

SAO 164 Module 5 Assignment – 2 Full Pits  
**Temporal Variability at the Study Plot Scale**

Location: Snowmass Ski Area, Snowmass CO

**Gabi Benel**

1/28/2018

# Objectives of This Assignment

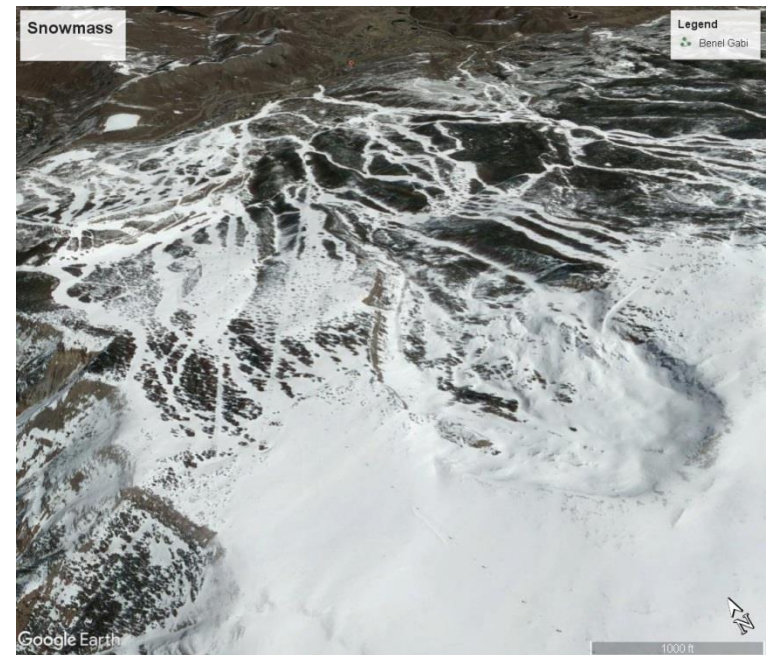
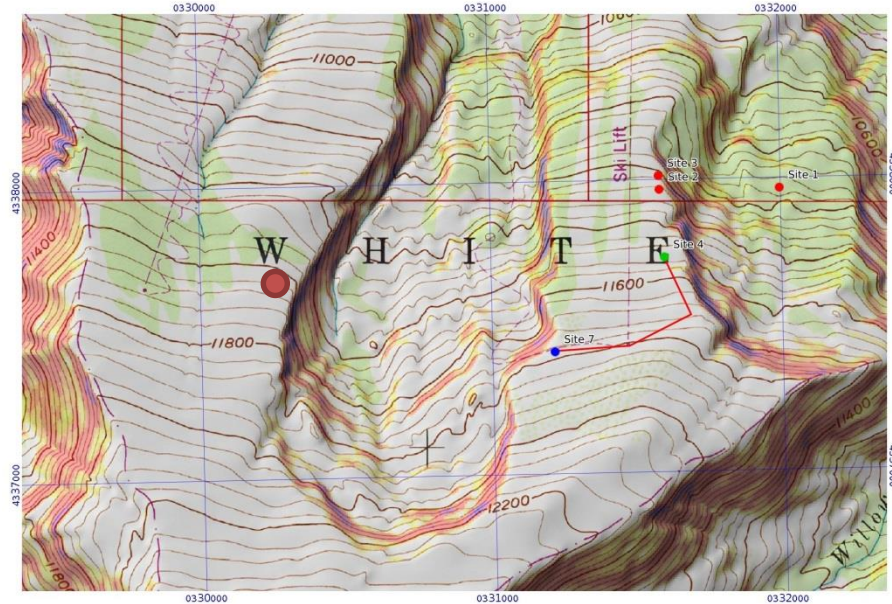
*Examine temporal evolution of the snowpack at the study plot scale.*

- This module is designed to examine the effects on the snowpack due to process occurring over time while minimizing the effects due to differences in terrain.

In this assignment, I am looking at snowpack evolution through time.

# Location

- “Big Burn”, Snowmass, CO
- <https://caltopo.com/m/U1M5>
- Details:
- Pit Location:
  - ELEV: 11,635’(NTL)
  - ASPECT: 30 (NE)
  - SLOPE: 14 deg
- Times / Dates:
  - Pit 1:
    - 20180122, 13:30
    - HS: 76cm
  - Pit 2:
    - 20180128, 14:00
    - HS: 86cm



# Notebook – Tour Plan, Pit 1

Date: 2019 01 22 Time: 13:00 Field Location: Top of Pit 1

Weather Forecast		Snowpack and Avalanche Observations			
SKY T <sub>DAY</sub> T <sub>NIGHT</sub> PRCP. 0" 0" T 20-35F -5-0°F W 10-20NW 10-20WN	20190121: FATALITY, SANJUAN ZONE, DZ ON NE, NTL, TORNADO TRAP				
Snowpack Summary					
20190121: 10" NEW SNOW Newly formed slabs drifted snow @ high elevations					
Avalanche Danger	Problems	Type	Likelihood	Size	Distribution
ATL	CONSID	1	WS <sub>a</sub>	likely	S-L NTL, NTL, NTL
NTL	CONSID	2	PS <sub>a</sub>	Poss	L NTL, NTL, NTL
BTL	MOD	3			
Notes:					
ROUTE IN IS FROM TOP OF LIFT 9 OR LIFT 7					
Terrain to Avoid:					
steep slopes below fresh cornices cross loaded slopes Exposed rocks, trees, thin cover					
Open Runs/Areas:			Closed Runs/Areas:		
Sheer Bliss Patsy's			Gandy's Upper Cirque Terrain,		
Fieldwork Needs:					
- STD 164 MIDDLE 5 PIT 1 - Temporal Time Scale - observe Peter C. and learn from him					
Emergency Response:					
Snowmass Ski patrol 970-923-0531 - Carrying Breach, A&E aid kit					

Field Weather Obs			
Time	1330		
Location	OLD MAN'S		
Elev.	11,635'		
Aspect	NE		
Sky	CLR		
Precip (type/rate)	NO		
HS	76 cm		
T <sub>AIR</sub>	-11°C		
T <sub>SURF</sub>	-16.5°C		
T <sub>-20</sub>	-12°C		
Surf. Form / Size	V(1)		
Pen Boot	60 cm		
Pen Ski	N/O		
Wind (Speed/Dir)	S-10 mph W		
Blowsnow	NONE		

- Did not observe wind slab @ surface in this location  
- Huge DH at ground (4mm+)

