TARBAT NESS

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Introduction

Tarbat Ness forms the southern headland of the Dornoch Firth and juts out into the Moray Firth in a north-easterly direction (Figure 3.16). It is composed mainly of a peninsula of Upper Old Red Sandstone, separated from the underlying Middle Old Red Sandstone by a fault in the east and south. The cliff and shore platform features at Tarbat Ness are excellent examples of the operation of a range of pitting, saltspray and honeycomb weathering and tidally zoned biological processes that are relatively unusual in Scotland. The landward-dipping beds, occasional joints and minor faults in the Old Red Sandstone have been differentially eroded to provide a coastline of great variety, including some of the best examples of differential erosion processes on tilted sandstone strata in Scotland. In addition, the striking contrast between the coastal forms on the high-energy south-east and lower-energy north-west coast of the peninsula adds to the geomorphological interest. Emerged gravel beaches and platforms, together with a prominent emerged cliff are also found along the coastline of Tarbat Ness and emerged sea stacks are also well developed south of Wilkhaven pier on the south-east coast of the peninsula.

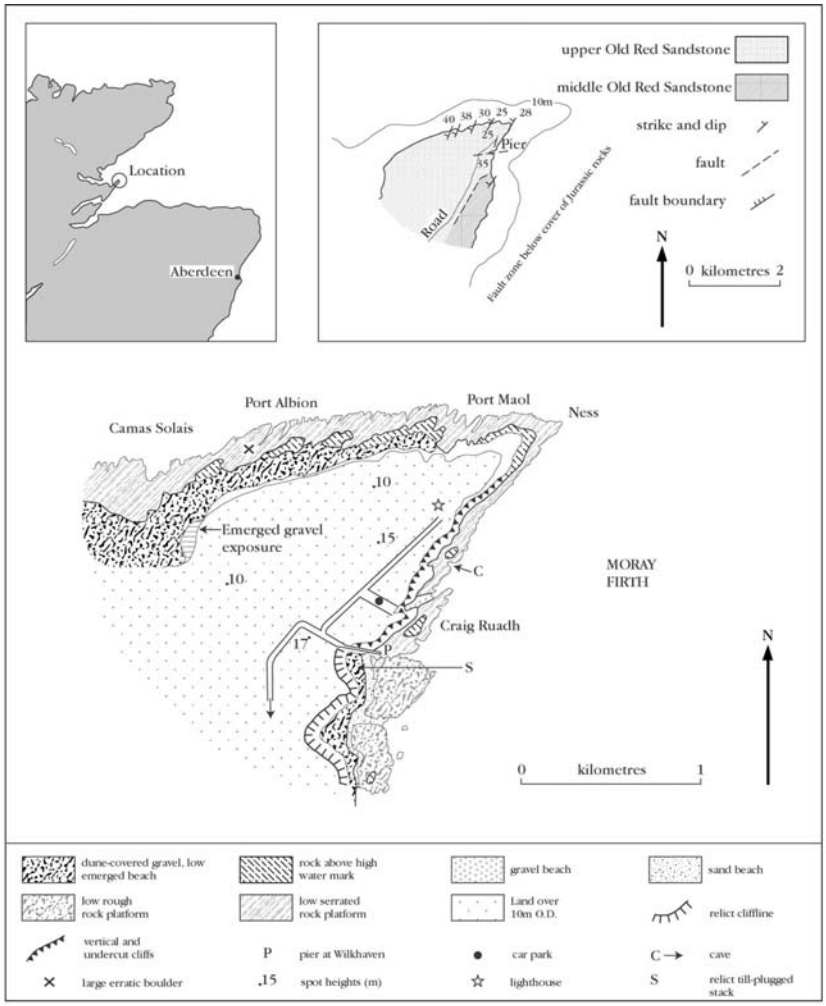

Figure 3.16: Geomorphological map and geological sketch map of Tarbat Ness, Ross and Cromarty, north-east Scotland. The eastern Moray Firth shore is fault-controlled and rocky with a prominent emerged cliffline. The northern Dornoch Firth shore has well-developed emerged gravel beach-ridges. At the Ness itself, the low rock shore platform is characterized by a range of well-developed weathering pits and tafoni that are rare on Scottish coasts. At 'S' an emerged till-plugged stack occurs in front of the relict cliff. (Modified from unpublished work by W. Ritchie.)

Hourly mean wind speeds in the inner Moray Firth at Tarbat Ness reach 3 m s^{-1} for 75% of the time and 18 m s^{-1} for 0.1% of the time but winds are mainly offshore. Onshore winds from the north-east (the longest fetch) account for only a small proportion of all winds, but winds from the south-east are almost as frequent as south-westerlies and have relatively long fetches of 25 km. Water depths off Tarbat Ness are relatively shallow, reaching 10 m depth at about 300 m offshore and 20 m at 5–10 km offshore (UKDMAP, 1998). The Ness is thus in a relatively sheltered location being subject to lengthy fetches only between north-east and south-east, with a maximum fetch to the north-west of 16 km. The north-west facing side is sheltered from the worst of the north-easterly storms that approach the ness obliquely and is mainly unaffected by easterly waves. Similarly, the south-east shore is also sheltered from the worst of the north-easterly storms but is more exposed to storm waves from the south-east.

