Archaeological and radiocarbon dating of the Holocene transgression maximum (Tapes) on Skuløy, Sunnmøre, western Norway

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A cross-section of a beach ridge from the Tapes transgression maximum on the southwest side of Skuløy, Sunnmøre, western Norway exposed four stratigraphically separated cultural horizons. The thickest horizon overlies ca. 1 m of beach sediment/eolian sand, and is covered by beach sediments from the Tapes transgression maximum. The preliminary archaeological investigations of the site have yielded four radiocarbon dates from two of the cultural horizons, indicating that the transgression maximum was reached shortly after 6320 ± 110 years BP, and in any case before 4530 ± 190 years BP. The duration of the transgression maximum at Skuløy was less than 1800 yrs.

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Results from relative sea level investigations are a valuable aid in the construction of the chronological framework for the Stone Age in Norway (Brøgger 1905, Nummedal 1924, Helskog 1974, Mikkelsen 1975, Møllenhus 1977, Bakka 1979). Information on earlier sea levels has also made it possible to formulate hypotheses about prehistoric environments and human adaptations.

Archaeological data have also provided information on former sea levels (e.g. Bjørgo 1981, pp.30–36; Bruen Olsen 1981, pp. 85–93). A major advantage of archaeological data is that prehistoric human activities have resulted in the accumulation of datable material in environments where such material is not found naturally. The uncertain vertical distance between the dated cultural remains and the synchronous sea level is, however, always a problem. It is apparent that this distance has varied greatly (Clark 1936, p. 15; Moberg 1957, p. 222; Bjørgo 1981, pp. 35–36).

In recent years four stone age sites underlying beach sediments from the Tapes transgression have been investigated in Norway (Fig. 1). A problem shared by all these sites is the time relationship between the cultural horizons and the beach sediments. The site at Stølen is unique in this context. A cross-section of the beach ridge from the Tapes transgression maximum exposed four separate cultural horizons which could be stratigraphically correlated to the beach deposits. Radiocarbon dates and the relationships of the horizons form the basis for the evaluation of the time lapsed between the different horizons and provide an indirect dating of the Tapes transgression maximum.

Study area

Skuløy is a 15 km^2 large island ca. 25 km north of Ålesund. It has the characteristic 'hat form' which is typical for the Sunnmøre islands (Holtedahl 1960) (Fig. 2). The site on the Stølen farm is located on the south side of the island (Fig. 3). The beach ridge from the Tapes transgression maximum has an elevation of ca. 10 m.a.s.l., and can be traced more or less continuously along the entire south and east sides of the island (Undås 1942, p. 15; Reite 1967) (Fig. 3).

The investigated cross-section is located ca. 25 m east-southeast of a small stream which cuts through the beach ridge, ca. 180 m from the present shoreline. Today this stream has an artificial course. The original course was nearly straight (Fig. 4). The investigated trench swings towards northeast when it cuts through the beach ridge (Fig. 5). The cross-section (Fig. 6) is not perfectly perpendicular to the beach ridge.

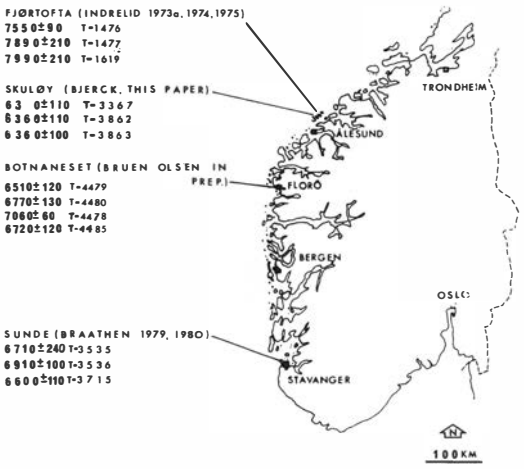

Fig. 1. Map over southern Norway showing sites with radiocarbon dated cultural horizons underlying beach sediments. All radiocarbon dates are presented in radiocarbon years BP with half-life of 5570 years, and were performed by the Laboratorium for Radiologisk Datering, NTH, Trondheim.

