Site 1 Teindland, near Elgin

Teindland and the surrounding parts of lower Strathspey is an important area for the study of Late Pleistocene environmental change in north-east Scotland (Sutherland, 1984a) (Map 1). Teindland is one of the few known sites on the Scottish mainland where organic sediments deposited during the last interglacial are preserved (Sutherland, 1993a). The area has been affected by ice streams flowing down Strathspey, across the coastal plain of Moray and from the Moray Firth. This has produced complex sequences of glacial and fluvioglacial deposits that provide evidence of multiple ice advances in the Late Pleistocene.

Teindland Quarry [NJ 297 570] is located in Teindland Forest, 5 km south-west of Fochabers (Figure A1.2). Organic deposits were first described there by FitzPatrick (1965), but the site and its interpretation have proved controversial (Edwards et al., 1976; Romans, 1977; Sissons, 1981, 1982; Caseldine and Edwards, 1982; Lowe, 1984). A more recent interdisciplinary study has provided significant new information about the sediments at Teindland, reporting a further discovery of organic materials from the nearby site at Red Burn [NJ 294 568], and setting up a formal lithostratigraphy for this part of Strathspey (Hall et al., 1995a; Hall, 2000) (Table A1.2). However, as explained in Chapter 8, many of the units have been renamed recently by Sutherland (1999). Most of Sutherland's names have been adopted here (see also (Table 7)).

The oldest deposit recognised in the Teindland area is the Red Burn Till Formation (Figure A1.3)a, which rests on weathered Devonian conglomerate. It is a stiff, reddish brown (2.5 YR 4/4), massive, matrix-supported diamicton. Quartzite and psammite clasts are dominant, but the presence of Devonian sandstone and Mesozoic siltstone and sandstone suggests ice movement from the north-west. At the Red Burn site (Figure A1.3)b, the Red Burn Till is overlain by a unit of sand with sporadic clasts that appears to correlate with the Deanshillock Gravel Formation at the base of the known sequence at Teindland Quarry. At the latter site, the Deanshillock Gravel is at least 3.5 m thick, comprises coarse cobble gravel with clasts of quartzite and psammite, and passes upwards into very pale brown (10 YR 7/4) sand, the Orbliston Sand Bed that is up to 3 thick. The Deanshillock Gravel and Orbliston Sand Bed are of probable glaciofluvial origin and, together with the Red Burn Till, probably date from Oxygen Isotope Stage (OIS) 6 (Hall et al., 1995a).

The Teindland Palaeosol Bed is developed on the surface of the Orbliston Sand Bed and is podzolic in character (FitzPatrick, 1965). It comprises a thin redeposited humic 'H' horizon, a bleached 'Ea' horizon up to 15 cm thick, an intermittently developed iron pan and a lower 'strong brown' (7.5 YR 5/8) 'Bs' horizon, 5 to 15 cm thick (Plate 23). Overlying the humic horizon are thin layers of organic sand with charcoal fragments. At Teindland Quarry (Figure A1.4), the Badintinian Sand Bed, up to 1.5 m thick, overlies these organic sands. The lower 80 to 100 cm comprises thin parallel beds of brown polleniferous sand. This pollen was partly derived from reworking of soils around the site and partly from contemporaneous sparse grassland. The upper 50 to 70 cm of the sand is nonpolleniferous. The presence of small gravel clusters, silt balls, an isoclinal fold and shear zones suggest a glacial or glacitectonic influence on, or more likely following, deposition in a small pond. The buried soil is less well developed at Red Burn, where the parent material is a greenish grey (5 GY 6/1) sandy diamicton and where the overlying organic sediments are thin and disturbed by cryoturbation (Hall et al., 1995a).

Pollen analysis of the Teindland Palaeosol Bed and the overlying organic sands shows that the earliest vegetation recorded at the site was woodland of 'interglacial' character (Edwards et al., 1976) with grassland openings. Pine and alder are represented at Teindland, and alder and hazel at Red Burn (Hall et al., 1995a). Podzolisation of the palaeosol ended with an influx of sands derived from erosion of the surrounding slopes, perhaps in response to burning during a grassland phase. The combined evidence of environmental deterioration from pollen and sediments suggests events characteristic of the end of an interglacial episode. Luminescence dates of 79 ± 6 and 67 ± 5 ka BP for the sands overlying the soil suggest that the soil developed towards the close of OIS 5e (Duller et al., 1995). Radiocarbon ages for the humic horizon of 28 140 + 480/-450 BP (NPL-78) (FitzPatrick, 1965) and of 40 710 ± 2000 BP (UB-2121) and 38 400 ± 1000 BP (UB-2209)* (Caseldine and Edwards, 1982) are regarded as too young as a result of contamination (Sissons, 1981; Lowe, 1984; Sutherland, 1993a).

