. Boulders in edge could originate from destroyed ringfort.

Number: TAT/3
Location: 200 m S of central part Clara Bog
Topography: flat/ microtopography: small hummocks (dm-scale).
Slope: flat
Vegetation/land use: grassland
Section orientation: 50-230
length: 25 m
height: 1 m
Moisture condition: moist
General description: Stony, sandy diamicton with large limestone boulders.
Texture: gravelly loamy sand

GRAVEL;
1. % gravel : 50%
2. gravel size: mean: 4-5 cm; max: 1.5 m
3. rock type : fossil-rich gray limestone/ dark gray fine grained limestone/ dark gray-black reef limestone/ sandstone/ yellowish brown glassy sandstone.
4. roundness : very angular, some subangular.
5. sorting : large boulders seems to occur in groups
6. striae : common

MATRIX;
7. texture : loamy sand
8. sand : 105 μm (mean)

Structure: weak
Consistence: very friable

Interpretation: Sandy loamy stony till. Section proves that boulders does not represent bedrock, since boulders are separated by a finer of matrix material. The lateral extension of the till in direction 320 proves that the contact till-peat is not horizontal.

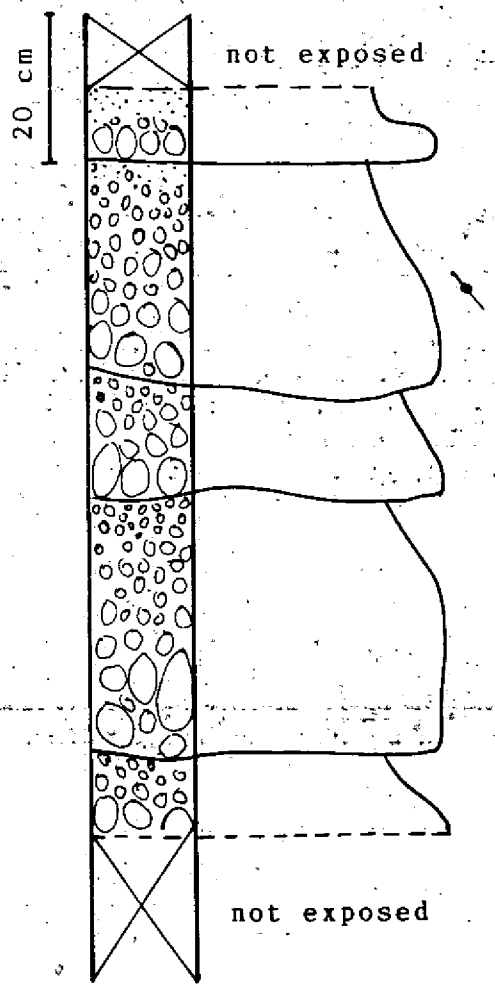
Number: TAT/4
Location: 250 m S of Clara Bog; near TAT/3
Topography: small hummocks (decameters across)
Vegetation/land use: grassland
General description: at surface outcrop of limestone boulders. Outcrops seems to be related with hummocks.

Interpretation: Sandy loame stony till.

Number: TAT/5
Location: N of Clara Bog; Armstrong
Topography: gently sloping; near summit of esker; rolling topography
Slope: gently sloping
Vegetation/land use: grassland
Section orientation: 20-200
length: 15 m
height: 1.5 m
Moisture condition: at top dry, moist at bottom of section
General description: bedded sands and gravels. See figure A1.

Interpretation: With eskers associated sands and gravel.

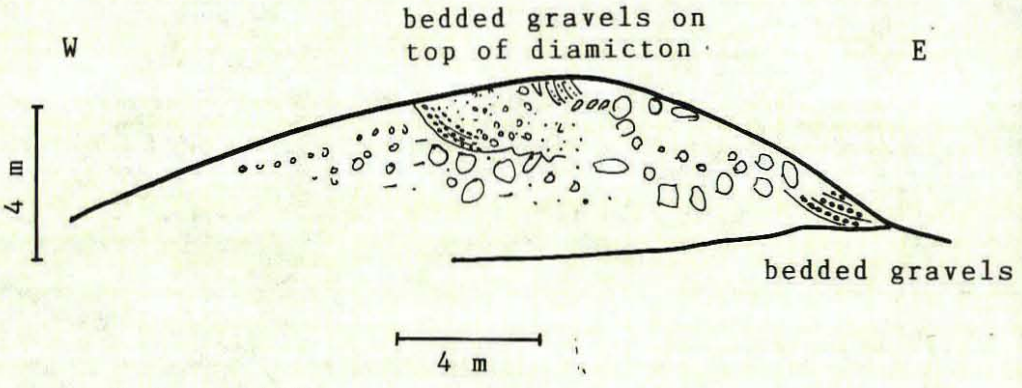
Figure A1:



Number: TAT/6
Location: N of Clara Bog; Dublin-Galway railway; nearby Clara & Basagher Junction.
Topography: Section is in small ridge. To S flat with small, broad microtopography (1-2 m above mean level). To N hilly topography.
Slope: 4 to 36°
Vegetation/land use: grass/small trees and shrubs
Section orientation: 80-260
length: 20-25 m
height: 2.5 m at maximum
Moisture condition: dry, at some places moist
General description: gravel and sands. Irregular structures. At some places diamicton like at other places well sorted with bedding structures. See figure A2.

Interpretation: Kame deposit and/or with esker associated sand and gravel.

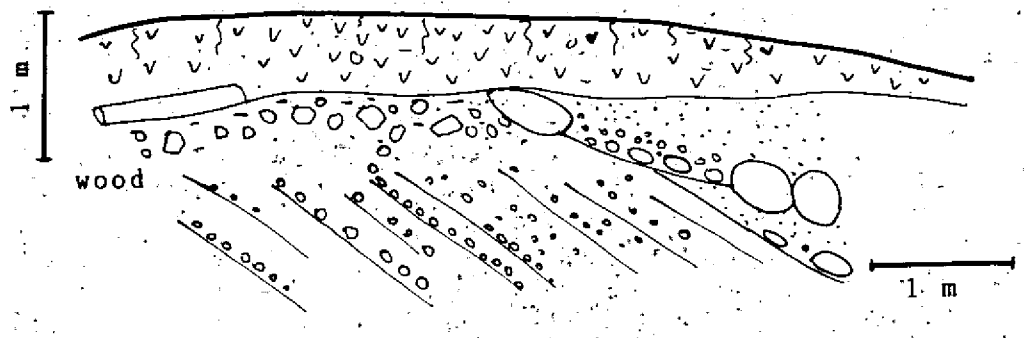
Figure A2:



Number: TAT/7
Location: N of Clara Bog; western part
Topography: on little hummock (± 30 cm above general level). Surrounding topography flat with small hummocks (cm-scale).
Slope: almost flat
Vegetation/land use: grassland
Section orientation: 110-290
length: 4 m
height: 1.5 m
Moisture condition: dry-moist
General description: underneath 0.5 m peat with wood fragments bedded sands and gravel. Structures: large scale foresets and large scale through cross bedding. On top gravel lag or gravelly diamicton. See figure A3.

Interpretation: With esker associated sands and gravels, maybe outwash gravel (large scale foresets could be the remnants of a bar).

Figure A3:



Number: TAT/8
Location: N of Clara Bog; between new and old railway track; S of Barony Bridge
Topography: small pit in a cigar-shaped ridge with long axe in 270-90 direction. Surrounding topography: to S flat as far as esker. To N small hummocks (height ± 1.5 m)
Slope: to 270 ; 2 10'/ to 90 ; 4 10'
Vegetation/land use: grassland
Section orientation: 270-90
length: 1 m
height: 0.5 m
General description: Very poorly exposed unsorted material with large subangular boulders and sandy matrix.
Texture: gravelly sand.

GRAVEL;
2. gravel size: < 1 m
3. rock type : finegrained limestone/ coarsegrained limestone (without fossils)
4. roundness : subangular
5. sorting : unsorted
6. striae : none

MATRIX;
7. texture : sand
8. sand : grain size in range 150-2000 μm, mean 600 μm.

Roundness subangular.

Interpretation: Gravelly diamicton (due to the quality of the section this area is mapped as an undefined till).

Number: TAT/9
Location: W of Clara Bog, NE part of The Island.
Topography: almost flat on little ridge (width ± 50 m). Surrounding topography: to N removed peat land, flat. To S area with large limestone boulders at surface (little hummocks).
Slope: from E to W: flat / to 360°: 5-7° / to 180°: 2-5°
Vegetation/land use: grass with ferns
Section orientation: 180-360°
length: 3 m
height: 0.4 m
Moisture condition: moist
General description: moderately well sorted gravelly loamy sand with very few large pebbles. No sedimentary structures.
Texture: gravelly loamy sand.

GRAVEL;
2. gravel size: < 10 cm, average ± 4 cm
4. roundness : subrounded
5. sorting : moderately well
6. striae : none

MATRIX;
7. texture : loamy sand

8. sand : very poorly sorted, grain size range: 105-2000 μm. Roundness: subrounded.
Consistence: loose

Interpretation: With esker associated sands and gravels, probably the most southwestern extension of the esker which defines the northern limit of Clara Bog.

Number: TAT/10
Location: W of Clara Bog, NNW part of The Island; location TAT/9 is on same ridge ± 100 to 245
Topography: dissection of ridge. Surrounding topography: to 300° flat removed peatland; to 120° edges of Clara Bog after 50-100 m removed peat land.
Vegetation/land use: grass with ferns and blackberry
Section orientation: 300-120
length: 5 m
height: 1.3 m
Moisture condition: dry throughout
General description: on top a 1 m thick dark grayish yellow sandy loamy diamicton with pebbles (strongly weathered). Middle part: fine gravel on top of coarse gravel lag. At the bottom a well sorted fine gravel. See figure A4 and A5.

A
Colour: (dry) 2.5Y 5/2 (dark grayish yellow)
Texture: gravelly silty clay loam
GRAVEL;
2. gravel size: < 10 cm
3. rock type : light gray fossilrich limestone/ black chert/ sandstone
MATRIX;
7. texture : silty clay loam
Consistence: loose (dry)

B
Colour: 2.5Y 4/2 (dark grayish yellow)
Texture: slightly gravelly sandy loam
GRAVEL;
1. % gravel : 5-10%
2. gravel size: < 3 cm
5. sorting : moderately-well sorted
MATRIX;
7. texture : sandy loam
8. sand : 75-105 μm (mode).
Remark: strongly calcareous, nodules.

C
Colour: 2.5Y 4/3 (olive brown)
Texture: gravelly sand
GRAVEL;
1. % gravel : 40%
2. gravel size: < 15 cm
3. rock type : dark gray fossil rich limestone/ light gray fossil rich limestone/ sandstone/ black chert.
4. roundness : subrounded
5. sorting : moderately vell
6. striations : none
MATRIX;
7. texture : sand
Consistence: loose

D
Texture: granule-fine pebbles gravel

GRAVEL;
1. % gravel : 90%
2. gravel size: 0.3-0.8 cm
4. roundness : subrounded
5. sorting : well.
MATRIX;
7. texture : sand
8. sand : 75 µm.

Interpretation: With esker associated sands and gravels, probably the most southwestern extension of the esker which defines the northern limit of Clara Bog.

Figure A4:

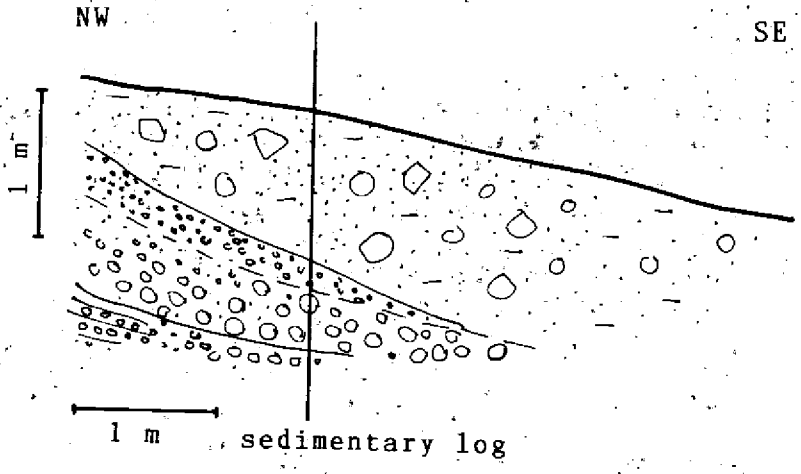


Figure A6:

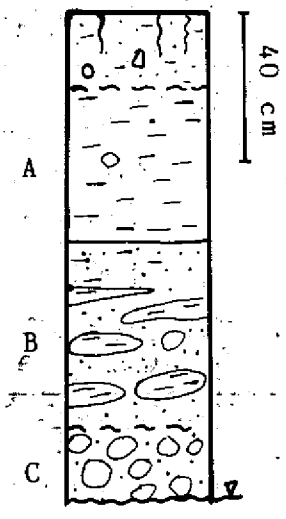
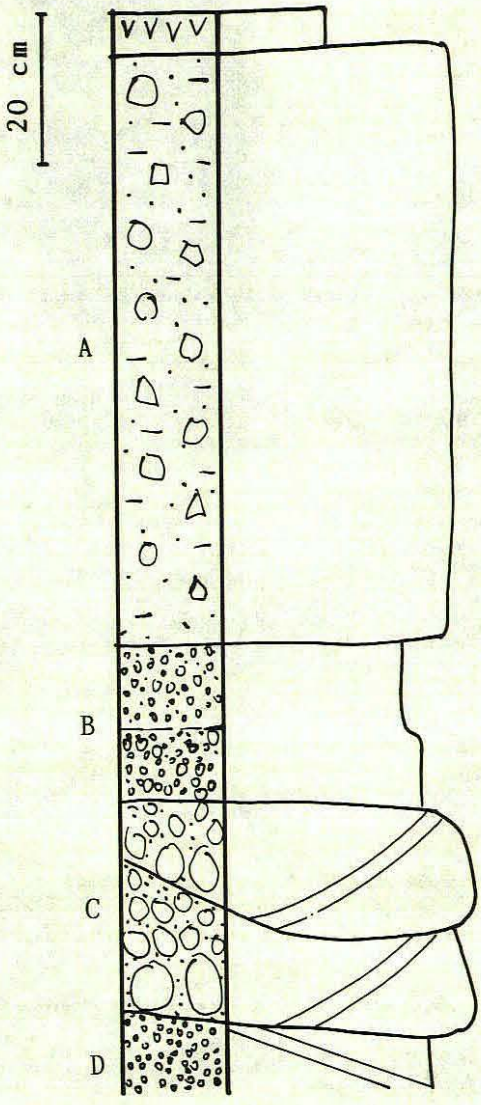


Figure A5:



Number: TAT/11
Location: S of central part Clara Bog; Derries
Topography: flat to undulating. Surrounding topography: small hill to W (± 2.5 m above local level)
Slope: flat
Vegetation/land use: oak at edge; grassland
Section orientation: 0-180
length: 0.2 m
height: 0.5 m
Moisture condition: moist
General description: mottled sandy clay loam. Mottling caused by gley development.
Color: oxidized: 2.5Y 4/4 (olive brown) / reduced: 5Y 4/1 (gray)
Texture: sandy clay loam

Consistence: very firm

Interpretation: Lacustrine deposit.

Number: TAT/12
Location: S of eastern part Clara Bog
Topography: flat. Surrounding topography: small hills to N (þ 3-4 m above local level)
Slope: flat
Vegetation/land use: grassland
Section orientation: 310-130° 12 m/ 264-084° 3 m/ 302-122° 20 m
length: 35 m
height: 1.3 m
Moisture condition: moist
General description: drain is divided in two parts separated (by chance) by a causeway. At NW-part no pebbles visible, only fines. In the central and E- part (both SE of causeway) a gradual decrease of pebbles towards the E is observed. This part is a gravelly diamicton. At the most northwestern part clay loam has been found on top of the diamicton.

Diamicton

Colour: 5Y-4/2 (dark olive) (Matrix).
Texture: gravelly-very gravelly sand

GRAVEL;
1. % gravel : % gravel varies in profile from 5 to 70%. Gravel accumulations occur 'random'; differences in gravel content can not be related to any visible structure
2. gravel size: 0.002 - 0.25 m
3. rock type : limestone (± 90% of total) and sandstone (± 10% of total) finegrained dark gray limestone/ fossilrich dark gray limestone/ yellowish brown sandstone/ black chert
4. roundness : very angular, some pebbles subangular
5. sorting : poorly sorted throughout. At some places accumulations of material of the same size.
6. striae : common

MATRIX;
7. texture : sand
8. sand : mean 210 μm; range: 105-600 μm. Moderately sorted. Subangular-subrounded.

Consistence: friable

Clay

Colour: oxidized: 2.5Y 4/4 (olive brown)/ reduced: 2.5Y 4/1 (yellowish gray)
Texture: silty clay
Structure: moderate-strong
Consistence: very firm

Interpretation: Diamicton is interpreted as a gravelly till, the occurrence of which is bounded to topographic higher grounds to N and S of location TAT/12. TAT/12 describes the boundary between the till and a lacustrine deposit (silty clay). The present day flat relief is caused by the deposition of lacustrine fines in the swales of a hummocky topography.

