

THE SEARCH FOR MAWSONS AIR TRACTOR

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SUMMARY

The location of the Air Tractor was estimated from images from 1911, 1931 and 1976. Ground Penetrating Radar (GPR) was used to search the ice where the Air Tractor was thought to be buried at Cape Denison. An area within the ice was found which looked consistent with the frame of the Air Tractor. An exploratory trench revealed it to be a layer of hard ice at sea level. Evidence is presented here that the Air Tractor may have been freed from the ice some time after 1976 in a significant melt. It is likely that its current position is deeper in the ice among the rocks at the edge of Boat Harbour.

Suggestions are made for mounting another search.

HISTORICAL NOTES ON VICKERS AEROPLANE¹:

Some highlights of the history of the Air Tractor are reproduced here.

The Vickers monoplane was based on the R.E.P. 60 HP five-cylinder air-cooled semi-radial engine plane. It was designed by Robert Esnault-Pelterie, a remarkable French inventor. The steel fuselage was built in France while the wings were made in England. After being tested at Vickers' new airfield at Joyce Green, Dartford, and then at Brooklands, it was crated and shipped to Australia for use by the Australasian Antarctic Expedition. However, the wings were damaged beyond repair on October 5, 1911, during a practice flight at Cheltenham Racecourse, Adelaide, before the expedition left for the Antarctic.

Mawsons reasons for using the air tractor

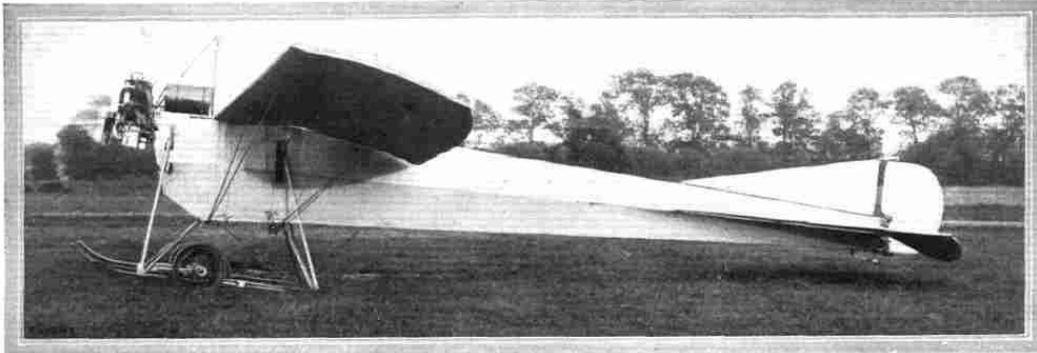
After his return, writing in the *Home of the Blizzard*, Mawson said that the reason for taking the aircraft was more to attract publicity for the expedition's cause rather than for its serious use in reconnaissance in the Antarctic. Shackleton and Scott had previously tried a motor car and a motorised sled, both of which had failed, and the air tractor represented a different idea.

¹ Some of the following information on the history of the Vickers plane is taken from a post on the Aerodrome Forum which can be found at: www.theaerodrome.com/forum/aircraft/39071-forum-attic-item-14-a-3.html. 'Home of the Blizzard' is available free for download from www.gutenberg.org/etext

THE VICKERS MONOPLANE.

It is only typical of the unerring foresight that Messrs. Vickers exhibit in all their new undertakings that they should have turned some of their vast energy to aeroplane construction, and further

monoplane, in fact it only appears in three places, the rear skid, the two main skids, and the wings. The wings are going to have metal booms, and there is little doubt that, in these times of rapid advance-



The Vickers Monoplane.—Side view, showing the protruding engine and the manner in which the wing trusses are carried to the base of the fuselage. An idea of the wing cross section may also be gathered.

that, in doing so, should commence work on such a successful and well developed machine as the R.E.P. monoplane.

The experience of such a pioneer as Robert Esnault-Pelterie counts for a good deal under any circumstances, but coupled with

ment, all these parts will be fashioned from steel, much in the same way as in motor car construction the wooden chassis frame, even though armoured with metal, had soon to give way to the neat and homogeneous steel stamping.

Figure 1 The Vickers plane used by Mawson. Note the ski attachments which proved essential on the ice.

Mawson, in the *Home of the Blizzard* writes:

“As erroneous ideas have been circulated regarding the "aeroplane sledge", or more correctly "air-tractor sledge", a few words in explanation will not be out of place. This machine was originally an R.E.P. monoplane, constructed by Messrs. Vickers and Co., but supplied with a special detachable, sledge-runner undercarriage for use in the Antarctic, converting it into a tractor for hauling sledges. *It was intended that so far as its role as a flier was concerned, it would be chiefly exercised for the purpose of drawing public attention to the Expedition in Australia, where aviation was then almost unknown. [my italics].* With this object in view, it arrived in Adelaide at an early date accompanied by the aviator, Lieutenant Watkins, assisted by Bickerton. There it unfortunately came to grief, and Watkins and Wild narrowly escaped death in the accident. It was then decided to make no attempt to fly in the Antarctic; the wings were left in Australia and Lieutenant Watkins returned to England. In the meantime, the machine was repaired and forwarded to Hobart.”

Note: Pilot Watkins was originally a member of the expedition to Antarctica, so, despite the comments above, it implies there was an intention to fly the plane at Cape Denison, and that it was not just a publicity stunt.



Figure 2: loading the airframe onto the Aurora in 1911

The Air Tractor in the Antarctic in 1911-1913

Minus its wings, the machine was converted into an air-tractor, and taken south. The first test of the machine as an air-tractor was made on November 15, 1912. After a short trial trip on November 20, 1912, the vehicle made a successful depot-laying trip with a load of 700 pounds on December 2, 1912. At 4 PM on December 3rd, the air tractor was taken by three men from the expedition's base at Commonwealth Bay on a major trip. Bickerton takes up the story:

Bickerton describes the working of the plane:

“I had always imagined that the air-tractor sledge would be most handicapped by the low temperature; but the wind was far more formidable. It is obvious that a machine which depends on the surrounding air for its medium of traction could not be tested in the winds of an Adelie Land winter. One might just as well try the capabilities of a small motor-launch in the rapids at Niagara. Consequently we had to wait until the high summer.

