The importance of nepheloid layers in the distribution of suspended particulate material in the Whittard Canyon system.

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Key Findings:

1. Both **transient and persistent** benthic (BNL) and intermediate (INL) nepheloid layers were found in two channels of the Whittard Canyon in 2012.

2. **Nepheloid layer distribution** was affected by **storm** activity , with a redistribution of **suspended particulate material** (SPM) found in both channels.

3. BNL and INLs appear to be associated with (i) the **permanent thermocline** (ii) cores of **Mediterranean Outflow** Water (MOW) and (iii) **internal wave** activity.

4. A mixture of **deep-sea suspension feeding fauna** were found on a vertical wall in the eastern channel of the Whittard Canyon. Their densities increased with depth within the depth range of NL occurrence. The increased availability of suspended food resources as a result of NLs may explain the distribution of the fauna.

Conclusion:

Our observations suggest that the Whittard Canyon and the oceanographic setting present there, may enhance NL activity and/or act as a funnel for SPM, creating biological "hotspots" with enhanced biodiversity and act as fast-track pathways for sediment and organic carbon transport from the continental shelf to the deep ocean.
Understanding oceanographic settings and phenomena such as NLs is paramount to understanding deep-sea habitats and global biogeochemical cycles.

Biodiscovery and Deep- Ocean Ecosystems

R.V. Celtic Explorer

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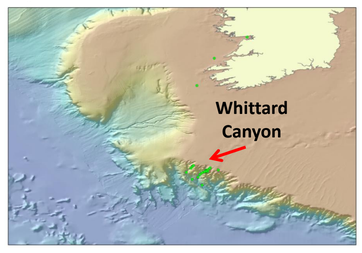
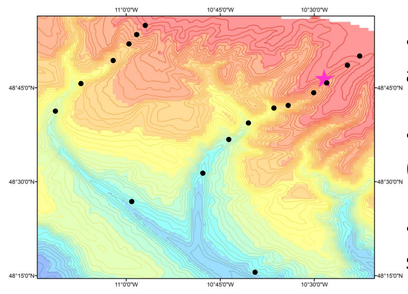
(Left) Location of Whittard Canyon (WC)

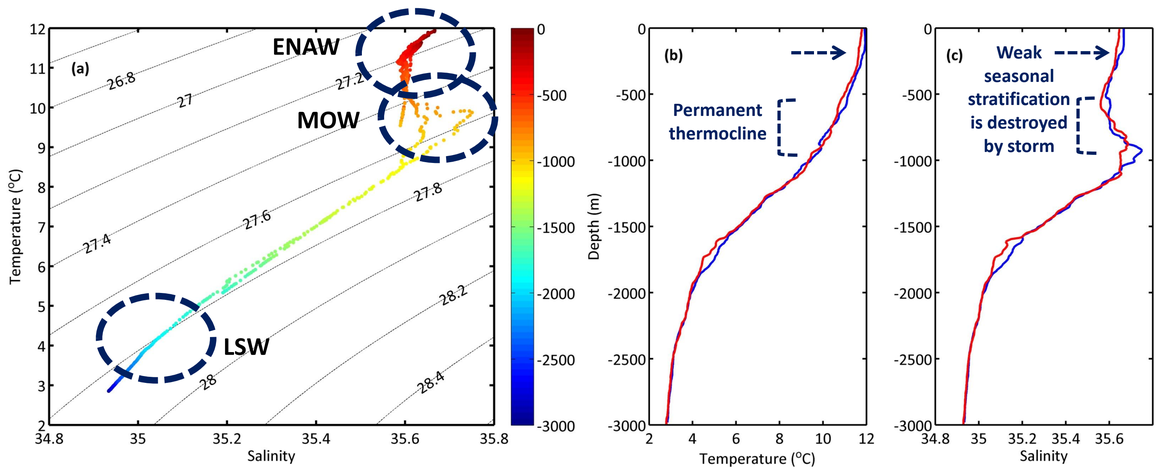
(Below) Eastern and Western channels of WC surveyed in 2012. (Only station locations used here are shown)





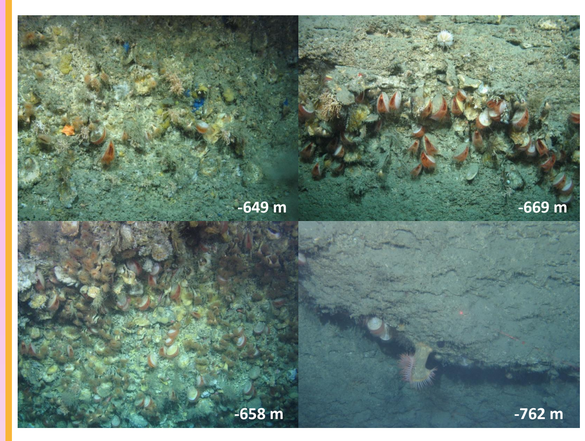
- 66 CTD profiles were made along and across two channels of the WC.
- Vertical profiles of beam attenuation (m^{-1}) were used as a proxy for SPM.
- The survey was punctuated by a severe storm (8 - 9 m swell height).

