THE SEARCH FOR MAWSONS AIR TRACTOR 2010

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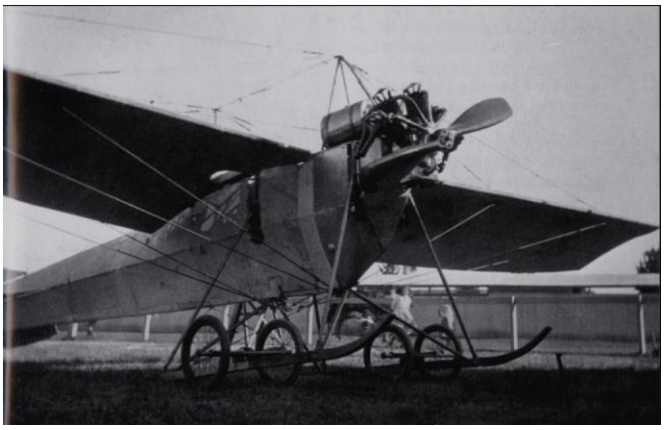
SUMMARY

1. Mawson took the first model of a French military monoplane, made by Vickers in UK, to Antarctica in 1911. The wings were removed following an accident in Adelaide, and the fuselage was intended for use as an 'Air Tractor' to pull sledges. After a brief trip, the engine seized and the frame was abandoned on the ice in 1913.
2. The frame gradually sank into the ice, and finally disappeared after the last photograph was taken in 1975. Dr Tony Stewart, expedition doctor, began the search for the remains in 2007-8, and this has continued for the last two years.
3. In 2008-9 season radar was used to locate the frame of the air tractor. A 3m x 3m x 1m wide trench was dug, but without success.
4. Extensive research was undertaken to gather as much evidence as possible using photographs and eye-witness accounts to narrow down the location.
5. This year (2009-10) a more extensive search was undertaken using radar, a magnetometer, a metal detector, ice drills and a visual and bathymetric survey of the harbour.
6. Small fragments were found in the harbour on New Years day, creating worldwide interest and being portrayed in the media as the discovery of the frame. This is not the case, and the present document discusses this finding in the context of the main search.
7. It was not possible to dig for the air tractor this year because of adverse weather. However considerable information has been gathered on the morphology and topography of the site. This has allowed more precise location of the remains, and formulation of a structured plan for next seasons' search.

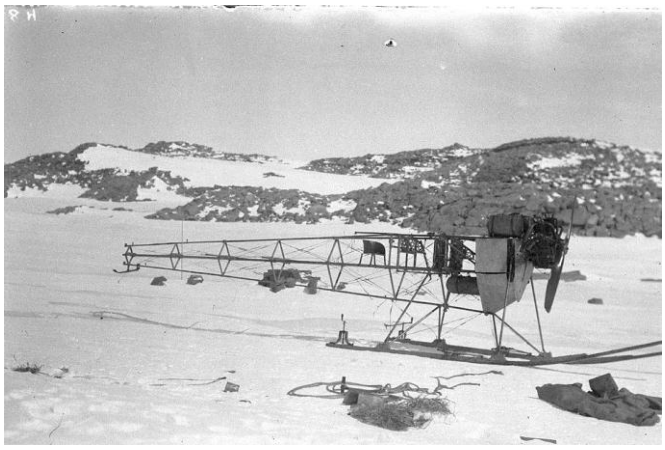
THE HISTORY OF MAWSONS AIR TRACTOR

A complete account of the history of Mawsons Air Tractor is available in the 2008-9 Mawsons Huts Foundation Expedition Report. What follows is a brief version.

The Vickers company constructed an aeroplane in 1911, licensed from the French company of Robert Esnault-Pelterie – a brilliant inventor. The plane was a single-wing military model designed for aerial observation. Vickers made a number of these planes, the one given to Mawson (he actually bought it, but Vickers eventually gifted it to him) was the second plane off the assembly line. However the first plane crashed during trials, and Vickers renamed Mawsons plane as Vickers No 1.

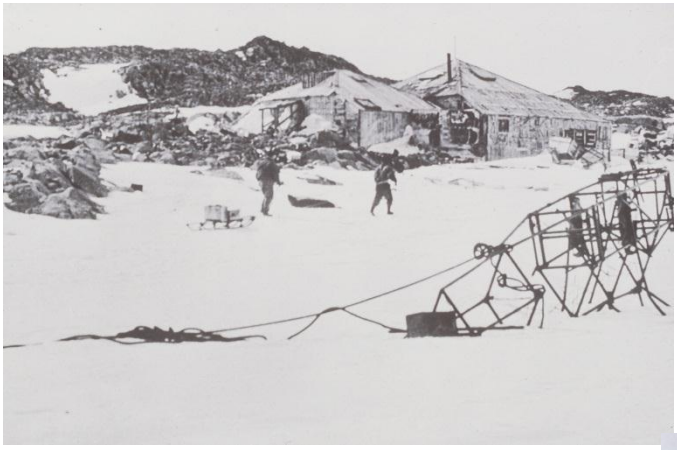


Mawsons plane in 1911. The wings were removed following a crash in Adelaide.



Mawsons plane at Cape Denison, ready to be used as an 'Air Tractor'. There are now 3 seats, the third being made at Cape Denison.

The last 3 segments of the fuselage were cut off before the plane was abandoned on the ice in 1913. Fragments of the last segment were found in the harbour this year.



The abandoned frame in 1912. Note the third seat has been removed, and the last 3 segments are gone.

Location of this frame is the objective of the present search.

The last known picture of the frame in 1976, taken by the AAD photographer Bob Reeves.