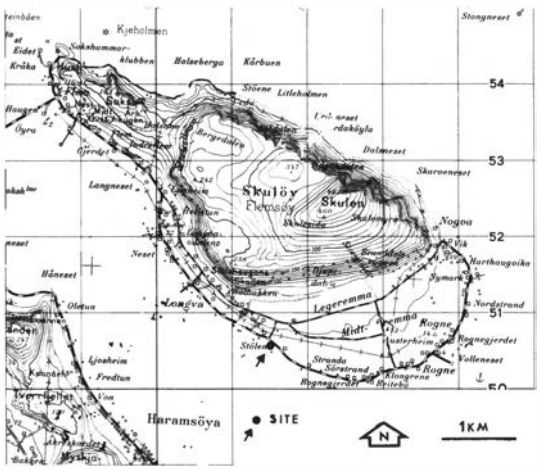

Fig. 2. Map over Skuløy showing the location of the site. (Map section 1220 III Brattvåg M-711 series reproduced with permission of Norges geografiske oppmålning.).

Description of the cross-section (Figs. 6 and 7)

The description and interpretation of the cross-section are based on visual evaluation in the field. The exact genesis of the sediments is therefore somewhat uncertain. Bed numbers in the description refer to Figs. 6 and 7. The beds' form, and stratigraphic relations are illustrated in Figs. 6 and 7 and are not repeated in the following description. The cross-section is described from bottom to top.

Bed 1. Poorly sorted sediment consisting of grain sizes ranging from clay to boulders, well rounded to rounded particles. The deposit was only observed in a test pit at the base of the cross-section and is interpreted as a glaciomarine sediment.

Bed 2. Unstratified, well sorted, medium grained sand, probably of eolian origin.

Bed 3. Peat, weakly humified, contains plant macrofossils (wood fragments, roots).

Bed 4. Unstratified, well sorted, medium grained sand, probably eolian.

Bed 5. *Cultural horizon*. Dark, brownish black lens with mixed charcoal and humus in sand (Bed 4). Contains worked flint. The horizon has not been further investigated.

Bed 6 and 9. Gravelly sand with well rounded cobbles, appears to be bimodally sorted (cobbles and sand). Bed 6, 9 and 11 merge, and cannot be separated towards the proximal side of the beach ridge. They are interpreted as beach sediment.

Bed 7. Well rounded, well sorted cobbles in a sand matrix, clear bimodal sorting. The cobbles are smaller and better sorted than similar sediment on the proximal side of the beach ridge (Bed 6, 9 and 11). Probably beach sediment.

Bed 8. Lens of unstratified, well sorted, medium-size sand with some cobbles. Probably eolian, or alternatively beach sand.

Bed 9. See Bed 6.

Bed 10. *Cultural horizon*. Greyish brown deposit of gravelly sand with well-rounded cobbles and some organic material. The bed is well mixed with charcoal and contains worked flint. Approximately 5 m^2 of the deposit have been investigated. The archaeological material is clearly flint dominated (92.5 %), but quartz/quartzite (3.3 %), quartz crystals (2.5 %), and basic rock types (0.8 %) have also been utilized. The proportions of raw materials are based on the total number of artifacts. Visible secondary preparation or use wear is apparent on 6.8 % of the artifacts. An edge fragment of an axe/wedge of fine-grained basic rock, a core tool of a similar rock type, microblades and microblade cores date the cultural horizon typologically to the Late Mesolithic Microblade Tradition, ca. 8000–5200 years BP (Indrelid in press, p. 19, Mikkelsen 1975, p. 31). Microblade-like flakes and bipolar cores are, however, more common than

Fig. 3. Airphoto over Skuløy looking northeast. The approximate position of the Tapes beach ridge is shown by open circles, the site at Stølen is marked by a closed circle. The trench with the described profile lies to the right of the site. (Photograph: Svein Skare, Historisk Museum in Bergen.)

