Reservoir Geology and Basin Analysis Research Group

NEW INSIGHTS ON THE INFILL PROCESS OF TUNNEL VALLEYS BASED ON SEDIMENT COMPOSITION AND SEISMIC FACIES ANALYSIS

GRASP

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Introduction:

This project focuses on an very large tunnel valley (width: 5km, thickness: 400m, lenght: 100 km) of Elsterian age, located in the Dutch offshore (Southern North Sea). Here we present some preliminary results from the sismostratigraphical and compositional study of a tunnel valley (TV) infill.

Objective of the study:

Understand the sediment provenance, age and depositional processes associated with the TV infill (glacial vs. post-glacial?).

Dataset:

- 3D seismic volumes covering the Southern North Sea (SNS);
- Cutting samples from a borehole (K14-12) entering a tunnel valley (Valley 6);
- Gamma ray log covering the whole thickness of the studied TV.

Methods:

- Seismic interpretation of internal/external TV geometries and related outwash deposits;
- Mineralogy, petrography, clay minerals, geochemistry, micro-paleontology analysis of cutting samples.

What is a "Tunnel Valley"?

One of the most typical landforms associated with glacial retreat in subglacial/ice-sheets termination settings.

Genesis:

1) By catastrophic jökulhlaup-like outbursts;
2) By glaciohydraulic supercooling or steady state overpressured;
3) By direct subglacial erosion.

Filling: Two main cases are usually considered:

1) Completely filled with glacial sediments during or shortly after the formation;
2) Left empty or underfilled by the ice and subsequently filled with sediments associated with different post-glacial processes and depositional environments.

(van der Vegt et al., 2012)

Fig. 1a) The 3D view of the interpreted basal surface of the TV is shown on the left side. Colors represent the depth in TWT.

The terminal sector of the TV#6 is shown together with the location of the borehole K14-12 from which cutting samples belong. The trace of the TV is also visible on the variance attribute calculated on the seismic data.

The location of the study area is also shown.

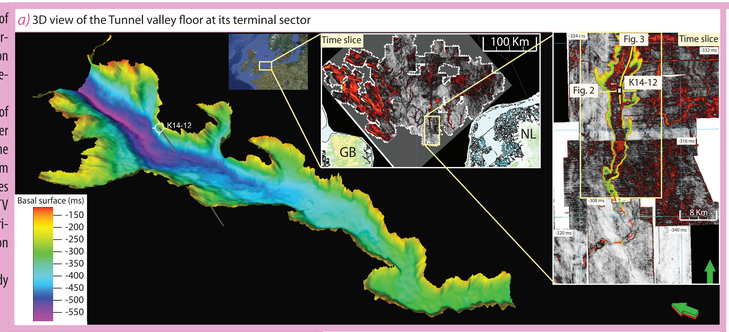
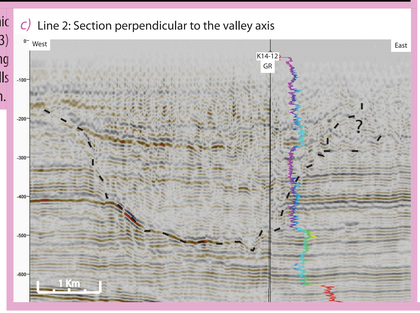
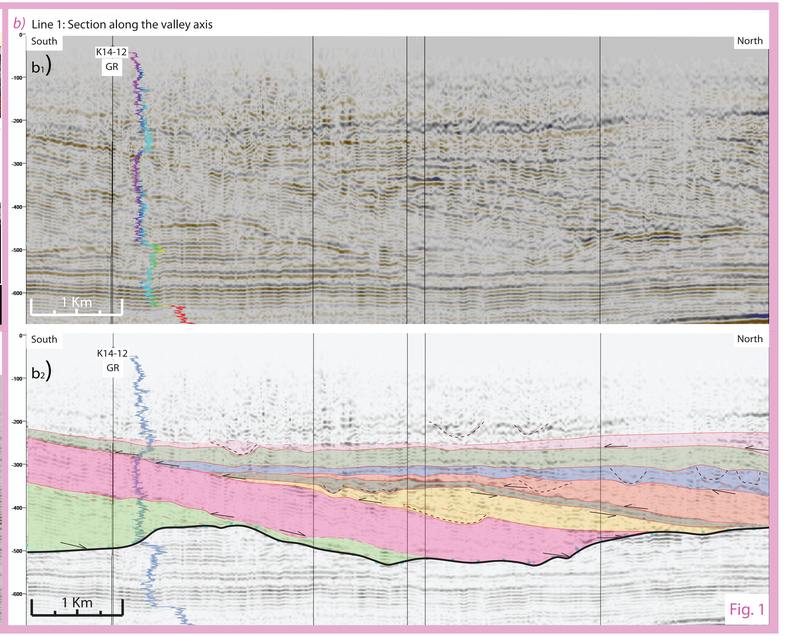


Fig. 1b) and 1c) Seismic sections showing the valley floor and the internal seismic facies/geometries of the TV. Northward dipping clinoforms dominate the infill. Praeg (2003) suggests they could be related them to a time-transgressive infill process of the TV during northward glacial retreat. Several small geometries probably related to erosional channel fills are identified suggesting a more complex depositional process than clinoform progradation.