Current evidence suggests that the frame sank in the ice, and is either intact on the rock 3m below present ice levels, or parts of the frame still exist in that vicinity.

Other propeller-driven vehicles

Mawsons idea to take a propellor-driven vehicle to Antarctica was innovative and in keeping with Antarctic exploration of the time where ponies and tractors had been used in addition to dogs.

However, this was the age of invention in transport, and, at the time, the engineering possibilities of propellors as a motive force were being investigated:

1912 – Count Bertrand de Lesseps in his Auto Aero. A contemporary of Mawson.

A German 'Air Tractor' for use in the Arctic.

(source the Alfred wegener Institute)

Problems with the air tractor

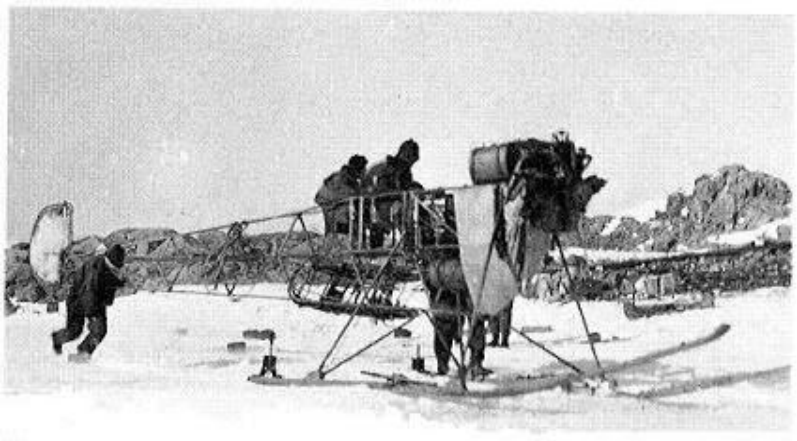
The air tractor was eventually abandoned after the engine cylinder was pierced by a broken piston rod at about 20 miles from Cape Denison. However, there were other problems in getting it to work satisfactorily.

The engine was hard to start, needing fine sunny calm weather and a blowtorch to warm up the crankcase oil. Bickerton records considerable difficulty in getting the engine working.

Steering was difficult, since the tailplane was designed to provide force when the airflow was much higher than ground speed. A second experiment using a steel skid was tried – this part was recovered, along with one wheel, from the harbour in 1976 and is now in AAD.

The ice rudder whose fittings were identified this year compared here with the fittings on the tailplane stored in Mawsons Hut. The ice rudder was recovered from the harbour in 1976 and is presently stored at AAD Kingston.

Braking the frame was a problem as well as steering. The solution was somewhat clumsy, but it did work – a spike on each skid which was wound down into the ice when the plane was to be slowed or steered. This meant someone hanging onto the frame and balancing on the skid while winding the spike into the ice – as Bickerton said, 'this provided the opportunity for acrobatics'.



The air tractor in action. Note the spike on the rear of the skids and two assistants who would have to jump on the skid and wind the spike into the ice to steer or slow the machine. The tailplane would not provide enough steerage at slow speed.

The fragments of tail section found in Boat Harbour 1 Jan 2010

New Years Day 2010 was a fine calm sunny day, with very low tides in Boat Harbour – only 100mm above Tide Datum, which is theoretically the lowest tide possible. To make matters more intriguing it was a Blue Moon (where there are two full moons in one month – only happens about every 7 years).

It also happened that one of the expeditioners – Mark Farrell (Heritage Carpenter) chose the exact time of the lowest tide to see what he could find at the waters edge just below the air tractor search area (he was looking for interesting sea creatures).

What he found created a worldwide explosion in media interest, with about 1.5 million hits on the Mawsons Huts Foundation website (www.mawsons-huts.org) , media stories in many countries, a political cartoon in the UK press and extensive TV coverage.

The find was variously – and inaccurately – reported as the airframe having been found, pieces of the airframe found, and even (from our very own ABC) 'large pieces of the airframe' found in the harbour.

What he actually found was 4 small joining pieces of the last section of the airframe. Each 100-150mm long, heavily corroded and fragile. These were resting among the rocks at the waters edge just below the surface. They have since been recovered and transported to Perth WA in seawater where they will be stabilised over the coming years.

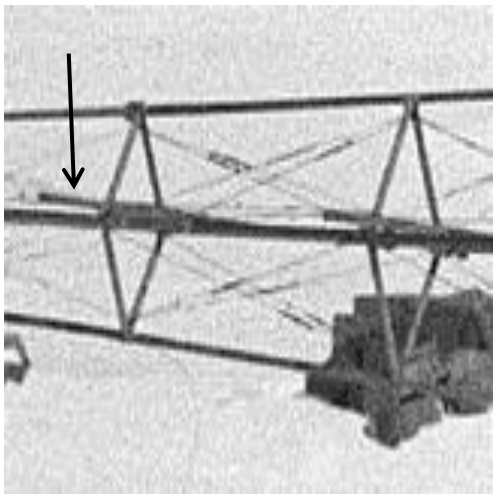
Fragments of the final section of the airframe found in Boat Harbour on 1 Jan 2010

The fragments were found at the edge of the water, just below the air tractor search area – Mawsons Huts can be seen at the top R of the picture.

The fragments were readily identified as being joining sections for the modular airframe – most likely from the last segment of the frame since the outer section of the two centre joining pieces have a terminating bolt on one side.

Fragments 1 and 2: Fragments of the airframe compared with existing spare parts from the workshop (centre). The terminating bolts are clearly visible on the top sections of these mirror-image joiners. The round tube at the bottom of both fragments contains wooden dowel which has been sawn off – this dowel is seen in pictures of the intact frame protruding either side of the fuselage.