With hopes postponed to an indefinite future, another difficulty arose. As it was found that the wind would not allow the sea-ice to form, breaking up the floe as quickly as it appeared, the only remaining field for manoeuvres was over the highlands to the south; under conditions quite different from those for which it was suited. We knew that for the first three miles there was a rise of some one thousand four hundred feet, and in places the gradient was one in three and a half. I thought the machine would negotiate this, but it was obviously unsafe to make the venture without providing against a headlong rush downhill, if, for any reason, power should fail.

After much consideration the following device was adopted:

A hand rock-drill, somewhat over an inch in diameter, was turned up in the lathe, cut with one-eighth-inch pitched, square threads and pointed at the lower end. This actuated

through an internal threaded brass bush held in an iron standard; the latter being bolted to the after-end of a runner over a hole bushed for the reception of the drill. Two sets of these were got ready; one for each runner.

The standards were made from spare caps belonging to the wireless masts. The timely fracture of one of the vices supplied me with sufficient ready-cut thread of the required pitch for one brake. Cranked handles were fitted, and the points, which came in contact with the ice, were hardened and tempered. When protruded to their fullest extent, the spikes extended four inches below the runners.

The whole contrivance was not very elegant, but impressed one with its strength and reliability. To work the handles, two men had to sit one on each runner. As the latter were narrow and the available framework, by which to hold on and steady oneself, rather limited, the office of brakesman promised to be one with acrobatic possibilities.

To start the engine it was necessary to have a calm and, preferably, sunny day; the engine and oil-tank had been painted black to absorb the sun's heat. On a windy day with sun and an air temperature of 30 degrees F., it was only with considerable difficulty that the engine could be turned--chiefly owing to the thickness of the lubricating oil. But on a calm day with the temperature lower -20 degrees F. for example--the engine would swing well enough to permit starting, after an hour or two of steady sun. If there were no sun even in the absence of wind, starting would be out of the question, unless the atmospheric temperature were high or the engine were warmed with a blow-lamp."

How the air tractor was abandoned:

Bickerton writes that the first trial came in November:

"It was not till November 15 that the right combination of conditions came. That day was calm and sunny, and the engine needed no more stimulus than it would have received in a "decent" climate.

"Hannam, Whetter and I were the only inhabitants of the Hut at the time. Having ascertained that the oil and air pumps were working satisfactorily, we fitted the wheels and air-rudder, and made a number of satisfactory trials in the vicinity of the Hut.

"The wheels were soon discarded as useless; reliance being placed on the long runners. Then the brakes were tested for the first time by driving for a short distance uphill to the south and glissading down the slope back to the Hut. With a man in charge of each brake, the machine, when in full career down the slope, was soon brought to a standstill. The experiment was repeated from a higher position on the slope, with the same result. The machine was then taken above the steepest part of the slope (one in three and a half) and, on slipping back, was brought to rest with ease. The surface was hard, polished blue ice. The air-rudder, by the way, was efficient at speeds exceeding fifteen miles per hour.

On the 20th we had a calm morning, so Whetter and I set out for Aladdin's Cave to depot twenty gallons of benzene and six gallons of oil. The engine was not running well, one

cylinder occasionally "missing". But, in spite of this and a head wind of fifteen miles per hour, we covered the distance between the one-mile and the two-mile flags in three minutes. This was on ice, and the gradient was about one in fifteen. We went no farther that day, and it was lucky that we did so, for, soon after our return to the Hut, it was blowing more than sixty miles per hour.

On December 2 Hodgeman joined us in a very successful trip to Aladdin's Cave with nine 8-gallon tins of benzene on a sledge; weighing in all seven hundred pounds.

After having such a good series of results with the machine, the start of the real journey was fixed for December 3. At 3 P.M. it fell calm, and we left at 4 P.M., amid an inspiring demonstration of goodwill from the six other men. Arms were still waving violently as we crept noisily over the brow of the hill and the Hut disappeared from sight.

On the two steepest portions it was necessary to walk, but, these past, the machine went well with a load of three men and four hundred pounds, reaching Aladdin's Cave in an hour by a route free of small crevasses, which I had discovered on the previous day. Here we loaded up with three 100-lb. food-bags, twelve gallons of oil (one hundred and thirty pounds), and seven hundred pounds of benzene. Altogether, there was enough fuel and lubricating oil to run the engine at full speed for twenty hours as well as full rations for three men for six weeks.

After a few minutes spent in disposing the loads, our procession of machine, four sledges (in tow) and three men moved off. The going was slow, too slow--about three miles an hour on ice. This would probably mean no movement at all on snow which might soon be expected. But something was wrong. The cylinder which had been missing fire a few days before, but which had since been cleaned and put in order, was now missing fire again, and the speed, proportionately, had dropped too much.

I made sure that the oil was circulating, and cleaned the sparking-plug, but the trouble was not remedied. A careful examination showed no sufficient cause, so it was assumed to be internal. To undertake anything big was out of the question, so we dropped thirty-two gallons of benzene and a spare propeller. Another mile went by and we came to snow, where forty gallons of benzene, twelve gallons of oil and a sledge were abandoned. The speed was now six miles an hour and we did two miles in very bad form. As it was now 11 P.M. and the wind was beginning to rise, we camped, feeling none too pleased with the first day's results.

While in the sleeping-bag I tried to think out some rapid way of discovering what was wrong with the engine. The only conclusion to which I could come was that it would be best to proceed to the cave at eleven and three-quarter miles--Cathedral Grotto--and there remove the faulty cylinder, if the weather seemed likely to be favourable; if it did not, to go on independently with our man-hauled sledge.

On December 4 the wind was still blowing about twenty miles per hour when we set to work on the machine. I poured some oil straight into the crank-case to make sure that

there was sufficient, and we also tested and improved the ignition. At four o'clock the wind dropped, and in an hour the engine was started. While moving along, the idle cylinder was ejecting oil, and this, together with the fact that it had no compression, made me hope that broken piston-rings were the source of the trouble. It would only take two hours to remove three cylinders, take one ring from each of the two sound ones for the faulty one, and all might yet be well!

These thoughts were brought to a sudden close by the engine, without any warning, pulling up with such a jerk that the propeller was smashed. On moving the latter, something fell into the oil in the crank-case and fizzled, while the propeller could only be swung through an angle of about 30°. We did not wait to examine any further, but fixed up the man-hauling sledge, which had so far been carried by the air-tractor sledge, and cached all except absolute necessities.

