Exxon
Liam Fitzgerald (1983)
Gold Basin Project

I. Avalanche Path Description

One obvious avalanche path threatens the drill site in Gold Basin. This is an open bowl, the top of which is approximately 900' wide, and faces from northwest through northeast.

This avalanche path drops a total of 1,500' from a starting zone, (average slope angle 40°), elevation of 11,480' through an un-confined track, (average slope angle of 20°), to the runout at an elevation of 9,980'. The average slope angle from starting zone to runout is 23°. The starting zone is void of any significant vegetation except on the east and west perimeters. The ground surface here is most likely talus and loose rock formations.

The track portion of the avalanche path is un-confined and an approximate width of 400'. It contains two flatter portions referred to in this report as the 1st and 2nd "Flats" separated by a steeper breakover.

The 2nd "Flats" is the more significant of the two with a pronounced moraine feature on its north end. The terrain then breaks over to the final steep pitch above the 3rd Flats, which is the runout zone of major avalanche activity here.

The runout zone of this path can be divided into three parts.

Runout zone #1 is the second "Flats". The majority of significant avalanche acitivity is most likely contained or deflected to the west by the moraine feature found here. The major or maximum avalanches involving considerably greater quantities of snow, and moving at a higher velocity, will travel accross the 2nd "Flats", over the moraine, and down to the 3rd "Flats" runout zone #2. A portion of the flow from the larger releases may be deflected eastwards, below the 1st "Flats", and to the east of runout zone #1, down a gully, and running into the dense timber located near the southeast corner of the drilling platform.

One or all of these runout zones will be involved depending upon which portion of the starting zone releases, the amount of snow involved in the avalanche, and the speed at which it is traveling.

A significant feature of this avalanche path is a large fetch, (an area upwind of the starting zone that accumulates snow which under windy conditions, will be transported to the starting zone, thus

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A significant feature of this avalanche path is a large fetch, (an area upwind of the starting zone that accumulates snow which under windy conditions, will be transported to the starting zone, thus greatly increasing the amount of loading), extending some 1,500' to the southwest of the western half of the starting zone. Snow depths in this west to northwest facing fetch area averaged from 50" to 60". The low snow densities near the surface of this upper elevation slope would allow for a significant amount of snow available for transport even with low to moderate windspeeds.

II. Weather Conditions

The Manti-La Sal Range is a high elevation desert mountain range surrounded 360° by desert. This unique situation creates seasonally severe weather. The large elevation difference between Moab, Utah, (elevation 4,845'), and Mt. Peale, (elevation 12,721'), produces typical oragraphic lifting, strong prefrontal winds, thunder, lightning, and rapid temperature change. The general weather pattern is the northwest flow, with southwest winds preceeding most storms, followed by a frontal passage with decreasing winds shifting to northwest.
In order to produce a general summary of weather conditions, it is necessary to have accurate and complete records of windspeed, wind direction, precipitation amounts, (rain and snow), and high and low temperatures for many years. For this report we were able to use records taken from the Miners Basin study plot, (elevation approximately 10,000'), for the seasons 78-79, 80-81, 81-82, and 82-83.
The measurements taken were for new snowfall, total snowfall, snow depth, 24 hour high and low temperatures and general ski and wind conditions. No definate conclusion can be drawn from this amount of information but it does help give general weather trends.
Average monthly snowfall, monthly high and low temperatures, average monthly snow depths, number of clear days and number of snow days of 1" or more have been derived from the available weather records. (See charts 1, 2, 3 & 4) Windspeeds and direction are difficult to estimate, but because of the high elevation, general geography and cornice observation, the potential for strong and gusty winds is assumed. The predominant wind direction is southwest through northwest.
The average yearly snowfall from October through May is estimated to be 287" with the greatest snowfall month being March, (60"). Average high-low temperatures are interesting, as there is a fairly large difference between the monthly high-lows, in some instances, as much as 24°F, occuring in December. (See chart #2)
Summarizing these weather trends and averages, one can expect snowfall beginning in October and continuing through May. Most precipitation would come in a series of small storms which would be followed by periods of clear weather with cold nighttime temperatures.

This pattern will produce numerous weak layers throughout the snowpack. These clear spells will be followed by a return to storm conditions, which upon occasion would deposit heavy quantities of snow accompanied by strong winds.

III. Snowpack Conditions

Our observations of the snowpack was limited to two days, as with the weather, however, speculations can be made as to the general trend of snowpack conditions from a limited amount of information and observations.

The 1982-83 snowfall season, (September through April), produced record snow accumulations, (based on S.C.S. records at Geyser Pass). Quite frequently, a deep snow cover also equates to a structurally strong snowpack. Sub-surface investigations made in the month of May in years of heavy snow would most likely reveal little of the structural weaknesses usually found in early season or after a winter of low snowfall. This however was not the case in our sub-surface investigations of the snowpack in the starting zone of the Lt. Tukuhnikivatz Peak slidepath.

