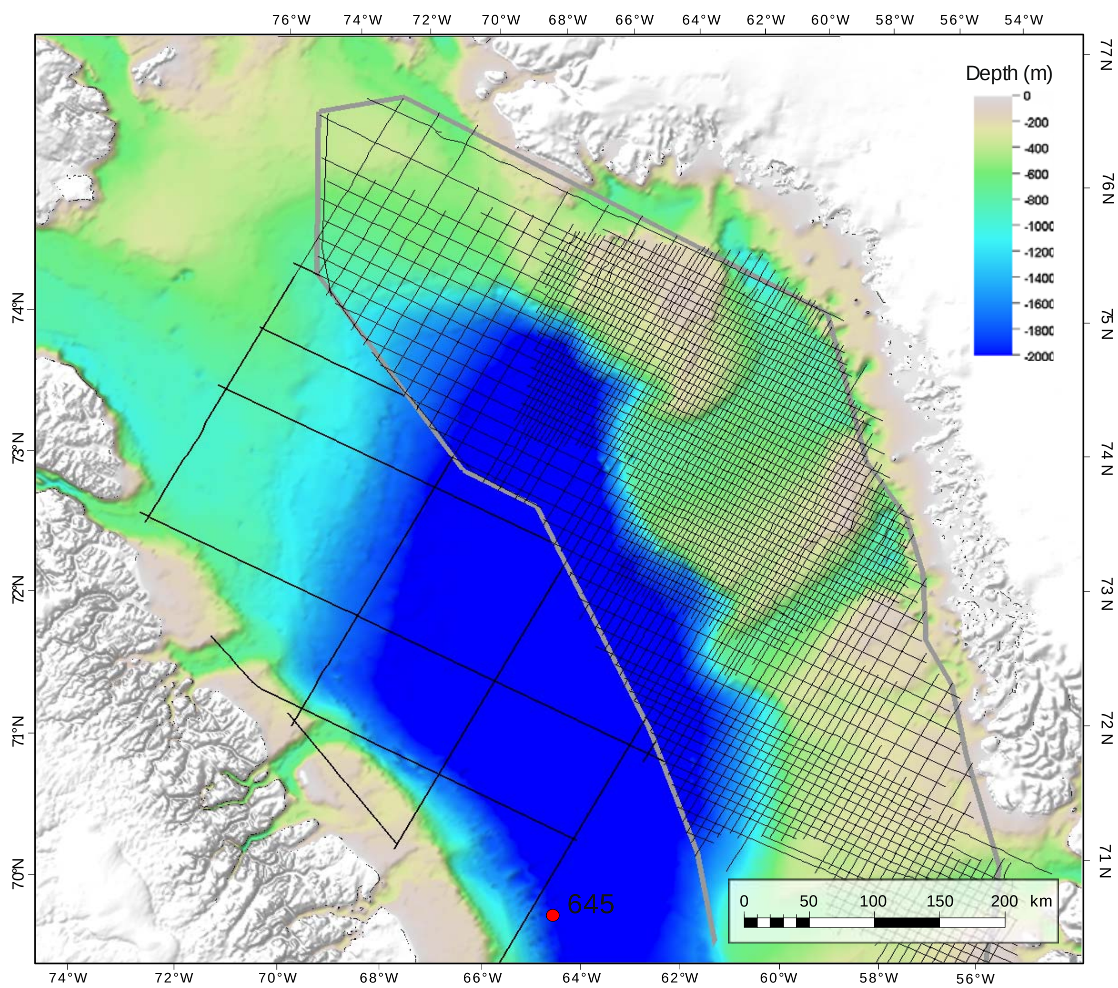

Figure DR1. Bathymetry map (IBCAO) showing seismic line grid used for the seismic-stratigraphic mapping of Neogene horizons in Baffin Bay and West Greenland margin. Data were acquired and processed by TGS in 2007, 2008, 2009, and 2010 as part of commercial exploration in the region. The seismic source was slightly different each year and varied from 3400-4100 cu. in. The shot interval for all surveys was 25 m. Data were recorded on a 6 km long streamer with a 12.5 m group interval for a nominal fold of 120. Processing followed a fairly standard sequence and included surface related multiple attenuation, as well as tau-p and radon demultiple followed by Kirchhoff pre-stack time migration and stacking. All data shown have been 0-phase converted. TGS is a geoscientific data and service company based in Norway (www.tgs.com).