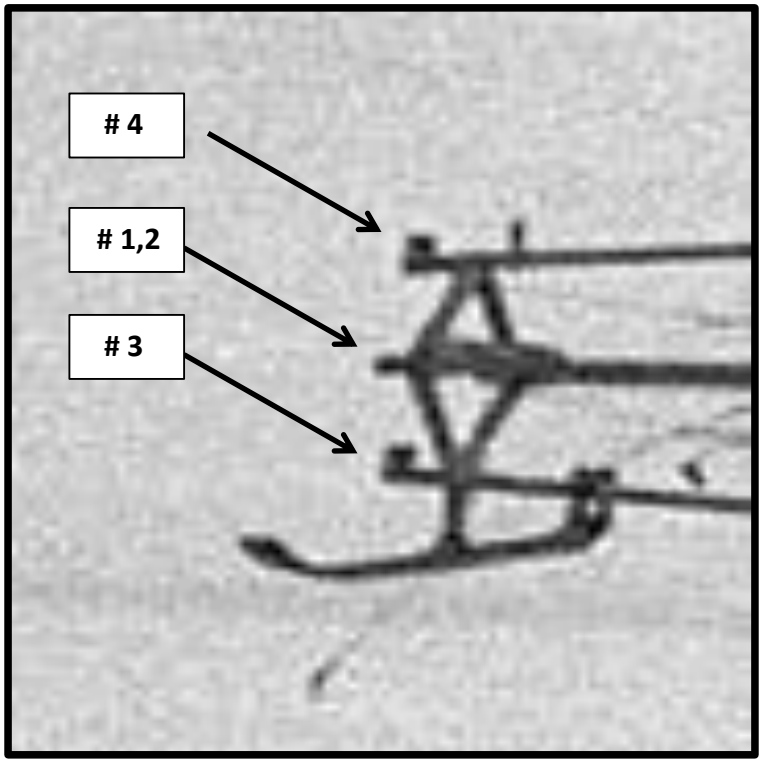
Picture of a section of the airframe showing the overall shape of the segments, and clearly showing the protruding dowel (arrow). On the right is a close-up showing the cut surface of the wood.



Fragment 3: Straight part from the bottom of the diamond-shaped frame section. It can be seen that a wooden dowel was inserted in the Left hand end, and subsequently cut off , and that there is a round section on top of that end, probably the remnants of a socket for the tail assembly.

Fragment 4: Straight part from the top of the diamond-shaped section – this is most probably where the skid or rudder was attached. The two remnants of these attachments are seen at either end.

This is a blown up part of an image of the air tractor which clearly shows where the fragments found in the harbour came from. Numbers correspond to the above pictures.



These pieces are clearly from the final section of the airframe, and have been cut off. Perhaps it was part of an experiment to find the best way to control the air tractor, and, along with the ice skid, it was jettisoned in the harbour when it failed.

The significance of these parts, still more or less intact, is that parts will survive almost 100 years in this environment. Even underwater, but exposed to repeated ice formation at the edge of the harbour, the thicker pieces have survived.

This suggests that remnants of the frame, large or small, would still be intact under 3m of ice in the area where the plane was last seen.

Boat Harbour search

The day after the findings above was also a calm day, and the opportunity was taken to look at the harbour bottom at low tide.

The harbour was shallow – about 600mm at the edges – and visibility was good. A viewing bucket was used while Marty Passingham rowed me around the S end of the harbour. I was able to see the bottom clearly, including the cracks between the rocks, and found no more sections of steel despite going over the area 3 or 4 times.

It can be seen from the photograph below that there is an area of seaweed – actually seaweed fragments about 200mm deep (dark area) – covering the bottom of the harbour at the Southern end. This could have concealed fragments.

A kite aerial photograph showing the bottom of Boat Harbour. The fragments were found at the bottom left (arrow). The underwater area around the fragments was thoroughly searched, including under the edge of the ice for about 50m in both directions and 30m from the edge, without finding anything else. It is possible that the seaweed debris (black area) concealed something of interest.

FINDINGS FROM 2008-9 SEARCH

Last year a search was conducted using radar imaging, and a trench was dug without finding the airframe.

The conclusions from that search plus interviews, images and temperature data was that:

1. The frame disappeared after 1976 when the last picture of it was taken.
2. The ice where the frame lay was not moving ice.
3. There was a big melt in 1981 as evidenced by temperature records from Dumont D'Urville and members of AAD who visited that year.
4. It was possible that a trench existed in the harbour which extended next to the assumed position of the frame.
5. During the melt of 1981 the frame could have melted out of the ice and fallen into the harbour.
6. Hard ice and seaweed was found at 2.5m in a trench dug in what was thought the most likely spot, suggesting a big melt had allowed seaweed to extend to the search area.

Accordingly it was suggested that this year efforts be made to:

1. Re-image the area using radar.
2. Use a magnetometer.
3. Survey the harbour.
4. Use differential GPS for more accurate position location.

In addition ice augers were taken in order to calibrate the depth of the ice, and a pulse induction metal detector was made to detect any ferrous objects.

The following describes the implementation and findings from the above techniques.

Grid pattern and DGPS

A grid 30x15m was set out using wooden stakes with painted numbers across the search area. This was used in all surveys as an accurate reference for position.

Plastic twine was laid as a guide between the stakes to ensure the grid was surveyed accurately.

