

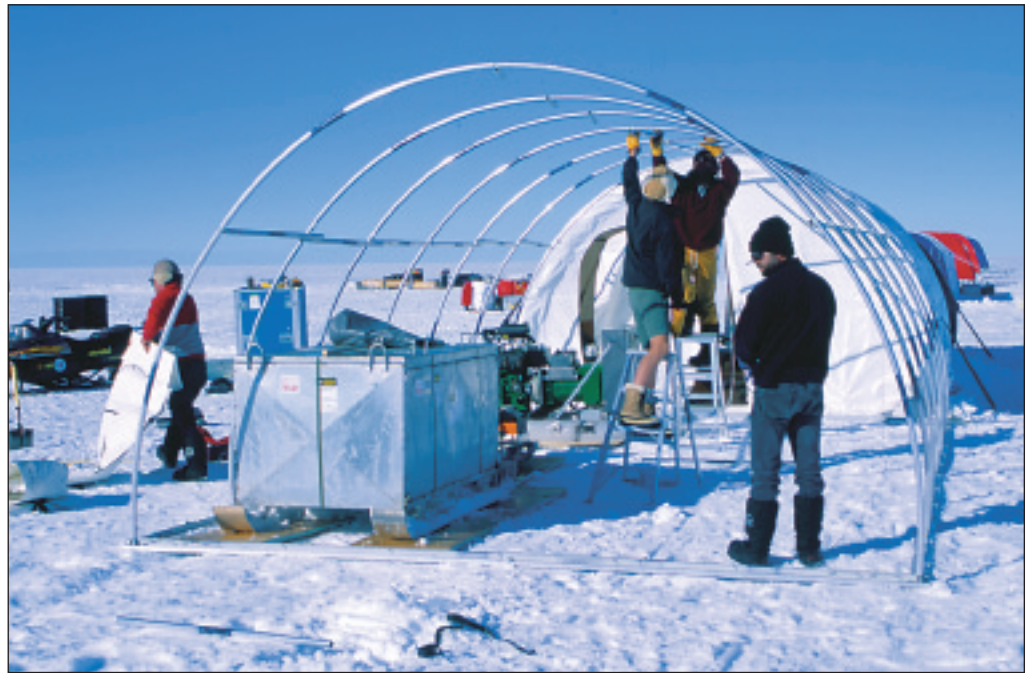
Peephole through the ice: the AMISOR project

THE AMERY ICE SHELF OCEAN Research (AMISOR) project is a new multi-year research project of the Australian Antarctic Division and the Antarctic CRC which aims to investigate the interaction between the Amery Ice Shelf and the ocean. The project will provide an assessment of the role of the Amery Ice Shelf in the ice sheet mass budget, and in driving deep ocean circulation.

Floating ice shelves, which fringe the Antarctic continent, are the main pathway for ice loss from the ice sheet, either via iceberg calving from their outer margins or as basal melting in the ocean cavities beneath.

The Amery Ice Shelf, the largest in East Antarctica, drains the Lambert Glacier–Amery Ice Shelf system, which accounts for 16% of the area of the grounded East Antarctic ice sheet.

Melt and refreezing processes on the underside of the floating shelves can be significant, but are poorly understood. As much as 50% of the total ice draining from the Lambert Glacier system is lost as melt beneath the Amery. The modification of ocean water properties that results from melting and freezing processes under ice shelves may be important in the formation of



Assembling a plant and equipment shelter for the AMISOR hot water drill this summer. Large unit at front is the air compressor for purging water from the system after drilling. MIKE CRAVEN

Antarctic Bottom Water, and hence critical in global ocean circulation.

Ice shelves are always thickest (800 m or more) closest to the point where they are joined to the grounded continental ice, and thinnest (~250 m) at their seaward front. The freezing point of sea water decreases with pressure, so as cold salty ocean water flows under an ice shelf it can come into contact with the shelf ice at a depth where it is above the local freezing point, and hence cause melt. This melt freshens the seawater and makes it more buoyant so that it rises again along the sloping

underside of the ice shelf. Eventually it will reach a point where it is once more below the freezing point, and new ice crystals are nucleated and may adhere to the underside of the ice shelf in a layer known as ‘marine ice’. (Figure 1)

