Excursion 13 St Monans–Ardross

Time	Half day
Maps	OS 1:50,000 Sheet 59 GS One-inch, Sheet 41
Excursion map	(Map 18)
Walking distance	2 km of rocky beach.
Purpose	The main objects of this excursion are to examine: (1) Carboniferous sediments belonging to the highest part of the Strathclyde Group, the Pathhead Beds; (2) a series of Carboniferous volcanic necks and their relationship to the country rocks; (3) the relationship between the Ardross Fault and the volcanic necks.
Route	As for Excursion 12, but proceeding direct to St Monans Harbour and thereafter walking along the shore section to rejoin the bus which should be sent on to the lay-by at Ardross Cottages [NO 506 006] 1.5 km south-west of St Monans. This excursion is seen to best advantage at low tide since many of the exposures are on the wavecut platform.

1. St Monans Neck: eastern margin [NO 52316 01445]

Follow the road west then south-west for 180 m from the harbour before descending to the shore at a rough cart track cut in the rocks 40 m short of the St Monans Burn. Sandstones lying about 15 m below the St Monans White Limestone outcrop here and dip 45° SE. Now continue along the track towards St Monans church. Adjacent to the St Monans Neck it will be seen that the sandstones are baked and shattered and that the dip steepens abruptly at the edge of the neck. On crossing the neck margin, at the top of the beach notice a 1.2 m basalt dyke immediately inside the neck. It extends only a few metres downshore. Beyond it the exposures consist of coarse tuff or agglomerate containing basalt blocks up to 30 cm across. Westwards this tuff becomes less coarse as it is traced into the neck. At the western end of the churchyard wall notice a 30 cm thick dyke which pinches out and is then continued *en echelon* 30 cm away. Downshore the eastern margin of the neck makes a pronounced feature: a wavecut platform of tuff standing a few metres above the level of the St Monans Burn which here crosses poorly exposed, folded sediments. The even surface of this platform is broken by protrusions caused by resistant calcite veins, small basic dykes and large basalt blocks within the tuff. There is little sign, however, of bedding in the tuff.

2. St Monans Neck: vent intrusion [NO 52266 01340]

Seventy metres SSE of St Monans Church notice a prominent trench which crosses the wavecut platform. This with its minor branches marks the course of a large basalt vent intrusion or dyke. It has been preferentially eroded by the sea because of its well developed columnar jointing normal to the dyke walls. The form of the intrusion at the seaward side of the neck is obscure, but several stacks composed mainly of tuff, perhaps baked by the dyke, project as much as 6 m above the wavecut platform there. The intrusion can then be traced north-west as a dyke to the neck margin and beyond where it cuts at right angles through the 'Long Shank', a prominent sandstone ridge. The dyke has been preferentially eroded here too, but some of its chilled margin can still be seen adhering to the sandstone.

3. St Monans Neck: western margin [NO 52185 01300]

Outside the neck the dyke bends round to the north and becomes concordant with the sediments which here dip steeply to the east. It has two branches both altered to white trap: one in the sandstone and the other in a coaly bed at the junction between the sandstone and the underlying shales.

Along the north-western part of the neck margin the intrusive nature of the tuff can be clearly seen, an intimate mixture of tuff and sandstone being exposed in the low cliff at the top of the beach. In the same low cliff 50 m to the east is a small dyke that dies out downwards. The tuff, being free of seaweed, is also best examined around here. The material in it is mainly of igneous origin: large fragments of basalt lying in a matrix of smaller fragments of similar material grading down to dust size. Pieces of sediment are relatively rare, but pieces of pale weathering limestone and also coaly masses veined with calcite (which were originally wood) do occur.

Study of aerial photographs indicates that the southern margin of the neck must lie just south of LWM. The northern margin is not exposed, but tuff extends at least 45 m north of the church. The neck is entirely filled with tuff or agglomerate except at its western margin where several large masses of sediment occur within it.

4. Ardross Limestones; Davie's Rock Neck; the Dovecot Neck [NO 52023 01261]

The next bay to the west is occupied by a NE-plunging anticline with dips of 60°+E and 40°–60° NW. The Lower and Upper Ardross Limestones, both of which are crinoidal, can be seen on both limbs, together with a 30 cm-thick oil shale (displaying a yellow efflorescence), which occurs beneath the Lower Ardross Limestone as at Pathhead east of St Monans (Excursion 12). Well displayed in the cliff at HWM is the Upper Ardross Limestone, which has been crumpled and broken over the crest of the anticline. This limestone, which consists of two distinct beds separated by 15 cm of shale, lies in a thick shale sequence. The shales are richly fossiliferous, especially in the vicinity of the limestone (which also contains many fossils although these are difficult to extract). The core of the anticline may be examined low on the shore where several prominent sandstone ridges are tightly folded, sheared and crumpled.