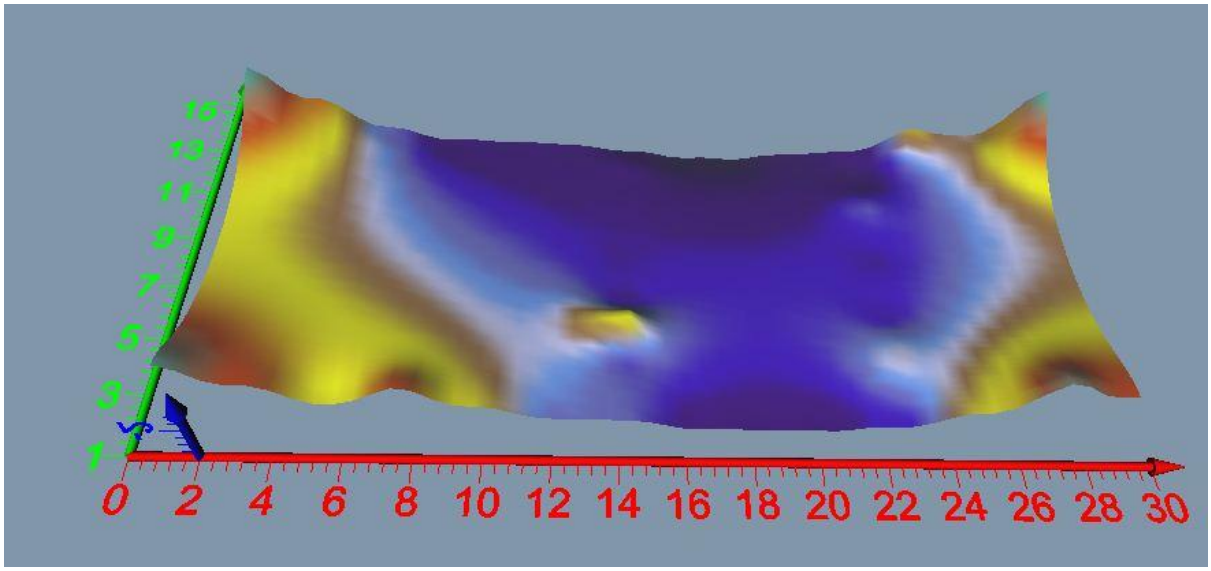
Differential GPS was also used to pinpoint the position of the grid markers and holes relative to the base GPS at Sorensen. These measurements were used to relate the position of the grid to other surveyed areas at Cape Denison, and to match the underlying rock level with the harbour bottom.

Ice auger drilling

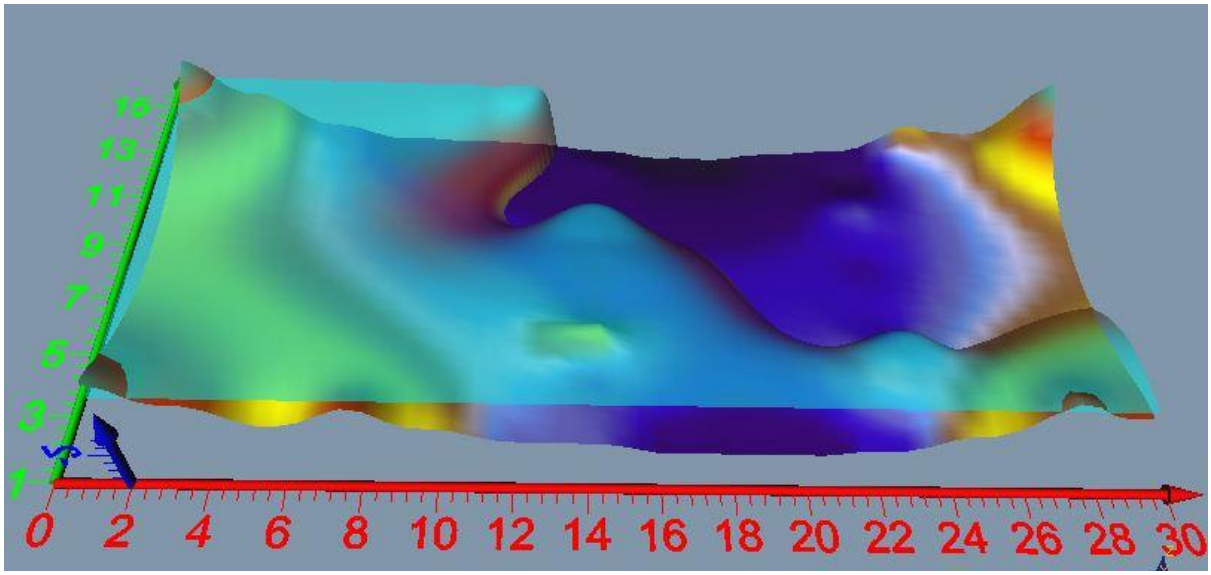
An ice auger was used to drill down to the bedrock. In all about 200 holes were drilled using an electric drill. It took around 10-15 minutes to drill one hole down to the rock. Measurement was made of the depth of the ice auger when it hit the rock, and note was made of the hardness of the ice and the presence of seaweed.

The ice was found to be hard in parts, and very soft in others. The area of soft ice formed a V shaped re-entrant into the search area. It suggests that at some stage the ice had melted completely leaving a channel which became lined with seaweed.

This picture shows the ice depth measured directly by the auger. It can be seen that the rock under the search area consists of a relatively flat surface which rises either side. The harbour is toward the top of the picture (the colours are false to emphasise the terrain). The small raised area at 14,3 corresponds to the position of the trench dug last year.