Number: TAT/13
Location: N of Raheenmore; Cloneen
Topography: flat. Surrounding topography: to W Mullagharush Hill and to E Clonagh Hill.

29

Slope: flat
Vegetation/land use: grassland
Section orientation: 358-178
length: 5 m
height: 1 m
Moisture condition: moist
General description: sandy gravelly diamicton
Colour: 10YR 5/1 (brownish gray) (Matrix)
Texture: gravelly sand

GRAVEL;
1. % gravel : 40-50%
2. gravel size: < 8 cm/ mean ± 2.5 cm
3. rock type : finegrained dark gray limestone/ red sandstone/ marble like limestone.
4. roundness : angular-subrounded
5. sorting : poor
6. striae : one pebble striated

MATRIX;
7. texture : sand
8. sand : mean 150 μm; max. 1000 μm (<5% of total). Subrounded

Structure: structureless/massive
Consistence: loose

Interpretation: sandy gravelly till.

Number: TAT/14
Location: S of eastern part of Clara Bog
Topography: in depression. In direction 200° and in 20° small steep hills (5-6 m above site altitude)
Slope: flat
Vegetation/land use: grassland
Section orientation: 200-20
length: 0.5 m
height: 0.3 m
Moisture condition: moist-wet
General description: underneath 0.5 m peaty material a gray sandy layer with small pebbles (< 1 cm and very rare) has been found.
Colour: 7.5Y 4/1 (gray)
Texture: sandy loam
Sand: 210 μm (mean). Well sorted. Subrounded-rounded.
Structure: structureless-weak
Consistence: very friable

Interpretation: lacustrine deposit.

Number: TAT/16
Location: SE of woodland on SE part of Clara Bog
Topography: in NE to SW flat. To SW-NW moderately high hills (± 5-6 m above site altitude).
Slope: flat
Vegetation/land use: grassland
Section orientation: 150-330
length: 10 m
height: 1.2 m
Moisture condition: moist-wet
General description: Section in cattle drinking pool. Underneath 40 cm clay a 40 cm thick layer of alternating clay and sand lenses has been found. At the bottom of the section a sandy gravelly diamicton. See figure A6.

A
Colour: oxidized: 10YR 5/6 (yellowish brown)/ reduced 10YR 7/1 (light gray)
Texture: clay, pebbles , 2 cm (<5% of total)
Structure: weak-moderate
Consistence: firm

B.
General description: Lenses are small (thickness max. 2 cm) "Augengneiss" appearance. Gley mottling in clay lenses. Some pebbles (very rare). Sand lenses are more abundant in bottom of unit (fining up sequence).

CLAY
Colour: oxidized: 10 YR 7/6 (bright yellowish brown)/ reduced: 2.5YR 7/1 (light reddish gray).
Texture: clay.
Structure: weak-structureless
Consistence: firm

SAND
Color: 5Y 5/1 (gray)
Texture: sand
sand: mean 105 μm, max 600 μm (very rare), large part (± 30%) 50-75 μm. Moderate-well sorted. Subangular-rounded.
Structure: structureless
Consistence: loose

C
Texture: gravelly-stony sand

GRAVEL;
1. % gravel : ± 30-50%
2. gravel size: < 25 cm
3. rock type : fine grained dark gray limestone/ fossil rich light gray limestone.
4. roundness : subangular
5. sorting : poor
6. striae : common

MATRIX;
7. texture : sand
8. sand : mean 75-105 μm, max 2000 μm (very rare). Overall poorly sorted, without the few large grains very well sorted. Subangular to rounded.

Interpretation: Unit A and B are lacustrine deposits. Unit C is interpreted as a gravelly till. In the deposition of unit C water played an important role.

Number: TAT/17

Location: S of E part of Clara Bog; Silver River; East Derries
Topography: flat
Slope: flat
Vegetation/land use: grassland
Section orientation: 305-125
length: 2 m
height: 1.2 m
Moisture condition: moist
General description: Underneath organic layer, gray clay unit with at the bottom some small yellowish gray bands. After 10 cm peat a thin clay layer. Below this clay layer another clay layer (2-3 cm thick) rich in shell fragments. At the bottom of the profile sand and (poorly exposed) clay. See figure A7.

A
Colour: 10YR 3/3 (dark reddish brown) / Yellowish bands: 10YR 5/3 (dull reddish brown)
Texture: clay loam
sand: 75 μm. Well sorted. Rounded.
Structure: weak
Consistence: firm

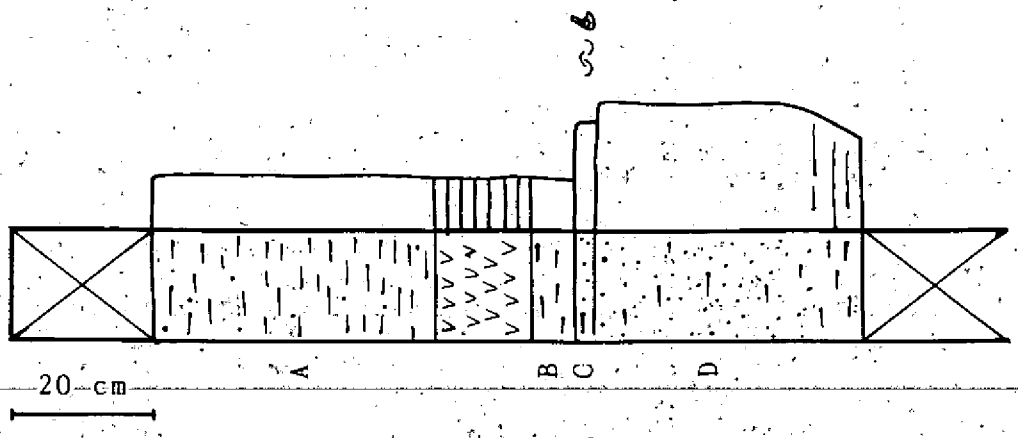
B
Colour: 2.5Y 5/2 (dark grayish yellow)
Texture: clay loam
sand: 75 μm (mean). Well sorted. Rounded.
Structure: structureless
Consistence: firm

C
Colour: 2.5Y 6/1 (yellowish gray) / Shells: 2.5Y 8/2 (light gray)
Texture: silt loam
sand: very fine sand. Well sorted. Rounded.
Structure: weak
Consistence: very friable
Fossils: shell fragments abundant

D
Colour: oxidized: 2.5Y 5/4 (yellowish brown) / reduced: 2.5Y 4/1 (yellowish gray)
Texture: sand
sand: 75 μm (mean). Well sorted. Rounded.
Structure: structureless/massive
Consistence: very friable

Interpretation: The part of the section above the peat layer is interpreted as a recent alluvial deposit. Underneath the peat the dominant sedimentary environment is probably a lake.

Figure A7:



Number: TAT/18
Location: S of central part of Clara Bog; Middle Derries
Topography: flat. In surroundings small, flat hummocks (1-2 m above site level).
Slope: flat
Vegetation/land use: grassland
Section orientation: various orientations
length: ± 30 m
height: ± 1 m
Moisture condition: moist-wet
General description: in drains outcrop of a brown clay unit with (rare) granule and very small pebbles. Clay interfingers at some places with a pebble rich clayey diamicton. This diamicton can also be found underneath the brown clay. The boundaries between the two units are clear and diffuse. See figure A8.

A

Texture: clay
GRAVEL;
1. % gravel : < 1%
2. gravel size: < 2 cm
MATRIX;
7. texture : clay

B

Texture: gravelly silty clay
GRAVEL;
1. % gravel : < 30%
2. gravel size: < 1.5 m
3. rock type : dark gray limestone/ dark gray reef limestone/ bluish grey fossil rich limestone/ yellowish brown sandstone

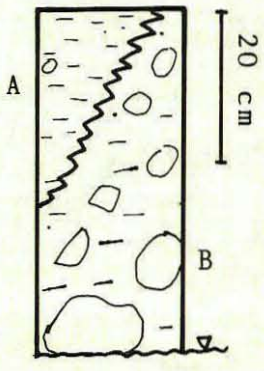
4. roundness : very angular. Some limestones with karst features more rounded.
5. sorting : none
6. striae : none

MATRIX;

7. texture : silty clay

Interpretation: Unit A is interpreted as a lacustrine clay. Unit B is a clay till with very large boulders. The alternation of lacustrine clays and the till at the surface illustrates the irregular bottom/shore topography of a former lake.

Figure A8:



Number: TAT/18a
Location: S of central part of Clara Bog
Topography: flat. To N Clara Bog, in other direction, small, partly steep hills.
Slope: flat
Vegetation/land use: grassland
General description: At least 1.5 m of dark grayish brown clay with few pebbles.

Interpretation: Lacustrine clay.

Number: TAT/18b
Location: S of central part of Clara Bog
Topography: flat
Slope: flat
Vegetation/land use: grassland
General description: More or less a similar situation as described in TAT/18. Specific here is the outcrop of a grayish yellow clay (comparable with clays found underneath Clara Bog) with few (rare) pebbles (< 0.5 cm). Clay unit merges diffusely into clay diamicton with big boulders (< 1.5 m).

Interpretation: Lacustrine clay and clay till with very large boulders (mapped here as "undefined till"). See TAT/18.

Number: TAT/19
Location: W of Clara Bog; Bohernagrisna
Topography: flat
Slope: flat
Vegetation/land use: grassland on removed bog land
Section orientation: 70-250
length: 1 m
height: 0.5 m
Moisture condition: moist
General description: dark gray clay without pebbles.
Colour: 7.5Y 4/1 (gray)
Texture: clay
Structure: structureless/massive
Consistence: firm

Interpretation: Lacustrine clay.

Number: TAT/20
Location: W of Clara Bog; Bohernagrisna
Topography: undulating, some small steep hills. Microtopography: small hummocks (dm-scale) representing partly buried big boulders.
Slope: variable
Vegetation/land use: grassland, trees and shrubs
General description: On higher ground E from site TAT/19 numerous outcrops of big boulders. Rocktype of most boulders is gray fossil rich limestone. All fences surrounding the fields composed of big boulders. Two huge accumulation of boulders form two little hills.

Interpretation: Sandy-loamy stony till.

Number: TAT/21
Location: 50 m N of Raheenmore.
Topography: flat, on edge of removed peat land - Clonagh Hill
Slope: flat
Vegetation/land use: grassland
Section orientation: 344-164
length: 1 m
height: 0.75 m
Moisture condition: moist
General description: yellowish brown diamicton. Poorly exposed. Abundant striated stones. Large boulders rare.
Colour: oxidized: 10YR 5/4 (dull yellowish brown) / reduced: 2.5Y 5/1 (yellowish gray)
Texture: gravelly loam

GRAVEL;
1. % gravel : 20 < % gravel < 50%
2. gravel size: < 15 cm
3. rock type : dark gray finegrained limestone/ finegrained dark gray fossil-rich limestone/ yellowish brown glassy sandstone
4. roundness : subangular
5. sorting : none
6. striae : abundant

MATRIX;
7. texture : loam
8. sand : mean: 150-210 μm. Max: 600 μm. Poorly sorted. Subangular to rounded.

Interpretation: Loamy till.

Number: TAT/22
Location: N of Raheenmore; S part of Mullagharush Hill
General description: Old limestone quarry. Bedded limestone. Individual beds 5-30 cm thick. Color (wet): N 3/0 (dark gray). Strike-dip measurements (made in N-S section quarry) from S to N: 108/04; 125/06; 095/08; 115/08; 078/10.

Interpretation: Limestone bedrock.

Number: TAT/23
Location: 200 m E of Raheenmore; W of Cruit Hill
Topography: flat. In direction NW broad hummock (± 2-3 m above site level).
Slope: flat
Vegetation/land use: grassland
Section orientation: 238-58
length: 10 m
height: 1.5 m
Moisture condition: moist
General description: loamy diamicton with abundant striated stones (limestone). Upper 0.5 m soil formation. Upper part is diamicton with soil formation, lower part is diamicton without clear soil development.
Colour: Upper part profile: 2.5Y 5/6 (yellowish brown) / Lower part profile: 2.5Y 4/4 (olive brown)
Texture: gravelly silty clay loam

GRAVEL;
1. % gravel : Upper part: ± 20% / Lower part: ± 50%
2. gravel size: < 35 cm
3. rock type : finegrained dark gray limestone/ dark gray fossil-rich limestone/ sandstone
4. roundness : large pebbles and sandstone (1!) subrounded. Rounded pebbles with high sphericity not rare.
5. sorting : none
6. striae : abundant

MATRIX;
7. texture : Upper part: silty loam / Lower part: silty loam-silty clay loam.

Interpretation: Gravelly silty clay loam till.

Number: TAT/24
Location: S of Raheenmore; Kilclonfert
Topography: flat; to S little hummock
Slope: flat
Vegetation/land use: grassland
Section orientation: 13-193
length: 1 m
height: 0.5 m
Moisture condition: moist
General description: in drain small exposure of diamicton.
Colour: oxidized: 2.5Y 4/6 (olive brown) / reduced: 2.5Y 6/1 (yellowish gray)
Texture: gravelly clay
GRAVEL;
1. % gravel : ??
2. gravel size: < 20 cm, most pebbles < 3 cm.
3. rock type : dark gray fossil rich limestone/ yellowish brown sandstone
6. striations : abundant
MATRIX;
7. texture : clay
Structure: structureless/massive
Consistence: very firm

Interpretation: Gravelly clay till.

Number: TAT/25a
Location: SE of Raheenmore; Barnan
Topography: flat
Slope: flat
Vegetation/land use: grassland
General description: In drains a gray clayey diamicton is exposed. Depth drains max. 40 cm. Max. boulder size ± 1 m. Striae abundant. Stonetypes: finegrained dark gray limestone/ dark gray fossil-rich limestone/ gray fossil-rich limestone/ sandstone/ volcanic rocks.

Interpretation: gravelly clay till.

Number: TAT/25b
Location: SE of Raheenmore; Barnan
Topography: flat
Slope: flat
Vegetation/land use: grassland
Section orientation: 102-282
length: 2 m (drain is ± 100 long)
height: 1.2 m
Moisture condition: moist-wet
General description: diamicton which seems to be divided in three units. Division based on color and texture matrix.
Remarks:
1. The width of the drain was very small (25 cm). A detailed description was not possible.
2. The gravel content probably does not vary much throughout the profile.
3. Material dug out gave an impression of the gravel content: ± 40%. All roundness classes were present.
4. Striae are common.
5. Stonetypes identical with TAT/25a. See figure A9.

A

Colour: 10YR 4/3 (dull yellowish brown)
Texture: gravelly clay loam

GRAVEL;
2. gravel size: < 10 cm
MATRIX;
7. texture : clay loam

B

Colour: 2.5Y 5/3 (yellowish brown)
Texture: gravelly sandy loam

GRAVEL;
2. gravel size: < 10 cm
MATRIX;
7. texture : sandy loam
8. sand : 300 μm (mode). Moderately sorted. Subrounded-rounded.

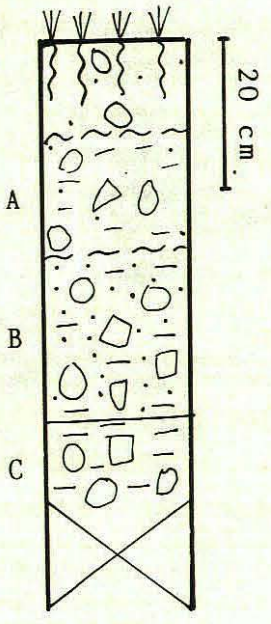
C

Colour: (wet) 10YR 6/4 (dull yellow orange)

MATRIX;
7. texture : clay

Interpretation: gravelly clay till.

Figure A9:



Number: TAT/26
Location: 350 m SE of Clara Bog
General description: On a recent ploughed field material from underneath organic rich top soil has been dug up. Pebbles are common. Subrounded. Large pebbles are rare. Maximum pebble size ϕ 25 cm. Color of matrix (moist): 5Y 4/1 (gray). Texture: loam-silty loam. Sandfraction 75 μm (mean), well sorted, subrounded.

Interpretation: Loamy till.

Number: TAT/27
Location: SE of Clara Bog; 200 m S of level crossing
Topography: little hummock
General description: gravel pit. Large scale foresets. See also TAT/58.

Interpretation: Hummock represents infill of a dead-ice hollow. Map unit "with esker associated sands and gravels".

Number: TAT/28
Location: V-notch Clara Bog
Topography: flat
Slope: flat
Vegetation/land use: bog
General description: at 6.5 m below peat surface gray clay with some sand grains and small limestone pebbles. Material saturated outside, inside fairly dry. Color: 5PB 4/1 (dark bluish gray).

Interpretation: Lacustrine deposit.

