

# Mapping and monitoring of dynamic seafloor features with hydroacoustic devices in sandy coastal areas

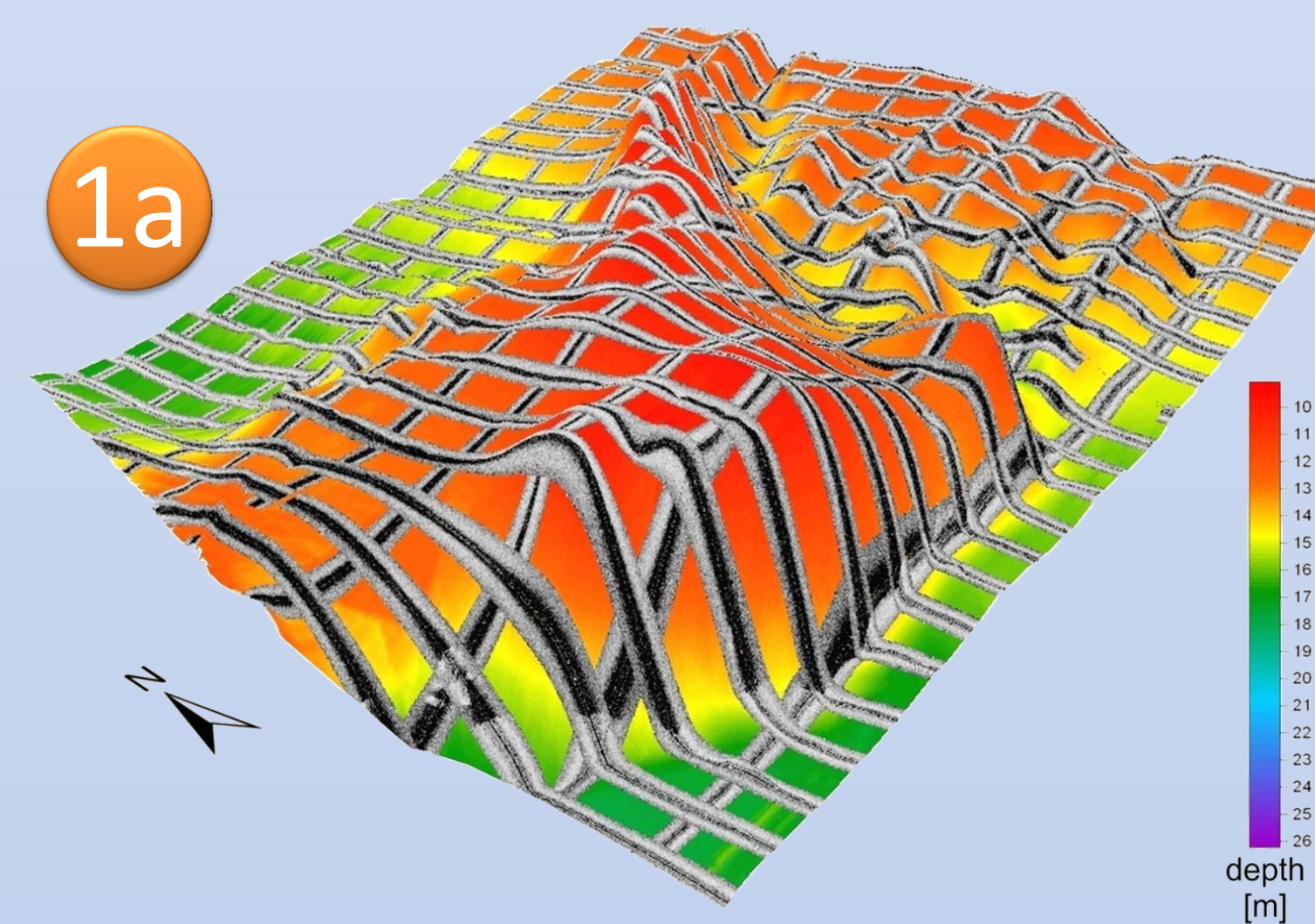
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In order to understand marine ecosystems, hydroacoustic devices have become an important tool for a quick and reliable mapping of seafloor properties in waters, where optical methods are not applicable any more. Moreover, information about changes on the seafloor due to sediment transport, biodiversity, or human activities can be observed. Within a time frame of 8 years (2007-2014) we observed an area off approx. 2500 km<sup>2</sup> located in the German Bight (SE North Sea) using different sidescan sonar devices (i.e. Imagenex YellowFin, EdgeTech 4200 and StarFish 990F). Additionally, several key areas were monitored with an interval of ~ 1 year. The full-coverage measurements of the seafloor were done with a resolution of 25 cm. For ground truthing underwater videos and more than 500 sediment samples were taken.