The relict landforms of Tarbat Ness and the Dornoch Firth are of great significance for the interpretation of the glacial and sea-level history of the area. The Holocene development of the Dornoch Firth has been reconstructed based on these and other emerged marine features (Firth *et al.*, 1995; Hansom, 1991; Ogilvie, 1923; Smith, 1968; Smith and Mather, 1973). However, in spite of extensive research on the current processes of the coastline of the inner Dornoch Firth (Hansom and Leafe, 1990), there has been no geomorphological research on the active coastal forms and processes of Tarbat Ness itself.

Description

Tarbat Ness is composed mainly of a peninsula of Upper Old Red Sandstone, separated from the underlying Middle Old Red Sandstone that crop out in the east and south by a fault boundary to the south of the pier at Wilkhaven (P on Figure3.16). There is a general decline in altitude of the headland from 17 m above sea level in the south and east to 10 m above sea level in the north and west. All of the features described below occur within the Upper Old Red Sandstone, which here is composed of a great variety of calcareous-rich layers, finer-grained red sandstone, grits and some conglomeratic beds. The beds individually range from a few centimetres to over one metre thick and some are fissile. The Ness itself is strike-aligned with a well-defined dip towards the WNW and mainland and this is reflected in the ridges and clefts in the shore platform that are angled obliquely to the coastline. Higher dips of 40° occur in the south and west, but these decline to 25° towards the north-east and the Ness itself. On the east coast south of the fault boundary at Wilkhaven Pier, there is greater variation in both strike and dip angles and a change in coastal morphology from the well-defined serrated shore platforms of Tarbat Ness to low and uneven platforms to the south.

The features of interest at Tarbat Ness centre on the development of distinctive shore platforms and on smaller-scale weathering features such as pitting and honeycombing. At the larger scale both the north-west and south-east sides of Tarbat Ness display excellent examples of serrated rock platforms that have been cut and weathered across dipping sandstone beds of varying resistances. On the north-west coast, differential and selective erosion of the steeply inclined sandstone beds of the shore platform has produced a staircase of steeply dipping parallel knife-edge ridges and narrow, linear clefts, typically no more than 2–3 m wide. At the upper levels of the platforms, the tops of the beds and protuberances are adorned with honeycomb weathering micro-forms and tafoni, while the clefts are occasionally partly filled with gravel deposits. The platforms on this coast reach 250 m wide at Camas Solais but taper to 50 m wide towards the north-east.

There is a greater variety of larger-scale rock forms on the more exposed south-east coast of the peninsula. To the north of the fault, the 12 m-high sandstone cliffs are in places overhanging due to active undercutting by waves. Farther north occur the remnants of higher shore platforms (e.g. Craig Ruadh) and several narrow inlets, one of which has a distinctive gravel beach at its head with steep rock cliffs on either side. Both contemporary and emerged shore platforms and the sides of the narrow inlets contain excellent examples of honeycomb, solution and abrasion micro-features. To the north, a series of seven sloping platforms, the upper surface of each representing the top of a more resistant bed of sandstone, have been cut into the receding cliffs producing a distinctive ‘stepped' profile. These steps progressively lower and coalesce north-eastwards into a low angular broken shore platform that extends offshore as a series of dipping reefs towards Tarbat Ledge. To the south of the Wilkhaven fault a low, uneven and 300 m-wide rock platform is backed by an emerged platform covered by a grassy terrace of emerged gravels.

At a smaller scale there is a wide range of weathering micro-forms at Tarbat Ness, ranging from solution pits, saltspray tafoni and honeycomb features. The greatest variety of pitting features, ranging in size from millimetres to one or more centimetres in diameter, is found just above the high-water mark on both the north-west and south-east coast of the peninsula and tend to develop selectively in certain strata. Larger pits and circular depressions are mainly found on the higher and flatter rock surfaces where they may become filled with stagnant water enriched by bird guano.

Interpretation

The rocky coastline of Tarbat Ness is dominated by varying amounts of the erosional processes of quarrying, abrasion, chemical weathering and biological weathering. However, none have been quantified or studied in any detail. As a result of the combination of exposure and dominant wave direction, there exists a fundamental contrast between the higher energy environment of the south-east facing coast and the more benign north-west coast. In addition, lithology and geological structure play an important role in determining coastal form. The landward-dipping beds, occasional joints and minor faults within the sandstones have been differentially exploited by erosion to produce a distinctive coastline, particularly on the exposed south-east coast. The variety of texture and composition of the tightly-bedded red and yellow

sandstones, grits and conglomerate beds have responded differentially to coastal processes producing considerable local variation in form.