This shows the above picture with superimposed areas of hard ice (white shade) and soft ice (no shading). It can be seen that the soft ice forms a 'bay' into the search area, implying this melted completely away at some stage. Seaweed was recovered from areas of soft ice.



The most likely landform under the ice.

Visual inspection of the sea bottom at the southern end of the harbour showed it to be rough rocks shelving under the ice.

The rocks under the ice are at the level of the harbour bottom: Using the depths from the auger measurements and the differential GPS measurements of the surface of the ice in the search area it was possible to derive an accurate height of the rocks at the bottom of each hole. This height was then compared to the height (all relative the the Sorensen DGPS benchmark) of the harbour bottom. It was shown that the rocks under the search area are level with the rocks on the harbour bottom.

The importance of this is that the rock under the search area is about 500mm below tide datum, and so 1500mm underwater on a high tide. Which explains how seaweed can be found at the bottom of the ice auger drill holes.

Gravel was recovered from some of the holes as well as seaweed. This suggests a composition of the landform under the ice – gravel, seaweed, rock and ice, which is illustrated by a photograph taken at low tide in the next bay near the Sorensen Hut.

The seabed under the search area probably looks something like this at low tide - gravel, rock, ice and seaweed shelving gently down to the water. The airframe is prob ably buried in the ice and gravel.

Metal detector

A metal detector was used in the auger holes immediately after drilling. The detector was a pulse induction type, more powerful than the usual passive type. The detector was made from a Canadian circuit, and a coil was wound with about 60 turns of AWG 20 wire on a plastic former. Aerial coax cable was used as the lead wire. While this is not an optimal arrangement, it is the best that could be done at the time. The sensor had a range of only 5cm but reliably detected metal.

Using the Pulse Induction metal detector. It was important to put the sensor down the hole immediately after drillng since ice particles tended to fall in.

The only positive results were found at 4 holes where the airframe had been located uising transects from pictures, from GPR results, and from magnetometry.

It is likely that these findings are a good indication that the frame, or parts of it, lie under the ice. However, the short range of the detector means that it may have missed positive findings in other areas, and using better equipment would be advisable before digging for the frame

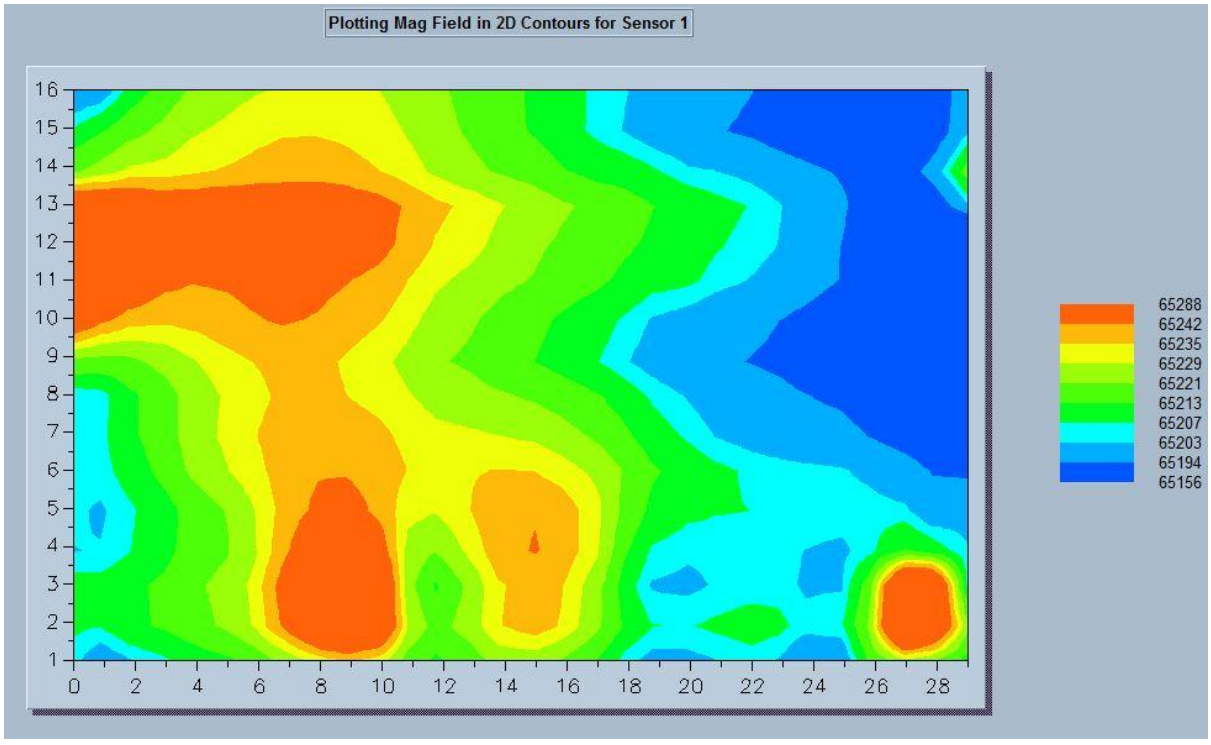
This combination of ice drilling and metal detection technology is likely to prove most effective in locating the airframe, since the results of a positive test are unequivocal evidence of metal objects. Therefore it is suggested that ice augers and a metal detector is taken and used prior to any dig.

An EM31 conductance meter is capable of detecting conducting material, and ice is transparent to it. It works well up to 6m and so would readily detect metal at 3m. If such a machine were employed, an idea would be gained of the location of a collection of metal objects, and the ice auger/metal detector technique would thereafter be a powerful way of pinpointing where to dig.

