Multi-proxy analysis of Late Quaternary ODYSSEA Contourite Depositional System (Ross Sea, Antarctica) and the depositional record of contour current and cold, dense waters

Michele Rebesco[1], Renata Giulia Lucchi[1], Andrea Caburlotto[1], Stefano Miserocchi[2], Leonardo Langone[2], Yanguang Liu[3], Caterina Morigi[4], Patrizia Macrì[5], Aldo Winkler[5], Alessio Di Roberto[5], Paola Del Carlo[5], Ester Colizza[6], Davide Persico[7], Giuliana Villa[7], Rudy Conte[1,8], Nessim Douss[1,6], Roland Neofitu[9], and Chris Mark[9]

[1]OGS, GEOPHYSICS, Sgonico (TS), Italy (mrebesco@ogs.trieste.it); [2]ISP, Istituto di Scienze Polari, CNR, Bologna, Italy; [3]First Institute of Oceanography, Ministry of Natural Resources, Qingdao, China; [4]Dept. of Earth Sciences, University of Pisa, Italy; [5]INGV, National Institute of Geophysics and Volcanology, Italy; [6]Dept. of Matematica e Geoscienze, University of Trieste, Trieste, Italy; [7]Dept. SCVSA, University of Parma, Italy; [8]Ca' Foscari University of Venice, Venice, Italy; [9]School of Earth Sciences, Science Centre West, University College Dublin, Ireland

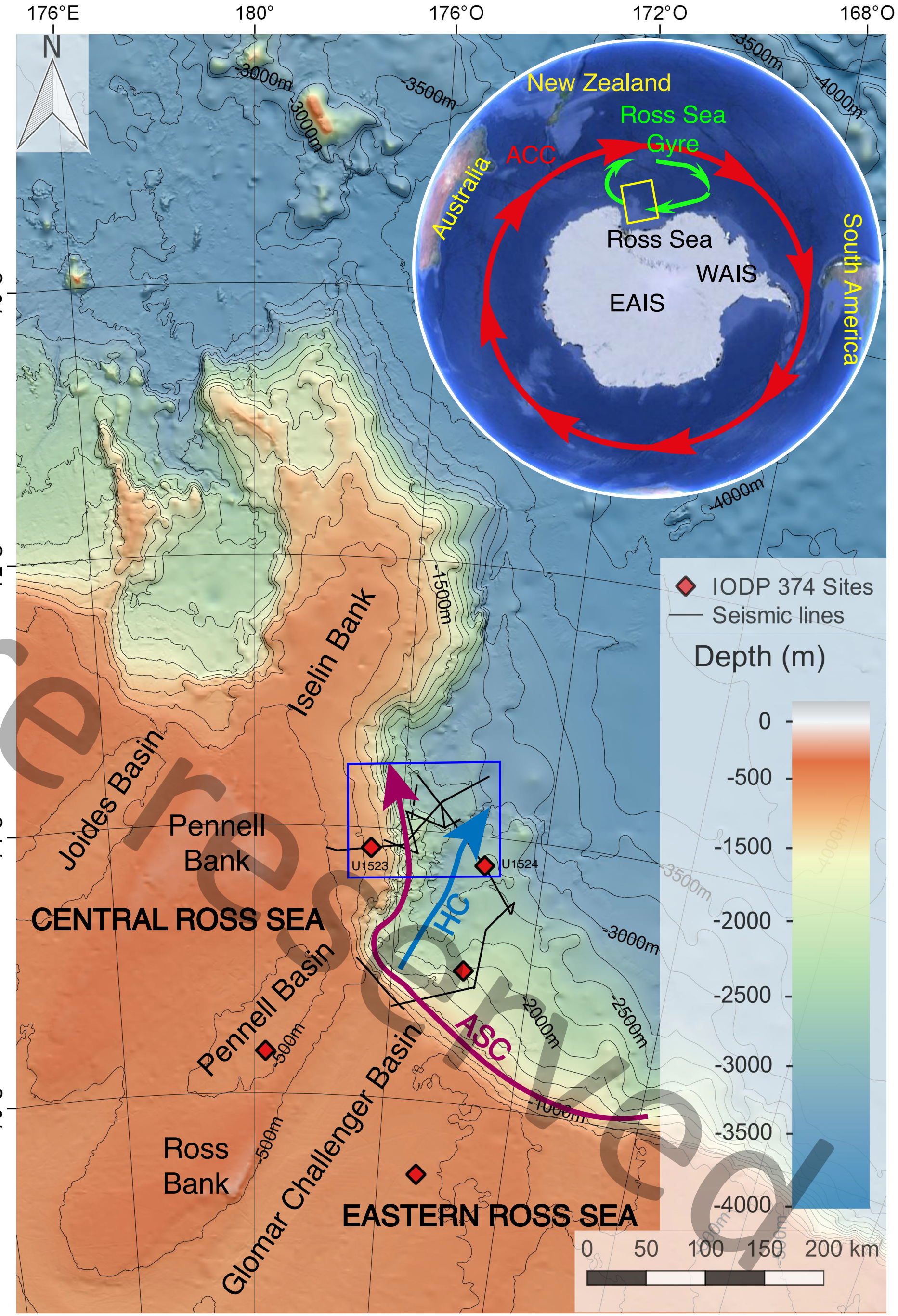
A multi-proxy investigation was conducted on the shallowest part of the ODYSSEA Contourite Depositional System, which we expect to contain:

i) the record of the Ross Sea brine formation (HSSW);
ii) the indication on contour current strength through time;
iii) interplay and modulation of brine and contour currents in association to climate change.

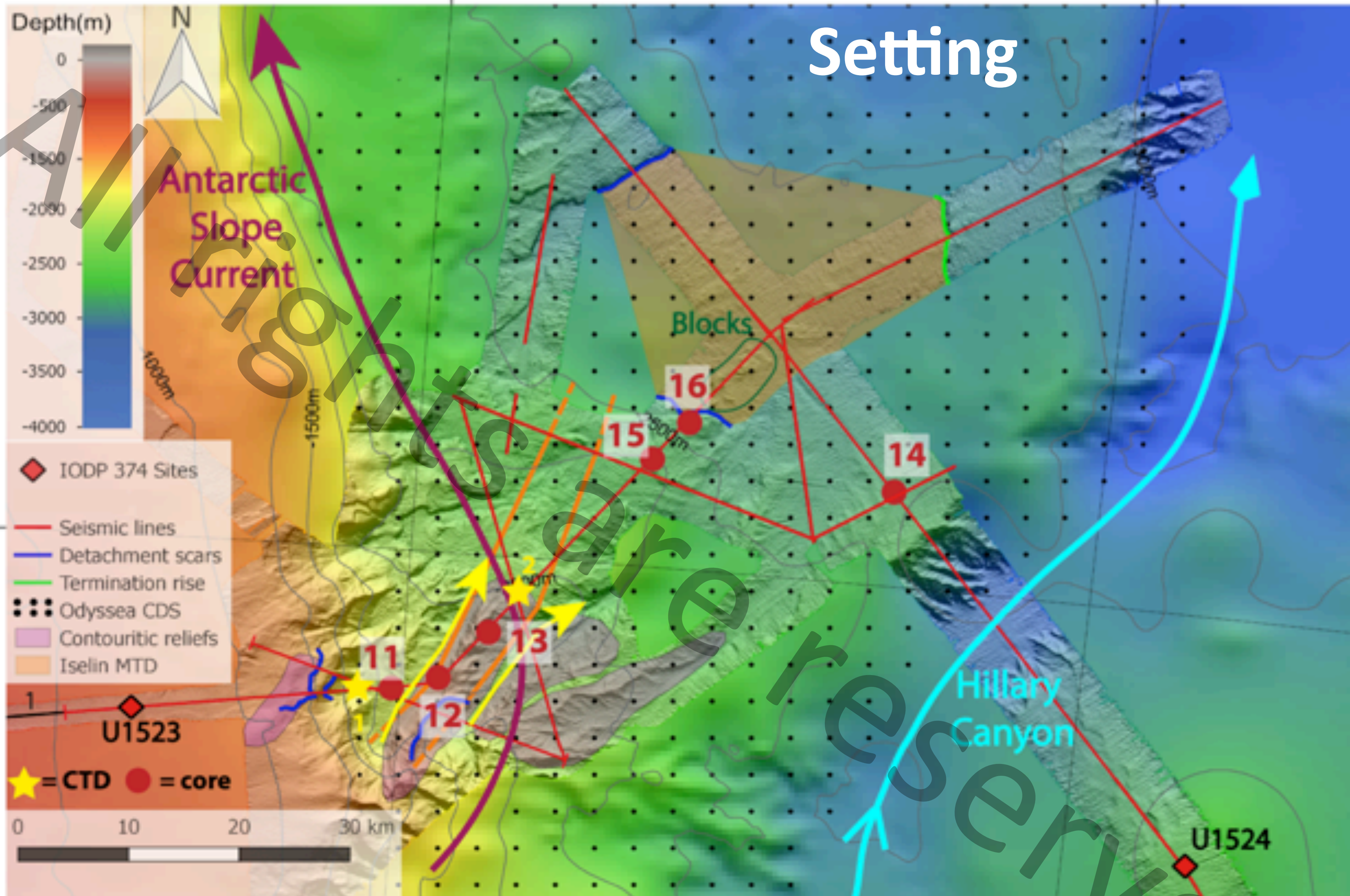
Study area and oceanography

The Ross Ice Shelf is the Antarctic region that over the last deglaciation experienced the greatest change in areal ice cover. Today, cold, dense and saline water masses forming the Ross Sea High Salinity Shelf Water (HSSW), produced in the Ross Sea polynya, flow from the shelf to the deep ocean providing a significant contribution to the propelling of the global ocean circulation regulating the climate. In particular, the Hillary Canyon in the Eastern Ross Sea is the main conduit through which brines descend the slope to reach the deeper ocean and is thus one of the greatest regions of cold, dense water export in the world.

HC=Hillary Canyon; ASC= Along-slope current; EAIS=East Atarctica Ice Sheet; WAIS=West Antarctic Ice Sheet

