project ARCA
ARCTIC PRESENT CLIMATIC CHANGE and PAST EXTREME EVENTS

Final Conference, Rome October 11, 2016

EXTREME MELTWATER EVENTS IN THE ARCTIC: SIGNIFICANCE AND ENVIRONMENTAL IMPACT

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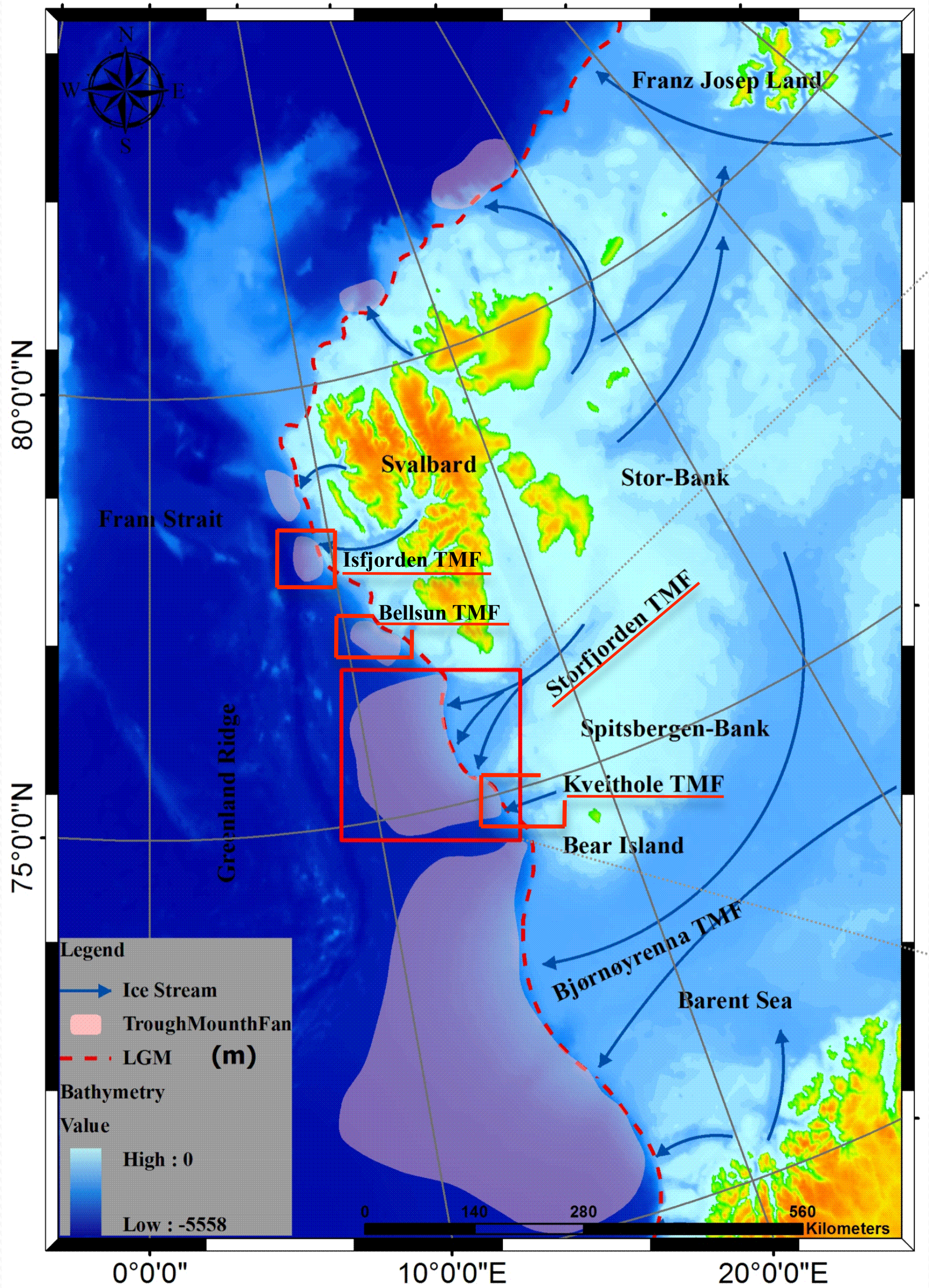
OGS

STUDY AREA



DATA ACQUISITION

SVAIS Project
BIO Hesperides, July-August 2007
coordinated by University of Barcelona

EGLACOM Project
R/V OGS-Explora, July-August 2008 coordinated by OGS

GLACIBAR Project
R/V Jan Mayen, July 2009
coordinated by University of Tromsø

CORIBAR Project
R/V Maria S. Merian, July-August 2013 coordinated by MARUM-Germany

Eurofleets 2 PREPARED project
R/V G.O. Sars, June 2014
coordinated by OGS

PNRA EDIPO Project
R/V *OGS-Explora*, September 2015
coordinated by OGS

DEGLABAR Project
R/V *OGS-Explora*, September 2015
coordinated by University of Barcelona

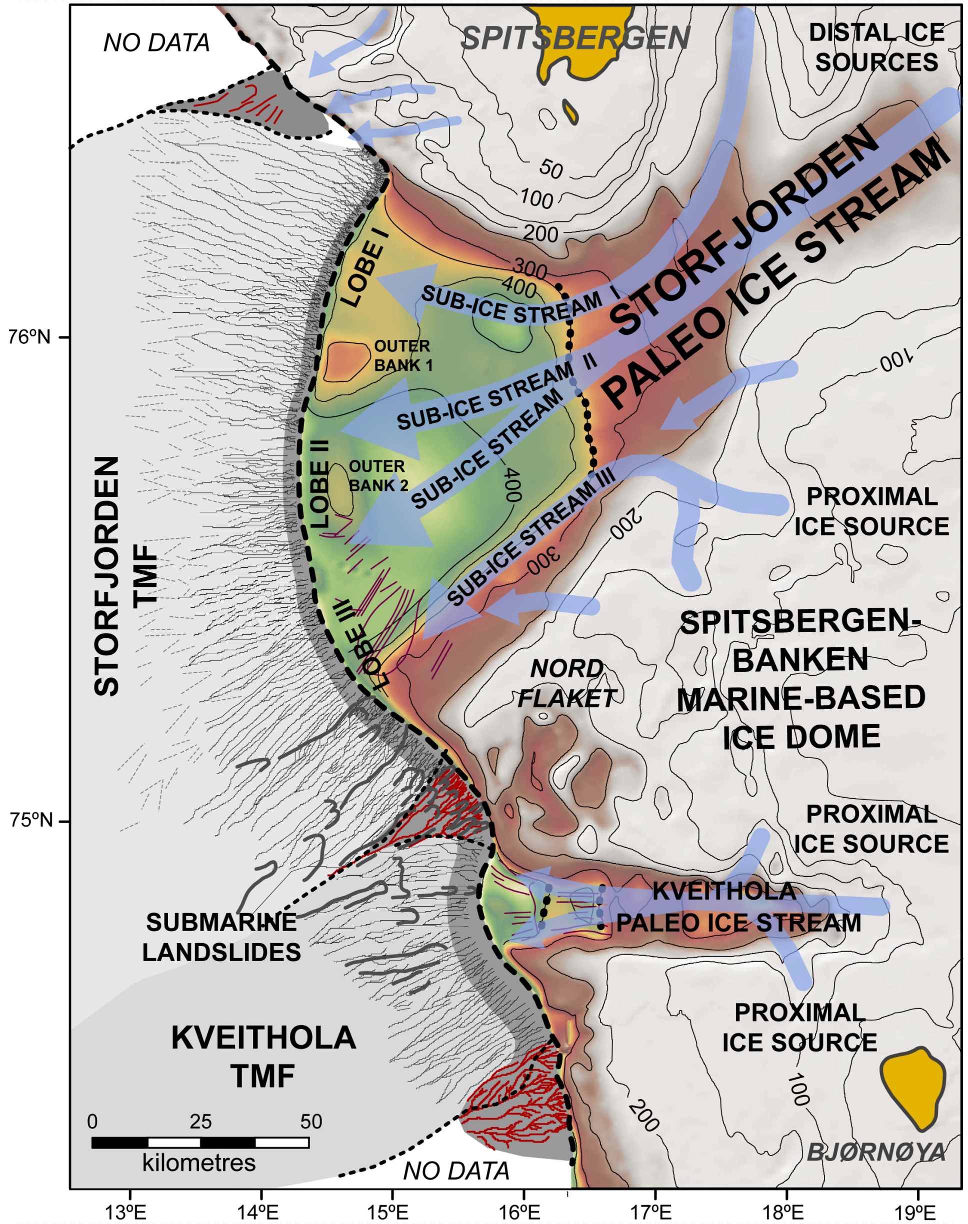
Eurofleets 2 BURSTER project
R/V Polarstern, June 2016
coordinated by OGS