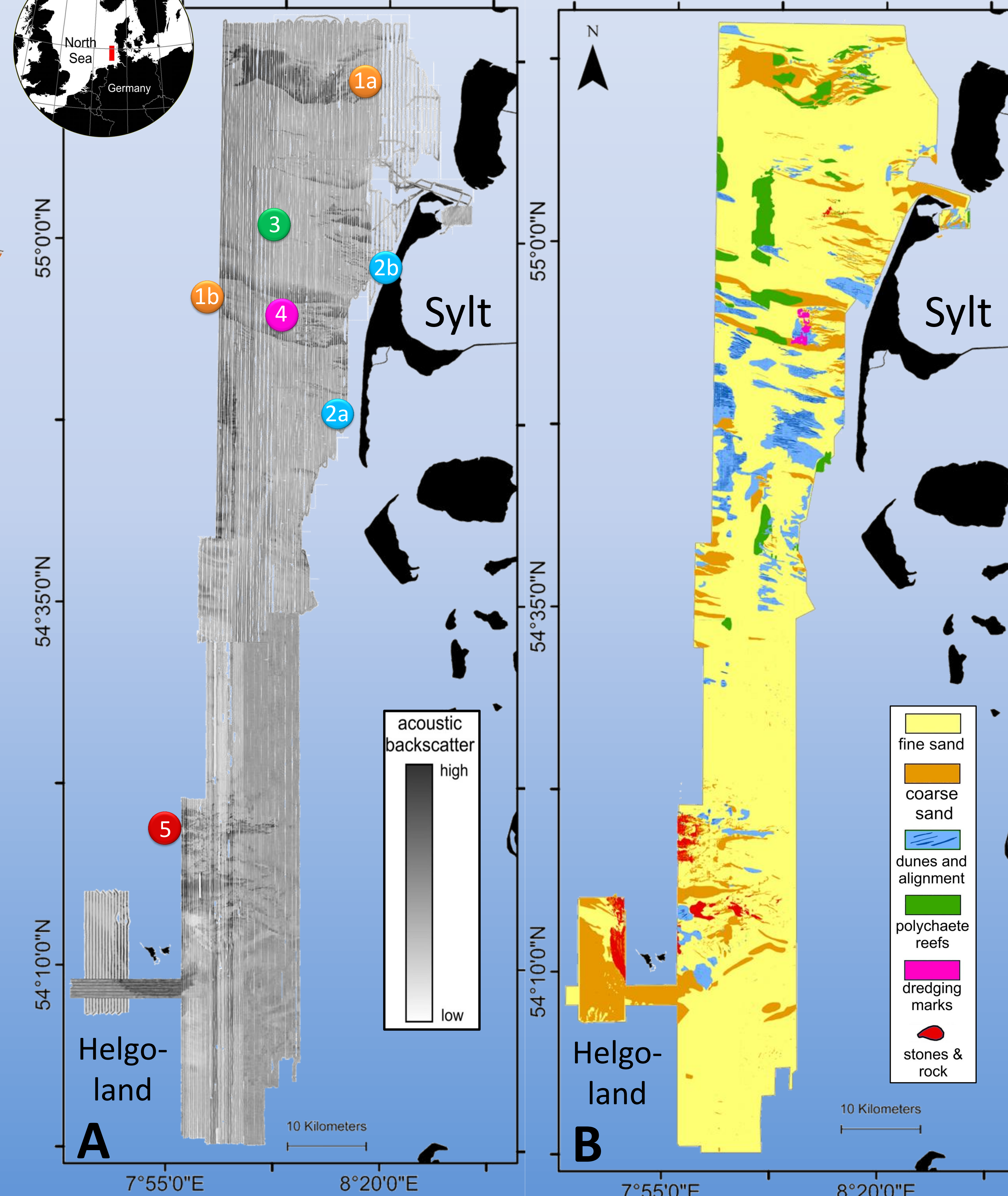
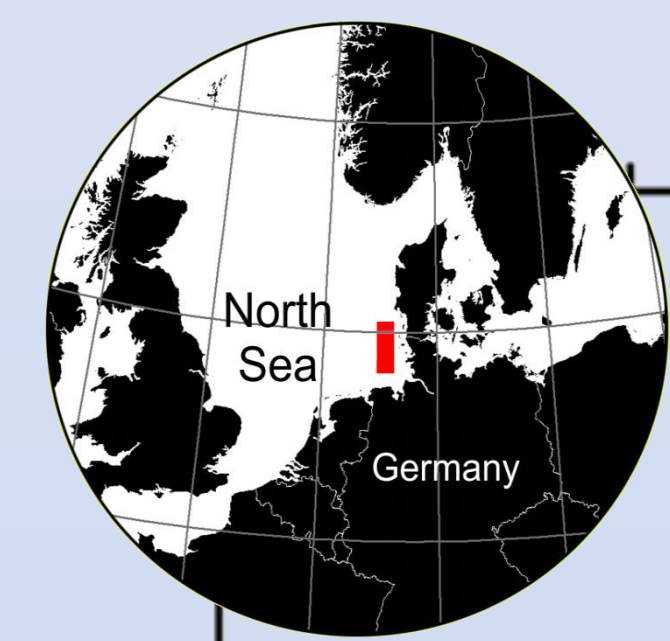
The investigation reveals that the area (water depth between 10 and 45 m) is characterized by different seafloor habitats ranging from muddy fine sand yielding low acoustic backscatter to outcropping rocks with high acoustic backscatter.