Number: TAT/29
Location: Soak Clara Bog; waterlevel recorder site
Topography: flat
Slope: flat
Vegetation/land use: bog
General description: at 8.5 m below peat surface gray clay with some small angular limestone pebbles. Material saturated outside, inside fairly dry. Color: 5PB 4/1 (dark bluish gray).

Interpretation: Lacustrine deposit.

Number: TAT/30
Location: Raheenmore; site of waterlevel recorder
Topography: flat
Slope: flat
Vegetation/land use: bog
General description: at 6.6 m below peat surface gray sandy clay with some little angular limestone pebbles (< 3-4 cm).

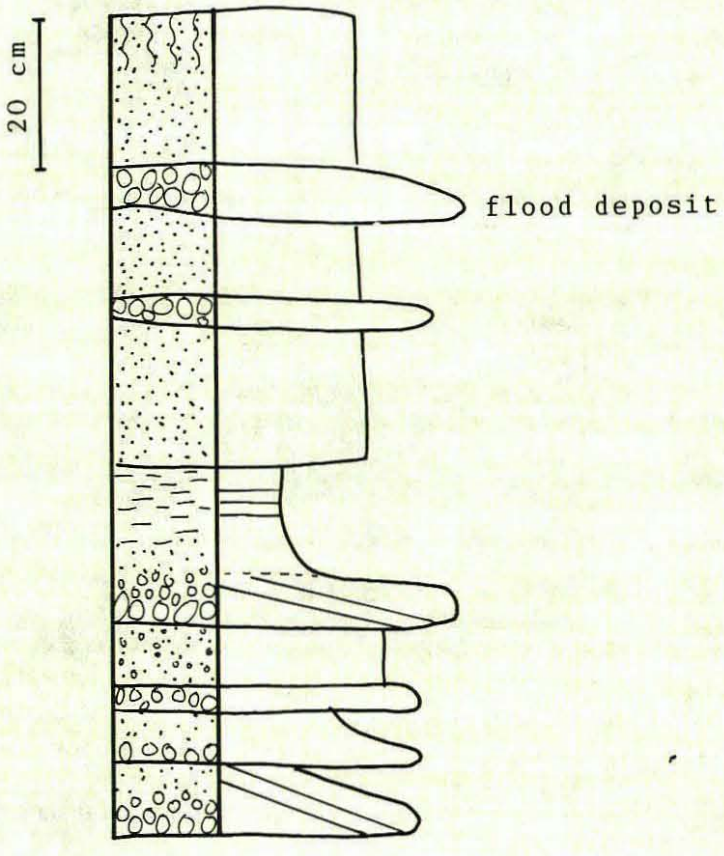
Interpretation: Lacustrine deposit.

Number: TAT/31
Location: N of Clara Bog; River Brosna; N Clonshanny
Topography: flat. In direction S small esker.

Slope: flat
Vegetation/land use: grassland
Section orientation: 90-270
length: 3 m
height: 1 m
Moisture condition: moist
General description: Profile is characterized by alternating fining upward sequences at the bottom. The top 60 cm is made up of fine sand with coarse gravel layers. See figure A10.

Interpretation: Alluvial deposits. Fining upward sequences represent floods. Fine sand is interpreted as an overbank deposit. The coarse sand and gravel within the fine sand are flood deposits.

Figure A10:



Number: TAT/32
Location: W of Clara Bog; N Bohernagrisna; few meters from old railway track.
Topography: flat
Slope: flat
Vegetation/land use: removed bog land
General description: Dark bluish gray clay. Shells are common. Some small pebbles (< 1% of total). Most pebbles angular to subrounded (< 2 cm).

Interpretation: Lacustrine deposit.

Number: TAT/32a
Location: W of Clara Bog; N Bohernagrisna
Topography: flat
Slope: flat
General description: Underneath 0.75 m peat, dark bluish gray clay.

Interpretation: Lacustrine deposit.

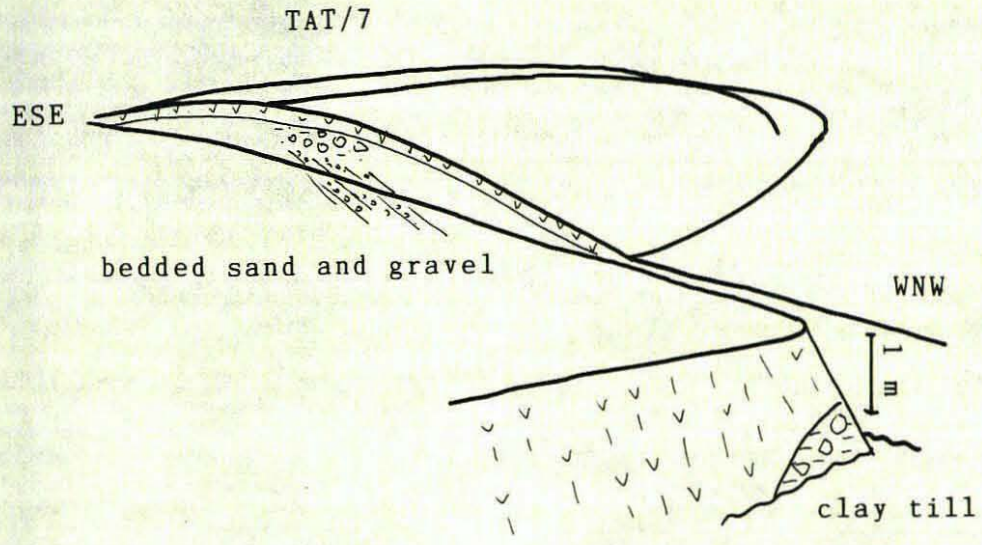
Number: TAT/32b
Location: W of Clara Bog; N Bohernagrisna
Topography: flat, to SW small hill.
Slope: flat
General description: On field some parent material is visible. Stony to very stony. All kind of roundness classes present. Different rock types. 'Gravel' seems to wedge out in NE direction (in direction of TAT/32) and to E-SE (in direction of TAT/32a). In SE part of field only peat at surface.

Interpretation: Till.

Number: TAT/33
Location: N of Clara Bog; western part
Topography: flat, to E little hummock (see TAT/7)
Slope: flat
Vegetation/land use: grassland
General description: Underneath 1 m peat a very small outcrop of a clayey diamicton. The topographic position in relation to the gravel of TAT/7 is illustrated in figure A11.

Interpretation: Clayey till.

Figure A11:

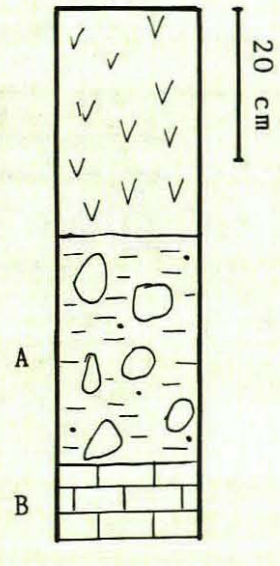


Number: TAT/34
Location: SE of Clara Bog; Coolnahely
General description: In roots of upturned three some signs of a clayey diamicton. Limestone and sandstone pebbles (< 50 cm).

Interpretation: Till.

Number: TAT/35
Location: E of Raheenmore; S of Cruit Hill
Topography: To N Cruit Hill, in other directions removed peat land.
Slope: flat
Vegetation/land use: grassland
Section orientation: 110-290
length: 1.5 m
height: 1.4 m
Moisture condition: moist-wet
General description: On top of striated limestone bedrock a clayey diamicton. Clayey diamiction is underneath 0.6 m peat. See figure A12.

Figure A12:



A

Colour: oxidized: 10YR 5/6 (yellowish brown) / reduced: 2.5Y 6/1 (yellowish gray)
Texture: gravelly clay
GRAVEL;
1. % gravel : 30%
2. gravel size: < 10 cm; most pebbles < 5 cm. Abundant small pebbles (< 1cm).
3. rock type : dark gray finegrained limestone/ light gray finegrained limestone/ yellowish brown sandstone/ sandstone with quartz veins/ dark greenish gray limestone.
4. roundness : All classes. Small pebbles subrounded.
5. sorting : none
6. striae : common
MATRIX;
7. texture : clay
Structure: structureless/massive
Consistence: very firm

B

General description: Limestone bedrock. Limestone is bedded, with a high amount of chert.
Bedrock surface: 030/09; 036/11.
Surface limestone striated. Directions of striae 098; 045; 090; 085; 090; 120; 095; 103; 104; 065; 063; 050.

Interpretation: Clay till on striated limestone bedrock.

Number: TAT/36
Location: W of Raheenmore; Cruit Hill
Topography: steep slope (W slope of Cruit Hill). Surrounding topography is flat.
Slope: 40°
Vegetation/land use: small trees and shrubs
General description: scattered dark gray fine grained limestone fragments on steep slope. Some 'fragments' seem to be attached to main limestone body. No strike-dip measurements possible. Color limestone (moist): 5G 1.7/1 (greenish black).

Interpretation: Limestone bedrock.

Number: TAT/37 and TAT/37a
Location: SW of Raheenmore; SE of Cruit Hill; W Kilclonfert
Topography: flat
Slope: flat
Vegetation/land use: grassland/ removed peat land
General description: underneath 0.1-0.3 m peat, gray clayey diamicton with gley development. Same diamicton as TAT/36. Height sections max. 0.5 m.

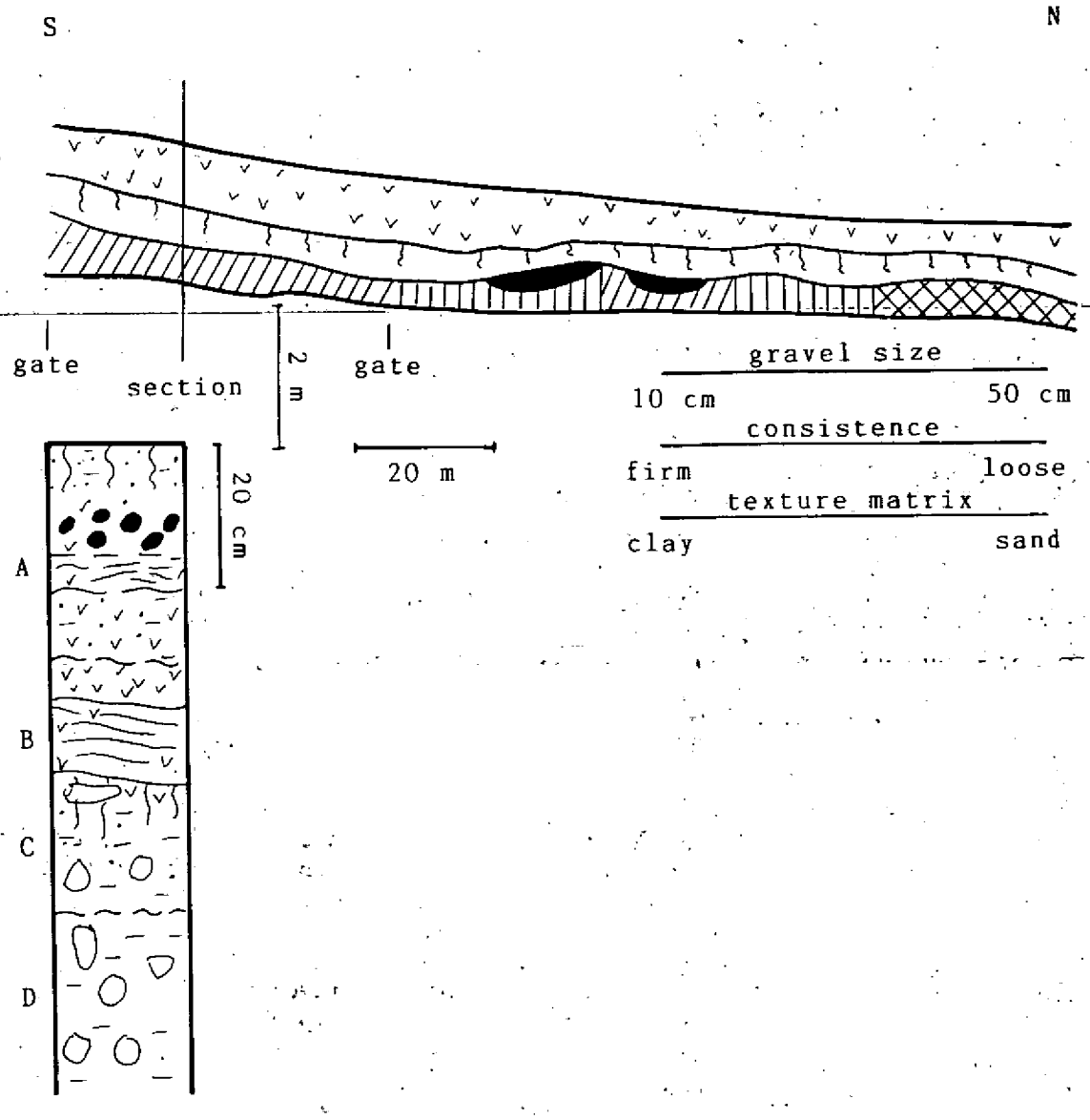
Interpretation: Clay till.

Number: TAT/38
Location: SW of Raheenmore; W Kilclonfert
Topography: flat. To E and W undulating terrain (± 2-3 m above mean level).
Slope: flat
Vegetation/land use: grassland
Section orientation: 30-120
length: 5 m
height: 2-2.5 m
Moisture condition: moist-wet
General description: underneath thin top soil, badly exposed clayey diamicton. No detailed study. Difference with TAT/37 and TAT/37a is the thickness of the diamicton.

Interpretation: Clay till.

Number: TAT/39
Location: S of eastern part Raheenmore; Puttaghan
Topography: flat, gently sloping towards Raheenmore (± 2-3½), Farm (± 2 m higher) to S on broad hill.
Slope: undulating
Vegetation/land use: beet, small trees and shrubs at edge of field
Section orientation: 186-006
length: 140 m
height: ± 2 m
Moisture condition: moist
General description: profile site: Underneath 90 cm peaty material, and a reddish brown layer an organic rich dark brown material is situated on top of a yellowish brown clayey diamicton with gley features. See figure A13. Section TAT/39 is in the southern part of the drain, which runs from S to N: towards Raheenmore. As illustrated in figure A13, a transition from a clayey diamicton to a gravelly diamicton can be observed in the drain. To the north gravel content and size increases. The consistence changes from firm to loose at the northern end of the drain.

Figure A13:



Profile site:

A

Colour: 2.5Y 3/3 (brownish black)
Texture: silt loam
Structure: weak-moderate
Consistence: very friable

B

Colour: 5YR 3/6 (dark reddish brown); 5YR 4/8 (bright reddish brown)
Texture: clay
Structure: weak
Consistence: loose (dry)

C

Colour: 10YR 3/3 (dark brown)
Texture: silty clay (few pebbles)
Structure: moderate
Consistence: very friable

D

Colour: oxidized: 2.5Y 5/6 (yellowish brown) / reduced: 2.5Y 6/2 (grayish yellow)
Texture:
GRAVEL;
1. % gravel : 20%
2. gravel size: < 10 cm; most pebbles < 2 cm.
3. rock type : dark gray finegrained limestone / black chert
4. roundness : subangular
5. sorting : none
6. striae : rare
MATRIX;
7. texture : clay
Structure: structureless/massive
Consistence: firm

Interpretation: Profile site: Unit A is interpreted as a disturbed layer with traces of coal. The same applies to B which is interpreted as an ash layer. D is a clay till. The drain shows the transition from a clay till to a gravelly till.

