

***Paleoclimate Records from the Antarctic Margin and Southern Ocean (PRAMSO) workshop***  
Auckland (New Zealand) 23<sup>rd</sup> of August 2014

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A Paleoclimate Records from the Antarctic Margin and Southern Ocean (PRAMSO) workshop was held in Auckland (New Zealand) on the 23<sup>rd</sup> of August 2014, before the start of the SCAR 2014 Open Science Conference (OSC), with the financial support of the SCAR-PAIS program. Convenors were Laura De Santis and Tim Naish. About 30 participants from a number of different countries (e.g., Australia, New Zealand, Korea, Russia, Spain, Italy, Japan, USA, UK, Germany) attended the workshop.

This was the third PRAMSO workshop, following on from the one held in Granada in 2009 during the 1<sup>st</sup> SCAR-ACE symposium (De Santis et al., 2009), and the one held in Portland in 2012 before the SCAR-OSC conference (De Santis et al., 2012). The purpose of the former PRAMSO workshops was to stimulate new Antarctic and Southern Ocean drilling proposals and ensure coordination among proponents, so that regional scientific objectives are tackled through a unified approach that addresses the IODP (International Ocean Discovery Program) science plan priorities (2013-2023), and the PAIS (Past Antarctic Ice Sheet Dynamics, 2013-2020) implementation plan. Related Antarctic scientific drilling workshops were held at the International Symposium on Antarctic Earth Sciences (ISAES) in 2007 (Santa Barbara, CA, USA, focused on Antarctic scientific drilling across platforms and programs; Rack et al., 2008) and 2011 (Edinburgh, Scotland, UK, focused on Antarctic shallow drilling projects and technologies; Rack and Luyendyk, 2011), as well as an NSF-sponsored workshop in 2013 (Houston, TX, USA, focused on the prioritization of Antarctic projects within the US geologic drilling community; Wellner et al., 2014).

New drilling proposals along depth and latitudinal transects in different sectors of both the East and the West Antarctic margins were submitted or revised and resubmitted to IODP for consideration as Mission Specific Platform (MSP) or as JOIDES Resolution (JR) expeditions, and to the ANDRILL program. Proposals for collecting new site survey data were also submitted to the EU/Eurofleets project and to national funding agencies, and some new cruises are now planned for the coming two years.

The third PRAMSO workshop held in Auckland, served to update the Antarctic community about the results obtained by recently drilled projects (WISSARD subglacial drilling, IODP Exp. 318, and ANDRILL), the status of submitted drilling proposals, discussion about future proposals to develop, and also considering modelling requirements.

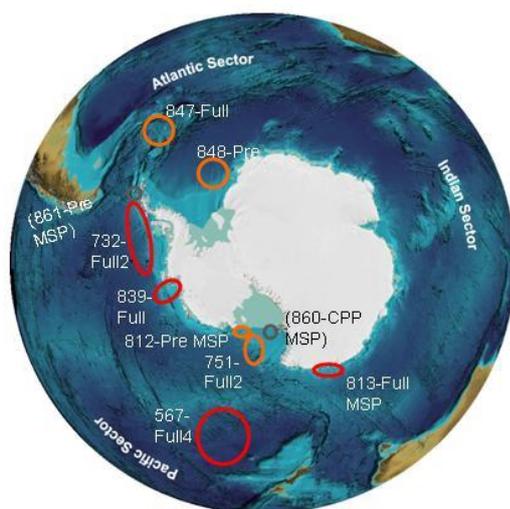
**Julia Wellner provided an overview of the Rapid Access Ice Drill (RAID) concept** for deep drilling of basal ice sheets and sub-ice bedrock (collecting both ice and rock cores). Key questions are at the interface of deep ice and geology. The basal ice to bedrock transition is a key target for RAID. The motivation for geologic drilling of the Antarctic interior was presented on a variety of timescales, with targets spread across the entire Antarctic continent. The goal is to go fast and deep to target bedrock, sedimentary basins, glacial beds, subglacial landscapes and in-situ measurements. The RAID project has been funded by the NSF through the University of Minnesota-Duluth (Dr. John Goodge) for development of the rig (DOSECC Exploration Services), with local testing scheduled before May of 2015, near Salt Lake City, Utah. NSF funding is incremental with periodic reviews and gates or off-ramps, through the development of the final system. The operational area for the rig will be based on science proposals that will be submitted by the community.