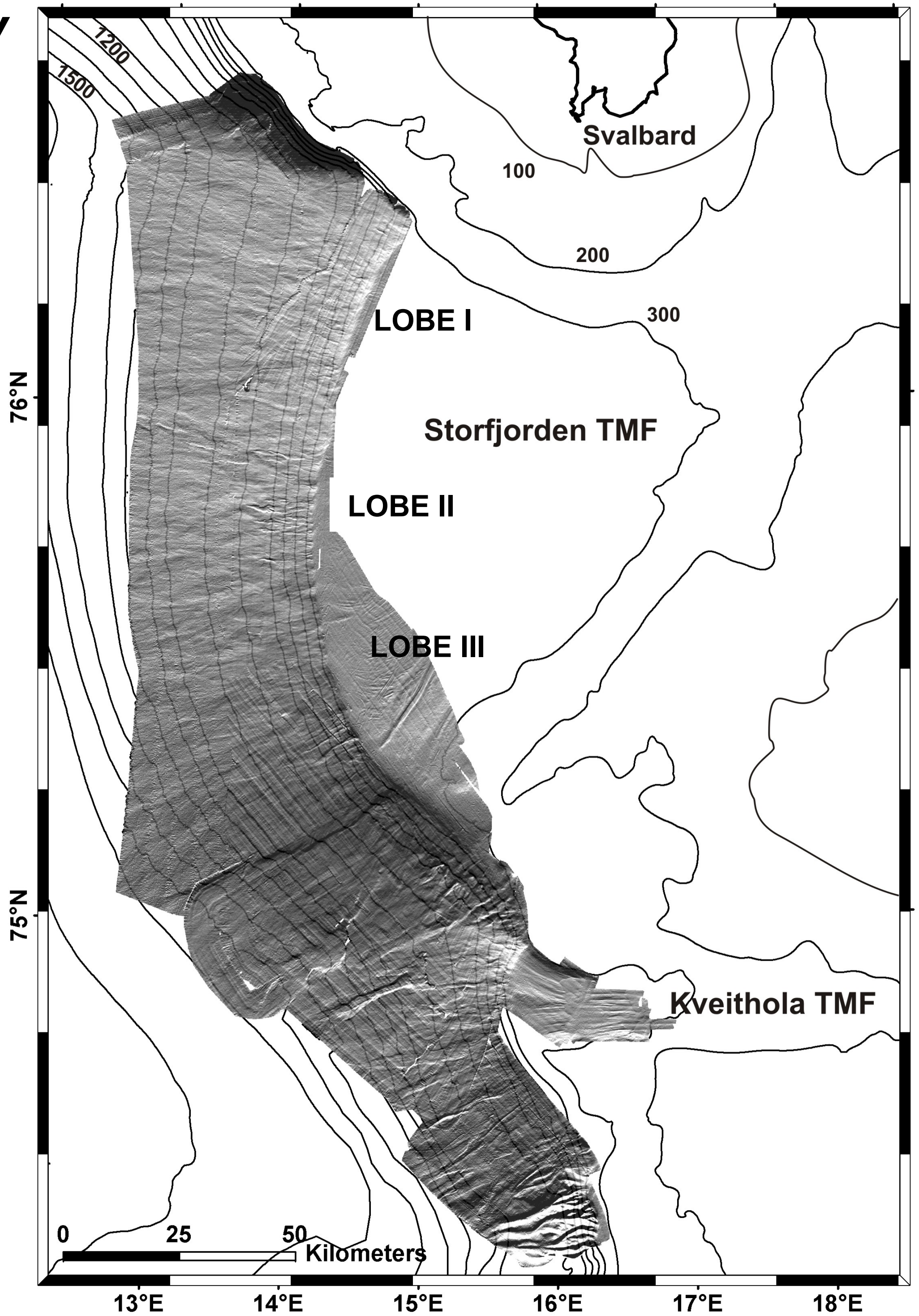
PNRA DEFROST Project
R/V Polarstern, June 2016
coordinated by OGS

DATA ANALYSES

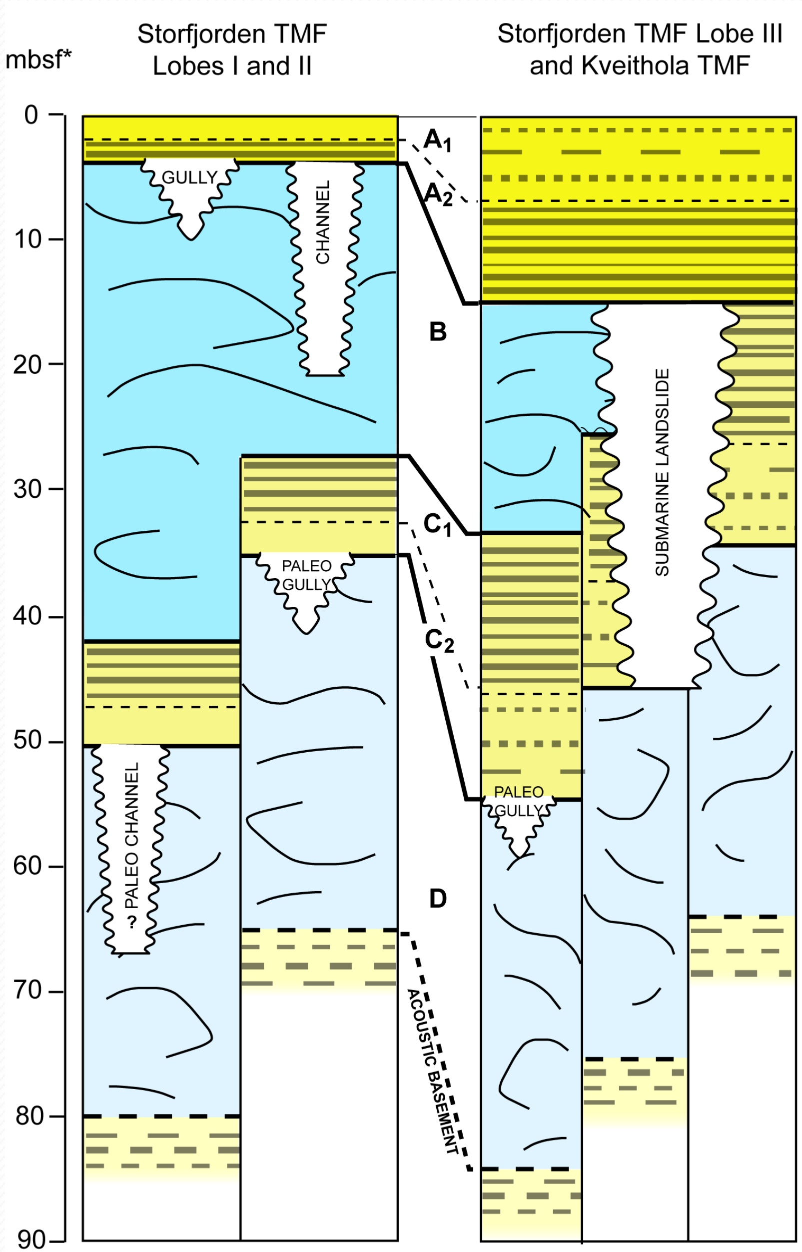
PNRA CORIBAR-IT Project (2013/C2.01)
PNRA AXED Project (PEA 2014)
PNRA DEFROST Project (PEA 2014)