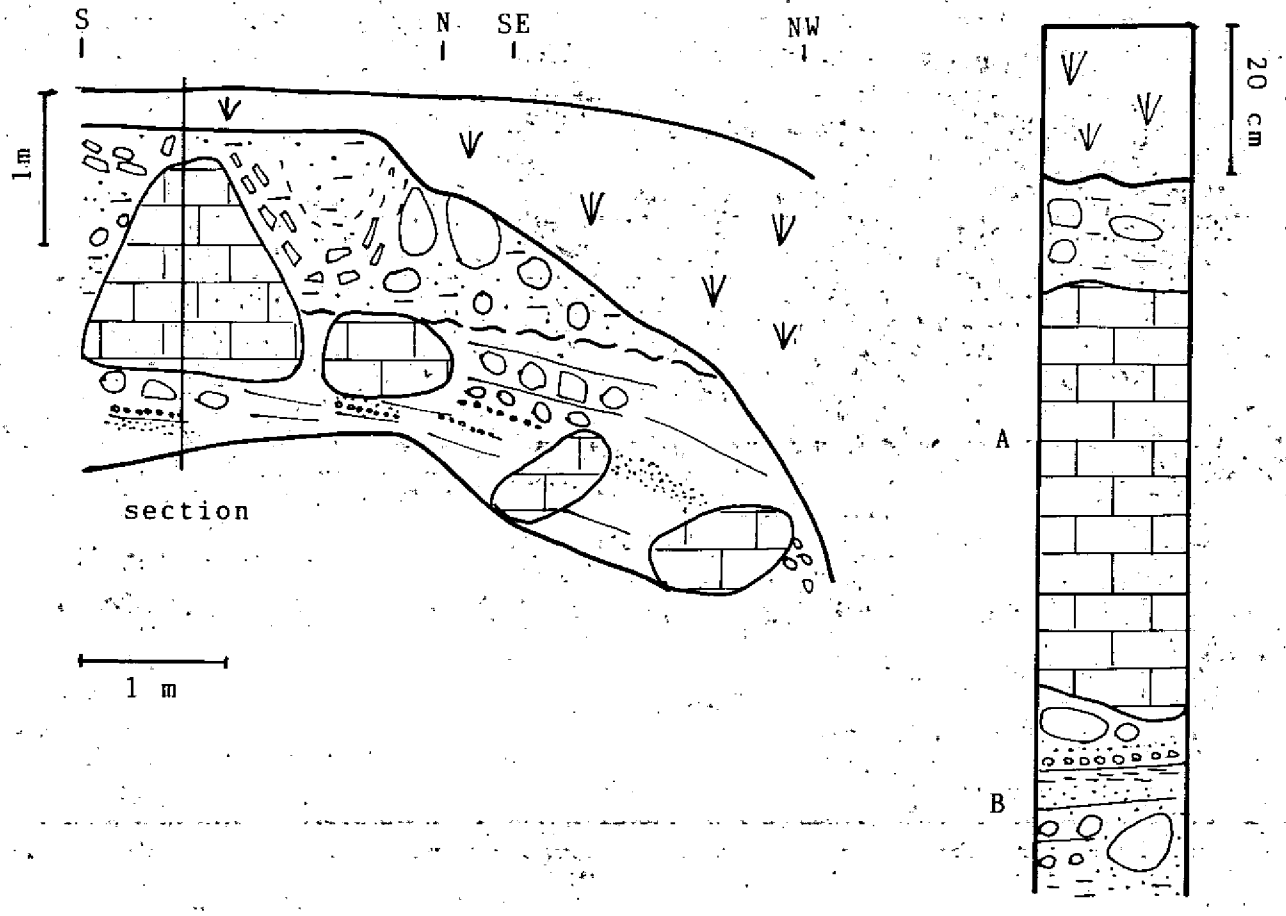
Number: TAT/40
Location: central part of Clara Bog;
Topography: flat, a few metres from edge of Clara Bog.
Slope: flat
Vegetation/land use: bog land
General description: material dug out (not exposed in situ).Bluish gray clay with small pebbles. No shell fragments.

Colour: 5PB 3/1 (dark bluish gray)
Texture:
GRAVEL;
1. % gravel : < 1%
2. gravel size: < 1 cm; most granule (and some very coarse sand)
3. rock type : dark gray finegrained limestone/ light gray finegrained limestone
4. roundness : pebbles: angular-subrounded
5. sorting : not sorted in sediment
6. striae : none
MATRIX;
7. texture : clay

Interpretation: lacustrine deposit.

Number: TAT/41
Location: S of Clara Bog; NE of The Island; Ballina
Topography: nearby top of small moderately steep hill (± 6-10 m above removed peat land). In N direction: removed bog land. Surrounding topography in other directions characterized by same type of hills as this one. Microtopography on dm-scale caused by partly buried big boulders.
Slope: 5
Vegetation/land use: grassland with small trees; burr
Section orientation: 178-358
length: 4-5 m
height: 3 m
Moisture condition: dry-moist
General description: First 1.5 m a diamictonlike deposit. Texture of matrix is sandy clay. Big limestone boulder incorporated in this layer. Some angular pebbles N of big boulder seem to show a circular orientated in the vertical. Underneath this layer a deposit with clear subhorizontal bedding is observed. At some places small patches of well stratified, well sorted fine gravel. Large boulders are also found in this layer. See figure A14 for overview section and figure A15 for section.

Figure A14 and A15:



Profile site:
A

Colour: (moist) 2.5Y 5/4 (yellowish brown)
Texture: gravelly-stony sandy clay

GRAVEL;
1. % gravel : varies throughout profile; from 40-60 % at some places to 10 % elsewhere.
2. gravel size: < 1.5 m
3. rock type : abundant finegrained dark gray limestone/ finegrained gray limestone/ sandstone/ black chert/
4. roundness : all classes, most angular
5. sorting : some sorting in uppermost part; circular orientation of angular pebbles.
6. striae : rare

MATRIX;
7. texture : sandy clay
Structure: weak
Consistence: loose

B

Texture: very gravelly sandgravel

GRAVEL;
1. % gravel : great variety
2. gravel size: < 0.75 m
3. rock type : ibid as A;
4. roundness : all classes, most subrounded
5. sorting : in general poorly sorted. At some places very well sorted (these patches are small bodies with a length of 30-40 cm).
6. striae : rare

MATRIX;
7. texture : variable; sand, loamy sand, sandy loam
Structure: structureless
Consistence: loose

Interpretation: Unit A and B are both interpreted as a kame deposit, gravelly till. Circular orientation of pebbles in unit A produced by mass- movement processes.

Number: TAT/42
Location: 300-400 S of V-notch Clara Bog
Topography: flat
Slope: flat
Vegetation/land use: bog
Section orientation: 310-130°
length: 5-6 m
height: 4 m
Moisture condition: moist-wet
General description: underneath 3.5 m peat outcrop of large fossil rich light gray limestone boulders imbedded in brownish gray clay. Description of matrix material and gravel type based on material dug out.
Colour: 10YR 4/1 (brownish gray)
Texture: gravelly-stony clay

GRAVEL;
1. % gravel : ?
2. gravel size: < 2 m
3. rock type : light gray fossilrich limestone/ gray finegrained limestone/ dark gray fossilrich limestone/ light gray

finegrained limestone/ bedded sandstones
4. roundness : angular
5. sorting : -
6. striae : rare
MATRIX;
7. texture : clay

Interpretation: Till, probably sandy-loamy stony bill.

Number: TAT/43
Location: N of Raheenmore; E Clonagh
Topography: flat
Slope: flat
Vegetation/land use: grassland
Moisture condition: moist
General description: small section (dm-scale) shows olive brown (2.5Y 5/3) diamicton with angular pebbles (< 25 cm). Texture of matrix is variable, at some places loamy sand but predominantly clay. Pebble types: dark gray finegrained limestone/ black finegrained limestone/ sandstone

Interpretation: Clay till.

Number: TAT/44
Location: NNE of Raheenmore; NE Clonagh
Topography: flat; removed peatland
Slope: flat
Vegetation/land use: grassland
Section orientation: 218-038
length: 30 m (= length of exposure of diamicton, drain is a few hundred meters long)
height: 2.5 m
Moisture condition: moist-wet
General description: in recently cleared drain outcrop of clayey diamicton underneath 2.3 m peat. Colour of matrix: 2.5Y 4/3 (olive brown). Pebbles subrounded (< 15 cm). Rock-types; dark gray finegrained limestone/ light gray finegrained limestone/ gray fossil rich limestone/ sandstone. Texture matrix: clay.

Interpretation: Clay till.

Number: TAT/45
Location: NNE of Raheenmore; NE Clonagh
Topography: flat; site is situated on little hummock (± 1 m above surroundings removed peat land)
Slope: flat
Vegetation/land use: trees; shrubs; grassland
Section orientation: 007-187
length: 1.5 m
height: 1.5 m
Moisture condition: dry-moist-wet
General description: Sandy gravelly diamicton at surface. High pebble content (þ 50 %). On top of diamicton coarse gravel layer. At bottom of profile matrix texture clay-rich (sandy clay).
Colour: 2.5Y 5/2 (dark grayish yellow)
Texture: gravelly-stony sand

GRAVEL;
1. % gravel : 40-60 %
2. gravel size: < 50 cm
3. rock type : dark gray finegrained limestone/ dark gray fossil-rich limestone/ gray finegrained limestone/ black chert/ black finegrained limestone/ light gray coarse grained limestone/ dark yellow sandstone
4. roundness : subangular-subrounded
5. sorting : clusters of large pebbles ?
6. striae : common

MATRIX;
7. texture : medium sand
8. sand : 300 μm (mean). Poorly sorted.
Structure: structureless/massive
Consistence: firm

Interpretation: Gravelly till.

Number: TAT/46
Location: ENE of Raheenmore; N Kilduff
Topography: flat. Surrounding topography: to NW little hummock (± 2.5 m above lowest part boulder). To S small hummock with on E side microtopography caused by boulders (< 0.5 m)
Slope: flat
Vegetation/land use: grassland
General description: enormous grey fossil rich limestone boulder. Magnitude: ± 3.5 x 5 x 4 m (part of boulder above surface). Karstified.

Interpretation: Site is located within gravelly tillgravel unit on map, based on interpretation of aerial photographs.

Number: TAT/47
Location: S of Clara Bog; SE part of The Island; 300 m SW of Killafeen Burial Ground.
Topography: flat; removed peat land.
Slope: flat
Vegetation/land use: grassland
General description: Small sections along drains show clayey diamiction. Stone types: gray finegrained limestone/ gray fossil rich limestone/ reddish fine gravelly conglomerates/ dark gray finegrained limestone. Size of pebbles < 1.5 m. Matrix texture: clay loam. Colour matrix: 5Y 4/1 (gray).

Interpretation: Clay loam till. Map unit: undifferentiated till.

Number: TAT/48
Location: S of Clara Bog; SE of The Island; E Kilpatrick
Topography: flat
Slope: flat
Vegetation/land use: grass/ shrubs/ small trees
Section orientation: ± NE-SW (drain)
length: ± 150 m
height: ± 2-3 m
Moisture condition: moist-wet

General description: along main drain through reclaimed peat land at some places small sections of brownish black clay with small pebbles (< 1 cm). Coarse fragments in clay are mainly coarse sand grains.

Color: 2.5Y 5/1 (brownish black)
Texture: clay
GRAVEL;
1. % gravel : rare
2. gravel size: < 1 cm
4. roundness : subrounded
Structure: moderate-(moist-dry)
Consistence: firm-very firm (moist-dry)

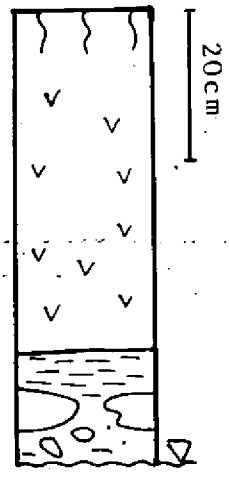
Interpretation: Lacustrine clay.

Number: TAT/49
Location: S of Clara Bog; SE edge of The Island; E Kilpatrick.
Topography: Irregular hummocks, probably caused by digging
General description: Large limestone boulders (< 3 m), sandy gravelly material.

Interpretation: gravelly till or till with big boulders.

Number: TAT/50
Location: S of central part of Clara Bog; NE of The Island
Topography: flat, microtopography dominated by bog remnants.
Slope: flat
Vegetation/land use: grassland; removed peat land.
Section orientation: 360-180
length: 5 m
height: 1.2 m
Moisture condition: moist-wet
General description: exposure of gray diamicton with large boulders. Diamicton is separated from peat by a dark bluish gray clay, which contains sand grains and small pebbles. See figure A16. Units A and B are distinguished from each other based on:
1. gravel content
2. drape-like character of the dark bluish gray clay.
3. colour: unit A is darker (organic material, mineralogy ??).

Figure A16:



A

Colour: 5BG 3/1 (dark bluish gray)
Texture: clay
GRAVEL;
1. % gravel : < 1%
2. gravel size: < 0.5 cm
Structure: weak-moderate
Consistence: firm

B

Colour: 2.5Y 5/2
Texture: gravelly-stony clay
GRAVEL;
1. % gravel : 25%
2. gravel size: < 1.5 m
3. rock type : light gray fossilrich limestone/ sandstone with horizontal bedding/ dark gray fossilrich limestone
4. roundness : angular; sandstone subrounded
MATRIX;
7. texture : clay

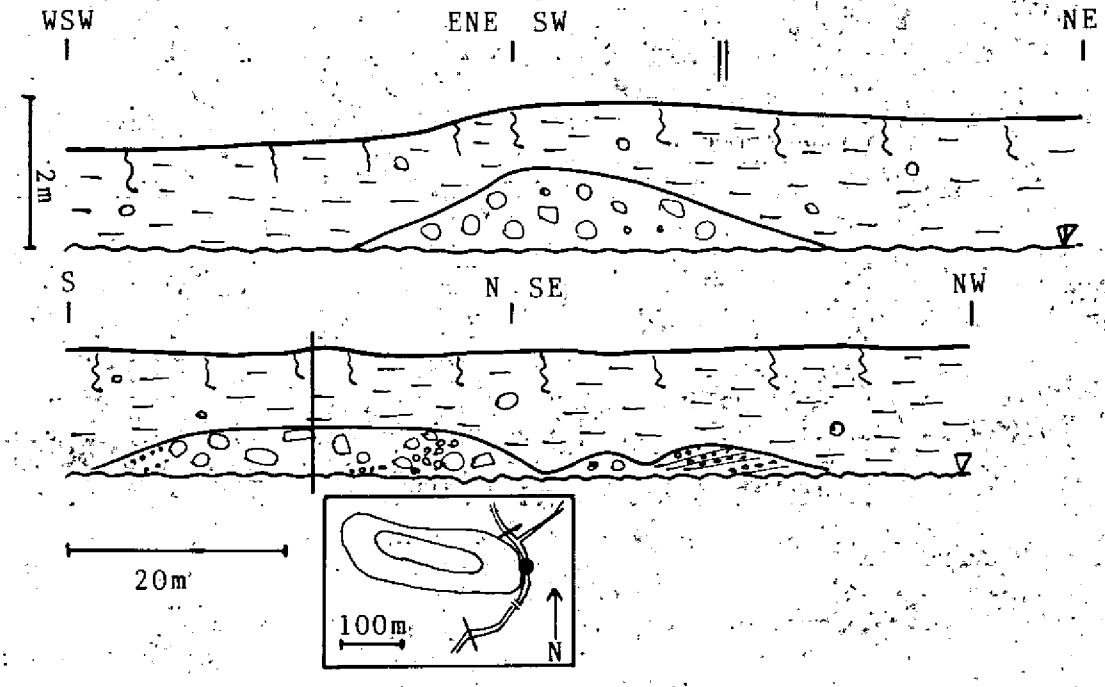
Interpretation: Lacustrine clay on top of clay till.

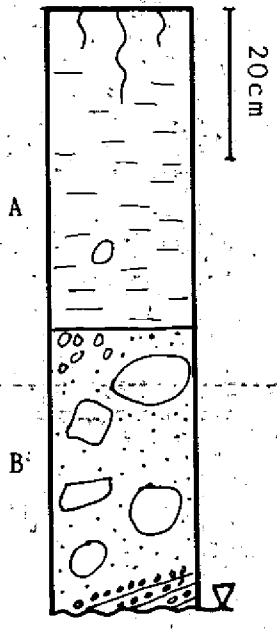
Number: TAT/51
Location: S of central part of Clara Bog; NE of The Island
Topography: flat
Slope: flat
Vegetation/land use: grassland
Section orientation: 90-270
length: 1.5 m
height: 1 m
Moisture condition: moist
General description: yellowish gray diamicton with high pebble content. Gray limestone pebbles very angular, 'crunched' character.
Color: 2.5Y 6/2 (grayish yellow)
Texture: gravelly-sandy loam
GRAVEL;
1. % gravel : 50%
2. gravel size: < 30 cm; mean ± 4-5 cm
3. rock type : gray finegrained limestone (75% of total)/ angular calcite crystals (þ 3 cm)/ gray fossil rich limestone/ dark gray finegrained limestone/ sandstone (1)
4. roundness : gray finegrained limestone very angular; other types: subangular-subrounded.
5. sorting : none
6. striae : none
MATRIX;
7. texture : sandy loam
8. sand : mean: 210 μm. Max: 600 μm. Poorly sorted; subangular-subrounded.
Structure: weak
Consistence: friable

Interpretation: Sandy loamy till.

Number: TAT/52
Location: S of eastern part Clara Bog; S Derries
Topography: flat. In E-SW small hummocks. Site is at lowest eastern point of westerly hummock.
Slope: flat
Vegetation/land use: grassland
Section orientation: 330-150
length: ± 30 m
height: 1.6 m
Moisture condition: moist
General description: Underneath a dull yellow orange, firm clay, a gravelly diamicton is exposed. Striae common. Locally subhorizontal bedded gravel. Situation in drain suggests a relation between hummocks and gravelly diamicton. See figure A17 and A18.

Figure A17 and A18:





A

Colour: oxidized: 10YR 6/4 (dull yellow orange) / reduced: 2.5Y 5/1 (yellowish gray)
Texture: clay (pebbles very rare)
Structure: moderate
Consistence: very firm

B

Colour: 5Y 4/1 (gray)
Texture: gravelly-very gravelly sand

GRAVEL;
1. % gravel : 40-60%
2. gravel size: < 0.5 m
3. rock type : dark gray finegrained limestone/ light gray finegrained limestone/ black limestone/ yellowish brown sandstone
4. roundness : subangular-subrounded-rounded
5. sorting : clustering of pebbles of same size is common. At some places small bodies (length in section ± 1 m) of rounded, sorted gravel. Locally along drain subhorizontally bedded gravel.
6. striae : common

MATRIX;
7. texture : varies throughout profile. Mean: ± medium sand
8. sand : varies throughout profile. Mean: ± 300 μm. Well sorted. Subangular.