**Reed Scherer explained about the WISSARD project**, with the drilling into Subglacial Lake Whillans (SLW) in 2012-2013, and continuing with the grounding zone drilling at the front of the Whillans Ice Stream in 2014-2015. The location is along the Siple Coast, looking at subglacial environments and drainage system around the grounding zone toward the ice shelf. The University of Nebraska-Lincoln (UNL) developed the WISSARD hot-water drill system with clean access protocols for environmental protection and microbial sampling, including filtration, UV cleaning, and the use of hydrogen peroxide to clean external surfaces. The borehole timeline incorporated the sequence and scientific priority of tools and sampling devices to optimize the time in the borehole. The strategy is to investigate the hydrologic system from SLW to the grounding zone (estuarine system into sub-ice

shelf cavity with ocean tides). The ice flows about 1 m/day over the lake and the lake periodically fills and drains; it was about 2 m deep in 2013 when the SLW was entered. The drilling planned for 2014-2015 will be in the grounding zone subglacial estuary where the potential to study sediment flux and tidal influences near the sedimentary grounding zone wedges is possible, including in situ measurements and oceanographic measurements (CTD, in-situ filtration unit, IPSIE-POP, etc). Clean access protocols are necessary and demand training of scientists, students, technicians and drillers. The access to SLW and sampling in 2013 found the first unequivocal evidence of microbes living in restricted subglacial environments. A Nature paper came out (Christner, et al., August 21, 2014), with many more questions still being investigated, such as what is the food source for the microbes . diatoms (not etched) and sponge spicules (nutrient source . etched surface). Sediment coring and sampling devices, multi-corer (up to 60 cm), piston corer (up to 3 m), and percussion corer (up to 5 m), were deployed sequentially. The upper-sediment is soft, with dissolved gas and clasts (diamict). Subsequent analyses were run using a variety of techniques. Microfossils are present, but more broken and fragmented than at upstream sites. This is consistent with cumulative shear at the base of the ice stream . efforts will be made to look at sterol and stanol biomarkers and fossils to provide insights into the Cenozoic history at this site. New analyses at other WAIS sites provide opportunities for Paleogene basin history that can emerge from accessing these areas. The deployment of the SIR (sub-ice rover) and oceanographic measurement systems, including long-term profilers and modelling of the ice shelf cavity are proposed for future drilling on the Ross Ice Shelf, offshore, from the Siple Coast.

**Karsten Gohl** (AWI, Germany, Chair of ECORD Facility Board of the European Consortium for Ocean Research Drilling) gave an overview of the **IODP and ECORD system, with the medium to long-term track of the JOIDES Resolution and the strategy of the Mission Specific Platform (MSP) schedule for the next few years**. KG also provided a short status update about IODP proposals in the system and in particular of the Southern Ocean and Antarctic proposals (as of August 2014). The new International Ocean Discovery Program (IODP) evaluates proposals (pre-proposals, full proposals, and revised proposals) through the Science Evaluation Panel (SEP) that meets twice a year and considers proposals related to the various kinds of platforms (JR, Chikyuu, and Mission Specific Platforms (MSPs), which includes various types of drilling systems. The map (below) shows the distribution of these proposals.

**Active IODP proposals for Southern Ocean and around Antarctica**  
Status: August 2014



**At JR or ECORD Facility Board for scheduling/implementation:**

567-Full (Thomas): at JR-FB  
732-Full (Channell): at JR-FB  
813-Full MSP (Williams): at ECORD-FB: scheduled for 2017  
839-Full (Gohl): at JR-FB

**Decision by Science Evaluation Panel (SEP):**

751-Full (McKay): solve site-survey issues  
812-Pre MSP (Wilson): full prop.  
847-Full (Weber): revise  
848-Pre (Weber): full prop.  
860-CPP MSP (Levy, ANDRILL-CH): deactivate  
861-Pre MSP (Balco): deactivate w. encour.  
863-MDP MSP (Peterson, ISOLAT): revise w. daughter prop.

(FIG 1): 567-Full (Thomas), 732-Full (Channell), and 839-Full (Gohl) are at the JR Facility Board (FB), and 813-Full MSP (Williams) is at the ECORD FB: Scheduled for 2017. Other proposals (751-Full (need to solve site survey issues), 812-Pre MSP (need to submit full proposal), 847-Full (revise), 848-Pre (need to submit full proposal); 860-CPP (deactivated); 861-Pre MSP (deactivated with

encouragement to resubmit); 863-MDP MSP (long-piston coring, revise umbrella proposal with daughter proposals).

