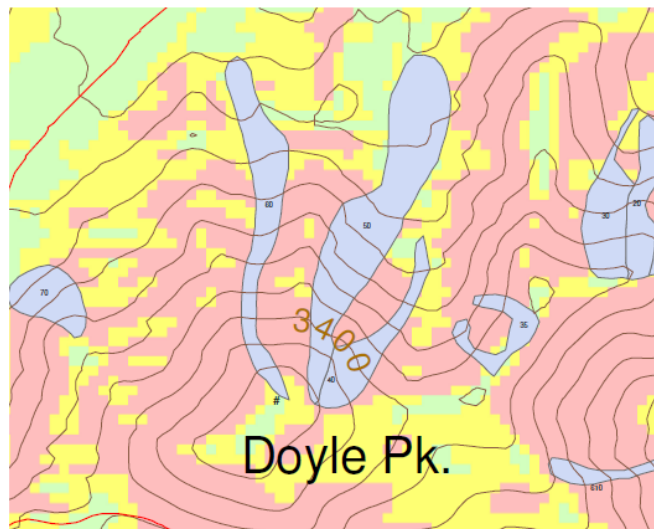


**Major Snow Avalanche Zones Map  
for the San Francisco Peaks, Coconino County, Arizona  
L.R. Dexter ©**

This document provides a descriptive key and metadata statement for an accompanying map of the same name. The map is made available as a public service to enhance the awareness of snow avalanches on the San Francisco Peaks. The map is designed to illustrate areas of potential major snow avalanche activity. Since avalanches can occur on very short and localized slopes, this map does not show every possible location where an avalanche can occur. In addition, the original study was limited to elevations above 8000'. A good example of avalanche terrain not included on this map can be found along the Lockett Meadow Road where heavy snow years have produced small slab avalanches on slopes above the road.

This map is designed with any eye toward backcountry use. The areas where major avalanches are known (or presumed) to occur are shown in light blue. The remaining colors indicate slope angles with light green areas representing the more shallow-angled slopes, yellow areas indicating intermediate-angled slopes, and pink areas showing the steeper slopes. These slope classifications are useful when traveling through terrain where small clearings in the vegetation could be potential avalanche slopes that are too small to be included as a distinct major avalanche path:

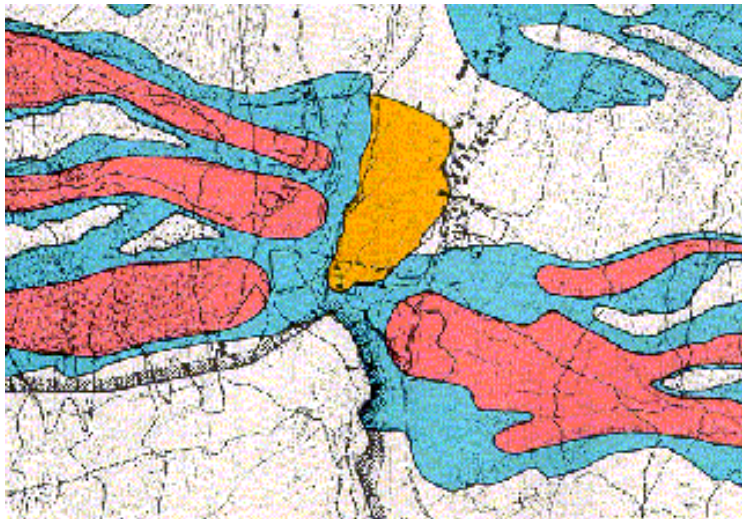


- Light Blue – Recognized major avalanche path
- Pink Zone – Slopes steeper than 25 degrees
- Yellow Zone – Slopes between 25 and 15 degrees
- Light Green Zone – Slopes shallower than 15 degrees
- 

Slopes in the pink category conservatively contain all the major avalanche path starting zones. Any open area in the pink zone should be considered a potential avalanche starting zone under the right weather and snowpack conditions.

Slopes in the yellow category contain occasional starting zones (especially for smaller paths) along with the tracks and runouts of the larger avalanche paths. Slopes in the green category define the typical lower limit of avalanche activity on the “Peaks” but can contain the extreme lower portions of runout zones for some of the larger avalanche paths.