Structure: structureless
Consistence: very friable

Interpretation: Underneath lacustrine clay deposit, gravelly till. Gravelly till associated with hummock. Probably kame-like deposit.

Number: TAT/53
Location: eastern part Clara Bog; plot ?
Topography: flat; bog
Slope: flat
Vegetation/land use: bog
General description: Underneath 10.3 m peat dark bluish gray clay (5PB 3/1) with some dark gray finegrained limestone pebbles. Subangular; < 1 cm. Few sand grains.

Interpretation: Lacustrine deposit.

Number: TAT/54
Location: eastern part of Clara Bog; plot ?
Topography: flat; peat bog
Slope: flat
Vegetation/land use: bog
General description: Underneath 10.2 m peat, olive black, dark gray clay (5Y 3/1). No sand, no pebbles.

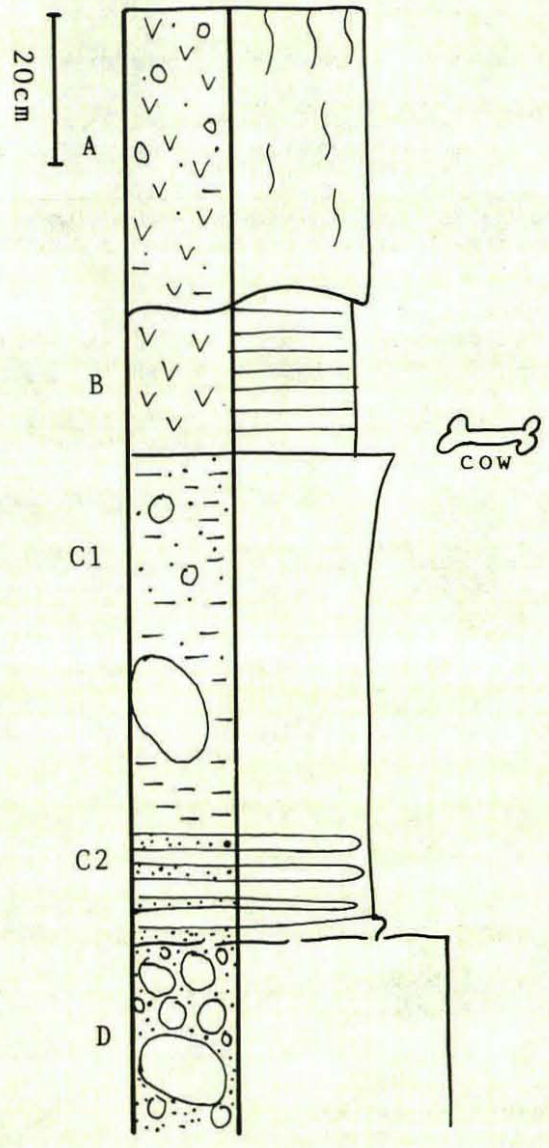
Interpretation: Lacustrine deposit

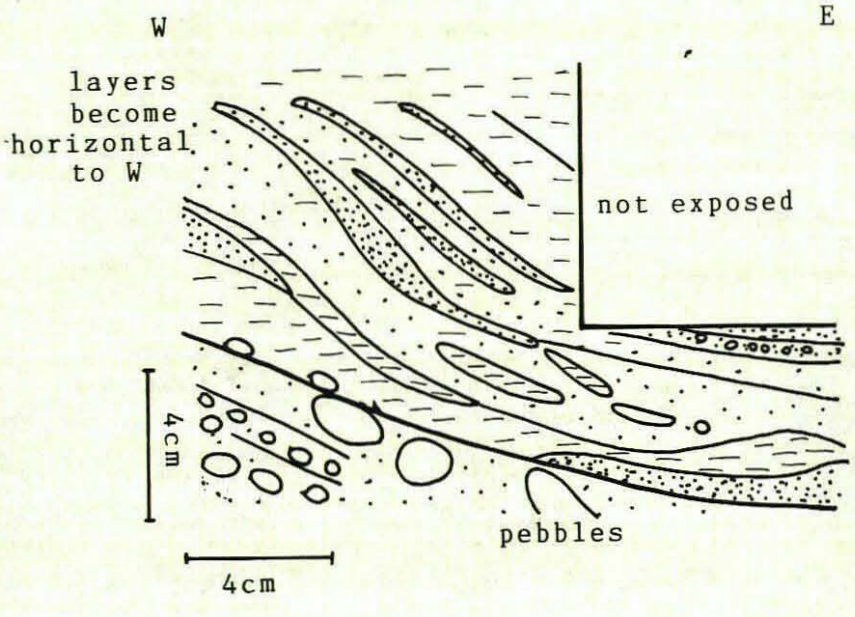
Number: TAT/55
Location: eastern part of Clara Bog; plot ?
Topography: flat; bog
Slope: flat
Vegetation/land use: bog
General description: underneath 6.3 m peat, gray clay (5Y 5/1). No pebbles, < 1% sand.

Interpretation: Lacustrine deposit.

Number: TAT/56
Location: at NE edge of Raheenmore; W Kilduff
Topography: flat; removed peat land
Slope: flat
Vegetation/land use: grassland
Section orientation: 280-80
length: 10 m
height: 1.6 m
Moisture condition: moist
General description: from top to bottom: first a reworked peaty layer followed by a layered peat with vertebrate (cow) remnants. A sharp boundary marks the transition from peat to grayish white, yellowish brown slightly gravelly clay-clay loam. At a depth of 125 cm a gravelly diamicton is exposed. See figure A19. The contact between the slightly gravelly clay and the gravelly diamicton is illustrated in figure A20.

Figure A19 and A20:





A

Colour: 5YR 2/2 (brownish black)
General description: reworked peat with sand, gravel and clay patches.

B

Colour: 5YR 1.7/1 (black)
General description: horizontally layered peat.

C1

Colour: 7.5YR 5/2 (grayish brown)
Texture: slightly gravelly clay loam

GRAVEL;
1. % gravel : 10%
2. gravel size: < 15 cm, most pebbles þ 1-2 cm.
3. rock type : finegrained dark gray limestone/ light gray finegrained limestone/ sandstone
4. roundness : angular-subangular-subrounded
5. sorting : none
6. striae : none

MATRIX;
7. texture : clay loam
Structure: moderate
Consistence: firm

C2

Colour: oxidized: 10YR 5/4 (dull yellowish brown) / reduced: 5Y 5/3 (grayish olive)
Texture: slightly gravelly clay

GRAVEL;
1. % gravel : 15%
2. gravel size: < 15 cm, most pebbles þ 1-2 cm
3. rock type : ibid C1
4. roundness : ibid C1
5. sorting : at bottom unit C2, alternating layers of medium-fine sand and clay. Sand layers are graded. See figure A20.
6. striae : none

MATRIX;
7. texture : clay
Structure: weak-moderate
Consistence: very friable-firm

D

Colour: 2.5Y 5/2 (dark grayish yellow)
Texture: gravelly coarse sand

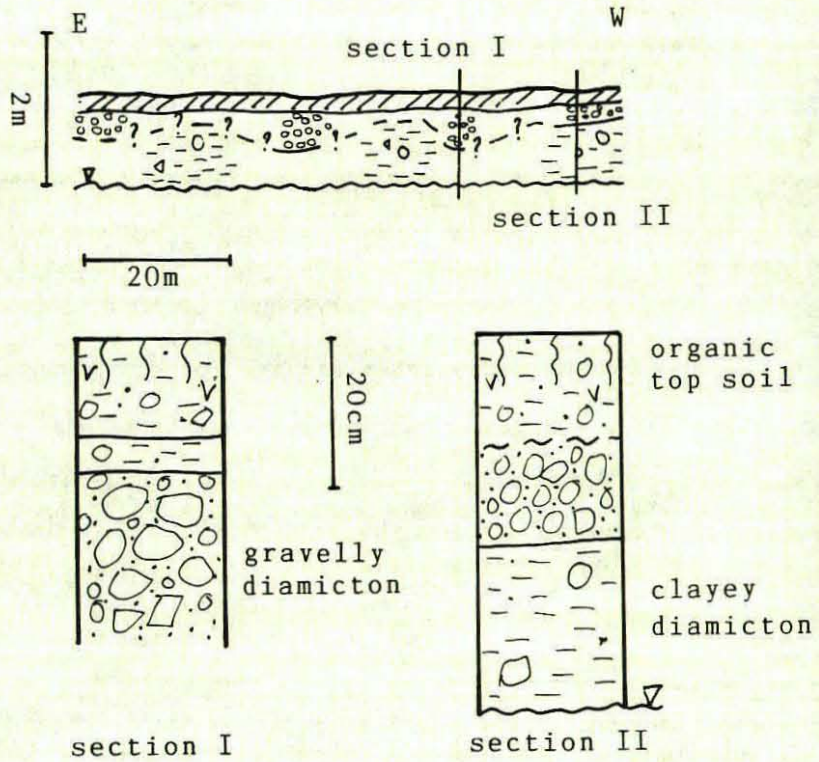
GRAVEL;
1. % gravel : 30-40%
2. gravel size: < 1.2 m
3. rock type : dark gray finegrained limestone/ light gray finegrained limestone/ sandstone
4. roundness : subangular-subrounded-rounded
5. sorting : in detail (see figure A20) slightly bedded
6. striae : common

MATRIX;
7. texture : coarse sand
8. sand : mean 420 µm. Poorly sorted. Subangular-subrounded.
Structure: structureless
Consistence: very friable

Interpretation: Unit C is interpreted as a lacustrine deposit. Unit D is a gravel or a gravelly diamicton and is probably morphological associated with Kilduff Hill.

Number: TAT/57
Location: W of Raheenmore; SW Cloneen
Topography: flat. To NE Mullagharush Hill. To S broad hummock (± 3-4 m above site). TAT/57 is situated in depression between these two elevations.
Slope: flat
Vegetation/land use: grassland
Section orientation: 080-260
length: 20 m
height: 1.1 m
Moisture condition: moist-wet
General description: along drain patches of a gravelly diamicton imbedded in a clayey diamicton. Clayey diamicton is slightly gravelly. Gravelly diamicton has a maximum thickness of ± 0.5 m and is situated on top of clayey diamicton. At some places the clayey diamicton is overlying the gravelly diamicton. See figure A21 for a situation sketch in the drain.

Figure A21:



Section I: description of gravelly diamicton.
Colour: 5Y 4/1 (gray)
Texture: very gravelly sand

GRAVEL;
1. % gravel : 50-60%
2. gravel size: < 10 cm
3. rock type : dark gray fine grained limestone/ light gray finegrained limestone/ yellowish brown sandstone/ fossil-rich light gray limestone
4. roundness : subangular-subrounded
5. sorting : none
6. striae : none

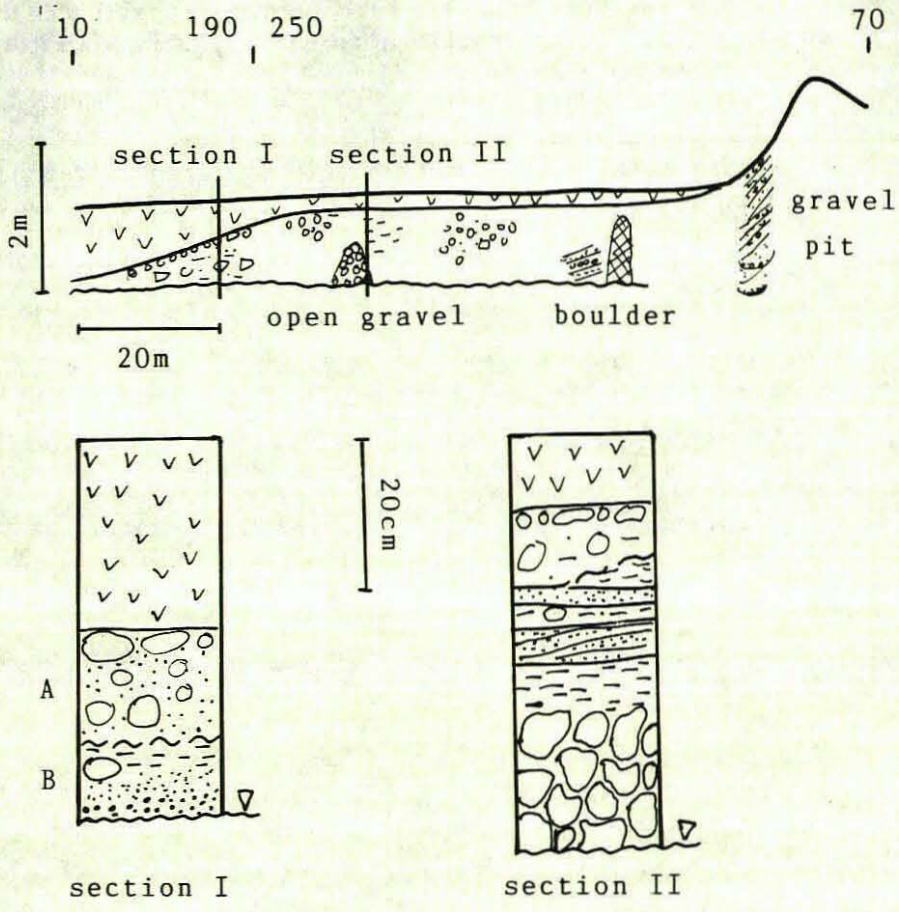
MATRIX;
7. texture : sand
8. sand : mean 300 μm, max. 2000 μm. Very poorly sorted. Subangular-subrounded.
Structure: structureless/massive
Consistence: very friable.

Section II: description of clayey diamicton.
Colour: oxidized: 2.5Y 5/6 (yellowish brown) / reduced: 2.5Y 5/1 (yellowish gray)
Texture: slightly gravelly clay
GRAVEL;
1. % gravel : < 5%
2. gravel size: < 5 cm
3. rock type : dark gray finegrained limestone (80% of total)/ other types could not be determined.
4. roundness : angular-subangular-rounded
5. sorting : none
6. striae : none
MATRIX;
7. texture : clay (with rare sand grains)
Structure: weak
Consistence: very firm

Interpretation: Sections are difficult to interprete. The first tenths of centimeters of both profiles could be disturbed by man. So, the yellowish brown clayey layer above the gray gravel, in Section I, is not very valuable. If the clayey diamicton is a lacustrine deposit, then the gravel is hard to explain. It must be an alluvial deposit. But at this site such a coarse alluvial deposit would be very unusual. In spite of the 'lacustrine look' of the clay it is interpreted as a clay till. The gravelly diamicton can then be explained as a gravelly till, probably a melt-out deposit.

Number: TAT/58
Location: E of Clara Bog; N Coolnahely
Topography: To N, E and S small hummocks. In hummock with NW-Se long axes, bedded gravel.
Slope: flat; slightly sloping to ± NW
Vegetation/land use: ploughed field
Section orientation: 70-250° ; 10-190°
length: 25 m ; 55 m
height: ± 1 m ; ± 1 m
Moisture condition: moist-wet
General description: In drains (see figure A22) irregular small patches of different materials. To NW material plunges under 1.5 m thick peat layer. In NW a slightly gravelly sandy diamicton is found. Following the section in direction 190° and 70°, gravel lags, open work gravel, subhorizontal bedded sands, clay deposits and gravelly, sandy and clayey diamictons can be observed. A little hummock is situated at the end in direction 70°. A gravel pit in this hummock shows bedded sands and gravel and large scale delta foresets, which plunge underneath the drain level (with the structures described above).

Figure A22:



Section I.

A

Texture: slightly gravelly sand

GRAVEL;

1. % gravel : < 10%
2. gravel size: < 15 cm

MATRIX;

7. texture : fine sand
8. sand : 210 μm (mean). Moderately sorted. Subangular-subrounded.

B

General description: unit B shows a fining upward sequence. At the bottom coarse sands changing into fine sands, silt and clay. Some pebbles are found in the uppermost layers (< 10 cm).

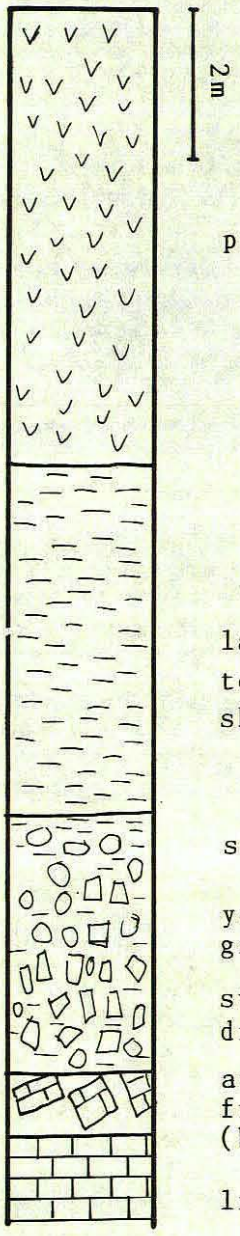
Section II.