The overall picture shows that after submission of the INVEST white paper and the initiation of the PRAMSO process, the Antarctic community submitted robust proposals into the IODP system for consideration for drilling. JOIDES resolution will stay in the western Pacific, Indian and Southern Oceans and move into the Atlantic Ocean starting in 2018 and 2019. The path from the SW Pacific to the South Atlantic is well established. Antarctic seasons with potential for JR drilling in the Southern Ocean are 2016/2017 (and will possibly drill sub. Antarctic legs), 2017/2018, and 2018/2019. Antarctic proposals typically have long transit times associated with them, which is a perceived limitation. Proposal pressure and other factors will determine the general JR shiptrack.

The ECORD MSP strategy and scheduling criteria for the next 5 years of the new IODP (through 2018) plan to achieve only one high-cost expedition in the current phase. Drilling in the Arctic Ocean (which has a high cost) is high priority for ECORD. EFB intends to schedule an Arctic expedition in 2018, either proposal 708, or another Arctic proposal. Only relatively inexpensive expeditions can be then scheduled for the other years from 2015 through 2017:

2015: proposal 758 Atlantis Massif (seabed drills MeBo & RD-II)

2016: proposal 548 Chicxulub Crater (1 drill-hole only)

2017: proposal 813 East Antarctic Shelf (seabed drill RD-II)

**David Harwood (University of Nebraska-Lincoln, ANDRILL Science Management Office (SMO) and Richard Levy, GNS Science, NZ) presented the ANDRILL strategy and the ANDRILL Coulman High Project.** The significant outcome from past ANDRILL projects is the success of high recovery of long core sequences with high resolution to look at stratigraphy, ice sheet history from proximal marine shelf settings, and other science drivers. The ANDRILL drilling system uses a minerals industry drill rig with diamond bit coring and wireline recovery of cores, conducting drilling from ice shelf and sea ice platforms through a combined water depth and ice thickness of 1000 meters or more. The system can be traversed across the ice on sleds to create an integrated mobile camp and drilling capability. The ANDRILL Science Committee and AOMG (ANDRILL Operations Management Group) help the community with planning and execution of projects. ANDRILL has expanded to additional countries (US, UK, NZ, Italy, Germany, expanding to Brazil, Japan, Korea).

ANDRILL needs a long process to plan, schedule, fund, and implement drilling projects (decadal scale, 8-10 years per project). It has portfolios of drilling projects identifying potential targets, as well as more challenging drilling strategies (e.g. moving ice shelf, other areas beyond the Ross Ice Shelf).

The aim of the ANDRILL Coulman High Project is to provide direct records of environmental conditions to address the nature and the response of ice sheets at thresholds in the cryosphere, involving sea level and carbon dioxide levels across which the response of ice sheets changes (e.g., 400 ppmv; 650 ppmv). The Coulman High Project focuses on the early Miocene through middle Eocene parts of the record. The CHP sites can provide a high latitude end-member of a SW Pacific latitudinal transect that connects with lower latitude sites. The status of the ANDRILL-CH proposal is: letters of intentions to commit have been collected from a variety of nations (NZ, Japan, Korea and Germany, with informal commitments from Italy, Brazil and the UK, with a proposal under review in the US). The challenge is budget. Funding from ICDP has been committed, a proposal to IODP was submitted, but this proposal was deactivated (rejected), but not because of the scientific goals (SEP was not requested to evaluate the science). More discussions are still possible.

**Chris Sorlien presented the IODP MSP 821-pre proposal on drilling in the Eastern Ross Sea** with a focus on seismic data and interpretation. The pre-proposal was submitted to IODP for MSP operations, SEP encouraged full proposal submission. The proposed sites are along the Ross Ice Shelf calving margin, and near Roosevelt Island. ANDRILL or MeBo strategies can possibly both be employed: with a deep hole strategy (ANDRILL) to get 800 meters of core at a single site, or MeBo shallow holes strategy to get offset holes with about 50 m penetration each. The target is glacial and preglacial deposits, from older to younger basins (Cretaceous to early Cenozoic), above and below the Ross Sea Unconformity 6 (RSU6), by correlating with DSDP leg 28 sites and by paleotopographic and ice sheet modeling, to test WAIS ice growth and paleoelevation. Seismic lines going from Marie

Byrd Land towards the Eastern Basin show glacial features (Sorlien, et al., 2007, Geology). The basement is within reach of shallow coring (<100 m).