# Notebook – Tour Plan, Pit 2

Date: 20180125 Time: 1200 Field Location: TOP OF BIG BURN

Weather Forecast		Snowpack and Avalanche Observations			
TODAY TOMORROW SKY CLR OVCST T 15-25F 8-15F W 10-20 WSW E-15 NW		20180125: ON GARREY PEAK, NB, BTL SS AS/r DLS			
Snowpack Summary					
- Friday 20180126: 4-8" of new snow - Lingering PSA problem from facets & DM. - Slabs in some places, not in others - very inconsistent					
Avalanche Danger	Problems	Type	Likelihood	Size	Distribution
ATL MOD	1	PSa	Poss	L	BTL-NL-DR NW-N-E
NTL MOD	2	WSa	Poss	S	NL-NL NE-E-S
BTL MOD	3				
Notes:					
Route in 4 FROM TOP OF LIFT 9 OR LIFT 4					
Terrain to Avoid:					
Recently formed wind slabs on easterly slopes above T4					
Open Runs/Areas:			Closed Runs/Areas:		
Shoe Bliss Poley's			All upper cirque terrain		
Fieldwork Needs:					
- Pic 2 from SA0164 MOD 5 Assignments - Temporal Time Scale - learn more from Peter C.					
Emergency Response:					
Snowmass Ski Patrol 970-928-0531 Have in reach, first aid kit					

Field Weather Obs

Time	1400			
Location	Big Burn			
Elev.	11,635'			
Aspect	NE			
Sky	SCT			
Precip (type/rate)	NO			
HS	86cm			
T <sub>AIR</sub>	-9.5°C			
T <sub>SURF</sub>	-12°C			
T <sub>-20</sub>	-9°C			
Surf. Form / Size	1.3m			
Pen Boot	60cm			
Pen Ski	6cm			
Wind (Speed/Dir)	Cal			
Blowsnow	Prev			

- "Pancake" wind crust at top of snowpack  
 - hard (1F) wind slab, ~5cm thick ~25cm down from surface. Supports skis but not boots.

# Pit Site - 20180122



ELEV: 11,635'(NTL)  
ASPECT: 30 (NE)  
SLOPE: 13 deg

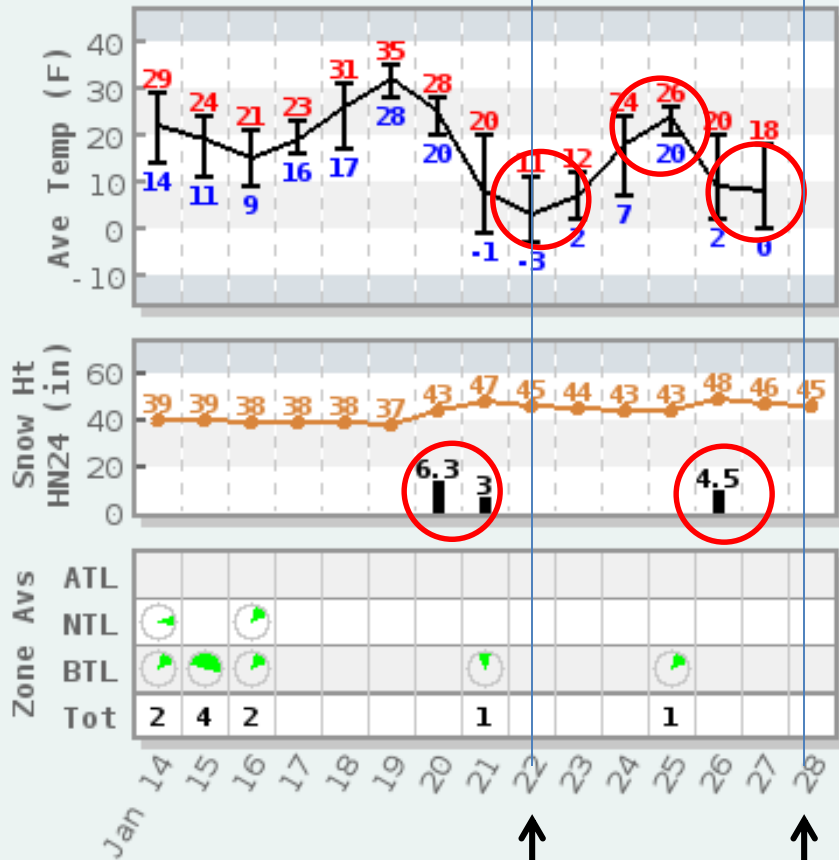
# Pit Site - 20180128



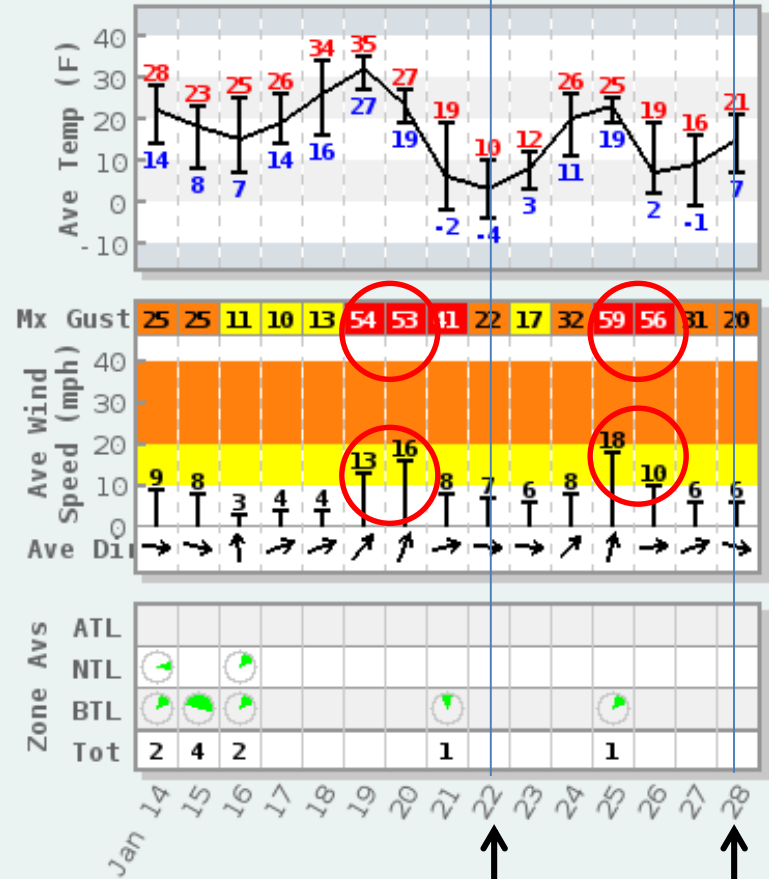
ELEV: 11,635'(NTL)  
ASPECT: 30 (NE)  
SLOPE: 14 deg

