3.4.10 Quaternary deposits, landscapes and soils

During the Main Late Devensian glaciation a vast stream of ice flowed in a general eastward direction through the Midland Valley and out to sea via the Forth estuary. It is believed that this ice extended as far as 60 km beyond the mouth of the Firth of Forth into the North Sea. Initially, the primary source for this stream was ice accumulation centred in the north, from which ice flowed over the Ochil Hills and into the southern Midland Valley. As the Devensian glaciation progressed, however, the Southern Uplands also became a dominant source area, and ice was pushed in a north-easterly direction into the Forth estuary. The processes that occurred during this glacial episode, and since then, have had a significant influence on shaping the character of West Lothian's landscape.

Quaternary superficial deposits cover approximately 43,098 hectares, or 91.7% of the surface area of West Lothian (Figure 4).

Using the NEXTMap Britain shaded-relief Digital Surface Model (Figure 10) and the BGS DiGMapGB-50 superficial deposits theme, West Lothian's landscape can be divided up into a series of broad domains (Figure 149):

3.4.10.1 Crag and tail topography

The crag-and-tail topography is pronounced in the vicinity of the Bathgate Hills, where outcrops of resistant igneous rocks have withstood the erosive power of successive Quaternary ice sheets. These outcrops, formed of Carboniferous basaltic lavas (Bathgate hills) and intrusive laccoliths and sills (Binny Craig, for example), have left a protected 'tail' of softer rock and sediment on their lee (down ice) side (Figure 142), (Figure 143), (Figure 150). The resulting topography is a prime indicator of the eastwards direction of ice flow in the West Lothian area during Quaternary glacial episodes.

As ice overrode this more elevated part of the landscape, pressurised subglacial meltwater was forced up and over the outcrops of igneous rocks. This is well illustrated at Torphichen Hill where meltwater has exploited weaknesses along faults in the quartz-dolerite sill, incising deep channels over the high ground (Figure 151).

3.4.10.2 Till covered lowland

Till is the material that is laid down beneath a glacier. It is present over much of the surface of West Lothian's lower lying terrain and in places exceeds 50 m in thickness. Tills tend to be an unstratified, heterogeneous mixture composed of a clay, silt or sand matrix supporting a variety of larger clasts ranging from pebbles to boulders. The stones contained in this mixture can give an indication of the source of the ice, and the route it took, before depositing material. In addition to local Carboniferous rocks (e.g. limestones, sandstones, siltstones, mudstones and basalts), tills in West Lothian contain porphyrites from the Ochil Hills and schists from the Grampian Mountains beyond. These exotic clasts indicate a general northern source for much of the ice that last overrode West Lothian. Clasts of red felsite derived from Tinto Hill in Lanarkshire, however, have been found near Calder House in Mid Calder, revealing the increasing influence of ice from a southern source during later stages of the Devensian glaciation.

Much of the till covered lowland in West Lothian is gently undulating. A number of dry gullies and over-deepened stream beds exist as a result of meltwater from retreating ice cutting through the till. In western West Lothian, near Blackridge, some subglacial streamlining of till is evident in the form of gentle southwest — northeast aligned ridges. These 'drumlin' features lie on the outskirts of a more pronounced drumlin zone, which lies farther to the west (Figure 152). Such elongated landforms are the result of powerful, rapidly flowing ice moving over soft deformable materials.

3.4.10.3 Glaciofluvial sand and gravel belts

During deglaciation, higher ground in the district became ice-free first, leaving lobes of retreating ice in the lower lying areas. Fast flowing meltwater from this decaying ice was centred along major east — west trending belts, depositing sands and gravels while washing out finer silts and clays. The meltwater systems of this time are clearly seen to have

been deflected around the Bathgate Hills. In places, moundy terrain is observed indicating the deposition of sediments into local pockets amongst the stagnating ice. Elsewhere, hollows have developed where detached blocks of ice were surrounded and buried by sands and gravels deposited by the meltwater. Subsequent melting of these ice blocks has left depressions in the land, referred to as 'kettle holes'. Linlithgow Loch (Figure 155), lying in a hollow bounded by high ground to the north and south, provides a large example of a kettle hole. While this hollow was choked by stagnating ice and glacial deposits, it is likely that meltwater was diverted northwest along the course of the present River Avon.