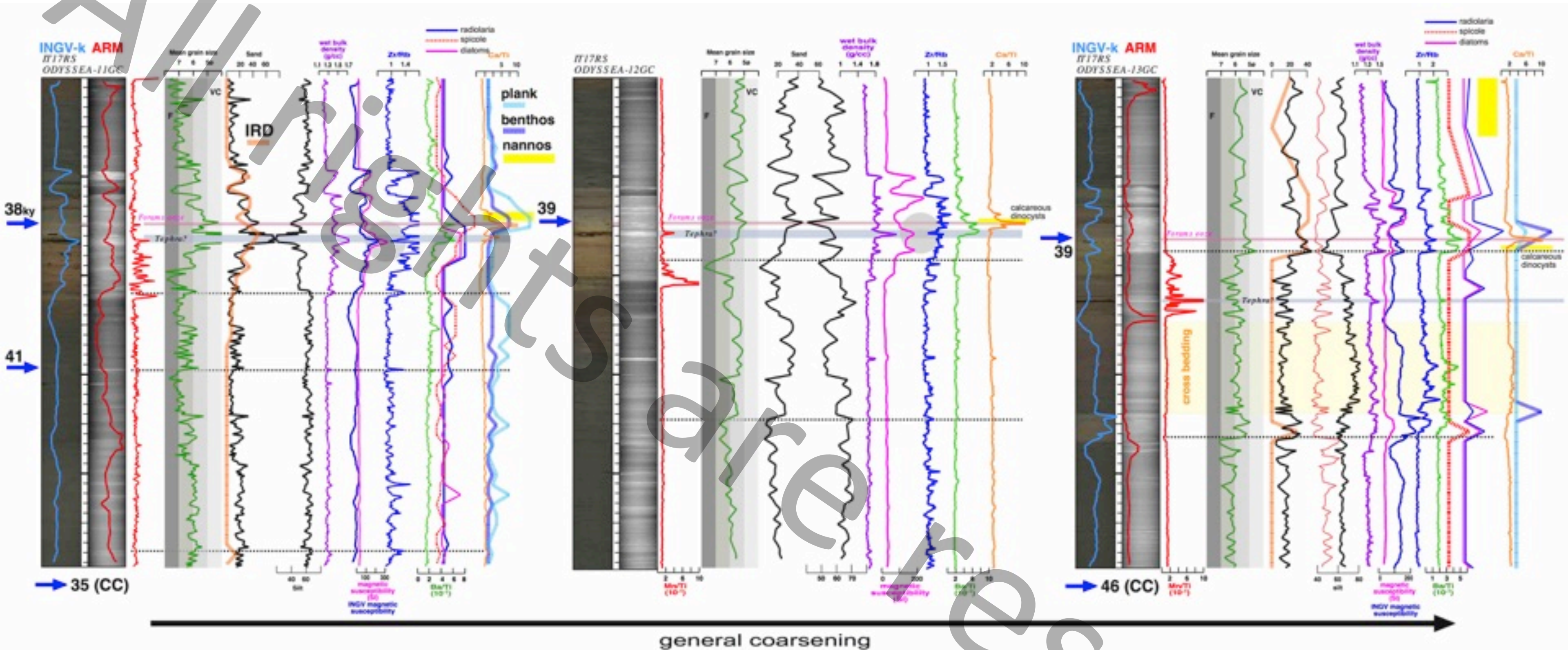


Setting



A Contourite Depositional System (the ODYSSEA CDS) on the western flank of the Hillary Canyon is inferred to have been generated in several hundred-thousand years by along-slope, contour currents that transported and accumulated the sediments brought down theHillary Canyon by means of brines.

