

THE SEARCH FOR MAWSONS AIR TRACTOR

UPDATE JULY 2009

SUMMARY

New evidence presented here suggests that the Air Tractor frame is situated:

- About 50m NW of the NW corner of the main hut.
- Next to an area of solid rock.
- At a depth greater than 2.5m but less than 4.5m.

The 2008-9 season

During the 2008-9 season a search was conducted for Mawsons Air tractor. It was established that the air tractor was not on glacial ice, was unlikely to have moved between 1913 and 1975. The air tractor has not been seen after 1975.

The position of the air tractor when it was visible above the ground (ie before 1975) was determined using transits from photographs. Radar scans of the ice around the position showed a significant echo at around 2.5m. A trench was dug to intersect what was thought to be the frame, but digging was ceased at 2.7m when no frame was found. A layer of hard ice containing seaweed was found at around 2.5m suggesting that a significant melt occurred down to that level. The trench floor was shown to be at the level of high water.

New evidence

After the expeditions' return in January 2008 contact was made with past expeditioners who had been on voyages to Cape Denison from 1975 onwards. Numerous images of the area near Mawsons Hut were obtained from these individuals and from the Antarctic Division archives. From these data an hypothesis has been developed suggesting where the frame is now, and where the search should be directed for the 2009-10 season.

The rest of this document presents the new evidence for the frames position.

Establishing the position of the frame while above the ice

The following two images show the position derived from transits (top image) and a comparison of that position with a 1931 photo by Frank Hurley (lower image).



The photo confirms the position of the frame in the NS direction (central white arrow).

Layer of hard ice found in trench

In 2008-9 trench was dug to intersect the estimated position of the frame, but the frame was not found. However a layer of hard ice was encountered, which is significant.

This picture shows the layer of hard blue ice found at the bottom of the trench (between the arrows). The depth of the bottom of the trench corresponds to the high water survey mark in the harbour.

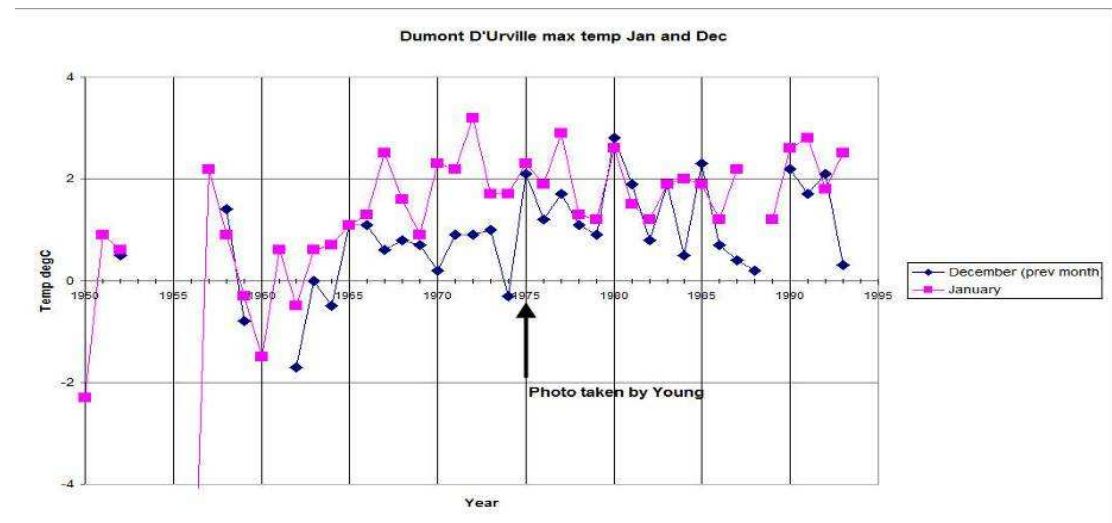
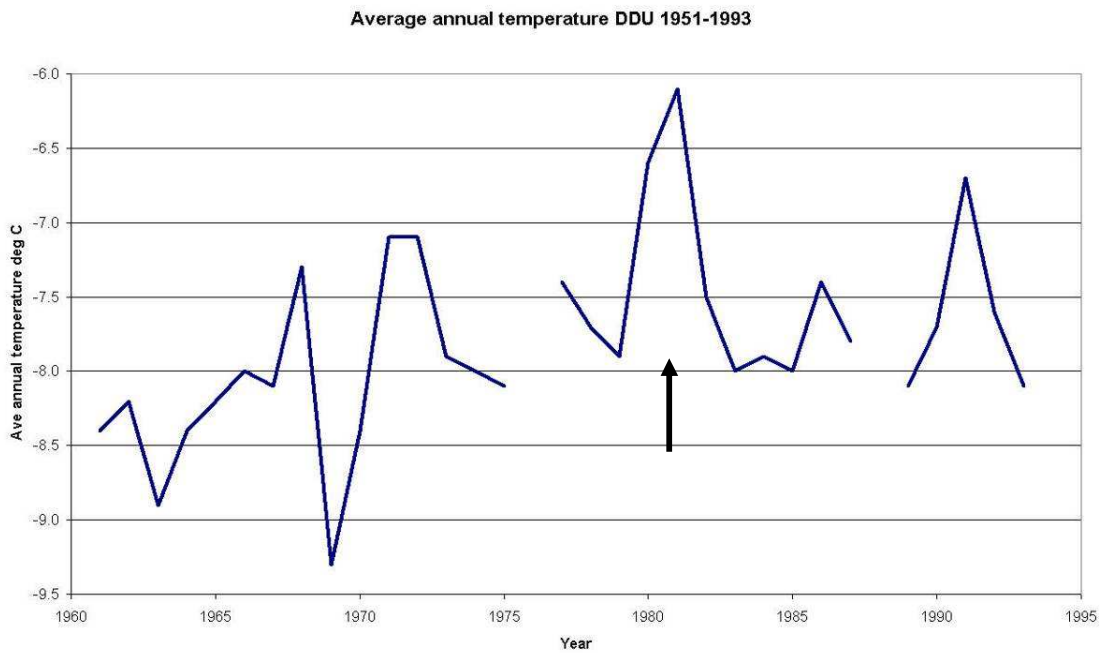


