A combined modern training set from three salt marshes and tidal flats of Mainland, Shetland Islands (UK), as a tool for local relative sea-level reconstruction

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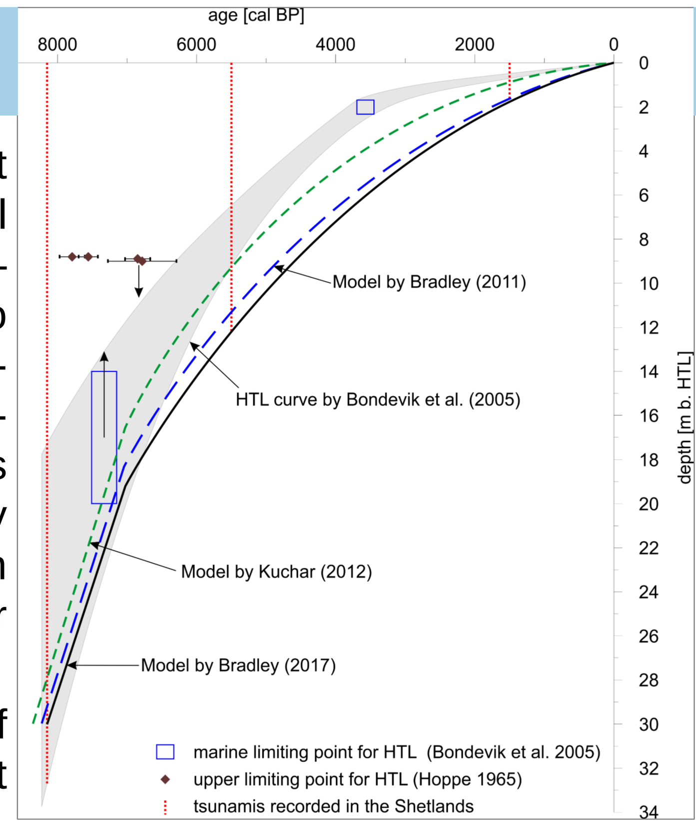
Introduction