We were sorry to leave the machine, though we had never dared to expect a great deal from it in the face of the unsuitable conditions found to prevail in Adelie Land. However, the present situation was disappointing.

Having stuffed up the exhaust-pipes to keep out the drift, we turned our backs to the aero-sledge and made for the eleven-and-three-quarter-mile cave, arriving there at 8 P.M. There was a cheering note from Bage in the "Grotto", wishing us good luck."

The Western Party then went on a two month sledging trip, and on their return saw the air tractor again:

"After continuing for about a mile Hodgeman told us to stop, flung down his harness and dashed back to the sledge, rummaging in the instrument-box till he found the glasses. "Yes, it's the aeroplane", he said. This remark took us by surprise as we had not expected it for eight miles at least. It was about midnight--the time when mirage was at a maximum. Consequently, all agreed that the machine was about twelve miles away, and we went on our way rejoicing, steering towards the Cathedral Grotto which was two miles south of the aero-sledge. After three miles we camped, and, it being my birthday, the two events were celebrated by "blowing in" the whisky belonging to the medical outfit.

On the 16th the weather was thick, and we marched east for ten miles, passing a tea-leaf, which it was afterwards found must have come downwind from the Grotto. For eight hours nothing could be done in thick drift, and then, on breaking camp, we actually came to a flag which had been planted by Ninnis in the spring, thirteen miles south-east of Aladdin's Cave. The distance to the air-tractor had been over-estimated, and the Grotto must have been passed quite close.

We made off down the hill, running over the crevasses at a great pace. Aladdin's Cave with its medley of boxes, tins, picks and shovels, gladdened our eyes at 10 P.M. on the 17th. Conspicuous for its colour was an orange, stuck on a pick, which told us at once that the Ship was in."

The frame was recovered in Jan 1913

by Capt. Davis of the Aurora:

“When Dr. Mawson's party was a week overdue, I considered that the time had arrived to issue a provisional notice to the members of the Expedition at Commonwealth Bay concerning the establishment of a relief party to operate from the Main Base. A party of four left the Hut on the 20th (20 January 1913), keeping a sharp look-out to the south-east for any signs of the missing party. They travelled as far as the air-tractor sledge which had been abandoned ten miles to the south, bringing it back to the Hut.”

Was the Air Tractor Vickers No1 or Vickers No2?

There has been some discussion about the designation of the air tractor – whether it was the first or second Vickers plane. In fact it was originally No2, but was promoted to No1.²

“...A.R. Low [the designer of the Vickers-R.E.P No.1 Monoplane] was phoned by Bertie Wood, who asked him to go to Brooklands to watch test flights being conducted by Robert Fenwick and Lieut. H.E. Watkins acting on behalf of Dr. Douglas Mawson, to whom Captain Wood had sold the next Vickers-R.E.P. for the following year's Australian Antarctic Expedition. Fenwick took off with an abnormally sharp climb, turned sharply at the end of the aerodrome, stalled, and spun half a turn in the ground. Vickers had quickly acquired their first repair job.....”

Herbert Wood did not let it be generally known that the first machine had crashed. No.2 was quickly substituted and redesignated No.1, and then sent to Australia for Mawson. In short Mawson ordered the No.2 but owing to the crash of the real No.1, the second aircraft was renamed as the No.1.

References

Further references to Mawsons plane can be found in:

Moments of Terror: The Story of Antarctic Aviation:David Burke, NSW University Press (1993)

² Harald Penrose “British aviation - the pioneer years” - p.308

THE SEARCH FOR THE AIR TRACTOR AT CAPE DENISON

The air tractor had been abandoned on the shores of Boat Harbour when the Mawson Expedition finally left in 1913. By this time the engine had seized, and the tractor idea had been abandoned. The engine, propellor and associated useful items were removed and returned to Australia, and the frame was left on the ice. A third seat had been added, and this was found and catalogued by Anne McConnell in 2008 on the other side of the harbour (see photo by Dr Tony Stewart in 2008 report). It was cut from the frame sometime before leaving, and tells us nothing about the position of the frame.



Figure 3: *Bickerton with the air tractor. Note third custom-built seat which was cut from the frame, and recently found at Cape Denison among the rocks across the harbour. The frame is at least 2.5m tall.*



Remains of air tractor seat found and catalogued in 2008 by Anne McConnell. The seat was found on the northeastern edge of Boat Harbour about 200m from the frame. Note the remnant of canvas on the back of the wooden platform. (Photo David London).

Mawson did finally get into the air in Antarctica in 1929-1931.

Mawson made to the Antarctic coast aboard the Discovery during 1929-1931 (the two BANZARE voyages), and visited Cape Denison for an overnight stay. He took two pilots Eric Douglas³ and Stuart Campbell, both of whom took pictures of the area, and of the Air Tractor frame, which were used in this report.

Eric Douglas comments in his diary:

“Flying was carried out only on fine days, generally the first fine day after a blizzard. Sea conditions generally ideal, sometimes slight ocean swell on, which made it difficult getting off. Air conditions perfect, practically no bumps, although some were felt when flying over the Antarctic coast. Engine ran splendid, developed full power and oil pressure remained steady (38 to 40 lbs/sqin). Machine controls gave no trouble and the machine behaved quite normal in the air ie stalling and climbing speeds. Lowest air temperature experienced was 15 F at 4200 ft. With the usual winter flying clothes on and good woollen underwear the low temperature was hardly noticeable.

Of course our flights were of short duration, generally about one hour, and it was midsummer.”

“The engine would start up when doped with a mixture of 2/3 petrol and 1/3 ether. But generally it was heated with warm air (conveyed through canvas flue from the boiler room) for about an hour previous to starting up. Temperature of engine raised to 45 F. Starting then quite easy and doping not necessary. (Crank case in air vent covered up. Oil pipes lagged with asbestos)”



Figure 4: Mawson finally takes to the air in Antarctica in a Gypsy Moth (RAAF) VH-UDL on the BANZARE voyages with Eric Douglas and Stuart Campbell as pilots.

Four images from the 1931 visit showing the Air Tractor Frame

The following two pages show the valley at Boat Harbour with the air tractor in 1931. The pictures are all from the collection of Sally Douglas, Eric Douglas’ daughter. They clearly show the position of the frame and the level of the ice at the time of the visit.

³ Sally Douglas, daughter of Eric, has kindly given permission for some photographs from her collection to appear in this report, along with an extract from Eric’s diary.



