Jan 26, 2010

Summary of 2010 Antarctic activities

Honeybee activities

As already summarized by Honeybee, all of their activities were very successful. This included:

- Drilling to 50cm by the Crary Lab, while also demonstrating remote operations by having the drill be commanded by 5th graders in California. Both the technical aspects – first drilling in Antarctica and remote drilling – as well as the educational component were highly successful.
- Drilling to 1m depth in the permafrost at Cape Armitage/back side of Observation Hill (77°S 51.030', 166°E 42.357'). The drilling was to 1m, in 10cm intervals, and samples were collected from each interval. Both the drilling and the passive sampling worked very well. Transporting, deploying the drill, drilling, and packing up took about 8hrs.
- Drilling to 1m depth twice through the dry- and ice-cemented-permafrost at University Valley. This was done with the operator not seeing the drill and all of his information on the operations coming from drill telemetry.
- Drilling to 2.6m in ice at University Valley (buried glacier; 77°S 51.950', 166°E 43.418'). Samples were collected.

For all of this drilling, the power generally did not exceed 100W, and melting of the subsurface only occurred in the (warmer) McMurdo area permafrost (most of this melting was likely due to a not perfectly straight auger, which then caused higher friction along the wall, rather than the actual drill process; the temperature at the drill bit did not exceed freezing.)

For more information, see the Honeybee summary by Kris Zacny.

Further work:

- Test ability of drill to go through dolorite.
- See if material type, etc., can be well determined from drill power, rate, etc.
- Analyze collected samples for grain size, with SOLID, and any other Mars-relevant instruments.

OSL sampling

Multiple samples for OSL dating were collected at Pearse Valley, University Valley, and some of the valleys neighbouring University. These are as follows:

- Pearse Valley:
    - Transect down the valley – 4 points. Samples every 10cm down to 30 cm. Site 1 - S77°43'12.5'' E161°35'34.8''; Site 2 - S77°43'07.4'' E161°35'11.4''; Site 3 - S77°43'04.6'' E161°35'31.7''; Site 4 - S77°43'04.9'' E161°35'39.3''
    - Soil samples collected with falcon tubes in a lateral moraine down to the ice table. The site is several meters from where Denis and Alfonso collected a core of ground ice in 2009. This will give a profile down to c.a. 2 meters for dating. The core is in the walk in freezer at Ames (S77°42'15.9'' / E161°35'04.9'')
- University Valley: (note that depths are thoroughly recorded on the cores, but the descriptions below may have numbers which are a bit off)
    - ~50cm core at the shallow ice site (77S 51.992', 160E 44.008', 1734m)
    - ~30cm at medium ice site (77S 51.892', 160E 42.960', 1710m); falcon tube samples were collected from the dry permafrost overlying the core. Depth to ice was 26cm.
    - ~15cm core from deep ice site (77S 51.701', 160E 42.492', 1679m); falcon tubes collected from overlying material. Depth to ice was 40cm.
- Valley North of University Valley: falcon tube samples. 77S 51.145', 160E 44.333'. Estimated depth to ground ice (this is from memory and not recorded) is 30cm.
- Farnell Valley: I *think* there are also samples collected from Farnell Valley, at 77S 53.028', 160E 41.027', 1672m; depth to ice-cemented ground ~40cm.

The Falcon tubes used were taped with electrical tape. All efforts were made to pack them in fully so that the soil would not move during transport (and the up direction was indicated), but I am really not sure that this was successful in a lot of cases. Where the up direction is not indicated, this is because during collection it was apparent that significant soil movement was occurring.

For the cores, the outsides were exposed to some light as they were pulled out of the corer. Efforts were made to keep them from direct sunlight. The cores were bagged (whirl packs) and placed in a thick garbage back or backpack generally with 5min of collection.

In collecting the surface samples to show that the material is reset before burial, rock samples were also included. This is because rocks are often buried and they disintegrate with time as they stay underground. A core can easily be taken through one of these post-burial decomposed rocks without this being apparent. Because of this, it might be interesting to check how much of these rocks are reset/what their apparent ages are.