Magnetometer survey

A magnetometer was loaned by Alpha-Geoscience (Sydney). Variations in the magnetic field were recorded every 0.5m across the grid pattern, the recording being done in the late afternoon when previous static recording had shown the magnetic field to be quiet.

Tony Stewart perfoms a magnetometer survey. The recording head is in the non-ferrous cart, and Jody Steele holds the tape to provide accurate sampling distances.



Magnetometer survey results plotted as a 2D map across the search area. The area where the airframe is thought to lie is shown by the red contour at 7,4. It is unclear whether the large red area at 4,12 is related to the underlying rock or ferrous artefacts. The localised area at 27,2 (right hand corner) is probably a case.

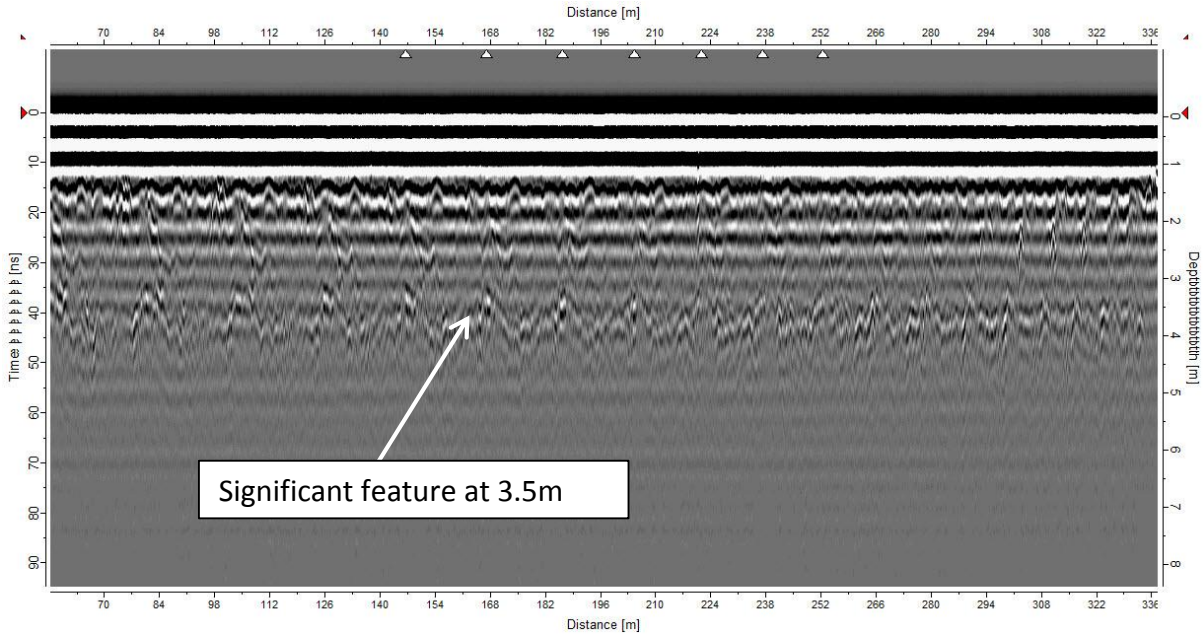
The results of the magnetic survey show a positve finding in the area where the air tractor is thought to lie, but also show a band running EW about 10m more northerly. No signals were found in this latter area using the metal detector, but it must be remembered that the metal detector had a very limited range. If the findings indicate metal, then the area would

be consistent with scattered fragments. On the other hand the findings may just indicate magnetic rock. Unfortunately nobody was able to tell us whether the rock was magnetic – the magnetometer placed near other areas of rock did not give a conclusive response. The general opinion was that the rock in this area is not magnetic, in which case these findings may be more significant.