Figure 5 Pictures of Mawsons Huts and valley 1931 by Eric Douglas from South (top) and North (bottom). The Ar Tractor frame can be seen near the harbour in the top image, and as a small dot under the right edge of the double rock outcrop to the right of mid-photo of the bottom one. (Photos from Sally Douglas collection)



Figure 6 Pictures of Mawsons Huts and valley 1931 by Eric Douglas from East (top) and West (bottom). The Air Tractor can be seen just above the front of the hut in the top image, and in line with the transit hut in the bottom image. (Photos from Sally Douglas collection).

After 1931

The French visited Cape Denison from around 1959 onwards as they established their presence at Port Matin, and Dumont D'Urville. It is not recorded (at least in Australian archives) exactly what they did when at Cape Denison, but clearly they did not move the frame.

The next Australian contact was in 1976 when AAD photographer Bob Reeves visited, and took the last photograph we have of the frame nearly buried in the ice (see below). Geologist Neil Young visited the following year with Dick Lightfoot and made a comment in a fax sent on 26th February 1977, from the Thala Dan. They had visited Cape Denison by helicopter from Dumont D'Urville, for approximately 5 hours. In the telex Young states "Aircraft parts as photographed last visit have now been carried to sea by movement of ice in this area, have recovered one aircraft wheel and what is possibly ice control skid for RTA and restoration." Both of these items are now in the AAD library at Kingston. It is possible that the ice control skid is actually the rudder from a boat which was wrecked later in Boat Harbour.⁴

The Oceanic Research Foundation under Dr David Lewis visited Cape Denison in summer 1981. Both the engineer, Dr Don Richards, and the cameraman Mal Hamilton, are certain there was no air tractor visible, and the photo at the end of this report supports their statements (figure 38).

Bob Reeves visited Cape Denison again in 1987, and remembers⁵ that the ice level was higher up the rock outcrops. He was interested in the frame and looked around to see if he could see any sign of it, but could not.

A number of other visits have taken place over the years, but (so far) the last documented sighting of the frame is in 1976. Which begs the question of where it is now. The frame was a large steel object (at least 6 x 2 x 2 m), and it would only have come out of the ice if it had melted, or the ice moved. The ice is not glacial at the edge of Boat Harbour, and does not appear to move, so it seems unlikely that ice carried the frame away.

The assumption on which this report is based:

The current search is based on the assumption that the frame is unlikely to have shifted far from its position in 1913. The reasoning behind this assumption forms the rest of the report.

⁴ Personal communication, Andie Smithies, AAD Librarian

⁵ Bob Reeves, personal communication

THIS REPORT details the process of conducting the search for the frame of the Air Tractor during the 2008-9 expedition. Ground Penetrating Radar (GPR) was used to visualise objects up to 5m below the surface of the ice. Patterns in the scan maps which were thought to represent the air frame turned out to be layers of hard ice, and the frame was not found despite a trench being dug in the ‘right’ spot to nearly 3m.

Details of the operation of Ground Penetrating Radar (GPR) are in a separate section for those who wish to know the technicalities. However, essentially it is a way of forming a picture of the ‘shape’ of the ice (rather like an echo sounder on a boat) at different depths. If an object is present, and big enough, it will show up. One of the problems with using GPR to for this sort of search however is that it will show up any discontinuity – including a change to a layer of hard ice. These discontinuities can look very like a buried object.

However, the fact that the frame was not found leads on to an examination of why it wasn’t. Using evidence from photographs of the landscape, and from weather data, a current position can be deduced. This should form the basis for another search next year, perhaps using different equipment.

FINDING WHERE THE AIR TRACTOR HAD BEEN FOR 64 YEARS

The first search, including digging a trench, did not find anything. I decided to start from scratch with the pictures of the frame given to me by Dr Tony Stewart, and derive a new position for the frame.

This section details the way in which the pictures were used to derive a precise position for the frame. This position is absolutely crucial to everything that follows, since the searches and the hypotheses about the frames present position depend on knowing where it was when it was last seen. The images in the text should be large enough to allow anyone else to check the reasoning, and to find the position again.

Note that none of this uses GPS coordinates to specify a position. GPS is notoriously inaccurate at pinpointing objects, despite what the makers say. Using differential GPS certainly helps, but it was not convenient to set up a DGPS system. Land based reference points are always accurate and are likely to last a long time.

Estimating the position of the air tractor from transits.

In order to accurately estimate the position of the air tractor, comparison was made between photographs from 3 sources (all supplied by Dr Tony Lawler prior to the trip to Cape Denison). These are pictures from 1912, pictures from the 1931 visit by Mawson and S Campbell and the 1976 visit by Bob Reeves.

Careful study of the pictures enabled three transits to be developed as shown on the Google Earth picture below:

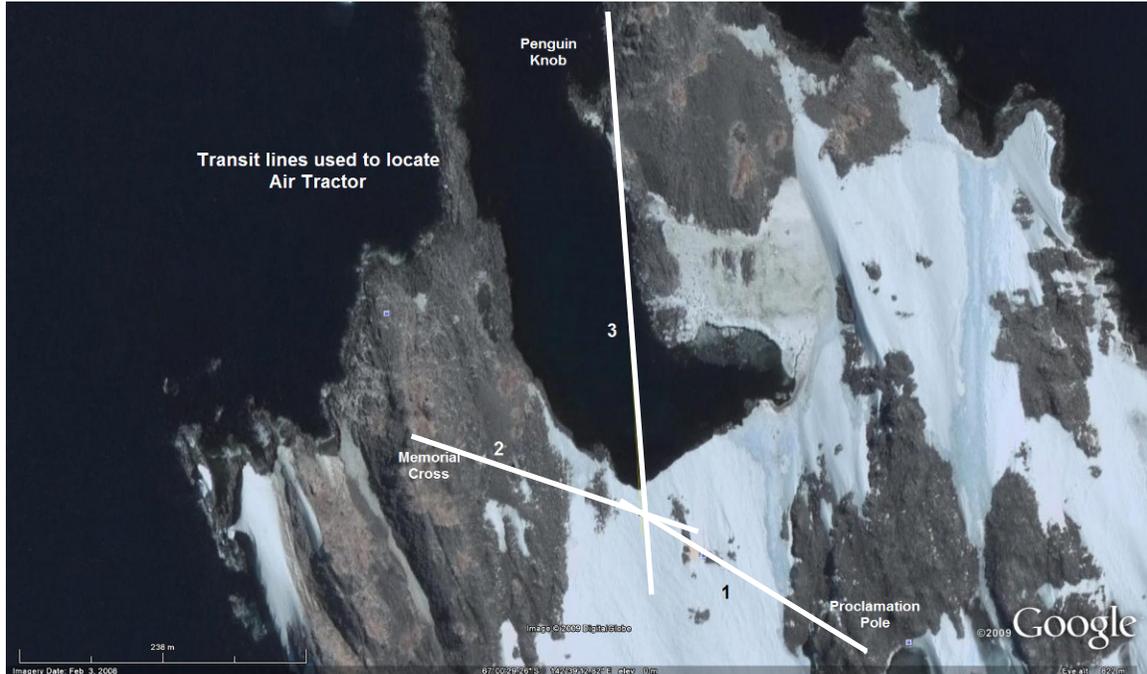


Figure 7 : *Google earth picture of Cape Denison showing the three transit lines (white)) derived from a study of images from 1931 and 1976. The lines were used to pinpoint the position of the air tractor frame.*

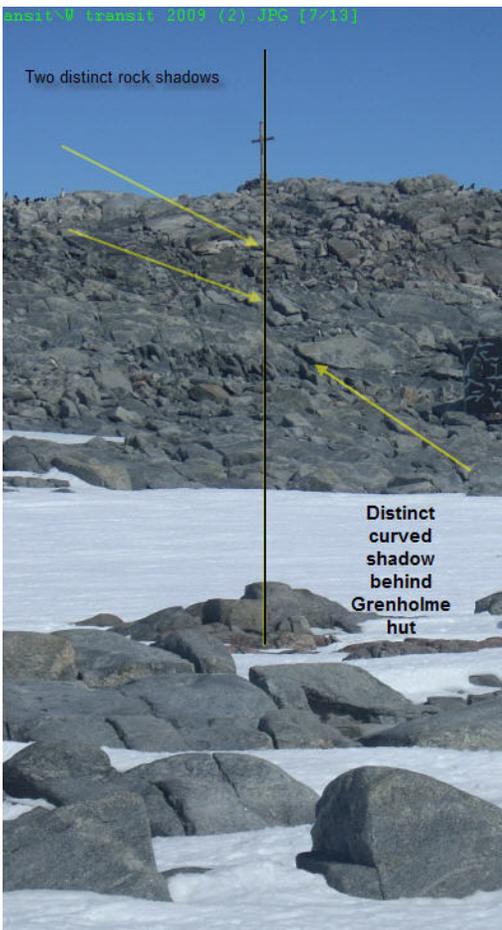
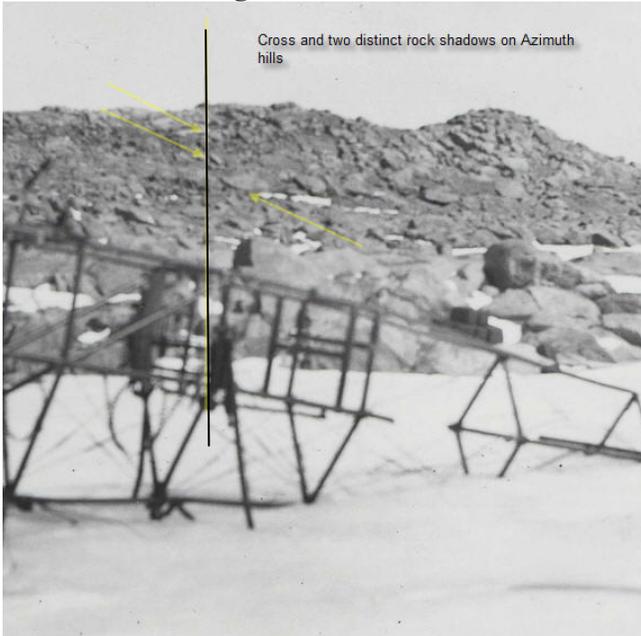
The three transits were tested on the ground and found to be very sensitive to translation, well separated from each other, and readily identifiable. They were therefore considered to be reliable indicators of the position of the air tractor frame. Given that it was known (see appropriate section below) that the ice did not move in the area (ie it is not glacial ice) then the position was accepted with confidence. This position is vital to all search efforts. A description of the three transits follows:

1) transit looking East



This transit is derived from the 1976 picture by Bob Reeves. It shows the frame about 500 mm out of the ice, and the transit points are the Proclamation Pole on the hill, and the NW corner post of the small porch on the workshop of Mawsons Hut.

