Excursion 14 Ardross–Elie Harbour

Lenth	Half day
Maps	OS 1:50,000, sheet 59 GS One-inch, sheet 41
Excursion map	(Map 19)
Walking distance	2.5 km of rocky and sandy beach.
Purpose	The main objects of this excursion are: (1) the examination of a series of Carboniferous volcanic necks exposed along the shore; (2) to examine Lower Carboniferous sediments belonging to the highest Strathclyde Group (Pathhead Beds) and the Lower Limestone Formation; (3) to study the south-western end of the Ardross Fault.
Note	The excursion follows on from Excursion 13 and may be combined with it, but it is advisable to visit this section during low tide.
Route	As for Excursion 12, but continue on the A917 past St Monans to the lay-by at Ardross Cottages [NO 506 006]. Follow the path to the beach and send the bus on to Elie harbour.

1. Ardross Cottages: faulting [NO 50684 00590]

The rocks exposed on the shore here are sandstones within the Pathhead Beds and lying about 25 m above the Upper Ardross Limestone which crops out at HWM 150 m to the east (see Excursion 13). These sandstones display cross bedding and slumping and are cut off downshore a short distance south of the bridge by a wrench fault branching off from the Ardross Fault. There is a marked topographic break along the line of this fault: a much more shaly sequence lying on the south side. On this part of the shore, the Ardross Fault itself can only be seen at extreme low spring tide. A mass of crinoidal limestone on the line of the fault was believed by Cumming (1936, p. 343) to be one of the Ardross Limestones.

2. Ardross Neck margin and dykes in neck [NO 50655 00406]

Walk south towards the 1.8 m high buttress that marks the margin of the Ardross Neck. Notice that the country rock is abruptly cut off at the margin of the neck, but that tuff veins pass out from it into the sandstone in which there are signs of local disruption for a few metres away from the margin. The tuff from the neck margin contains abundant blocks of sediment, including large masses of both sandstone and limestone, the latter believed to be the St Monans White Limestone. Further inwards it will be seen that the tuff is composed almost entirely of material of igneous origin and is cut by many calcite veins. Seawards the neck seems to end against the line of the Ardross Fault, but the contacts are not exposed.

Notice the NW–SE basalt dykes which cut the neck. These have been excavated by the sea near LWM but higher up the beach they stand up above the general level of the platform cut in the tuff (see (Plate 4)). The dykes contain large corroded anorthoclase xenocrysts, microphenocrysts of augite and pseudomorphs after olivine.

3. Ardross Neck: Ardross Fault and tuffisite [NO 50356 00110]

Westwards, a sandy bay interrupts exposures on the shore but, adjacent to the sand dunes and beyond the bay, the exposures still consist of tuff believed to be part of the same neck. Towards the south-western end of the Ardross Neck, tuff containing sedimentary material occurs on the southeastern side of a trench marking the line of the Ardross Fault.

Unfortunately, much of the lower part of the beach here is covered in loose boulders, but sufficient exposures occur between the boulders to indicate that there is a large area occupied by tuffisite and several small masses of basaltic breccia. The limits of the tuffisite cannot easily be determined. At LWM shales and sandstones outcrop in a minor anticline. These are believed to lie stratigraphically about 180 m beneath the Ardross Limestones (Cumming 1936, p. 349).

4. Wadeslea Neck: eastern margin and tuff [NT 50303 99794]

Westwards from the Ardross Neck sediments outcrop for a short distance before the eastern side of the Wadeslea Neck, marked by another buttress, is reached. Note that the sediments are bent and buckled against the side of the neck and are cut by at least one small white trap dyke striking parallel to the neck margin. The visible outcrop of this neck is quite narrow at 1–11/VM and broadens seawards. It has a steep seaward face and a planed off top. The tuff in the greater part of the neck is of igneous origin, the 'dull green agglomerate' of Cumming (1936, p. 359), but there is a narrow marginal zone of tuffisite breccia.