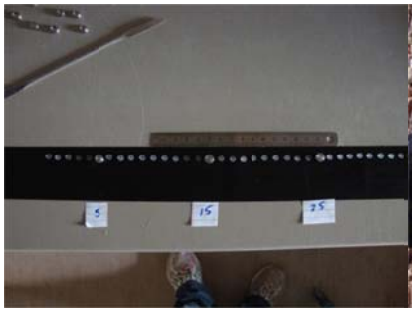
Dosimetry

Samples for biology (i.e., aseptic collection) were collected at multiple sites; this includes the shallow, medium, and deep ice at University, and from the valley north of University Valley. For samples with "aseptic" written on them, these were collected with a scupula that were sterilized with alcohol swabs before collection. For samples labeled "~aseptic", these were collected either with the bag itself or with some other object that had a sterile inside; i.e., these samples were effectively aseptically collected, but there is a very minor chance that there was some contamination.

A string with dosimeters was deployed in the shallow ice site down to about 70cm depth. See pictures that follow. The uncovered silicon wafers were set every 1cm, and the gamma-measuring ones (i.e., in the steel containers) were very 10cm. A rock was tied at the bottom of the string to try and keep it straight. Note that this is the whole from the core that was sent to Denis (same location as all shallow ice cores and samples). The hole had filled in with snow between drilling it and deploying the dosimeters. As much snow as possible was removed from the hole (i.e., an arm's length). A piece of plastic and multiple rocks were placed over the hole after deployment of the sensors: these will hopefully keep it from getting filled with snow again.

The second string of dosimeters could not be deployed near the camp, as the hole drilled by the IceBite drill had filled in during the intervening time.

The dosimeters were baked at 230C for ~45min. They were over 200C for closer to 1.5hrs. They were not exposed to UV between baking them and packing them. The second string which could not be deployed will be sent back to Ginni – hopefully this will provide info if the tape used cuts down significantly on the beta or gamma radiation.