It must be emphasized that the coding used on this map is different from that found on the typical snow avalanche zone maps created for developed areas such as ski resorts. These developed-area avalanche maps typically include three or four color-coded hazard zones as shown below from a Swiss example:



- Red Zone – No habitable structures allowed
- Blue Zone – Directly protected structures only
- Yellow Zone – Avalanches rare or of low impact
- White (green) Zone – No avalanche restrictions

These hazard maps are oriented toward structural placement and require engineering studies to delineate the various zones with any degree of confidence. Please keep the differences between the map types in mind.

The “Peaks” avalanche map is the culmination of work done beginning in the mid-1970s and continuing to this day. The map was compiled by Leland Dexter with field assistance from Arthur Pundt, Ken Walters, and other members of the San Francisco Mountain Avalanche Project or SFMAP (see History of Avalanche Studies on the San Francisco Peaks). The original map was produced as a limited number of hand-drawn copies for inclusion with Dexter’s M.S. degree thesis titled *Snow Avalanches on the San Francisco Peaks, Coconino County, Arizona*. The thesis is available for use at the Cline Library, Northern Arizona University. Recently a digital copy of the full thesis has been produced and is available by request from the author ([lee.dexter@nau.edu](mailto:lee.dexter@nau.edu)) or by direct download from the Kachina Peaks Avalanche Center web page ([www.kachinapeaks.org](http://www.kachinapeaks.org)).

The data used to create the original map included USGS 7.5' topographic maps, USFS aerial photography, and ground-based field studies. The avalanche path map was created by using an optical zoom-transfer scope (Bausch & Lomb ZT4-H) to superimpose aerial photographs onto a paper USGS 7.5 minute topographic quadrangle. Avalanche paths were subsequently traced onto the paper map using geomorphic and vegetative indicators seen in the photos. Field verification followed and included tree-damage observations, tree-ring avalanche event dates, geomorphic confirmation of path boundaries, and snow avalanche event observations. During the three winter seasons 1977-1980, SFMAP members actively scoured the Peaks looking signs for avalanche activity. They recorded an average of seventeen avalanche events per year on the San Francisco Peaks during those years. Backcountry avalanche paths which have produced notably large or frequent natural avalanche activity include Telemark (#100), Snowslide Canyon (#170), Humphreys Cirque (#200), Dunnam Canyon (#210), Crossfire (#360), Allison Clay (#450), and Monte Vista (#560). Many of the avalanche paths located in the Arizona Snowbowl permit area have responded to explosives control.

The numbering and naming system developed by San Francisco Mountain Avalanche Project is used on the map. The path numbers start with #1 (Boulderfield) on the lower eastern slopes of the mountain where avalanche activity is minimal. Numbering progresses counterclockwise around the outer flanks, with an excursion into, and out of, the Inner Basin; and ends up at back at the east side with Waterboard (#620). The numbers increment by 10 so that other paths identified as significant in subsequent years can be inserted between existing numbered paths without having to renumber the entire sequence. Several examples exist of paths inserted in such a fashion (the Core Ridge groups and Cleaver groups for example). For smaller avalanche paths found within the boundaries of a major path, or path group, a decimal numbering system is proposed. As an example, the larger of the two "Core Ridge" formations has a grouping of small chutes collectively called Hardcore South Group (#173) and Hardcore North Group (#177). When it becomes necessary to identify these smaller paths for avalanche purposes, the numbering would become #177.1, #177.2, #177.3 etc. It should be mentioned that naming conventions applied to the summits themselves reflect original and correct spelling (for example Aubineau and not Abineau; Rees and not Reese. These names may disagree with those printed on USGS and USFS maps).

Between 2004 and 2006, Dexter digitized the original map into ArcView/ArcGIS format, adjusted some of the avalanche path boundaries to match newer Digital Ortho Quarter Quad (DOQQ) photography, and updated some of the path names to match conventions developed in more recent years by the Arizona Snowbowl Ski Patrol (provided by B.J. Boyle)(see the attached metadata statement). Updating will continue as a new series of DOQQs are in production at the USGS as of early 2006 and general release is expected soon. Once the avalanche path layer was produced, a USGS Digital Elevation Model (DEM, 10 meter grid spacing) was processed to yield a 50 meter contour layer and a classed slope layer. A USFS trails layer and a summits layer were added to complete the final map. Collar information was added and the map was exported in .PDF format for public use. Two .PDF versions are available. The first is optimized for 8.5 x 11 inch printing and the second is optimized for larger format plotting. There are some companion products available including a path outline map with names labeled directly on the map, a spreadsheet list of path names and numbers, and a metadata statement for the avalanche path GIS layer. Samples of these items are attached below:



PATH_NAME	DEX_NUMBER	MAJOR_GRP
Boulderfield	1	Baby Peaks East
Dice	10	Baby Peaks East
Hidden	20	Baby Peaks East
Baby Peaks	30	Baby Peaks East
Scorpion	35	Baby Peaks East
Black Bear	40	Doyle Peak North
Telescope	50	Doyle Peak North
Sickle Moon	60	Doyle Peak North
Sneaky Pete	70	Doyle Peak West
Jay's Slide	80	Fremont Peak North
Silverton	90	Fremont Peak North
Offchute	95	Fremont Peak North
Telemark	100	Fremont Peak North
Roadway	110	Fremont Peak North
Corner	120	Fremont Peak West
Weatherford	125	Fremont Peak West
Study Plot	130	Fremont Peak West
Blowout Basin	140	Agassiz Peak East
Inner Basin	150	Agassiz Peak East
Survey Post	160	Agassiz Peak East
Softcore South Group	165	Core Ridge
Snowslide Canyon	170	Agassiz Peak East
Hardcore South Group	173	Core Ridge
Hardcore North Group	177	Core Ridge
Riser	180	Humphreys Peak East
Spring Slide	190	Humphreys Peak East
Humphreys Cirque Group	200	Humphreys Peak East
Dunnam Canyon	210	Humphreys Peak East
Cleaver South Group	213	Humphreys Peak East
Cleaver North Group	217	Humphreys Peak East
Beard Canyon	220	Humphreys Peak East
Cutoff	230	Cliffbands Southeast
Zipper	240	Cliffbands Southeast
Crisco	250	Cliffbands Southeast
Cliffband	260	Cliffbands Southeast
Squeaker	270	Cliffbands Southeast
Aspen	280	Cliffbands Southeast
Bear Jaw Canyon	290	Bear Jaw Canyon
Liberator	300	Bear Jaw Canyon
Stabilizer	310	Bear Jaw Canyon
Dike	320	Bear Jaw Canyon
Aubineau Canyon	330	Aubineau Canyon
Cohonina	340	Aubineau Canyon
Sinagua	350	Aubineau Canyon
Anasazi	355	Aubineau Canyon
Crossfire	360	Aubineau Canyon
Espil	365	Aubineau Canyon
Northridge	370	North Ridge
Rockpile	380	North Ridge
Noname	390	North Ridge
White Horse	400	Humphreys Peak West
Night Mare	405	Humphreys Peak West
Lew Canyon	410	Humphreys Peak West
Pipeline	420	Humphreys Peak West
Maybe Not	430	Humphreys Peak West
Philomena Spring	440	Humphreys Peak West
Allison Clay	450	Humphreys Peak West
Flying Dutchman	460	Humphreys Peak West
Temptations (Gadzooks)	470	Humphreys Peak West
Rustler	480	Snow Bowl
Sundance	490	Snow Bowl
Shiprock	495	Snow Bowl
Big Bowl/Lower Bowl	500	Snow Bowl
Larry's Line	510	Snow Bowl
Upper Lightning	520	Snow Bowl
Seven Meadows (Gully One)	525	Agassiz Peak Southside
Solitude (Gully Two)	530	Agassiz Peak Southside
The Glades (Gully Three)	535	Agassiz Peak Southside
Watson	540	Agassiz Peak Southside
Snake Eye	550	Agassiz Peak Southside
Monte Vista (Rick's)	560	Agassiz Peak Southside
Meadow	570	Fremont Peak East
Kachina	580	Fremont Peak East
Angel Food	590	Fremont Peak East
Determination	600	Fremont Peak East
Outside	610	Baby Peaks East
Waterboard	620	Baby Peaks East

## *San Francisco Peaks Avalanche GIS Layer Metadata*

**LAYER/DATA SET NAME:** Avalanche06

**DATA CREATOR/CUSTODIAN SECTION:**

1. *Contact Person:* Leland R. Dexter (Creator)
2. *Contact Telephone:* 928-523-6535
3. *Contact Email:* lee.dexter@nau.edu
4. *Contact Mailing Address 1:* Department of Geography, NAU Box 15016
5. *Contact Mailing Address 2:* Northern Arizona University
6. *Contact City:* Flagstaff
7. *Contact State:* AZ
8. *Contact ZIP Code:* 86011