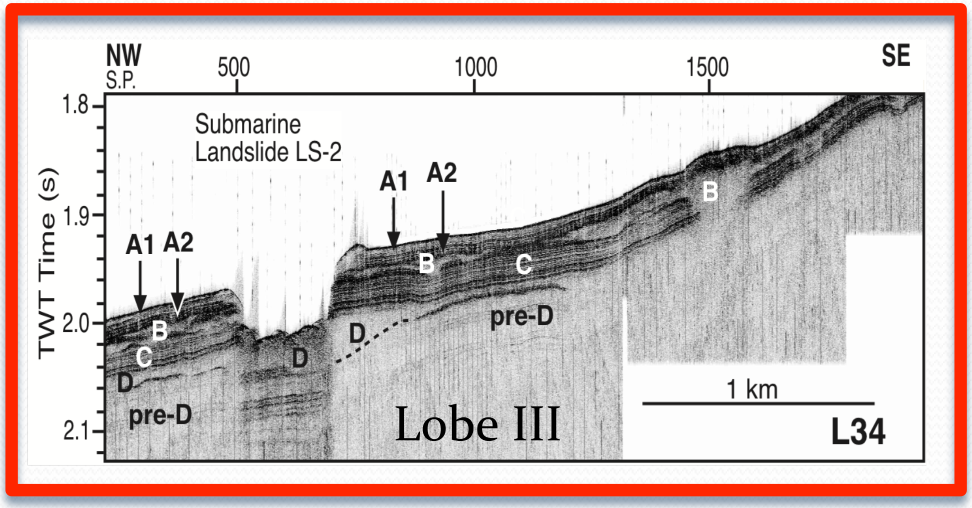
CONTINENTAL MARGIN MORPHOLOGY
(multi-beam bathymetry)
reconstruction of palaeo-ice streams

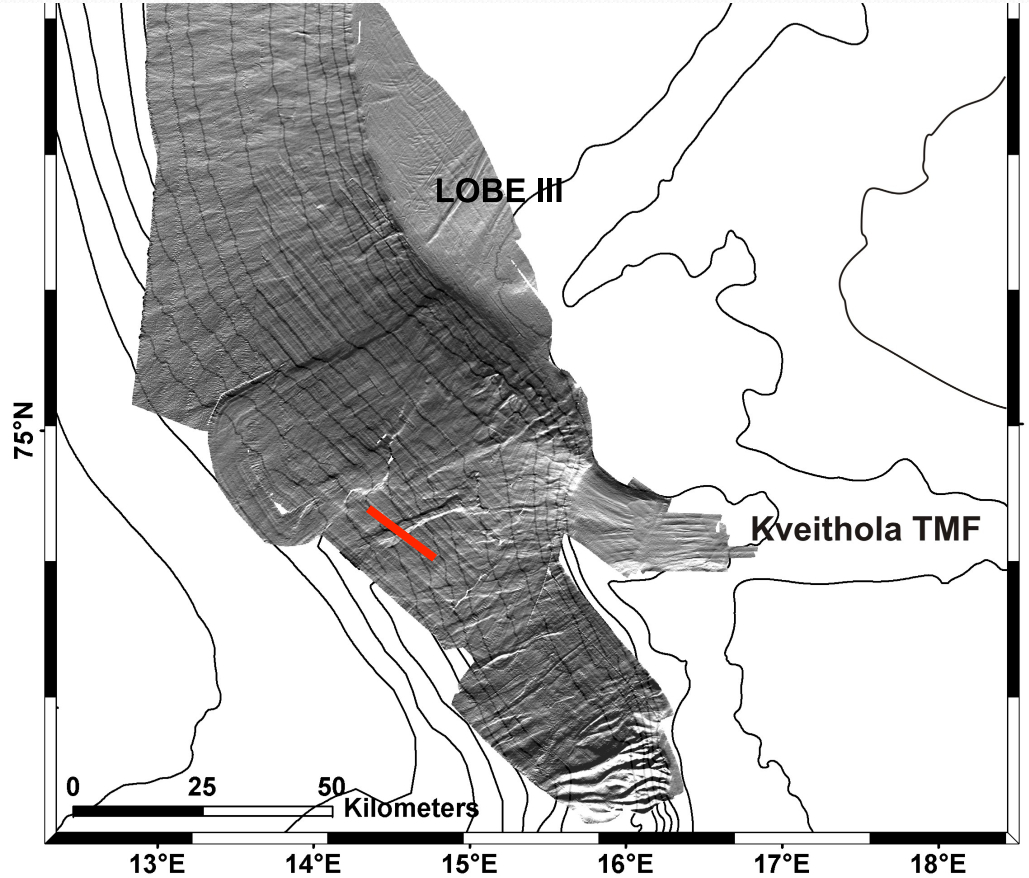




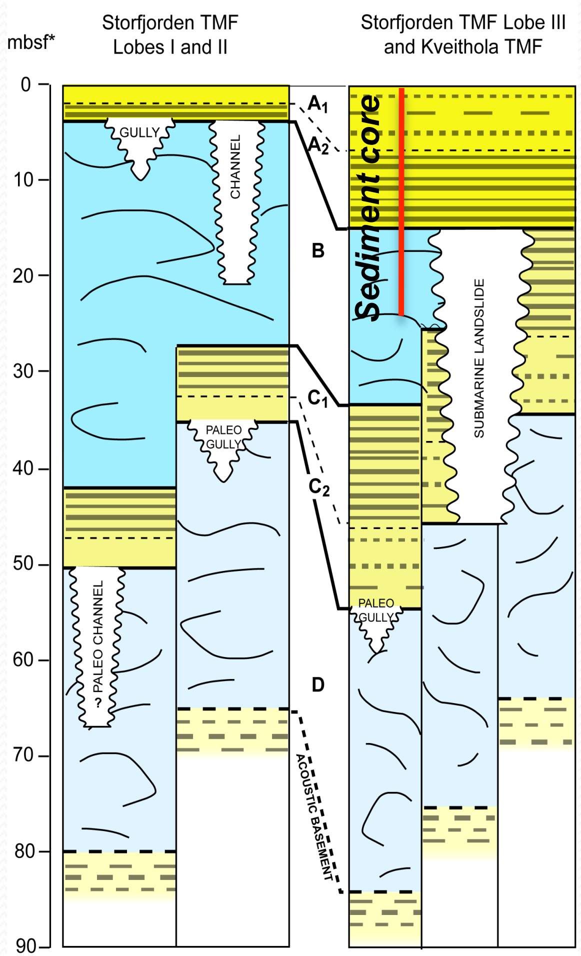
CONTINENTAL MARGIN ARCHITECTURE
(acoustic and seismic profiles)