The seafloor west off the Island of Sylt mainly consists of Holocene sand often arranged in wide bands of **coarse to medium sand** surrounded by fine sand. Here, relicts of Pleistocene push **moraines** become visible stretching perpendicular to the coast in westerly direction (1a & 1b). In the sonograms they reveal high backscatter intensities and are generally consisting of coarse sand.

Near the coast, large fields with numerous of **subaquatic dunes** could be identified (2a & 2b). Depending on the prevailing flow field they show symmetric or asymmetric shapes. The asymmetric dunes are flow-transverse and migrate in flow direction (2a). Hence, they are an indicator for a permanent sediment transport in one direction. Our studies suggest that the positions of the symmetric dunes (2b) are relatively stable over the years (2c). These seafloor patterns are known as **sorted bedforms**. They consist of coarse rippled sands that underly finer sands and appear at locations where the finer sand was winnowed away.

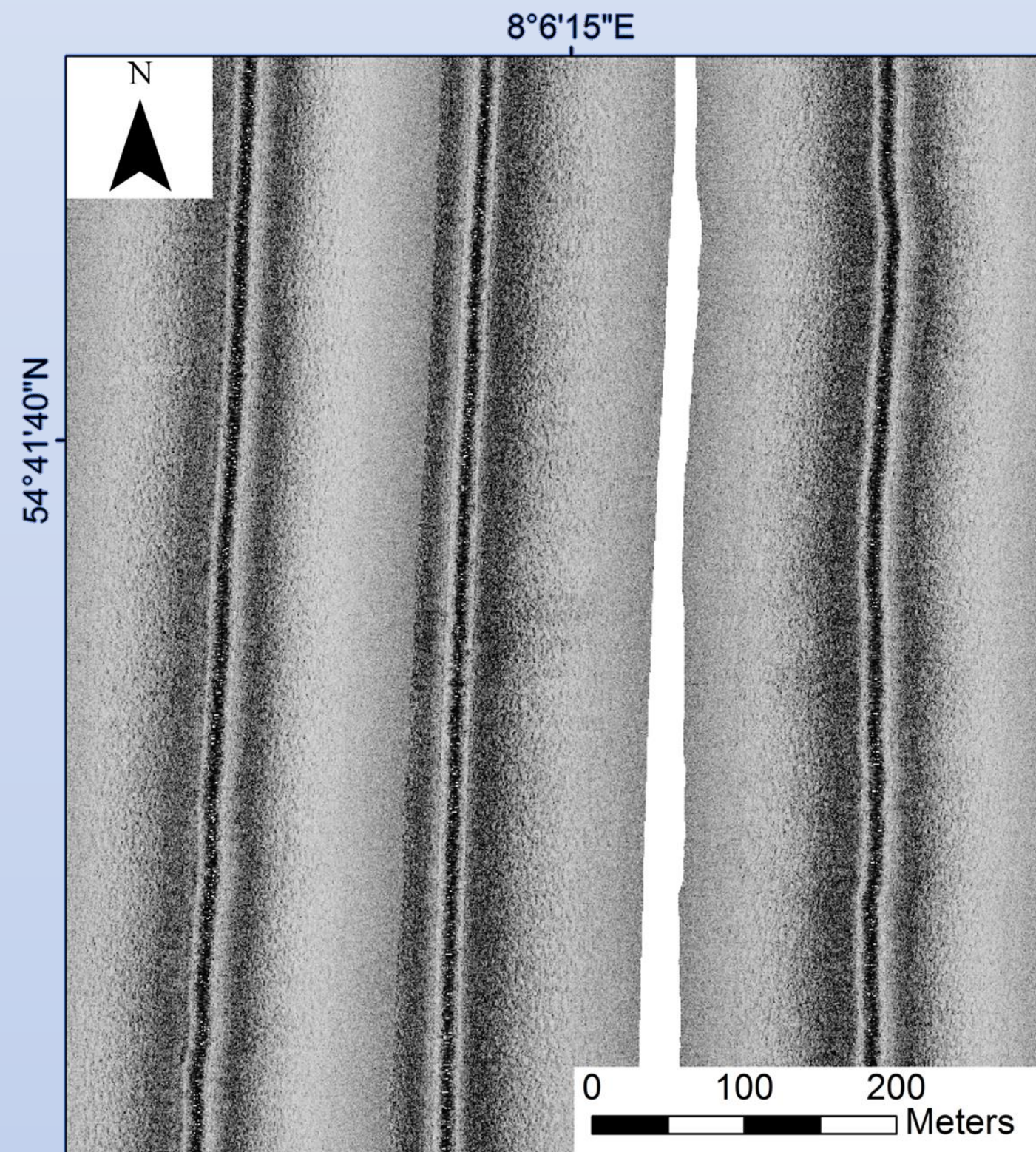


Terrain model with superimposed sidescan sonography illustrates relicts of a Pleistocene moraine (vertical exaggeration: 200).



Left: Sidescan sonar mosaic of the surveyed area showing the amount of backscatter from the seafloor. Right: Habitat classification based on sidescan sonograms and sediment samples.

Rough seafloor with numerous dark spots in the sonograms (3) could be detected especially in the northwest of the survey area. Here, the seafloor is - depending on the season - densely populated with tube-dwelling and reef forming **polychaetes** which could be verified by grab sampling.