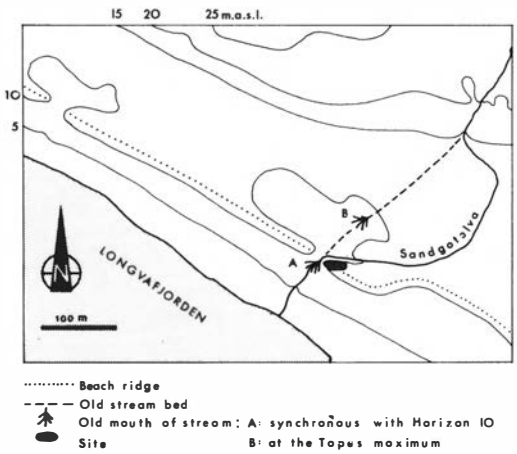

Fig. 4. Map over the site area illustrating both the original and the present stream beds, and the relation between former mouths of the stream and the site. (Taken from Økonomisk Kartverk AP 104-5-4.)

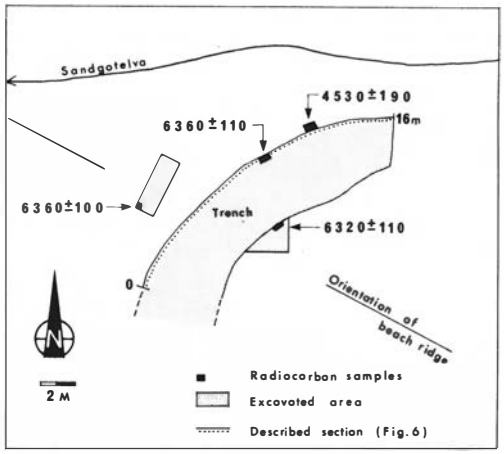

Fig. 5. Horizontal plan of the site showing the locations of the radiocarbon dates and the excavated areas. The cultural horizons were discovered in the walls of the machine excavated trench, which was dug to lay the Sandgot river in pipes. The trench continues south towards the present beach.

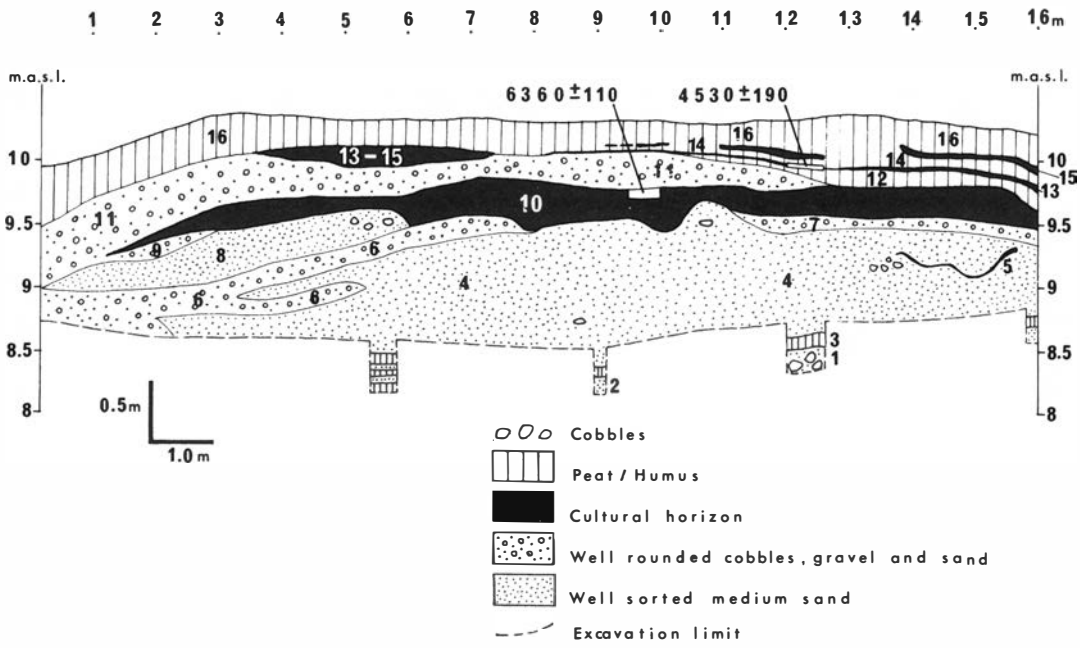

Fig. 6. West wall of the trench through the Tapes beach ridge. (Fig. 5). The vertical scale is doubled. The profile cuts through the beach ridge in a curve and is not perpendicular to the beach ridge. The numbers on the different beds refer to the description of the cross-section.

