Geomorphology 104 (2009) 82–92

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph

Beach ridges from the Varanger Peninsula (Arctic Norwegian coast): Characteristics and significance

Eulalia Sanjaume [a,*], Jon Tolgensbakk [b]

[a] Dpto. de Geografía. Universitat de València. Ap. 22060, 46080, Valencia, Spain
[b] Institutt for geofag, Universitetet i Oslo, pb. 1047, Blindern 0316, Oslo, Norway

ARTICLE INFO

Available online 29 May 2008

Keywords:
Beach ridges
Norwegian Arctic coast
Isostatic uplift
Climatic changes
Sediment supply
Coastal evolution

ABSTRACT

The most common coastal sedimentary forms on the arctic coast of the Varanger Peninsula are raised beach ridge plains. The majority of the ridges consist of coarse material, but there are also sandy beach ridge areas close to the river mouths of some of the major rivers. Some bays having the same isostatic rebound and dynamic conditions have been studied to test if the number of beach ridges in each locality is significant to prove climatic changes, storminess, and rates of sediment accumulation, or if the number of beach ridges in each bay is only dependent on their intrinsic characteristics and self organization. Because the number of ridges varies not only from bay to bay, but even within the same bay, it has to be accounted for by contrasting internal and local evolution (sediment supply, offshore gradient and coastal evolution). These differences between various bays or parts of the same bay invalidate the explanations that global processes (planetary orbital forces, relative sea-level changes or past climatic condition) are responsible for beach ridge development.

1. Introduction

This paper shows the characteristics and significance of beach ridges from several bays on the Varanger Peninsula. The chosen "staircase" beach ridge plains have the same orientation, identical dynamic conditions, and the same isostatic uplift rates, so a comparison of data from these areas should be meaningful. The number of coarse material beach ridges in different bays is compared as well as the difference in number of coarse and sandy beach ridges. This comparison might be useful to discriminate the main factors for beach ridge development: global changes or intrinsic characteristics.

The Varanger Peninsula (5700 km^2) is located north of 70°N and east of 28°E (Fig. 1). It is limited in the west by Tanafjorden, in the south by Varangerfjorden, and in the east and north by the Barents Sea. The coastline around the peninsula totals 550 km. The southern littoral, along Varangerfjorden, as well as the western coast are quite linear. The coast facing the Barents Sea is more irregular with some small fjords. Båtsfjord and Syltefjord are the two longest (about 15 km) and deepest (more than 100 m).

The predominance of some processes and forms (determined by its latitudinal location) give this northern coast a very special character, only comparable with some other arctic areas. Indented fjord coasts dominated by rock outcrops, steep cliffs and only small, locally-derived, accumulations of sedimentary material (Klemsdal, 1982) are typical. Frost shattering is an important process as it is the main mechanism providing sediment supply to the littoral system. In the mountain areas of the Varanger Peninsula, the glaciers were cold based and frozen to the bed during the whole period of glaciation. This explains why there is no sign of glacial erosion on large parts of the peninsula even though the area has been glaciated several times. Glacial deposits on valley floor and melt water channels along valley sides show that the valleys must have been formed before the last inland ice disappeared more than 10 000 years ago (Sørbel and Tolgensbakk, 2004). In addition, large systems of parallel meltwater channels strongly indicate a down-melting of a cold ice. The inner and higher parts of the peninsula are to a large extent covered by boulder fields due to frost shattering.

The main coastal features on the peninsula are different types of cliffs, many with wave-cut platforms (active or relict); sandy bays close to major river mouths; dune fields in areas with abundant sediment supply; and isostatically raised beach ridges often covering the whole area from the marine limit (maximum altitude reached by the sea during the postglacial period) to the present shoreline. There are some sandy beach ridges, but most of them are composed of cobbles and boulders (Sanjaume and Tolgensbakk, 2005a). The present shoreline is characterized by steep, reflective, cobble and boulder beaches. Moderately to well sorted, well rounded cobbles of quartzite with a mean diameter between 10 and 15 cm constitute the bulk of the modern beach sediment in the area (Sanjaume and Tolgensbakk, 2005b).