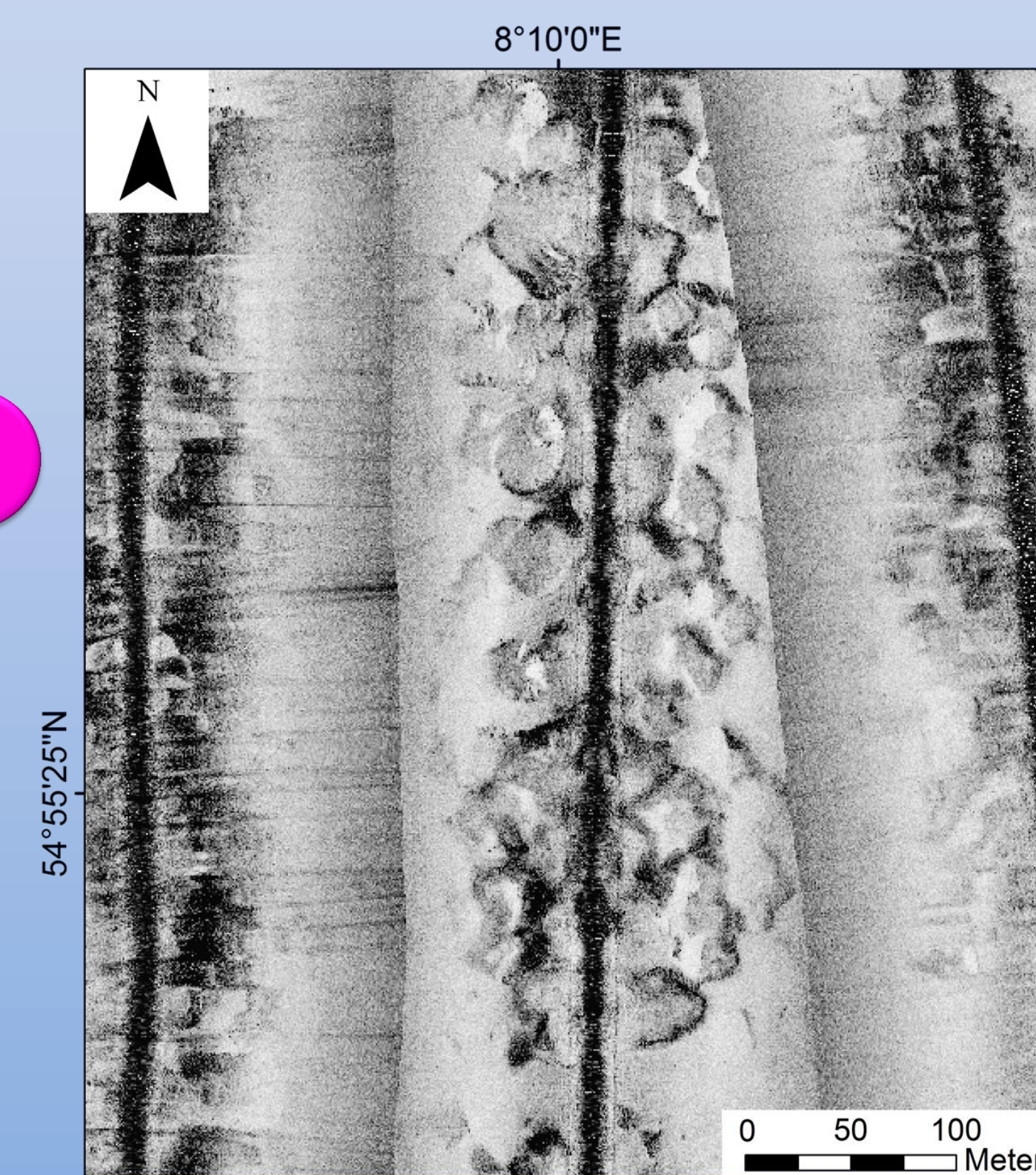


Sidescan sonar mosaic showing rough textures on the seafloor caused by polychaete reefs.