General description: at the bottom of section II an open gravel is exposed. Well sorted. Mean of pebble size ± 10 cm. Above the gravel a gray-orange clay, drape-like deposit. A clear boundary separates the clay from subhorizontal bedded sands. At the top of the profile a gravel layer is situated above a more sandy clay diamicton.

Interpretation: The high variability of different facies points to a proglacial environment with fluvioglacial, small scale debris flowlike, and melt-out deposits. The sediments in the gravel pit are interpreted as the infill of a depression in a dead ice environment.

Number: TAT/59, CL1
Location: Clara Bog, northern part; on bog road at car parking.
Topography: flat
Slope: flat
Vegetation/land use: disturbed bog
General description: drilling operation with the mobile drill of the Geological Survey. For Profile description see figure A23. An artesian well was struck probably at 12.2 m. Discharge: ± 1 l/s.

Figure A23:



Number: TAT/60
Location: S of central part of Clara Bog; SW Derries
Topography: flat; to N little hummock
Slope: flat
Vegetation/land use: grassland
General description: underneath 80 cm clay (pebbles very rare) a coarse gravel is found. Subrounded.

Interpretation: Lacustrine clay on top of gravel or gravelly diamicton.

Number: TAT/61
Location: 400 m S of eastern part Clara Bog; SW Doory
Topography: flat; removed peat land
Slope: flat
Vegetation/land use: grassland, trees
Section orientation: 260-80

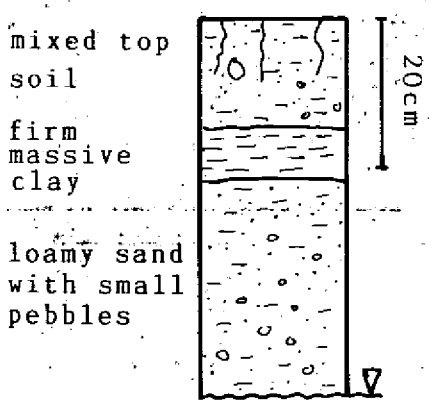
length: 5-10 m
height: 1.75 m
Moisture condition: dry-moist-wet
General description: gravelly diamicton with on top silty clay. Silty Clay.
Colour: 2.5Y 6/2 (grayish yellow)
Texture: silt loam
Consistence: firm
Gravelly diamicton.
Colour: 2.5Y 4/3 (olive brown)
Texture: gravelly-very gravelly sand
GRAVEL;
1. % gravel : 30-70%
2. gravel size: < 75 cm, mean: ± 1-10 cm
3. rock type : black limestone with chert/ dark gray finegrained limestone/ light gray finegrained limestone/ bedded light gray sandstone/ yellowish brown sandstone/ red sandstone
4. roundness : very angular to subrounded
5. sorting : locally slightly sorted, overall diamicton
6. striae : none
MATRIX;
7. texture : sand
Structure: structureless/massive
Consistence: loose-very friable

Interpretation: Lacustrine deposit on top of gravelly till.

Number: TAT/62
Location: S of eastern part Clara Bog; S Doory
Topography: site situated in depression between two elevated areas.
Slope: flat
Vegetation/land use: grassland
Section orientation: E-W
length: 5 m
height: 1 m
Moisture condition: moist
General description: Underneath 30 cm yellowish brown mixed top-soil, a 5 cm thick, black, very firm and massive clay is found. Underneath this clay a loamy sand with small pebbles. Dark gray, structureless, friable. See figure A24.

Interpretation: Black clay is interpreted as a recent overbank deposit of Silver River. Sandy loam is probably 'old' alluvium or a lacustrine deposit.

Figure A24:



Number: TAT/63
Location: SE of Raheenmore; SE Barnan
Topography: flat; removed peat land
Slope: flat
Vegetation/land use: grassland
General description: clayey diamicton, locally gravelly (up to 40% gravel content) Pebble size: < 25 cm. Majority of pebbles between 1 and 4.5 cm.

Interpretation: Clay till.

Number: TAT/64
Location: N of Clara Bog; on road to Clara
Topography: hilly; eskers
Slope: -
Vegetation/land use: gravel pit
General description: see 'Description of facies types' and figure A25, A26, A27, A28 and A29.

Interpretation: Esker.

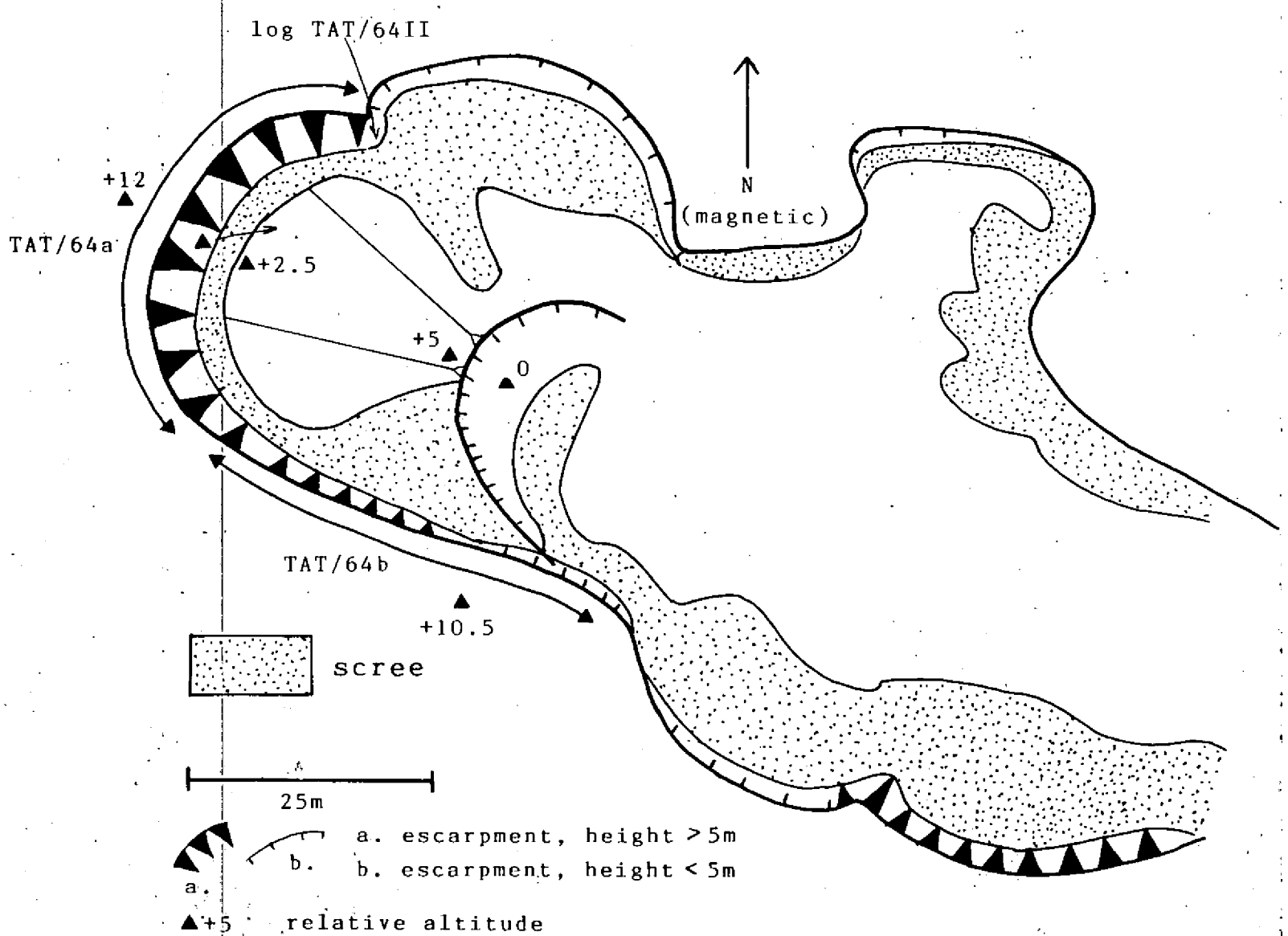
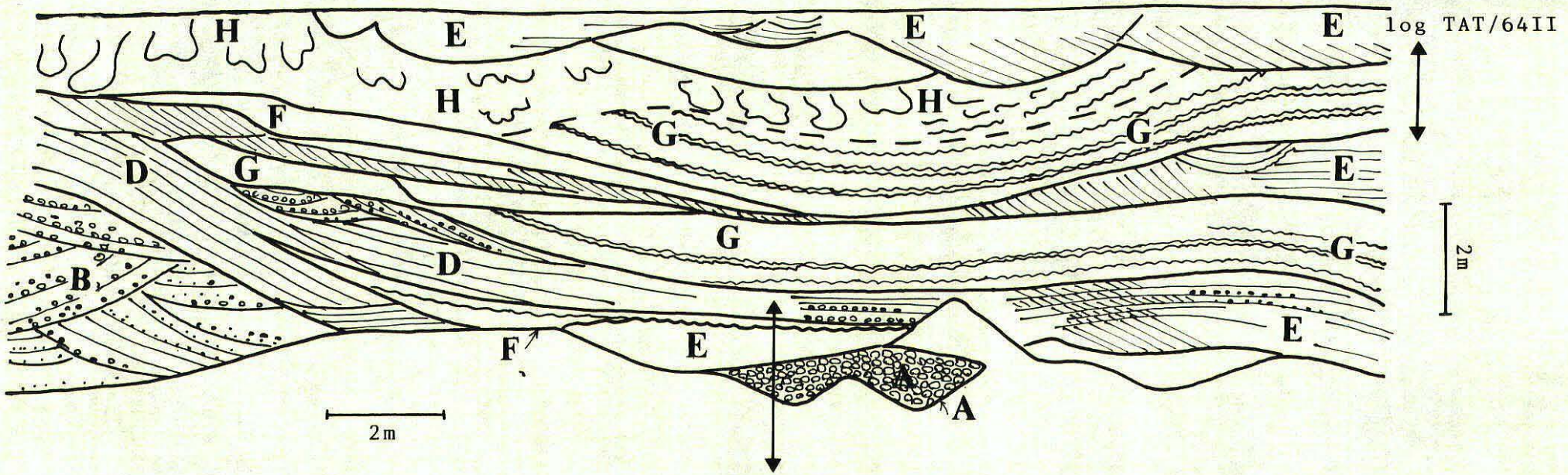

log TAT/64II
+12
TAT/64a
+2.5
+5
0
N
(magnetic)
TAT/64b
+10.5
scree
25m
a. escarpment, height > 5m
b. escarpment, height < 5m
a.
b.
▲+5 relative altitude

Figure A25:

Figure A26:

TAT/64a

S N WSW ENE W E



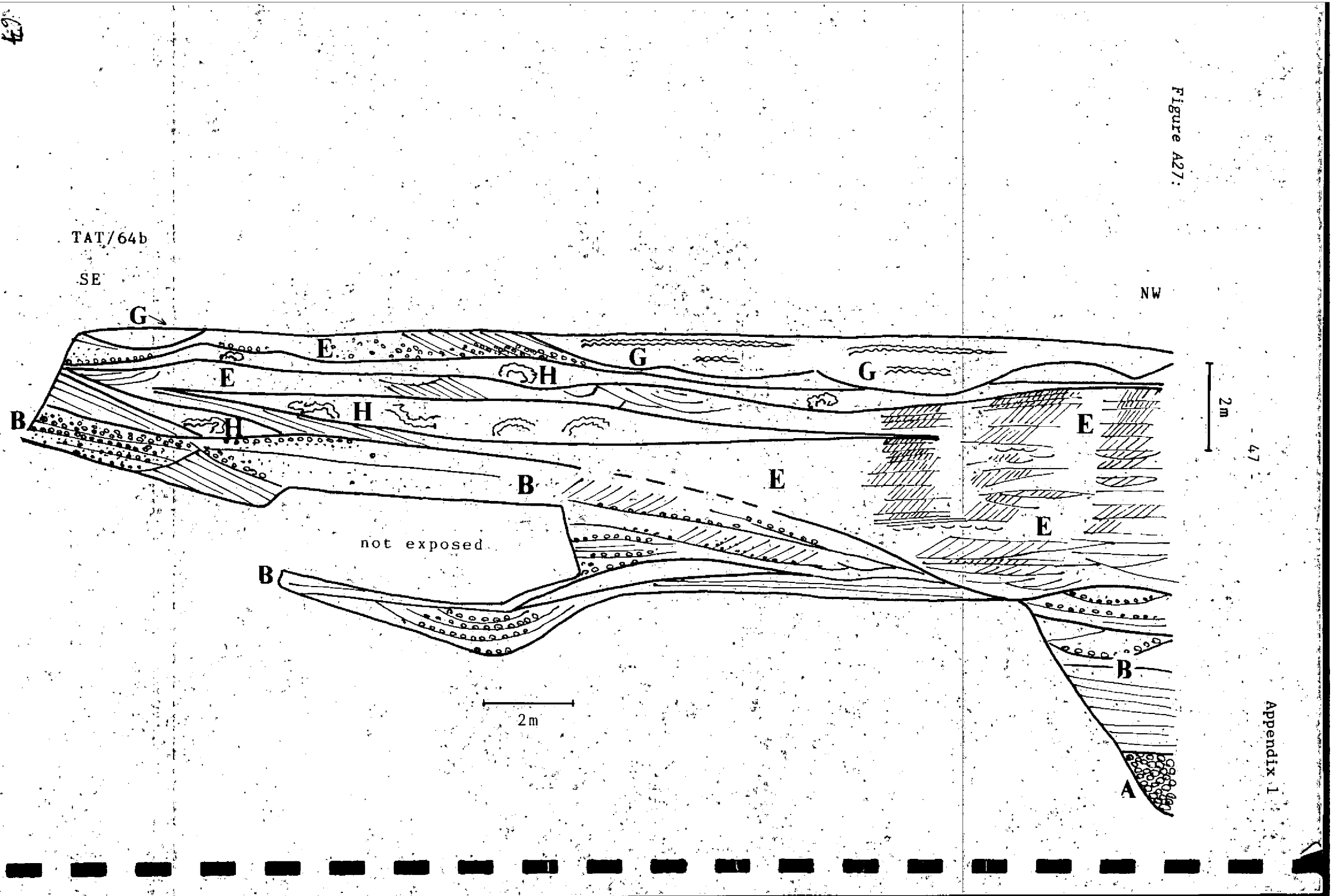
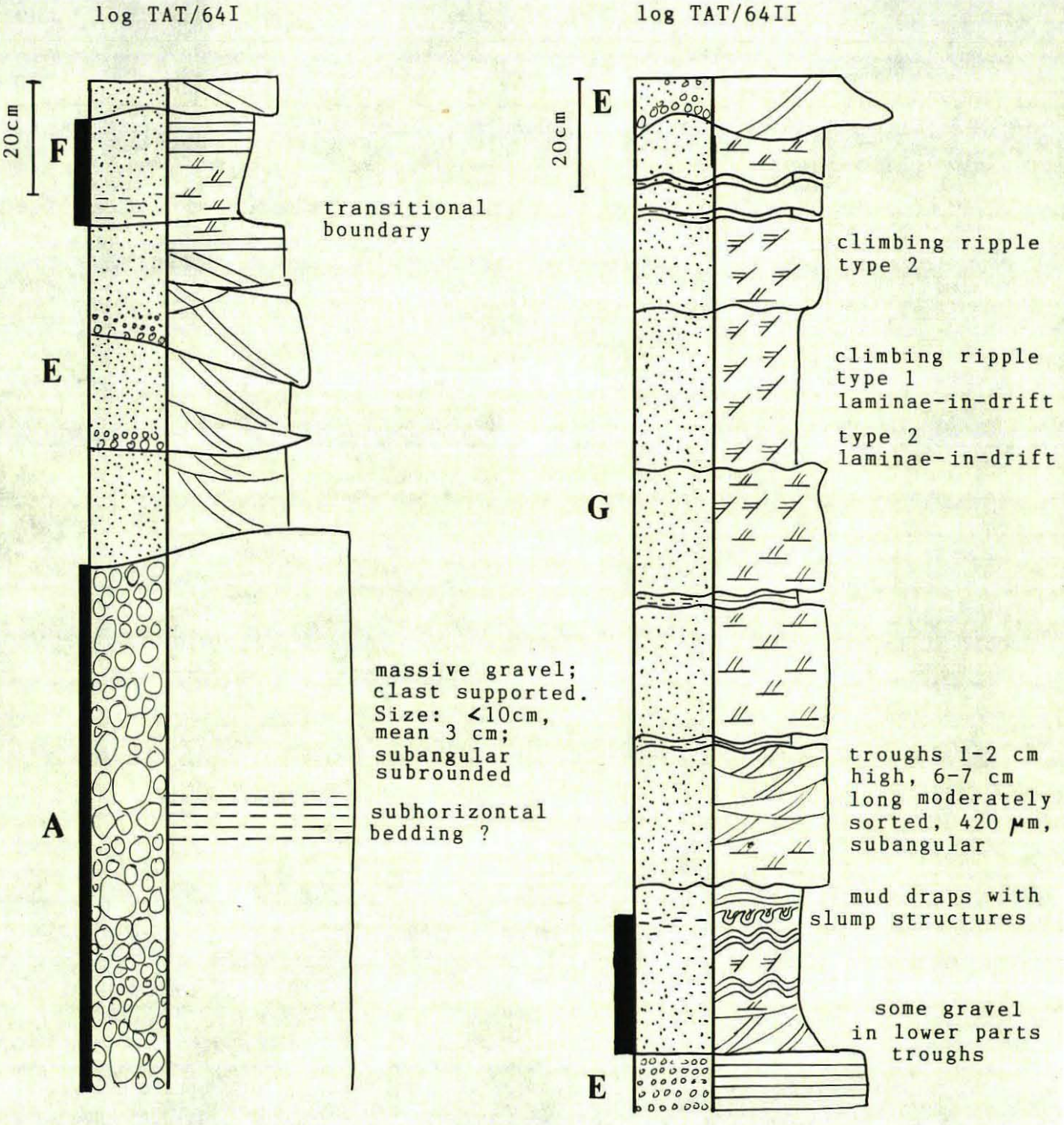