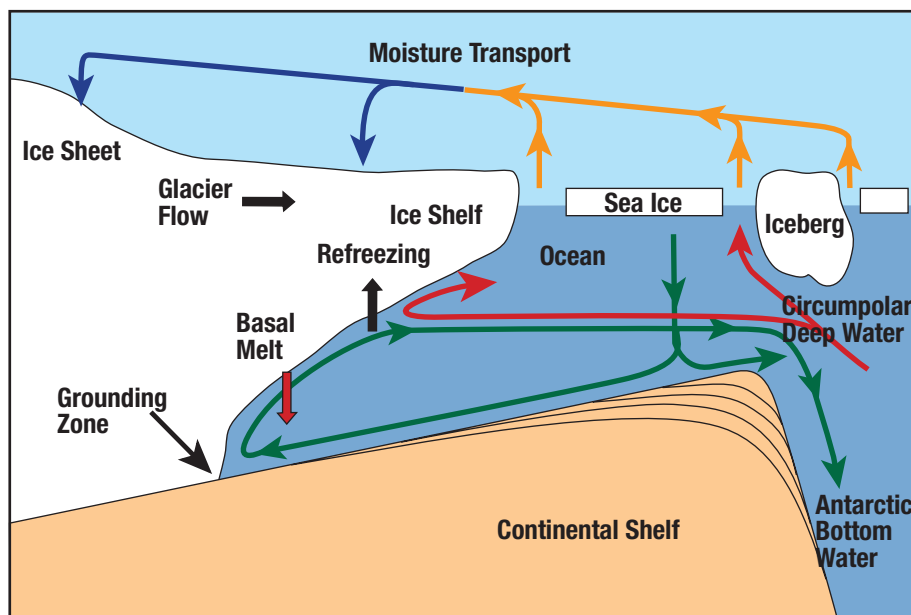


Figure 1: Schematic representation of the 2-D circulation under an ice shelf. Salt rejected by winter sea ice growth forms dense, high salinity water, which sinks and flows under the ice shelf. This causes melt when it comes into contact with deep ice. The freshened plume rises under the base of the shelf and can either refreeze as marine ice or mix with warm salty Circumpolar Deep Water to form Antarctic Bottom Water.

There is also a horizontal pattern to the distribution of melting and freezing under the ice shelf, linked to the clockwise ocean circulation. Recent work at the Antarctic CRC by Helen Fricker has delineated the distribution of marine ice from satellite radar altimeter data, and ice thickness soundings. In places the accreted marine ice is almost 200 m thick (Figure 2).

The AMISOR project aims to better quantify these processes through both an oceanographic component and a shore component. The oceanographic component, led by Nathan Bindoff of the CRC, will make detailed measurements across the front of the Amery Ice Shelf of the characteristics and flow of the seawater entering and leaving the ocean cavity beneath the shelf. The first phase of these measurements will be made from RSV *Aurora Australis* during voyage 6 of 2000/01. Moored instruments will be left in situ to continue measurements over a full annual cycle.

The shore component of AMISOR will make *in situ* measurements of the processes beneath the shelf through a series of access holes drilled completely through the shelf. These holes are to be made using a new hot water drilling facility designed and constructed within the AAD. The drilling party, led by Mike Craven, was deployed on the Amery in mid December 2000, and on New Year's Eve successfully penetrated through 380 m of ice into the ocean cavity. Once the drill facility was assembled and tested it took only 24 hours to sink the 300 mm diameter borehole using a high-pressure jet of hot water. The hole was subsequently reamed to 400 mm diameter and a series of measurements made in the ocean beneath the shelf. These show that the top 40 m of the 440 m deep cavity beneath the shelf is a relatively fresh layer derived from basal melt under the shelf. Some instruments have been left in the borehole to continue measurements over several years.

Further measurements in this and subsequent boreholes, combined with the oceanographic data from the front of the shelf, will provide estimates of the amount and distribution of melt and freezing under the shelf, and will be used to validate numerical models of the ocean circulation in the cavity being developed by John Hunter, Roland Warner and colleagues.

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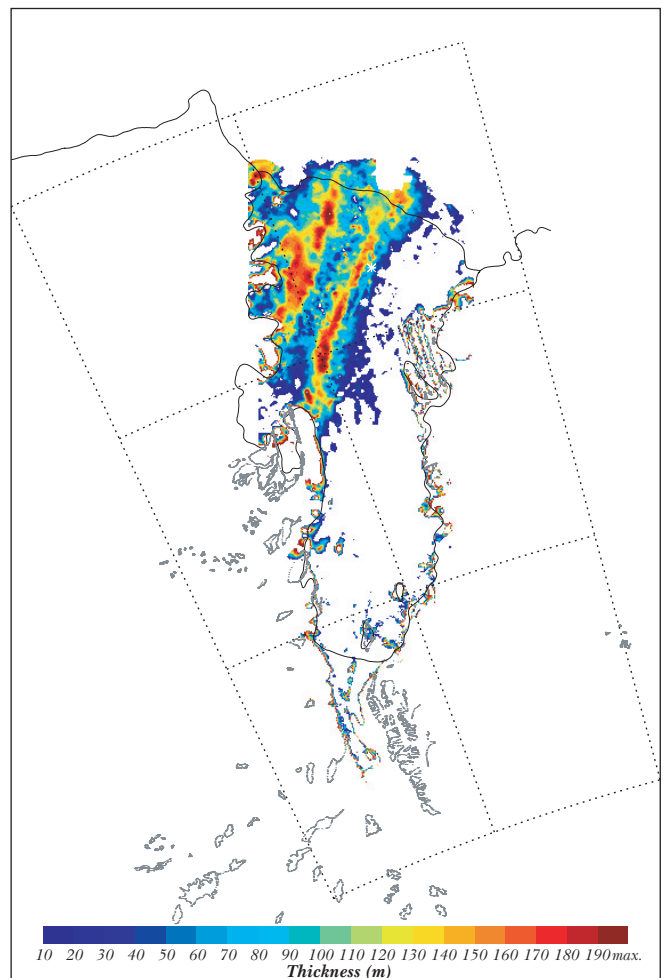


Figure 2: The thickness (in metres) of accreted marine ice underneath the Amery Ice Shelf.



The hose reel and motor controller of the AMISOR hot water drill showing crimping tool for hose fittings.

MIKE CRAVEN