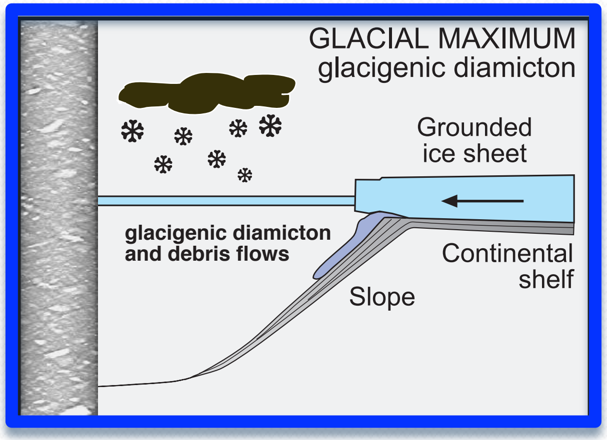


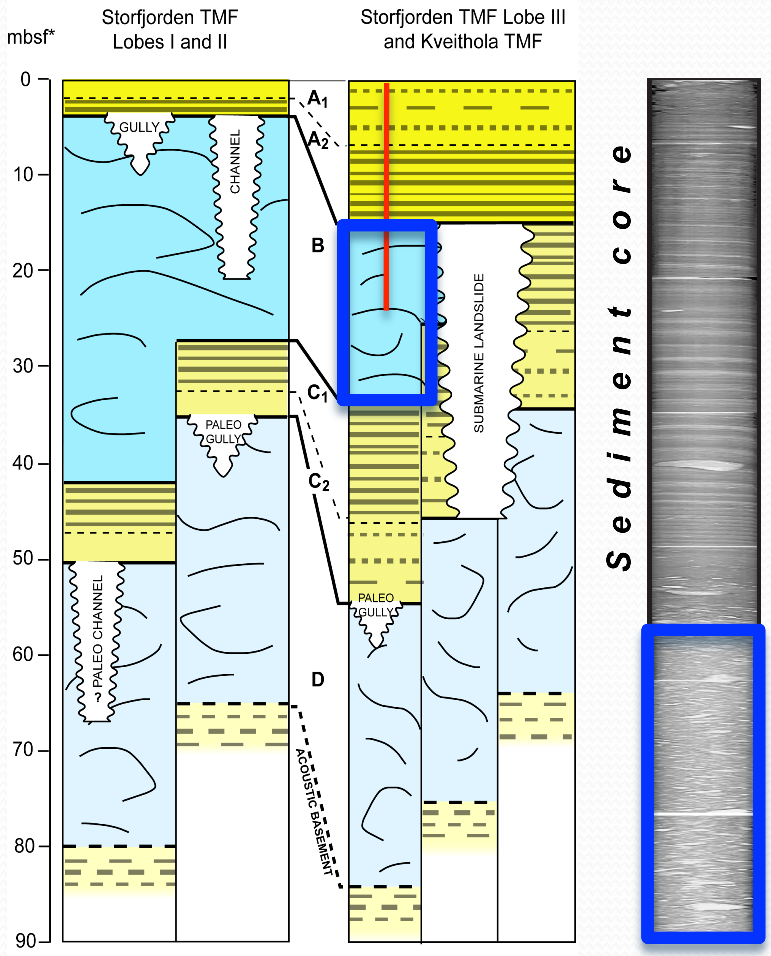


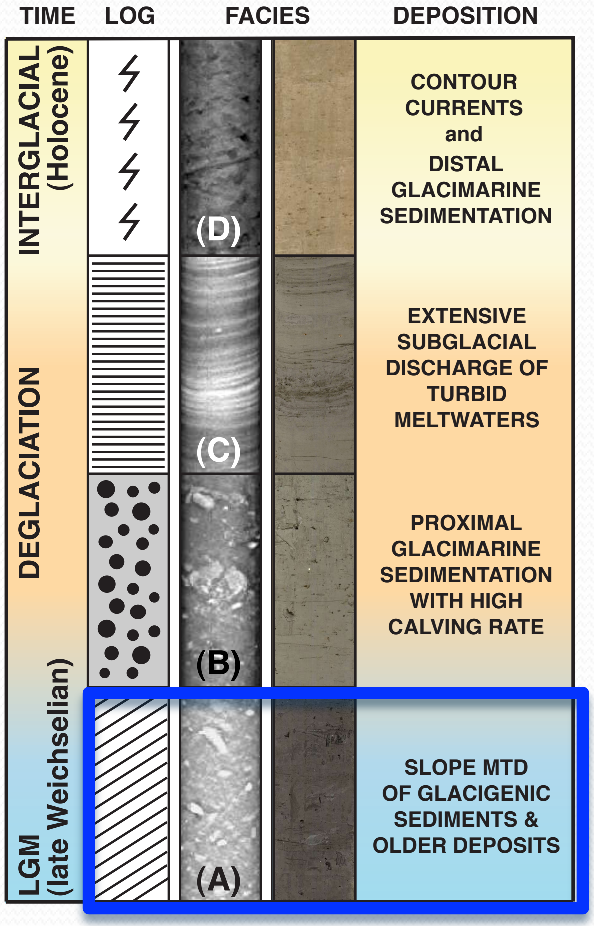


SEDIMENTARY SEQUENCE AND RECONSTRUCTION OF DEPOSITIONAL PROCESSES THROUGH THE STUDY OF SEDIMENT CORES