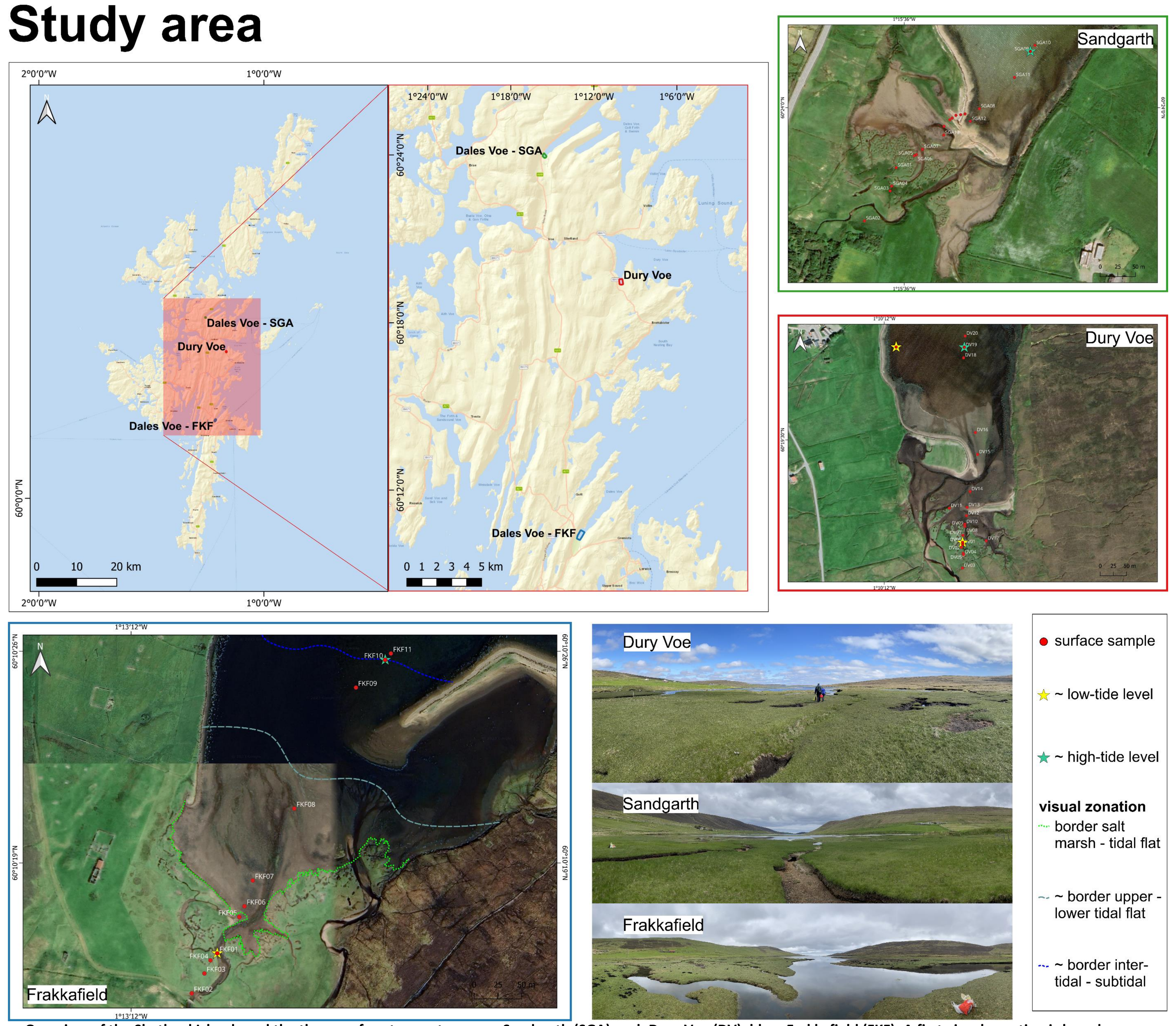
Managing coastal-protection challenges and hazard assessment requires high-resolution reconstructions of the relative sea-level (RSL) evolution. The NORSEAT Project (*Storegga and beyond – North Sea tsunami deposits offshore Shetland Islands*) aims to identify and trace Holocene offshore tsunami deposits and improve reconstructions of RSL change and of palaeo-tsunami run-up in the Shetland Islands, United Kingdom. Existing RSL data is sparse and the chronology needs to be extended to the early Holocene, which shall be enabled by a combined modern training set of foraminifers and ostracods for a RSL transfer function (TF).

Here we provide first results of the microfaunal analysis of modern samples from three different salt marshes and adjacent tidal flats.



RSL data of the Shetland Islands; state of the art

Study area



Overview of the Shetland Islands and the three surface transects: green: Sandgarth (SGA), red: Dury Voe (DV), blue: Frakkafield (FKF). A first visual zonation is based on observations in the field

Applied Methods

44 Surface samples (diameter 5 cm) were collected comprising the uppermost 3 cm of salt-marsh and tidal-flat deposits. Additional sediment samples serve for sedimentological and geochemical analysis.