Conditions could be characterized as being typical of an upper elevation, north facing, continental type snowpack; basically, structurally weak. One can therefore assume that if these conditions were observed at the end of this snow season, that this is most likely the normal condition of the snowpack.

Analysis of available weather records indicate periods of light to moderate snowfall, (most likely of low H_2O equivalent), followed by periods of cold and possibly clear weather during which time temperature gradient metamorphism would be the dominant trend within the snowpack. A pattern such as this most likely produced the snowpack observed in our brief inspection. Our investigations revealed a weak and complex snowpack, capable of producing widespread surface avalanching with moderate snowfall and accompaning wind, and deeper climax avalanches with heavy snowfall.

These conditions most likely exist throughout most of the winter and early spring.

IV. Avalanche Activity and Hazard to Drill Site

Most of the activity occuring on this slidepath would be small, of either loose snow or shallow windslab. The combination of cold temperatures and low density snow would produce numerous loose snow avalanches and also weak surface conditions. Under windy conditions the low density snow will provide a considerable amount of material for transport, (with or without accompanying precipitation), and redeposition as a slab on top of the weak snow surface found on the leeward slopes.

These small releases should present little hazard in themselves, as the smaller avalanches will most likely travel no further than the first flats, (see diagram). Due to the slow rate of stabilization and settlement, structural weaknesses are likely to persist long after being buried beneath the snow surface. This factor could allow heavy sustained snowfall accompanied by wind or a succession of small storms falling on to weak layers producing a widespread avalanche several layers deep.

The slabs involved in these avalanches would most likely be of low density, (30% or less). Considering this and the terrain characteristics, it is reasonable to assume that many of the moderate to large avalanches on the Lt. Tukuhnikivatz Peak slidepath would travel most of the length of the path at relatively high speeds and be accompanied by a considerable amount of airborne snow.

We belive that most of these avalanches would be quite capable of reaching the second flats and upon occasion, beyond. This category of avalanche, however would not present any significant threat to the drill site, as much of the force of the avalanche will be contained or deflected by the moraine barrier.

A major or maximum release capable of reaching the bottom of the runout zone #2 and threatening the drill site would most likely involve most of the starting zone and fail on a temperature gradient layer deep within the snowpack. The amount of snow involved in this type of release, combined with the terrain features of a steep starting zone and a track with flats and breakovers, would produce a very large "high performance avalanche."

It would combine a destructive airblast as well as a large volume of flowing snow moving at a high rate of speed. Trees in the track portion of this path indicate a damaging flow height of snow and wind blast from the maximum releases to be from 10'- 20', (snow depths in these locations were measured to be 105"). In the runout zone, the height of tree damage is from 50'- 70', (snow depth 100").

The second flats and the associated moraine no doubt contribute to the extensive damage to the timber in runout zone #2. The maximum release will cross the second flats with little deceleration and become airborne due to the configuration of the moraine and the second breakover. Thus, the terrain feature that will deflect the snow away from the third flats in the majority of releases will in the maximum release produce a more destructive avalanche than if it were not there. This was most likely a strong factor contributing to the extensive timber damage in the vicinity of the drill site. Through inspection of aerial photos taken in February, 1977, it is obvious that the runout has been extended through one half acre or more of dense mature timber to its present boundary. This terrain feature makes it virtually impossible to defend the site from being reached by a maximum release.

The return interval of an avalanche capable of the destruction of this most recent major release is perhaps once in fifty years. Therefore, the probability of that size slide reoccuring in any one year period, (the anticipated time for exploratory drilling), in the next four or five decades is low. But the possibility must be considered due to an almost continual exposure of the workers to the potential hazard.

Also to be considered, is the fact that any future release of similar size to that of the avalanche that caused the recent extensive tree damage, will not doubt travel past the present boundary of timber in runout zone #2 and substantially threaten a portion of the drill site.

From our investigation we have observed no avalanche problem associated with the access road.