5. Wadeslea Neck: sediments in the neck, white trap dykes [NT 50043 99572]

The western margin of the Wadeslea Neck is quite different from the eastern margin. It should be examined near LWM 140 m east of Lady's Tower [NT 499 994]. The precise boundary is hard to trace, there being a marginal tuffisite breccia zone in which quite large rafts of sandstone still retain approximately the dip and strike of the adjacent country rock. Note that the St Monans White Limestone crops out in one or two fairly prominent stacks near LWM and strikes into or indeed lies within the vent. To the north-east, away from the margin, the vent material is the more usual greenish tuff and rises as a 1.8 m high buttress above the adjacent sediments and tuffisite breccia.

The sediments between the Wadeslea Neck and the Elie Ness Neck to the south-west are crossed by two NW–SE trending white trap dykes a few metres thick. These terminate to the north-west at the Elie Ness Neck while to the south-east one passes out to sea and the other ends part way down the shore. The country rock consists of sandstones and shale folded into a north–south anticline with dips of 20°–35°. To the south this fold is abruptly truncated by the Elie Ness Neck.

6. Wadeslea Neck: tuffisites [NT 49946 99602]

A series of small tuffisite necks cuts the eastern limb of the anticline at this locality and another lies on the anticlinal axis. These should be carefully examined. Most of them contain no igneous material; instead blocks of sandstone and shale up to 2.5 m long are scattered at random through a mainly shaly matrix. Neck 2 contains white trap fragments in a tuffaceous matrix and Neck 8 has a tuffaceous matrix; it occupies a small fault and has weathered with a perfectly flat top so that it now looks like a small roadway on the beach. The majority of these small necks are probably related to the nearby Wadeslea Neck. They represent pipes up which little or no igneous material other than gas has passed and which are now filled with tuffisite composed of shaken-up and shattered country rock produced by high pressure gas action. The formation of such tuffisite was a common feature in the early stages of volcanic activity of the Carboniferous vents of Fife and the Lothians (Francis 1962).

7. Lady's Tower: Elie Ness Neck [NT 50007 99465]

The Elie Ness Neck is of considerable size, being at least 450 m in diameter. The eastern margin of this neck is well exposed and may be examined in the small bay immediately east of Lady's Tower where the relationship between the neck and the country rock may be studied. At the southern end of the bay, there is considerable down drag of the beds as they approach the neck and the anticline referred to above is abruptly cut across, while at the northern end of the bay, the sediments are puckered and sharply bent and are veined with tuff. At HWM a white trap dyke packed with xenoliths and cut by many carbonate veins is well displayed. Drag of the sediments until they are almost vertical can also be seen.

8. Elie Ness Neck: tuff, bedded tuff and dykes [NT 49700 99350]

Near the eastern margin of the neck the tuff is poorly bedded and much faulted while light and dark coloured tuff may be seen to be in cross cutting relation to each other. Notice also the numerous, mainly small, short and irregular basalt dykes in this part of the neck. Much of the neck is occupied by bedded tuff dipping in the main concentrically at 15°–45° towards the centre of the vent. The bedded tuff is well displayed 90 m south-west of Lady's Tower where the bedding is emphasised by distinct grain size and compositional variation. The coarser beds contain blocks of older tuff together with smaller masses of pyroxene and hornblende up to 10 cm across (see (Plate 5)). Both large and small blocks of basalt are common and, together with the pyroxene and hornblende masses, are set in a fine tuff matrix which, as noted by Heddle (1901 vol. 2, p. 48), also contains irregularly distributed pyrope garnets locally known as 'Elie Rubies'. Cross bedding formed as part of base surge deposits is also present locally. Base surge deposits may be formed in Surtseyan type eruptions (Fisher and Schmincke 1984) thus agreeing with the opinions of Forsyth and Chisholm (1977) and Francis (1983) that the Carboniferous vents of East Fife are of this type. Some bands are fine-grained and darker in colour, owing to the presence of an appreciable amount of shale. Occasional sandy beds have also been recorded. Scattered limestone pebbles are conspicuous as they weather white or pale grey. Coal fragments, formerly wood and now cut by calcite veins, are also present though not common. A larger dyke, about 2 m wide and striking north-south, is conspicuous 45 m east of the lighthouse. In common with many of the other dykes, it contains corroded xenocrysts of hornblende, biotite and pink feldspar. A good example of faulting in the bedded ash can be seen a few metres west of this dyke.