# Wx Conditions Overview – 2 week period

Snowmass SA Timberline (AspenSkiCo) 115



Snowmass SA Big Burn (AspenSkiCo) 1193



\*note snow amt is in inches



# Summary of significant wx events

- **Prior to all pits:**
  - Jan 20/21: 23.6cm snow, light density
  - Increase in wind from more S and SW direction
- **At pit 1 time:**
  - Drop in temp
  - Calming winds
- **Between pit times:**
  - rise in temp
  - light winds at first from west, then increase in winds and change in direction to S, SW
  - Jan 26: 11.5cm new snow
- **At pit 2 time:**
  - Drop in temp
  - Light winds from west

# Wx Conditions Overview

	Pit 1, 20180122	Pit 2, 20180128
Time	1330	1400
Sky	CLR	SCT
Precip	NO	NO
Wind Speed / Dir	LIGHT / W	LIGHT
Blowing snow	NONE	PREV, W
Pen	FOOT 60cm / SKI N/O	FOOT 60cm / SKI 6cm
HS	76cm	86cm
Tair	-11C	-9.5C

# Pit 1 (20180122) Photos

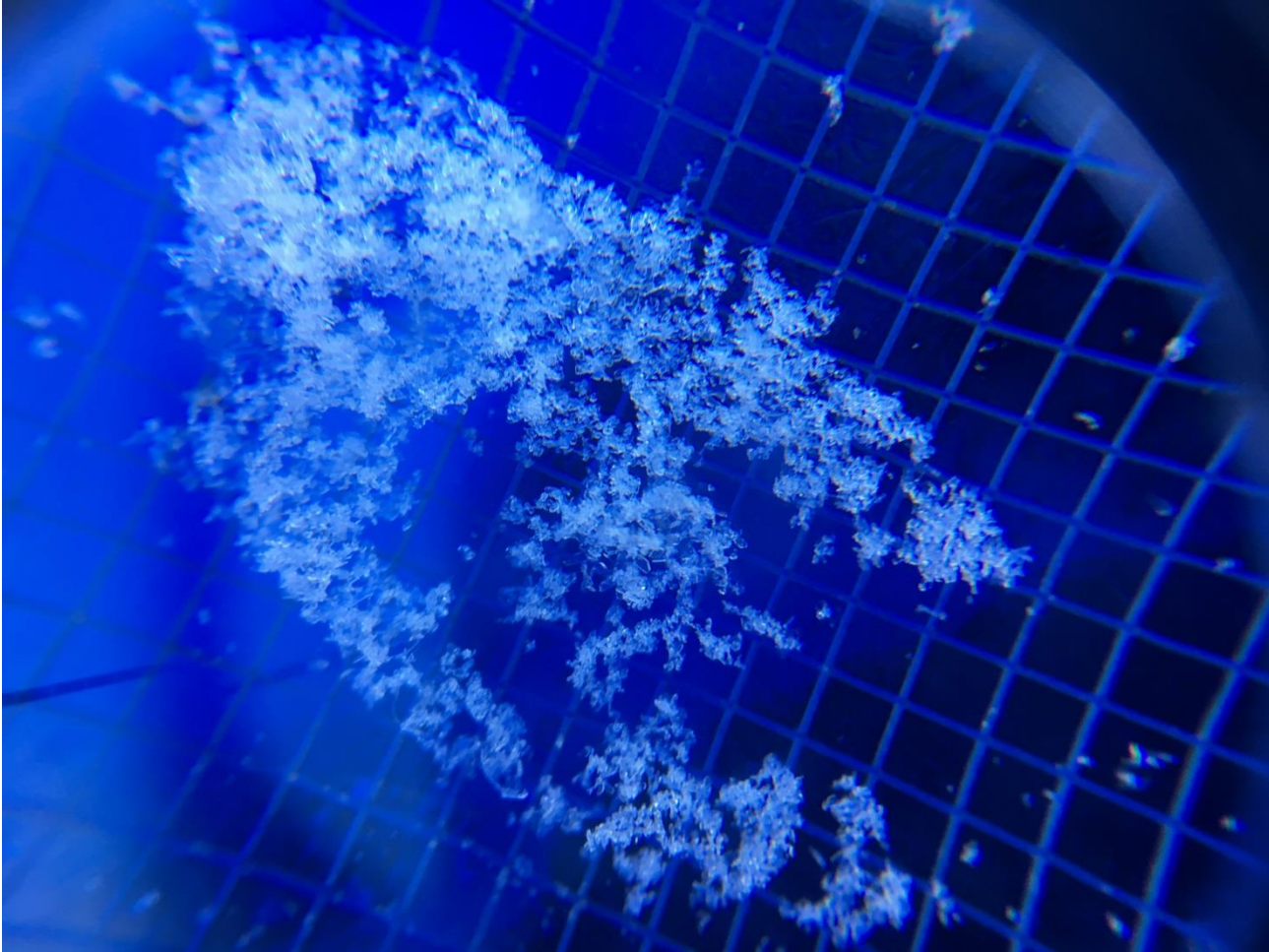


# Pit 1 Photos



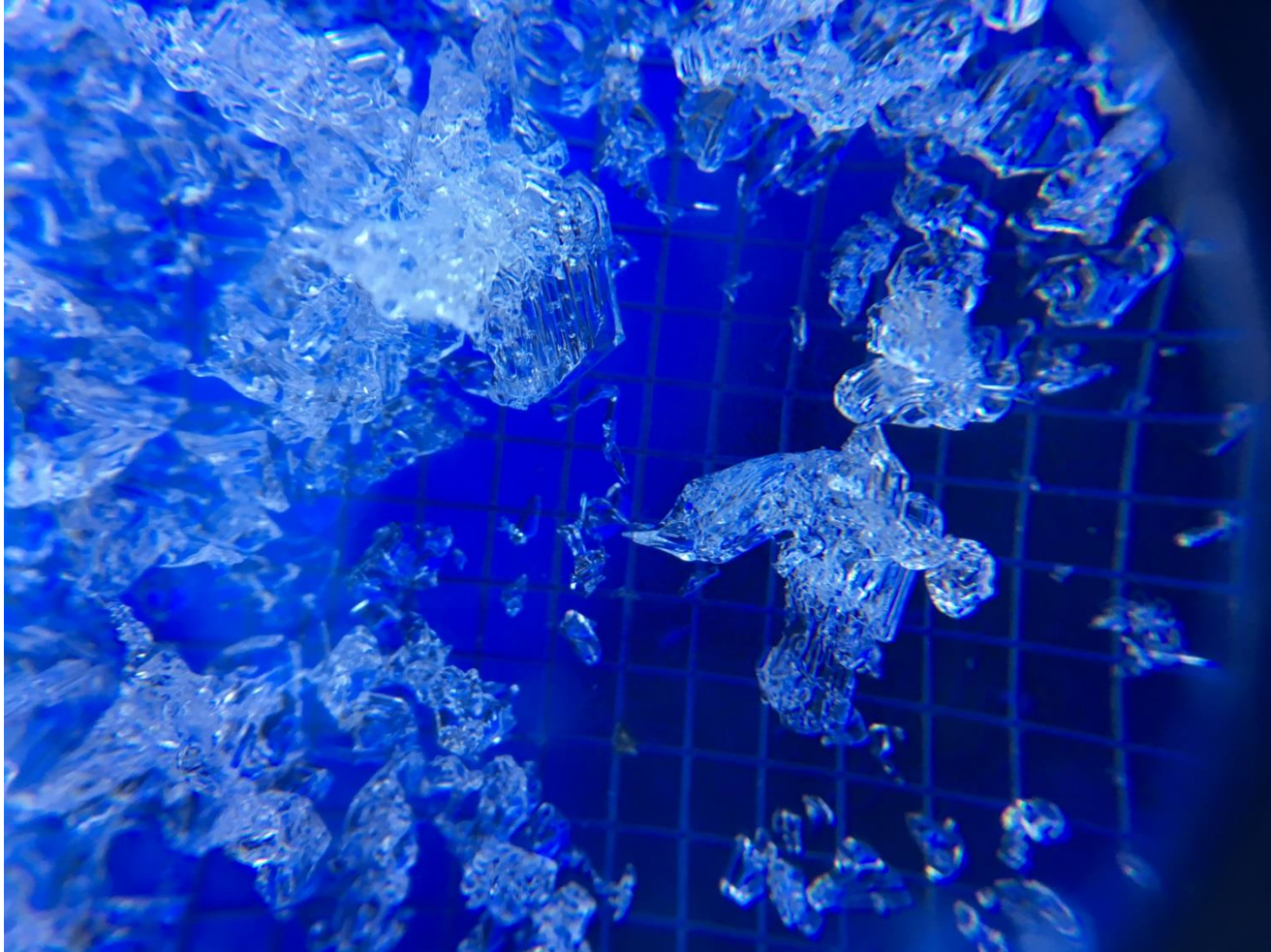
Results after a compression test. Image is shown to better illustrate layering of snowpack.

# Pit 1 Photos



Grain photos from pit 1 – smaller grains from upper snowpack

# Pit 1 Photos



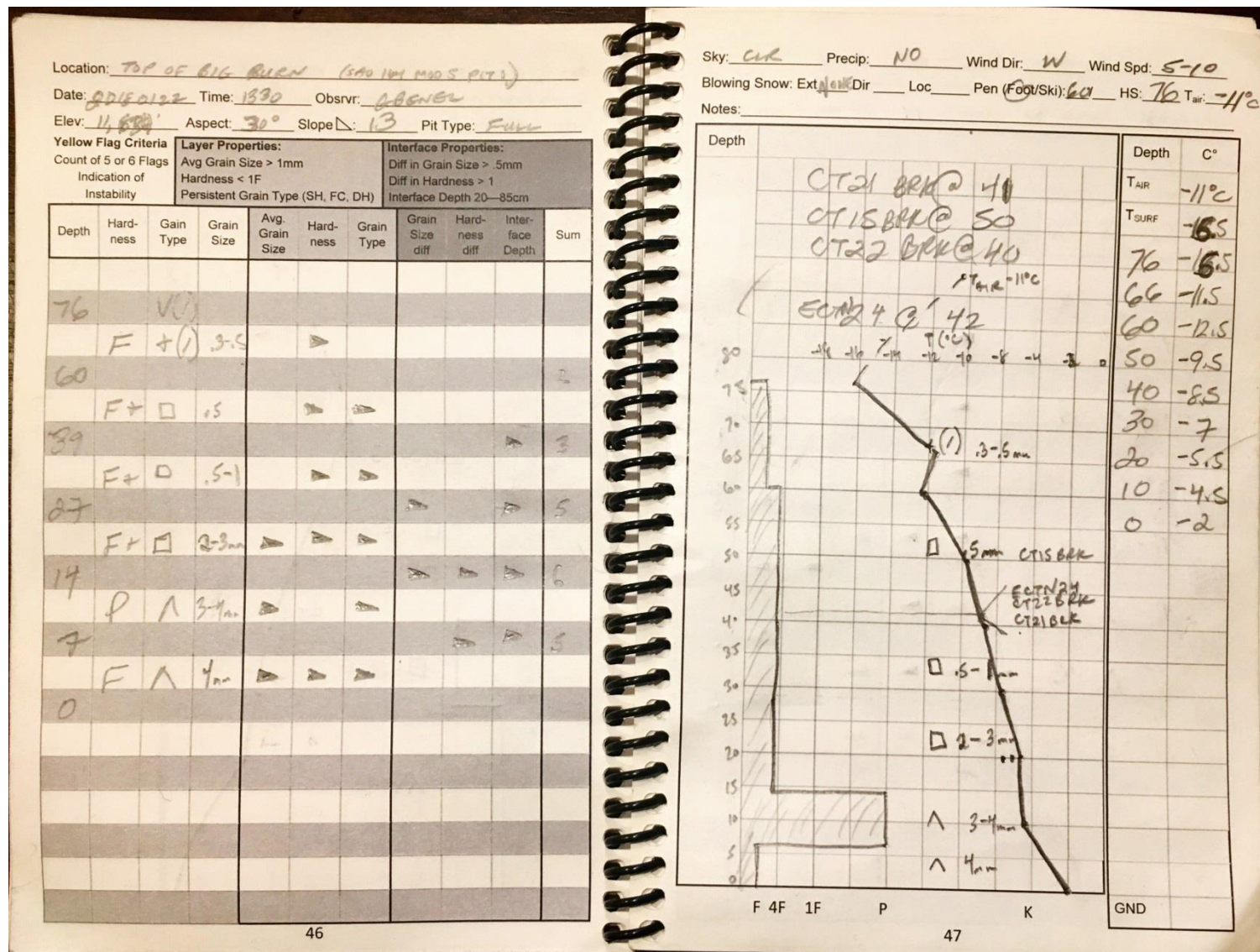
Grain photos from pit 1 – basal facets

# Pit 1 photos



Photos of various results from instability tests

# Pit 1 Results - notebook





# Pit 1 Results – Snowpilot

Old Man's 1 SAO 164  
 Aspen Snowmass  
 CO  
 Elevation: 11634 ft  
 Aspect: 30°  
 Specifics:

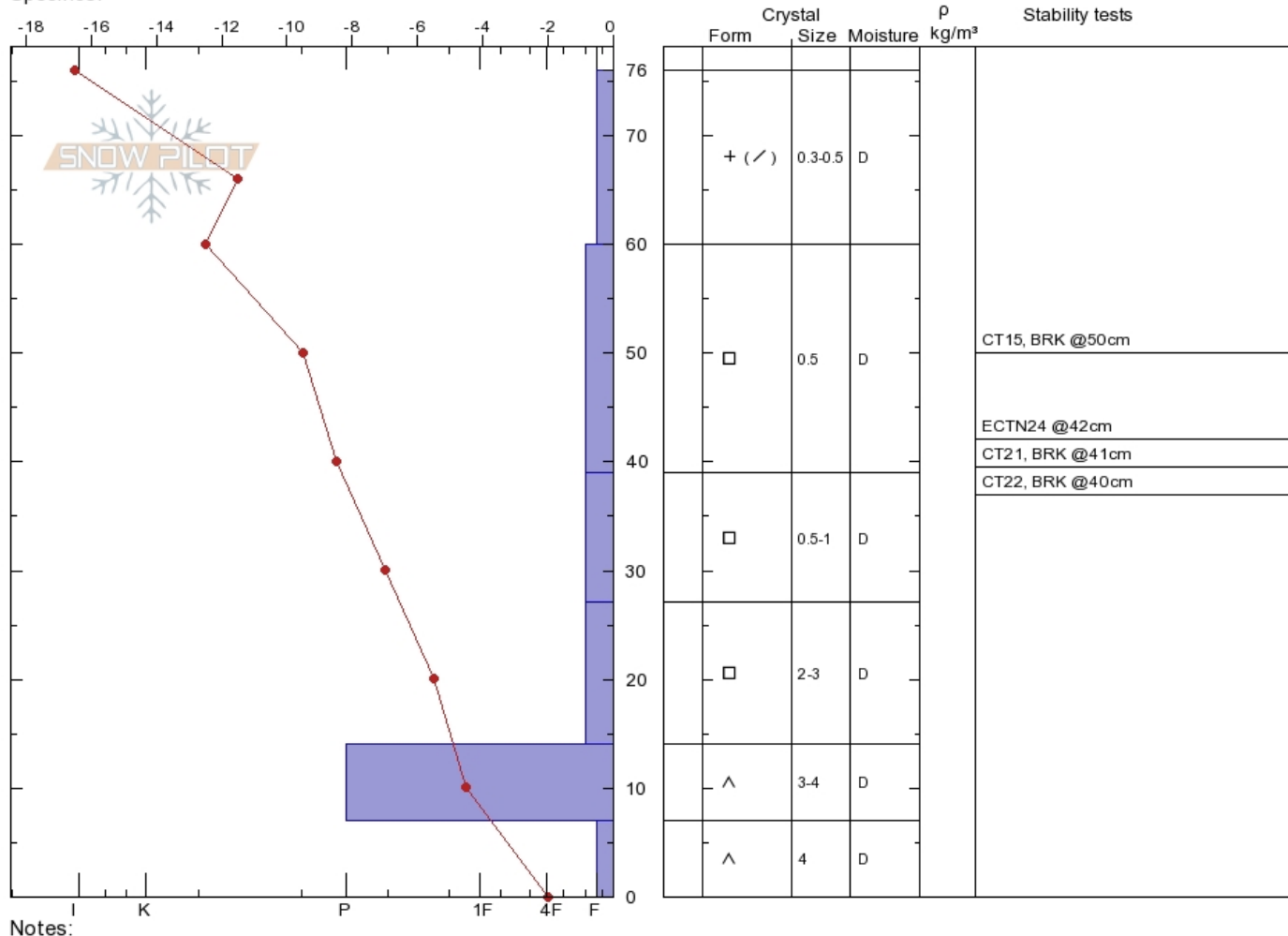
Gabi Benel  
 Mon Jan 22 13:30 2018  
 Co-ord: 13S 330261W 4337594N  
 Slope Angle: 13°  
 Wind Loading: no

Stability:  
 Air Temperature: -11°C  
 Sky Cover: CLR  
 Precipitation: NO  
 Wind: W Calm

HS76 PF60

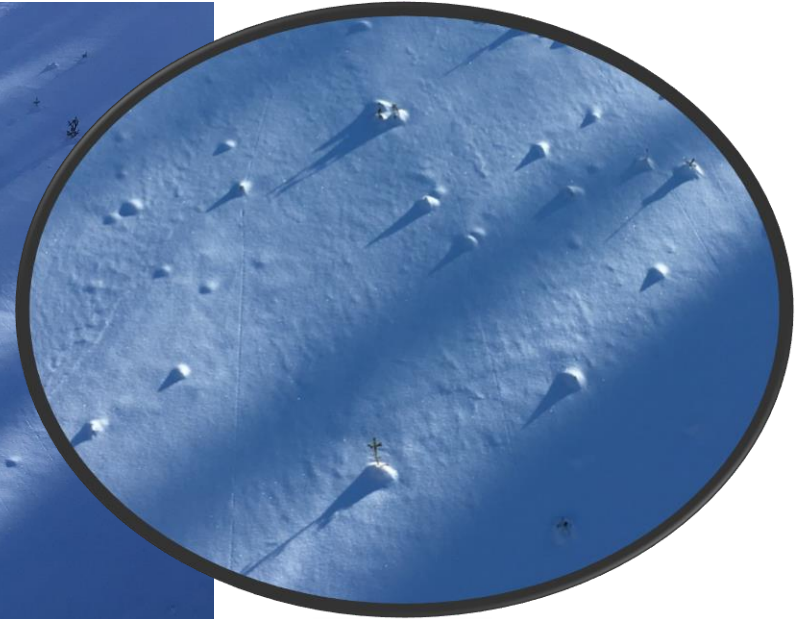
Layer Notes

Stability Test Notes



Notes:

# In between . . .

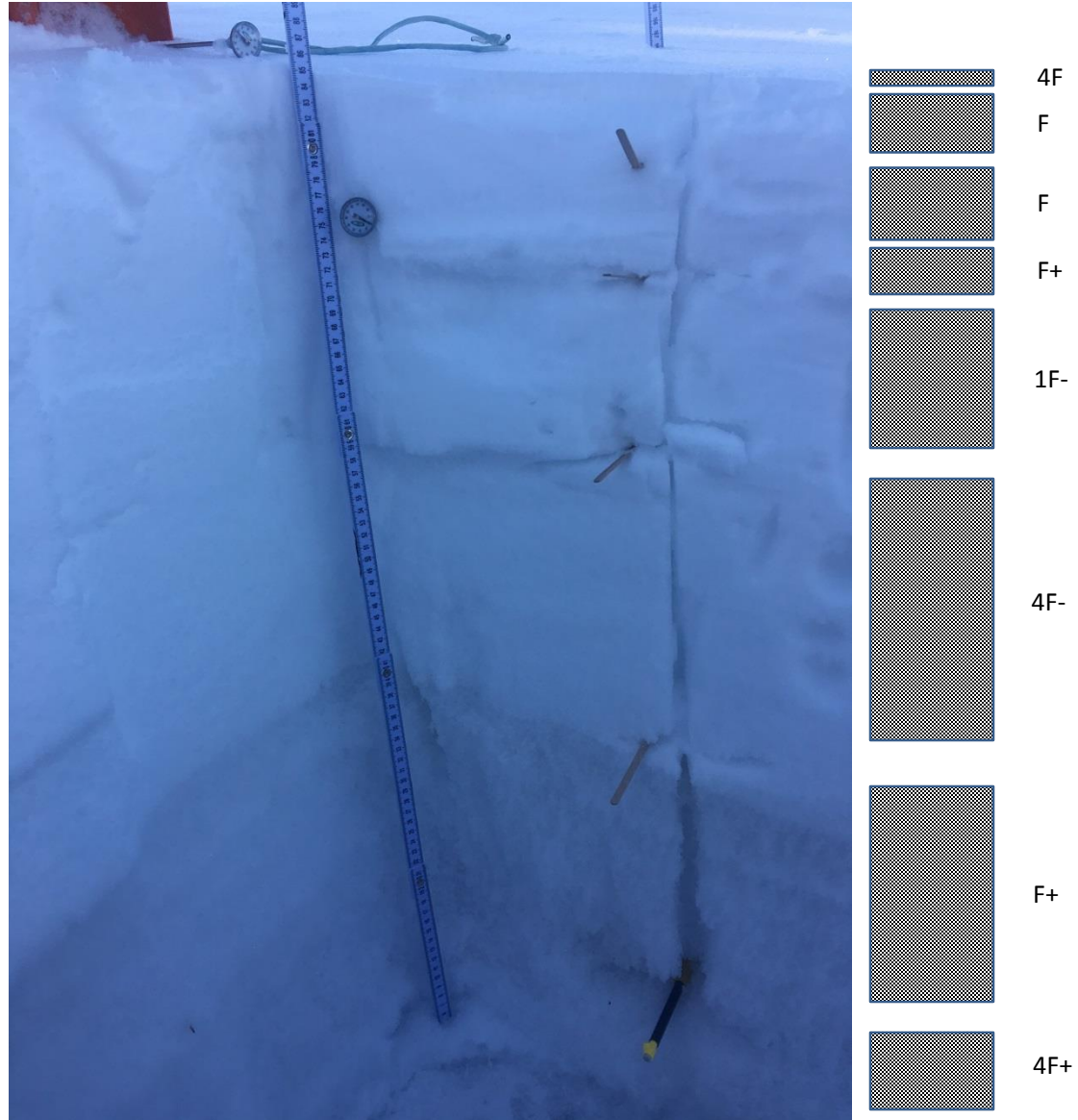


20180123 –  
settlement cones in  
nearby area.

# Pit 2 (20180128) Photos



# Pit 2 Photos



Layering of snowpack visible on pit observation wall.

# Pit 2 Photos



3cm wind crust at top of snowpack (83 – 86 cm)

# Pit 2 Photos



Instability test results

# Pit 2 Results - notebook

Location: TOP OF BIG OVEN (500 164 PUD 5 PIT 2)  
 Date: 20190124 Time: 1400 Obsvr: C-BENGL  
 Elev: 11,635' Aspect: 30° Slope: 17 Pit Type: FLW

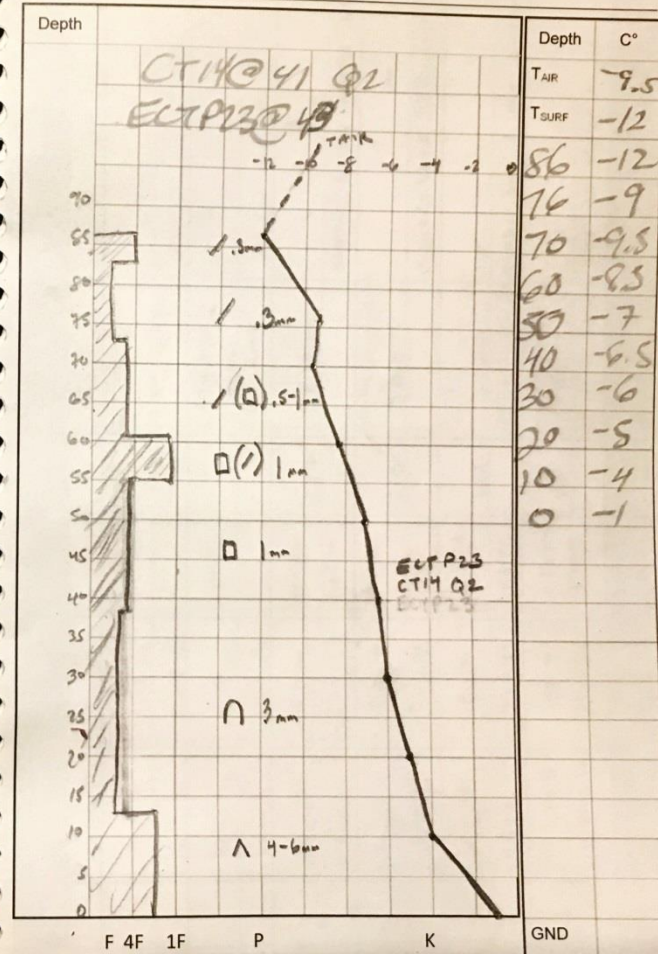
**Yellow Flag Criteria**  
 Count of 5 or 6 Flags  
 Indication of  
 Instability