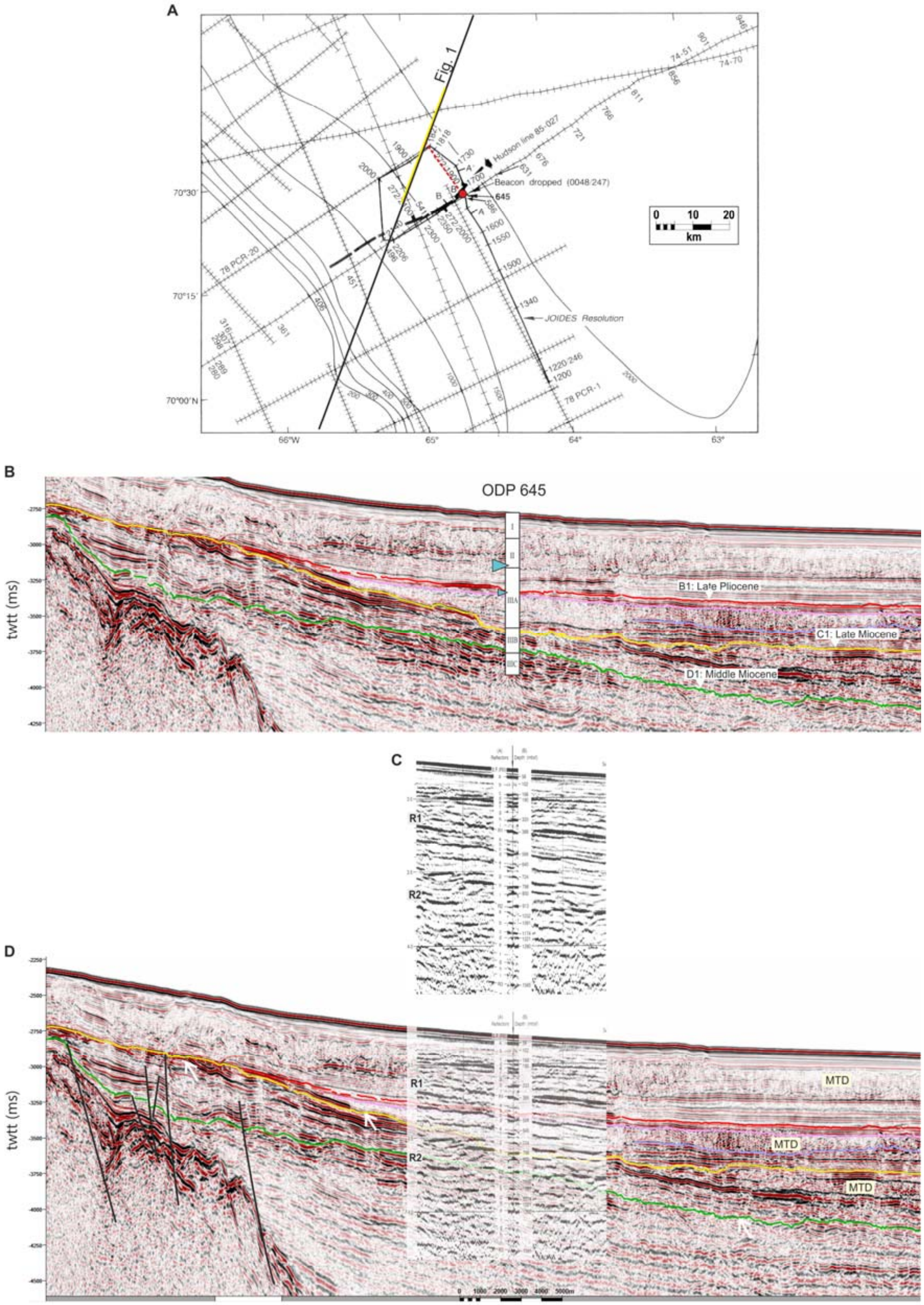

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Figure DR2. Seismic tie to ODP site 645. A: Map showing the position of the TGS seismic line from Fig. 1B in relation to original site survey lines and drilling site (Shipboard Scientific Party, 1987). B: Seismic section expanded from Fig. 1B with correlation of seismic horizons to lithological units in ODP site 645. Vertical scale shown in milliseconds (ms) two-way travel time (twtt). The stratigraphic column from ODP 645 is projected onto the TGS seismic line based on the time-depth conversion reported in Shipboard Scientific Party (1987) and maintaining a similar water depth, approximately 2000 m (2800 ms twt). C: Enlarged section from site survey profile 74-51with key reflectors R1-R2 and corresponding drilled depths (mbsf) indicated. D: The site survey section from panel B superimposed on the TGS seismic section from panel B. See also original profile displayed as Fig.14b in Harrison et al. (2011). Several intervals of mass transport deposits (MTD) are seen on the TGS seismic profile and recognised on original site survey dip sections as unconformable wedges that pinch out in an upslope direction (Shipboard Scientific Party, 1987). Erosive contacts (white arrows) and faults are indicated. Seismic profile courtesy of TGS.

Seismic-to-corehole correlation: Survey profiles striking the slope display an apparent conformable succession with the R2 reflector identified at about 3700 ms twt. This time-depth correlates with horizon d1 of the present study, defining the top of a stratified, high-amplitude interval intersected by numerous small-scale faults (e.g. dewatering faults). The seismic tie to R2 and the biostratigraphically defined chronology from ODP 645 indicates a middle Miocene age for horizon d1, e.g. 15-17 Ma. Horizon c1 appear as a truncated reflector below a mass-transport deposit, corresponding to the transition between lithological unit IIIA and IIIB. The erosional character of horizon c1 implies a hiatus, for which the sediments below the unconformity suggest a maximum age of 9-11 Ma (see below). Horizon b1 is located ~100 ms below the R1 reflection marked on the low-resolution vintage profile.