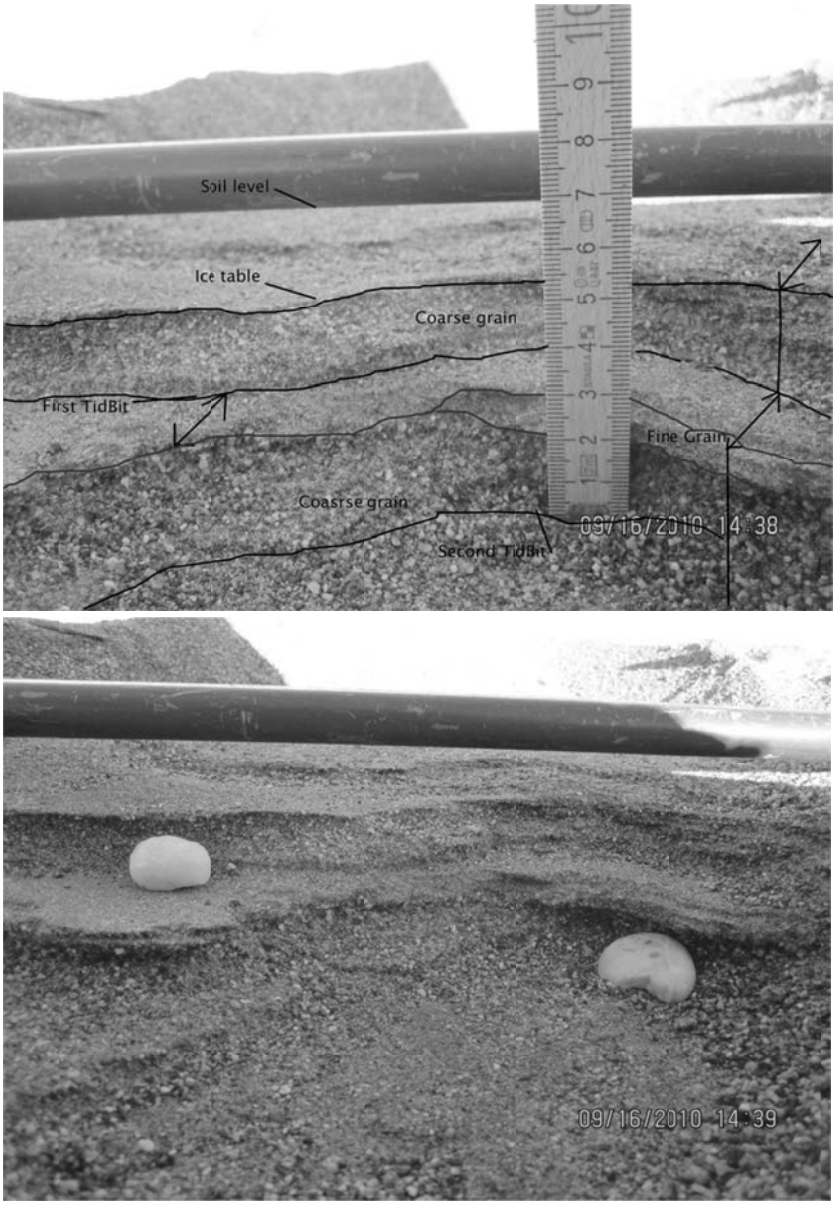
Pearse Valley snow packs

Sensors at 2 Ponds site:

Recovered sensors and data. LED pieces of TidBit sensor closest to the surface broke. Data from this sensor was not downloaded, but sensor was retrieved. Data will be downloaded by Onset (logger sent in) No snow found at the site. The soil profile was as follows:

- 0-2 cm. Loose, dry sand. Likely windblown. Ice table at 2 cm

- 2-4 cm. Layer of ice-cemented soil. Coarse sand all the way through. 1st TidBit was recovered at the base of that layer
- 4-7 cm. Layer of ice-cemented soil. That layer is different from the above. 1st cm of the layer is fine grain. Next 2 cm are coarse grain. 2nd TidBit recovered at the base of that layer. Below that layer is more ice-cemented soil.



The small rocks represent the position of the TidBits.

Re-deployment of buried snow sensors:

Sensors re-deployed to gully site on October 18th 2010, where a 20 cm thick layer of buried snow was observed. Snow was covered by a thin (2-3 cm) layer of dry soil. Sensor distribution as follows:

4-channel HOBO:

- 2 hour interval / Logger Serial #: 1122967
- Channel 1@ 20 cm depth. Base of thick snow layer (T)
- Channel 2@ 15 cm depth. Inside thick snow layer (T)
- Channel 3@ 10 cm depth. Inside thick snow layer (T)
- Channel 4@ 5 cm depth. Base of layered snow (ECHO)

TidBits:

- 1 hour interval
- TidBit 1 @ 5 cm depth. Base of layered snow (T)
- TidBit 2 @ 1 cm surface cm depth. Base of soil layer (T)

HOBO Pro (RH and T).

- 1 hour interval
- 10 cm above surface
- S/N 2429435

Data was downloaded on November 8th after the buried snow had disappeared.

Climate instrumentation: Weather Stations and Hobos

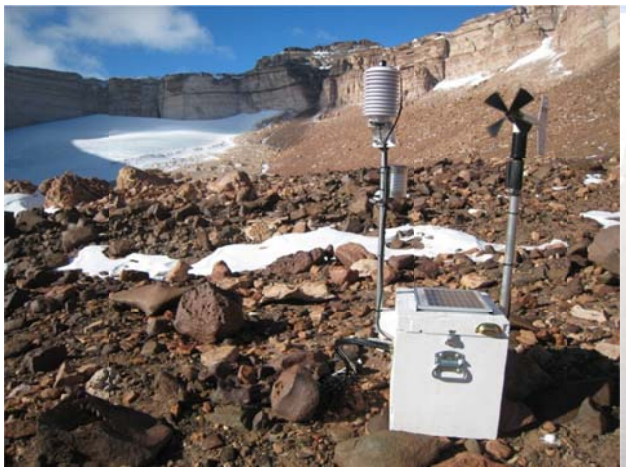
University Valley:

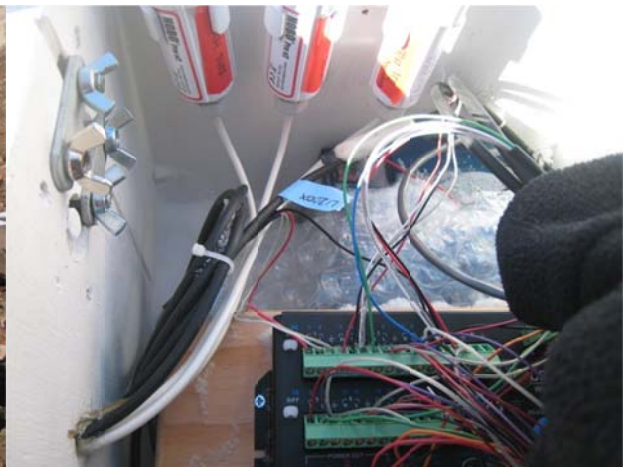
- The main weather station at University Valley was downloaded. We now have a complete data set for Dec 11, 2009 to Dec 8, 2010; we also have air data (T/RH/wind/light) starting Dec 3 2009, making for a total of 368 days of data. All the data looks good. Some difficulties were encountered in downloading the data because of recurring disconnects between the computer and the Campbell; these were attributed to the computer getting too cold. With multiple re-connects, all the data was downloaded.