At Teindland Quarry, the organic sediments are overlain by up to 2.2 m of bedded sandy diamicton, the Woodside Diamicton Formation, with crude parallel bedding and localised wash horizons. Sedimentary characteristics are reported to be consistent with deposition as debris flows and pond sediments within a subglacial cavity. As deposition of the Woodside Diamicton seems to have followed soon after the final phase of sand deposition, an OIS 4 age seems likely.

At Teindland Quarry, only gravels and sands overlie the Woodside Diamicton. However, at nearby sites, three younger tills are recognised, the Altonside, Tofthead and Waterworks tills. The dark grey Altonside Till Formation is recorded from temporary pits beneath the floor of the valley of the Red Burn (Figure A1.3)a, from excavations for a waterworks at Altonside [NJ 281 573], and from the base of the river cliff on the banks of the Spey at Tofthead [NJ 343 576]. Clast types include pebbles of Mesozoic mudstone and sandstone and suggest that ice flowed from the Moray Firth. The widespread presence of a dark grey till, locally with shell fragments and in places beneath a sandy brown till, is confirmed by boreholes in the lower Spey valley (Aitken et al., 1979). At Tofthead, a brown, gravel-rich till, up to 3 m thick, rests on various disturbed gravels and diamictons and on the Altonside Till (Connell, 2000). This Tofthead Till Formation appears to be derived from the west or north-west and represents the last major movement of ice across this part of Strathspey (Peacock et al., 1968). At the Waterworks site, a greenish grey sandy till with a strong west-north-west to east-north-east fabric (and probably equivalent to the Tofthead Till) overlies the Altonside Till and is succeeded by more than 4 m of iron-stained gravels. These gravels are partly reworked into a red brown till, the Waterworks Till Formation, which appears to represent a minor readvance of ice from the west or north-west (Hall et al., 1995a). These till units are undated, but it is likely that both the Tofthead and Waterworks tills date from the Main Late Devensian glaciation.