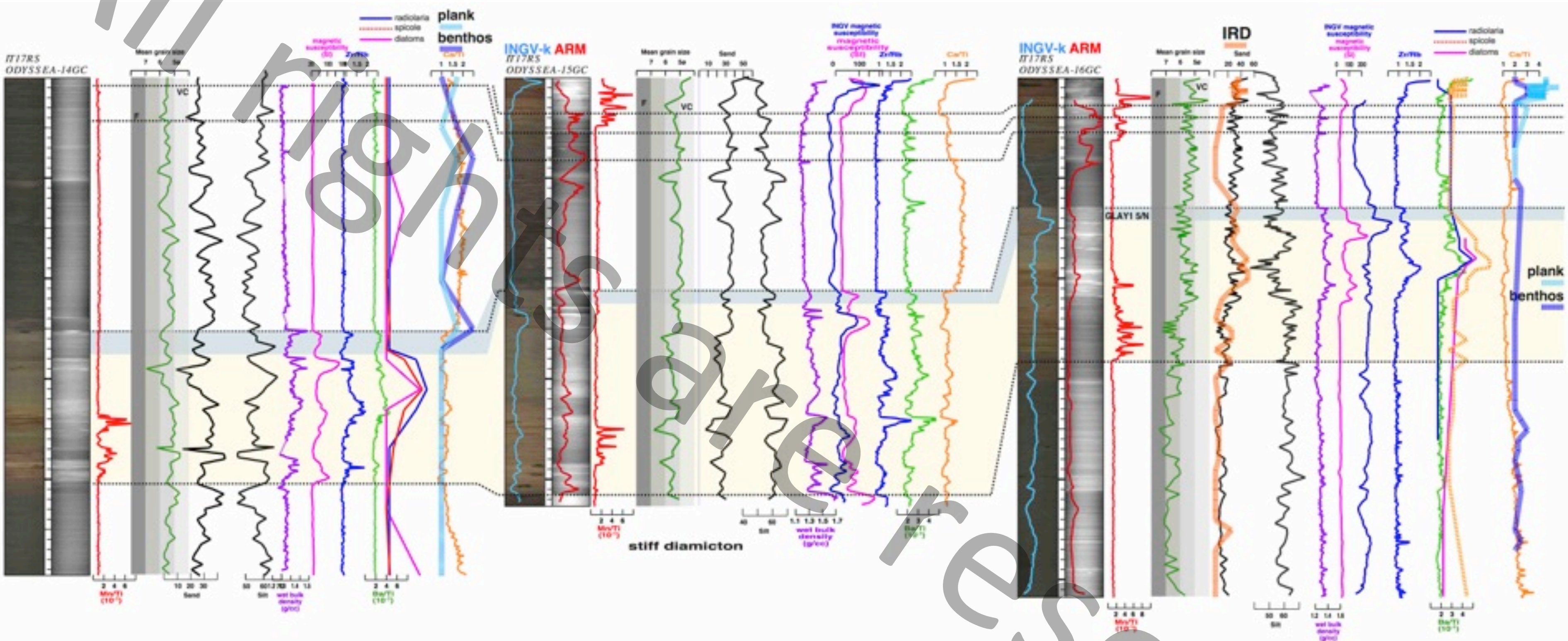
ODISSEA CDS proximal cores



Proximal cores:
GC11, GC12 and GC13, have partially recorded Marine Isotope Stage 3 (MIS 