

Chapter 17

Sea Ice

The sea ice conditions at McMurdo and Palmer Stations are very different from each other. In McMurdo, air planes can land on it and heavy equipment can be operated on it. In contrast, at Palmer only foot travel is allowed on the sea ice. No vehicles, not even snowmobiles, are allowed on the sea ice because typically the ice at Palmer is too thin to safely support their weight.

Although the conditions may vary, the hazards of working on sea ice are the same wherever you are in Antarctica. Because of the different modes of operation on the sea ice, the check-out procedures and equipment used differ at both stations. The following sections describe the hazards of working on the ice and then detail the check-out procedures for each station.

The USAP's past experience with equipment and personnel lost through the ice has dictated the requirement for education, common sense, and the use of caution when traveling over sea ice.

17.1 Sea-Ice Hazards

Although the sea-ice conditions and traveling conditions are different for Palmer and McMurdo, the hazards associated with traveling on the sea ice are similar for both areas.

17.1a Weather

Weather can turn bad while you're out on the sea ice. It's important to continually monitor for signs of approaching bad weather. Watch for a lowering ceiling of clouds and fog blowing in from open water. Blowing snow can disorient you. Poor weather conditions will obscure surface definition, making it impossible to detect cracks. Use extra caution if surface definition or visibility is poor.

Check the weather station instruments at Palmer Station prior to going out on the sea ice. Strong winds can be particularly dangerous at any location and even in the stable McMurdo conditions. If the wind is severe enough, the ice edge can drastically change. At Palmer Station, within a few hours the ice can clear out, leaving open water which can possibly strand field parties away from the station or trap them out on the sea ice, adrift on a floe.

17.1b Ice Thickness

Ice thickness is a major concern for everyone who wants to travel on sea ice. The ice sheet can become thin in certain areas due to erosion from strong currents which cause shoals, and at the center of active or newly formed cracks, especially if the thin ice has been covered with snow. Land formations that indicate a potential shoal are long, low-angle ridges or peninsulas that descend into the sea.

Historically at Palmer Station, areas of thin ice have been found in the area around Elephant Rocks, the

channel between Torgersen and Litchfield Island, over the shallow reef off the south end of Humble Island, and the narrow channel between Shortcut Island and Shortcut Point. This is by no means a complete list, and conditions do change during the season and from year to year.

At McMurdo Station, local areas with historically thin ice are Cape Armitage at the base of Ob Hill, Hut Point, and the Knob Point/Cinder Cones area. As the air and sea temperature starts to rise, the sea ice becomes progressively weaker and starts to thin, both from the top and bottom. During the austral summer ice temperature monitoring stations are established at various locations and monitored on a regular basis.

The effects of winds, waves and swell are important factors during the early stages of ice formation in terms of how quickly the ice sheet stabilizes. Six inches of ice formed under calm conditions may be stable and safe to ski over, but that same thickness of ice formed under rough conditions may be unstable, thus more hazardous for travel due to cracks.

17.1c Color changes

It's a good habit to pay close attention to the color of the ice as you traverse it. It should be emphasized that if you note changes in color, something about the ice sheet has changed and needs to be investigated. In general, white colored ice is typically the safest, indicating good ice at least 6 to 12 inches thick. Gray colored ice is considered young ice ranging in thickness from 4 to 6 inches. Gray ice will "probably" support an

adult on skis but should be avoided if possible. Gray ice can also form as a result of surface flooding and subsequent freezing of the surface water. So it is always important to investigate areas of gray ice. Black ice is newly formed thin ice and should be **avoided at all times**. Otherwise, you're likely to go for an unwelcome swim.

17.1d Cracks

Cracks are fissures or fractures in the sea ice produced by the stresses of wind, wave, tidal action, and thermal forces. Whenever possible, avoid cracks altogether. If it becomes necessary to cross a crack, cross it in a line perpendicular to the crack's direction of travel. Never cross a crack system in a location that will place a vehicle on more than one crack at a time. Avoid sets of cracks which form pie slices. These have a nasty way of breaking off and turning over under the weight of a vehicle. You can generally expect to find cracks anywhere on the sea ice. However, certain sites historically produce a series of cracks year after year. Typically, cracks will form around any coastline, island, grounded iceberg, or glacier jutting out into the sea ice. These cracks tend to radiate out from the land, similar to the spokes of a wheel.