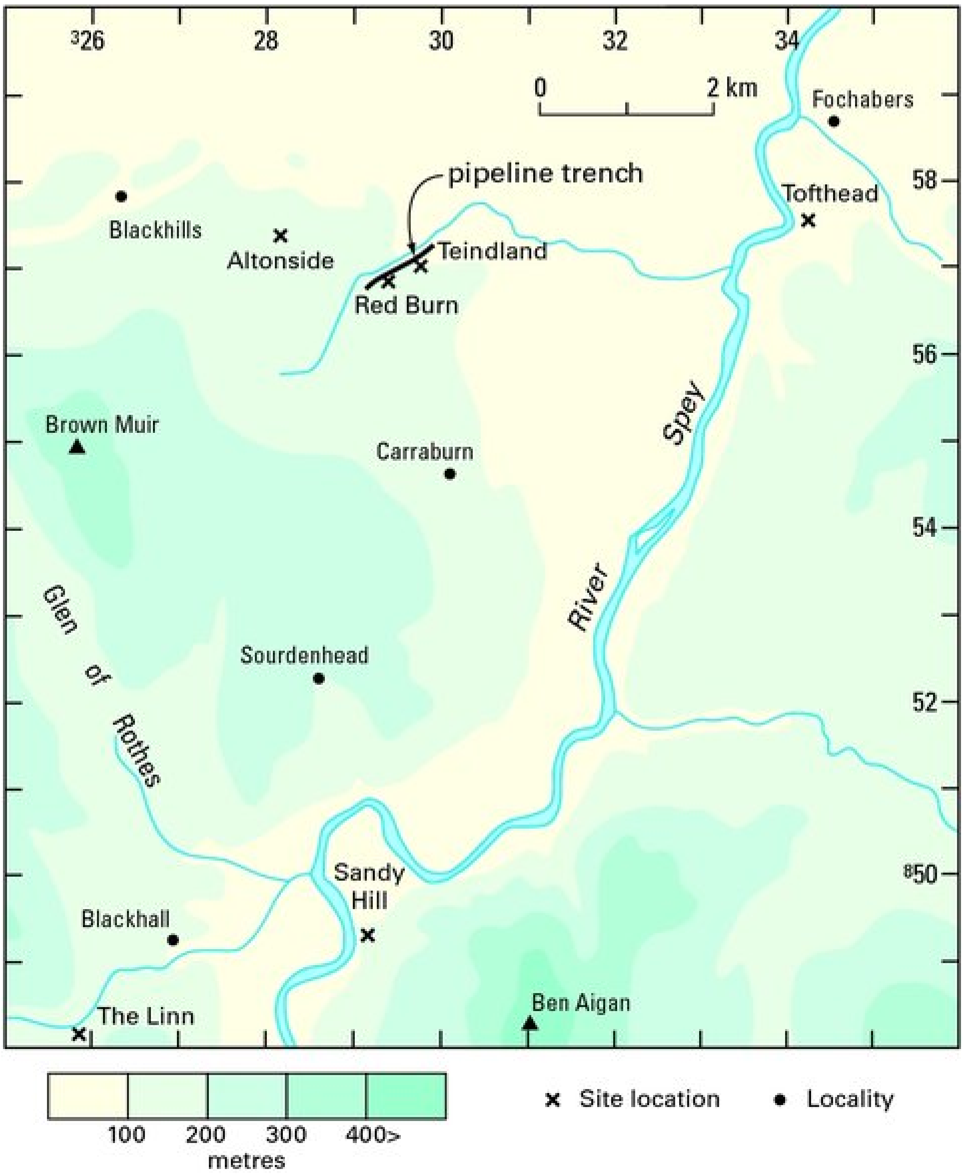
The existence of at least four separate till units in lower Strathspey postdating OIS 5 suggest multiple glaciation of this area by at least two ice streams, one crossing the Moray Firth and the other crossing the Moray lowlands (Table 7). The widespread occurrence of gravels and sands intercalated between till units raises hopes that in future it will be possible to constrain more closely the ages of these and other till units.

(Table A1.2) Lithostratigraphy of the Teindland area.

Unit	Name proposed in this publication	Original name in Hall et al. (1995a)	Depositional environment	OIS
9	Waterworks Till Formation*	Waterworks Till	Glacial	2
8	Tofthead Till Formation*	Tofthead Till	Glacial	2
7	Altonside Till Formation**	Altonside Till	Glacial	?2
6	Woodside Diamicton Formation*	Teindland Till	Glacial	4
5	Badentinian Sand Bed*	Teindland Upper Sand	Lacustrine ?	4/5a
4	Teindland Palaeosol Bed*	Teindland Buried Soil	Soil formed late in interglacial period	5e
3	Orbliston Sand Bed*	Teindland Lower Sand	Glaciofluvial	6
2	Deanshillock Gravel Formation*	Teindland Gravel	Glaciofluvial	6
1	Red Burn Till Formation**	Red Burn Till	Glacial	6

- *Central Grampian Drift Group
- **Banffshire Coast Group

References



(Figure A1.2) Location of sites in the vicinity of Teindland (after Hall et al., 1995a).

Unit	Name proposed in this publication	Original name in Hall et al. (1995a)	Depositional environment	OIS
9	Waterworks Till Formation*	Waterworks Till	Glacial	2
8	Tofthead Till Formation*	Tofthead Till	Glacial	2
7	Altonside Till Formation†	Altonside Till	Glacial	?2
6	Woodside Diamicton Formation*	Teindland Till	Glacial	4
5	Badentinian Sand Bed*	Teindland Upper Sand	Lacustrine ?	4/5a
4	Teindland Palaeosol Bed*	Teindland Buried Soil	Soil formed late in inter-glacial period	5e
3	Orbliston Sand Bed*	Teindland Lower Sand	Glaciofluvial	6
2	Deanshillock Gravel Formation*	Teindland Gravel	Glaciofluvial	6
1	Red Burn Till Formation†	Red Burn Till	Glacial	6