Two volcanic necks cut the anticline: an eastern one, Davie's Rock Neck, and a better known one further west, the Dovecot Neck. Davie's Rock Neck contains a plug of 'basalt' which forms the stack after which the neck is named. A careful examination of the contact here will show that the basalt has been altered to white trap adjacent to the surrounding shales while these have been brecciated for a few metres outwards from the basalt. The greater part of the neck, however, is occupied by broken up sediments or tuffisite through which run small and continuous white trap dykes. Several similar dykes which occur in the surrounding shales are probably associated with the neck though they can seldom be traced directly into it. One of these can be seen in the cliff just north of the basalt plug; another in a minor fault a few metres west of the neck; and two more to the east striking E–W across the Ardross Limestones.

The Dovecot Neck [NO 519 012] is considerably smaller than the Davie's Rock Neck, being only 55 m long and 36 m wide, but it too forms a feature on the shore. It lies at HWM and contains a group of enormous blocks of sandstone including one measuring 22 m x 6.5 m. Along with smaller pieces of sandstone and shale, together with ironstone nodules, these blocks are set in a matrix of fine-grained, pale green tuff. The eastern margin of the neck is sharply defined and cross cutting whereas the western margin wedges along bedding planes into the country rock. A subsidiary pipe-like mass or offshoot of tuff lies to the south-east of the main neck. Two dykes cut the neck, one of which continues to the south-east for 90 m across the anticline. Minor white trap dykes also occur on the north-west of the neck and the adjacent sandstone is cut by veins of pyrite and barytes. The neck cuts both the Upper and the Lower Ardross Limestones.

5. Newark Castle: deltaic sandstone with slumping; tuffisite [NO 51828 01137]

Newark Castle [NO 518 012] stands on a synclinally folded, thick sandstone in which cross bedding and convolute bedding are well displayed (this sandstone is also exposed in the Long Shank and between Pittenweem and St Monans – Excursion 12, Location 2). It will be seen from the map that dips are steep in this fold and that to the west the Ardross Limestones reappear from beneath the sandstone. West of the castle, in the shales between the Upper and Lower Ardross Limestones, a white trap dyke cuts across the strike, runs through the Upper Ardross Limestone and dies out in the sandstone cliff to the east. Two sills of tuffisite, consisting of sedimentary fragments in a hard shaly matrix, occur a short distance below the Upper Ardross Limestone. Notice that the higher of these has been intruded mainly beneath the Lower Ardross Limestone, but that it transgresses this limestone at one point to lie in part above it as well. The white trap dyke mentioned above cuts the two tuffisite sills and can be followed to the west where it also runs through a small

volcanic neck including a basalt plug within which the dyke rock is unaltered.

The dyke finally dies out in the sediments beyond. Folding is well displayed in the sediments a short distance downshore from this small neck.

6. Ardross Fault: Newark Castle Neck; dykes [NO 51666 01142]

The Ardross Fault is first encountered at the grassy point 130 m west of Newark Castle. From the map it can be seen that the sediments on the south-east side of the fault are intensely folded while those on the north-west side are not. Francis and Hopgood (1970, p. 181) have suggested that this is due to a fairly considerable downthrow on the north-west side bringing relatively high level structures opposite relatively low level structures.

A series of volcanic necks is aligned along the fault and it will be noticed that most of these appear to be truncated by it although at distances of 90 m and 140 m south-west of the Coalyard Hill Neck, two very small necks appear to lie in or very close to the plane of the fault. Cumming (1936, p. 351) put forward the view that the Ardross Fault cuts the necks, displacing them by 1200 m dextrally, and is therefore younger than the necks. More recently Francis and Hopgood (1970, pp. 179–84), while confirming the dextral component and timing of the fault relative to the necks, did not accept his amount of lateral movement and suggested that a strong vertical component was also involved. Upton (1982, p. 268) agreed broadly with Francis and Hopgood and suggested that the necks utilised a zone of weakness which can also be linked to the fault zone. The remainder of the excursion is designed to examine: (1) the phenomena within and adjacent to the volcanic necks on this part of the shore; (2) some of the features displayed on the shore which have given rise to the above views.