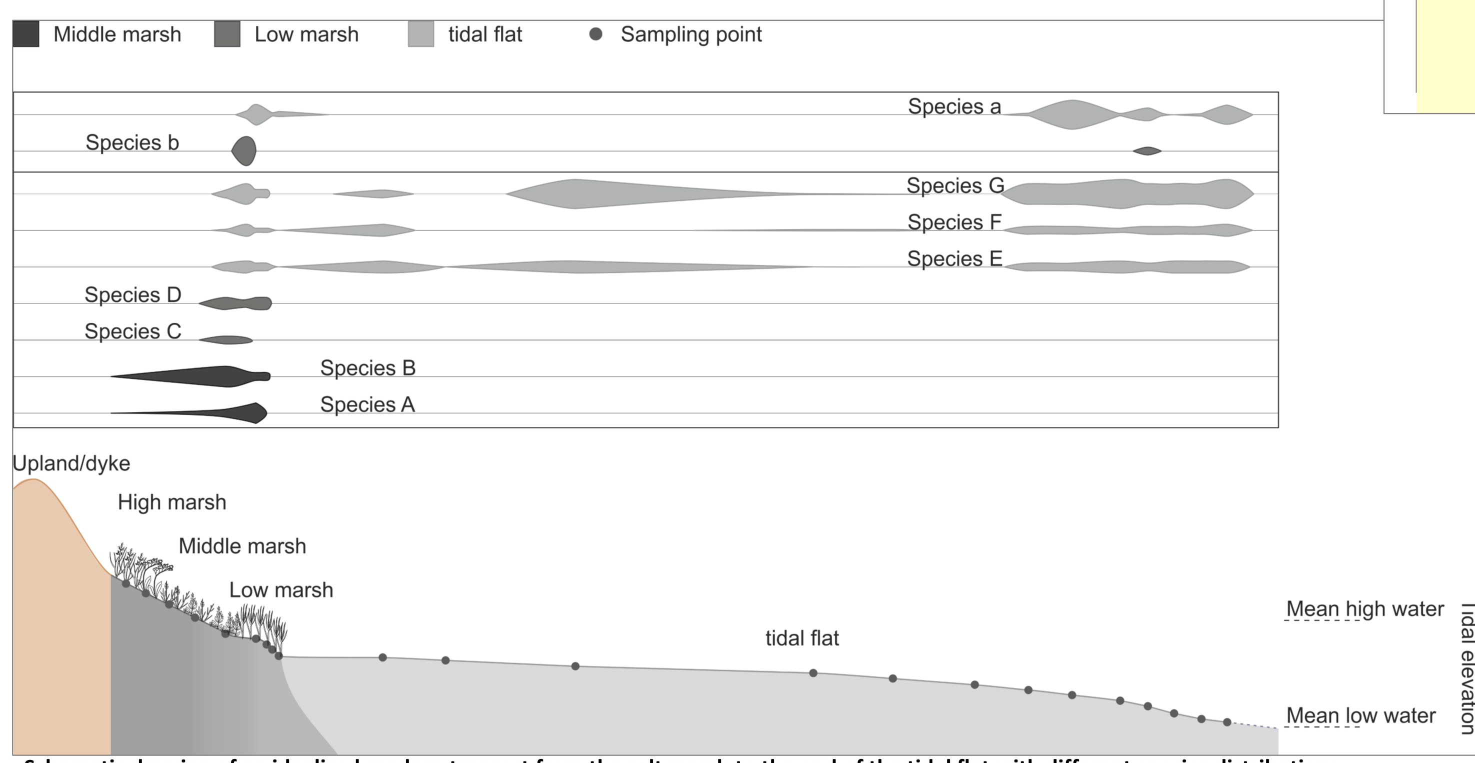

Sampling at high-tide level (left) and in the salt marsh (right) (Photos: J. Scheder 2023)

For each transect, one sample was collected at the high-tide level, one at the low-tide level and the lowermost sample was collected ~10 m (laterally) into the subtidal. Samples were stained with rose bengal to distinguish between living and dead microfauna.

Location and elevation relative to mean sea level were determined using a differential global positioning system (Leica DGPS). The DGPS was operated offline and post-processed to get final data.


Sampling below low-tide level (left); DGPS equipment (right) (Photos: J. Scheder 2023)

The species distribution of foraminifers and ostracods is determined on the >100 µm fraction of the surface samples. A lateral and vertical zonation of the species distribution can be used to derive a TF for RSL change, if the distribution is driven by the elevation relative to mean sea level.