* Central Grampian Drift Group
† Banffshire Coast Drift Group

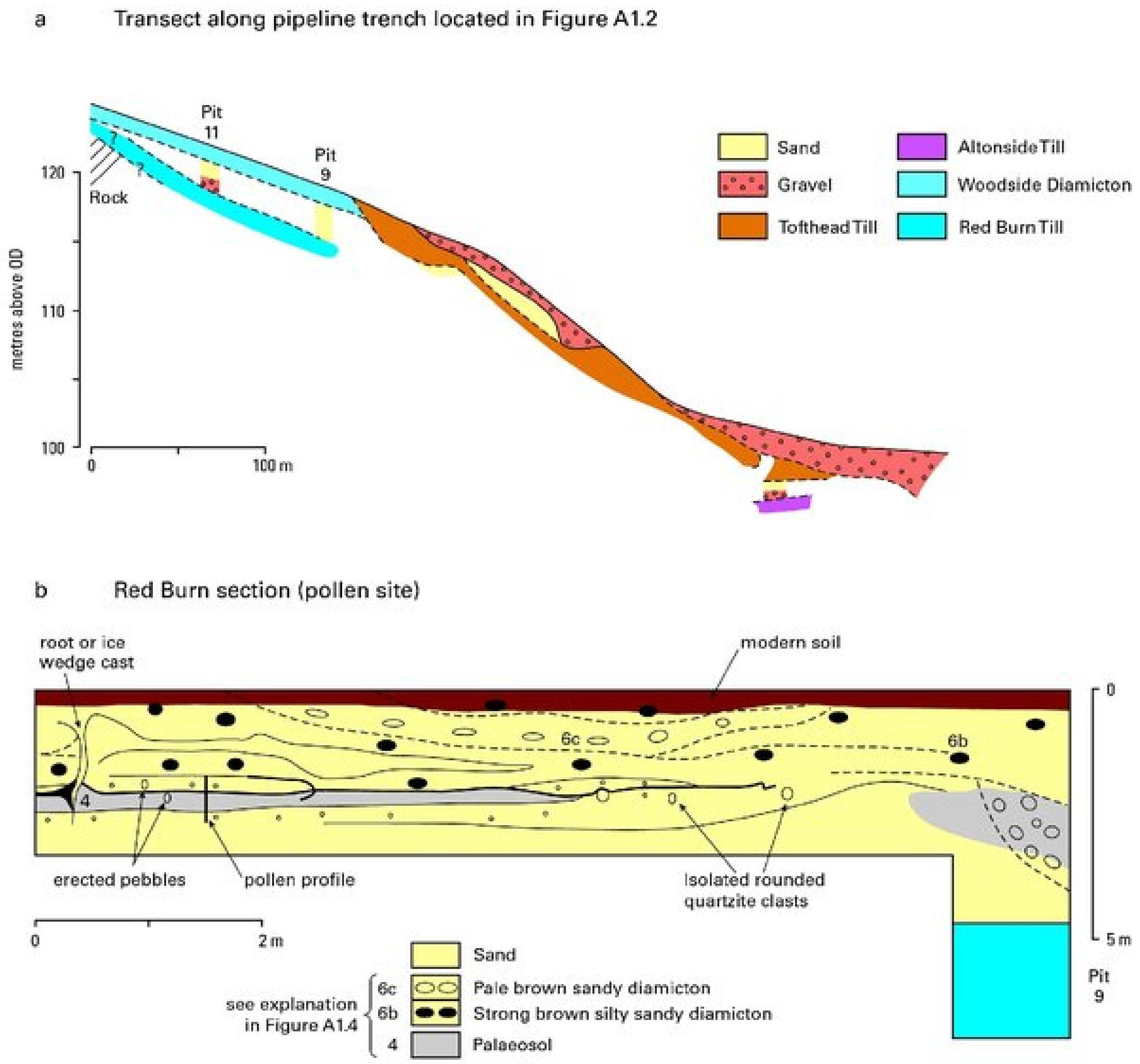
(Table A1.2) Lithostratigraphy of the Teindland area.