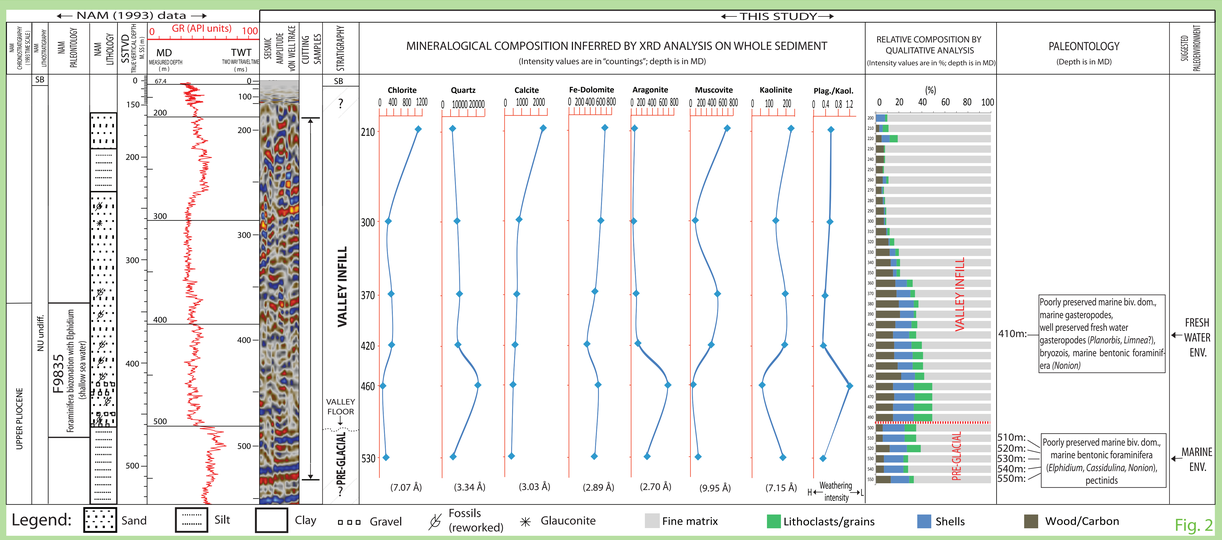


Fig. 2 The preliminary results of the sediment composition study are shown together with the composite well-log document provided by Nederlandse Aardolie Maatschappij (NAM). A tentative correlation between borehole and seismic data is also

Discussion:

Main changes in the GR-log correlates well with changes in the seismic amplitude and with the lithological trend. Higher level of detail in the vertical stratigraphical stacking pattern could be visible on the seismic data as well but require a more detailed mapping of seismic bodies in several seismic sections.

Variations in shell and wood fragments, lithoclast/grain and matrix content indicate a sharp increase in size and abundance of litho- and bio- clasts at the valley base followed above by a general fining-upwards sequence.

The finding of a well preserved and very fragile fresh water gasteropode in the valley infill at 460m depth, suggests a local provenance of the infill material and an associated low energy depositional process. A depositional setting dominated by grounded-ice and subglacial deformation is therefore not highly plausible. However, a glacial environment cannot be ruled out yet.

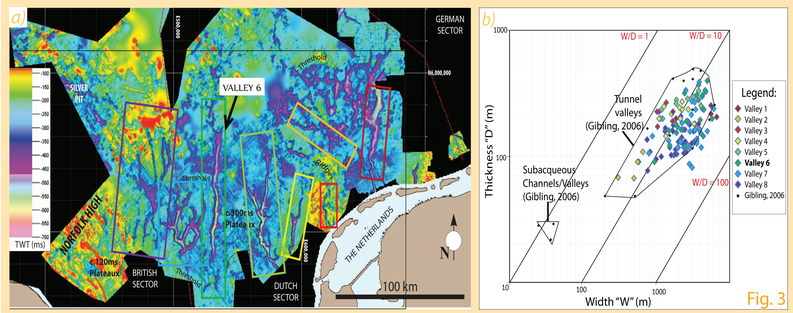


Fig. 3a) SNS map showing the depth of the glacial unconformity. Main TVs visible on seismic data are highlighted by boxes with different colors. Same colors are used in the W/D chart. The glacial unconformity map is from Moreau et al. (2012).

Fig. 3b) Crossplot showing the W/D ratio of different TVs sectors. Values fit in the TV's area (according to Gibling 2006's definition) and suggest a subglacial genesis, while subacqueous channels/valleys form in a proglacial setting.

Future project direction:

Cutting samples will be studied from several points of view. Beside the compositional aspect, the chronology of the sediment infill will be addressed by dating wood and shell fragments (amino acids, $^{87}Sr/^{86}Sr$, $\delta^{18}O$) and pollens.

The final goal of this study is to develop a depositional model along depositional dip, linking tunnel valley systems, their termination and their genetically related outwash deposits (e.g. ice-contact and proglacial settings) in order to identify their facies associations, architecture and reservoir potential.

References:

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