  Some basic stats of the weather data are (min, max, mean):

  - Air T: -45.5°C, -2.9°C, -24.3°C
  - Surface T: -47.8°C, 8.3°C, -25.8°C
  - Deepest T (~45cm): -36.6°C, -11.1°C, -25.0°C
  - Wind speed: 0 m/s, 14.6 m/s, 2.8 m/s (14.6 m/s = 52.6 km/h)
  - Battery Voltage: 12.2 V, 14.5 V, 13.0 V
- The weather station box was found with a significant amount of snow in it; this included snow on the terminals where the sensors are connected. There are no unexpected/shorted values in the data, and so it seems that the snow did not have much of an effect. It is unknown how the snow got into the box. The box was left open for a few days to allow the snow to sublime away. A plastic sheet was put on top of the Campbell to hopefully protect it from direct snow accumulating on the terminals. Snow in the bottom of the box where the batteries are should not be a problem.

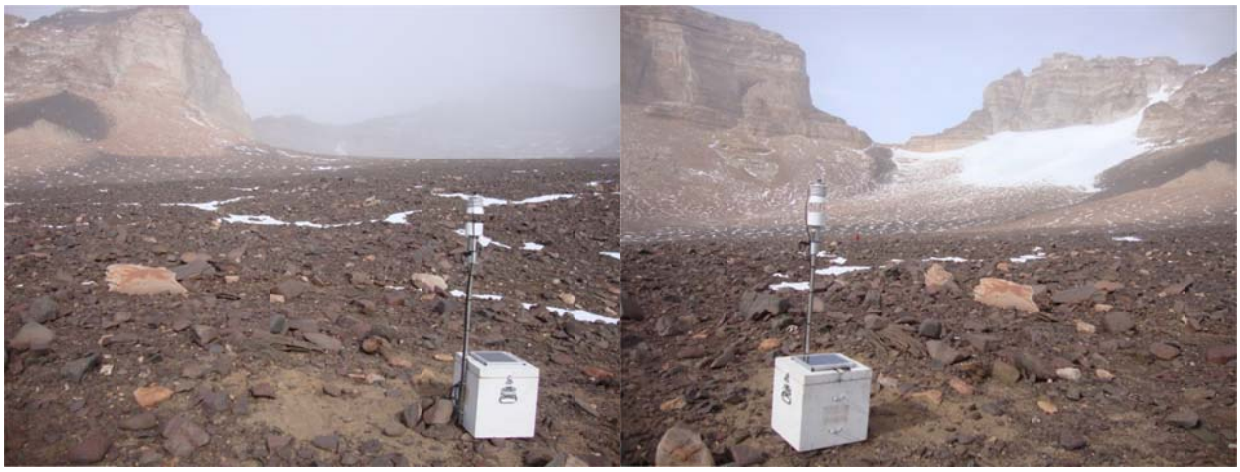
- The main station was reprogrammed for a day to collect high frequency data: i.e., every 30sec. This was especially to get a better record of wind activity.
- The main station is currently collecting data at a 30min interval, and is reprogrammed so that it can be downloaded using the USB-to-serial memory stick adapter (just plug in the memory stick, wait for the red light to stop flashing, and done!)
- The data from the aluminium-can encased air T/RH Hobo is higher during sunlit times than the Campbell sensor. This is likely due to the non-ideal radiation shield. It also appears to be 1-2 degrees lower in the coldest nights in winter.
- The subsurface T/RH hobos had their batteries replaced with the batteries from the recently-purchased T/RH hobos; i.e., they did not have brand new batteries put in them, but pretty new ones. They were relaunched to continue recording with a 1 hr interval, but not to record their battery voltage. This extends their recording time to 902 days.
- All Hobo stations (shallow, medium, deep ice) were downloaded; all the data looks good.
- All batteries were replaced at the shallow ice site with no problems or difficulties. All sensors were relaunched to record every 1 hr, but not to record their battery voltage; this allowed us to keep to same recording inverval, but to have them last for > 2 years.
- At the medium ice site, the T/RH sensor under the rock stopped functioning after the battery was changed (showed -94C). This is likely due to a disconnect between the sensor and the circuit board, but this was not discovered at the time. The sensor will likely not record any useful data from that point on. The 4-channel external industrial refused to connect to the computer after the battery was changed. The reason for this is completely unknown. All sensors (that could be connected to) were relaunched with a 1 hr measuring interval and no recording of the battery voltage.
- At the deep ice site, the 4-channel external industrial sensors had the same failure mode as that at the medium ice site. All other sensors functioned fine after the battery change. The sensors were relaunched to a 1 hr interval and no battery voltage recording.