2) transit looking West

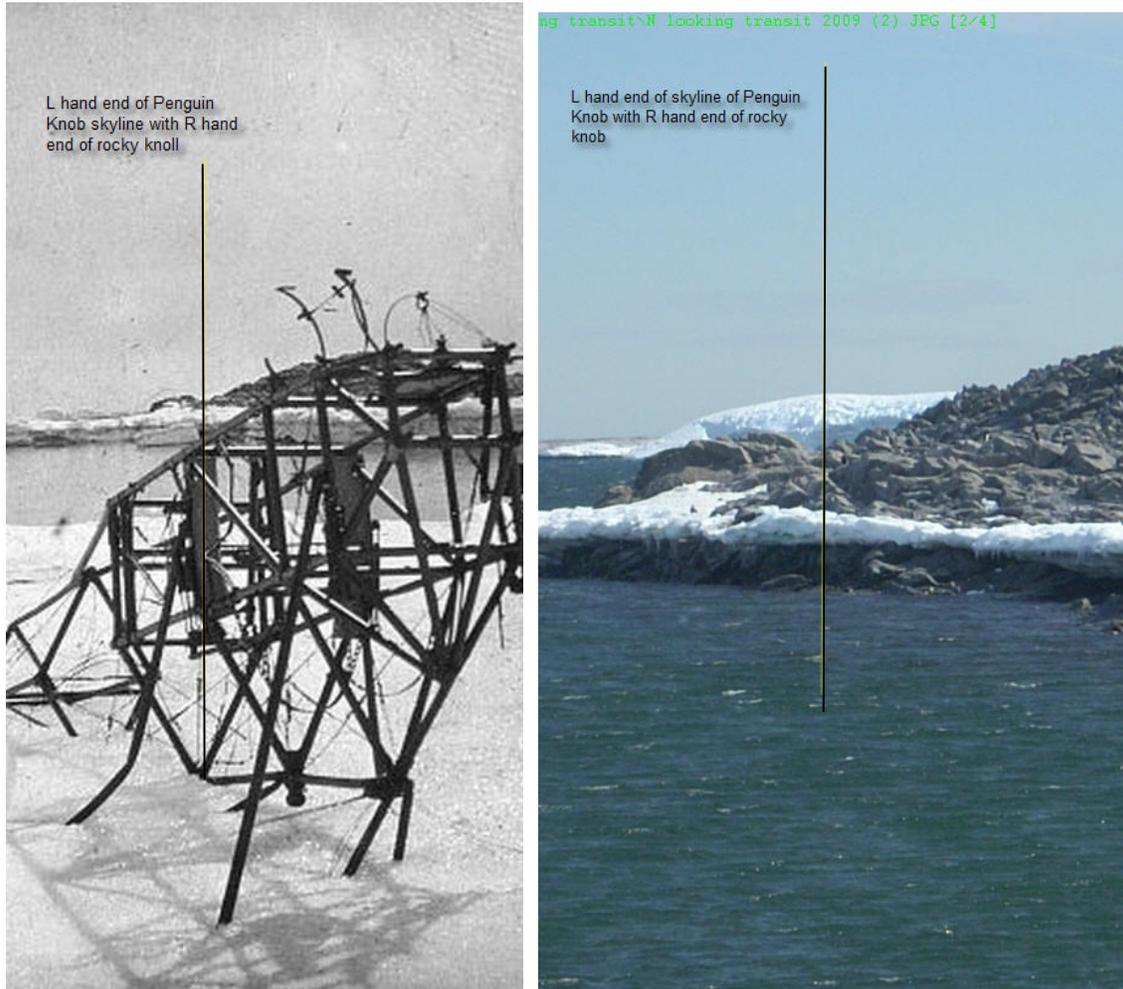


This picture is taken from the 1931 expedition by S Campbell. The rock shadows provide the transit in conjunction with the Memorial Cross – it is necessary to see the rock face in sunshine at about 1pm to match the original photo.

The transit points are the Memorial Cross, and two distinct rock shadows on the hillside. The curved shadow behind Granholme hut provides a good orienting feature.

The triangular rock at the bottom right of the picture is an obvious feature which appears on other photographs, and proves useful to orient the view.

3) transit looking North



This picture is from 1931. The rocky knob is about 100m in front of Penguin knob, and the transit line is quite easy to see, though it looks hard in the picture.

Using these three transit lines, it was possible to find a place on the ice where the frame used to lie. In practice it was relatively easy to find the spot, providing the shadows on Memorial Hill are right direction, which means waiting till about 1pm. The transits also prove to be sensitive to movement – it only took movement of half a metre or so in any direction to affect the transit lines.

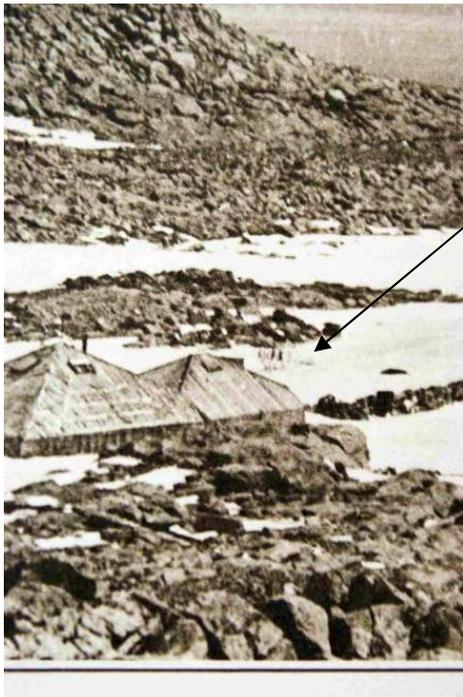
Establishing whether the ice under the plane moves

The next step in the search was to decide whether the ice moves in the area. The glacier is about 500m up the hill, and the ice on either side of the Cape Denison area is constantly moving. However, it was shown from the photographs that the plane did not move in at least 45 years.

Obviously it is vital to know if the plane is buried in *glacial* ice, in which case it would be expected to move slowly toward the sea. From pictures taken in 1912, 1931 and 1976 it is clear that this is not the case:



Figure 8: the airframe in 1912 This photograph is taken from a few metres north of the place in the 1976 image below. Moving the camera into the 1976 position would give exactly the same transit as the 1976 picture. The frame is already partly buried in the ice. [Note that the third seat has been cut from the frame, which establishes that its 2008 discovery on rocks across the harbour is not related to the position of the tractor.]



(1931)



(1976)

Figure 9: taken from 1931 and from 1976 – the photographs are taken from points almost exactly opposite each other (the air tractor frame in 1931 is shown by an arrow). No movement of the frame is seen in 45 years, supporting the proposition that the ice is not glacial in this area. Comparing the 1976 picture with the 1912 picture in figure 6 shows there has been no movement in 64 years.

Capacity of the Ground Penetrating Radar to sense the plane:

Ground Penetrating Radar is particularly sensitive to metal objects. Two aerials were used - 250Mhz and 500Mhz. These have an effective depth of about 4m and 5m in ice, and a resolution of 45 cm and 25cm respectively. A thin rod sideways to the aerial would not be seen, but lengthways it would. The air tractor frame is made of steel tube about 40mm x 1.5mm. Individual tubes would be too small to be seen when crossing the beam, but the whole frame is made of tubes and metal straps oriented in many different directions. It is 6m long, and it is unlikely that either aerial would miss the aggregate mass of metal.