The Newark Castle Neck is filled with dull green tuff and its boundaries are difficult to delineate except on the southeastern side where it ends against the Ardross Fault, shales being exposed beyond the fault plane. Francis and Hopgood (1970, p. 177) suggested that here the Ardross Fault is coincident with the original neck margin. The course of the Ardross Fault is visible on this part of the shore on account of differential erosion of the sandstone and tuff, or sandstone and shale, which are in juxtaposition across the fault. On the south-eastern side of the fault, beginning 36 m south-west of Newark Castle Neck and opposite a very conspicuous vertical sandstone ridge, is a 115 m long irregular neck filled with intrusion breccia. Just outside the western end of this neck, a white trap dyke ends abruptly against the fault thus providing time relations of the dyke emplacement and faulting. Now walk north-east back along the fault towards the sandstone ridge where the margin of the small neck will be seen to end abruptly against the fault. Some 45 m east from the above white trap dyke much white trap is exposed apparently lying in the fault plane. A close examination of this suggests, however, that it too may have been sheared by the fault.

7. Coalyard Hill Neck: faulting in country rock; eastern margin of neck [NO 51471 01054]

At this locality the cliff at HWM provides good examples of faulting in gently dipping sandstone. From this point walk west until the north-eastern margin of the Coalyard Hill Neck is reached. The edge of the neck forms a distinct step on the shore platform, tuffisite within the neck standing above the level of the shales in the country rock to the east. From the map it will be seen that there is a large area of tuffisite at both the south-western and north-eastern ends of the neck. When the neck margin is examined in detail, it will be seen that the tuffisite ramifies into the country rock and that it is locally impossible to draw a distinct boundary between them. Similar phenomena can be seen as the neck margin is followed south to the Ardross Fault. Forsyth and Chisholm (1977, p. 196) also regard the Ardross Fault here as being coincident with the original margin of the Coalyard Hill Neck over a distance of 100 m.

8. Tuffs at the Ardross Fault [NO 51429 00953]

At this locality tuff is present on both sides of the Ardross Fault. To the south-east the tuff, which extends eastwards for 180 m to a basaltic plug, shows a marked alignment as do large sandstone xenoliths and Francis and Hopgood (1970, p. 176) have pointed out that this appears to have been controlled by the strike of the country rocks which have been invaded and replaced. The tuff of the Coalyard Hill Neck on the northwestern side of the Ardross Fault, while again

having a major sediment component, lacks the strong alignment of the southeastern side. Francis and Hopgood (1970, p. 175) have concluded that this tuff, which they refer to as part of the outer neck of the Coalyard Hill Neck, has been little affected by faulting (1970, p. 181).

9. Coalyard Hill Neck; dyke and tuff [NO 51283 00909]

Walk west across the Coalyard Hill Neck to a point at HWM [NO 513 009] where a NNW trending basalt dyke forms a conspicuous feature on the shore. The dyke has been emplaced in the tuff and has, in turn, been cut by later veins of tuff. Xenocrysts of anorthoclase and hornblende occur in the dyke rock. In this part of the neck the tuff comprises mainly fragments of basalt, but scattered dove-grey limestone fragments are present and in part the tuff has a distinctly grey colour due to the content of pulverised shale. In the main, however, the tuff is of igneous origin and it forms part of Francis and Hopgood's (1970, p. 175) inner neck in the Coalyard Hill Neck. Irregular calcite veins are widespread.

Ninety metres SSW, in the first stack, notice the coarse agglomerate within the neck. In it blocks of basalt up to 30 cm across are particularly abundant and are not infrequently rounded. The rock may be described as a lava breccia.

10. Coalyard Hill Neck: Ardross Fault; 'basalt-capped' stack [NO 51284 00832]

From the lava breccia walk east for 40 m to the second stack – the 'basalt capped' stack [NO 513 008] – where the bulk of the stack comprises tuff and the cap basalt. The seaward margin of the Coalyard Hill Neck is particularly well displayed in this area where it appears as a line running along the Ardross Fault, accentuated by differential marine erosion of the sediments and tuff on opposite sides of the fault. The sediments to the south-east show signs of drag suggesting dextral movement on the fault. Starting 65 m south-west of the 'basalt capped' stack, the course of the Ardross Fault becomes difficult to follow. Also in this vicinity and within a few metres of the neck margin, the tuff displays a rough alignment of the fragments. Francis and Hopgood (1970, p. 173) suggest that the tuffs are aligned parallel to the fault owing to their being in a shear zone. A careful examination of the fault-bounded margin of the Coalyard Hill Neck, 275 m south-west of the 'basalt capped' stack, shows two *en échelon* faults, a north-east one dying out to the south-west in the sediments and a south-west one dying out to the north-east in the tuff.