- **Tidal Cracks** occur up to 150 yards offshore in fast ice when the tidal action moves the sea ice above or below the level at which it is shore bound. These cracks are usually parallel to the shore line. When crossing tidal ice zones, walk on the ice instead of snow whenever possible.

Snow masks many of the larger cracks in tidal crack systems. Always carry a probe and use it often when working in these areas.

- **Straight Edge Cracks** (see figure 17-1 below) form as tension is released in the ice sheet. The ice thickness at the edge of this crack will be the same as the surrounding ice thickness. These cracks typically form quickly, and the crack shows either open water or a thin layer of ice covered with snow.

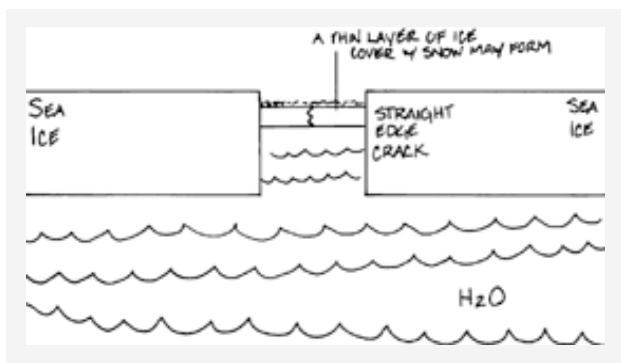


Figure 17-1: Straight edge Crack.

- **Spreading Cracks** form as forces acting on the ice sheet cause the ice to crack and spread apart over time. These cracks tend to form slowly and can stay active for quite some time. The center of actively spreading cracks may be open water or thin ice. The safe edges of these cracks are difficult to judge without getting out of your vehicle and profiling the crack. See figure 17-2.

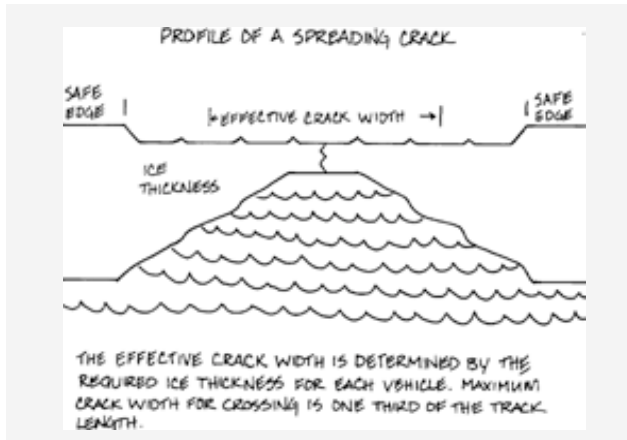


Figure 17-2: Spreading Crack.

- Pressure Ridges** (see figure 17-3) form when ice is broken by pressure and thrusts up into a chaotic pattern of elevations and depressions. Use caution when crossing pressure ridges, as the uneven chunks of ice can be hazardous to your footing. Occasionally, pressure ridges may pull apart, forming a combination Spreading/



Figure 17-3: Pressure Ridge. (photo by Tim Cully)

Pressure Ridge. Because the ice that forms a pressure ridge is not structural, always drill this type of formation to determine its effective crack width.

17.1e Melt Pools

Melt pools (see figure 17-4) are areas on the sea ice that have subsurface melting. This usually occurs later in the season, typically in late November through December. An ice lens usually forms over the melt water, giving the impression that it's solid. Always drive around melt pools. If it's impossible to drive around a melt pool, get out of your vehicle and drill the underlying ice to determine its thickness.