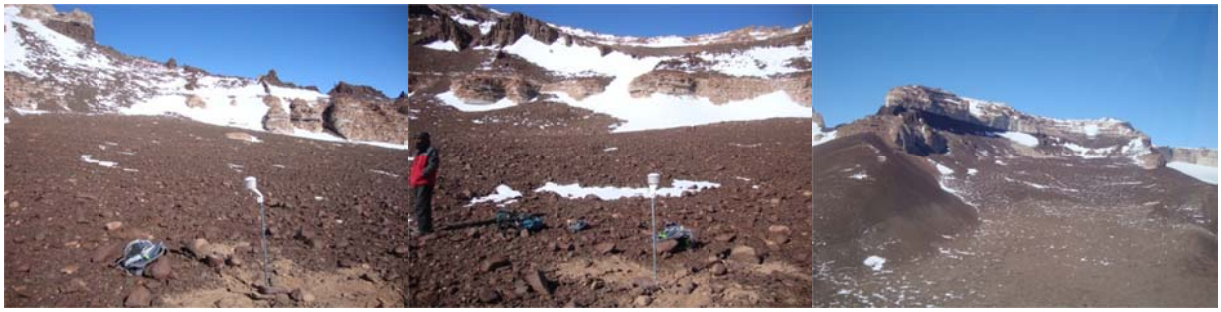
Farnell Valley:

- The Farnell weather station was deployed at 77S 53.028', 160E 41.027', 1672 m; depth to ice-cemented ground = 42 cm (which is exactly the same as at the University Valley weather station!). The station was deployed on Dec 1, 2010.
- Sensors were deployed at:
    - 42 cm – T (Campbell sub2)
    - 30 cm – T/RH (Hobo sub2)
    - 20 cm – T (Campbell sub1)
    - 10 cm – T/RH (Hobo sub1)
    - Surf – T (Campbell surf)
    - Climatronix AIO (T,RH,wind speed & dir, P) – 128 cm
    - Light sensor – 142 cm



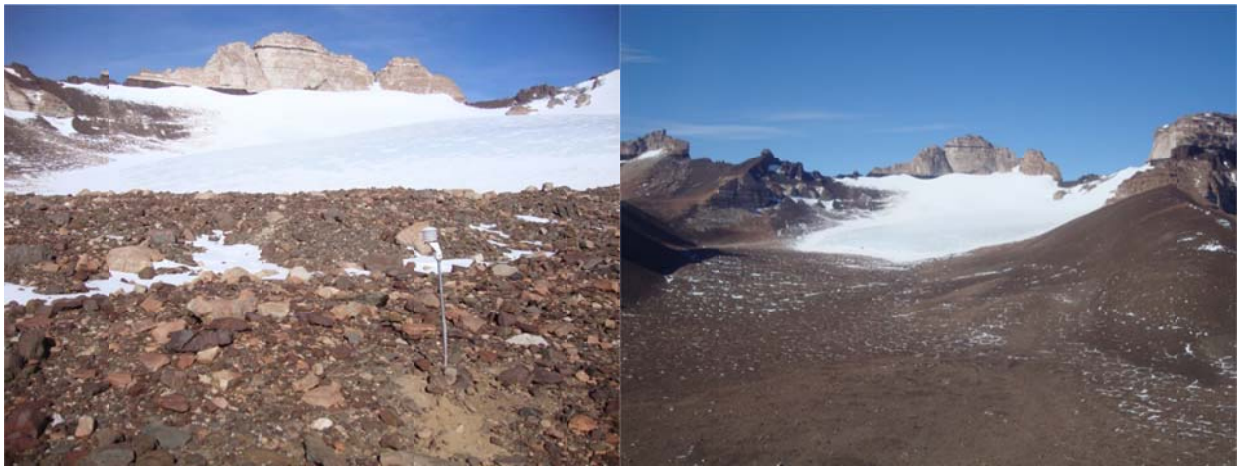
Valley North of University Valley:

- Deployed a Hobo 'mini weather station' near the head of the valley: 77S 51.173', 160E 44.509', 1954 m; depth to ice-cemented ground ~40cm. The sensors were deployed as follows:
    - Air T/RH – 107 cm above ground (S/N 9810674)
    - T – surface (S/N 9829482; ch. 1 of 2xT logger)
    - T/RH subsurface – 18cm depth (S/N 9810672)
    - T deep – 36 cm (ch. 2 of 2xT logger, S/N 9829482) <- note that due to rocks it was difficult to deploy the sensor right at the ice-cemented groundinterface, but it is close.
- The sensors were set to a 1hr recording interval



Valley 2 North of University Valley:

- Deployed a Hobo 'mini weather station' towards the side with the snow pack. This valley has a lot of undulations, and so it was not obvious where to deploy the station. It is near the middle of the valley, on an extended ridge: 77S 50.106', 160E 47.666', 1652 m; depth to ice-cemented ground = 34 cm. The sensors were deployed as follows:
    - Air T/RH – 109 cm (S/N 9810667)
    - T surface – surface (S/N 9829485, ch. 1 of 2xT sensor)
    - T/RH subsurface – 18 cm (S/N 9810675)
    - T deep – 34 cm, at ice-cemented ground interface (S/N 9829485, ch. 2 of 2xT sensor)
- Sensors are set to a 1hr recording interval; battery voltage is not recorded.



Pearse Valley:

- All the data from Pearse Valley was downloaded. The data looks good overall, but more work needs to be done to see whether/how much the missing radiation shield affected the air temperature and humidity measurements. We now have a complete data set for Nov 28, 2009 to Oct 17, 2010, making for a total of 322 days of data. All the data looks good. Some difficulties were encountered in downloading the data because of recurring disconnects between the

computer and the Campbell; these were attributed to the computer getting too cold. With multiple re-connects, all the data was downloaded.

Some basic stats of the weather data are (min, max, mean):

- Air T: -50.4C, 5.7C, -20.2C
- Ground T: -46.9C, 10.7C, -21.0C
- Wind speed: 0 m/s, 14.6 m/s, 2.2 m/s
- Battery Voltage: 12.2 V, 14.5 V, 13.0 V

- The station program was not changed. The station is still recording as programmed last year.
- In Oct 2010 the radiation shield was found dismembered. This means that for some portion of the collected data, the T/RH sensors was not protected from direct solar radiation. The magnitude of the effect of this is unknown. The initial fix to this problem was to put an aluminum can around the sensor, with the remaining white radiation shield (with the licor on it) at the top. From the University Valley data we know that the aluminum can does affect the air temperature (and therefore humidity). On Dec 5 the aluminum can was change with a proper radiation shield.
- An attempt was made to connect to the station on Dec 8, and it was unsuccessful. It is not know why a connection was not possible; no connection problems occurred in October. The temperature was warm enough (above freezing) that it should not have been a problem. Future things to try are a slower Baud rate for the connection (the max 115000 was attempted).
- We may be able to use the snow pack air T/RH sensor to check the validity of the weather station air temperature and humidity measurements.