3: 60 – 25 ka B.P.) to the beginning of MIS1.

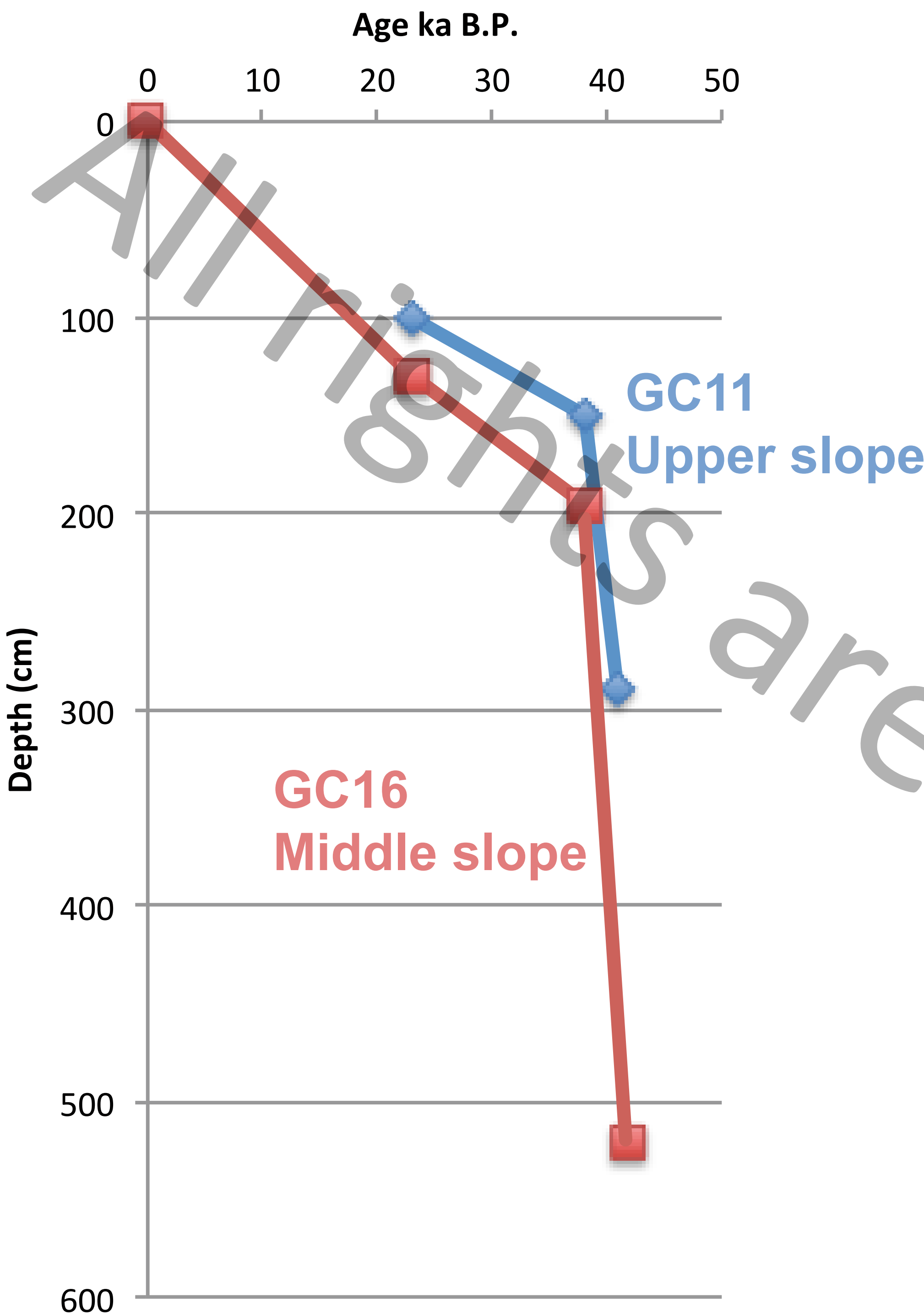
More details about core GC13, in Neofitu et al., 2020, EGU2020-5011.