Hydrography



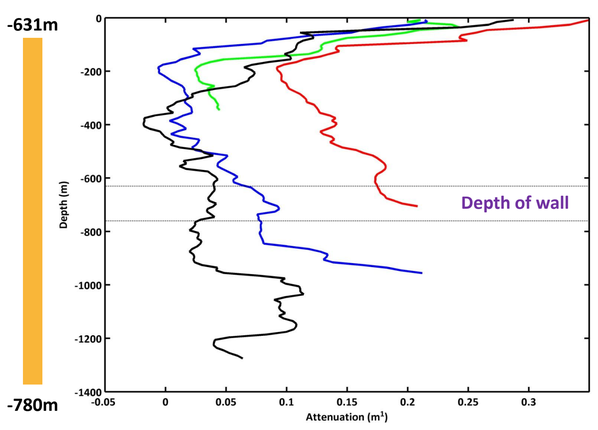
(Above) Water mass properties in the Whittard Canyon; (a) Temperature-salinity plots (CTD cats at 750 m, 1000 m, 1820 m, 3100 m). Isopycnals indicate potential density σ_t (kg m^{-3}) and the colour bar indicates depth (m); (b) Temperature (°C) profiles and (c) Salinity profiles, at 3100 m before (blue) and after (red) the storm.

Acesta-Neopycndonte assemblages found on vertical wall



(Left) Photographs at different depths of vertical wall in the Eastern channel of the WC taken with ROV *Holland I.*

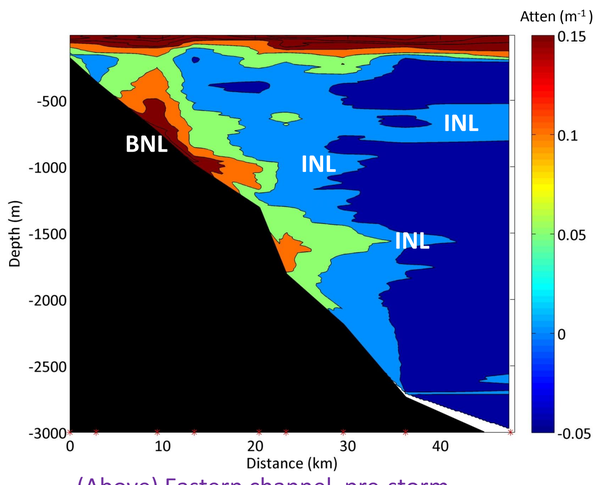
- *Acesta excavata* and *Neopycnodonte zibrowii* were found together, with particularly high densities in the vicinity of small overhangs.
- *Acetsa* and *Neopycnodonte* densities were positively correlated, with both densities increasing with depth.
- The average height of *Acesta* shells also tended to increase with depth.



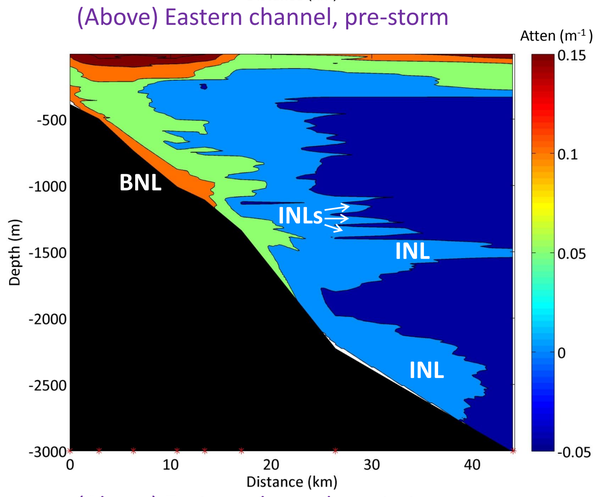
(Right) Light attenuation profiles (m^{-1}) in the Eastern channel of the WC at 375 m (green), 750 m (red), 1000 m (blue) and 1320 m (black). Dashed line indicates depth of vertical wall (630 - 760 m).

- A general increase in SPM was found within the depth range occupied by the vertical wall.
- Highest values were seen to extend from the seabed at 750 m in BNLs and into INLs in the deeper profiles.
- The increase in SPM is likely to be associated with MOW flowing within this depth range (800 - 1100 m).