9. Elie Ness Neck: intrusion breccia plug, Ardross Fault [NT 49611 99330]

At the western end of the Elie Ness Neck and 50 m north-west of the lighthouse examine a late plug of basaltic breccia measuring 25 x 18 m. This passes steeply downwards through the bedded ash which is baked at the contacts. The plug consists of blocks of basalt up to 1.2 m across set in a matrix of smaller basalt blocks, the interspaces being occupied by finer grained material and crystalline calcite. Bedded ash extends from this plug along the south-eastern side of Woodhaven to disappear at HWM. The abrupt disappearance of the Elie Ness Neck to the north-west may be due to the Ardross Fault. Lack of exposures prevents proof of this, but it seems quite probable (Cumming 1936, Francis and Hopgood 1970, p. 169).

10. Woodhaven: dolerite and limestones [NT 49654 99666]

A small mass of dolerite crops out in the centre of Woodhaven at HWM. It is cut by veins of tuffisite especially on the eastern side, while the western side is altered to white trap suggesting that the country rock may lie only a few metres away. Veins of carbonate up to 15 cm wide traverse much of the rock. Just west of the dolerite, two limestones are exposed. That nearer the dolerite is recrystallised in part, probably as a result of metamorphism by the dolerite which has also affected the overlying shales to some extent. This limestone, which is crinoidal and at least 6 m thick, is probably the St Monans White Limestone. The Woodhaven Limestone, about 1.5 m thick, lies 40 m higher in the succession. Both the limestone and the immediately overlying shales are fossiliferous yielding crinoids, '*Productus*', '*Chonetes*' and *Composita.* This limestone is believed to be equivalent to the Charlestown Main Limestone, Wilson (1966, p. 113) having discovered the Neilson Shell Bed fauna in the overlying shales. Almost all the sediments in Woodhaven therefore belong to the Lower Limestone Formation. Above this, a series of sandstones, shales and minor calcareous beds dips at 20°–50° to the north-west. The strike swings round to NW–SE on approaching the harbour wall. Note that these beds are cut by three branching white trap dykes which strike roughly E–W.

11. Woodhaven: tuffisite, dykes and margin of the Elie Harbour Neck [NT 49395 99597]

A basalt dyke appears near LWM in Woodhaven and a short distance further west cuts through a small tuffisite neck measuring 9 x 30 m and aligned roughly along the length of the dyke. This neck appears to be composed entirely of brecciated sandstone and shale. By following this dyke west the well known Elie Harbour Neck is approached. Examine the eastern margin which is much faulted. Locally there is a limestone present which dips very steeply into the neck, as

do the other beds. The tuff forms a buttress here too and stands above the level of the country rock.