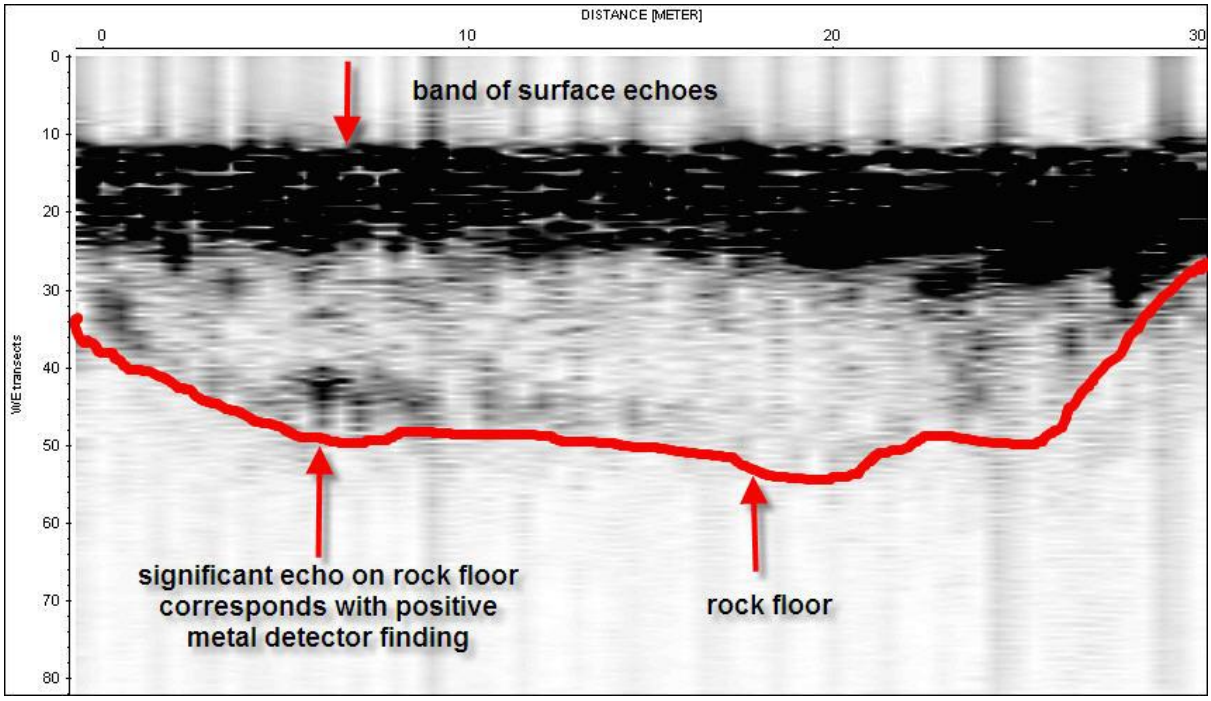
Ground penetrating radar

Ground penetrating radar (GPR) equipment was taken - again on loan from UTAS. The search patterns last year (see 2008-9 report) were spiral, this year the pattern was linear and Reflex software was used to analyse the results.

One of the important results from the ice drilling was that the ice depth was calibrated and so the radar results from last year were able to be reinterpreted with known depths. These results could then be combined with the grid analysis from this year to provide a picture of the structures under the ice.



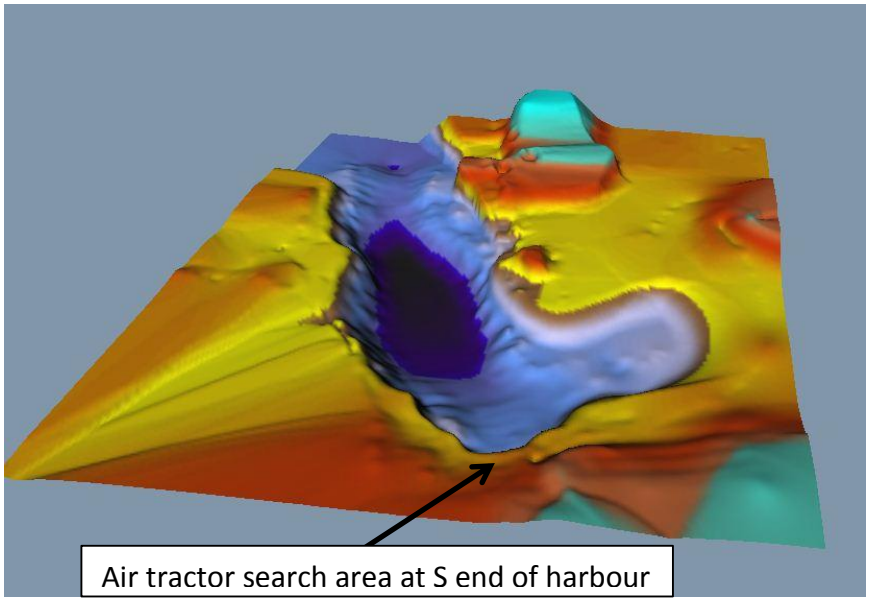
This is a radar trace from a spiral track from last years' GPR search. It appears that a significant feature lies at about 3.5m. It is visible in multiple echoes as the radar unit passes round the spiral.



This is a linear trace through the area where the airframe is thought to lie (from photographic evidence). The rock floor can be seen across the 30m of the search area, and what appears to be a significant echo at 6-7m, which is roughly where the frame should lie, and corresponds to the area where the metal detector gave positive findings.

Boat Harbour bathymetry

Boat Harbour was surveyed, as is detailed elsewhere in this report. The findings were that the harbour shelves gently to the south, and that there is no trench or discontinuity in the harbour floor into which the airframe could have fallen. The rock under the searcha area is a gently shelving platform.



Boat harbour survey. It is clear that the harbour shelves slowly from a maximum depth of about 6m to a shallow basin at the southern end. The area where the air tractor is thought to lie is continuous with this profile.

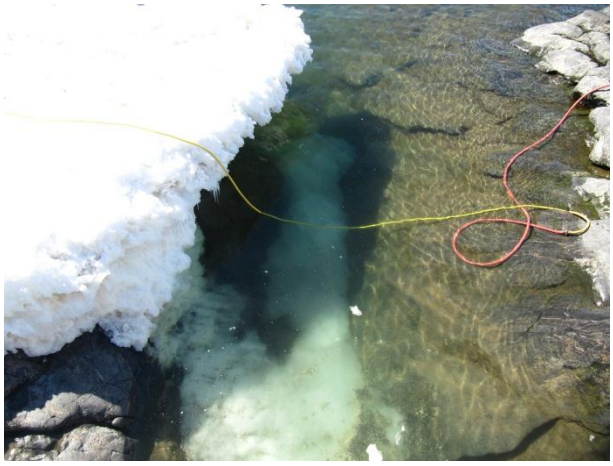
Ice freezes on the bottom of the harbour

One of the hypotheses of the fate of the air tractor is that it fell into the bottom of the harbour, was frozen into the ice and taken out to sea.

Don McIntyre, who came to Cape Denison during the search, said that the ice freezes on the bottom of Boat Harbour – contrary to its usual practice of freezing from the top down. The same phenomenon was observed at DDU (see below).