Oxygen Isotope Stage	Teindland/Elgin	Boyne Limestone Quarry/Keith	Gardenstown/ Banff	Byth/ Crossbrae	Kirkhill/Leys	Peterhead/ Cruden	Ellon/Fyvie	Aberdeen	Banchory	Stonehaven
Flandrian (Holocene) 1										
Loch Lomond Stadial 2a		Garral Hill Gelifluctate Bed		Todholes Gravel Bed			Woodhead Gelifluctate Bed			
Windermere Interstadial 2b		Garral Hill Peat Bed		Thinholds Peat Bed			Woodhead	Mill of Dyce Peat Bed	Loch of Park Gyttja Bed	Glenbervie Peat Bed
Dimlington Stadial 2c	Spynie Clay Formation Waterworks Till Formation Tofthead Till Formation	Kirk Burn Silt Formation Airnhoch Till Member Blackhills Sand & Gravel Formation Old Hythe Till Formation	Kirk Burn Silt Formation Airnhoch Till Member Blackhills Sand & Gravel Formation Crovie Till Formation	Crossbrae Gelifluctate Bed Auchmedden Gravel Formation Byth Till Formation	Manse Gelifluctate Bed Kirkhill Church Sand Formation East Leys Till Formation Hythe Till Formation	St Fergus Silt Formation Ugie Clay Formation Essie Till Formation Hatton Till Formation Sandford Bay Till Member	Ugie Clay Formation Kippet Hills Sand & Gravel Hatton Formation Bearnie Till Member Auchnochries Sand & Gravel Formation	Tullos Clay Member Drumlithie Sand & Gravel Formation Glen Dye Silts Formation Mill of Forest Till Formation Nigg/Kingswells Till members Ness Sand & Gravel Member Den Burn Till Member	Lochton Sand & Gravel Formation Glen Dye Silts Formation Banchory Till Formation	Drumlithie Sand & Gravel Formation Ury Silts Formation Mill of Forest Till Formation
early Late Devensian glaciation	Allanside Till Formation	Whitehills Glacigenic Formation	Whitehills Glacigenic Formation		Corse Diamicton Formation	Rafts at Oldmill	Pitlurg Till Formation	Anderson Drive Diamicton Formation		
3				Howe of Byth Gravel Formation	Corsend Gelifluctate Bed					
4	Woodside Diamicton Formation		Pishlins Burn Gravel Bed			Aldie Till Formation Hardslacks Gelifluctate Bed				
5a-d	Badentinan Sand Bed			Crossbrae Farm Peat Bed		Berryley Peat Bed				Burn of Benholm Peat Bed
Ipswichian Interstadial 5e	Teindland Palaeosol Bed Orbliston Sand Bed	Truncated palaeosol			Fernieslack Palaeosol Bed	Moorseat Farm Sand Bed				
6?	Deanshillock Gravel Formation Red Burn Till Formation	Crag of Boyne Till Formation		Crossbrae Till Formation	Rottenhill Till Formation West Leys Sand & Gravel Formation Camphill Gelifluctate Bed Swinedon Sand Bed	Camp Fauld Till Formation	Pitlurg Till in part? Tillybrex Sand & Gravel Formation Bellscamphie Till Formation			Benholm Clay Formation Birnie Gravel Formation
7?					Kirkhill Palaeosol Bed					
8?					Pitscow Sand & Gravel Formation Kirkton Gelifluctate Bed Dorsend Gravel Formation Leys Till Formation					
References	Hall et al. (1995)	Sheet 86W Godwin and Willis (1959) Peacock and Merritt (2000a)	Sheet 96E Peacock and Merritt (1997)	Hall et al. (1995) Whittington et al. (1998)	Connell and Hall (1987)	Sheet 87E Connell and Hall (1987) Whittington et al. (1993)	Sheet 87W Connell and Hall (1987) Hall and Jarvis (1993)	Bremner (1931, 1943) McLean (1977) Munro (1986) Murdoch (1977)	Sheet 66E Vasari (1977)	Sheet 67 Auton et al. (2000)

NOTE: In general, minimal ages are shown. For example, Crossbrae Gelifluctate Bed may be OIS 2c to 4, Anderson Drive Diamicton may be OIS 6, Kirkhill Palaeosol Bed may be OIS 9 or 11.
All Peat and Palaeosol beds are assigned to the group of the underlying or enclosing deposit.
Italicised units are informal: they have not been entered into the BGS Lexicon.