12. Elie Harbour Neck: sandstone raft, bedded tuff [NT 49256 99590]

Excellent exposures of concentrically dipping, well bedded tuff may be examined within the Elie Harbour Neck, the centre towards which they dip lying beneath the position of a large sandstone raft, 75 m south-east of the warehouse at the harbour. The tuff, in which dips are as high as 75°, is similar to that in the Elie Ness Neck. It contains large basalt blocks, some of which are vesicular, and also small pieces of white-weathering limestone, some of which are crinoidal. Perhaps the most interesting feature within the neck is the relationship of the large sandstone raft to the adjacent tuff. The sandstone itself is not unusual, though it is locally pink due to relatively high concentrations of almandine garnet, and it contains minor shale bands and a thin coaly bed. When the contact between this sedimentary raft and the tuff is examined, however, it is apparent that there is a passage between the one rock type and the other. The intermediate rock has the appearance of a coarse sandstone or grit, but contains tiny chips of pale, greenish-grey, altered basalt or white trap. It seems likely that gas action has broken down the sandstone at the margin of the raft and introduced small fragments of tuff or lava, so that a sharp boundary between the two rock types no longer exists. An unaltered basalt dyke appears within the bedded ash and passes close to the sandstone raft before dying out a short distance west. The bedded tuff can be followed to the western limit of the exposures without finding any sign of the edge of the neck being near. A few exposures of tuff occur within the harbour at the foot of the quay and indicate, as Cumming (1928, p. 135) pointed out, that the neck was much larger than was originally thought by Geikie (1902, pp. 244–5).

Rejoin the bus at the harbour and return to St Andrews by the same route as taken on the outward journey.