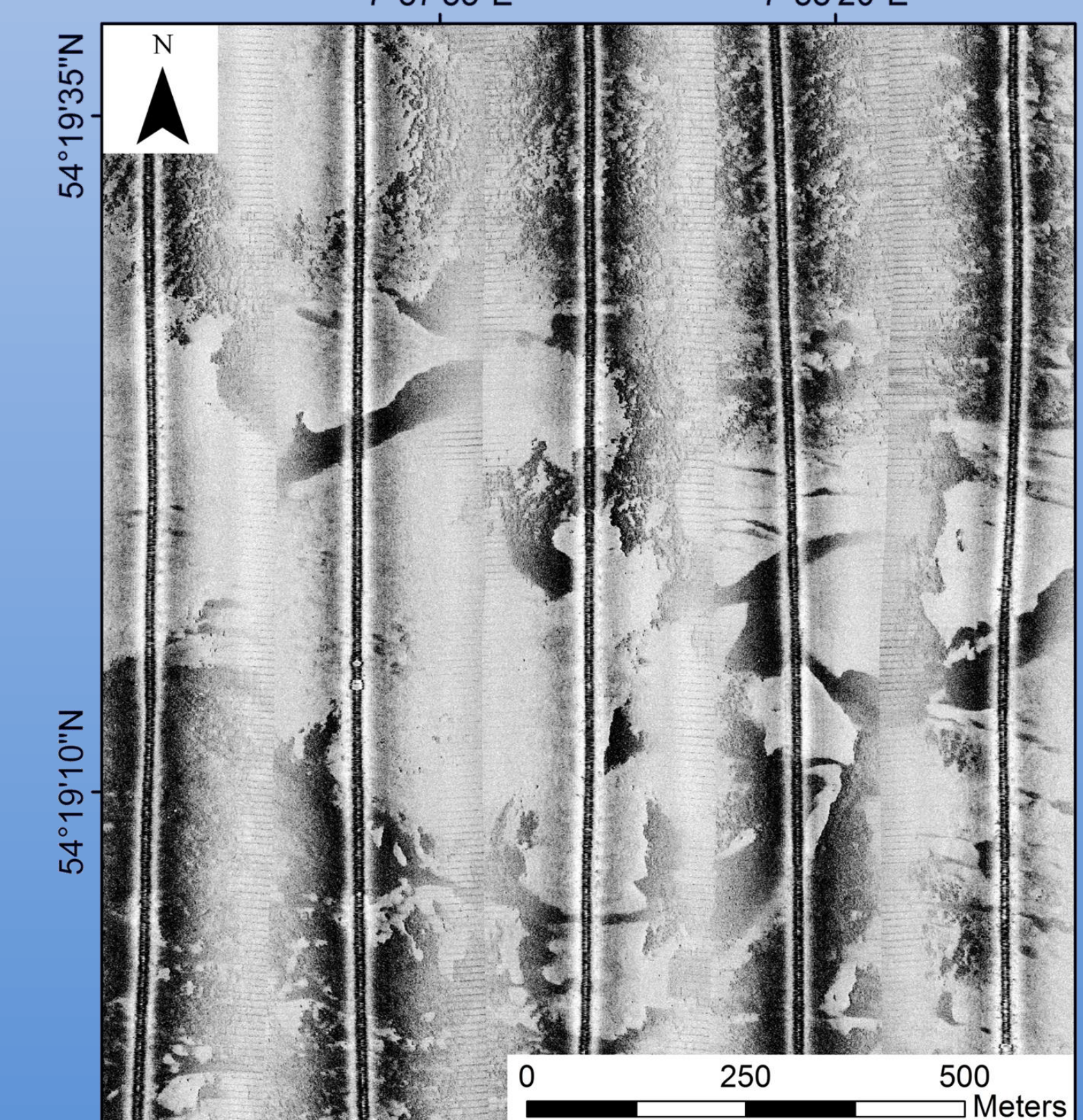


Grab sample showing tubes of the polychaetes *Lanice conchilega*.

West off the Island of Sylt lies a **dredging area** (4) where sandy material is extracted for beach nourishments at the nearby coast. The excavation-marks produced by the dredging ships become apparent in the sonograms. The cone-shaped holes seem to form sediment traps for very fine-grained material.