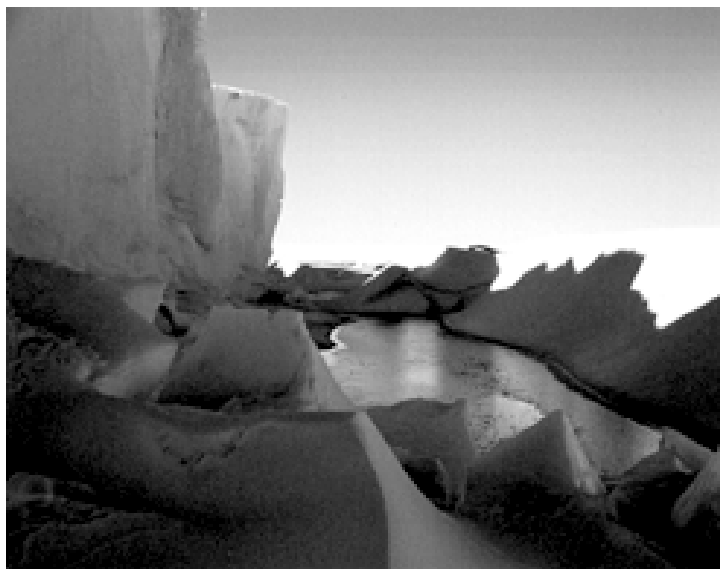


Figure 17-4: Melt Pool. (photo by Tim Cully).

17.1f Seal Holes

Seal holes are a good example of a possible trap. They are usually easy to spot as they develop a “fumarole,” a cone shape projecting upward from the ice. This is caused by the seal constantly pushing ice and water from the hole. However, if there is a new accumulation of fresh snow, it may hide the hole. So, if you see a seal lying far from the ice edge, there will most likely be a seal hole or a crack nearby.

17.1g The Ice Edge

The ice edge can be dangerous because there is always the possibility of breakouts, at any time in the season. Travel to the ice edge should be undertaken during periods of good weather and calm sea conditions. Also, you need to be alert to the possibility of attacks by leopard seals (and possibly Orca whales). It’s a good idea to be roped up and belayed by a team member when working at the ice edge.

What to do if you fall in...

If you fall through the ice, holler for help, clamber out as quickly as possible. One Old Antarctic Explorer (OAE) recommends carrying a sharpened ice pick type tool, protected in an upper pocket to assist in climbing out over slippery ice. Another source recommends that once out, roll in fresh snow on the surface. The idea behind this is that, the fresh snow helps absorb moisture (i.e. it’s quick drying). Be sure someone in the party has radioed the station for help. If able, keep on your feet and in motion. Immediately head back to the station or

to the closest survival cache, depending on your situation. Your outer clothing will quickly freeze, giving excellent wind protection, while inner heat of exercise will eventually dry out the cold, wet inner layer. If on the other hand, the victim is unable to walk, that person can be pulled back to the station in a sled.

17.2 Sea Ice of McMurdo Sound

Personnel working on the sea ice around McMurdo will be traveling by either tracked vehicle or by snowmobile. Following is a checklist of the equipment and things you need to do before leaving the station:

1. Check your vehicle and ensure the fluid levels are OK and that there is plenty of fuel.
2. Have the following equipment in your vehicle:
 - ECW Gear
 - Extra Food and Water
 - Survival Bag
 - Kovacs Ice Auger with Extensions
 - Extra Ice Auger Bits, Sharpened
 - Bit File
 - Ice Axes
 - Square Shovel
 - Ice Screws, Assorted
 - Rope (Old Climbing Rope)
 - Carabiners
 - Slings: 1 Short and 1 Long
 - Throw Bags (see the BFC staff on how to assemble)
 - Radio with Spare Battery

3. Call the Weather Office for the current and long-range forecasts for the area in which you'll be traveling and working.
4. Radios: When traveling by snowmobile, EACH snowmobile must carry a VHF hand-held radio and a spare battery. When traveling in a tracked vehicle, two radios must be carried per vehicle, the vehicle radio and one hand-held as a back-up.
5. Check out with the FOCC (call sign "MAC Ops") by passing the following information to the radio operator prior to departing McMurdo:
 - Vehicle call sign (three-digit number and vehicle type)
 - Group number (S, T, W, or A event number)
 - Number of people in your group
 - Estimated time of arrival to destination
 - Estimated time of return to station
 - Name and phone number of a contact person in McMurdo

McMurdo Area Sea Ice Travel Policy:

Solo travel on the sea ice is not allowed unless your group has approval from the NSF Representative in McMurdo. Two or more field-party members may remain overnight at a sea-ice location; solo overnights are never allowed.