**Rob McKay presented the IODP 751-Full2 proposal on Ocean ice sheet interactions and WAIS variability in the Ross Sea with a number of co-authors.** The Ross Sea has good coverage of seismic data with 6 primary and 15 alternate drill sites identified. The objectives of the proposal include: (1) evaluate the contributions of West Antarctica to far-field ice volume and sea level estimates (WAIS and EAIS marine-based ice sheets) using data and models to reconcile intervals of maximum Neogene and Quaternary Antarctic ice advance with far-field records of eustatic sea-level change); (2) reconstruct ice proximal atmospheric and oceanic temperatures to identify past polar amplification and assess its forcing/feedbacks (reconstruct past changes in oceanic and atmospheric temperatures using a multi-proxy approach); (3) assess the role of oceanic forcing (e.g., sea level and temperature) on WAIS stability/instability (connections between the Amundsen Sea and Ross Sea through the ocean). The upper-slope site in a contourite drift is expected to record some of the along slope water mass changes; (4) Identify the sensitivity of WAIS to Earth's orbital configuration under a variety of climate boundary conditions; and 5) reconstruct Eastern Ross Sea paleobathymetry to examine relationships between seafloor geometry, ice sheet stability/instability and global climate . snapshots in time, by drilling and dating interglacial sediments, even in the shelf a continuous record is not expected due to erosion.

SEP review process rated the science objectives as excellent, and the talk focussed on issues raised by SEP, which are valid concerns that apply to all other ship-based Antarctic drilling proposals (drilling recovery, discontinuous section, icebergs, sea ice) and have largely been addressed, but further data was required for potential safety concerns at specific sites on the continental rise, and SEP requested several sites to be moved away from buried sediment ridge crest, and this is being undertaken by the proponents. Diamictites are perceived by SEP to be difficult to recover, but it is argued for this proposal ~30% is adequate for addressing key scientific objectives, especially if correlated to a more continuous record in the continental rise. Examples of core quality and recovery are shown from past ODP and IODP drilling legs, and it is wave condition (ship heave) conditions that is key to recovery of diamictites. Additionally, drill bit stability improves downhole leading to better recovery for deeper holes (assuming ship heave is low). The Ross Sea has the advantage over other sector of the Antarctic, in that sea ice at the continental shelf break tends to restrict wave height on the continental shelf and it is out of the path of major storm pathways. Where recovery is not enough downhole logs can fill in gaps in core recovery (e.g. in ANDRILL and ODP 1166, leg 188) and should be given higher priority than for previous Antarctic legs. The sea ice concentrations in the Ross Sea are variable throughout the season. Location map of concentrations for past years are shown to develop probable scenarios and risk profiles for each site.

**Karsten Gohl illustrated the upcoming shallow seabed drilling project in early 2015 and the IODP proposal 839-full, focused on investigating potential past collapses of the WAIS in the Amundsen Sea Embayment (ASE).** This area has been the subjected to massive ice loss in the past decades and retreat of ice shelves, and the question is whether this is indicative of a larger collapse in the future and what will be its contribution to sea level rise. One of the principal hypotheses to be tested is: Modified circumpolar deep-water providing warmth to the ice shelf to stimulate melting in all warm climatic periods?The two phase strategy consists of MeBo shallow drilling (~70 meters penetration) during RV Polarstern expedition PS90 in February-March 2015, followed by IODP prop. 839-full drilling in the future. Both projects have distinctively different drill targets but complement each other. Targets include grounding zone wedges (LGM retreat), Late Pleistocene-Holocene (LGM retreat, CDW incursions, meltwater pulses, subglacial sediments), Miocene-Pliocene (WAIS extent during warm and/or high CO2 periods, CDW activities), and Greenhouse-Icehouse transition.

Sequence stratigraphy across the shelf can be accessed by offset series of cores using the MeBo 70 (max 70 meters penetration) seabed drilling system (the newly constructed MeBo 200 system for deeper penetration down to 200 m will be tested in the North Sea in Oct 2014, but it won't be available for the cruise in 2015). The primary target is a 300-400 m thick isolated sedimentary basin off the Pine Island Glacier (PIG) front, potentially supplied by sediments from subglacial meltwater pulses or older deposits that may have survived past advance-retreat cycles.

The IODP prop. 839-full focuses on transect drilling to obtain continuous records (22 sites, most of them alternate sites to address sea ice risk scenarios) from pre-glacial to early glacial to latest glacial

periods. Seismic profiles and site locations addressing various targets on the Amundsen Sea shelf are shown with stratigraphic age estimates inferred from indirect (jump) correlation with similar Ross Sea shelf sequences. Sediment drift sequences of the continental rise potentially allow drilling Miocene. SEP rated the IODP prop. 839-full as with outstanding science and forwarded it to JRFB for scheduling.

