# Determining the date and frequency of avalanches using dendrochronology and the extent of the runout zone based on remote sensing imagery at Ursus Hole, Cascade Mountain, Canada

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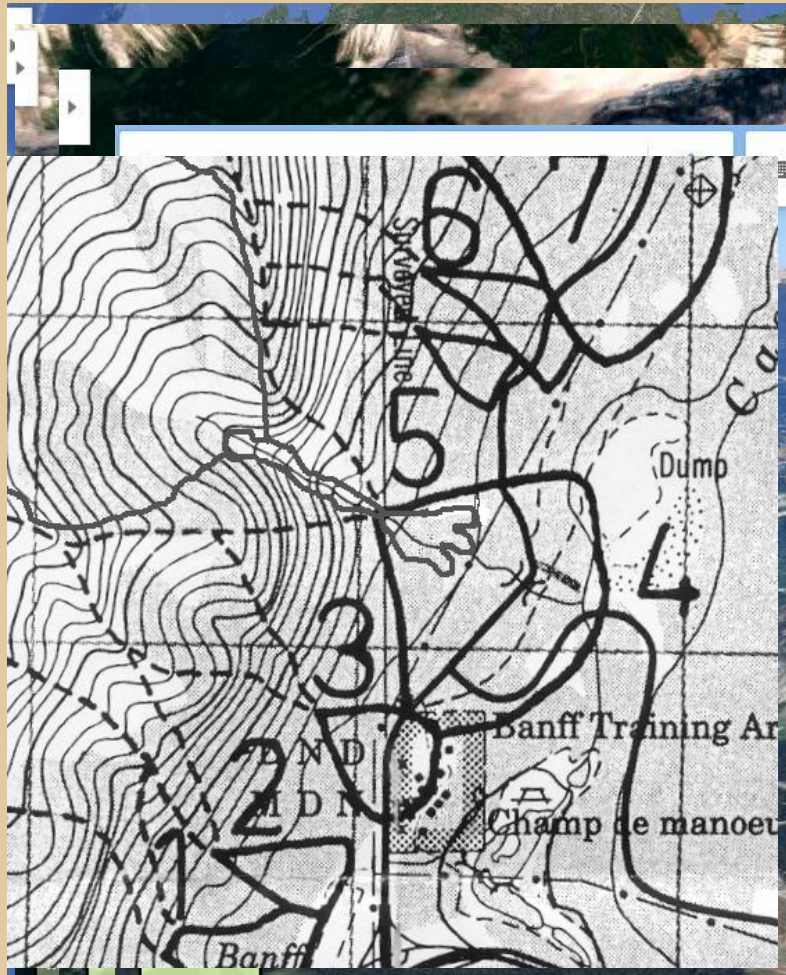
# Ursus Hole, Cascade Mountain, Canada geographycal location







- Bowl shaped snow collecting basin with ridges and forest stripes
- Confined avalanche path
- Length of runout zone ~ 500m
- Angle of runout zone ~14°