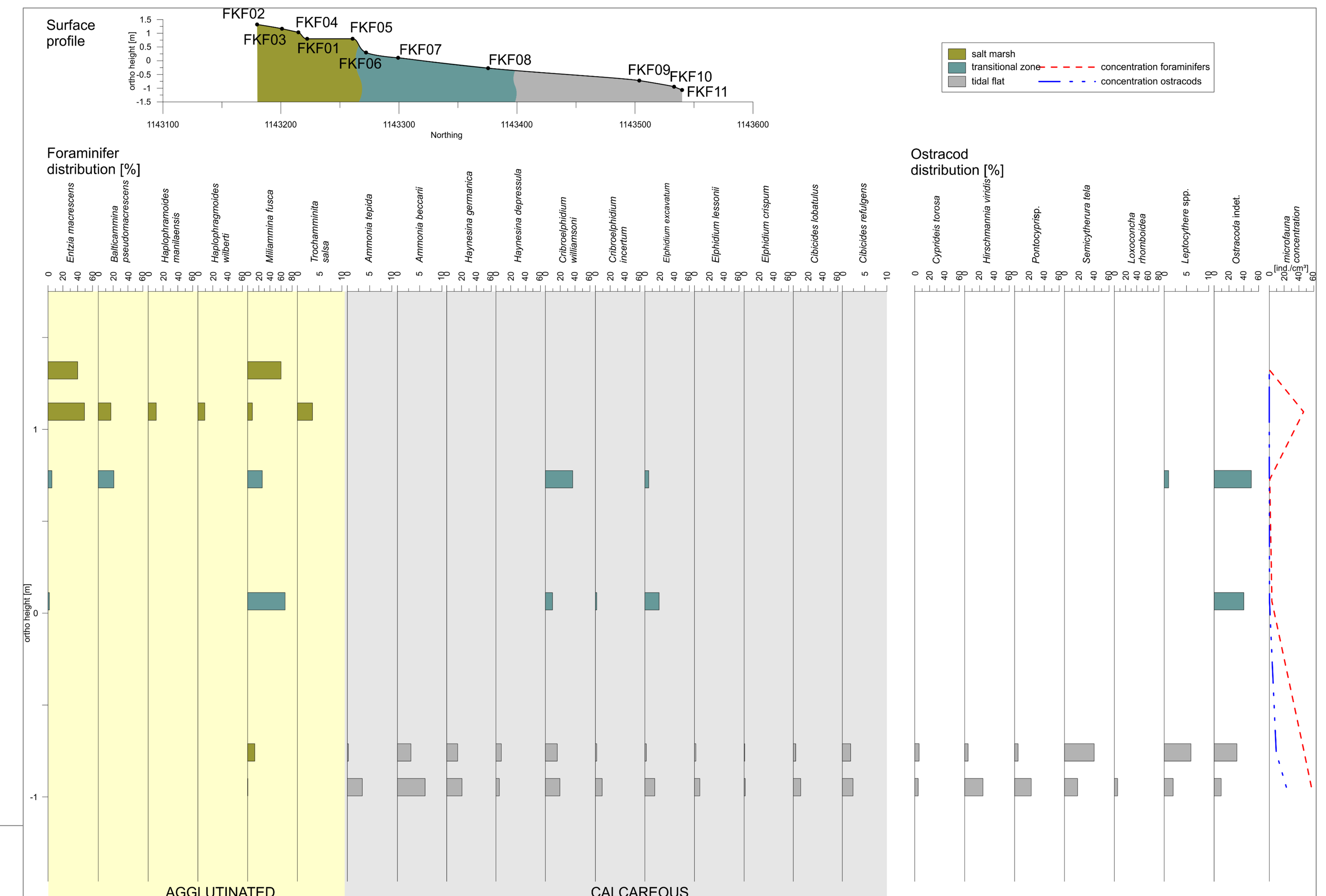


Schematic drawing of an idealised modern transect from the salt marsh to the end of the tidal flat with different species distributions (Scheder 2020, *unpublished*)