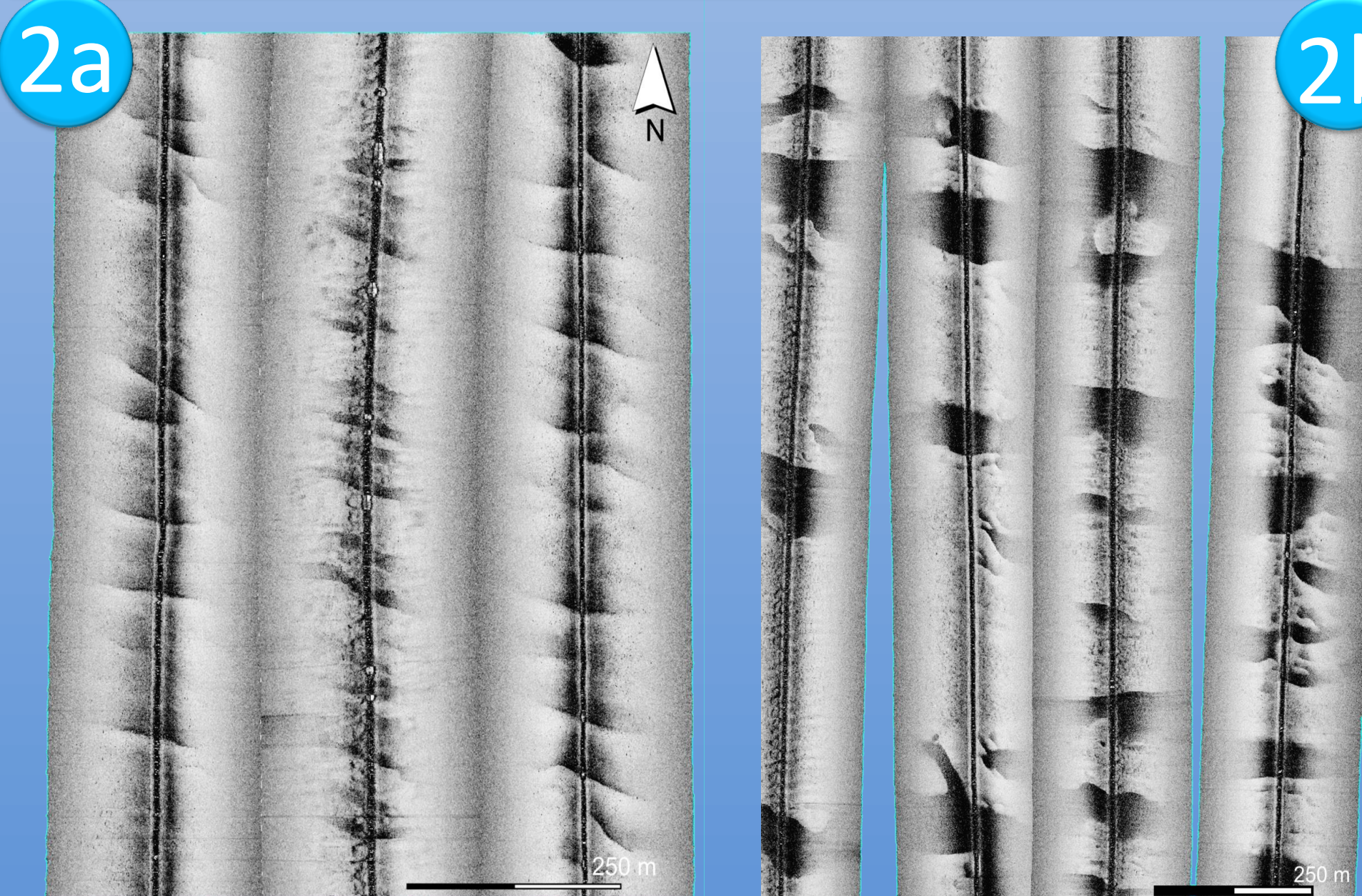


Sidescan sonar mosaic showing excavation marks resulting from dredging activities.