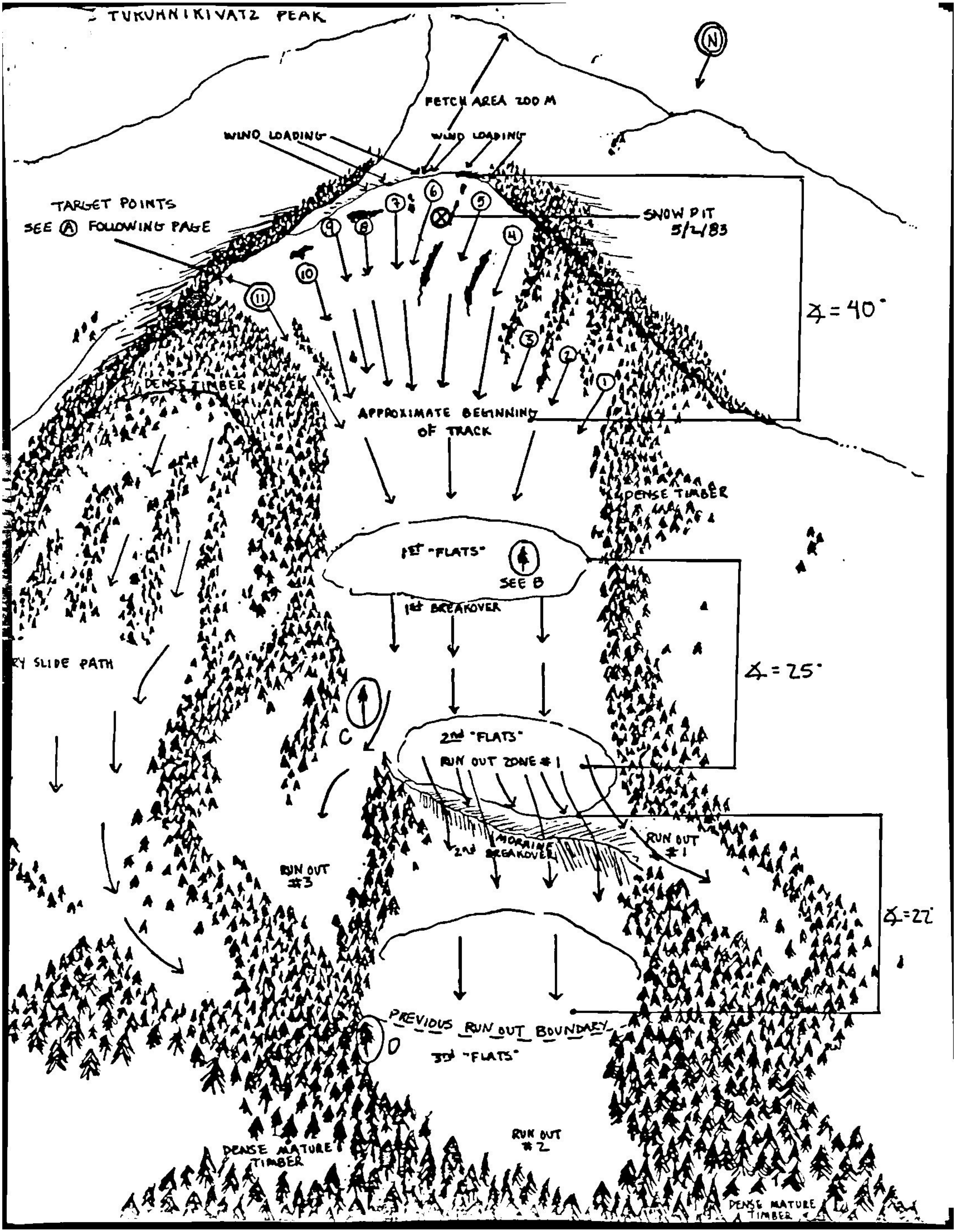
VII. Weather Monitoring and Avalanche Hazard Forecasting Program

It is recommended a full-time experienced avalanche hazard forecaster be employed. The responsibilities of this person should include monitoring weather conditions and instruments, consultation with National Weather Service, and recording of all weather data. This information will be assimilated for avalanche hazard forecasting. Other responsibilities include active avalanche control work, explosive handling, snowpit analysis, and avalanche rescue.

During periods of avalanche instability, the forecaster, in conjunction with the drill site foreman, should have the authority to evacuate personnel from the drill site while control work is being conducted. Carrying out some segments of control work will require assistance from site personnel or an outside source.

The installation of a weather station and snow study plot is crucial to effective forecasting of the avalanche hazard potential. This station should be located in the vicinity of the drill site, with the exception of the windspeed and wind direction indicators. These instruments should be located above the Lt. Tukuhnikivatz slidepath, with the readout located at the drill site. Weather station and snow study plot instruments should include; hydrothermograph, precipitation intensity gauge, barometer, master snow stake, 24 hour stake, and interval stake. Daily records of weather and avalanche activity and of snowpack conditions should be kept.

In an average winter, weather and avalanche forecasting should begin in early November and continue through late April. Access to the slide path starting zones via helicopter will be necessary during this period to conduct studies of snowpack conditions.