3.4.10.4 Upland, streamlined

The upland, streamlined domain includes areas of higher ground that lie on the fringes of hills and plateaus to the south. When viewed from above, a degree of streamlining is evident, indicating that the overriding ice was still thick enough and moving fast enough to modify the underlying terrain. Ice moulding of bedrock is evident in areas such as Leven Seat where the underlying sedimentary rocks are shaped in alignment with ice direction (Figure 153). The streamlined upland landscape is also evident on areas underlain with harder bedrock, such as Corston and Auchinoon Hills (Figure 117).

3.4.10.5 Upland, limited modification

Lying at the margins of the Pentland Hills, these upland areas have experienced significantly less glacial modification than the lower lying landscape which lay within the main ice flow path. Rising up to 550 metres, the ground here will have supported a thinner, slower moving cover of ice, with a reduced capability to erode and modify the landscape. Although till is present in the Pentlands, it is thin and patchy compared to lower lying ground. Accumulations of coarse, angular clasts, derived from frost shattering and solifluction also occur here as a legacy of the cold conditions that persisted for a period following ice retreat from the Pentlands.

3.4.10.6 Raised beach

Raised beaches comprise material, originally deposited in a coastal environment, which has since been elevated due to falling sea-level or uplifting land. In West Lothian raised beach deposits (Figure 154) occur as a result of glacio-isostatic uplift following the removal of ice overburden at the end of the Devensian glaciation. The deposits are primarily composed of sands, but also contain gravels and muds. They are found as areas of flat land or terraces bordering the Forth estuary.

3.4.10.7 Modern beach

The modern beach can be defined as the area lying between the present low- and high-water marks, alternately covered by water and exposed to air during tidal cycles. In West Lothian the modern beach area comprises outcrops of bedrock and deposits ranging from cobbles through to silt. The most dominant deposit, however, is fine sand transported by river systems entering the Forth estuary (Figure 55).

3.4.10.8 Alluvium

Alluvium is material deposited by a river. In West Lothian it is usually occurs as relatively flat ground lying adjacent to river systems that have been operating during the Holocene. Sediments can comprise clays, silts, sands and gravels depending on the velocity of water at the time of deposition. In upland areas, where river velocity is higher, larger pebbles and cobbles may be present, however, lowland alluvial deposits tend to contain finer sediments. In West Lothian most alluvial deposits have a high sand and clay content.

3.4.10.9 Influence of Quaternary landscape on soils and vegetation in West Lothian

Because in Scotland, soils formed at the end of the last glaciation, and because soil formation is a slow and continuous process, soil properties and characteristics are influenced by the underlying material (often till or bedrock geology) and

the landforms left following ice retreat.

Much of West Lothian falls within the till covered lowland domain.

The high clay content and highly consolidated nature of this deposit limit water infiltration and this will lead to formation of soil which has low permeability and is often waterlogged. Brown forest soils with gleying and peaty gleys predominate here, supporting grassland and rush pastures over undulating low ground. Where terrain is slightly higher and steeper, areas of moist Atlantic heather moor and blanket bog occur. Most of the soils developed on the till-covered lowland are capable of producing a moderate range of crops but are restricted by drainage limitations.

The crag and tail domain supports similar soils to the till covered lowland, with brown forest soils with gleying and peaty gleys commonly occurring. This is to be expected as crag and tail lee sides tend to support a till cover. The main difference between the domains is the soil parent material, with stones of basaltic rock having a greater presence in this domain.

The coarse nature of glaciofluvial sands and gravels have allowed the development of more freely draining brown forest soils and brown forest soils with gleying. Under natural conditions, such areas would have formerly supported broad leaved woodland. Soils in this domain now form prime agricultural land with few limitations to sustained agricultural use. Even under high rainfall, the soil can be readily cultivated.

Like glaciofluvial deposits, the sandy raised beach deposits lend themselves well to the development of freely draining soils. Brown forest soils and brown forest soils with gleying also occur here providing good agricultural land.

