

# IODP Proposal Cover Sheet

1002 - Pre

Totten Glacier Climate Vulnerability

Received for: 2021-04-01

Title	Totten Glacier Climate Vulnerability under varying Neogene climate conditions: Lessons for East Antarctica Ice Sheet climate sensitivity		
Proponents	Bradley Opdyke, Yair Rosenthal, Philip O'Brien, Amy Leventer, German Leitchenkov, Federica Donda, Yusuke Yokoyama, Taryn Noble, Linda Armbrrecht, Andrew Roberts, Sophie Warny, Eelco Rohling		
Keywords	Antarctica, Paleoclimate, Ice sheet history	Area	East Antarctic margin

## Proponent Information

Proponent	Bradley Opdyke
Affiliation	The Australian National Univeristy
Country	Australia

Permission is granted to post the coversheet/site table on [www.iodp.org](http://www.iodp.org)

## Abstract

The Aurora Subglacial Basin is part of the East Antarctic Ice Sheet (EAIS), and drains to the Sabrina Coast through the Totten Glacier (TG), which is recognized as one of the largest drainage-system in East Antarctica. Like glaciers in West Antarctica, the TG is largely grounded below sea level and hence susceptible to marine ice instabilities. Current melting rates of the TG are among the fastest in the EAIS. They are likely enhanced by incursions of relatively warm modified Circumpolar Deep Water (mCDW) to the glacier grounding line, indicating high vulnerability to rapid collapse, with a potential contribution of ~ 3.8 meters to sea level rise. Seismic correlations between proposed coring sites on the Sabrina slope rise (this proposal) and sites along the EAIS margin, suggest that the TG history might have been different from other East Antarctic glaciers. We propose to reconstruct the response of the TG to climate changes since the mid-Miocene, with an emphasis on warmer than present intervals, such as Pleistocene super interglacials, the mid Pliocene and the Mid Miocene Climate Optimum. We also seek to examine the impact of the mid-Pleistocene and following climate transitions on TG dynamics. This proposal takes advantage of unique features of the Sabrina Coast including: 1) Well bedded, glaciomarine sediments with higher Plio-Pleistocene sedimentation rates relative to sites previously cored on the Antarctic margin; 2) High resolution seismic data, which provide a highly detailed image of the sites' seismostratigraphy; 3) Miocene-age dipping outcrop strata, accessible at shallow depth; 4) Multiple potential coring sites outside the Summer sea ice front; 5) Availability of biogenic proxies, including diatoms, radiolaria, foraminifera (in certain intervals) and organic biomarkers allowing for stratigraphic and paleoceanographic reconstructions that can be correlated both with the TG history and global events. Correlation to the global isotope stack (LR04) and ice core records will illuminate the sensitivity of the TG to local and global climate conditions through the Neogene.

We propose a Joides Resolution expedition to recover 5 primary sites (11 alternates), spanning the Holocene to mid-Miocene. Our proposed strategy is designed to reach target time intervals via APC/XCB at minimum burial depths by choosing cores covering the target intervals at maximum temporal resolution. Cores on both sides of the Sabrina coast target possibly different deglacial regimes of the Totten glacier, allowing us to test the proposed hypotheses. The wide range of sites offer contingency for different sea ice conditions.

## Scientific Objectives

The overarching goal of this proposal is to improve our understanding of the EAIS sensitivity to climate change through the reconstruction of the Totten Glacier history under varying climate conditions during the Neogene, with the primary emphasis on the Plio-Pleistocene. Specific objectives include:

1. Reconstruct the mid-Miocene to Holocene TG melting history with an emphasis on warm intervals including mid Miocene climate optimum (MMCO), Pliocene warm period and Pleistocene super interglacials, by recovering continuous sedimentary records at variable temporal resolutions.
  2. Assess the TG response to the major climate transitions across the Neogene, including the mid Miocene climate transition (MCT), Northern Hemisphere Glaciation and mid Pleistocene Transition as well as to major glaciations (e.g., MIS G10, M2, MMCO).
  3. Assess the mechanisms affecting TG melting (e.g., global temperatures, sea level rise and changes in water-mass circulation near the TG).
  4. Correlate the TG history with other east and west Antarctic glaciers, and with global paleoceanographic reconstruction.
  5. Determine the TG response to Northern Hemisphere millennial climate perturbation (e.g., Heinrich events) by targeting high resolution sites.
  6. Evaluate the TG vulnerability under variable background climate states in relation to current models of EAIS melting.
  7. Determine if the region received large meltwater pulses during particular parts of the climate cycle.
- This proposal addresses Challenges 1 and 2 of the current IODP Science Plan and three strategic objectives of the 2050 framework related to Earth's climate system response to elevated levels of atmospheric CO<sub>2</sub> and ice sheets response to a warming climate.

### Non-standard measurements technology needed to achieve the proposed scientific objectives

Have you contacted the appropriate IODP Science Operator about this proposal to discuss drilling platform capabilities, the feasibility of your proposed drilling plan and strategies, and the required overall timetable for transiting, drilling, coring, logging, and other downhole measurements?

no

## Proposal History

Submission Type **Resubmission from declined proposal**

Declined Proposal Number **982-pre**

### Review Response

We have added a more diverse range of proponents, including a greater range of experts covering siliceous microfossils, ice and sea level modelling, ancient DNA and provenance studies of Antarctic marine sediments. We have included more early career researchers. We have revised the presentation of primary and alternate sites to make it clearer. The hypotheses we are testing are more clearly defined. There is now a more explicit reference to the IODP science plan Themes and explicit references to past Antarctic drilling experience. We have also included logging in the time budget. We have included a tool kit of proxies for intended for achieving the science goals of the Expedition.