11. Coalyard Hill Neck margin [NO 51110 00798]

Returning once more to the top of the beach, the margin of the Coalyard Hill Neck can be examined 230 m east of Ardross farmhouse at HWM [NO 510 008]. Notice that the country rock has been disrupted. A small basalt plug (6 m across) is exposed just inside the neck and is packed with lighter coloured xenoliths of peridotite, carbonated peridotite and, to a lesser extent, pyroxenite. Both they and the basalt are cut by numerous carbonate veins. Seventy-five metres east of here and 15 m south of HWM may be found another small basalt mass containing scattered, large, yellow anorthoclase xenocrysts. It has been cut by several late tuffisite veins. The tuff in which this mass is emplaced is similar to that seen at Locality 9 with basalt blocks, usually less than 8 cm across, set in a tuffaceous matrix. Where the neck margin reaches HWM, in an upstanding mass, the tuff contains several large blocks of recrystallised *Lithostrotion* limestone. Various authors, including Cumming (1936) and Forsyth and Chisholm (1977), believe these to be pieces of the St Monans White Limestone in which case they must have fallen some 60 m down the neck since immediately outside the neck at this point are exposures of the Lower Ardross Limestone. This is known elsewhere to lie about that distance below the St Monans White Limestone. The 'Shrimp Band' lies 3.5 m below the Lower Ardross Limestone and dips gently north. It is difficult to locate and collecting from it is also difficult. For 275 m west the exposures consist of shale cut by a small tuffisite neck, by minor faults and by several tuffisite dykes a few centimetres wide.

To the south is a large area of tuffisite forming the southwestern end of the Coalyard Hill Neck. The surface of this too stands a metre above the adjacent shales. Observe that the bedding of the country rock can often be traced for considerable distances into the tuffisite. This part of the Coalyard Hill Neck also ends abruptly against the line of the Ardross Fault.

12. Small necks on the line of the Ardross Fault [NO 50937 00573]

Now follow the Ardross Fault south-west beyond the end of the Coalyard Hill Neck. The first of the minor necks is reached 90 m to the south-west. It displays the following features: (1) the sandstones on the south-eastern side of the fault are strongly sheared; (2) the tuffs within the neck, though possibly sheared, appear to be less so than the country rock; (3) the white trap crosses the fault plane with no sign of being disturbed. Francis and Hopgood (1970, p. 175) suggest that almost all the volcanics predate the fault (hence are sheared). This white trap dyke, however, gives the appearance of being later than the fault.

A few metres further to the south-west another tuffisite neck measuring 90 x 18 m is bounded by the fault at its northeastern end, but diverges from it when traced to the southwest. From this neck onwards, footing is difficult low on the shore. Follow the outcrop of the Upper Ardross Limestone up the shore. Adjacent to the neck it is folded into a tight anticline and syncline, possibly formed at the time of the main fault movements. Further up the beach there is a gentle southwest dip which continues to the cliff at HWM. There the Upper Ardross Limestone and the overlying shales are richly fossiliferous and have yielded the brachiopods '*Productus*', *Athyris, Schizophoria* and *Lingula,* bivalves and many gastropods including *Euphemites* and *Soleniscus.* Next examine the cliff exposures to the east. A series of sandstones underlies the limestone. Two thick beds of sandstone are separated by a thin coal seam with seatearth and the top of the lower sandstone displays well developed ripple marking. Exposed from time to time at the base of the cliff is a thin bed of sandstone with interesting slump structures.

Either continue south-west onto Excursion 14 or walk 200 m south-west to the track up to Ardross Cottages to rejoin the bus for the return journey to St Andrews.

References

CUMMING, G. A., 1936. The structure and volcanic geology of the Elie–St Monans district, Fife. *Trans. Edinb. Geol. Soc.,* 13, 340–65.