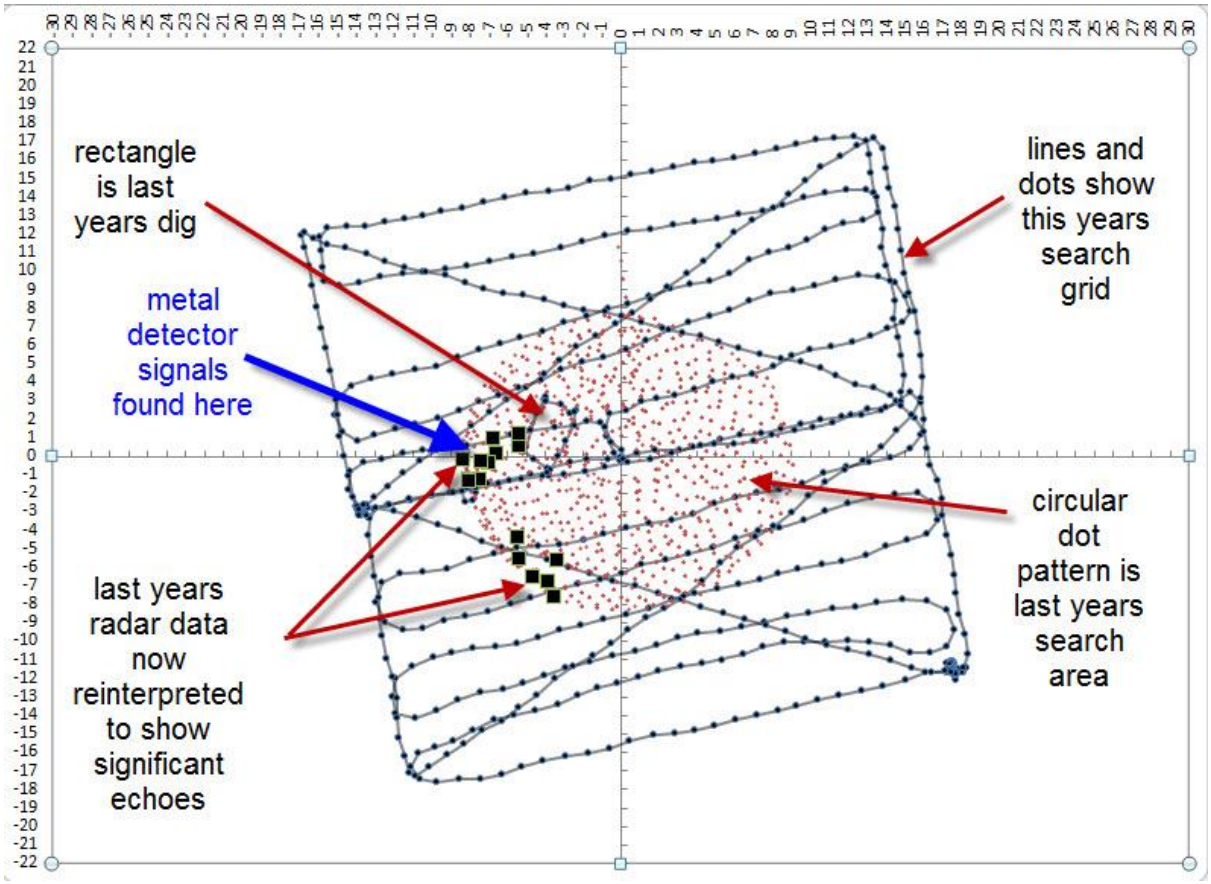
If the air tractor disintegrated, and if the parts were distributed along an exposed rocky shore, then it is possible that they were held in the ice and taken out in the following years' melt.

However, the positive findings detailed previously suggest that it is likely that at least a part of the frame is still present.



PUTTING IT ALL TOGETHER

The findings from this year can be summarised in a diagram which combines the data from this year and the data from last year:



The grid pattern is shown by dotted lines (from DGPS survey). The dots show last years search pattern, and the positive metal detector signals are shown in relation to the grid and last years trench. The positive magnetometer data (not shown in this diagram) forms a band which passes through the trench and the area of positive signals.

SUMMARY

Our knowledge of the area has improved considerably following this year's work.

1. It is now clear that the surface under the ice where the air tractor is thought to lie is relatively flat, consisting of gravel, seaweed and rock.
2. There is evidence of a large melted section of ice which extends in a V shape south from the waters edge by about 20m and approaches the area where the air tractor is thought to lie.
3. The images from various historical sources clearly put the air tractor on the ice about 2m west of last years trench.
4. The harbour mapping shows that there is a gently shelving rock bottom extending under the ice at the southern border, and that the area where the air tractor may lie is about 1.5m underwater at the highest tide, and 0.5m above tide datum.
5. The fragments found at the edge of the harbour have been identified as parts of the final section of the fuselage, and are unlikely to be part of the main fuselage which is still being sought. The fact that these fragments are intact suggests the air frame, or parts thereof, will be intact.
6. It is highly significant that a positive metal detector reading was found where the air tractor is thought to lie.
7. The magnetometer survey supports the finding of both the GPR and the metal detector survey, but includes other positive areas whose significance is unclear.
8. Ground penetrating radar shows positive echoes consistent with an object at the point where the airframe may lie.

CONCLUSION

1. It is likely that the frame sank in the ice since it was last seen in 1976.
2. It is possible that the frame disintegrated and the parts were taken out to sea in ice forming on the bottom of the harbour.
3. It is more likelty that they remain in situ on the rock at a depth of 3m in the ice. If so, then can be recovered using further search techniques and finally a dig.
4. The most useful direction for future search is to use an EM31 conductance meter to indicate the presence of conductive material (it should work well at 3m), then, as was done this year, to use an ice auger and improved metal detector to locate metal objects.
5. Assuming that the findings are positive, then a trench would take 4 people about 2 days to dig in order to locate the frame.