In anything other than Weather Condition 3 (good weather) snowmobile travel is not allowed. During

Weather Condition 2, tracked vehicles may be allowed to check-out depending on the forecast.

17.2a How To Profile A Crack for Vehicle Crossing

To profile a crack, start by probing aggressively with an ice axe across the crack. Then determine where the safe edges of the crack are by sliding the pick of the axe over the surface. Drill test holes approximately 15 inches apart starting in the center of the crack to determine its Effective Width. The Effective Width should be no more than 1/3rd of the length of your vehicle's track. A crack's Effective Width is the distance between one 30-inch-thick (or thicker depending on vehicle weight and time of year) safe edge and another 30-inch-thick safe edge as determined by drilling.

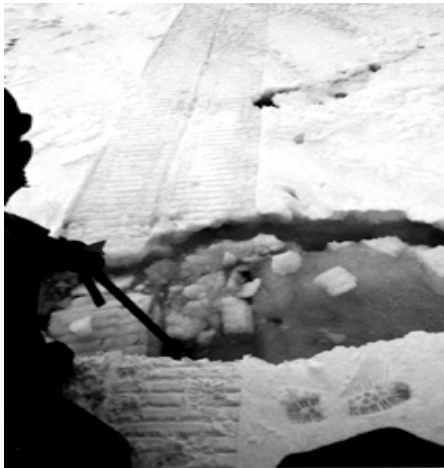
Traveling Tips:

- Don't travel off the flagged roads if surface ice conditions are obscured by blowing snow or poor visibility. Remember, cracks in the sea ice can open up at any time.
- Stay well away from the coastline, islands, and landed objects such as grounded icebergs. Working cracks tend to form around these. Stay away from large concentrations of seals.
- Never travel over ice thinner than 30 inches (75 cm). This 30-inch rule is an NSF regulation, which provides a safe margin of error for sea-ice travel in light vehicles, such as pickup trucks



*Figure 17-5: Van crossing large melt pool.
(photo by Tim Cully)*

and Sprytes. Heavier vehicles require more ice. Each operator must know his or her vehicle's requirements for ice thickness. Call the BFC for more information.



*Figure 17-6: Don't trust existing vehicle
tracks. (photo by Tim Cully)*

- The strength of ice decreases as its temperature increases. Consequently, vehicles require a thicker ice for safe travel as the season progresses. Each operator is responsible for knowing the requirements of his or her vehicle. Call the FSTP for more information.
- When traveling, drill and assess any changes in color or texture of the ice sheet. These changes could indicate changes in thickness of the sheet.

Sea Ice Seasonal Period Temperatures:

Seasonal Period	Ice Surface Temp. (° F)	Time of Year (Approximate)
1	-4 to 14	WINFLY to late November
2	14 to 23	Late November to mid-December
3	23 to 27	Mid-December to early January
4	27 to 28.5	Early January to February

17.3 Sea Ice in the Peninsula Area

Personnel working on the sea ice around Palmer Station will be traveling on foot. Following is a checklist of the equipment you need and the things you need to do before leaving the station.

Equipment:

- Skis for lead person in the party
- 2 radios and spare batteries per party
- Ice axe
- Throw rope, ice screws, carabiners, slings
- Local map with routes and hazards
- Compass and/ or GPS
- Food and water (Nalgene water bottles for hot water warming if necessary)



*Figure 17-7: Walking on the sea ice in front of Palmer Station.
(photo by Marian Moyher)*

- Headlamp or flashlight
- Hand warmers
- Plastic trash bag and pee bottle for human waste management
- Spare clothing, which should include:
 - Spare mittens and socks
 - Extra hat
 - Sunglasses, goggles
 - First aid kit

Things to do:

- Check the weather station trends for the past 4 to 6 hours. Pay special attention to wind direction, speed and barometric pressure. See Chapter 10 for more information on weather.
- Obtain approval for the trip from the Station Manager or SAR Leader.
- Check out with the Comms Tech prior to departing Palmer Station and make sure to receive confirmation that your radio is operational before you leave the vicinity. The following information must be provided:
 - Field party name
 - Number of people in your group
 - Destination
 - Estimated time of arrival at your destination
 - Estimated time of return to the station

- When you arrive at your destination:
 - Report arrival at destination.
 - Report any changes in destination.
 - Report start of return to Palmer Station.
 - Report arrival at Palmer Station.

