Can halite form lowstand wedges?

New insights into basin margin evaporites from the Permian Zechstein

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Where? Southern North Sea

When? Latest Permian

What? Unique evaporite geometries

Why? Sedimentology and exploration

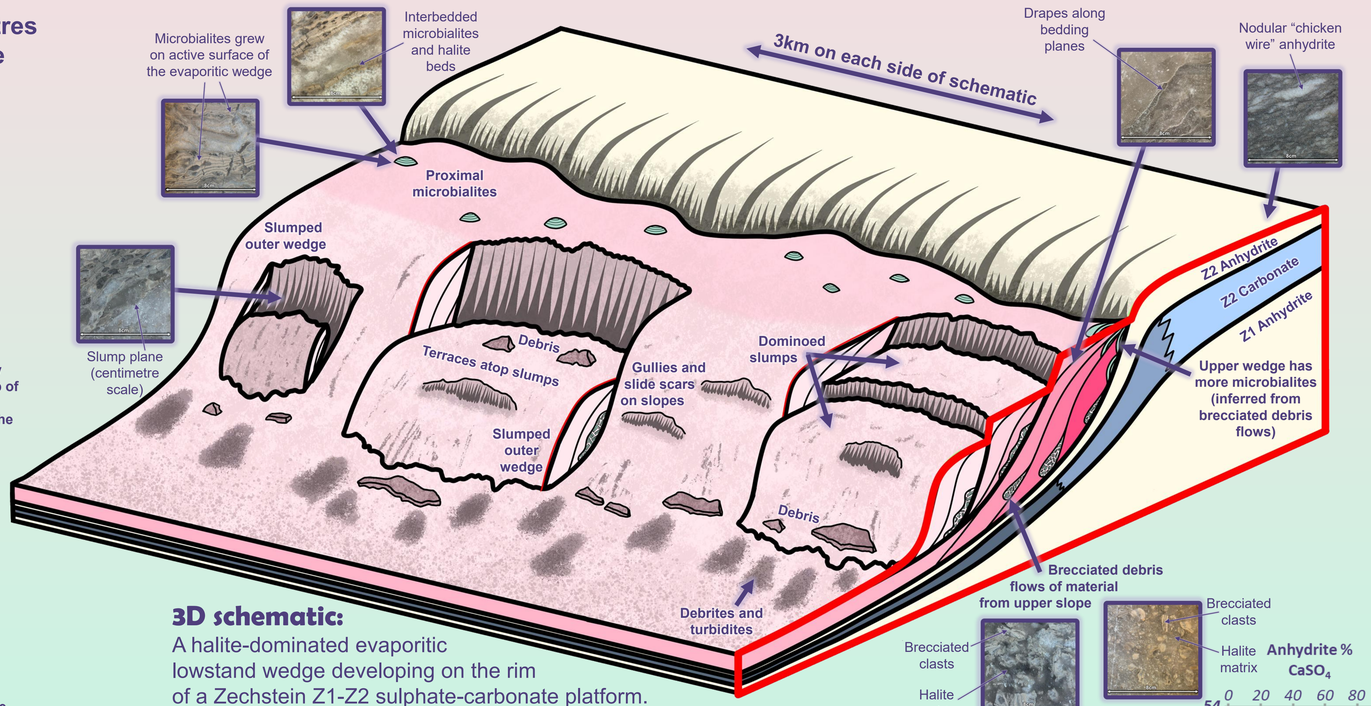
How? 3D seismic data, core analysis, petrophysics, and geochemistry

Summary

- Analogues predicted that Zechstein platforms in the Southern North Sea would be fringed by carbonate lowstand wedges. Instead, a new well (41/05-2, UK Continental Shelf) encountered halite within the lowstand wedge geometry.
- The evaporitic wedges feature domino slumping along weak progradational bedding planes, resulting in blocks that collapsed into the basin. The earliest progradational beds contained the highest concentration of microbialites which helped to stabilise the evaporitic wedges on the rims of carbonate platforms, whilst also indicating that the wedges were part of an environmental transition from marine highstand into basin desiccation.
- Microbial fragments were reworked downslope into brecciated debris flow deposits which demonstrates a relationship between wedge construction and syndepositional collapse on the outer slopes.
- A lack of post-anhydrite marine recharge depleted Ca^{2+} from the brine which limited anhydrite ($CaSO_4$) precipitation within the wedges. This depletion in Ca^{2+} led to dolomitic microbialites ($CaMg(CO_3)_2$) in the lower wedge. However, the upper wedge features Kutnohorite ($Ca(Mn,Mg)(CO_3)_2$) showing that Mg^{2+} also eventually became depleted and was replaced by Mn^{2+}.
- This analysis characterises a rare evaporitic phenomenon which can hide in plain sight in seismic data and act as a depositional intermediary between platform construction and basin-fill halite precipitation.

