Transverse ridges and eskers around Easterton Steading, between Nairn and Forres.

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The transverse ridges around the old steading at Easterton [NH 939 573] comprise examples of broadly NNW to SSE trending, asymmetric transverse ridges (see **Kingsteps**, Fig. 42). They occur on intervening ground between those ridges that are developed between Culloden Moor and Tomluncart [NH 844 525] (see **Upper Strathnairn**), and those around **Mosstowie** [NJ 156 609]. The former group of ridges, named as the 'Dalcross Suite' of moraines by Fletcher et al. (1996), are described as subparallel ridges, 2-5 m high, spaced 75-150 m apart, asymmetric in profile, with the steeper faces generally on the western (up-glacier) side. They were interpreted as either crevasse squeeze ridges or possible De Geer moraines. The second group around Mosstowie are larger asymmetric transverse ridges, typically 3-7 m high, 200-1200 m long, and often more lobate in form. The largest are spaced almost 200 m apart (see **Mosstowie**); steep faces also generally occur on the western side of each ridge. These were interpreted as De Geer moraines by (Finlayson et al., 2007).

The transverse ridges around Easterton [NH 939 573] are generally lobate in plan, typically 115-440 m long and 35-45 m in wide; some of the more lobate ridges exceed 100 m in width. They extend for a distance of c. 5 km, ENE from Bogheads [NH 925 569] to Muirside [NH 972 583]. The spacing between the ridges varies considerably, from as little as 30 m to more than 480 m and their height generally ranges from about 4 to 10 m; the highest, Downie Hillock [NJ 968 588] (see **Kingsteps**, Fig. 42 D) exceeds 12 m in height and is up to 120 m wide. Exposures in the ridges are generally small and sparse, but they indicate that most of the ridges are composed of reddish brown sandy diamict; accumulations of boulders of sandstone and metasandstone are present on some ridge crests, but they may not be in situ as most of the ground has been, subjected to intensive arable cultivation.

The best known exposure in the ridges occurs in a 15 m long excavated face, at the northern end of the steading at Easterton, which

has been visible for almost 20 years. The highly weathered face shows up to 2.1 m of very sandy diamict with a distinctive mottled and 'churned' appearance. The matrix of the diamict ranges in colour from pinkish grey to moderate reddish orange (Fig. 45) The clasts within diamict are mainly subangular pebbles of metasandstone and pale orange sandstone; some angular blocks of semipelitic gneiss, brown sandstone and quartzite, up to 40 cm in diameter, are also present.

Figure 45. Exposure in the diamict underlying the asymmetric transverse ridge at Easterton (hammer 35 cm).

Most of the lobate ridges are asymmetric in profile, with steeper slope on the western side. A group of six more symmetrical, relatively narrow ridges, 50-200 m long and 3-10 m high, occur on thickly forested ground to the south-east of Easterton. Sparse exposures indicate that these ridges are composed of stratified sand and gravel and they are similar in character to esker ridges within the braided esker complex, that lies to the south of the A96 and c. 0 5 km east of Courage Farm [NH 940 555].

The ground between the asymmetric ridges is mostly underlain by till, and declines in elevation from 30-40 m OD at the western end of

the area, south of Lochloy House, to around 25 m OD near Downie Hillock, some 5 km to the east. They all occur on ground higher than the elevation of the highest Kingsteps Late Devensian shoreline fragments (c. 23 m OD), which are, up to 1 km distant, but the eastern-most ridges lie only a few metres above the highest eastern shoreline.