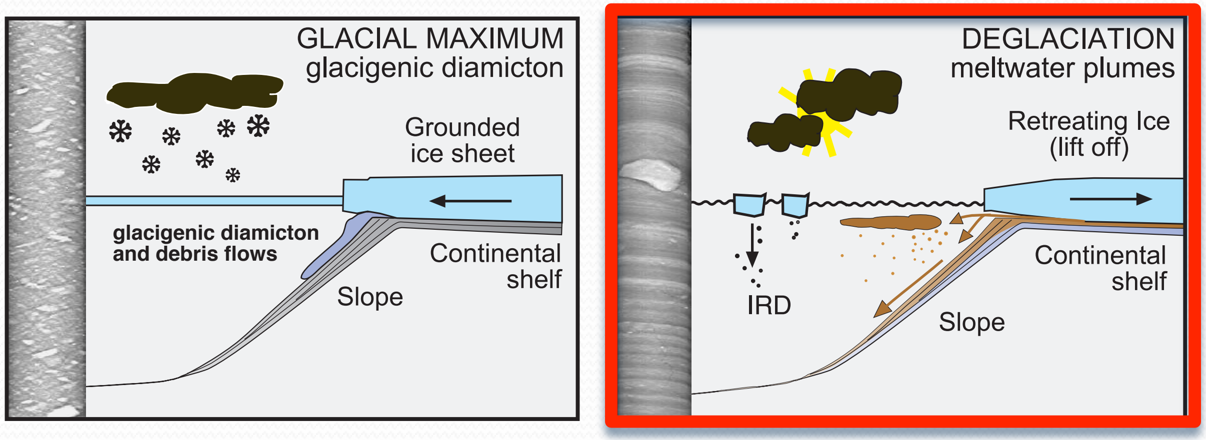


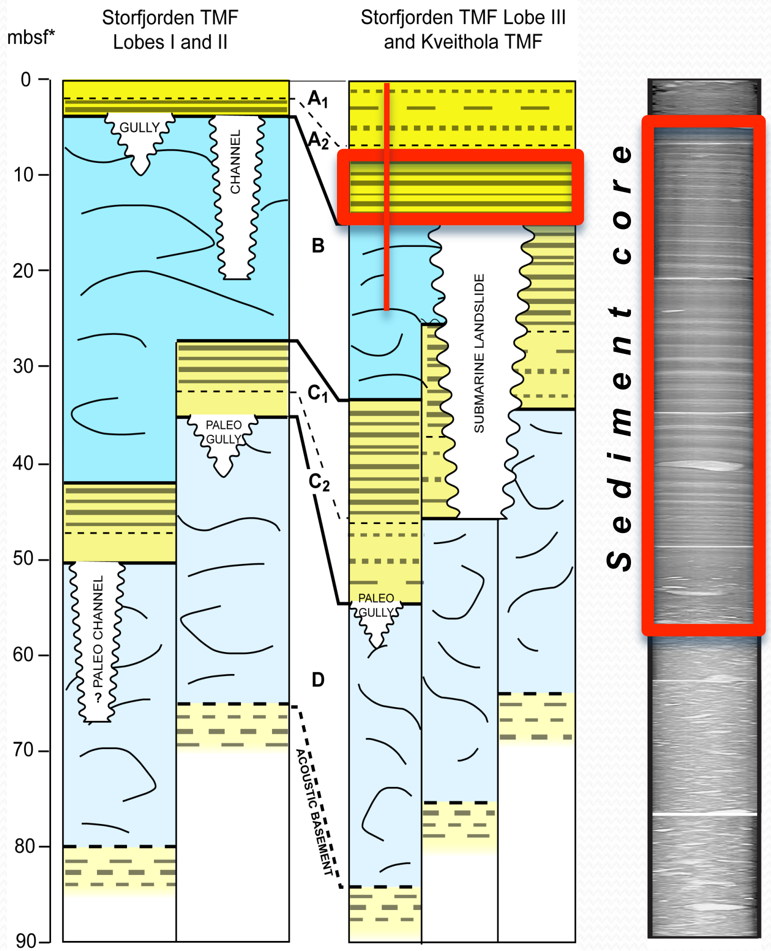


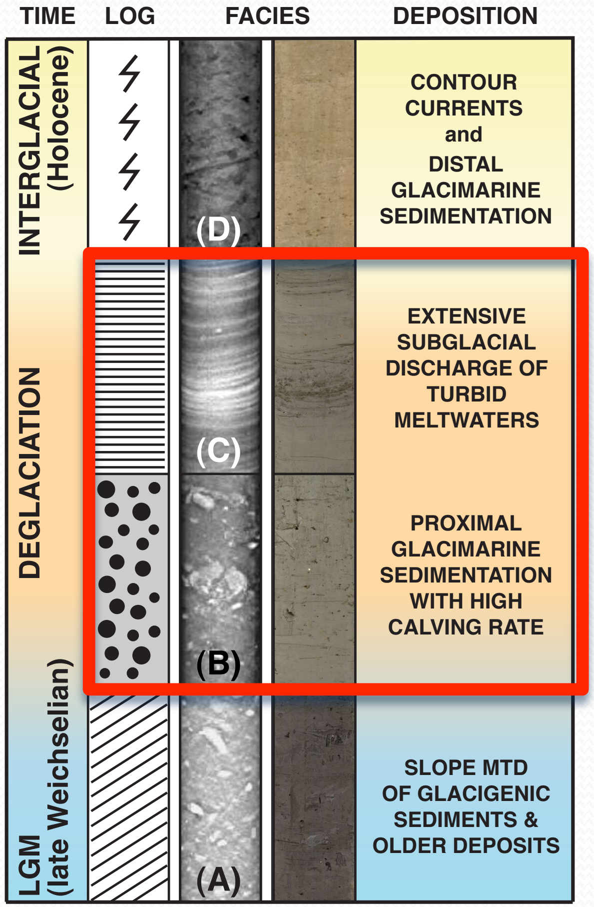




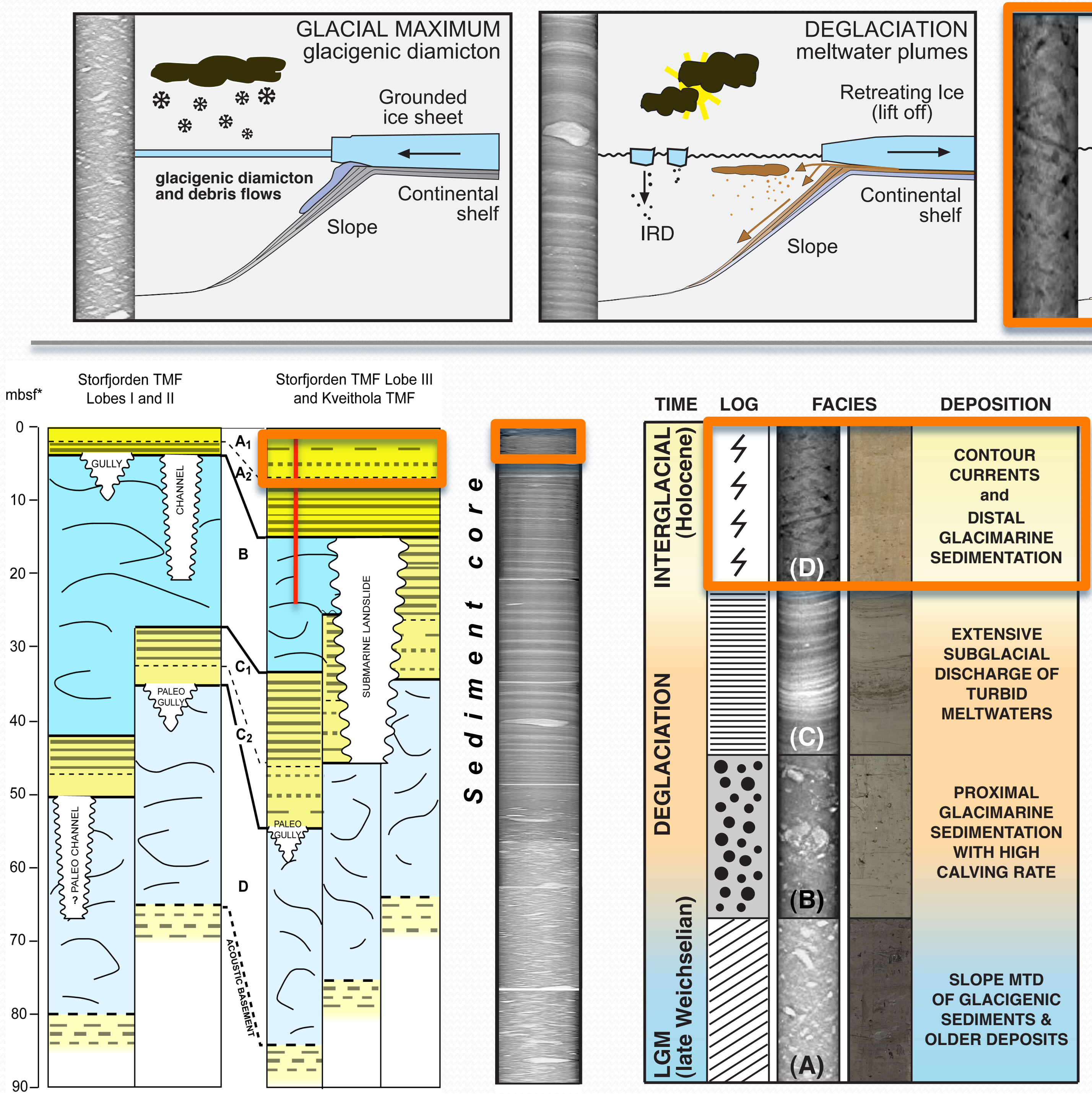
Deposition of glacigenic highly consolidated deposits during the glacial maximum extension