Soils in the upland areas develop on thin covers of till, or thin sandy stony slope deposits. With higher precipitation and lower temperatures, soils tend to be peaty podzols and humus-iron podzols with some gleys and peat. Hilltops and gentle slopes can carry blanket peat while gleys occupy slope bases. The uplands support a semi-natural habitat with Atlantic heather moor communities and flying bent grassland.

Alluvial soils in West Lothian tend to have high clay contents and are therefore relatively poorly drained. Soils are young and tend to be mineral alluvial soils or peaty alluvial soils where water logging occurs.

3.4.10.10 West Lothian Geodiversity Sites

1 Baad Park Burn

18 Abercorn Point

46 Tophichen Hill

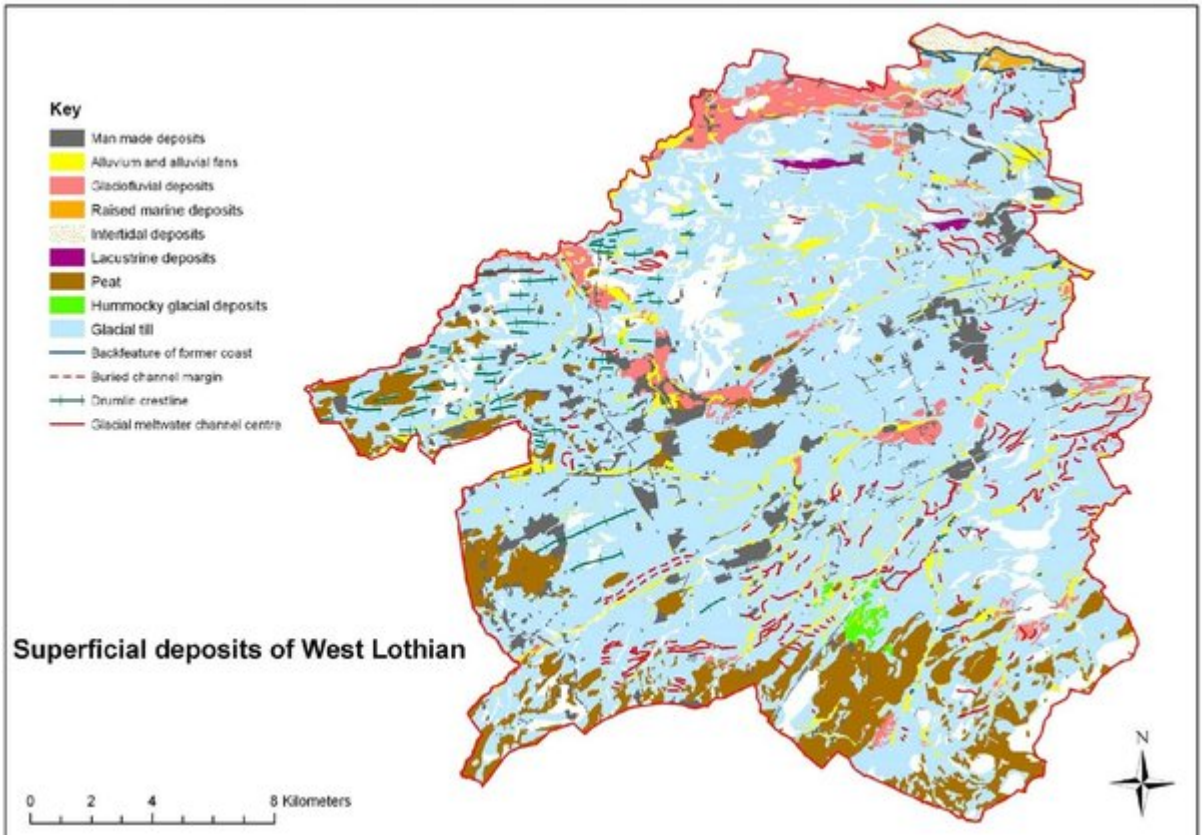
47 Linlithgow Loch

48 Tailend Moss

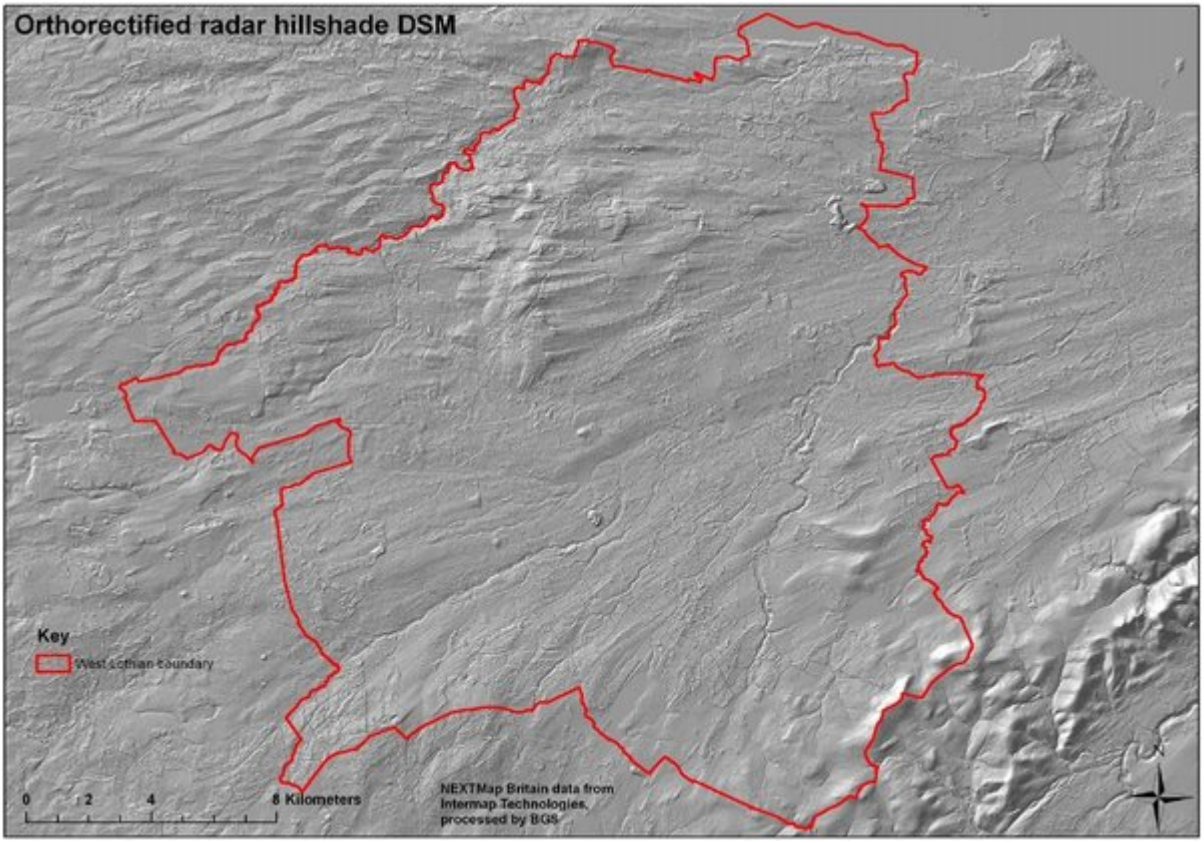
49 Longridge Moss

50 Easter Inch Moss

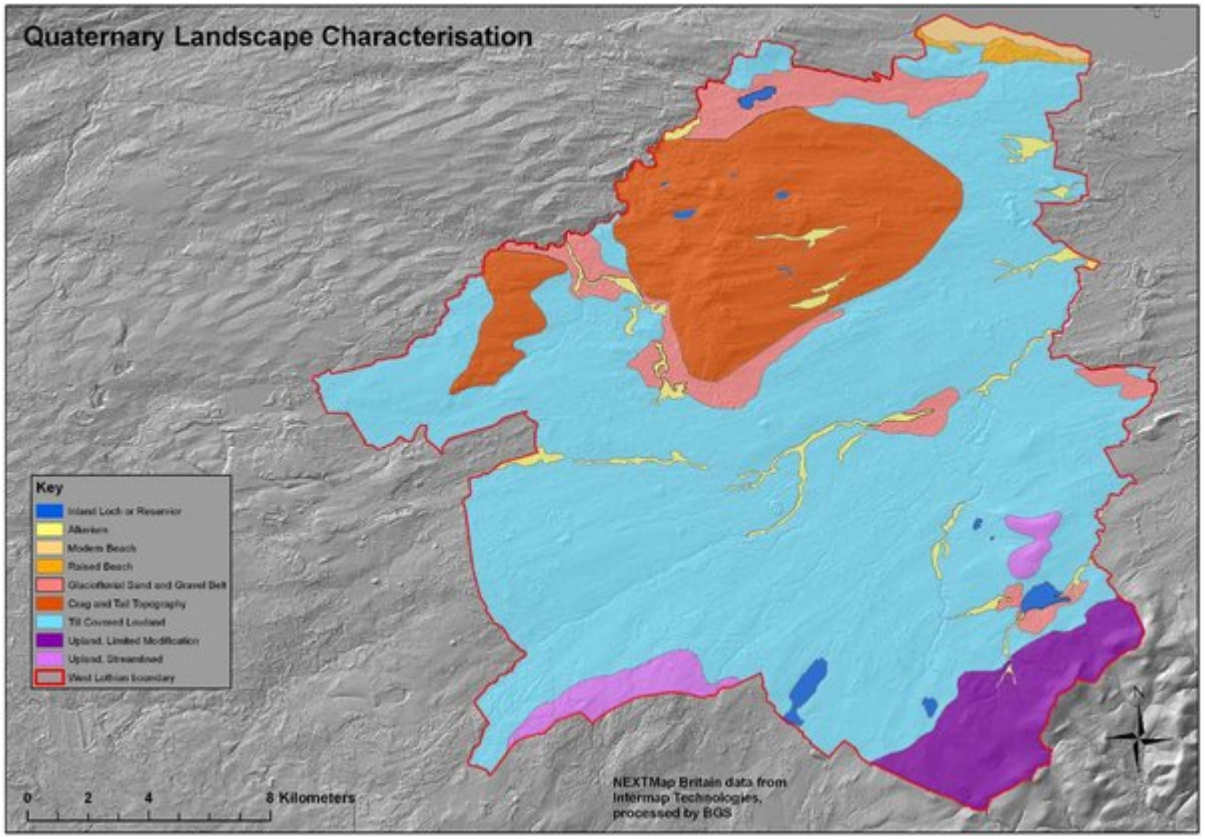
51 Calder Wood



(Figure 4) Superficial deposits of West Lothian.



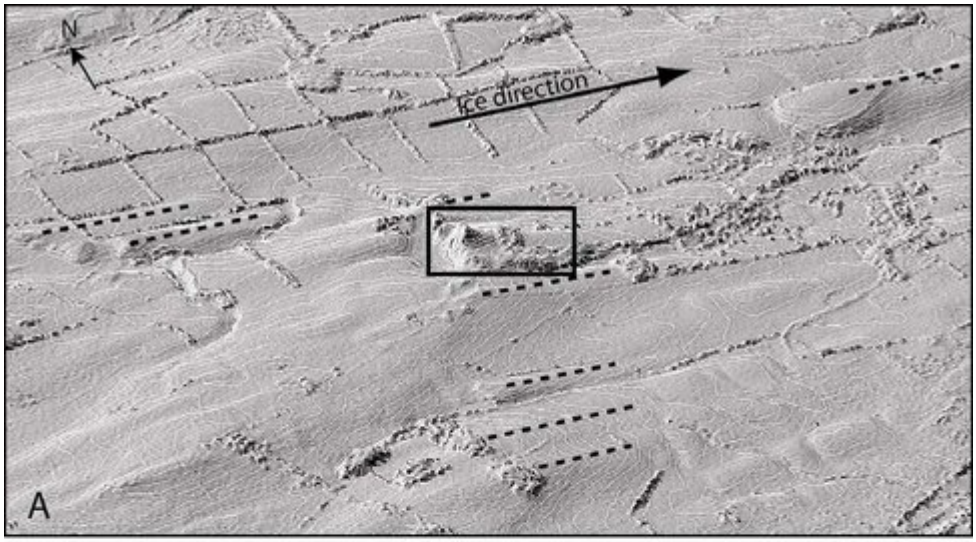
(Figure 10) NEXTMap Orthorectified radar Digital Surface Model of West Lothian.