TUKUHNIKIVATZ PEAK
N
FETCH AREA 200 M
WIND LOADING
WIND LOADING
TARGET POINTS
SEE (A) FOLLOWING PAGE
SNOW PIT
5/2/83
1
2
3
4
5
6
7
8
9
10
11
∡ = 40°
DENSE TIMBER
APPROXIMATE BEGINNING
OF TRACK
DENSE TIMBER
1st "FLATS"
SEE B
1st BREAKOVER
RY SLIDE PATH
∡ = 25°
C
2nd "FLATS"
RUN OUT ZONE #1
MORAINE
2nd BREAKOVER
RUN OUT
#1
RUN OUT
#3
∡ = 22°
PREVIOUS RUN OUT BOUNDARY
D
3rd "FLATS"
RUN OUT
#2
DENSE MATURE
TIMBER
DENSE MATURE
TIMBER

(A)

TARGET POINT	SLOPE ANGLE	DEGREE OF EXPOSURE
1		
2	44°	35°
3	41°	10°
4	39°	360°
5		
6	40°	330°
7	35°	320°
8		
9		
10	41°	290°
11		

	TREE DAMAGE HT.	SNOW DEPTH
(B)	141"	105"
(C)	240"	98"
(D)	50-70 FEET	100"

SLIDE PATH CHARACTERISTICS

STARTING ZONE
- ELEVATION 11,489'
- WIDTH 800' (APPROX.)
- EXPOSURE NE-N-NW
- AVERAGE SLOPE ANGLE 40°

TRACK
- UNCONFINED
- WIDTH 450' (APPROX.)
- AVERAGE SLOPE ANGLE 20°

RUN OUT
- AVERAGE SLOPE ANGLE 8°

TOTAL VERTICAL DROP 1,509'

AVERAGE SLOPE ANGLE - STARTING ZONE TO END OF RUN OUT 23°

Chart #1

MONTHLY TOTAL SNOWFALL IN INCHES

ason	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	Total Snowfall For Year
8-79	40"	28"	48"	75"	76"	65"	29"	29"	353"
0-81	39"	26"	10"	25"	22"	57"	18"	19"	216"
1-82	48"	29"	34"	59"	22"	61"	8"	17"	278"
2-83	33"	57"	59"	17"	50"	60"*	18"*	21"*	302"**
erage	40"	35"	37.5"	44"	42.5"	60"	18"	21"	287"

* No records available for these months.
Average from previous years used.

** Estimated total.
Actual total probably considerably higher.

Chart #2

MONTHLY AVERAGE HIGH-LOW TEMPERATURES AT 10,000'

son		Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
	Hi		41°F	26°F	23°F	29.5°F	36.1°F	45.7°F	49.1°F
-79	Lo		16.7°F	3°F	1.5°F	6.8°F	12°F	19.1°F	26.8°F
	Hi	48°F	38°F		34.5°F	35.2°F	37.1°F	48.2°F	49°F
-81	Lo	22.9°F	16.4°F		13.1°F	9°F	10.5°	25.0°F	26.1°F
	Hi	42°F	38.4°F	31°F	32.9°F	32°F	34.9°F	45.5°F	49°F
-82	Lo	22.6°	17.6°F	9.5°F	3.7°F	7.3°F	12.5°F	18.2°F	26.2°F
	Hi	41°F	31.4°F	37.4°F	31°F	29.5°F			
-83	Lo	20.9°F	12.4°F	7.8°F	10.4°F	11.0°F			
age	Hi	43.5°F	37.2°F	31.4°F	30.3°F	31.5°F	36°F	45.4°F	49°F
p.	Lo	22.1°F	16.2°F	6.7°F	7.1°F	8.5°F	11.6°F	20.7°F	26.3°F

Chart #3

onth	# of Clear Days	# of Days With Snowfall of 1" or more	# of Days With High Winds *
.. 79	7	16	4
eb. 79	10	11	3
arch 79	6	13	4
pril 79	11	5	2
ay 79	12	6	2
ct. 80	19	7	0
ov. 80	18	4	0
an. 81	14	6	1
eb. 81	13	7	1
arch 81	2	17	2
pril 81	6	5	4
ay 81	5	7	0
ct. 81	9	11	3
ov. 81	11	7	4
ec. 81	9	8	5
an. 82	11	9	0
eb. 82	12	6	5
rch 82	5	15	2
pril 82	7	4	3
ay 82	10	3	2
ept. 82	4	4	7
t. 82	7	6	2
v. 82	11	12	0
c. 82		8	2
n. 83	10	9	4
b. 83	6	11	4

* Wind conditions monitored at 10,000', not at ridge tops, where winds would be stronger and more constant.

AVERAGE SNOW DEPTH PER MONTH AT 10,000'

November 1978	10"
December 1978	31"
January 1979	55"
February 1979	70.5"
March 1979	76"
April 1979	76"
May 1979	41"
October 1980	13"
November 1980	15"
January 81	25"
February 1981	31"
March 1981	37"
April 1981	35"
May 1981	3"
September 1982	5"
October 1982	10"
November 1982	20"
December 1982	44"
January 1983	51"
February 1983	64"
May 1983	100"