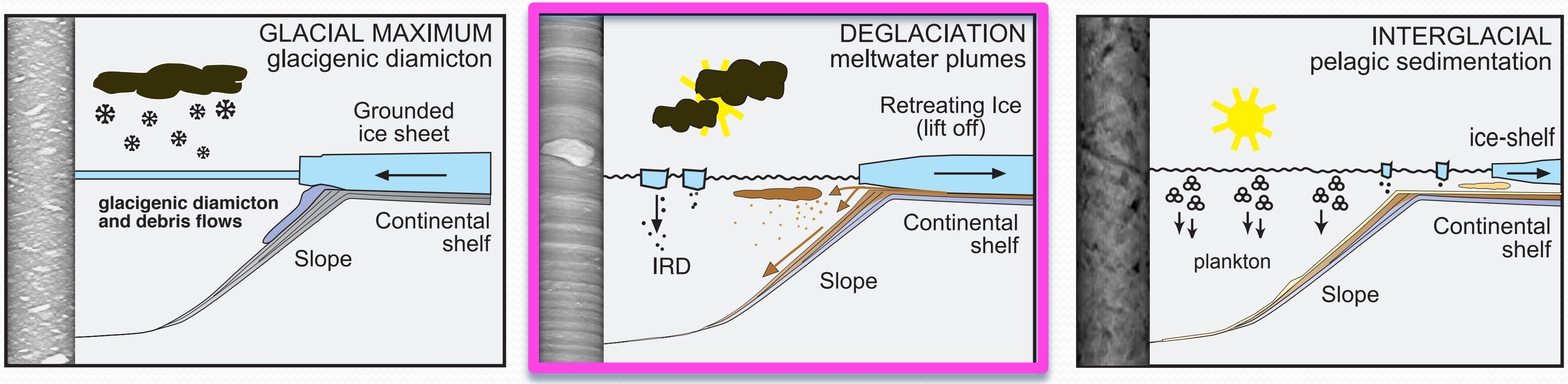


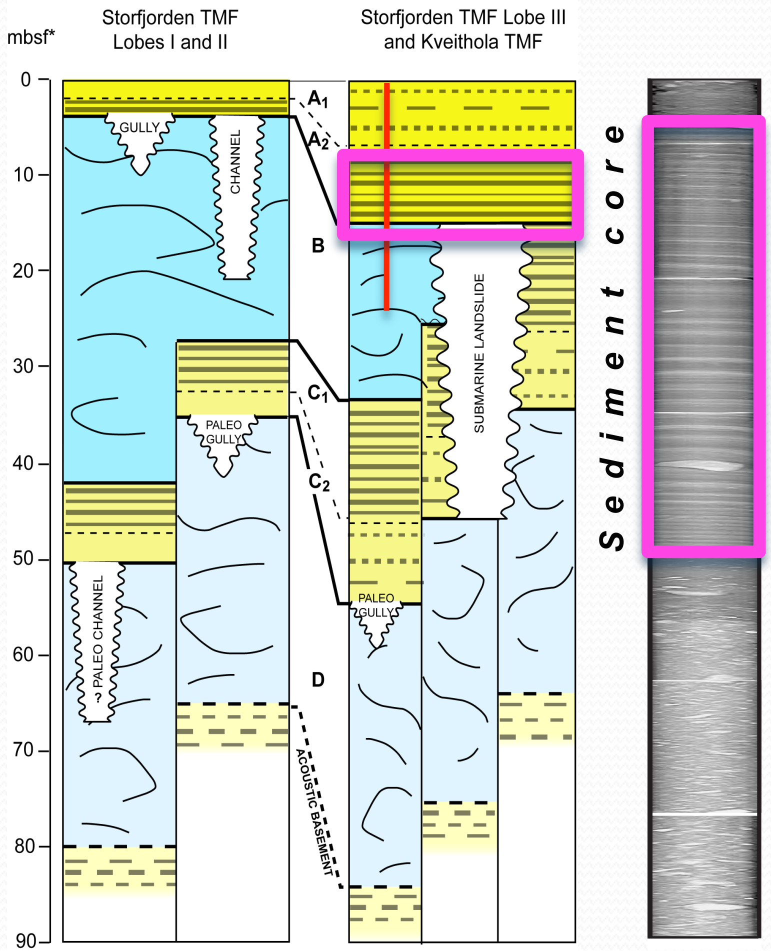


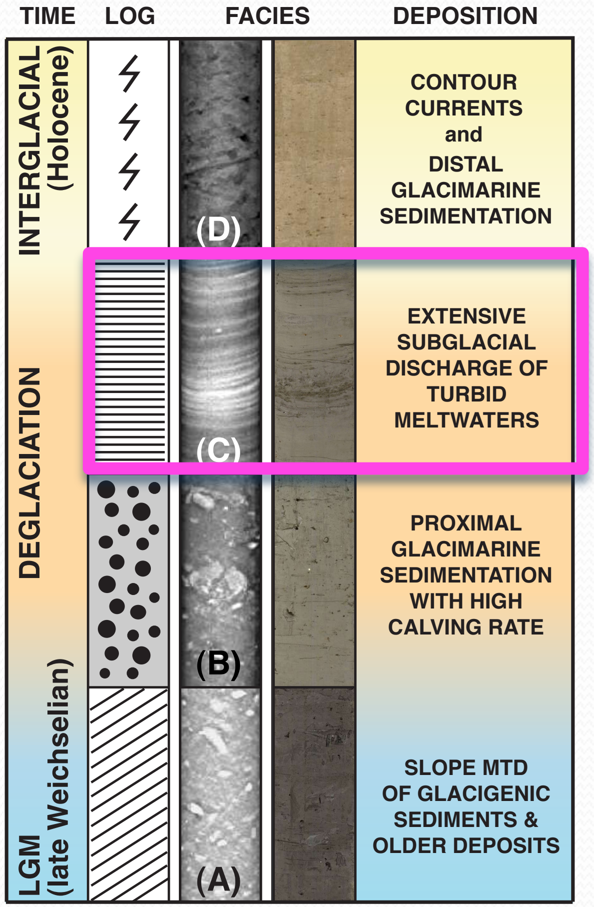
Settling of Iceberg-rafted detritus (IRD) and meltwater, sediment laden plumes both related to ice-sheet decay



Vertical settling of bioclasts, wind transported sediments, and occasionally IRD





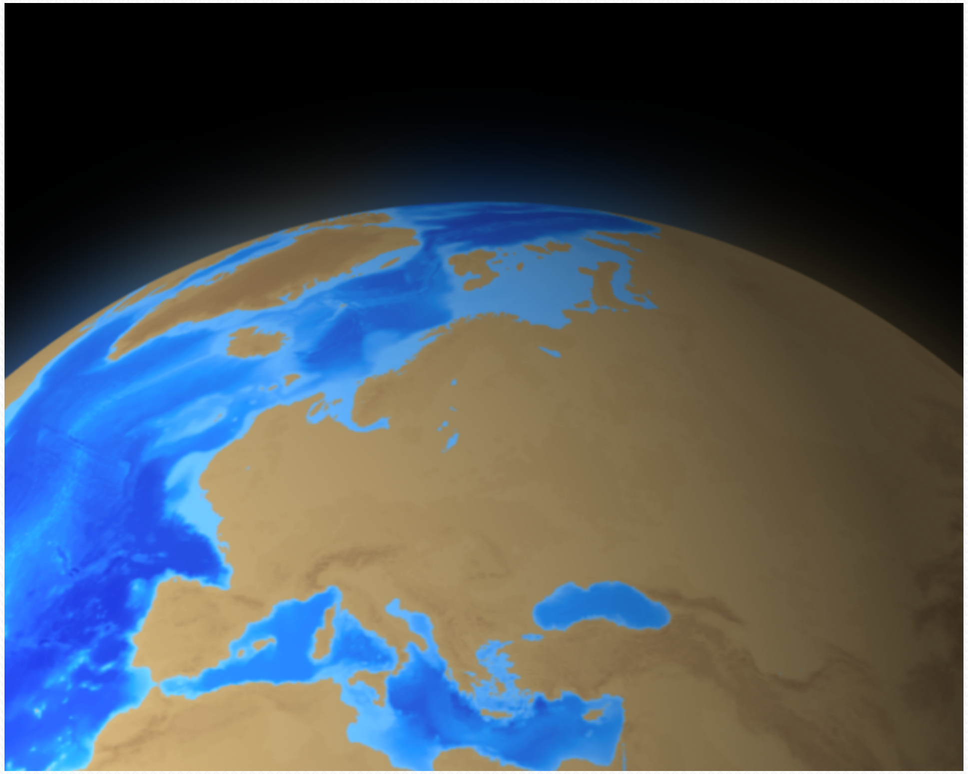


The laminated sediments deposited from turbid metlwater plumes (***pulmites***) during the main phase of deglaciation