The hard ice implies that the temperature rose sufficient to melt the ice down to 2m. Evidence from temperature records was sought to confirm this finding.

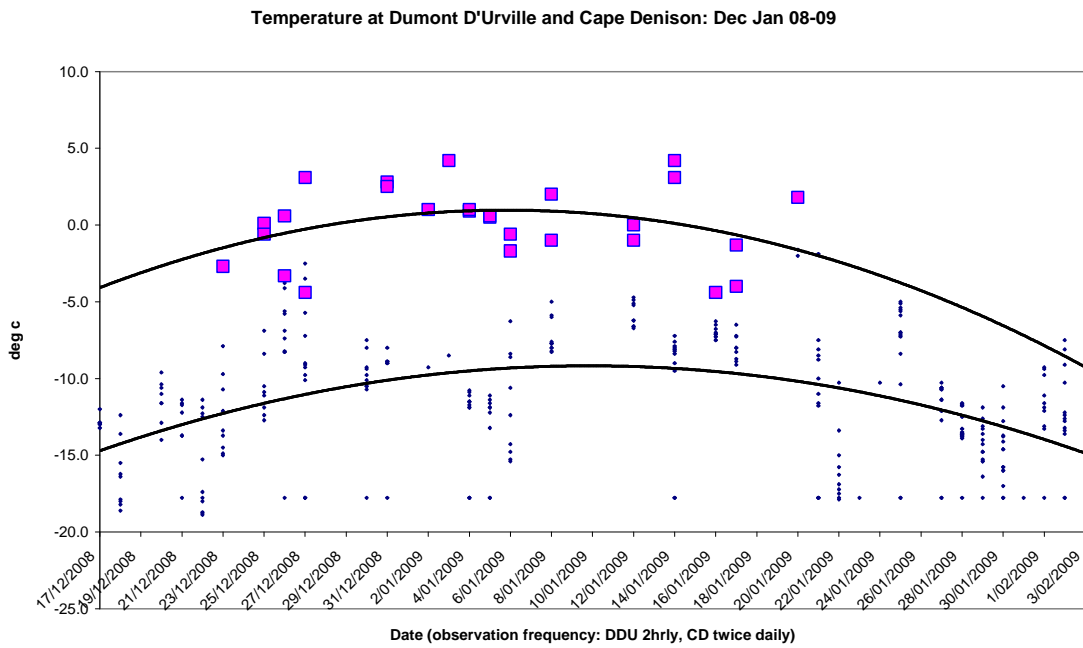
Evidence that temperatures were high around 1975-1981 at Cape Denison

It is important to note that continuous records do not exist for Cape Denison so Dumont D'Urville (DDU) temperatures are used as a proxy for Cape Denison.

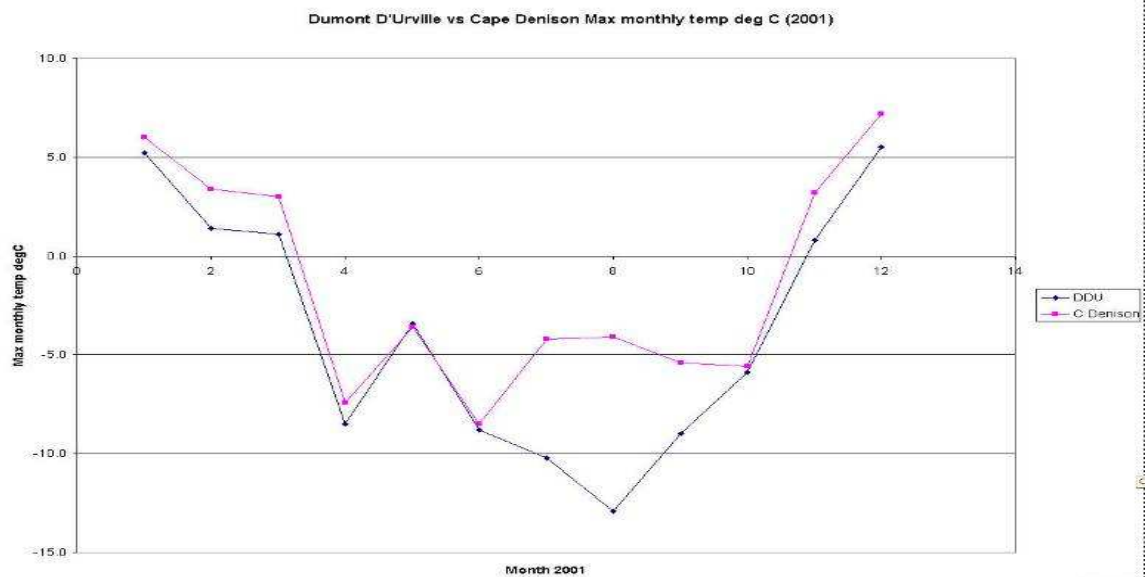
Temperature records from D'Umont Durville station indicated a rise in temperature around 1980. Monthly temperatures in 1977 and 1980 indicate that substantial melting occurred (lower graph).