ODISSEA CDS distal cores



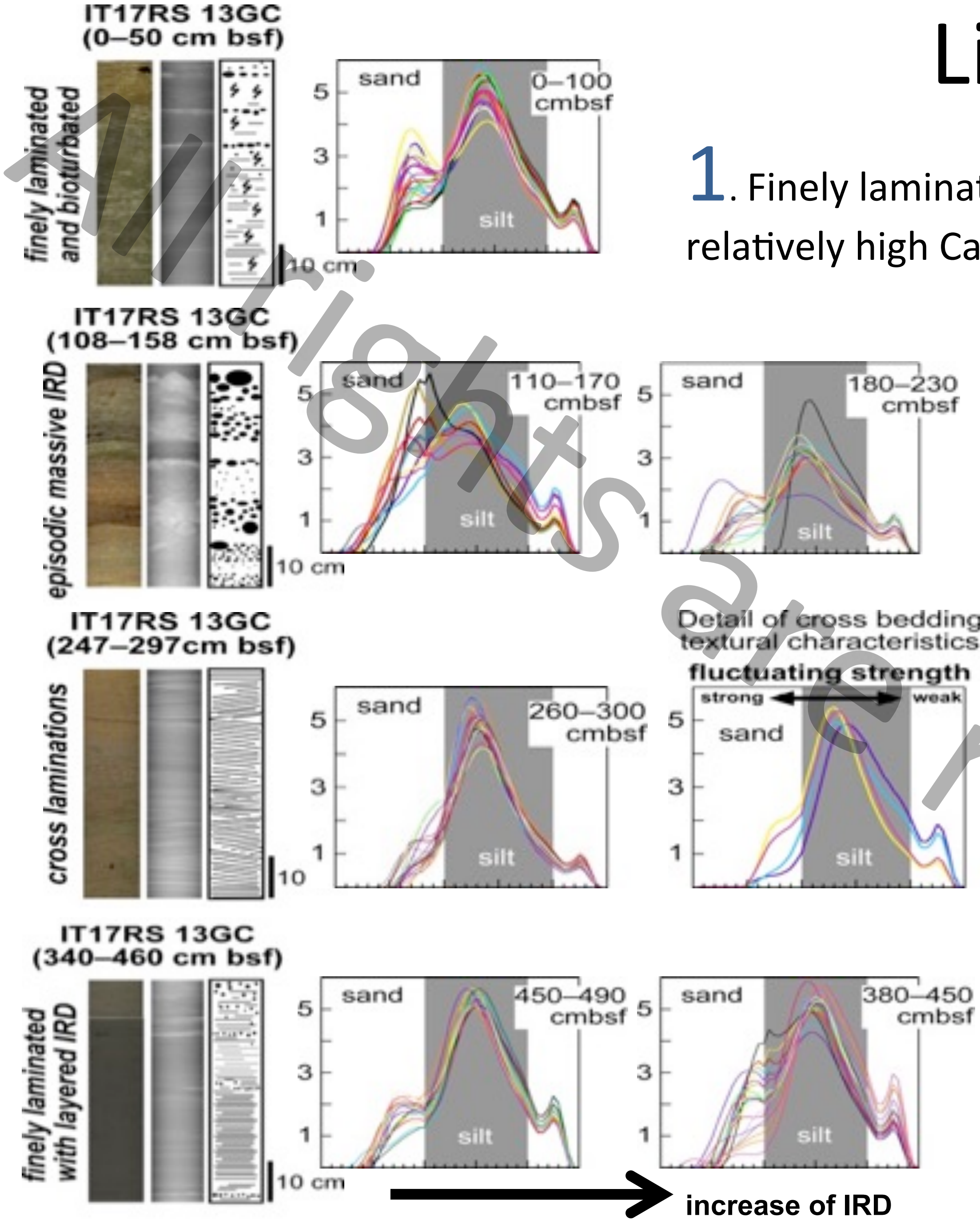
Distal cores:
GC15 and GC16 record the MIS 3 to MIS 1.
In GC14, MIS 1 is not recorded or lost during the sampling procedures.