(Figure 149) Quaternary landscape characterisation of West Lothian.

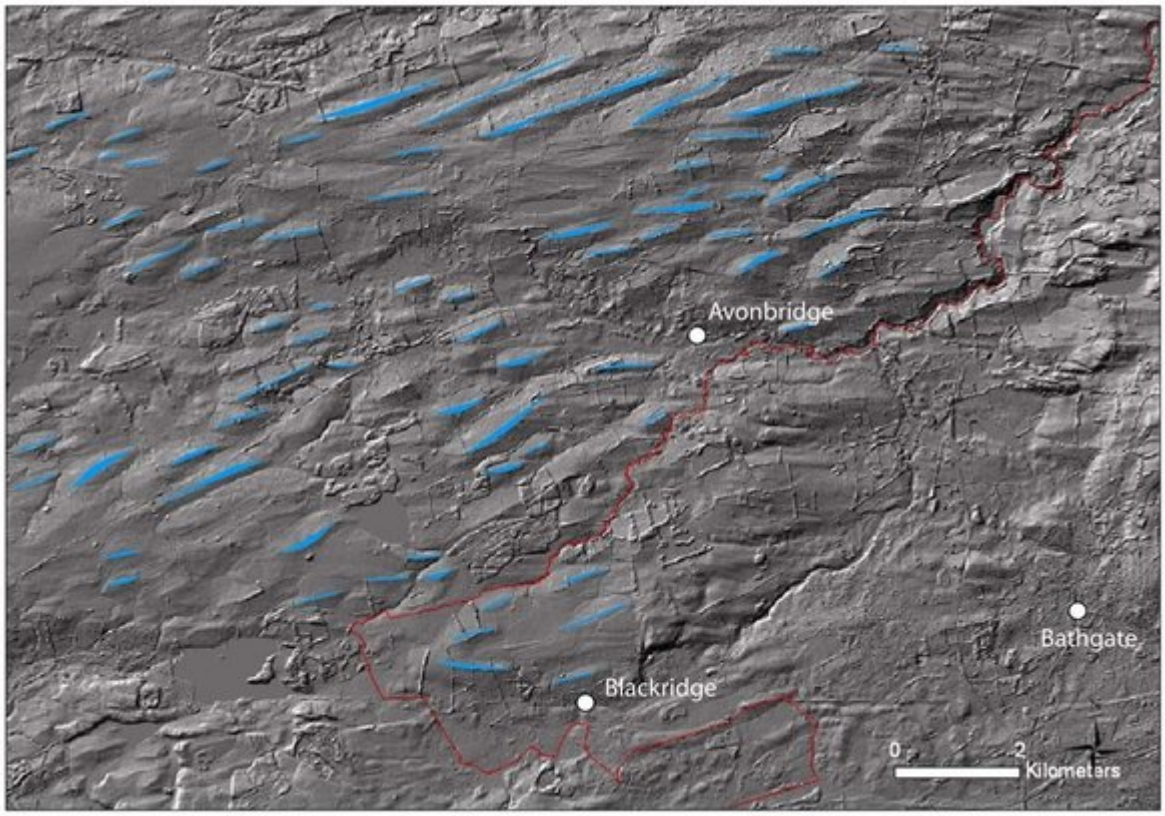
(Figure 142) Panoramic view Binny Craig from the south — a classic 'Crag and Tail' landform sculpted from a basalt sill intruding the West Lothian Oil Shale Formation. 'Crag' on left and 'Tail' on right [NT 0432 7346] (WLGS 42).

(Figure 143) Binny Craig Sill displaying columnar jointing in basalt. Binny Craig [NT 0432 7346] (WLGS 42).