The summer temperature at Cape Denison is 5-10 deg higher than DDU as shown by last years data:



Based on 2001 data (see below), this temperature difference is likely to have been present in previous years.

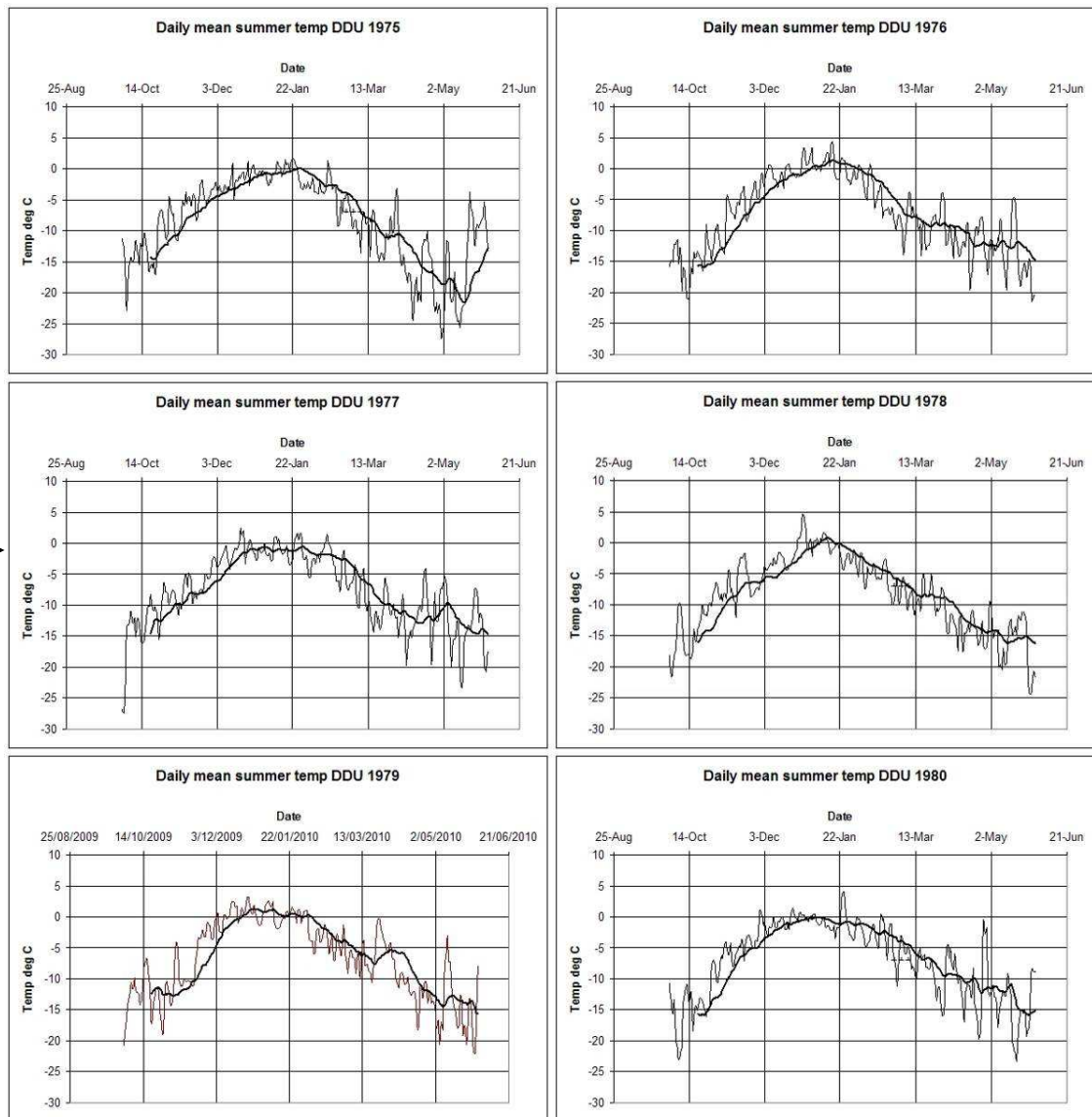


Detailed summer temperature records around 1975-1981

The important temperature readings are those in summer, when melting occurs. It is the *duration* of the raised summer temperature which determines how *much* the ice melts.