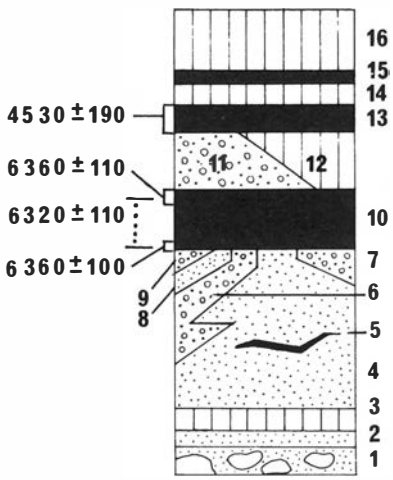

Fig. 7. Schematic drawing of the stratigraphic relations in the profile (Fig. 6) showing the stratigraphic locations of the radiocarbon dates. For Symbol key see Fig. 6. Bed numbers are identical to those used in the text and Fig. 6.

microblades and microblade cores (Signe Nygård pers. comm.). The use of bipolar cores appears to be associated with the younger part of the Late Mesolithic Tradition and the beginning of the Neolithic period, but the chronological relationships of this technique are uncertain. Also characteristic for the horizon are grinding slabs, hammerstones, blades, and flakes with assorted kinds of retouch. The deposit contained large amounts of burnt hazelnut shells and ca. 30 fragments of burnt bone. Among these are identified trout (Salamo trutta) and unspecified medium-sized mammals (Rolf W. Lie, Zool. Mus., Univ. i Bergen, pers. comm.).

Three radiocarbon dates are available from bed 10:

(T-3863) 6360 ± 100 years BP: The sample was taken from a 20 × 20 × 3 cm area in the bottom of the bed, at the boundary to Bed 6 (Figs. 5, 6, and 7). The sample consisted of burnt hazelnut shells from a charcoal concentration with burnt bone fragments.

(T-3367) 6320 ± 110 years BP: The sample was taken from a charcoal concentration in the profile and cannot be related to a specific part of the bed. The sample consisted of a mixture of burnt hazelnut shells and charcoal.

(T-3820) 6360 ± 110 years BP: The sample was taken from an area 50 × 20 cm in the upper 10 cm of the bed (Fig. 5, 6 and 7), and consisted of a mixture of burnt hazelnut shells and charcoal.

Bed 11. Gravelly sand with well rounded cob-

bles, which appears to be bimodally sorted, especially towards the proximal side of the beach ridge. The bed is interpreted as a beach sediment from the Tapes transgression maximum. The deposit differs from a 'normal' beach sediment in three ways:

1) A dark, brown colour that probably is due to organic material.

2) Large, well-rounded cobbles (10–15 cm) which are conspicuous in the otherwise even grain size.

(3) Cultural remains in the form of worked flint. Some 300 artifacts, i.e. 13 % of the total number of artifacts from Stølen, are from this bed. The proportions of the raw materials are nearly identical with the under- and overlying cultural horizons. Elements from both Late Mesolithic and Early Neolithic periods are among the artifacts: A tanged point, an edge fragment from an ax/wedge of fine grained basic rock, microblades, and microblade cores (Indrelid 1973b, pp. 53–55, 1976, p. 7, in press, p. 17, p. 19).

The archaeological material in the beach sediment can be explained in two ways. The artifacts could be the result of the in situ preparation and accumulation of spalled flint during the formation of the beach ridge, or the artifacts could be the result of resedimentation of worked flint from the underlying cultural horizon (Bed 10) and secondary mixture of artifacts from the overlying cultural horizon (Bed 13). The amount of artifacts is relatively large and appears to be evenly distributed throughout the entire deposit. Only 10 % of the artifacts have traces of water-rounding (Fig. 8). From these observations it is concluded that human activity was simultaneous with the deposition of the bed. This also explains the content of larger cobbles; such cobbles were consistently observed in the underlying cultural horizon (Bed 10), and were probably gathered for use in different constructions. The content of organic material can be the result of human activity or downwash from the overlying peat. The water-worn artifacts (Fig. 8) support the interpretation of the sediment as a beach gravel.