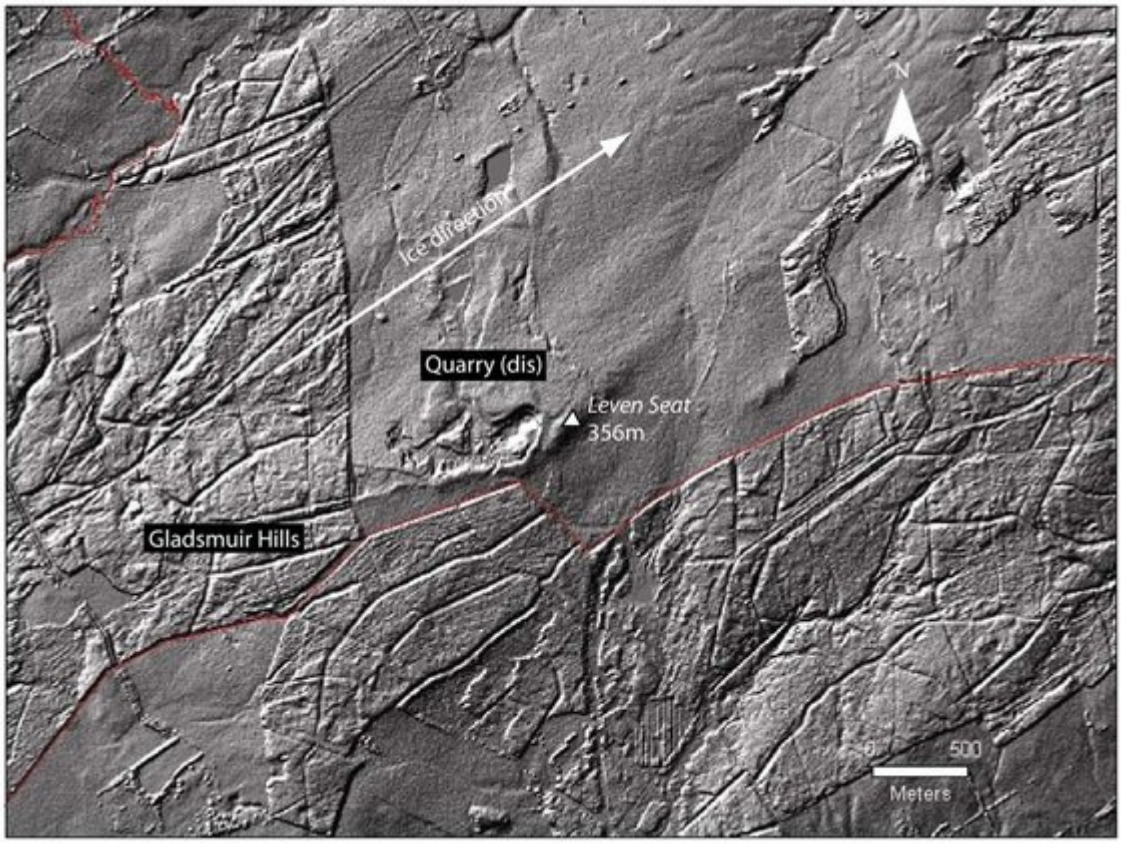
(Figure 150) A: Oblique hill-shaded digital surface model showing Binny Craig (outlined) and surrounding crag and tails (dashed lines). Contours at 25 metre intervals. B: Binny Craig clearly showing the outcrop of resistant basalt and 'tail' of protected softer rock (WLGS 42).

(Figure 151) Deep channels cut by glacial meltwater along faults in Torphichen Hill [NS 975 725] (WLGS 46).



(Figure 152) Drumlinized zone to the west of West Lothian. A transition from the drumlin zone to the crag and tail topography occurs where igneous rocks outcrop at the surface.

(Figure 155) Linlithgow Loch and Linlithgow Palace. The loch is very large kettle hole formed by the melting of a large detached mass of ice trapped within glacial deposits [NT 004 776] (WLGS 47).



(Figure 153) Streamlining of upland terrain around Leven Seat.

(Figure 117) Auchinoon Hill from south-east of Harperrig Reservoir. Auchinoon Quarry (WLGS 36) left of centre.

(Figure 154) Post-glacial cemented raised beach deposits above the modern beach at Abercorn Point 2 [NT 0835 7952] (WLGS 18).

(Figure 55) Burdiehouse Limestone on the west limb of the Hopetoun anticline. Hopetoun Shore 3 [NT 0894 7935] (WLGS 17), Hopetoun Member, West Lothian Oil Shale Formation.