In order to estimate how much melt occurred around the time the airframe disappeared in 1975 the DDU average daily summer temperature was plotted for the years 1975-1981.

These records are shown below.



Daily mean summer temperatures from Dumont D'Urville station between 1 October and 30 May for the years 1975-1981. A 20 day moving average has been applied to the data (heavy line). Note that each year shows a peak of zero degrees around mid January except for 1977 and 1980 when temperatures around zero are sustained for a period of about 7 weeks. Cape Denison temperatures are higher (by up to 10 degrees) compared with DDU.

This is evidence in support of the hypothesis that a large-scale ice melt could have occurred sufficient allow the air tractor to sink quickly through the ice. Photographs support this hypothesis.

Photographic evidence of large scale melting in 1977 and 1981

Images taken by expeditioners at Cape Denison were available for the years 1975, 1977, and 1981. These images confirm the findings of the temperature record, and clearly show that the ice level was very much lower in those years. In 1981 extensive melting occurred sufficient to expose large areas of rock around the hut in the vicinity of the known position of the air tractor.



1975: this picture was taken by the AAD photographer Bob Reeves. It is the last known picture of the air tractor frame. It shows about 500mm of the airframe sticking out of the snow. Note the level of the ice at the base of the hut – the crates (arrowed: visible below the R hand wall of the main hut) can be used as a marker to compare with other pictures.

Subsequent pictures show that the ice level did not change all that much in the next few years, but the frame disappeared, suggesting it sank further in the ice.

The level to which the frame was buried, and the level of the ice, is crucial to subsequent arguments about the present position of the frame.



1977: this picture was taken in 1977 by Bill Young, the voyage leader. Dick Lightfoot, the deputy voyage leader, and Andrew Jackson, recently at AAD, were both present on this trip and confirmed that the air tractor was not visible.

It shows the level of the ice was down to the rocks in the foreground, but that the level around the hut was about the same as in Bob Reeves' picture of 1975 (see the arrow which shows the crates in front of the hut, and compare with the Bob Reeves picture above).

This implies that the frame disappeared between 1975 and 1977. The fact that the ice level is about the same as 1975 means that the frame has not disappeared because it was buried by snow. Therefore either the ice melted completely away leaving the frame on bare rock after which it (presumably) blew into the harbour (which is unlikely), or – more likely - it simply sank deeper into the ice.

Evidence that the frame is probably deeper in the ice

The two images discussed above show ice at a similar level, but significantly show that the airframe has disappeared between the first and the second image. Clearly it has either melted out of the ice or it has sunk deeper. This section discusses these hypotheses.

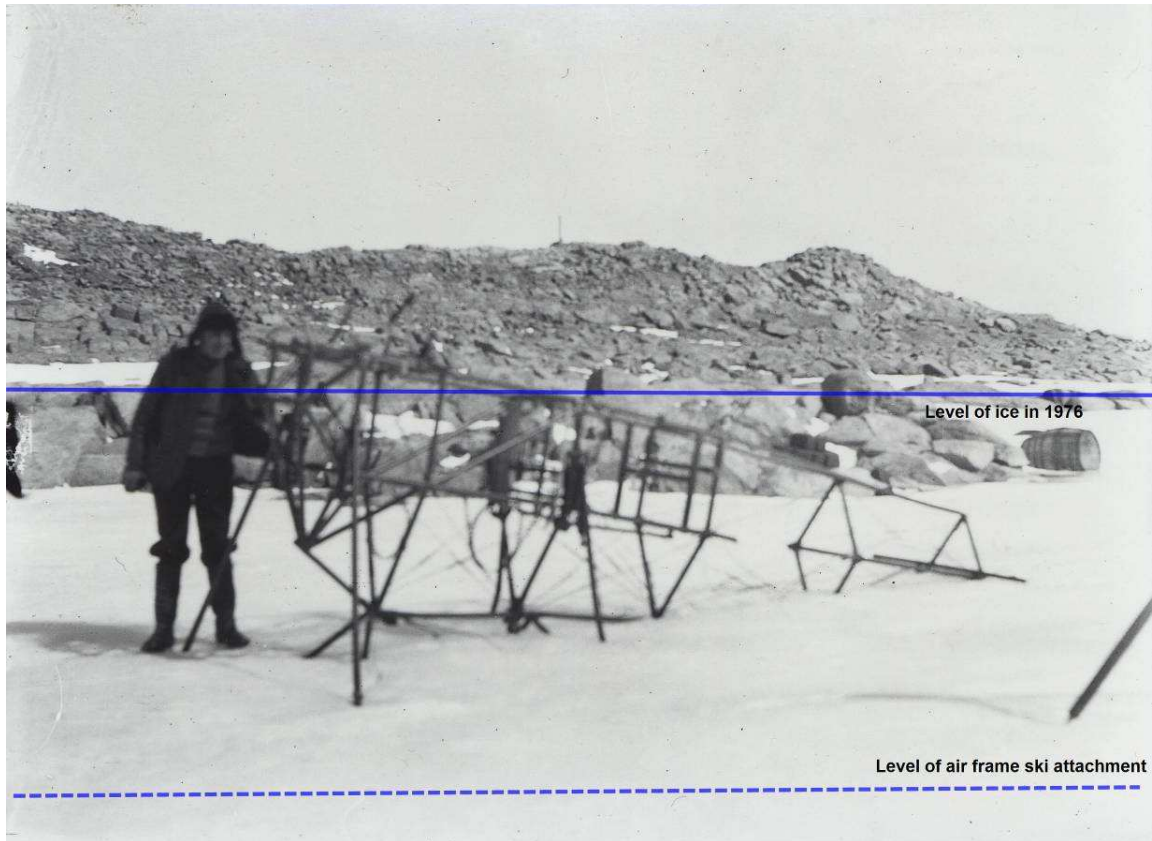
1) It is highly unlikely that the frame was freed from the ice because it would need a huge melt – far bigger than in 1977 and 1981. The frame disappeared in 1976, but the temperature records do not show an unusually prolonged rise that summer.