**DATA IDENTIFICATION SECTION:**

9. *Layer/Data Set Name:* Avalanche06
10. *Date Created:* December 2004
11. *Date Last Modified:* January 2006
12. *Data Representation Model:* Vector
13. *Data Object Type:* Polygons
14. *Digital Format:* ESRI Shapefile
15. *Thematic Key Words:* San Francisco Peaks, Snow Avalanche, Backcountry Skiing
16. *Data Extent SW corner:* 435500 (E), 3906700 (N)
17. *Data Extent SE corner:* 443500 (E), 3906700 (N)
18. *Data Extent NE corner:* 443500 (E), 3913700 (N)
19. *Data Extent NW corner:* 435500 (E), 3913700 (N)
20. *Data Dictionary:*
  - a. *Path\_name* (C), name of the avalanche path given by Dexter, 1981
  - b. *Dex\_number* (I), number of the avalanche path given by Dexter, 1981
  - c. *Major\_grp* (C), major avalanche path group
  - d. *Path\_type* (C), type of path (simple, complex etc.)
  - e. *Apx\_aspect* (C), approximate aspect of the path
  - f. *Load\_dir* (C), loading direction
  - g. *Ob\_ev78\_80* (I), number of observed events from 1978-1980
  - h. *Ob\_ev\_yrs* (I), number of years with observed events from 1978-1980
  - i. *Tre\_ring\_dt* (I), years where tree ring indicators show avalanche activity
  - j. *Data\_sourc* (C), data source = L.R. Dexter
  - k. *Yr\_mapped* (I), year the path was originally mapped
  - l. *Yr\_modifie* (I), year the path was re-mapped
  - m. *Notes* (C), any comments
21. *Data Completeness:* Complete as presented by Dexter, 1981, Subject to further field updates.
22. *Data Consistency:* Some objects derived by tablet digitizing were modified by heads-up screen digitizing following DOQQ based features.
23. *Description:* Snow avalanche terrain on the San Francisco Peaks from Dexter, 1981, 2004-6

**SOURCE SECTION:**

24. *Source Name:* Snow Avalanche Zones on the San Francisco Peaks
25. *Source Format:* USGS paper 7.5 minute quadrangle
26. *Source Quality:* Very good, new manuscript
27. *Source Scale:* 1:24000
28. *Creator of Source:* L.R. Dexter
29. *Date of Source:* 1981 NAU MS Thesis, revised September, 2004 from DOQQs
30. *Data Conversion Methodology:* Tablet digitizing with heads-up updating from DOQQs
31. *Other Lineage Notes:* Features drawn on a standard 7.5 minute topo base map using an optical zoom-transfer scope and conventional USFS air photos in 1981. Features updated in 2004 with DOQQs from the early 1990s.

(Continued)

**PROJECTION SECTION:**

32. *Coordinate System:* UTM, Zone 12, North
33. *Horizontal Datum:* NAD 1927
34. *Vertical Datum:* NAVD 1929
35. *Projection:* Transverse Mercator
36. *Horizontal Units:* Meters
37. *Vertical Units:* Meters

**ACCURACY/PRECISION/RESOLUTION SECTION:**

38. *Horizontal Accuracy:* 2 meters RMS at digitizing time
39. *Horizontal Precision:* 20 meters
40. *Vertical Accuracy:* Unknown
41. *Vertical Precision:* Unknown
42. *Resolution (or RESEL per Tobler, 1987):* RESEL = 858 meters
43. *Minimum Mapping Unit:* 30 meters

**METADATA REFERENCE SECTION:**

28. *Metadata Revision Date:* January 17, 2006

**COMMENTS SECTION:**

44. *Data Set Description:* Snow Avalanches on the San Francisco Peaks, Coconino County, Arizona
45. *Bibliographic Reference:*; See Dexter, L.R. (1981) Snow Avalanches on the San Francisco Peaks, NAU MS Thesis for more details.
46. *Other Comments:* A .PDF copy of a map created using this data layer (combined with others) is available for free public distribution. The original GIS data layer is proprietary.