FORSYTH, I. H. and CHISHOLM, J. I., 1977. The geology of East Fife. *Mem. Geol. Surv. Gt. Br.*

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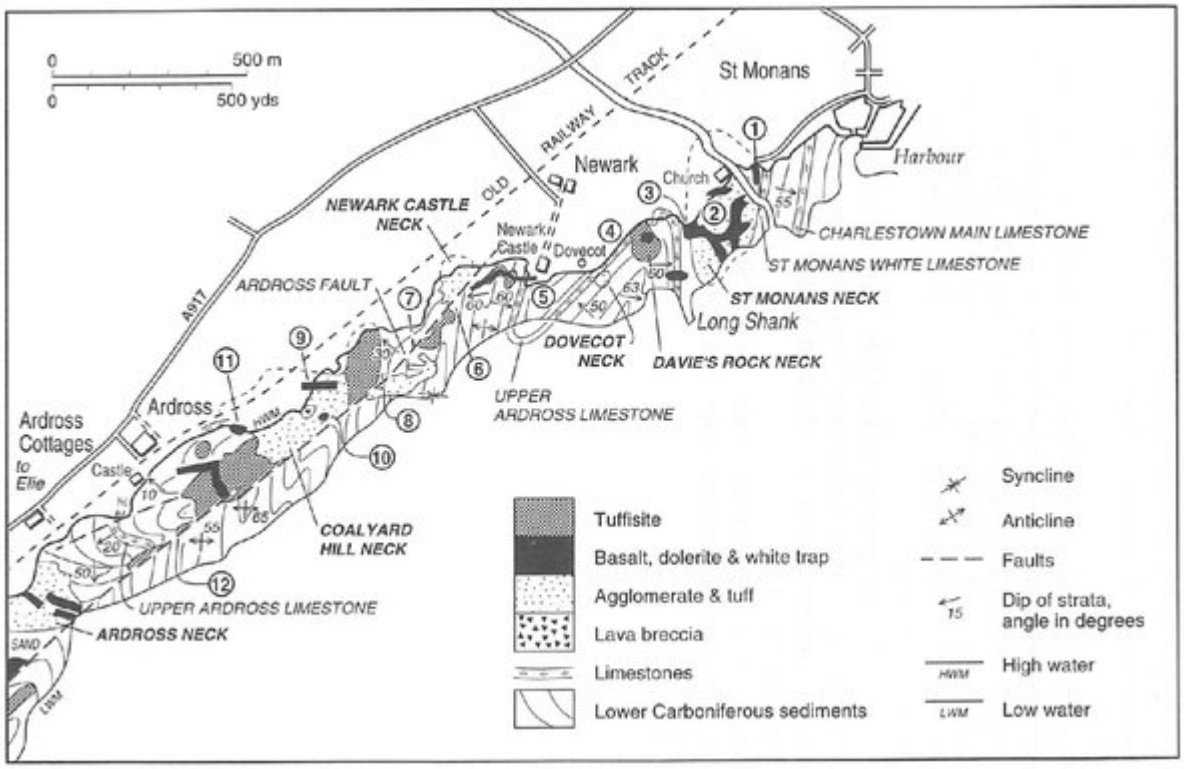
UPTON, B. G. J., 1982. Carboniferous volcanism. In Sutherland, D. (Ed.) *Igneous rocks of the British Isles.* 255–75. Wiley, London.