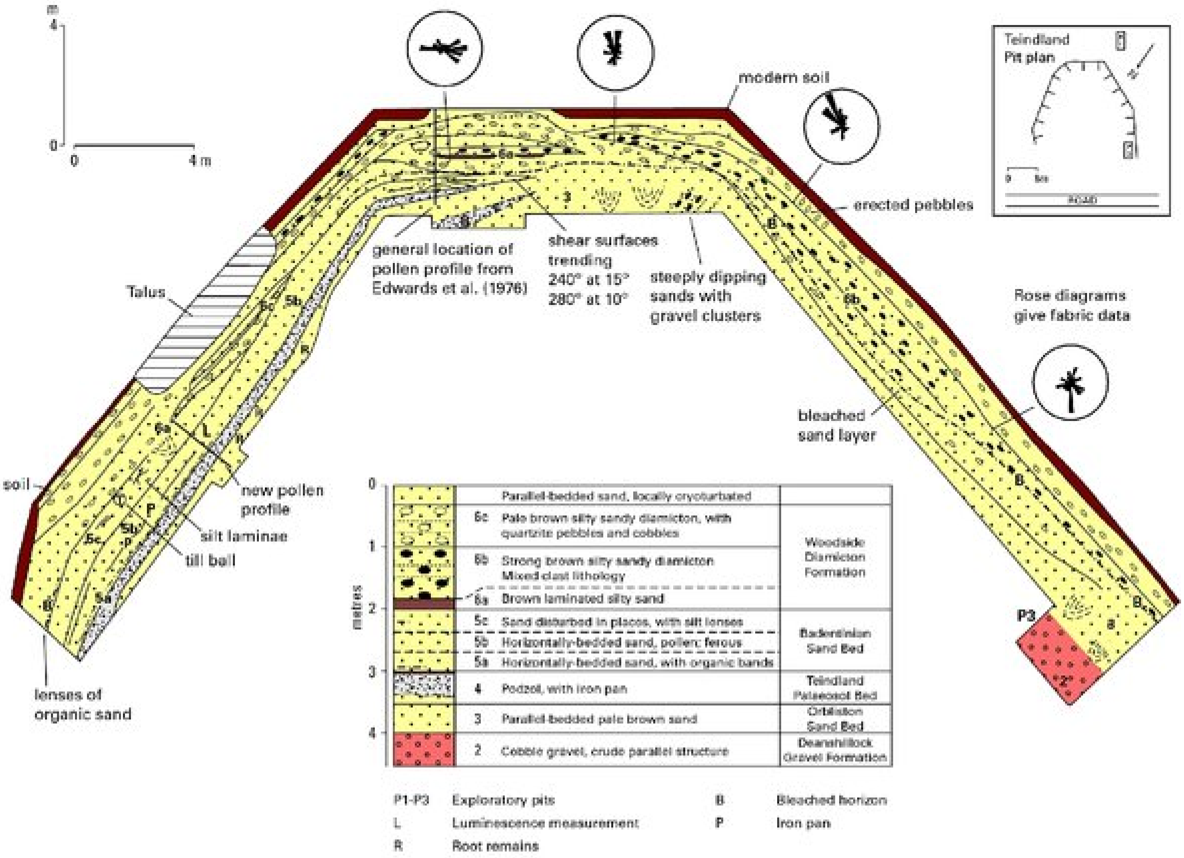
Central Grampian Drift Group · East Grampian Drift Group · Banffshire Coast Drift Group · Logie-Buchan Drift Group · Mearns Drift Group · Dated unit

(Table 7) Correlation of lithostratigraphical units in north-east Scotland.



(Figure A1.3) Lithostratigraphy at Red Burn (after Hall et al., 1995a).

(Plate 23) Partially glacitectonised, podzolic Teindland Palaeosol Bed below sandy diamicton of the Woodside Diamicton Formation at Teindland quarry [NJ 297 570]. Luminescence dates of 79 ± 6 ka and 67 ± 5 ka have recently been obtained from the sands overlying the palaeosol bed to the left of the scale card. (P104118). Scale bar showing 1 cm intervals.



(Figure A1.4) The original Teindland pollen site (after Hall et al., 1995a).