2) The most likely scenario is that the frame sank deeper into the ice. It was situated in the lowest point of the valley where all the melt streams meet. In a high-melt year the snow and ice around the frame would have been saturated with water, making the ice soft and friable and promoting a tendency for objects to sink.

A minimum depth for the ice at the last known position of the frame in 1975 can be estimated from the two pictures below. The frame is about 2.5 metres high (assuming the person standing next to it is about 2m).



The next picture was taken in 1931 and shows a partly buried frame overlaid with horizontal lines drawn where the 1975 level was, and a lower line at the original level of the skis. There is roughly 2m between them.



Therefore when the 1975 picture by Bob Reeves was taken, the bottom of the frame must have been about 2m below the surface. The picture from 1981 (see next section) shows exposed rocks almost up to the position of the airframe as deduced from transits. This implies that there must be a drop-off or valley in the rocks at least 2m deep just at the edge of the rocks.

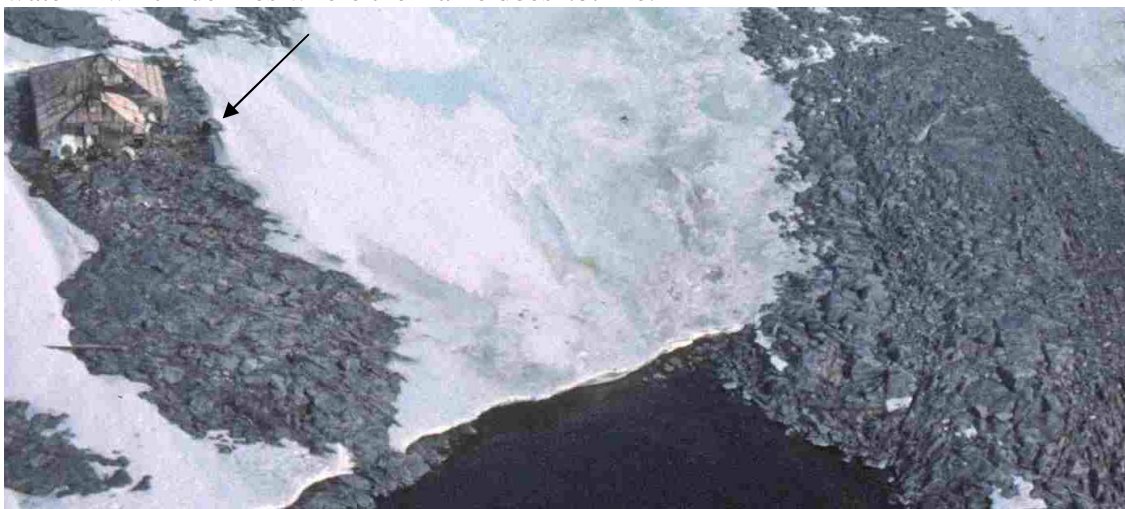
The next section shows photographs of the biggest melt known in 1981, and the area of exposed rock and water.

The level of ice in 1981 reveals the extent of rock in the search area

The temperature records suggest that 1980-81 was a year in which the ice melted at Cape Denison, exposing a lot of rock which had not been previously seen. The next two photos show that virtually all the rock around the harbour was exposed.