**Karsten Gohl** presented also the Channel/Larter et al. IODP **proposal 732-full2 to drill sediment drifts along the Antarctic Peninsula and West Antarctica (Bellinghausen Sea)**. Main questions to be addressed by drilling are: When did the Antarctic Peninsula become fully glaciated? What was the response of APIS and WAIS during Pleistocene deglaciations, to the intensification of northern hemisphere glaciation at 2.7 Ma, and the change to large ice volume fluctuations after the Mid-Pleistocene Transition (e.g., sea level linkage)? What was the relationship between ocean temperature change and ice shelf stability? How has surface water stratification changed during the Pliocene-Pleistocene and what role has this played in deep-water ventilation, and atmospheric pCO<sub>2</sub> variation? One of the sites is potentially able to reach Cretaceous sediments.

First proposal submission was in 2007 and obtained the highest ranking by the IODP Science Steering and Evaluation Panel (SSEP), was sent to the Science Planning Committee (SPC) in 2009, and is now with JR FB for scheduling. Additional site survey cruise with the RRS James Clarke Ross is scheduled for Jan-Feb 2015 led by Rob Larter.

**Mike Weber** reported about proposals **IODP 848-pre (Weddell Sea – late Neogene ice sheet and sea level history of the Weddell Sea) and 847-full (Drake Passage)**. The aim of 848-pre is to provide direct data on the Interhemispheric ice-sheet synchronicity during the LGM (Weber et al. 2011, Science). Lots of variability is observed in the EAIS record during the deglaciation, with two events at 16 ka and 19 ka. The seismic data for 848-pre was reprocessed and put into the IODP data base. The proposal aims at achieving the first complete Late Neogene reconstruction for the Weddell Sea, ice-sheet dynamics, interhemispheric phasing of ice-sheet and climate events, ocean circulation, and bottom-water production. The proposal aims to drill three contourite drifts northeast of Riiser-Larsen Ice Shelf that contain high-resolution sections to reconstruct EAIS dynamics through Plio-Pleistocene times. Alternate sites cover the ridges and one high-resolution Plio-Pleistocene site in the Scotia Sea. Sediment cores and high-resolution seismic data are available for all sites.

IODP 847-Full is targeting Plio-Pleistocene reconstruction of ice-sheet, atmosphere and ocean dynamics in Iceberg Alley. A Nature paper (Weber et al., 2014) came out just recently describing the iceberg routing through Iceberg Alley, which is where the majority of Antarctic icebergs are discharged, so it is possible to look at high-resolution responses of WAIS and EAIS during deglacial melt water pulses to look at rapid (decade timescale) ice sheet collapse mechanisms. There are about 50 dust control points that can be correlated to ice core records. Ice age scale model controls the precision of the sediment age model (200 to 400 years precision is possible). Climate and dust coupling between Patagonia and Antarctica, including modelling of climate and ice-sheet events and interhemispheric phasing, and Drake Passage throughflow and paleoceanographic interactions with the ACC. Initial reviews are back and positive, indicating the need to work on deep time intervals and on seismic data submission.

**Trevor Williams** presented the **IODP-MSP proposal 813-full from the George V Land and Adelie Land Shelf**. The proposal aims to provide direct data of Early Cretaceous and Eocene warmth, subsequent cooling, and transition to the Oligocene and younger strata of the glacial world. Tilting and erosion of the strata allow these targets to be reached with shallow penetration coring by seabed drills such as MeBo (~80m) or BGS Rock Drill RD2 (~50m). Good seismic coverage already exist from the Australian-Italian WEGA 2000 project, with additional stratigraphic information from Deep Freeze coring cruises and NSF-CHAOS 2001 project. A new cruise on the NBP earlier this year by Amy Leventer and Eugene Domack collected new dredges and seismic profiles along the primary transect of proposed drill sites. Dredge samples contain sedimentary clasts with a range of rock types.

The expedition has time to drill between 8 to 15 sites, but many more sites are proposed as alternates in case of sea ice over the primary sites. MeBo is scheduled through 2017, so ECORD is looking at the RD2. The primary sites are located in the Mertz polynya (good for sea ice conditions) and alternate sites are located to the west along the margin, where there are variable sea ice conditions depending on year. Satellite sea ice coverage time series can help to plan strategy to anticipate potential conditions and best time window for drilling operations. Sea ice conditions by month from

2007-2014 show that January and February are the best months to attempt drilling. This proposal is on schedule for IODP-MSP in FY2017, contingent on finding a research vessel to deploy the sea bed drill