Bed 12. Peat, highly humified, containing some pebbles. Interpreted as organic accumulation as a result of poor drainage behind the beach ridge. A single oblique-edged projectile point was found in the peat.

Bed 13. *Cultural horizon*. Brownish black, plastic, organic material rich in charcoal, containing worked flint. Towards the proximal side

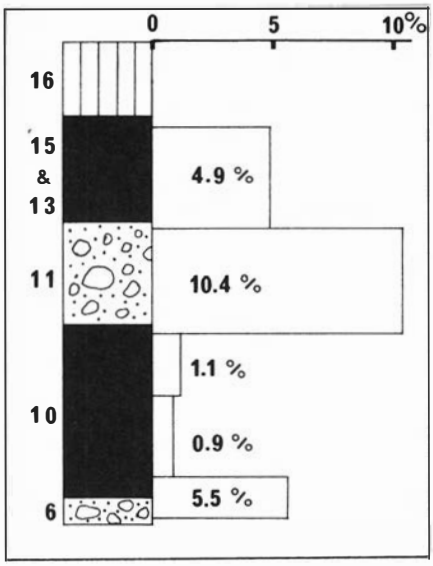

Fig. 8. Relative proportions of artifacts with water-rounding following the last episode of flaking. Calculations are based on the number of artifacts (1676) in the different excavation layers in the investigation area (3 m^2) farthest west (Fig. 5).

of the beach ridge (3–3.75 m in the profile, Fig. 6) the bed gradually merges with the underlying beach sediment. This portion probably represents both cultural horizons (Bed 13 and 15). In the excavated areas west and east of the trench (Fig. 5), the same relationship was apparent. The archaeological remains from these beds have therefore been combined in the analysis.

The finds consist of 433 artifacts, i.e. 19 % of the total amount of artifacts. 8 % of the artifacts have visible traces of use wear or retouch. The proportions of different types of raw materials, based on the total number of artifacts, are as follows: 93 % flint, 6 % quartz/quartzite, and 1 % quartz crystals. One tanged point, 1 pottery shed, 1 bore, 3 blades, 16 microblades, 1 possible microblade core, bipolar and irregular cores, and flakes with assorted kinds of retouch are among the artifacts. The artifact assemblage does not permit certain chronological identification. The use of tanged points and ceramics points to the first half of the Younger Stone Age (Indrelid 1973b, pp. 53–57, in press, pp. 17–18), probably within the period of time from 4500–5200 years BP.

One radiocarbon date is available from Bed 13:

(T-3861) 4530 ± 190 years BP. The sample was

taken from a 50 × 50 cm area × the thickness of the entire bed (Figs. 5 and 6). The sample consisted of a mixture of charcoal and burnt hazelnut shells.

Bed 14. Peat, weakly humified, contains plant macrofossils. The bed is discontinuous, but can be traced between Beds 13 and 15 (cultural horizons).

Bed 15. *Cultural horizon*. Dark brown peat mixed with sand and charcoal, contains worked flint. The bed is discontinuous, probably due to disturbance by recent agricultural activity. The archaeological remains are described in Bed 13.

Bed 16. Silty sand loam, interpreted as cultivated soil.

Discussion and conclusion

The radiocarbon dates from Bed 10 show that the accumulation of beach sediment in the lower part of the Tapes beach ridge (Beds 6, 7, and 9) began prior to 6360 ± 100 years BP. The different tongues of coarse beach sediment (Beds 6, 7, and 9) can be attributed either to storm action or to slight fluctuations in relative sea level. The type and thickness of the sediment between these beds indicate that some time elapsed between each episode of deposition. However, investigations of active beach ridges in the Orkney Islands (where a transgression is occurring today) shows that deposition is highly variable. After years of stability, storm waves can cause rapid accumulation of sediment on a beach ridge. The gradual rise of sea level imparts increasing wave energy to each episode of extreme weather, and the ridge is moved farther up the beach (Peter Emil Kaland, pers. comm.). Thus the different beds of coarse beach gravel at Stølen can simply be due to shifting weather conditions during a gradual transgression.