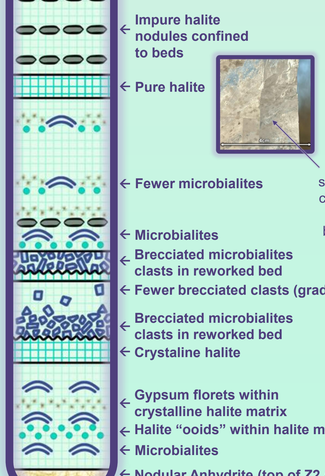
		Z2, Z4 & Z5	Facies	Proximal-Distal	Information (41/05-2)	Southern North Sea nomenclature
Upper Permian	Zechstein Group				Z2 Halite (green), the basin-fill halite that preserves the evaporite wedges.	Stassfurt Halite Formation.
		Core used in study			Polyhalite crust above core. Halite core lies in the Z2 Anhydrite chronostratigraphic package. Z2 Anhydrite (yellow)	Basalanhydrit Formation.
		Z2			Z2 Carbonate (blue), which thins distally into an organic rich member.	Hauptdolomit Formation.
					Z1 Anhydrite (yellow). The middle of this formation can contain anhydrite, halite or carbonate members, depending on locality.	Werraanhydrit Formation. Middle Carbonate Member / Werrahalit Member.
		Z1			Z1 Carbonate (blue), mostly absent across study area. Z1 Shale (grey), a regional shale indicating marine transgression and the initiation of the Zechstein Sea.	Zechsteinkalk Formation. Kupferschiefer Formation.
Lower/ Middle Carboniferous	Rotliegend				Rotliegend fluvial and aeolian clastics (red), which onlap the basin margins. Unconformity between Permian and Carboniferous stratigraphy.	Leman Sandstone Formation / Silverpit Formation. *Nomenclature after Doonenbal and Stevenson (2010), Southern Permian Basin Atlas*

54 metres of core

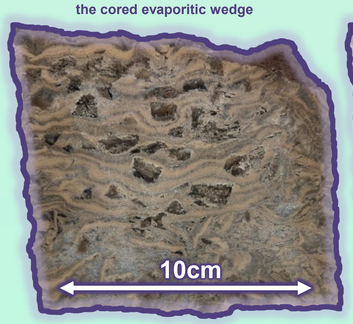


3D schematic:

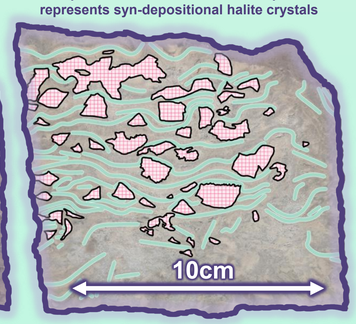
A halite-dominated evaporitic lowstand wedge developing on the rim of a Zechstein Z1-Z2 sulphate-carbonate platform. The outer wedge features slumps and associated debris, as evidenced through seismic analysis and brecciated microbialites within the core.



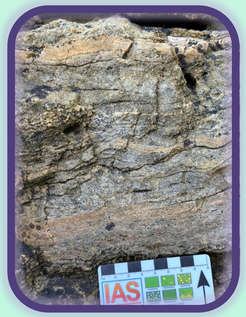
Polished slab of in-situ microbialites from the base of the cored evaporitic wedge



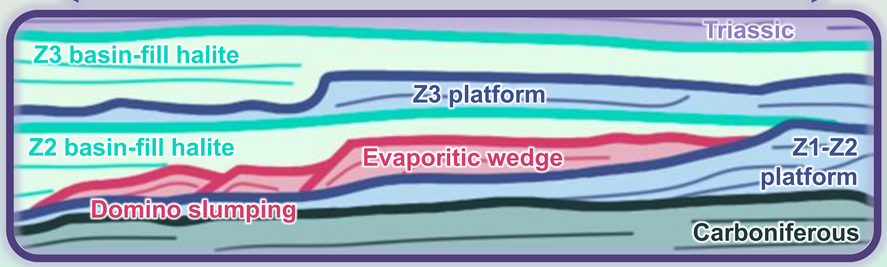
Interpreted section where green represents microbial lamina and pink represents syn-depositional halite crystals



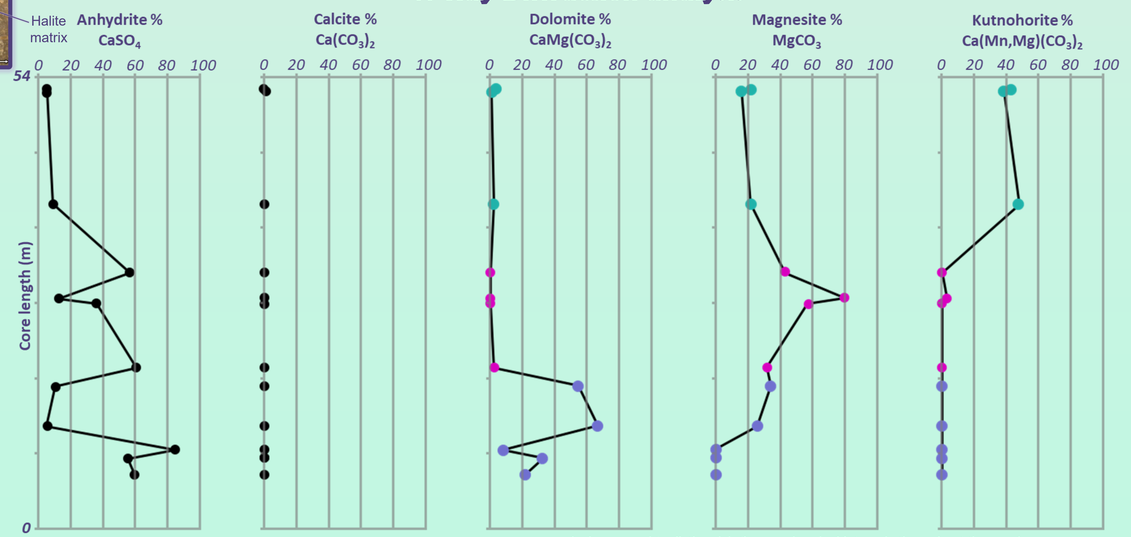
Outcrop analogue: Z2 Carbonate, Blackhalls Rocks, Northeast England



3km, seismic has no vertical exaggeration



X-Ray Diffraction analysis



(colours used to distinguish the geochemical intervals throughout the core)