**Layer Properties:**  
 Avg Grain Size > 1mm  
 Hardness < 1F  
 Persistent Grain Type (SH, FC, DH)

**Interface Properties:**  
 Diff in Grain Size > .5mm  
 Diff in Hardness > 1  
 Interface Depth 20-95cm

Depth	Hardness	Gain Type	Grain Size	Avg Grain Size	Hardness	Grain Type	Grain Size diff	Hardness diff	Interface Depth	Sum
86		/	.3							
83	4F	/	.3		▼					
73	F	/	3		▼					
61	F+	(D)	.5-1		▼					
56	4F-	(D)	1		▼	▼	▼	▼	5	
49	4F-	(D)	1.5		▼	▼				
13	F+	(D)	3		▼	▼	▼	▼	5	
0	4F+	/	7-6		▼	▼	▼	▼		

Sky: SCT Precip: NO Wind Dir: \_\_\_\_\_ Wind Spd: CALM  
 Blowing Snow: Ext NO Dir W Loc \_\_\_\_\_ Pen (Foot/Sk) 16 HS 86 T<sub>air</sub>: -25  
 Notes: \_\_\_\_\_



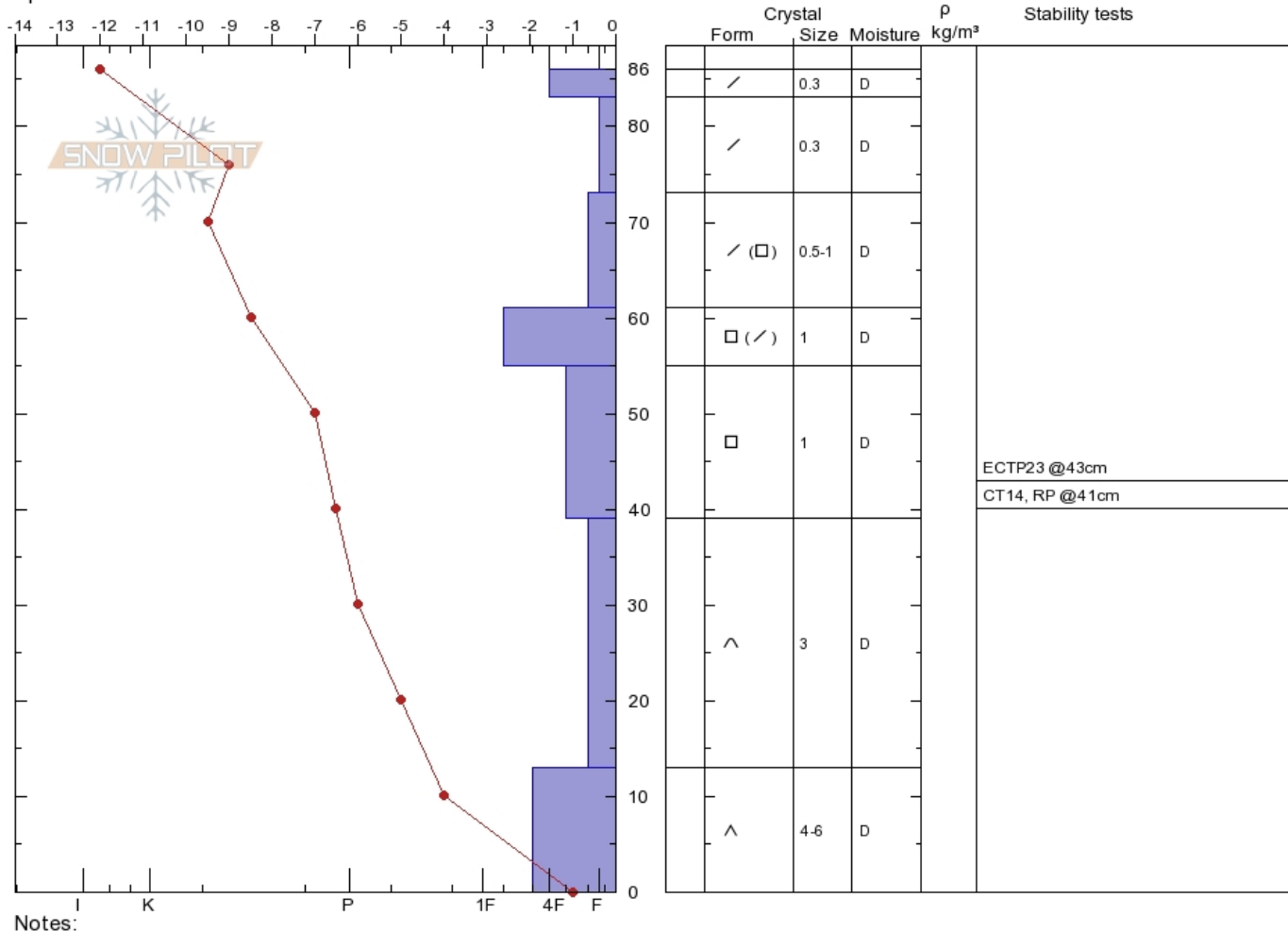
# Pit 2 Results – Snowpilot

Old Man's 2 SAO 164  
Aspen Snowmass  
CO  
Elevation: 11635 ft  
Aspect: 30°  
Specifics:

Gabi Benel  
Sun Jan 28 14:00 2018  
Co-ord: 13S 330261W 4337594N  
Slope Angle: 14°  
Wind Loading: previous

Stability: HS86 PF60  
Air Temperature: -9.5°C  
Sky Cover: FEW  
Precipitation: NO  
Wind: Calm