The radiocarbon dates from Bed 10 yielded nearly identical ages. However, the samples have some thickness, and the dates represent a level somewhat below the upper boundary and above the lower boundary of the bed. The cultural horizon (Bed 10) is 100–300 m^2 in area, and relatively thick. In view of the abundant local resources and the present model of the population and settlement pattern in the West Norwegian Older Stone Age, it is reasonable to suggest that Bed 10 represents several generations of occupation.

The upper, most distinct layer of beach sediment (Bed 11) represents the Tapes transgression maximum. The radiocarbon dates from Bed 10 indicate that deposition began after 6320±110 years BP. During the Tapes transgression maximum, waves have washed over the site, and this may in fact have caused the abandonment of the site. The nearby stream (Sandgotelva) has probably been a decisive factor in the choice of the site. Sea-level rise probably moved the mouth of the stream to the other side of the depression behind the beach ridge, at least during high tide (Fig. 4).

These factors decreased the attractiveness and potential of the site and provide an argument for the Tapes transgression maximum to follow immediately after the deposition of Bed 10. The archaeological remains from Bed 11 also indicate that the site was occupied during the Tapes transgression maximum. However, the function and intensity of this phase of the occupation were probably different due to the changing physical conditions at the location. The actual living quarters were most likely moved to a nearby location.

The dates from Bed 13 set a minimum age for the beach sediment in the ridge. This implies that the regression began prior to 4530 ± 190 years BP at Stølen. The peat horizon behind the beach ridge (Bed 12) is probably a result of poor drainage during and after the formation of the beach ridge, and represents a time period of unknown duration between the beginning of the regression and Bed 13. The radiocarbon dates from Beds 10 and 13 show that beds 11 and 12 were deposited within 1790 ± 220 years.

No detailed sea-level investigations from Sunnmøre are presently available. However, such an investigation is under way (I. L. Kristiansen. S. E. Lie, L. Lømo, J. Mangerud, Geol. inst. Avd. B, Univ. of Bergen, pers. comm.) and has provided a probable age of between 8220 ± 90 (T-3984A) and 7560 ± 110 (T-4162A) years BP for the Tapes transgression maximum near Ålesund (Fig. 1).

The nearest relative sea-level curves are from Frosta, Trondheimsfjord (Kjemperud 1981) and Fonnes, Nordhordland (Kaland in prep.). The Tapes transgression is not apparent in the Trondheimsfjord due to rapid isostatic rebound. The duration of the transgression maximum at Fonnes is based on radiocarbon dates from a continuous brackish water phase in one of the basins. The maximum duration of a stable relative sea level appears to be 1200–1300 radiocarbon years, from 7200–5900 years BP. Fluctu-

ations in relative sea level greater than 10–20 cm should have been registered in this basin (P. E. Kaland, pers. comm.).

Investigation of a Tapes beach ridge at Haramsøy, ca. 4 km west of Stølen has provided a maximum age of 7280 ± 100 years BP (T-831) (Hafsten & Tallantire 1978, Hafsten 1979). The radiocarbon sample was taken from the uppper part of a peat horizon underlying the beach ridge. Pollen-analytic results support the relationship of the radiocarbon dates and the synchronous sea level. The vegetational composition in the upper pollen spectra indicates an increasing groundwater level and a distinct increase of beach flora. This is seen in connection with proximity to sea level, the transgression maximum.

The radiocarbon dates from Stølen show that the formation of the beach ridge began before 6360 ± 100 years BP. The lower part of the beach ridge at Haramsøy could be synchronous with Beds 6, 7 and 9 at Stølen. The radiocarbon dates from Stølen are thus in good agreement with the dates from Haramsøy. Together these radiocarbon dates indicate that accumulation of the Tapes beach ridge began after 7280 ± 100 years BP, and that the maximum relative sea level was reached between 6320 ± 110 and 4530 ± 190 years BP. The stratigraphy at Stølen indicates that the transgression maximum is much closer to 6320 than 4530 years BP. This is slightly younger than preliminary investigations in the Ålesund area indicate (Kristiansen et al., pers. comm., see p. 92). The earlier transgression maximum at Ålesund may be attributed to its more inland location.

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