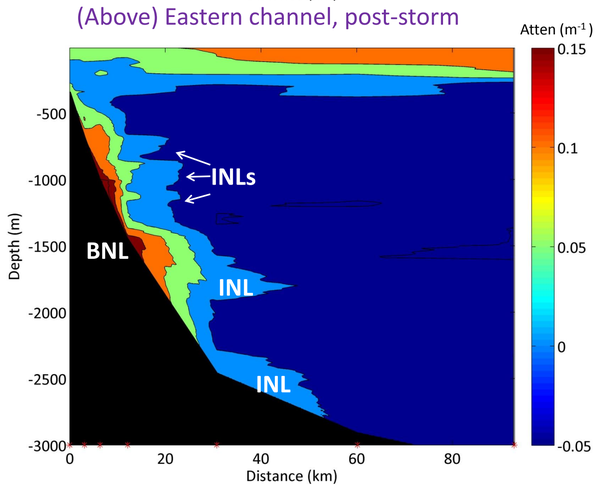
Nepheloid Layer Distribution



(Above) Eastern channel, pre-storm



(Above) Eastern channel, post-storm



(Above) Western channel, post-storm

Eastern channel, pre-storm

- Along the canyon axis a BNL was found down to ~2500 m depth, with increased benthic turbidity between 600 - 1200 m and 1500 - 1800 m.
- INLs were found, associated with the BNL, centred at 750 m, 1000 m and 1600 m.
- The INL present 750 m arises due to an association with the permanent thermocline (600 - 1000 m).
- The INL at 1000 m is likely to be generated as a result of the MOW flowing within this depth range, (high salinity core between 900 – 1000 m; see hydrography), as a contour current along the continental margin and impinging on the seabed.
- The INL at 1600 m appears to be associated with large isopycnal displacements and tidally induced internal wave energy, propagating within the channel.

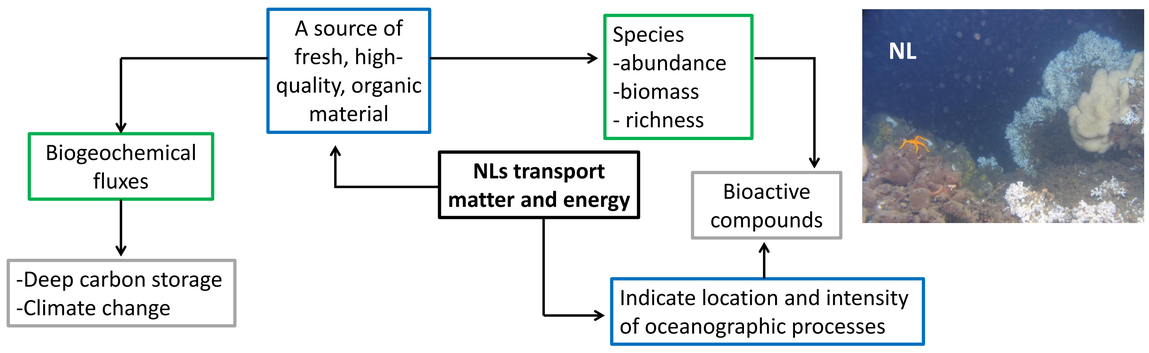
Eastern channel, post storm

- The BNL and INL at 750 m were found to persist after the storm, but with a significant decrease in turbidity.
- SPM appears to be redistributed down the channel axis,extending out into large INLs at 1600 m and 2500 m.
- Intense mixing at the slope due to density displacements and baroclinic energy propagating in the channel are likely to be responsible for this lateral movement of material.
- The INL at 1000 m appeared to decay into numerous smaller INLs between 900 – 1100 m after the storm. These INLs became thinner and less intense with time (~5 days), indicating their transient nature.

Western channel, post storm

- Similar NL features and distribution were seen in both the Eastern and Western channels.
- A BNL reaching down to ~2700 m depth was found in the Western channel, with increased turbidity at 1000 m and 1500 m.
- Large INLs, associated with the BNL, were found centring at 1700 m and 2500 m, and smaller ones at 750 m, 1000 m and 1100 m.
- INLs were seen to extend >20 km, with thicknesses similar to those in the Eastern channel (50 - 100 m).
- Turbidity in the surface planktontic layer decreased after the storm (also seen in the Eastern channel). This is likely due to downwelling and movement of material as a result of storm activity.

The importance of nepheloid layers



Key questions arising:

(1) What is the **distribution** of NLs along the Irish Continental Margin? → Open slope V's Canyons?

(2) What physical dynamics are involved in the **generation** of NLs? → Are they associated with MOW contour current?

(3) What is the **role** of NLs in the transport and control of the quality of material transported from pelagic to benthic ecosystems and across the shelf edge?
- → Carbon storage below the permanent thermocline?
- → Contourite deposits?
- → Effects on deep-sea fauna?

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