**Gerhard Kuhn presented IODP pre-proposal SUBANTPAC** (submitted October 2014 by Lamy et al.) **is focused on transects across the ACC system in the southeastern Pacific Ocean**, which is influenced by the westerly winds and LGM sea ice. The original IODP proposal was CESOP (Cenozoic Southern Ocean Pacific) by Gersonde et al., 2008. The pre-site surveys provided a large number of cores and seismic data, and the IODP proposal South East Pacific Paleoceanography (SEPAP), which was rejected provided baseline data. There was another proposal focused on Patagonia and the Antarctic Peninsula based on Marion Dufresne cores and ODP site 1233 along the Chilean margin . subantarctic South Pacific, where the ACC bifurcates to flow both north and south (PCC and CHC) north of the polar front. Proposal for additional cores to be taken in February Polarstern cruise. EPR-5B / PS75/054 cores have basement age of 12-13 Mya. Calcium carbonate record at this site from last glacial cycle.

**SOWEPAP (Southwest Pacific Paleoceanography) proposal, by Lamy et al. is in preparation for submission by the April 2015 IODP deadline.** It combines IODP 625 full and another proposal. High resolution sequences recorded by Parasound surveys and sediment coring will be combined to define additional proposed sites for drilling, including a number of proposed sites off the Ross Sea continental margin. This proposal represents the deep ocean end of the Ross Sea drilling transect that is aimed to investigate the marine based WAIS and EAIS dynamics by linking the subglacial (WISSARD) record to the inner shelf (ANDRILL) and the outer shelf . upper rise (IODP 751-full).

**Gavin Dunbar presented the initial ideas for a potential future ANDRILL proposal for drilling Siple Coast (Kamb Ice Stream).** The principle science objectives are to assess the stability of the WAIS in the Neogene to Quaternary, and to identify any WAIS collapse events during this time period. Background comes from prior ANDRILL results, which showed open water conditions frequently occurred at the AND-1b drill site on the mid-continental shelf until ~1 Ma. An open question is whether or not these conditions represented a full collapse of WAIS given the substantial distance of the AND-1b drill site from WAIS and the fact that flow lines show it is actually covered by ice derived from EAIS during cooler periods. Whilst model simulations strongly support a link between open water at AND-1b and WAIS collapse, proximal evidence from the margin of WAIS itself is presently not available. To obtain a direct evidence of WAIS stability and to fully assess the validity of this model-based hypothesis paleo-environmental records proximal to WAIS are required. The key challenge to testing this hypothesis is identifying a location where such a sediment record has been preserved near the present day grounding line in the central Ross Sea. Additionally it must be assessed if deep geological drilling in this region is technically or logistically feasible if such a site can be identified.

On this later point, it was identified that that the grounding zone of the Kamb Ice Stream is stagnant at present (unlike Whillans Ice Stream) and therefore may be technically easier to drill. Additionally, the site is accessible from the South Pole Traverse (SPoT) route using tractors. Seismic coverage of the Kamb grounding zone wedge already exists and there are plans to extend the survey northward to characterize the sub-surface geology seawards of the grounding line. This will be achieved by linking in with a Marsden Fund/NZ Antarctic Research Institute project for grounding zone mapping by Huw Horgan at Victoria University. Seismic surveys are planned for 2015-2016, with the potential for a hot water drill hole through the Ross Ice Shelf in 2016-2017 to provide access to the ocean and seafloor beneath for short (~1m) gravity coring and oceanographic measurements. The seismic surveys will be designed to identify potential glacial marine sediment packages with a focus on regions where accommodation zone development relating to Neogene and Quaternary subsidence could have preserved open marine or glacial marine sediments.

**Phil O'Brien** illustrated the plan for submitting a new proposal to IODP for investigating the **Totten Glacier margin** (with German Leitchenkov), which is experiencing a rapid melting of the ice shelves. In front of the Totten Glacier lies a thick sequence of syn-glacial (post 34 Ma) sediments. The subglacial Aurora Basin feeds down through the Totten glacier and deposits sediments downstream. Science questions include: Has Totten experienced major melting phases in the past? What landscape changes preceded the development of the subglacial basins? What is the heat flux at the

base of the ice? What is the geology at the base of the ice? Sea ice coverage is an issue that would need to be mitigated by alternate site selections.

An Australian survey is planned, but it is limited by the construction of the new ship, so this may occur in February 2016 (*now rescheduled for January-February 2017*). Practical issues are who can contribute additional site survey data? Who wants to help write the proposal? What is the best vessel for drilling? Need to develop the scientific arguments for drilling further.