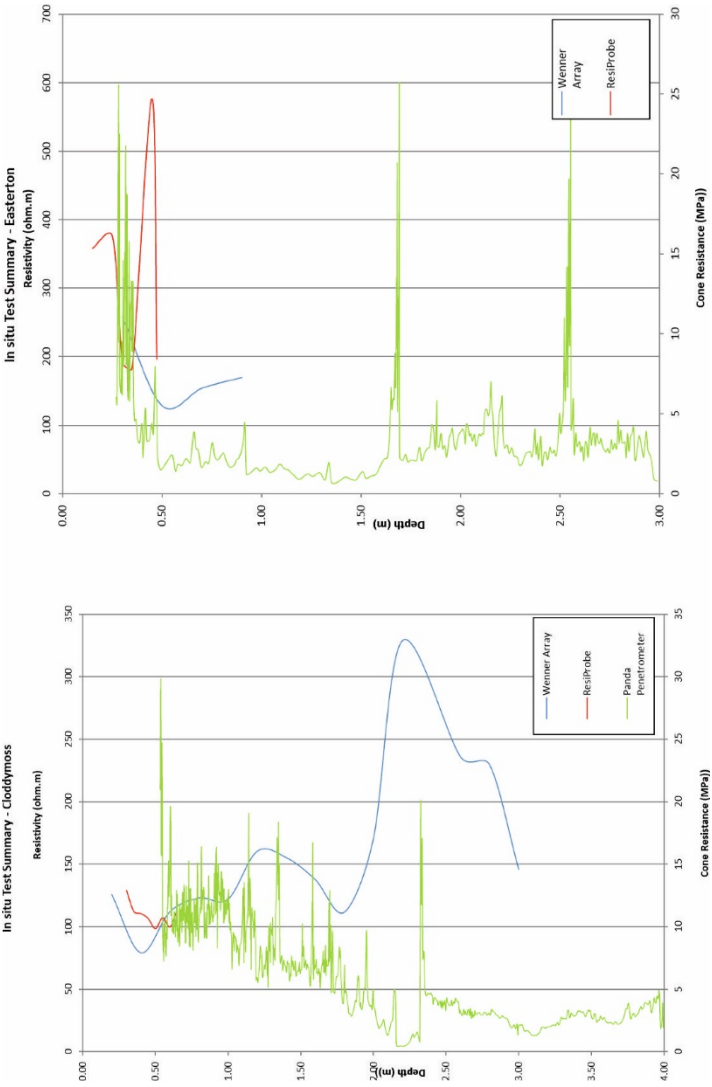

Figure 46. Cone penetrometer, Wenner Array and ResiProbe results from the diamicts at Easterton and Cloddymoss (from Dobbs et al., in prep).

Geotechnical testing (including cone penetrometer and resistivity measurements) were conducted on a freshly excavated, flat-lying unweathered exposure of the diamict on the northern side of the Easterton steading and on the till underlying the Ardersier Silts at **Cloddymoss**. The testing results (Fig. 46) come from one of a series of provenance engineering and hydrogeological properties studies (Walden and Auton, 1999; 2000; Northmore et al., 2012; Dobbs et al., in prep) undertaken by BGS on the glacigenic sequences in the Nairn-Forres area. At both sites, the engineering classification of the diamict is a 'Gravelly very silty Sand', but more cobbles were present at Easterton. The cone resistance was generally higher in the upper 2.5 m of the Cloddymoss profile, where the cone encountered scattered pebble clasts; it decreased significantly below this depth. At Easterton, the highest cone resistance was in the top few centimetres of the profile, and at depths of c. 1.7 and 2.5 m where clasts were encountered. The results indicate that clasts are concentrated in distinct layers within both diamicts, and that the matrix of both has a similar strength (in the region of 3-5 MPa).

The appearance of the diamict in fresh exposures is similar at both Cloddymoss and Easterton. It is generally an orange to reddish brown, massive, matrix-supported deposit with sparse traces of stratification formed by discontinuous sand wisps. The clasts comprise pebbles and cobbles predominantly of metasandstone, brown and pale yellow sandstone and granite. The mottled pale grey-orange appearance of the weathered face at Easterton is important, however, as it emphasises that the matrix of the sediment is less homogenous than it appears in un-weathered exposures. The pale colouration is in part due to the presence of sand in the matrix, derived from pale yellow and grey sandstones, typical of the Upper Devonian, rather than from the darker reddish brown sandstones that characterise the Middle Devonian outcrop of the inland area, and farther west along the coast. This paler orange colouration is typical of the tills that were laid down by the Moray Firth ice once it had moved across a significant amount of ground underlain by Upper Devonian bedrock.