Figure A27:

Figure A28 and A29:



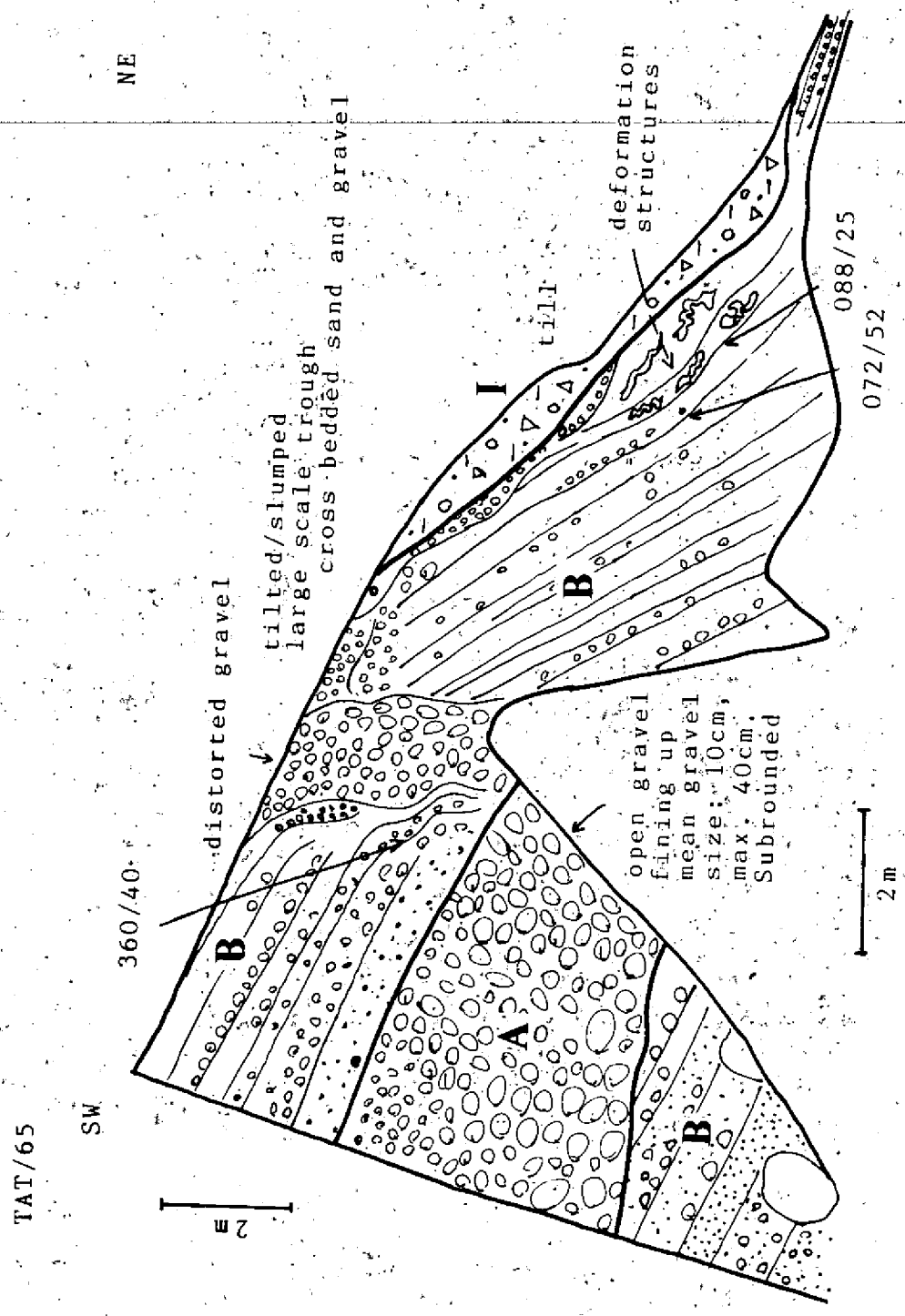
Number: TAT/65
Location: N of eastern part Clara Bog; N Maryborough; near railway track.
Topography: hilly; eskers
Slope: -
Vegetation/land use: gravel pit
General description: see 'Description of facies types' and figure A30 and A31.

Interpretation: Esker.

TAT/65
S
N
dip to W
dip to E
mean gravel size 0.15m;
max. lm. subrounded
imbrication common
2m
2m
A
A
A
B
B
B
B

Figure A30:

Figure A31:


TAT/65
SW
NE
360/40
distorted gravel
tilted/slumped
large scale trough
cross bedded sand and gravel
till
deformation
structures
088/25
072/52
open gravel
fining up
mean gravel
size: 10cm,
max. 40cm,
Subrounded
2m
2m
A
B
B
B
I

Number: TAT/66
Location: NE of Clara Bog; N Kilnacarra; first turn right on Clara - Kilbeggan road.
Topography: hilly; eskers
Slope: -
Vegetation/land use: sand pit
General description: see 'Description of facies types' and figure A32, A33 and A34.

Interpretation: Esker.

TAT/66

W

E

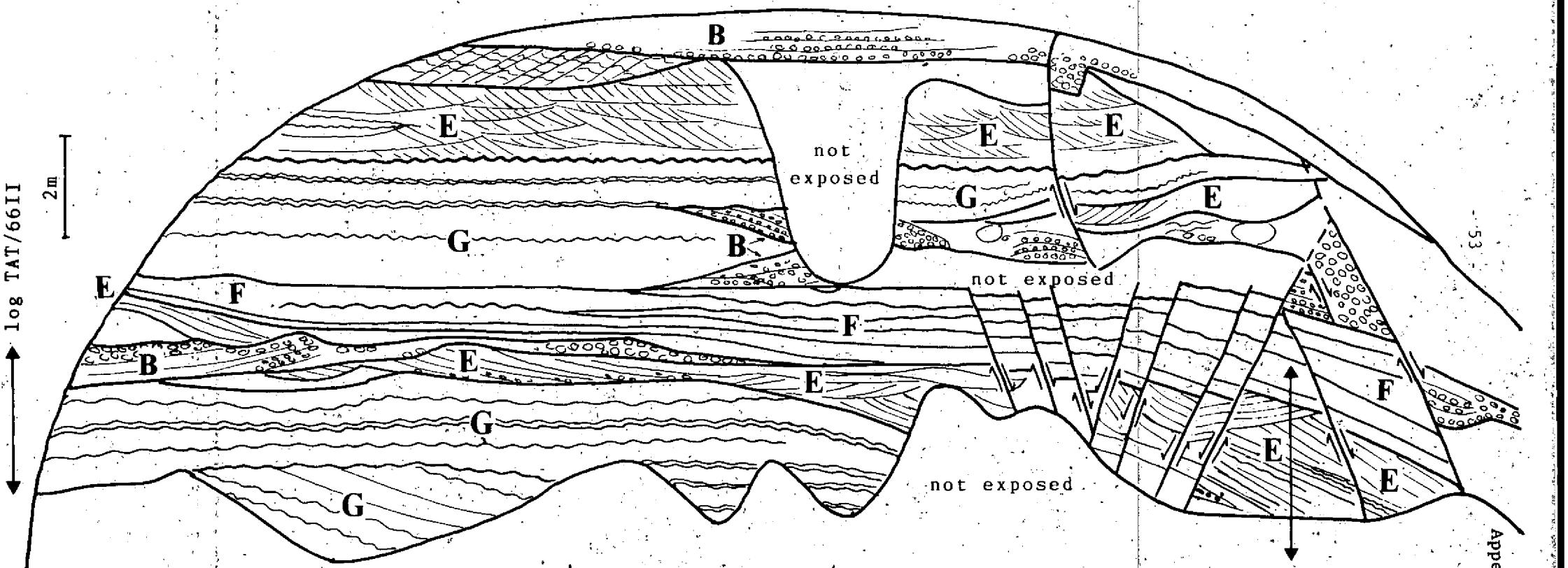


Figure A32:

Appendix 1

Figure A33:

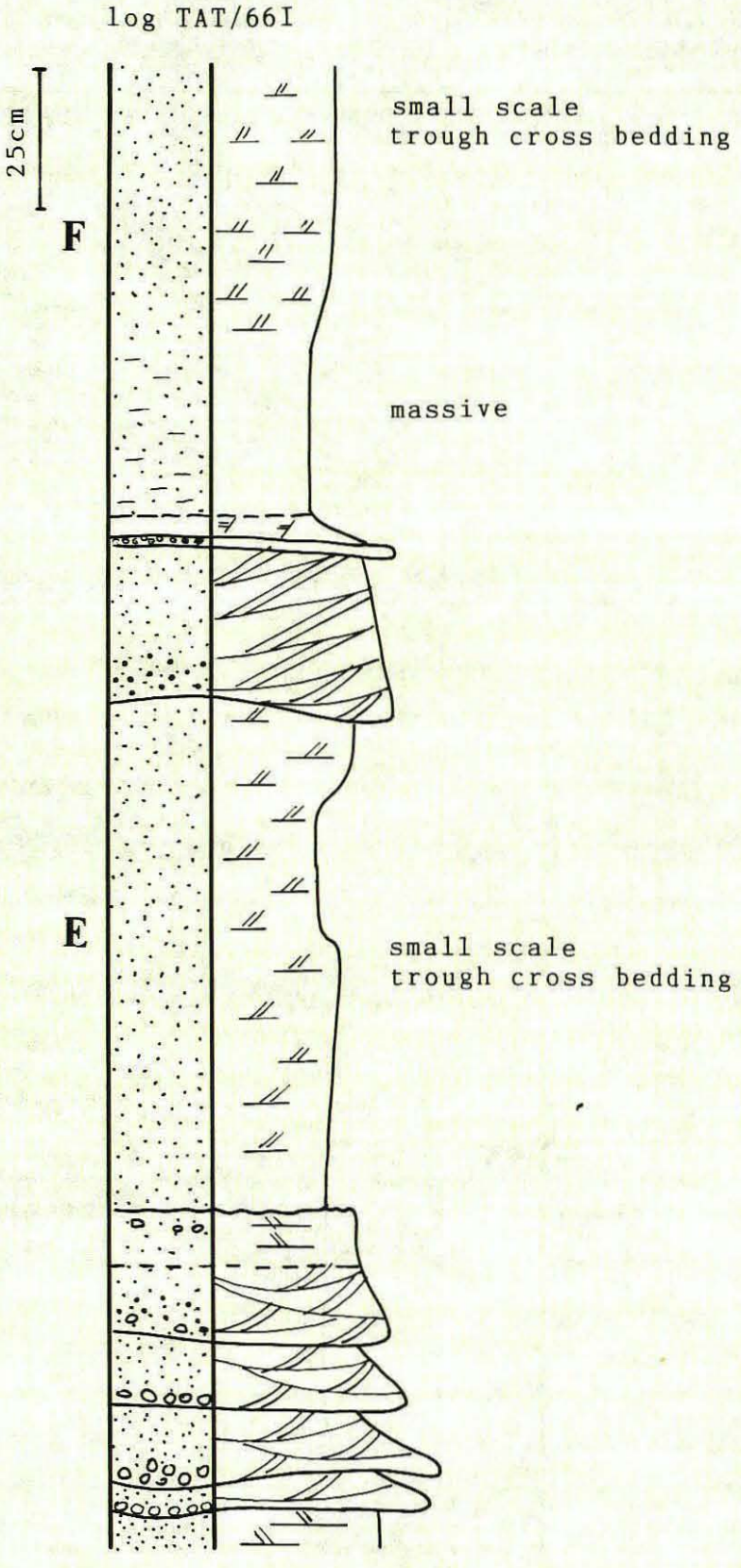
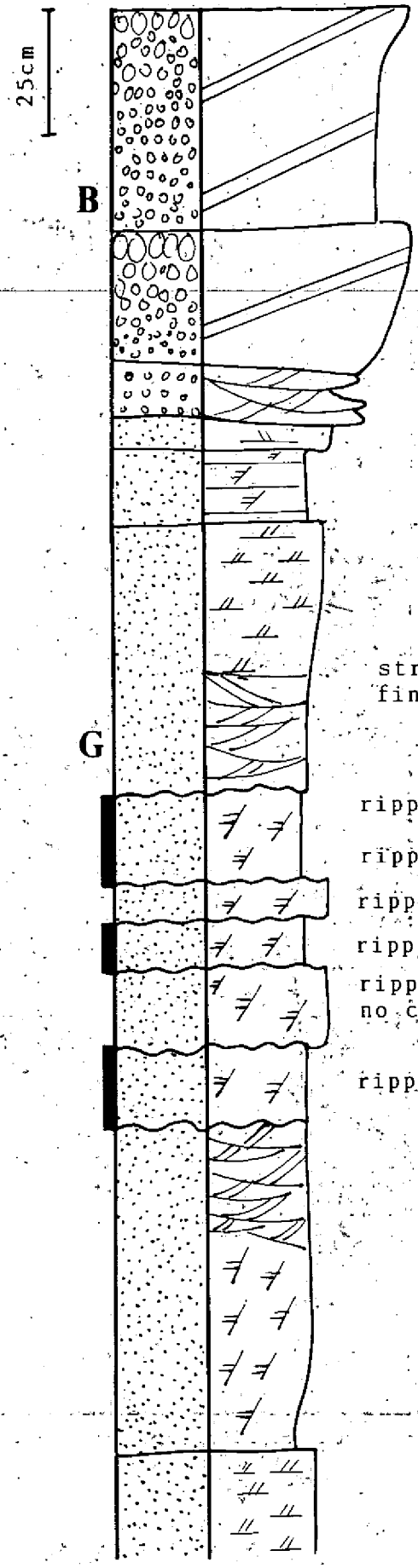

log TAT/66I
25cm
F
E
small scale
trough cross bedding
massive
small scale
trough cross bedding

Figure A34:

log TAT/66II



Number: TAT/67
Location: E of Clara Bog; on Clara - Tullamore road.
Topography: hilly; eskers
Slope: -
Vegetation/land use: gravel pit
General description: see 'Description of facies types' and figure A35.

Interpretation: Esker.