Phil O'Brien raised the issue of heat production from the crust as a contribution to understanding the basal conditions of the ice sheet. *Samples of basement provided by drilling, erratics and IRD can all be used to improve the current understanding of heat flow.*

**Rob McKay presented ideas for an IODP APL (Ancillary Program Letter)** . Rob outlined what an APL is how this APL request works in the IODP system, and the potential benefits an APL would have for Antarctic proposal, where sea ice risk may affect either ends of a drilling season window for an expedition that is proximal to the continent. In general, APL must require less than 10% of dedicated ship time, including transit (i.e., for 60 day expedition = 6 days). Rob discussed two possible scenarios, that may be attached to the Ross Sea proposal, DSDP Sites 279 and 278. These site lies across the modern day Polar Front, represented the low latitude member of the high to low latitude transect strategy that would link to the IODP751 full sites. When the drift deposit at DSDP Site 278 was drilled they the upper ~100m of the record was not recovered (Schuur et al., 1998, Paleoceanography). DSDP 278 indicates a Early-Pleistocene to Mid-Miocene unconformity, with mid-Miocene strata outcropping on seafloor nearby, thus either a Early to Late Pleistocene or Mid Miocene target could be proposed in this region

A 9m piston core (SP136-111) collected at DSDP 278 site demonstrates that an age model of the late Pleistocene can be reconstructed using cyclostratigraphy (oxygen isotope and physical properties). Advanced piston coring until refusal would be targeted (~250 mbsf), with estimated time on site of 106 hours. There are plans to core this site with a giant piston cores using the Korean icebreaker. The exact target to be proposed (if at all) depends on the success of the Korean coring and the length of the Pleistocene-Pliocene section recovered.

**Laura De Santis presented ideas for new future shallow drilling proposal in the offshore of Northern Victoria Land** (Wood Bay and Lady Newnes Bay, see Sauli, et al., 2014, Marine Geology). Series of prograding grounding zone wedges formed in front of these two bays and also to the north suggesting . paleo ice flow direction toward Drygalski main glacial valley. The age of the glacial wedge should be younger than 18 Myr. It is downlapping onto the Ross Sea Unconformity RSU2 (Brancolini, et al., 1995) that is correlated to Unconformity 10 of Bart et al. (2011) and dated early Pliocene. The new proposal may build on the previous SHALDRIL Proposal (Bart, 2009) targeted to the Plio-Pleistocene chronology of the Northern Basin, by extending the area to the coastal bays, by using shallow drilling of these prograding wedges that can address the nature of the North Victoria Land Ice Cap and outlet glaciers through time, with the formation of glacial marine valleys and till ridges expanding to the shelf edge and then retreating.

Another key area for future drilling proposal is the Ross Sea Central Basin, where sediment drift and models (e.g. the GCM ROMS 2.1 with ice dynamics and thermodynamic) showing direction and speed of currents interacting with topography, can be used to identify potential site locations for drilling. This area also targets of alternate sites of IODP proposal 751-full. The sediment drifts are observed along several morphological sills connecting the Ross Sea to the Ocean. They have different orientation geometry and would document bottom current pathways change across the central Basin gateways. The drifts are shallow and can be also drilled with MeBo or Rockdrill during a focuses, dedicated project.

**Minoru Ikehara presented IODP pre-proposal for the Indian sector of the Southern Ocean** . with proposed sites on the Del Cano Rise, Conrad Rise, and Enderby Abyssal Plain, based on site survey cruises from 2008, 2011 and KH-15-5 in January-February 2016.

Primary scientific objectives and questions address sea ice coverage and variability, water mass stratification, and other topics, by drilling Conrad Rise sediment drifts and sediment wave (Oiwane,

Ikehara, et al., 2014, Marine Geology). The waves are separated by an early Pleistocene hiatus from lower units with parallel reflectors, with no evidence of sediment waves.

Schematic sedimentation model and bifurcation of the ACC around Conrad Rise is shown. The hypothesis to test is about the ACC and Weddell Gyre changes through the Cenozoic, focusing on Conrad Rise as the place to recover evidence of the ACC bifurcation. Cores from the Del Cano Rise. The proposal will be revised and resubmitted as pre-proposal in 2015, as part of the ISOLAT IODP 863-MDP (Marion Dufresne cruise) . umbrella proposal, with daughter proposals forthcoming for these sites along a transect.

During the final short discussion **Phil Bart** raised the question: Does each Pleistocene  $\delta^{18}\text{O}$  shift correspond to major WAIS groundings in the Ross Sea? The Ross Ice Shelf calving front and Ross Sea banks and troughs were investigated with a dense grid of seismic lines. Mapping shows backstepping stratigraphy in the Glomar Challenger Basin (GCB) paleo-trough to the Whales Deep Basin Trough.