Depth to ice-cemented ground mapping

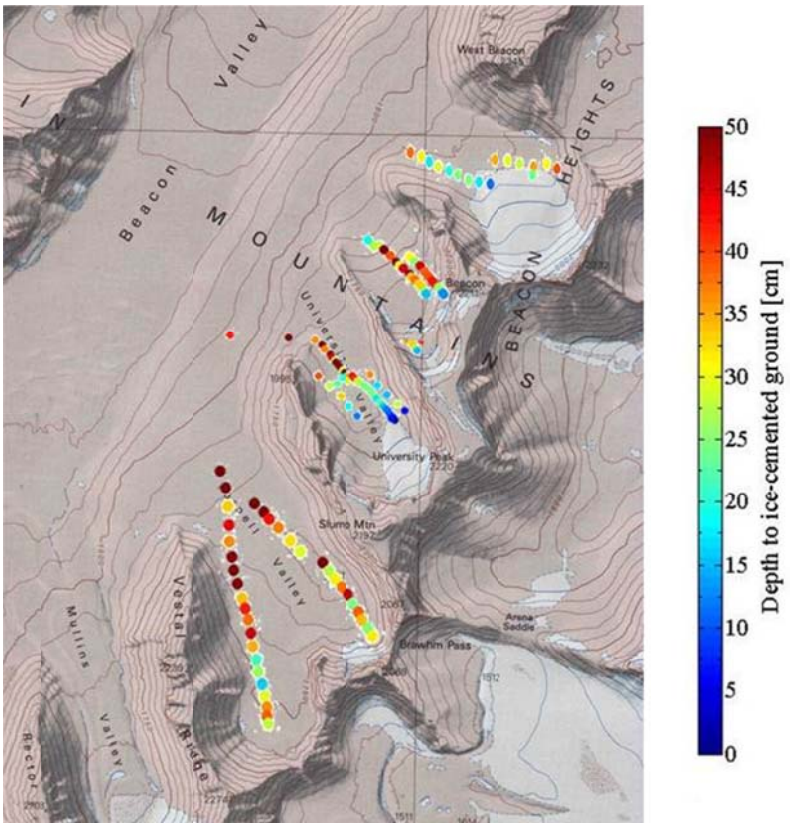
This year we used a hand drill to drill into the ground, effectively feeling a change in resistance when the ice-cemented ground layer was reached. We could verify that the ice-cemented ground really was reached since mud would be present on the end of the drill bit when it was pulled out. We used a magnet to mark the depth to which the auger had penetrated – this allowed for fast retrieval of the drill bit, i.e., before it could be frozen into the ground. On one battery charge we could get about 30-40 holes, which meant ~10 locations with triplicate data at each location. This method for probing the depth to the ice-cemented ground was quite efficient.

Using this method, we:

- finished mapping University Valley, quite far towards the mouth;
- mapped two lines in Farnell Valley – from each one of the lobes to the mouth;
- mapped two lines in the valley north of University Valley; and
- mapped two almost perpendicular lines in the valley 2 north of University Valley.

For all of these points, we tried to test the middle of polygons, where possible. Where this was not possible was noted in the notes.

The results are not obvious to interpret – there is a lot of variation even when the ground cover seems similar. The variation is increased by changes in topography, hummocks, etc.



Locations of mapped points are approximate.

Sublimation-dominated active layers

For studying the processes in the active layer, we collected additional data to aid in the modeling efforts. This includes

- downloading the data from the Hobo stations in the shallow, medium, and deep ice (see *Climate instrumentation: Weather Stations and Hobos* above);
- collecting albedo measurements from light and dark rocks (A = 0.32 and 0.16, respectively), soil (A=0.20), overall surface (A=0.21), and snow (A=0.55);
- measuring the horizon at the weather station and the shallow ice Hobo site; and
- collecting core pieces to measure the ice content and ice pore filling.

The Hobo and weather station will be used to determine the thermal conductivity of the soil and ice-cemented ground.

McGill biology

For biology analyses at McGill we collected:

- core in the shallow ice and aseptic collection of the surface material at University Valley;
- chips of the ice-cemented ground in the deep ice site and aseptic samples at the ice-cemented ground interface and at the surface at University Valley; and
- (maybe) a sample of the surface material at the valley north of University Valley.

We attempted to collect samples for soil gas analysis, however, most of the jars seemed to have leaked. The jars are being shipped back (at -20C or colder) in case they are still of use. Not sure why they leaked; leaking was apparent both before the dirt was added (jar marked) and also seemed to have occurred after the addition of the dirt.

Due to a misunderstanding, unfortunately no buried rocks were collected.

John Hopkins biology

The samples collected for this analysis are:

- Cores from shallow, medium, and deep ice at University Valley;
- Surface sample (aseptic) at the shallow ice are in University Valley.
- Samples across the Pearse Valley, at surface (0-1 cm); 5 cm; 10 cm; and 20 cm

Oxidants study

A core sample at the shallow ice site at University Valley was collected for oxidants analysis.

Massive ground ice

GPR data was collected at the buried massive ice by Wayne. At the site where the Honeybee drill was tested, the depth of the ice appeared to be a bit less than 3m. In addition, massive ground ice was found at the mouth of University Valley (77°S 52.016', 160°E 43.228'). This was sampled by collecting >1m long core. The ice was ice with incorporated small rocks and soil, but still transparent.