Differential and selective erosion of the calcareous sandstone beds has produced many of the larger-scale landforms such as the steeply dipping parallel platform ridges on the north-east coast and the ‘stepped' platforms at the tip of the peninsula. Wave quarrying of small-scale faults or joints in the dipping beds has resulted in excavation along these joints to produce a series of characteristic knife-edge ridges and linear clefts. Geological structure, particularly the strike and dip of the strata, plays an important role in determining the morphology of the larger forms on each coast. A much more broken profile with large scarps and short dips characterizes the south-east coast, whereas the north-west coast has long, smooth-topped, dipping beds separated by small scarps. Except on the south-east coast, and where gravel is locally available, few platform surfaces show signs of fresh abrasion. The fresh scars that do exist have angular edges indicating that wave quarrying is important in places.

At Tarbat Ness, erosional micro-forms, such as small pitting features, are typically the product of karst-like solutional processes produced by spray action on the calcareous beds, although salt crystal growth is likely to account for the formation of the tafoni features. Wave-spray processes extend to greater altitudes on the south-east coast and at the Ness itself and, as a result, pits and tafoni are found at greater altitudes on these coasts. However, it is on the upper surfaces of the north-west coast platforms that several of the more delicate solutional features occur, principally because wave energy is less and the features have time to develop. Additionally, burrowing and boring by intertidal organisms plays an important role in the development of some micro-forms, particularly close to the water surface at the edges of rockpools where micro-notches have developed. Although unstudied, there is likely to be a biological zonation relationship between the types of organisms found, the morphology and altitude of the erosional forms produced, and the wave and spray processes operating. In addition, whereas some pits and circular depressions closely resemble karst-type solution hollows and cavities, some of the lower and larger pits and depressions now appear to be subject to mechanical abrasion from gravels within them. All of the lower altitude features are currently active although some, especially those at higher elevations, may be partially relict. There is great scope at Tarbat Ness for detailed research to determine the relationships between the factors responsible for the development of such micro-forms.

The relict cliff and emerged beaches that occur higher up on Tarbat Ness provide spectacular evidence of former relative sea-levels in Lateglacial and Holocene times. Although they are of great geomorphological interest in their own right (Hansom and Leafe, 1990; Hansom, 1991; Firth *et al*., 1995), they are also of relevance to the sea-level context within which the platforms and micro-scale features of Tarbat Ness have developed. The southward extension of the active cliff at Craig Ruadh is represented by a relict cliff at Wilkhaven and comprises a rock cliff veneered with glacially derived tills and gravels that fill the gap between the cliff and a sea stack rising from the emerged shore platform. Thus it appears likely that the general morphology and association of cliffs and shore platforms at Tarbat Ness was largely in place before the last glaciation and as such is inherited. Tarbat Ness probably became ice free at about 14 000 years BP, and the glaciogenic sediments became trimmed by a high sea level at about 20 m OD. Gravel beaches were also constructed up to 20 m OD at this time (Hansom and Leafe, 1990). On the north-west side of Tarbat Ness, the high gravel beaches are cut by a prominent cliff whose base lies at 10 m OD. This cliff was probably first cut during the fall to a Lateglacial low sea level at about 10 500 years BP, but then reoccupied as the Holocene sea rose to 6 m OD at 6500 years BP. It is this last rise in relative sea level and the subsequent fall to present levels that has resulted in the erosional trimming of the present shore platform and the weathering of its surface. Present-day processes are thus likely to be engaged in the superficial trimming of an exhumed surface.

Conclusions

The principal geomorphological interest of Tarbat Ness GCR site lies in the range of active micro- and macro-cliff and platform forms. In addition, the juxtaposition of these actively evolving forms with the well-preserved emerged beaches and relict cliffs set back from the present coast adds to the scientific interest of this site.

The Upper Old Red Sandstone peninsula of Tarbat Ness displays a great variety of meso- and micro-scale forms on the cliff and shore platforms. The micro-forms in the rocks and platforms display excellent examples of pitting, salt-spray and honeycomb weathering and tidally zoned biological processes. Differential and selective erosion of dipping beds, occasional joints and minor faults in the sandstone have produced a coastline of great geomorphological variety. The ‘stepped' profiles and parallel ridges of the shore platforms characteristic of this coast provide textbook examples of differential erosion processes on tilted sandstone strata. In addition, the contrast between the coastal forms on the high-energy south-east coast where abrasion is in evidence, and the low-energy north-west coast of the peninsula where weathering processes are more important adds to the geomorphological interest. The adjacent emerged gravel beaches and relict cliffs allow the development of both meso- and micro-forms at Tarbat Ness to be effectively placed into a temporal framework.

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