Looking at **conceptual models about how these units may have formed**: Two possible construction processes are: vertical stacking of till during successive glacials, or horizontal shingling (i.e., progradation) during successive glacials. Seismic data will look similar, but the glacial history may be very different and could impact drilling strategies.

**Nick Golledge** (VUW and GNS, NZ) presented his **Antarctic ice sheet modelling for geological research**, focusing on the last 25,000 years, showing the Last deglaciation through dynamic modelling . continental scale changes, only as good as the input data. Scotia Sea IBRD data and timescale (Weber et al., 2014) compared to mass ice loss from model from Golledge et al., in press. Interesting is the comparisons between what is being simulated and what is observed from a high-resolution marine record (Golledge et al., 2014). There are good possibilities for improved linkages between geological interpretations and models to answer the question: How fast was the ice flowing? Centennial scale peaks form millennial scale cycles. Is it possible to get down to this level with models (possible to generate 1 meter / century rates of sea level equivalent change), showing if ice sheets can respond at these levels?

Mass loss arises from combination of basal conditions (basal melt and substrate rheology = sliding) and changes in the surface dynamics (drawdown) of the ice sheet. We should try to put a timescale on ice stream variability. Ice streams in the Ross Sea are less topographically constrained and therefore can change quickly. Geothermal heat flux is one of the main things that need to be better defined to improve the ice model.

Discussion was also about ice sheet model responses and resolution on timescales shorter than centuries (e.g., decades, annual?), which could be quite challenging.

The model can also be used to look at erosion, deposition of sediments, hypothesis testing, - in terms of sediment flux, where would sediments come from and where would they be deposited?

### **Final Thoughts and Summary**

**Carlota Escutia** reminded that past programs like ANTOSTRAT, DSDP/ODP/IODP, and continental margin drilling (DVDP, CIROS, MSSST, CRP, and ANDRILL) provided prioritization by the Antarctic drilling community about key scientific questions that can be addressed by drilling. Strategy for the JR involved transects from the continental rise across the slope and shelf (where there is more ice and more sand, leading to potentially poor recovery). This transect strategy also leads to the use of offset drilling to step back through time at a series of sites to provide insights into the geologic history. New technologies provide new opportunities, so new systems like MeBo and the British Rock Drill have great potential to accomplish some of the goals that have been described. The PAIS strategy, including inshore-offshore transects to provide snapshots into the ice history from near-field to far-field and data-model intercomparisons, which helps the community to accomplish our long-term objectives. Wilkes Land was very successful due to sampling strategies (offshore and onshore) and also because of coordinated post-expedition science work on samples that have resulted in important outcomes of the expedition. The PAIS strategy of continent-to-abysal transects along single ice drainage systems integrates with the SCAR Horizon 2020 strategy (Kennicutt et al., 2014). PAIS deliverables should

provide links to the ice core records and aim to provide answers to the IPCC questions about ice sheet and southern Ocean changes in response to global climate warming.

The PRAMSO workshop was followed by the Antarctic Seismic Data Library workshop, in the afternoon. Some of the participants were attending both workshops and gave presentations on how the seismic data are used and are crucially needed to search best location for drilling and to develop cooperative research proposals.

Some of the submitted proposals are still in the status of preparation of data to be submitted to the IODP data bank. Others are dealing with format requirement to upload seismic data and the information into the IODP Data Bank. Proposal PI's are strongly advised to read carefully the guidelines at: [https://ssdb.iodp.org/documents/SSDB\\_DataGuidelines.pdf](https://ssdb.iodp.org/documents/SSDB_DataGuidelines.pdf)

The probability of having two seasons of Antarctic and Southern Ocean IODP expeditions using the JOIDES Resolution is quite high, but then, after 2020, we will likely have to wait a long time before the JR would head back to the Antarctic margin, due to the competition with proposals for drilling in other areas of the world's oceans. In this context, a prioritization of JR Antarctic projects by the PAIS drilling community would be desirable. Otherwise we risk the prioritization is done by the IODP science panels or the operator Facility Board. However, the employment of other drilling platforms and tools, like MeBO, Rockdrill, or others, can stimulate the development of international proposals. A new generation of drilling proposals is expected for the next few years, especially once the shallow drilling MeBo cruise in the Amundsen Sea and the MSP on the Wilkes Land shelf will have been successfully achieved.

We plan other workshops in Goa, India (ISAES-2015) and in Kuala Lumpur, Malaysia (SCAR-OSC 2016) to keep the community updated and continuously coordinated in a common framework under the PAIS implementation plan.

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