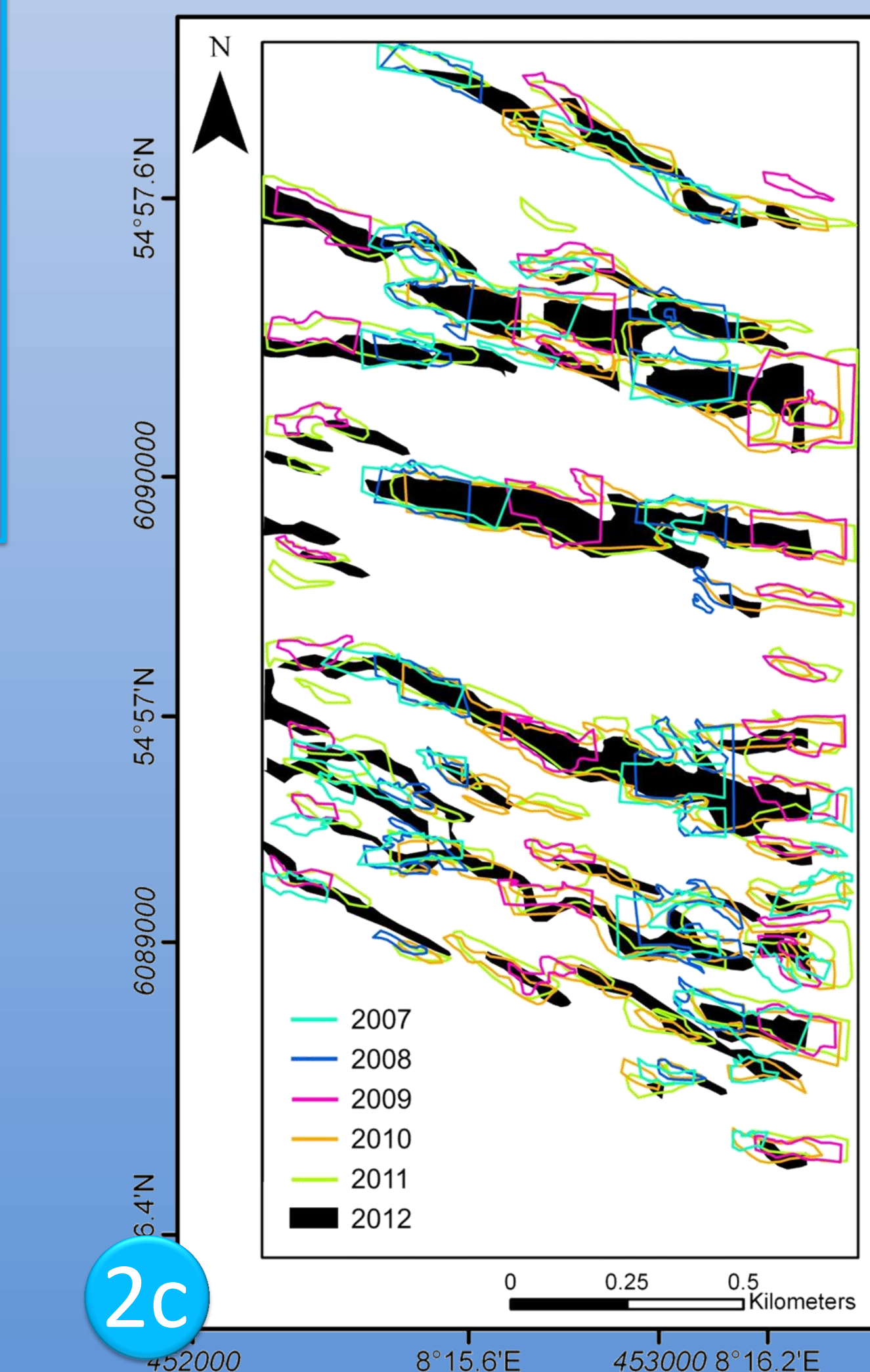


Sidescan sonar mosaic of a subaquatic stone reef.

The seafloor around the Island of Helgoland is characterized by outcropping Mesozoic limestones and coarse Pleistocene material which is sometimes covered by a thin layer of Holocene sand. A sidescan mosaic of such a subaquatic reef is illustrated in 5. The **rocks** and coarse material reveal high acoustic backscatter (dark grey to black). The light grey areas represent zones with fine sand.



Sonographies of fine and coarse sand patterns. Left: asymmetrically shaped subaquatic dunes. Right: Sorted bedforms



Interannual comparison between the shape and position of a field of sorted bedforms reveals no significant changes.