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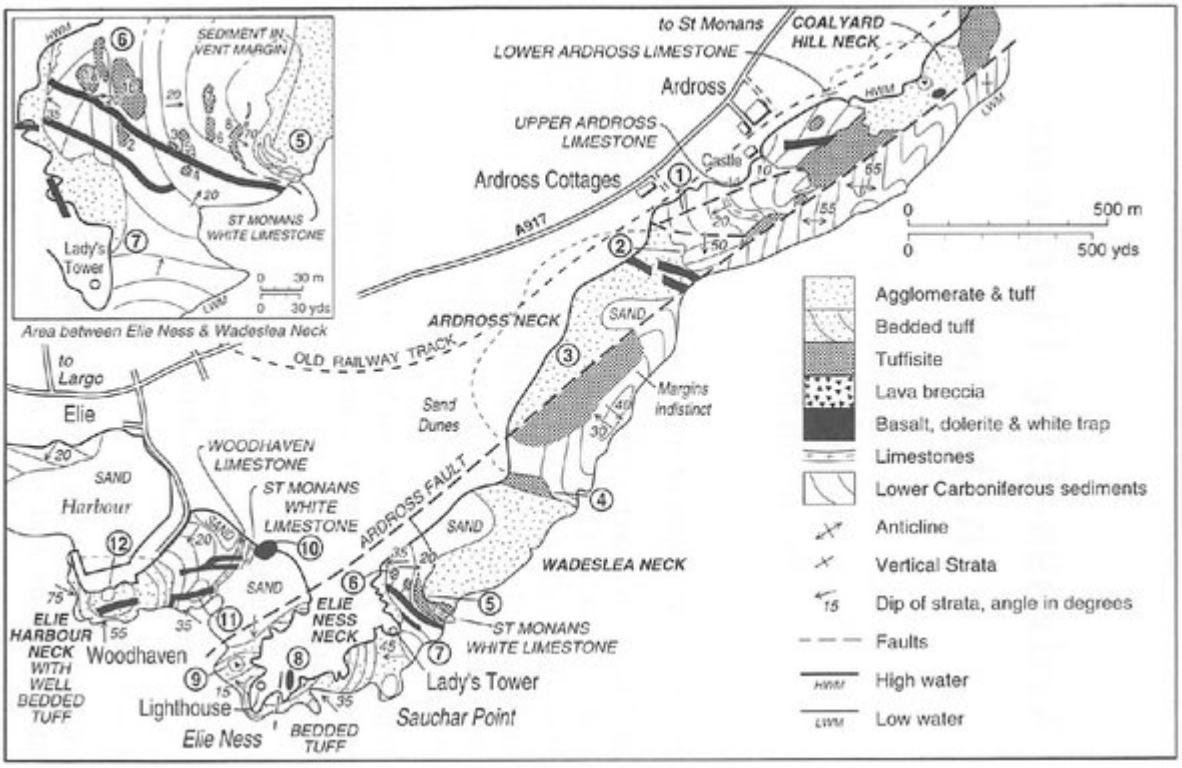
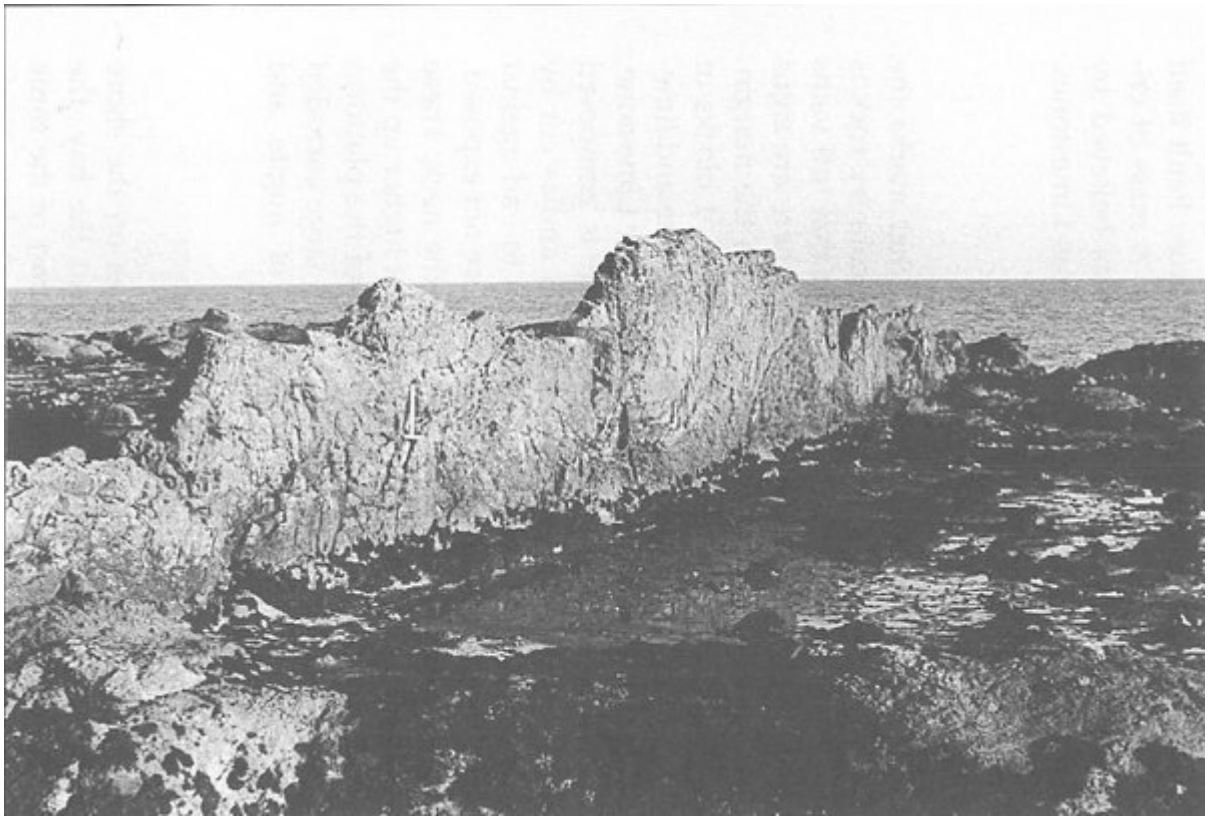


(Map 19) Ardross–Elie Harbour.



(Plate 4) Basalt dyke cutting the tuffs of the Ardross Neck, Elie. The tuff comprises almost exclusively igneous fragments; the dyke contains anorthoclase xenocrysts.

(Plate 5) Bedded tuffs, Elie Ness Neck, Elie. The tuff comprises blocks of basalt and older tuff in which are scattered aggregates and crystals of pyroxene and amphibole and, very rarely, pyrope garnet or 'Elie Ruby'. Excursion 14, Location 8.