Layer Notes





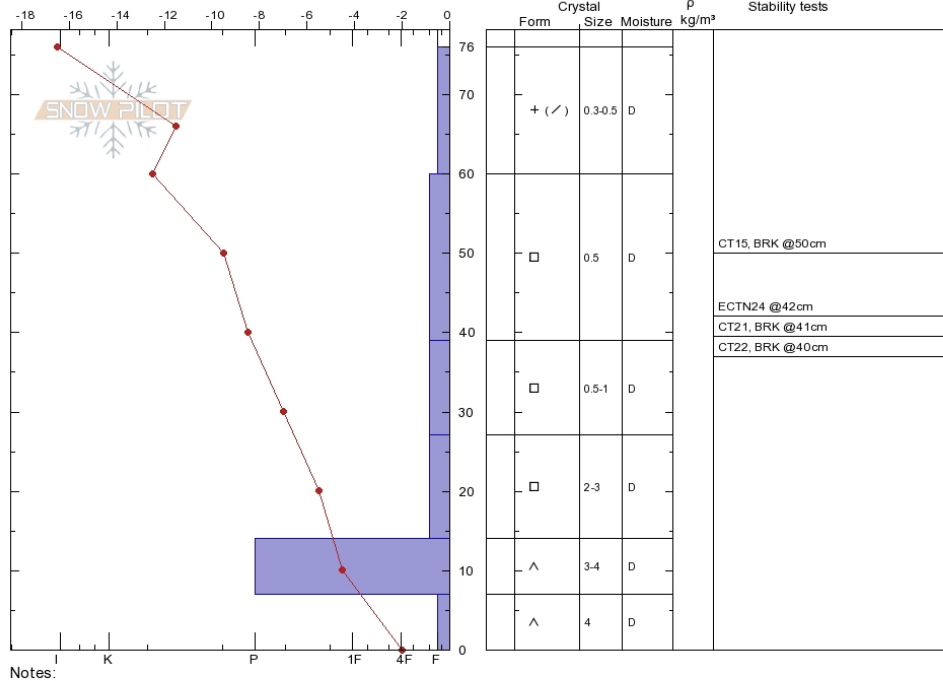
# Comparison Between Pits

**Old Man's 1 SAO 164**  
**Aspen Snowmass**  
**CO**  
 Elevation: 11634 ft  
 Aspect: 30°  
 Specifics:

**Gabi Benel**  
**Mon Jan 22 13:30 2018**  
 Co-ord: 13S 330261W 4337594N  
 Slope Angle: 13°  
 Wind Loading: no

Stability:  
 Air Temperature: -11°C  
 Sky Cover: CLR  
 Precipitation: NO  
 Wind: W Calm

HS76 PF60  
 Stability Test Notes  
 Layer Notes

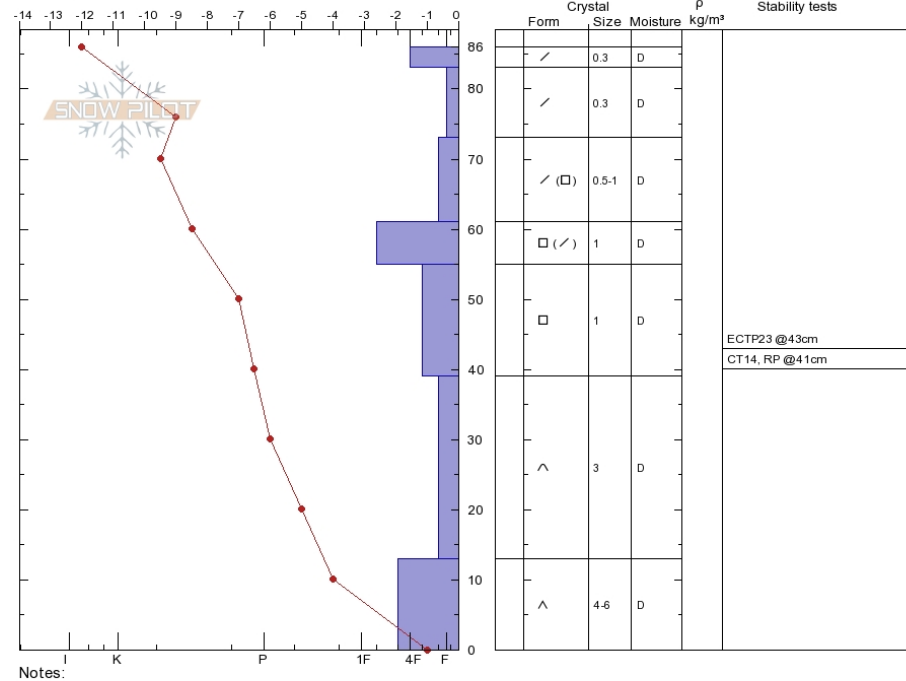


**Old Man's 2 SAO 164**  
**Aspen Snowmass**  
**CO**  
 Elevation: 11635 ft  
 Aspect: 30°  
 Specifics:

**Gabi Benel**  
**Sun Jan 28 14:00 2018**  
 Co-ord: 13S 330261W 4337594N  
 Slope Angle: 14°  
 Wind Loading: previous

Stability:  
 Air Temperature: -9.5°C  
 Sky Cover: FEW  
 Precipitation: NO  
 Wind: Calm

HS86 PF60  
 Stability Test Notes  
 Layer Notes



Note different height scales and  
different temperature scales

# Comparison Between Pits

- What were the differences in the pits, layers, tests?
  - Pit 1 was after a significant snow event for this season (~25cm). It showed a fairly uniform structure, with the new snow above multiple faceted layers, with smaller grain sizes towards the top of the snowpack (0.5 – 1mm) and larger grains at the bottom (2-4mm). I did not observe any slabs or crusts developing in the midpack. There was a hard layer (refrozen DH) near the ground that was 7cm thick.
  - Pit 2 was dug 5 days later and after another snow event of ~11.5cm and a significant wind event. HS increased from 76cm to 86 cm. I observed a more layered snowpack, with decomposing and fragmented forms. The snow from the Jan 20/21 storm had settled (looked like ~10cm of settling) and was increasing in hardness. A hard layer, 6cm thick 1F- was found above this snow, having resulted from wind transporting snow after the Jan 20/21 event, before the Jan 26 event. This layer was supportive to skis, but not to boots. The Jan 26 snow was above this and I did not observe this layer increasing in hardness yet. There was a thin (~3cm) wind crust at the surface of the snowpack. I did not observe a frozen hard layer at the ground in this pit location, but that could be due to slightly different pit location.
  - Instability tests between the two pits varied. In the first pit, results were CTH and ECTN around 40cm from the ground, with Q3 shear qualities. This was the new snow / old snow interface, on facets. In the second pit, tests were showing CTM and ECTP in a similar location as pit 1. The slab development is promoting easier failure on the faceted layers and more propagation.
  - Grain size overall was smaller for a larger amount of the snowpack for pit 2. There are a lot more decomposing particles, and the facets in the midpack were smaller and some had rounded edges (“martini ice cube” shape)
    - The temperature gradient through the snowpack is greater in pit 1 than in pit 2, especially in the midpack.

# Comparison Between Pits

- What were the similarities in the pits, layers, tests?
  - HS between the two pits was not that large – only 10cms.
    - I expected it to be greater due to the Jan 26 storm and the wind transported snow, but it was not. I think this is due to the settlement of the Jan 20/21 snow.
  - Failure location in the snowpack from the instability tests were the same
    - The failures are still happening on the faceted layers, not under the new slab that has developed nearer the top of the snowpack (@61cms in pit 2). Pit 2 is showing failure more readily (CTM vs CTH), more propagation, and shear qualities that are more Q2 than Q3.
  - There are faceted grains through much of the snowpack in both pits, with very large (4-6mm) DH at the bottom of both pits. The hard (P) layer at the ground in pit 1 was not observed in pit 2, but that could be due to a slightly different location for pit 2.