Palmer-Area Sea Ice Travel Policy:

At least two people must travel together while out on the sea ice. In an emergency situation or if unable to return to the station, radio for help and travel to the nearest survival cache. **Under no circumstances should a stranded party attempt to camp on sea ice.**

Sea-Ice Routes and Availability

The Station Manager in coordination with science and station personnel will ultimately determine the routes for sea ice travel. Routes open for travel will be posted on the dining room bulletin board and discussed at station meetings.

The factors that determine whether sea ice travel will be allowed and by which routes, include the following:

Minimum Ice Thickness: Sea ice in the Palmer area often consists of several layers of ice with pockets of slush or water in between. Because of this, it is unsafe to set strict minimum thickness standards. When evaluating the ice sheet for thickness, at least one layer of the sea ice must be a minimum of 6 inches thick. This thickness cannot include slush layers, wet pockets, or air holes. Ice quality in that layer must be such that drilling demonstrates a firm resistant medium. Because of the enormous variability of sea ice from year to year

and throughout the season, extreme caution is exercised in evaluating minimum ice thickness.



*Figure 17-8: Drilling ice with Kovacs Ice Auger.
(photo by Tim Cully)*

Contiguous Quality: The sea ice must be “joined in order” and not made up of unconsolidated bits of brash, pancake, or bergy ice. The ice sheet surface must be consistently thick.

Proximity of the Ice Edge and/or Unconsolidated Pack Ice: Depending on the location (exposure to currents, off-shore winds, calving glaciers, survival cache availability, etc.) ,the desired sea-ice route must be at least 200 meters from the ice edge, calving glaciers, or unstable ice.

Proximity to Vessel/Ice Breaking Operations: The sea-ice route must be at least 30 meters from ship operations. Sea ice access is restricted when a vessel is in the vicinity.

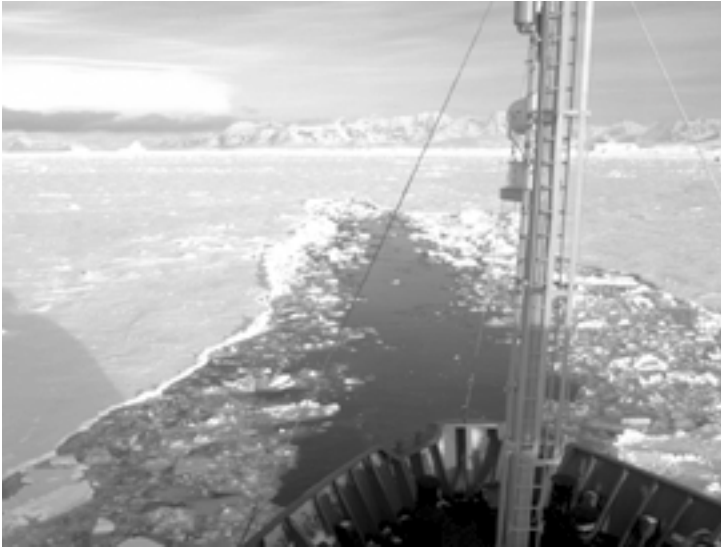


Figure 17-9: Ice breaking operation. (photo by Marian Moyher)

Winds and Weather: Wind direction and speed must be favorable to the route to be traveled, i.e., not from the northeast (off-shore), or not toward the direction of ice edge or unstable ice. Winds must not be in excess of 20 knots if the ice edge is at the tip of Bonaparte Point or closer. Otherwise, winds should not be in excess of 30 knots. (**Note:** The sea ice in Arthur Harbor has completely blown out in as little as 6 hours.)

Proximity to Emergency Caches and Possibility of Rescue: The sea-ice routes will be connected to areas with Survival Caches when possible. When safe sea-ice conditions remain beyond October, first the routes are re-evaluated and additional restrictions may come into effect. Sea-ice routes must have the potential for ‘over-ice’ rescue or alternative rescue possibilities.