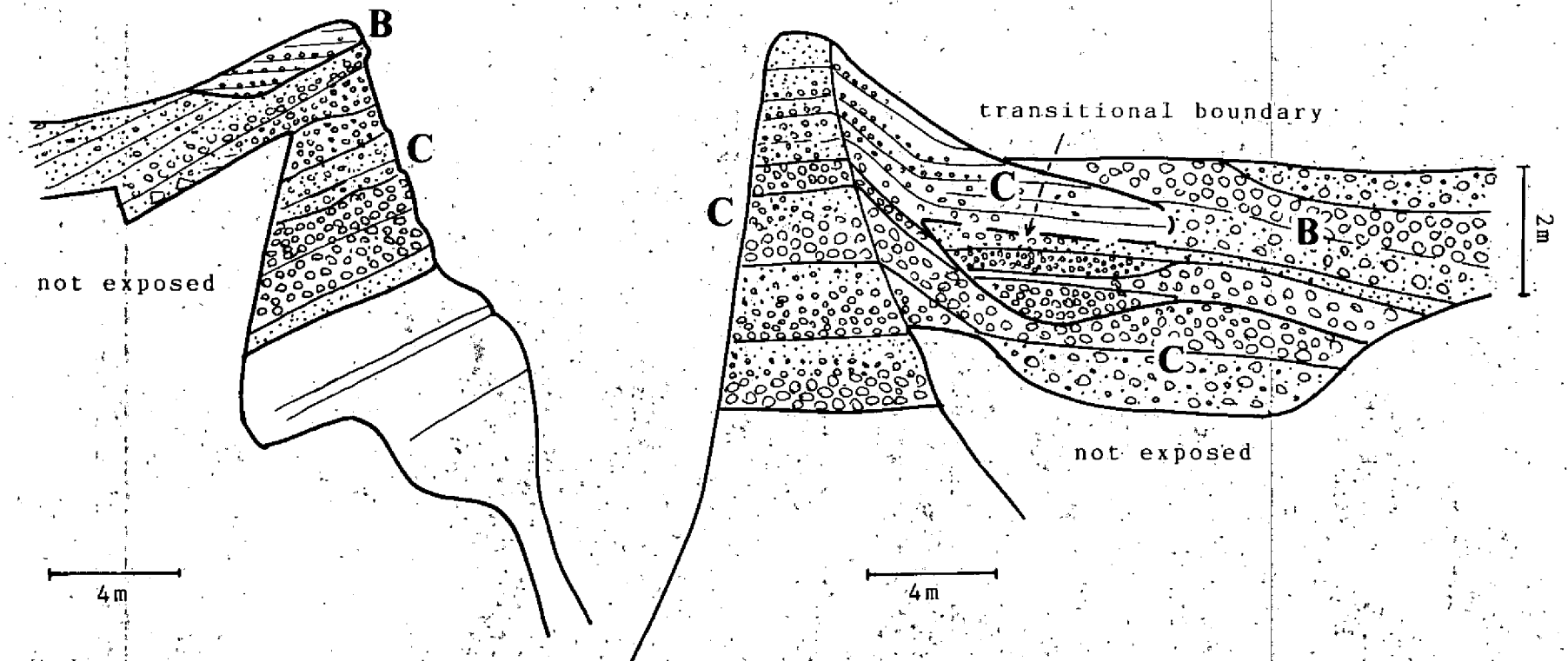

TAT/67
W
E
B
C
2m
not exposed
4m
NW
SE
transitional boundary
C
C
B
C
2m
not exposed
4m

Figure A35:

Description of facies types in the Clara Esker.
Observation points TAT/64, TAT/65, TAT/66 and TAT/67.

Letters A, B, C, D, E, F, G, H and I refer to letters on drawings of pits and logs.

A. Texture: Coarse gravel.
Sedimentology: Massive, no sedimentary structures. Maybe at some places even bedding. Max. pebble size: < 1 m. At Clara pit (TAT/64) moderately well sorted. At Maryborough pit (TAT/65) large range in pebble size. Probably clast supported. Thickness bed: ± 4 m.
See: TAT/64, TAT/65 and log TAT/64I.

B. Texture: Sand and Gravel.
Sedimentology: Large scale trough cross bedding with moderately deep scouring and even bedding. Length of individual sets up to 20 m, at the least 4 m.
See: TAT/64, TAT/65, TAT/66, TAT/67 and log TAT/66II.

C. Texture: Sand and Gravel.
Sedimentology: Large scale (height > 5 m) delta foresets. Very high pebble content (þ 50%).
See: TAT/67.

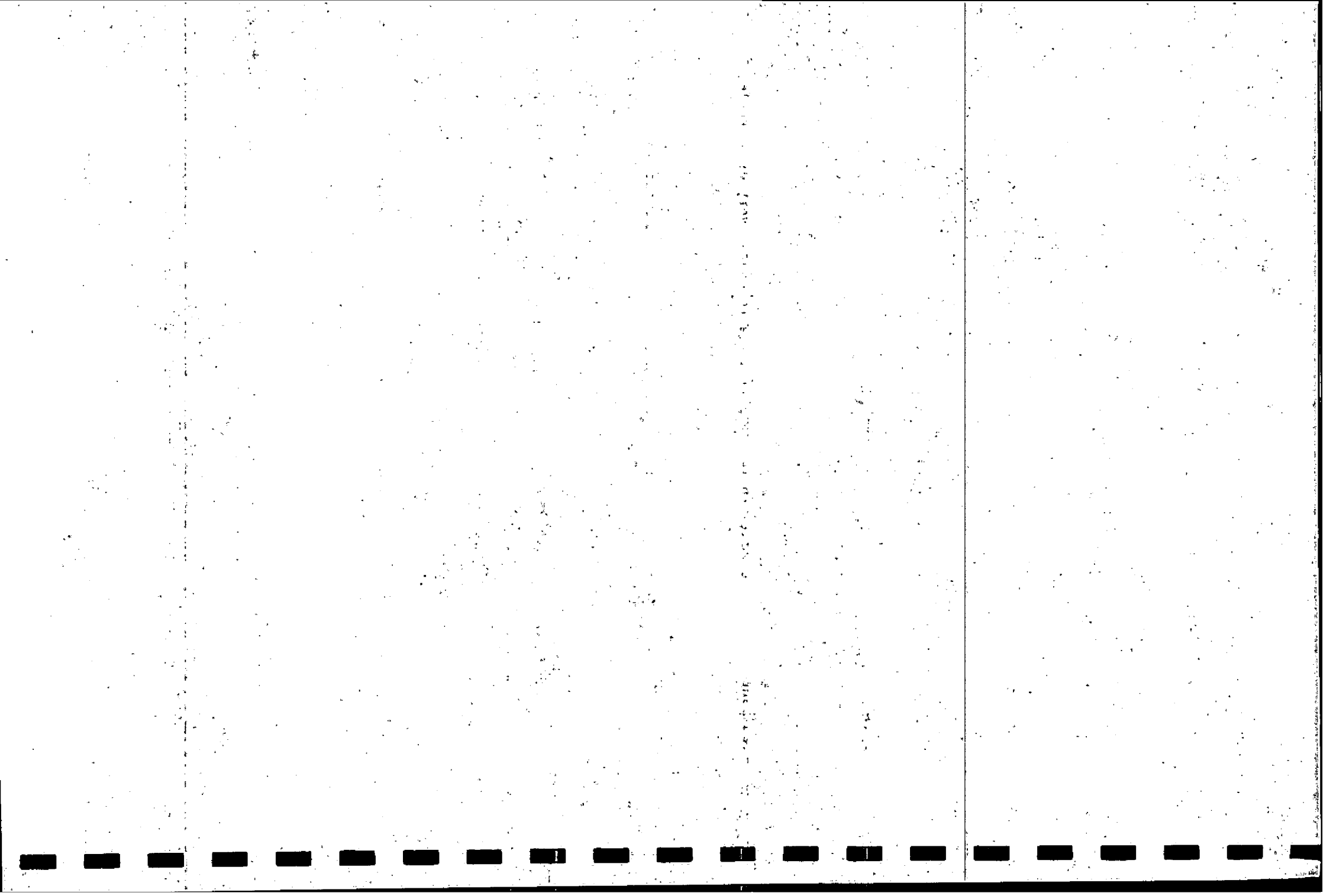
D. Texture: Sand.
Sedimentology: Large scale (height > 5 m) delta foresets and bottomsets (length > 5 m). Pebbles rare. Bottomsets seem to interfinger with small- medium scale, stratified sand (unit E).
See: TAT/64.

E. Texture: Sand.
Sedimentology: Medium scale (> 0.5 m; < 1 m) delta foresets and trough cross bedding. Small scale cross stratification with angular ripple trains.
Trough cross bedding with frequent reactivation surfaces very common.
See: TAT/64, TAT/66, log TAT/64I, log TAT/64II, log TAT/66I and log TAT/66II.

F. Texture: Sandy loam.
Sedimentology: Massive sand, but also even lamination and small scale cross lamination (normal ripples).
See: TAT/64, TAT/65, log TAT/64I and log TAT/66I.

G. Texture: Silt - Fine Sand.
Sedimentology: Climbing ripple sequences. Especially the exposed structures in the pit described in TAT/66 are of textbook quality!
See: TAT/64, TAT/66, log TAT/64II and log TAT/66II.

I Texture: Gravelly loamy sand.
Sedimentology: Gravelly loamy till on top of esker deposits.
See: TAT/65.



① Ring ~~Malcolm~~ 3 in field
~~(start Geophysics 9.SAP.)~~ 6 weeks

② Ring ~~Ethel — field assistant (3 weeks)~~

③ Ring Willie —
① ~~depth @ 19m (annyte)~~
② ~~When can Malcolm start geophysics?~~
③ ~~talk (Attock? whole area) Air photos~~

arrange for equipment Ring KB on Tuesday

④ Plan Geophysics Transects for Radar.
-RH = most practical.

⑤ Ask Jim or Jan about ~~Geophysics~~ (money?)
NB Radios

⑥ Ring K.B. on Tuesday morning.

(1) Sort out EH samples

(2) Plan geological augering — Kenneth EB / Frank & Reports
↳ alluvial bdys.

(3) ~~Arrange Aphrocalth~~.

mon — Auger
Esker - lacustrine bdy below peat.
1 Transect in Fleming's field (west)
2 " " Minnocks Gh (East) (Exposure Pit)
3

Profiles

Show DISTRIBN and consistency of lacustrine clay.

Forest Area (line a, b & c): Lacustrine clay contains a lot of F + Cse. sand, pebbles + stones. (Line b, c show sandy layer)

LINE 5:- Plastic clay is thicker near bog (where peat is thickest also surface level incs. dramatically).

LINE 6:- from N. to S. plastic + firm clay become thicker. (At F6 only stones are found beneath peat). (surface level unit is small)

LINE 11:- v. thin firm clay + a thick Plastic clay (G11 = thin sandy layer present). Surface level incs. from E. to W.

LINE J:- small till body in middle. Surface above till, v. little higher than above clay. (J3 = thin sandy layer + thick plastic layer)

(J5 & J11 — no firm clay present).

LINE I:- till body in middle (like profile J). Sth. of till body, profile = much more sand, thinner peat (than in Nth).

(I3, I4, I5, I13 the plastic clay is succeeded by Firm cl.)

surface is undul, surface level decs from N to S. Till body causes a high surface level.

LINE H:- Profile shows undul. till body, in the middle filled up with lacust. clay.

Unusual clay SEQ:- i.e. plastic, followed by very firm, then firm clay.

(H14 = No plastic clay; H13 = plastic clay is v. thick, contains a sandy layer.

Ch. 3 RESULTS

TOPOGRAPHY:

Study Area: Central flat terrain {Bdy by: Bog - NW; higher terrain to W. & E}.

Flat terrain = has the shape of a basin in the middle (Bottom of depression = 50.5m) (located along the road.)

Study Area opens to the south.

Western slope = long; great difference in heights. / Contours of slope = wavy ⇒ implies an undulating surface

EAST slope = short; small differences in height.

Absolute difference in Ht. = 9.0m (Study area lowest vs Highest).

Grid size is big ⇒ larger scale undulo. in NW & micro-relief is generalised.

Main drain cuts from NW to SE through central depression.

PEAT — clay/Till interface

Till — mainly in Western area

LACUSTRINE CLAY — dominate Eastern area.

(In the far East = isolated till Island).

SHAPE:- similar to surface i.e. Big flat terrain in the middle, bdy by bog in N & NW, & higher terrain to W & SE

also small opening to Sth. & W. slope is longer than E. slope, also.

Till contours in western part of the AREA are wavy ⇒ implying an undulating surface.

Regular sequence of contours from W. up to 52m ctr. line; A higher Till hillock is found near the bog rd.

E. slope is short but has a long fold at the Sth.

LAKE MARLS with molluscs are found in the N. near the bog & @ one gd. site (G11) in the centre.

Dividing line between the clay & till is wavy & does not follow (interface) surface ctrs.

(main drains cut thru' till & lacustrine clay, but Road lies on lacustrine clay only).

Comparison of maps

① Surface ctrs V's PEAT THICKNESS:- No relation

② Surface ctrs. V's Interface (Peat-clay/till):- similar surfaces — esp. the seq. of ^ clts. of the till in the W. part (indicating undul. both surfaces).

In general; till @ higher AREA (esp. West) & (lesser extent in EAST), while lacustrine clay is found in LWR. AREA in the middle.

LACUSTRINE CLAY deposited in standing WATER ⇒ expect clay/till bdy // to contours. Not true ⇒ differential accumulation of clay on an uneven sub-soil.

CLAY more susceptible to compaction than till ⇒ deform an originally horz. surface. (clay prob. higher + more contr. surface at deposition)

(1) Geological boundaries: —

(1) Delineate bdys (where exactly).

(2)(i) What type of bdy. (auger to see if it is ~~Gelt~~ resting on clay or till — where clay meets till)

(ii) How does Esker go under bog

(iii) Bdy of lake clays — extent of glacial lake.

(2) SECTIONS EXPOSED: —

(1) TILL — how do you interpret where you don't have exposure.

(i) Interpret till as fully as poss (desc.)

characterise TILLS — esp. ISLAND, & also Rahanmore.

(2) Esker

(3) Check Morphology — Air photos mainly.

Lake clays

(1) Depositional history: field evidence & Oscar's work. What did Oscar call till's? What happened @ margins?

3 Main Areas:

1. Finalise Geological bdys.
2. Characterise Tills.
3. Characterise Eskers.

Priorities

① Lake Clay bdy.

② Character of ESKER SEDS; tills; lake clays (components, thickness, etc.) } sections How best to bound & determine characteristics

Lacustrine seds — what are they?

Produce model & figure out what it means?

NB Find bdy of lake basin — How extn was lake? How extn are lake deposits?

Have a feel for type of sediment ⇒ implications?

Interpret SED → what does it tell us → what does one imply → complete circle.

Do fieldwork & then check in literature → what sequence would be produced ~~with~~ a particular one?

QUATERNARY GEOLOGY OF AREA (CLARA)

Geology = ① Pleistocene ② Recent = Quat. deposits.

① Overlying Pleistocene deposits = sandy-loamy & stony in texture, with a high con of big boulders

② Holocene deposits = predominantly LACUSTRINE/alluvial or ORGANIC origin

DURING GLACIATION

Area covered by ice sheet:

Underneath ICE SHEET (actively moving) → a basal till (sheet) accumulated.

BASAL TILL

① OVERCONSOLIDATED; ② Often have a high clay content

ESKERS

Ridges of ese. gravel + boulders — deposited in tunnels in the ICE Sheet (subglacial formed & same time)

ABLATION TILLS

Late stages of glaciation — ablation Tills were deposited by the meltwater of the ice body — ① V. variable in grain size & composition

② Gravit^{n} Processes — Tills deposited in forefield & over edge of the ice.

Study Area Tills

mainly consist of ese. materials & poorly sorted. (Huge boulders in a silty/sandy matrix are common)

ABLATION TILL — formed irregular hilly terrain — inter connected & isolated lakes & pools, interspersed by till islands

After Deglaciation

Eskers formed the only conts higher grounds (streams or rivers were not developed yet)

Meltwater stagnated in the natural depressions (behind the positive landforms & against the ice body) resulting in a landscape dominated by lakes & puddles.

Meltwater of ice sheet brought with it substantial quantities of finely sorted material (silts & clays) (which were products (i.esp. GRADING of high

These fine mats accum. in ponds, lakes, as

Remaining ese. (eg deposit on slopes is indicate) wash out deposit.

Fine deposits in the basins sometimes co mat. like stones, the latter have been brought floating ice.

Eventually Drainage System developed:-

Streams:- ① Drained some of the lakes ② Eroded the subsoil in the connecting channels

③ Deposited fluvial sediments & redeposited some of the finer material

Climate improved:- Veg returned & after awhile PEAT developed in the wettest areas!

2 Methods

(Distrib° of Lacustrine deposits + their interaction with other deposits):

CLARA BOG

Geomorphology:- Esker in N & NE, Island = undul topography in W-SW

① ESKER BELT = max. width N. of Central Clara & decs. rapidly to E & W. ["Broad Ridge with multiple crests"]

② ISLAND :- irreg. surface topography with hummocks; superposed (< 200m length) microtop. Cge. blders buried.

③ SSE :- altn. of flat areas with undul. med scale hummocks (200-300m long)

Geology

[S & W of Clara = 2 differ till types found.
Based on Textural comp — 2 differ types till are recognised.
[3rd type Till = assemblage of differ Till facies (limited spatial distrib^n & bdys not yet defined (time limited))].

Typical Till (for CLARA) :- sandy-loamy & stony in texture, with a high % of big boulders
- this unit probably underlies SW CLARA.
- high content l.gr. lst. boulders, may indicate Lst. Bedrock near surface.
∴ Till = expression of slight displacement of fractured bedrock.
OR big blders lodge in clusters due to larger drag force of obstacles (blders cf bedrock)

Gravelly till/gravel — located @ several places in study area (related to geomorph. features).
e.g. = ① Conical hills NNE Ballina Hill; ② Broad hummocks near Silver R.
cf ① & ②
Interp^n = Ice marginal deposits (KAMES).

Gravelly Tills in Flat terrain also ∴ gravel/till/gravel may underlie "Removed Bog" areas.

SSE CLARA

"undefined Till" found in Area of undul/rolling landscape with broad med. scale hummocks. [IF THESE Till deposits underlie the bog ∴ same type of Morphology/...
[more work needed on lith^al & sed^al chars — for genetic class^n].

Nth. CLARA

Fluvioglacial Deposits — Eskers & assoc. sands & gravels.