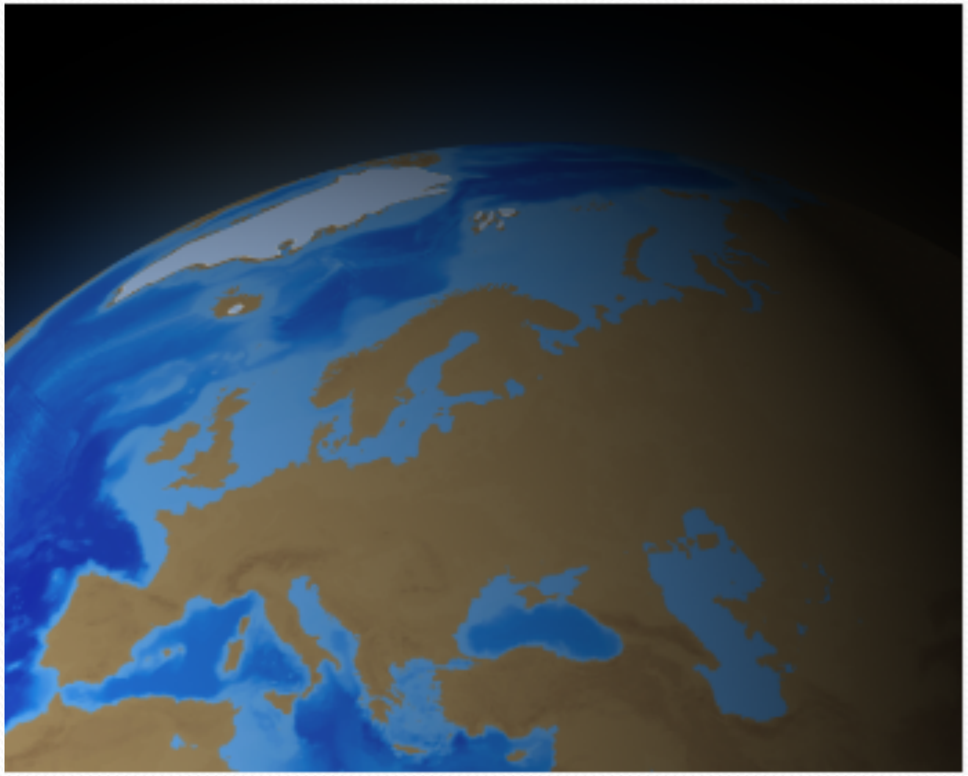
Duration **130 years**
Sedimentation rate **3.4 cm/y**

According to core correlation with other sediment cores recovered in the NW Barents sea margin the plumite event occurred between **14.7-14.4 ky BP**