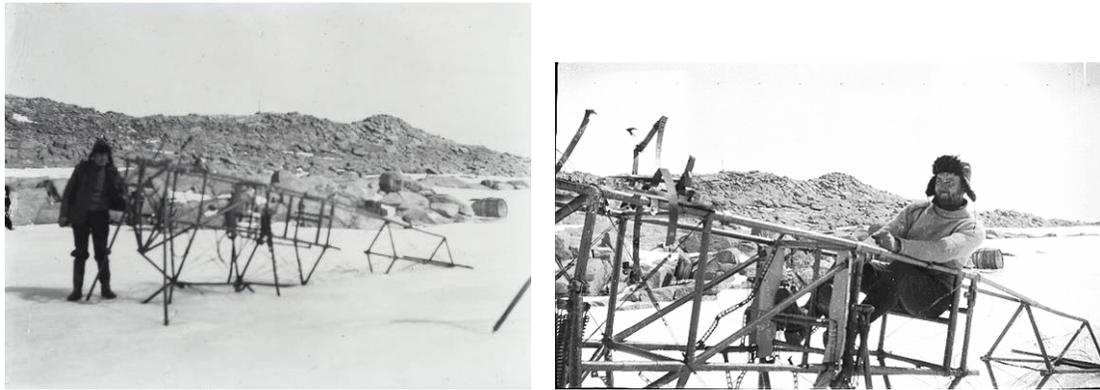


Figure 10: from BANZARE 1931: indication of the amount of metal in the airframe. Pilot Eric Douglas is seen sitting in the frame in the right hand picture, on the left an unknown man (possibly Frank Hurley) gives scale to the frame. (Photo Sally Douglas collection)

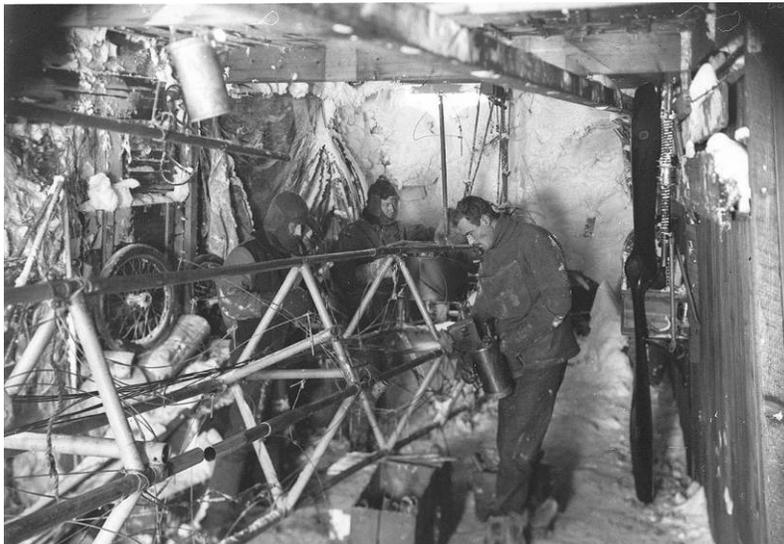


Figure 11: the amount of metal in the frame should make it visible to radar using either the 250Mhz or 500Mhz aerial. The lower picture shows Bickerton at work on the frame in the 'aircraft hangar' on the west side of the main room of the hut.

Is the air frame likely to be on rock?

One of the theories about the air frame was that it had sunk down to the rock, and was stuck there, sitting just below the surface. This was tested by comparing photographs taken when there was a big melt which exposed the subsurface features in the valley. In 2002 Dr Ian Godfrey, Expedition Leader, took a number of pictures of the landscape, some of which are used here. He did not see any sign of the air tractor in 2002.

After the position of the frame had been found from the transit lines we knew where the frame had been (at least up to 1976). We could then place an object of similar size (a quad bike and trailer) at the spot, and, comparing the pictures, effectively locate it back to the melt of 2002 to see if the frame was on or near rock.

Photographs were taken from the same place, using the same lens, and matching the images. This wasn't nearly so easy as it sounds, and I would like to acknowledge David London, photographer, who provided his expert assistance in this part of the project.

At the end of this exercise it was clear that the air tractor frame had been sitting close to a melt creek, and that it was in an area of ice – not rock. We now knew three things:

- 1) that it was not visible in 2002,
- 2) the height of the frame was at least 2.5m,
- 3) the depth of ice in 2002 was lower than present day by about 1m.

Dark objects warm up on the ice surface, and sink remarkably fast – we were constantly digging out our equipment, especially after warm days. Therefore the frame, if it were present, would have sunk to at least 1m below the present day surface level. A rough estimate of the rate at which it was sinking was hard to make – careful analysis of the photographs showed it had not sunk much in the 19 years between 1913 and 1931, but it had clearly sunk faster in the next 45 years. A rough estimate was 40mm per year from 1931 to 1976 when it was last seen. At that rate it should be a further 1m lower by the time we searched for it in 2009, which would put the top of it about 500 mm below the surface.

And as it turned out an object looking very like the air tractor frame was found 2.5m down on the radar scan, but there was nothing near the surface.

The air frame and the melt creek

One prominent feature of the 2002 photographs, and noted by Ian Godfrey, was that in 2002 the ice melted. He said there was 'water everywhere', with a large running creek down the middle of the valley, and exposed rock and artifacts everywhere. The size of the creek, and the position of the frame, are very significant in a later discussion of its present position.

The following images show the melt of 2002 compared with 2008, and the ice level from 1931.



2002 from SE of the hut, showing Boat Harbour (Photo:Ian Godfrey)



Figure 12: *Extensive exposed rock is seen in 2002 (top). The air tractor frame position is represented by the quad bike and trailer seen in the lower image above the hut roof (arrowed). It can be seen that the frame would have been close to the edge of the harbour in a melt. (Photo:David London).*



(Photo:Ian Godfrey)



Figure 13: Facing Memorial Hill. The depth of snow cover was estimated by measuring the prominent rock in the middle of the picture, and is about 1m higher in 2008 (lower picture). The quad bike and cart represent the place where the air tractor was estimated to have been. (Photo:David London).



(Photo:Ian Godfrey)

Figure 14: Facing S across Boat Harbour. The air tractor position is arrowed and can be seen to sit almost over the 2002 glacial melt stream. Note exposed rocks in upper picture (2002). Compare the level of snow 2002 with 2008 (bottom). (Photo:David London).