Perchlorates and other salts

Extensive sampling was performed at University Valley to document the distribution of perchlorate indirectly by actually directly measuring the concentration of nitrates (as these are found to be related

in other settings). Andrew Jackson dug many pits, sampled many salts under rocks and the soils around them. The general trend seems to be that the dark, caked-on soil under rocks is the highest in nitrates. Much of this material was collected to try and conduct isotopic analysis on the material in order to determine the production mechanism responsible for the perchlorate. Interesting, the indirect nitrate analysis suggests that the perchlorate concentrations at University are similar to or higher than those found in the Atacama desert – the highest concentrations on the planet.

Numerous samples were collected including ice cores, snow pack cores, ice-cemented ground cores, soil depth profiles, surface salts, and surface soils as outlined below. These samples will be evaluated for concentrations of major anions, cations, and ClO_4^-, ClO_3^- concentrations. Stable isotopes analysis of N and O in NO_3 will be performed on select samples.

Soil depth dependent sampling, ground ice chips, and surface salts were collected at numerous sites along University Valley.

Depth dependent samples were collected by digging pits and sampling the sidewall by using a spatula or pushing a falcon tube into the side wall directly. Surface salts were scraped off of rocks in the immediate vicinity. Ice cemented ground was chipped off using a hammer. Sample sites included multiple locations in University Valley, one site in Farnell, and one site in North University Valley.

An ice core from the university glacier and core from a snow pack on University glacier as well as cores of ice cemented ground from two locations in University Valley were obtained.

A survey of salts throughout the valley from different environmental settings and rock types was made by scraping slats from below rocks along both valley axes and by sampling rocks of varying size and composition at each location.

A surface soil transect was conducted from the glacier to the mouth of University Valley generally along the valley center line. The samples were either to a depth of 30cm or the total depth of soil above the ice cemented ground if <30cm. Soil was samples by digging a small pit to 30cm or depth to ice cemented ground and then mixing a full depth interval in a bucket and sub-sampling the homogenized mixture.

Bulk salts (~10kg) from under rocks were collected at two sites in University valley. The sites were in the general location of the camp and near S 77.51.701; E 160.42.492. Bulk soil samples were also obtained near the camp. These samples are specifically to be used for evaluating the stable isotopic composition of perchlorate.

Sandy Glacier

A day trip was undertaken to Sandy Glacier. This allowed us to explore the area. Of special interest at Sandy Glacier is the layering of ice and sand, which may have similarities to what is seen at Mars Polar Layered Deposit. During our trip, we had time to look around the area.

The depth to ice-cemented ground throughout this area seems to be about 20cm. For most of right side of the valley (looking uphill), only sand is present and glacier ice is not present. At the head of the valley there is a lot of exposed glacier ice, and the mixing of sand and glacier ice is more apparent.

One of the very interesting features throughout the area is the presence of polygons forming in the sand. These polygons are about 10m across, and their troughs are just 5 cm deep. Closer to the head of the valley the troughs are much deeper – a full hand can be put in. These may possibly be cravasses? On the left side of the valley (looking up valley), the glacier layers come up to the surface. This seems to be a very nice exposure. Wayne sampled this area, as the ice seemed tilted, thus allowing us to sample a stratigraphy/time sequence of the layers. The "tilting" could be the result of unequal melting/subliming of top versus bottom of the glacier. Kris took lots of pictures. A short core was collected in the alluvial channel where the helo landed. Unfortunately we did not have enough time to collect another core in the more pristine surrounding area.

Endoliths are present in the surrounding sandstone.

Heli Land: 77S 28.973', 161E 56.456'
Good layering (where Wayne sampled): 77S 28.744', 161E 56.691' <- can land just upslope from here

Other

A precipitation measurement device was left out by the weather station: a tube with a plastic bag inside to collect all the precipitating snow. As the snow sublimes, it will still leave behind all of the chlorine and such that it had carried up, this allowing us to measure total precipitation rate using known Cl concentrations for Antarctic snow. The tube is about 1m high, thus keeping away low-level drifting snow. Snow blown in from the plateau will likely still be caught, but that is effectively precipitation if it is lofted that high?

Rocks were collected for desert varnish analysis – sent to Kim Kuhlman.

No samples were collected from Beacon Valley or of the (small) snow packs.