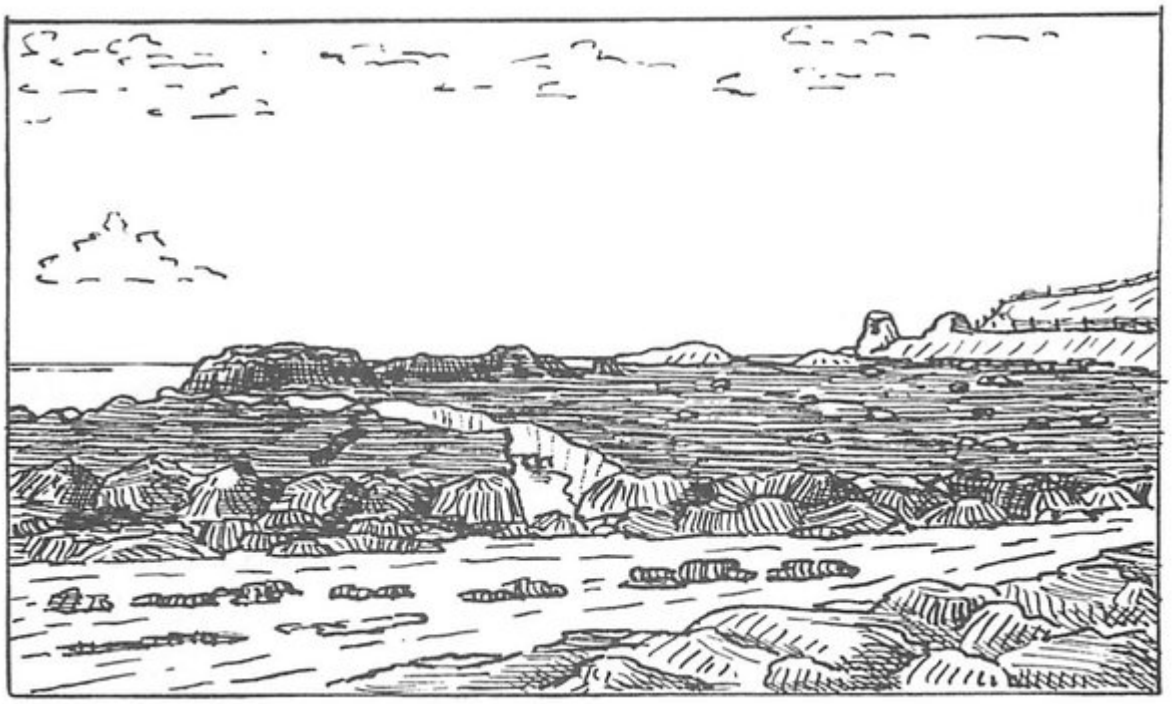
Figures

(Figure 12) The St Monans Neck seen across the St Monans Burn. The level wave-cut platform is underlain by tuff, while the trench marks the site of a dyke-like vent intrusion. In the background are sea stacks of tuff, dark, and sandstone beyond the neck, light in colour.

(Figure 13) The Ardross Fault, running directly away from the observer, separates dark tuffs within the Coalyard Hill Neck on the left from steeply dipping Carboniferous sediments on the right. In the background are the ruins of Newark Castle.



(Map 18) St Monans–Ardross.



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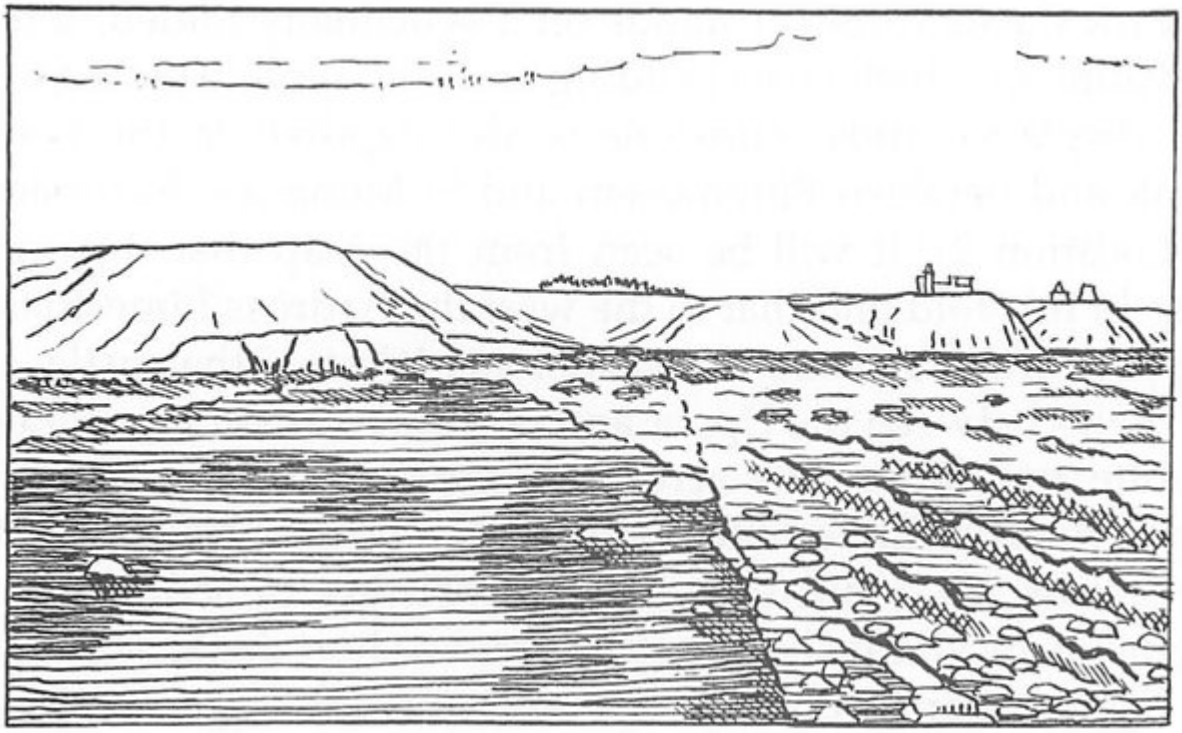

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