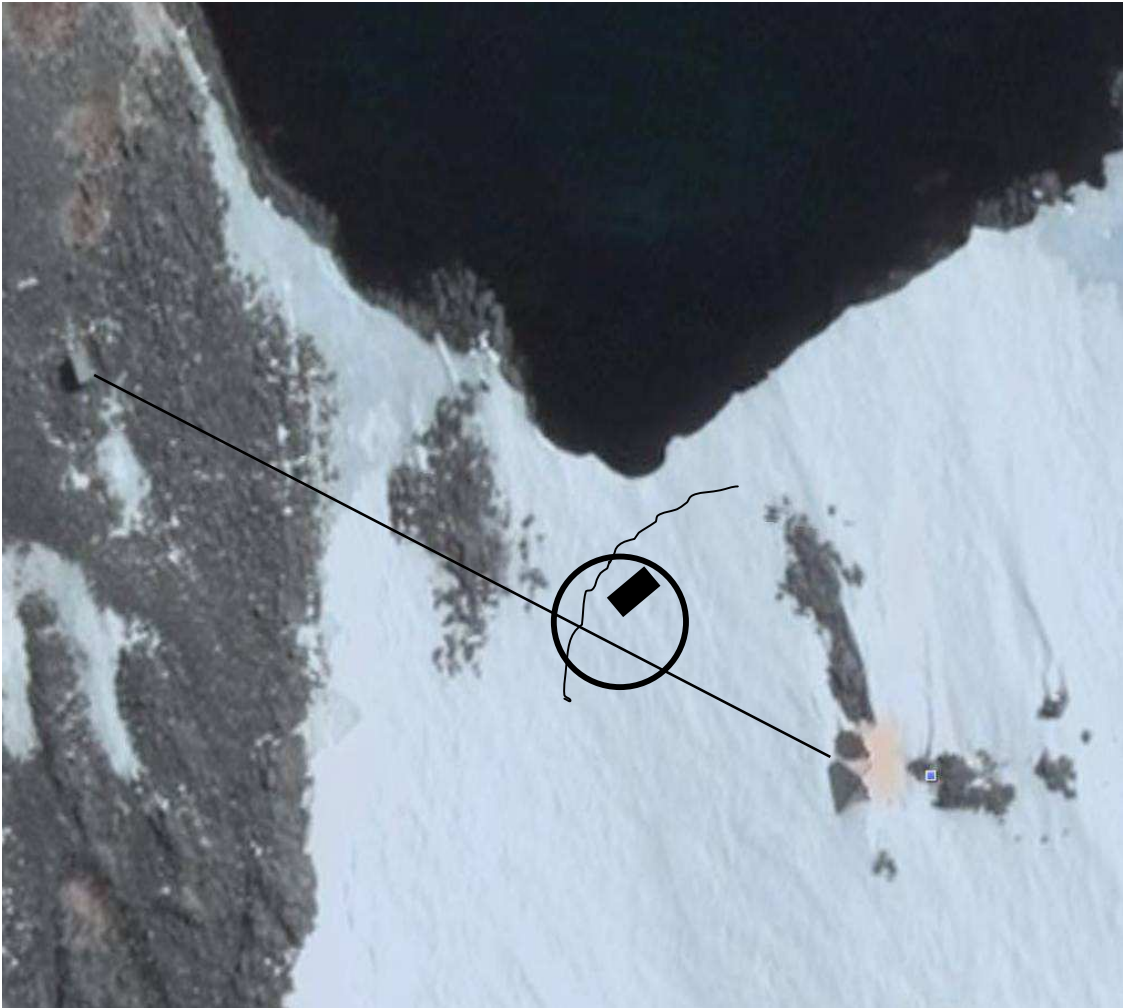


Of particular interest is the area around the hut where the search was conducted. Again the crates, seen here at the edge of the ice, suggest that the level is not all that much lower than in 1975 and 1977. This aerial photograph shows the extent of exposed rock and water – which defines where the frame does *not* lie.



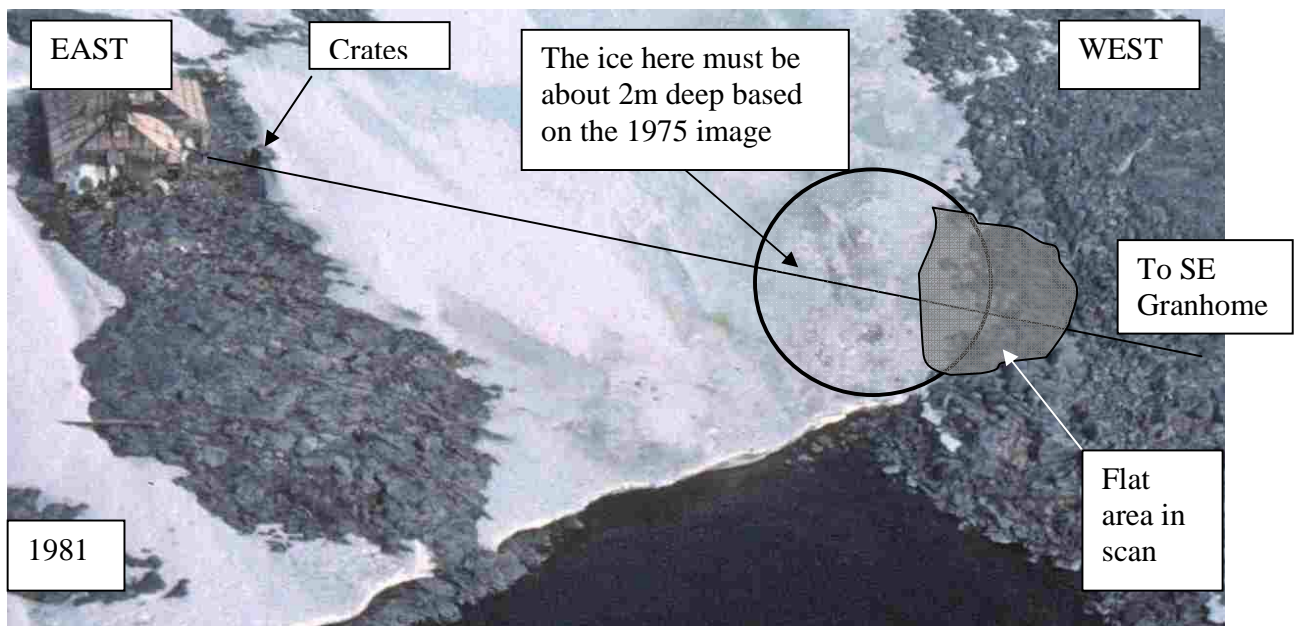
The area of interest from the 2008-9 search

Comparing the 1981 image (above) with the known position of the 2008-9 dig it is possible to establish the boundaries of the rocks, and thus the edge of the area where the frame cannot possibly lie (curved line in the image below). The 2008-9 trench is the small black rectangle.



