Constructing an offshore tsunami event stratigraphy for the Shetland Islands

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Offshore tsunami deposits have received considerably less attention than their onshore counterparts, despite the fact that they have a higher likelihood of being preserved in the sedimentary record, especially in sufficiently deep marine environments, below the storm wave base. Here we provide the first results from our study of Holocene tsunami deposits offshore the Shetland Islands. The region is characterized by an irregular coastline with fjords and numerous embayments, and relatively deep waters (up to 100 meters in depth), providing a sheltered environment, and by an extensively studied and well-documented onshore record of tsunami deposits, which should facilitate correlations between onshore and offshore event deposits.

Within the NORSEAT Project (North Sea Tsunami Deposits Offshore Shetland Island), we aim to identify and trace tsunami deposits offshore, thoroughly study their characteristics and extent, and determine whether the offshore record holds evidence of events additional to those already known from the onshore record (i.e. the Storrega tsunami and two events at ca. 5500 yr and ca. 1500 yr BP), which would offer new insights into recurrence intervals. Two surveys with RV Belgica have already been conducted, during which high-resolution geophysical data (multibeam bathymetry and backscatter, geoacoustic and seismic data) were collected, along with several vibrocores, in three embayment areas around the Shetland Islands.

Bathymetric data and sub-bottom profiles reveal a complex geomorphology, including a.o. elevated features, like bedrock exposures, and isolated depressions that function as sub-basins. The sedimentary sequences infilling these sub-basins are characterized by a complex stratigraphy and comprise several different sedimentary units. Along the west and east fjords of Sullom Voe, three distinct sub-environments (inner, middle, and outer voe) exhibit a diverse and well-preserved stratigraphy, potentially including a significant event deposit. A set of prominent strong reflectors at a depth of 1-2 m below the seafloor is interpreted as dynamic shallow marine deposits, which is supported by the results of the vibrocores retrieved at these sites. Out of the total 31 sediment cores taken, many contain coarser-grained layers sandwiched between finer-grained deposits. These coarser layers, often with sharp basal contacts and normal grading patterns, suggest temporary interruptions of the steady-state sedimentary regime and are interpreted as possible event deposits based on their contrasting textural and lithological characteristics.

In the next phase of our analysis, we aim to obtain the exact timing and detailed information about the depositional setting based on radiocarbon dating, grain size analysis, geochemical analysis, mineral distribution patterns, and the distribution of microfossils within the sediment cores, which should help us to build a robust tsunami event stratigraphy for the region, combined with planned sea-level reconstructions, assess their run-up heights based on the onshore-offshore connection and the fundamental research on sedimentary signatures and facies patterns of offshore tsunami deposits.

Keywords
Offshore Tsunami Deposits; Shetland Islands; RV Belgica; Geophysical Data; Sediment Cores