Age model and sedimentation rate



The age model has been reconstructed combining ^{14}C AMS radiocarbon dating on foraminifera tests, tephrochronology, biostratigraphy, palaeomagnetic record, sediment facies analyses that takes into account the sediment physical properties (wet bulk density, water content and grain size), and compositional characteristics (XRF core scan and geochemistry).

Lithofacies

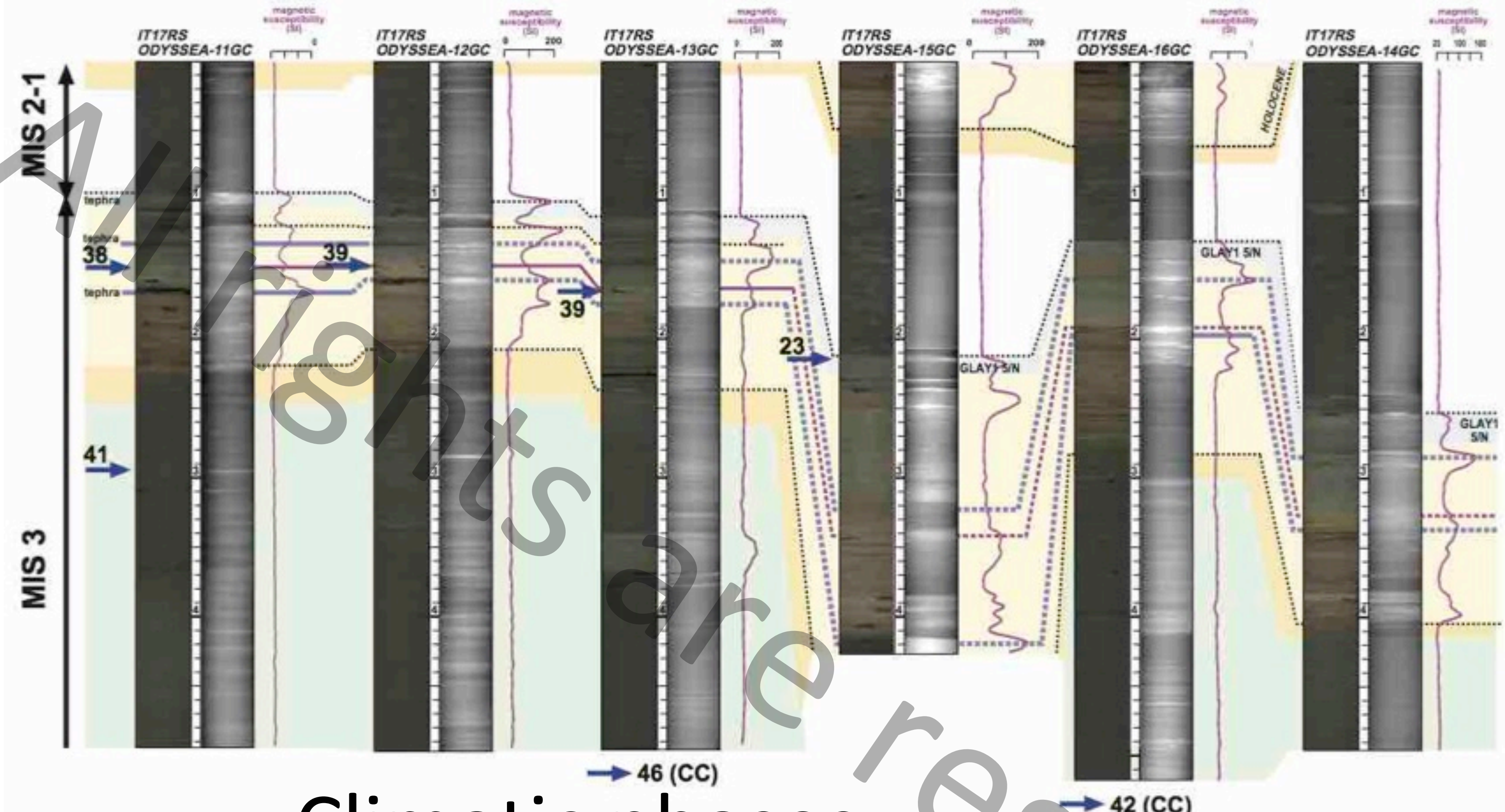


1. Finely laminated and bioturbated sediments, relatively high Ca content, rare calcareous microfossils.

2. Bioturbated, abundant, sparse and/or layered IRD. High Ca content. Abundant foraminifera and reworked calcareous nannofossils. Mn peak at the base of this facies.

3a. Cross laminations

3b. Finely laminated, not bioturbates sediments with layered IRD.



Climatic phases

11 ka BP - present: relatively warm. Contour current deposition.

27-11 ka BP: Cold phase. Glaciomarine deposition.

39-27 ka BP: Warming phase, sea-ice free (calving zoneproximity), good sea floor oxygenation. Possibly related to the sea level change at around 39 kyr BP (Siddal et al. 2008).

42-39 ka BP: Cold period. Steady bottom currents under harsh climate conditions (barren sediments). Local intensification of the bottom currents produced cross laminations (core 13GC).

Warm | Oxydized interval
Chilly | Cold
Forams' ooze (▪▪▪▪ correlation)