The area of interest is shown as a circle in the above image.

When these measurements are transferred onto the 1981 image an estimate can be made of where the frame is likely to lie with respect to the rocks. The shaded area in the image below at the western edge of the circle corresponds to the flat area found on the 2008-9 radar scan discussed in the next section. The ice must be around 2m below the 1975 surface at the eastern edge of the circle as discussed in the previous section (arrow).

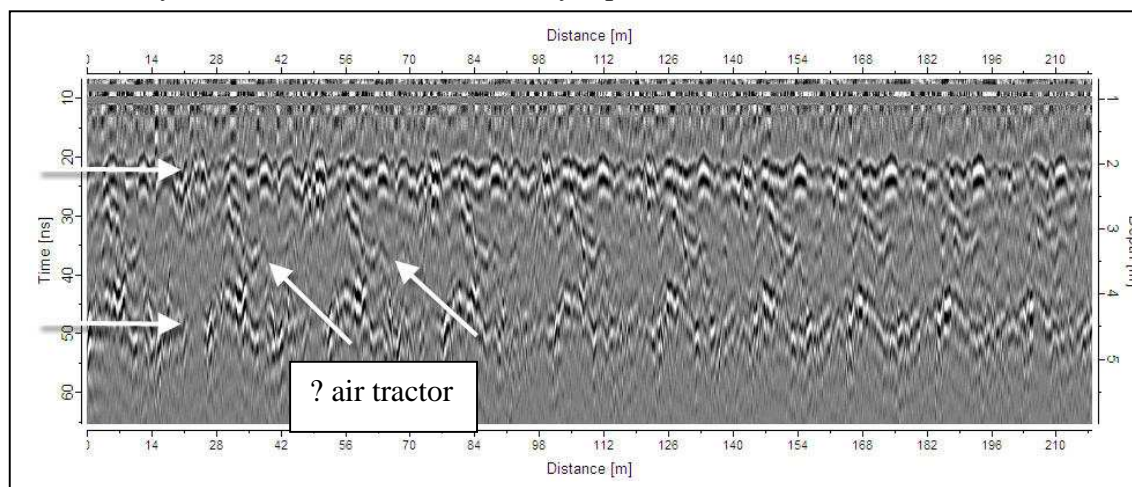


Thus the area where the search should take place this year lies on a line between the NW corner of the main hut and the SE corner of Grenhome hut, at a distance of 50m from the hut.

Evidence from radar images

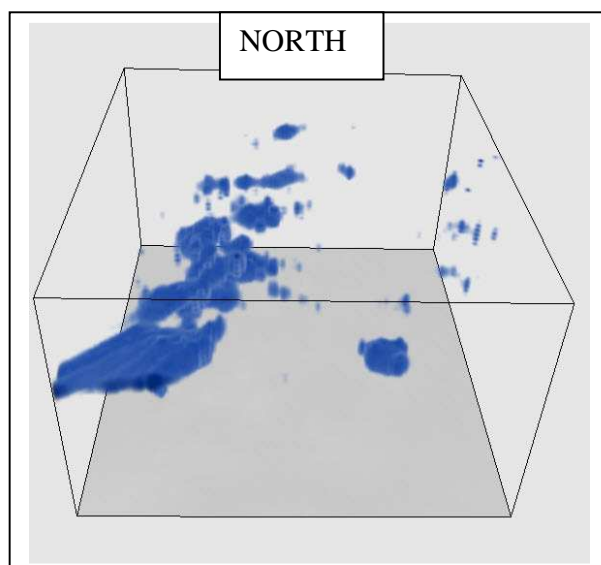
Ground Penetrating Radar was used to find the frame. The search pattern was a spiral, so features repeat throughout the trace with every circuit of the scanning equipment.

- The radar results (below) show two irregular layers. One at around 2m is probably the ice layer which was found when digging the trench. The other may be the floor of the harbour or of the ‘valley’ in the rocks W of the hut. The two horizontal white arrows in the scan below show these layers.
- In one spiral the results show show an anomaly which appears to descend from the first layer toward the second. This may represent the airframe.



A 3D image of the above was made where the anomalous reflections are emphasised and coloured blue. The upper and lower extent of the box represents the area between the ice layers. It can be seen that the anomaly is a long object (about the right size for the airframe), lying at about the right orientation.