Preliminary results and discussion

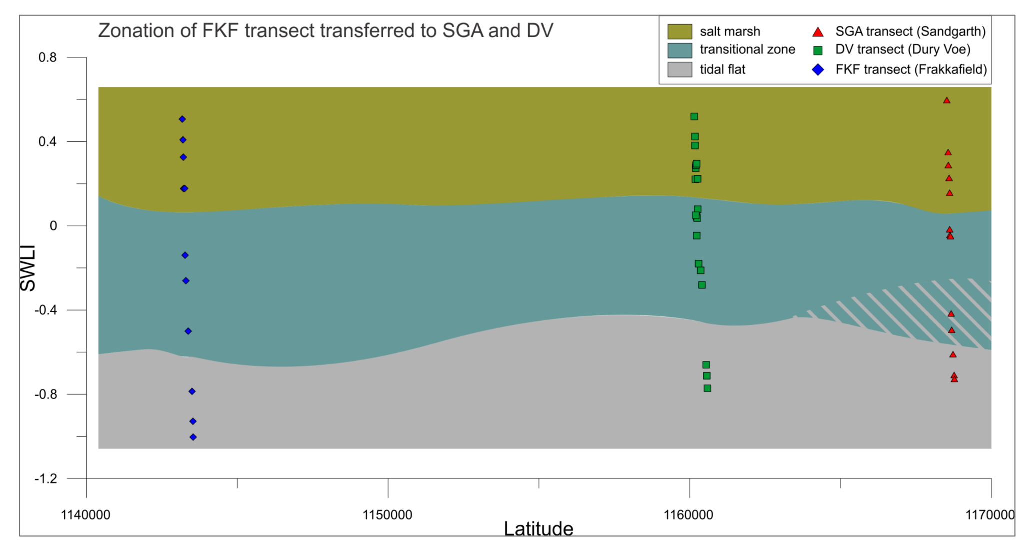
First results of the Frakkafield (FKF) transect support the first visual zonation of the site. The salt marsh is characterised by a diverse microfauna of agglutinated foraminifers, typical for salt marshes and dominated by *Entzia macrescens* (Brady, 1870) and *Miliammina fusca* (Brady, 1870).The salt marsh is void of calcareous microfauna, which may be due to high organic contents and related humic acid dissolving any carbonate material.

The upper tidal flat can be seen as a transition with some agglutinated foraminifer species still present (lower diversity) together with three calcareous foraminifer species typical for shallow-marine conditions and tidal flats. So far, the very few ostracods are not yet determined in detail and the only genus that is definitely present is *Leptocythere* (Sars, 1925). However, the microfauna concentration is very low in this zone.



Towards lower elevations, the microfauna concentration rises. The distribution in the lower tidal flat is more diverse and characterised by 11 foraminifer and at least six ostracod species, which are all typical for this intertidal environment. Foraminifers are dominated by the *Ammonia* group (*A. tepida (Cushman, 1926) and A. beccarii* (Linnaeus, 1758)) with subsidiary *Cribroelphidium williamsoni* (Haynes, 1973) and two species of *Elphidium* (*E. excavatum* (Terquem, 1875), *E. lessonii* (d'Orbigny, 1839)). The few individuals of *M. fusca* were probably relocated by the strong tidal current. The diversity of ostracods is also higher in this zone. Preliminary identification suggests *Semicytherura* cf. *tela* (Horne & Whittaker, 1980) and *Leptocythere* as dominant taxa.

The individuals of *Leptocythere* that have not been identified to species level will need to be determined in more detail, as they appear in the upper as well as in the lower tidal flat.



Outlook

The microfaunal data will be complemented by sedimentological (grain size) and geochemical (organic and carbonate content) data. After identifying the main driving environmental parameter for the microfauna distribution, the TF will be derived from the combined training set. When combining all three sites, elevations are to be transferred to a standardised water-level index (SLWI). The final TF will be applied to the Holocene offshore record of the Shetland Islands to reconstruct the RSL evolution.

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