SIGNIFICANCE OF THICK PLUMITE SEQUENCE RECORDED IN THE IN THE ARCTIC MARGINS AFTER LAST GLACIAL MAXIMUM



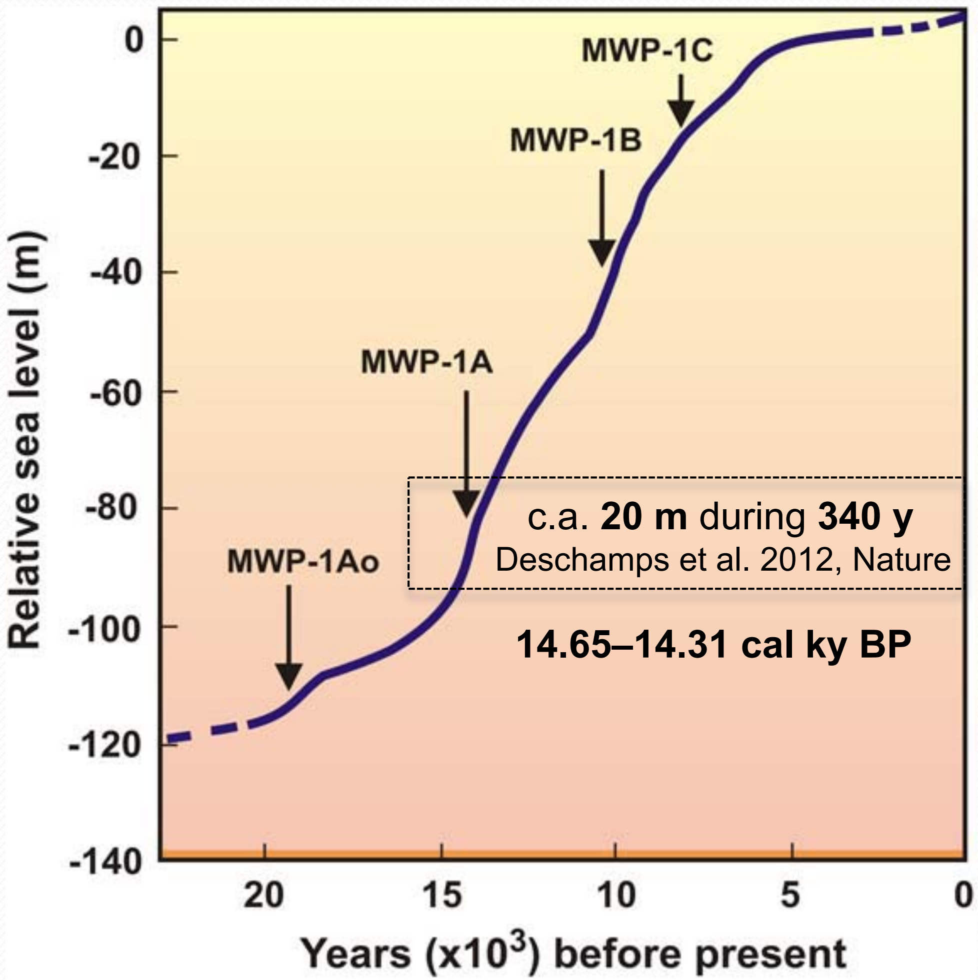
SEA LEVEL DURING LAST GLACIAL MAXIMUM



SEA LEVEL AT PRESENT

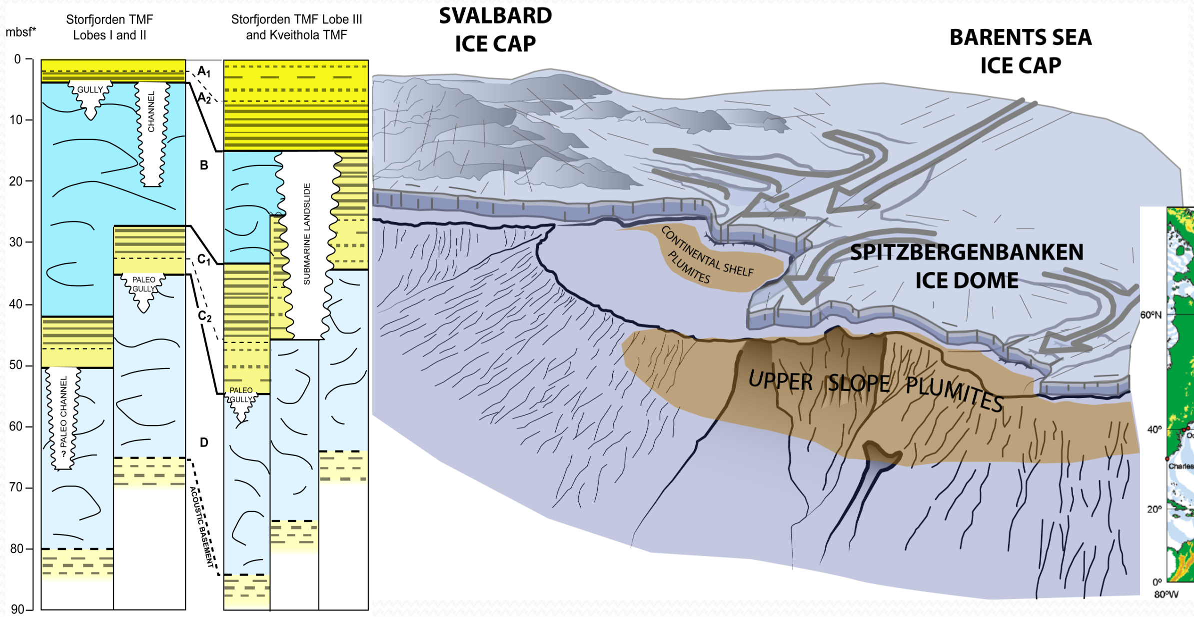
SIGNIFICANCE OF THE EXTREME MELTWATER EVENT RECORDED AROUND SVALBARD

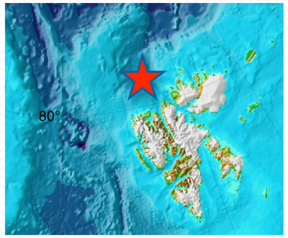
POST GLACIAL SEA LEVEL RISE

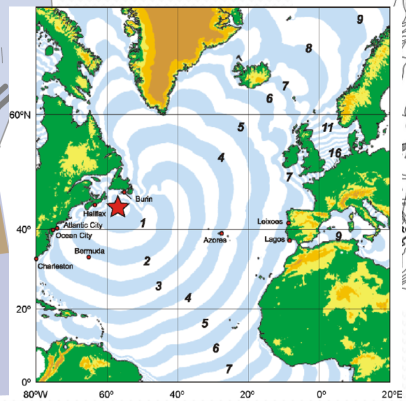


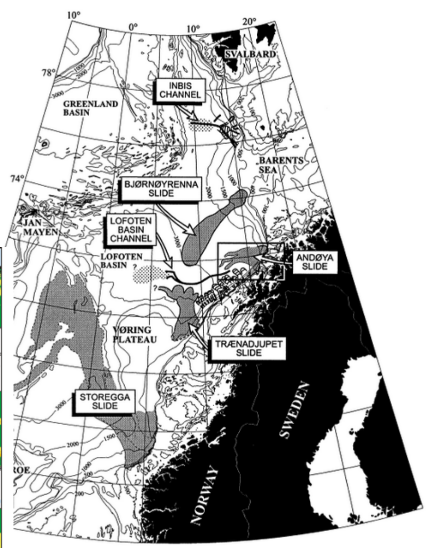
Radiocarbon and palaeomagnetic constrains indicated that the several m-thick plumites recovered around Svalbard represents **the marine sedimentary record of Meltwater Pulse 1A** (MWP-1A) responsible for the settling of about **1.1 10^{11} tonnes** of sediments on the upper slope of the Storfjorden-Kveithola TMFs during about **130 years** with an extreme sedimentation rate of **3.4 cm y^{-1}**.

ENVIRONMENTAL IMPACT OF EXTREME MELTWATER EVENTS









The thickness of plumites on the studied area exerts a major control on the number and volume of submarine landslides representing in the Arctic area a "weak layer"

The majority of landslides on the TMF occurred during deglaciation or early in the interglacial cycles and they are most often rooted in the previous deglacial/interglacial boundary.

Other landslides associated to plumites in the Arctic/sub-Arctic are:

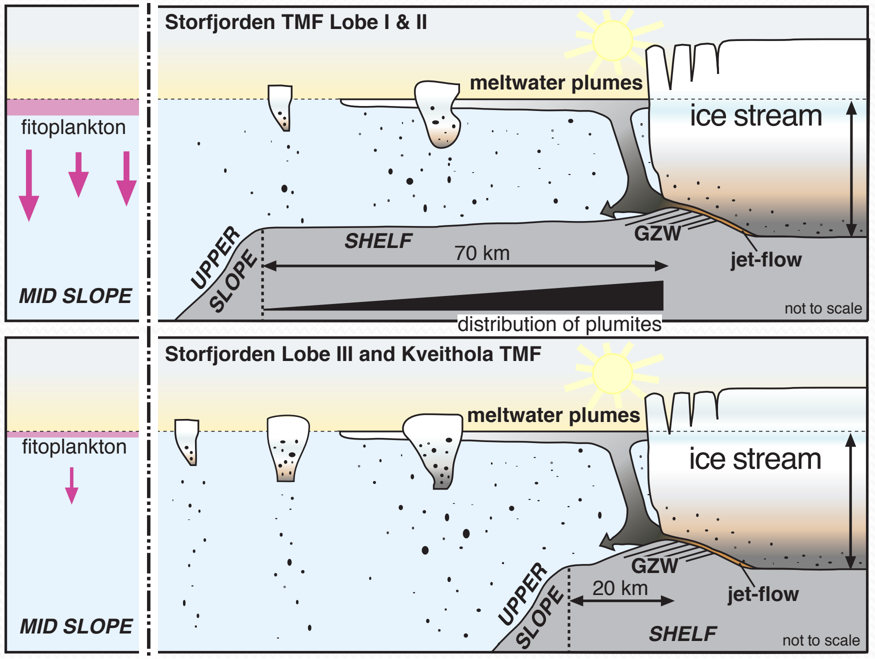
» Hinlopean/Yermak Megaslide, north of Svalbard (dated 30 kr BP, ca. 1150 km^3 vol.)
» Storegga submarine landslide, southern Norwegian margin (dated 8300 y BP, 3.500 km^3 vol.)
»Trænadjupet submarine landslide, southern Norwegian margin (dated 4000 y BP, 900 km^3 vol.)
» Grand Banks submarine landslide, Newfoundland slope (dated 1929 AD, 200 km^3 vol.)

ENVIRONMENTAL IMPACT OF EXTREME MELTWATER EVENTS

Meltwaters delivered to oceans a huge amount of cold, fresh waters and sediments

SUSPENDED SEDIMENTS

« Suspended sediments can limit sun penetration in surface water masses inhibiting the primary productivity (photosynthetic organisms)



The bioproductivity reprised earlier off Lobe I and II with respect to Lobe III

COLD, FRESH WATERS

« The presence of fresh meltwaters at the sea surface enhanced sea ice formation (lower freezing point) modifying the albedo both contributing to climate cooling (cold stadial between Bølling and Allerød interstadials). The presence of multi-years sea ice can explain the absence of ice rafted debris during deposition of plumites.

« Cold meltwaters may have interact with the deep ocean circulation modifying the characteristics of the thermohaline circulation in turn forcing climate change.

CONCLUDING REMARKS

• The several meter thick meltwater deposit (*plumites*) observed in the Western and Northern Barents Sea sedimentary sequence, has been pointed as the Arctic marine record of the Meltwater Pulse 1A event that was responsible for a global sea level rise of about 20 m only during 340 year (about 5.9 cm/y)

• Extensive meltwater release determined a perturbation on oceanic water masses enhancing sea ice formation and possibly interacting with the deep thermohaline circulation. Both interactions led to climate cooling

• Surface suspended sediments derived from meltwaters inhibited the primary productivity by reducing sunlight penetration

•The thickness of plumites on the studied area exerts a major control on the number and volume of submarine landslides representing in the Arctic and sub-Arctic area a ”weak layer” preconditioning slope instability

More information on:

Rebesco et al., 2011, Marine Geology, 279:141-147.
Pedrosa et al., 2011, Marine Geology, 286:65-81.
Sagnotti et al., 2011, Geochemistry, Geophysics, Geosystems, 12 (11), Q11Z33.
Rüther et al., 2012, Boreas, 41:494-512.
Lucchi et al., 2012, Advances in Natural and Technological Hazards Research, Springer Science book series, 31: 735-745.
Rebesco et al., 2012, Advances in Natural and Technological Hazards Research, Springer Science book series, 31: 747-756.
Rebesco et al., 2013, Deep Sea Research Part I, 79:156-168
Lucchi el al., 2013, Global and Planetary Change, 111:309-326.
Rebesco et al., 2014, Quaternary Science Review, 92:227-234.
Llopart et al., 2014, Advances in Natural and Technological Hazards Research, Springer Science book series, 37: 95-104.
Llopart et al., 2015, Quaternary Science Reviews, 129:68-84.
Lucchi et al., 2015, αrktos online, DOI 10.1007/s41063-015-0008-6.
Sagnotti et al., 2016, Geophysical Journal International, 204:784–797.
Rebesco et al., 2016, Quaternary Science Reviews, 147:178-193.
Carbonara et al., 2016, Palaeogeography, Palaeoclimatology, Palaeoecology, in press.