Tephra (▪▪▪▪ correlation)
Colour marker Munsell GLAY1-5/N
AMS ^{14}C calibrated ages (cal ka PB)

References

Lucchi, R.G., Caburlotto, A., Miserocchi, S., Liu, Y., Morigi, C., Persico, D., Villa, G., Langone, L., Colizza, E., Macrì, P., Sagnotti, L., Conte, R., Rebesco, M., 2019. The depositional record of the Odyssea drift (Ross Sea, Antarctica). Geophysical Research Abstracts, Vol. 21, EGU2019-10409-1, 2019. EGU General Assembly, Vienna (Austria), 7–12, April, 2019 (POSTER).

Neofitu, R., Mark, C., Rebesco, M., Lucchi, R.G., Douss, N., Morigi, C., Kelley, S., Daly, J.S., 2020. Tracking Late Quaternary ice sheet dynamics by multi-proxy detrital mineral U-Pb analysis: A case study from the Odyssea contourite, Ross Sea, Antarctica. Geophysical Research Abstracts. EGU General Assembly, Vienna (Austria), 3–8, May, 2020 (POSTER for session CL1.11).

Methods

Six gravity cores, collected in both the proximal and distal area of the ODYSSEA CDS, were studied through multi-proxy analyses including sediment physical properties (texture, structures, water content, wet bulk density), paleomagnetism and rock magnetism, compositional characteristics (XRF, geochemistry and detrital apatite, zircon, and rutile U-Pb on ice-rafted debris) (Lucchi et al., 2019; Neofitu et al., 2020) and microfossil content (planktonic and benthic foraminifera, calcareous nannofossils and diatoms).