Discussion

Most of the asymmetric ridges around Easterton are of similar form to those in the Mosstowie area, west of Elgin, but they are generally shorter in length. They are similar in height, and profile, but less regularly spaced; they are developed on till in both areas and appear to be composed principally of diamict. The small flutings on the till surface seen at Mosstowie have not been recorded around Easterton. No bedded glaciomarine or glaciolacustrine sediments were recorded between the ridges in either area.

Narrower symmetric ridges composed of bedded sand and gravel, present in the southern part of the Easterton area, were not evident around Mosstowie. These ridges appear to be eskers. They form part of an extensive discontinuous suite that represent, at least in part, a continuation of the system of which the braided eskers and the 'flat-topped ridge' at **Flemington** are good examples (Firth, 1990b; Auton, 1992; Gordon and Auton, 1993). A similar 'flat topped ridge' associated with ribbon eskers occurs on the eastern side of the River Nairn, near Raitloan [NH 885 531], just across the river from the eastern end of the Flemington Eskers, at Howford [NH 875 538]. The esker suite continues eastwards as a ribbon esker near Newton of Park [NH 904 541], as multiple ribbons between Meadowfield [NH 928 552] and Kinsteary House [NH 926 544] and as a single ridge, named Hillend Belt on the OS 1: 10k Sheet. The nature of sediments forming the Hillend Belt Esker were well exposed in 1999, in an 80 m-long excavation at [NH 934 548]. In cross section, this showed up to 7.2 m of interbedded sand, gravel, silt and diamict, dipping at up to 40° away from the sharp crest of the ridge.

The Hillend Belt Esker lies about 150 m from the braided esker complex east of Courage Farm mentioned above, from which it is separated by a spread of basin peat. The symmetric sand and gravel ridges that impinge onto the southern part of the Easterton area represent discontinuous ribbon eskers, protruding through blanket peat, that form a northerly trending extension of this complex. The curvilinear form of some the most northerly of these ridges, which arc eastwards,

suggests that their shape may have been have influenced by the same ice movement responsible for the asymmetric ridges of diamict.

The presence of eskers associated with the asymmetric transverse ridges around Easterton is intriguing, for similar associations of features have been reported from former calving bay margins (e.g. Dowling et al., 2016). However, if the ridges are analogous to De Geer moraines formed by a glacier surging into either a lake or the sea, as suggested by Finlayson et al (2007) for the very similar features at Mosstowie, there is very little evidence of glaciolacustrine of glaciomarine sediments on the intervening ground between the ridges around Easterton. The curvilinear form of the eskers, surrounded by poorly drained peat, does however suggest the former presence of small bodies of ponded water. Such bodies of peat are commonly associated with infill of kettleholes, formed by the melting of buried ice.

At Mosstowie, the asymmetric ridges are associated with ice-marginal drainage channels, but at Easterton, they are associated with eskers, suggesting englacial or subglacial drainage. It is unclear whether the formation of the asymmetric ridges and the eskers were contemporaneous, or whether the eskers were laid down prior to the ridges being formed, and the alignment of the eskers was modified by ice movement associated with ridge formation. The close proximity of both types of features does suggest that they were closely linked in time, and a complex ice-marginal glacial land system resulted from the nearby presence of bodies of active and stagnant ice. This may also be true of the 'Dalcross' suite of moraines and the nearby Flemington Eskers.

It is also unclear, that if the eskers and the ridges at Easterton did form at the same time, whether the direction of subglacial and englacial drainage within the eskers, was directed from north to south or south to north, i.e. into or away (downslope) from the nearby braided esker complex, east of Courage Farm. Comparison with other esker complexes in the region suggests downslope drainage is the more likely, perhaps lubricating the bed of the advancing ice.