## Proposed Sites (Total proposed sites: 16; pri: 5; alt: 11; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
TSS-09A (Primary)	-64.55403 116.63866	2097	850	0	850	1) Expanded Plio-Pleistocene section to show millennial-scale response to climate forcing 2) Date surfaces WL-8 and WL-7 to understand timing of major changes in regional sedimentation and environment.
TSS-04A (Primary)	-64.4058 116.0789	2223	550	0	550	1) Acquire expanded Plio-Pleistocene section 2) Date surfaces WL-9, WL-8 and WL-7 understand timing of local (WL-9) events and regional changes
TSS-10A (Primary)	-64.2556 115.9733	2252	350	0	350	1) Acquire expanded Plio-Pleistocene section in western-most ridge seaward of the Totten Glacier 2) Date surfaces WL-9, WL-8 and WL-7 understand timing of local (WL-9) events and regional changes
TSS-01A (Primary)	-64.7095 114.5512	1659	300	0	300	1) Acquire Plio-Pleistocene section in shallowest location with best chance of preserving calcareous fossils 2) Acquire sediment from the most inshore and westward location to see if local paleoceanographic effects are detectable
TSS-14A (Primary)	-64.6549 119.7886	3004	450	0	450	1) Acquire expanded Plio-Pleistocene section at the eastern edge of the study area which likely receives detritus from the Moscow University Ice Shelf outlet of the Aurora Basin for comparison with sites sampling sediment derived from the Totten Glacier 2) Date surfaces WL-8 and WL-7 to test if these surfaces are of the same age as further West.
TSS-11A (Alternate)	-64.2510 115.6518	2159	350	0	350	1) Acquire expanded Plio-Pleistocene section in western-most ridge seaward of the Totten Glacier 2) Date surfaces WL-9, WL-8 and WL-7 understand timing of local (WL-9) events and regional changes
TSS-12A (Alternate)	-64.2635 116.3533	2373	350	0	350	1) Acquire expanded Plio-Pleistocene section in western-most ridge seaward of the Totten Glacier 2) Date surfaces WL-9, WL-8 and WL-7 understand timing of local (WL-9) events and regional changes
TSS-02A (Alternate)	-64.625733 114.915883	1877	200	0	200	1) Acquire Plio-Pleistocene section in shallowest location with best chance of preserving calcareous fossils 2) Acquire sediment from the most inshore and westward location to see if local paleoceanographic effects are detectable
TSS-03A (Alternate)	-64.61125 115.21107	2074	250	0	250	1) Acquire Plio-Pleistocene section in shallowest location with best chance of preserving calcareous fossils 2) Acquire sediment from the most inshore and westward location to see if local paleoceanographic effects are detectable
TSS-05A (Alternate)	-64.3851 115.5360	2142	350	0	350	1) Acquire expanded Plio-Pleistocene section in western-most ridge seaward of the Totten Glacier 2) Date surfaces WL-9, WL-8 and WL-7 understand timing of local (WL-9) events and regional changes
TSS-13A (Alternate)	-64.6215 119.6420	3107	300	0	300	1) Acquire Plio-Pleistocene section at the eastern edge of the study area which likely receives detritus from the Moscow University Ice Shelf outlet of the Aurora Basin for comparison with sites sampling sediment derived from the Totten Glacier 2) Date surfaces WL-8 and WL-7 to test if these surfaces are of the same age as further West.
TSS-15A (Alternate)	-64.6252 119.6359	3111	400	0	400	1) Acquire Plio-Pleistocene section at the eastern edge of the study area which likely receives detritus from the Moscow University Ice Shelf outlet of the Aurora Basin for comparison with sites sampling sediment derived from the Totten Glacier 2) Date surfaces WL-8 and WL-7 to test if these surfaces are of the same age as further West.

## Proposed Sites (Continued; total proposed sites: 16; pri: 5; alt: 11; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
TSS-16A (Alternate)	-65.0134 119.9846	2804	850	0	850	1) Acquire expanded Plio-Pleistocene section at the eastern edge of the study area which likely receives detritus from the Moscow University Ice Shelf outlet of the Aurora Basin for comparison with sites sampling sediment derived from the Totten Glacier 2) Date surfaces WL-8 and WL-7 to test if these surfaces are of the same age as further West.
TSS-06A (Alternate)	-64.3741 114.8943	1864	480	0	480	Sample probable early Pliocene to late Miocene sediments on the western edge of the study area to compare conditions between the Plio-Pleistocene and older periods younger sections
TSS-07A (Alternate)	-64.3798 114.8132	1977	400	0	400	Sample probable late Miocene sediments on the western edge of the study area to compare conditions between the Plio-Pleistocene and older periods
TSS-08A (Alternate)	-64.3831 114.7670	2022	400	0	400	Sample probable middle Miocene sediments on the western edge of the study area to compare conditions between the Plio-Pleistocene and older periods