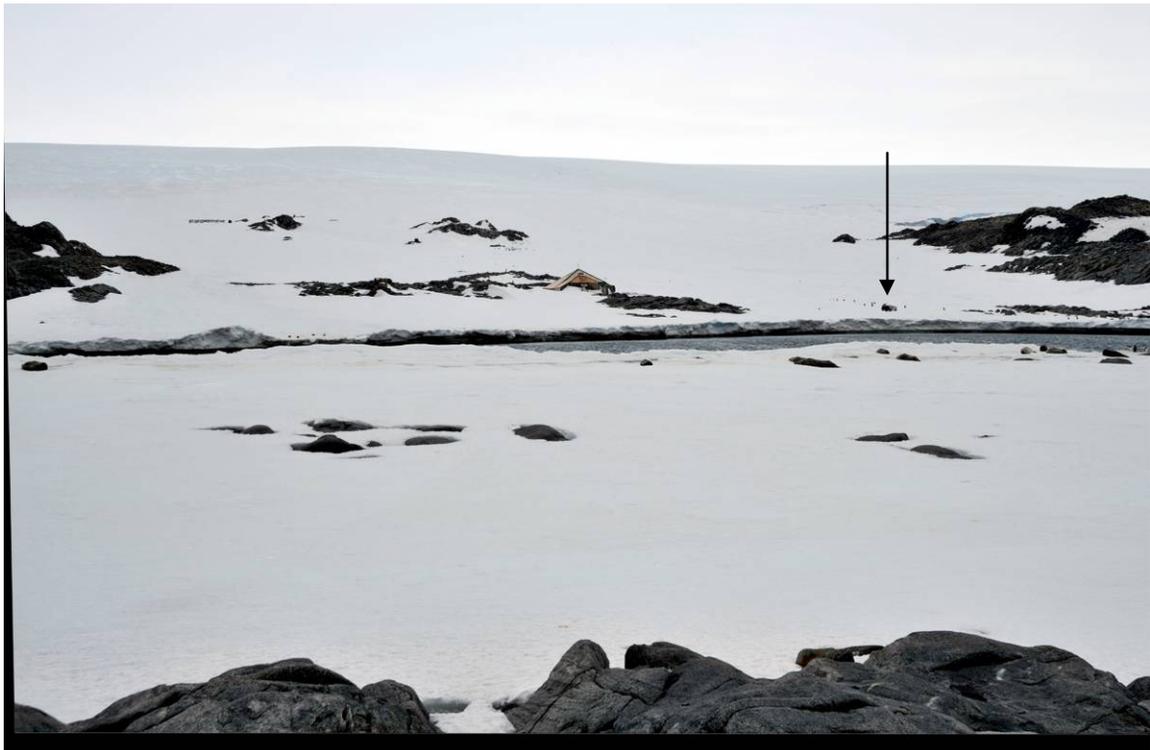




Figure 15: *If the air tractor had sunk in the ice, and was still there, where would it be? This is a general view of the bay seen facing N from the hill behind the huts. The images are from 3 different years. The air tractor is seen in the upper picture (1931) and the quad bike (arrow) in the lower one (2009). The middle picture is from 2002. The ice level in 2002 is about the same as in 1931, and about 1m lower than 2009. The frame is about 2.5m high.*



A magnified image of the air tractor in the top picture shows that it had already sunk about 1m down in the ice by 1931. By 2002 it was not visible. Therefore the top of the frame would be at least 1m below the 2009 surface, and the bottom about 3.5m below it.

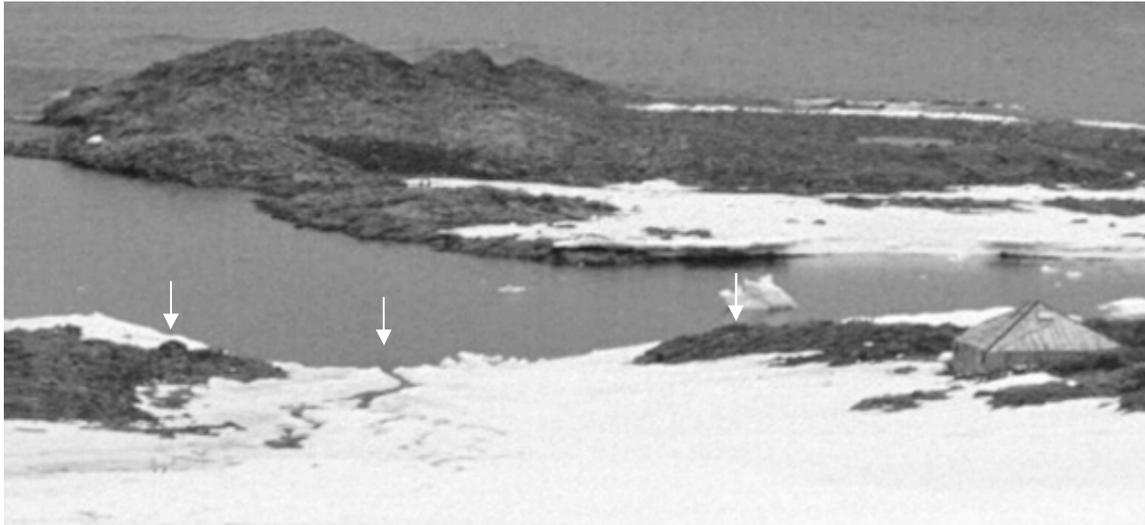
We found a radar anomaly at 2.5m, and dug down to the sea level at 2.7m but found no frame.



(Photos: Eric Douglas 1931, Ian Godfrey 2002, David London 2009)

The air tractor frame and the melt stream

The position of the air tractor relative to the melt stream is important, as will be seen later, in making an estimate of its present position. It is likely that the ice melted around the frame sometime after 1976. If the frame was sitting more or less in what would have been a substantial watercourse, and this in turn fed into a channel in the rocks, then it is probable that it was washed, or fell, into the channel – where it remains now.



This is a picture of the important area from the 2002 image (above) showing the melt stream. Note the prominent rocks on either side of the stream (all arrowed) which are used to determine the position of the frame using the 1931 picture below. The frame was in the melt stream, suggesting that a larger melt creek would have directly affected the frame. (Photo:Ian Godfrey)

Three pictures, all taken from the hill toward the South allow a precise placement of the air tractor. A picture taken in 1931 by Eric Douglas of the frame and the harbour (below) is compared with Ian Godfrey's 2002 picture of the snowmelt (above), and this year's picture of the transit-line cross (below). The exact place from which the pictures were taken varies, as does the focal length of the camera lens so it is not possible to directly superimpose the images as has been done above. However, prominent rocks can be identified in all three pictures. These rocks are in line with the Air Tractor, and thus at the same focal distance from the lens. These points can therefore be used to define a proportional scale which is used to compare the images, and thus to place the tractor relative to the stream.



Figure 16 *This picture from 1931 clearly shows the air tractor near the edge of Boat Harbour (photo Sally Douglas collection)*



Figure 17 *Picture taken this year showing level of ice, identifiable rocks in the same focal plane, and the air tractor position represented by the quad bike.*