

Understanding Tunnel Valleys in the North Sea: a 200-year history of enigmatic subglacial landforms

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Tunnel valleys are kilometre-scale elongate depressions formed beneath ice sheets, and are present extensively across NW Europe including in the North Sea, where they are found buried and at seabed. Much debate surrounds the nature of formation of tunnel valleys and their relationship to Quaternary ice sheet dynamics; this talk summarises how our understanding of tunnel valleys reflects changes in the data available to examine them, how they relate to the evolution of our understanding of the glacial history of the North Sea, and what implications this has for the offshore wind and marine industry.

Open seabed tunnel valleys in the North Sea (e.g. Silver Pit) were known by fishermen for hundreds of years, and surveyed by the British Navy in the 1800's; they were first described scientifically by de la Beche (1834, p.109) as "trough-like cavities" in an otherwise "great tract of plain" and formed as 'cracks' by upward bending of strata. Scientific understanding of tunnel valley formation developed alongside the glacial theory of geology in Europe, although the suggestions that the North Sea offshore tunnel valleys were subglacial in nature was not made until the 1950's (Robinson, 1952). From the 1960's, the seabed tunnel valleys were imaged in 2D seismic data, with much debate regarding their origin as fluvial, tidal, or glacial. In the 1970's, further 2D surveys revealed the existence of extensive networks of buried tunnel valleys at a number of stratigraphic levels across the North Sea, although the nature of the widely spaced 2D data precluded an understanding of the planform geomorphology of the tunnel valleys.

Since the 1990's, 3D seismic data has been used to image the subsurface of the North Sea; thousands of tunnel valleys reaching hundreds of kilometres in length are buried beneath the North Sea, and 3D seismic data highlights their extent and complexity. Tunnel valleys are critical to understanding the glacial history of the region – in size, they are the most significant Quaternary landforms preserved in the North Sea, and confirm unequivocally the existence of ice sheets extending across the North Sea area during this time. Furthermore, by imaging the planform geometry of the tunnel valleys, 3D seismic and gravity data revealed the complex networks of tunnel valleys are formed by cross-cutting 'generations', which, in turn, has led to further questions regarding their formation, evolution, and critically, relationship to Quaternary ice sheet dynamics (Stewart et al. 2013; Ottesen et al. 2020). More recently, high-resolution 2D and 3D seismic data has revealed further detail of tunnel valley infill and the complexity of their formation over time; the presence of landforms, such as crevasse-squeeze ridges and eskers, within tunnel valley fill, shows the North Sea tunnel valleys may be formed and modified within a variety of depositional environments, and very quickly, in the order of hundreds or thousands of years (Kirkham et al. 2021, 2022).

References

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