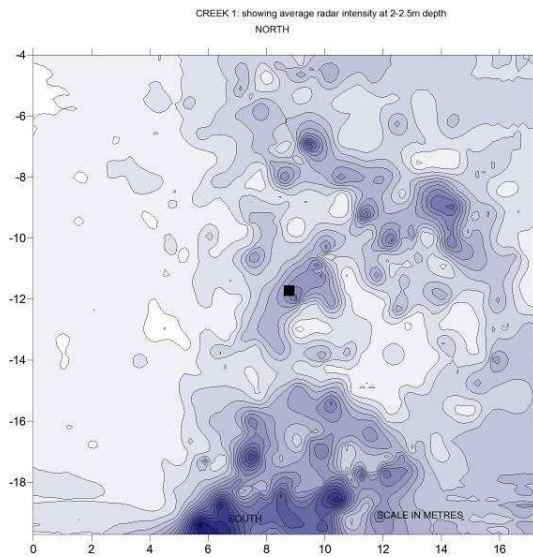
This is a 3D reconstruction of the anomalous reflections shown in the radar trace above. The artefacts shown as “?air tractor” have been coloured blue. The upper and lower borders of the box are the upper and lower ice layers shown as white arrows in above.



Flat area suggests solid rock at the edge of the scanned area.

The results from spiral search shows an area to the West almost devoid of features, consistent with the radar pulses reflecting from solid rock.

The following image is a contour map of the radar reflections at a depth of 2.5m:



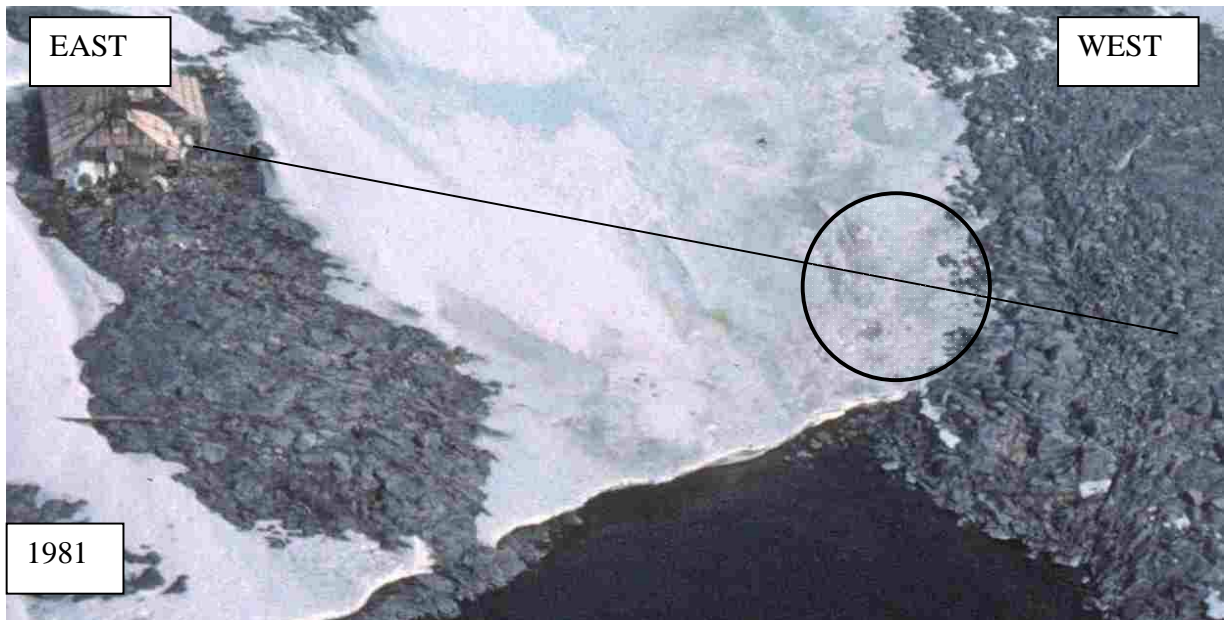
Note the blank area in the left half of this contour map, which is roughly where the bare rocks show in the 1981 image. (The small square in the centre relates to the search technique). This area is greyed out in the image (page 14) showing the area of interest.

Suggestions for searching in 2009-10

1. The sastrugi needs to be levelled to provide a flat reference surface for the radar aerial (otherwise the scan results will represent surface irregularities). This is done using a steel plate towed behind a quad:



2. The search will use ground penetrating radar. It is suggested that a square search pattern be employed as well as a spiral one to make interpretation more intuitive.
3. The area of the search is shown above, and lies about 50m from the NW corner of the main hut on a line with the SE corner of the Grenhome hut.
4. A magnetometer and a conductance meter may be used if available. They will show the frame as anomalies in the readings from the search area. They are not as accurate as radar, but will provide confirmation that a large metallic object is present.
5. The ice will be cut using chainsaws as before, but the chains should be modified by cutting half the kick back flanges from in front of the cutting chisels.



1981 image showing the rocks underlying the search area. This is probably the biggest melt for the past 40 years - the 2008-9 ice covered almost all these rocks. The area where the search should take place this year is circled. It lies on a line between the NW corner of the main hut and the SE corner of Granhome hut, at a distance of 50m from the hut.

Dr Chris Henderson
Sunday, 26 July 2009