High-latitude coasts are dominated by coarse clastic material, often of glacigenic origin (Forbes and Syvitski, 1995). Gravel beaches

* Corresponding author.
E-mail addresses: Eulalia.Sanjaume@uv.es (E. Sanjaume), jon.tolgensbakk@geo.uio.no (J. Tolgensbakk).

0169-555X/$ – see front matter © 2008 Published by Elsevier B.V.
doi:10.1016/j.geomorph.2008.05.029

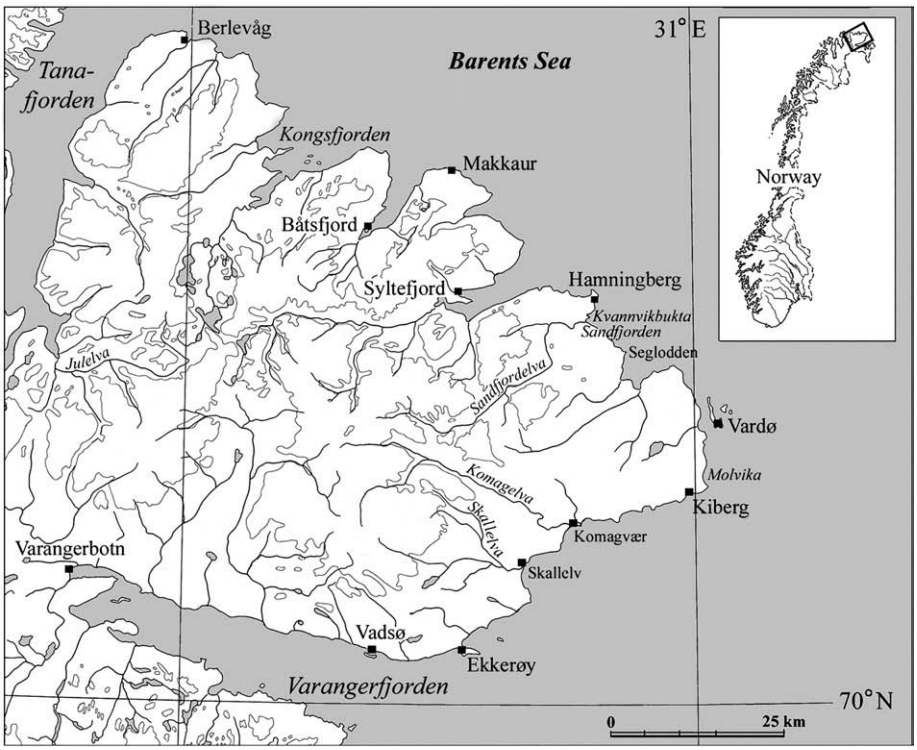

Fig. 1. Key map of the Varanger Peninsula.

have distinctive morphodynamic characteristics and their long-term stability is conditioned by strong morphosedimentary inheritance and feedback effects in combination with important external controls such as sea-level change, wave climate, and sediment supply (Carter and Orford, 1984; Orford et al., 1991; Forbes et al., 1995a). In Canada, Taylor and McCann (1983) found that glacial deposits were not abundant and, because most of the sediment is derived from local bedrock, beach sediment thickness is less than a few meters. The same condition exists on the Varanger Peninsula.

2. Deglaciation of the Varanger Peninsula

The timescale for the ice recession is not known in detail. But based on calculations of shoreline displacement, it is assumed that the areas in the north and northeast on the Varanger Peninsula were deglaciated around 15 000 BP (Andersen, 1979) and Varangerfjorden around 12 000 years BP (Sollid et al., 1973; Rose and Synge, 1979) Raised shorelines and shoreline diagrams are used for relative dating and correlations of glacial retreat stages (Marthinussen, 1962, 1974). The two main "reference-levels" used to construct shoreline diagrams, the Main Line and the Tapes transgression levels, are in most places easy to recognize based on morphological criteria. Because the deglaciation of the Varanger Peninsula started earlier in the north than in the south, the marine limit is not constant. Due to differential uplift, it varies between 60 m a.s.l. around Berlevåg in the north, to almost 100 m close to Vadsø in the south. The marine limit exceeds 86 m at Hamningberg (Sollid et al., 1973). This is very high for this

Fig. 2. Tapes beach ridge in Kvannvikbukta.

Fig. 3. Tapes abrasion terrace in Store Molvika.