Biostratigraphic and lithological summary of ODP 645: Dinocyst and benthic foraminifera assemblages assigns an early to early middle Miocene for unit IIIC and middle to late Miocene for unit IIIB (Baldauf et al., 1989; Head et al., 1989; Kaminski et al., 1989). The occurrence of *Bolboforma metzmacheri* in the upper part of IIIB suggests an age range of late Miocene – early Pliocene for this interval (Kaminski et al., 1989; Berggren et al., 1995), while dinocyst data indicate an age of no younger than early late Miocene, about 9-11 Ma (Head et al., 1989; Piasecki, pers. comm.). The presence of suspension-feeding agglutinated species (e.g. *Rhizammina*) and the poor preservation of calcareous benthic foraminifer suggests a deep-marine setting (bathyal – abyssal) influenced by corrosive bottom-water currents (Kaminski et al., 2005). The lithology of units IIIB and IIIC varies between muddy fine sand and silty mudstone with common laminations and burrows, while the clay mineral composition is abundantly smectite (Thiébault et al., 1989). In contrast, unit IIIA display a more heterogenic character with graded bedding and common shale intraclasts (Shipboard Scientific Party, 1987) which are likely reworked from older formations commensurate with the seismic signature of a mass transported interval above the c1 unconformity. Samples from lithological unit IIIA are generally devoid of fossils but isolated faunal specimens and the stratigraphic context suggest a late Miocene to Pliocene age (Kaminski et al., 1989). An increase in chlorite:smectite and the first occurrence of ice-rafted pebbles from about 500 mbsf (small blue triangle) is indicative of initial climate cooling in the Baffin Bay region (Korstgård and Nielsen, 1989; Thiébault et al., 1989). Unit II was assigned a late Pliocene - early Pleistocene age (pre-2010 ICS nomenclature), based on occurrences of *Neogloboquadrina pachyderma* sinistral (Baldauf et al., 1989; Kaminski et al., 1989). A persistent increase in crystalline and carbonate ice-rafted debris from about 300 mbsf (large blue triangle) signals the onset of major glaciations in the Baffin Bay region (Korstgård and Nielsen, 1989).

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