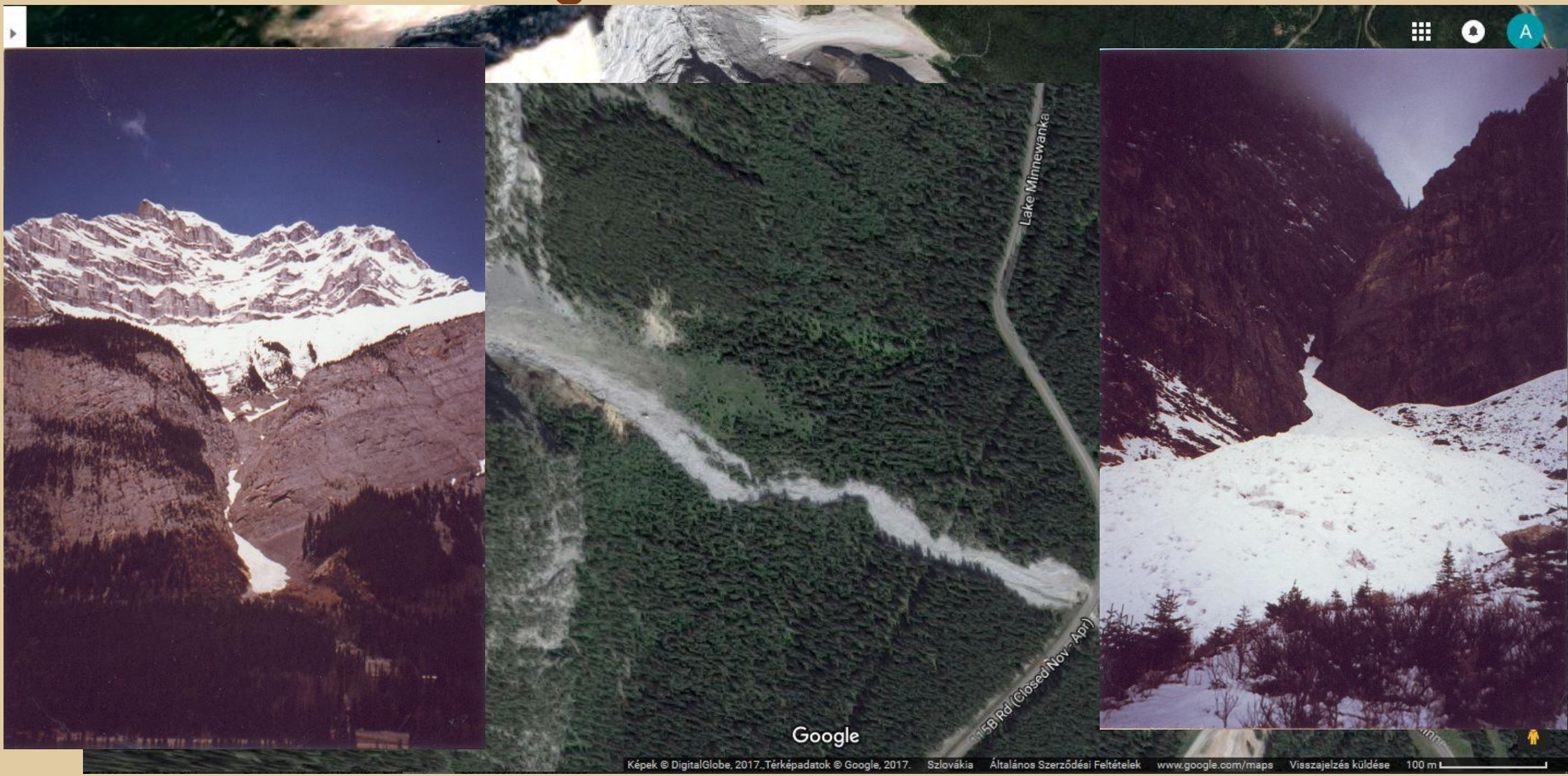
# Avalanche path and frequency

## remote sensing and dendrochronology

- Canada: data on avalanches are not as detailed and old as in Europe
- Avalanche path and frequency can often only be determined by botanical clues and remote sensing imagery
  - Delineation of the runout zone by remote sensing imagery
  - Determination of avalanche return frequency by dendrochronology

# Avalanche path

## remote sensing



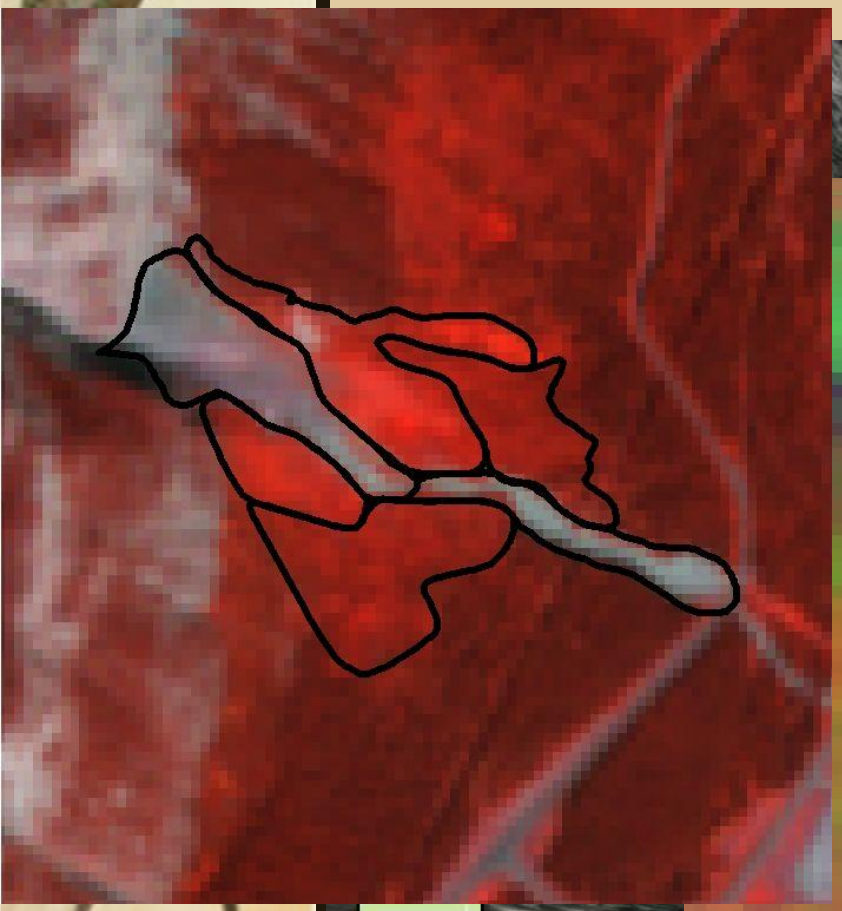
# Avalanche path

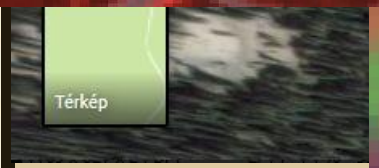
## remote sensing

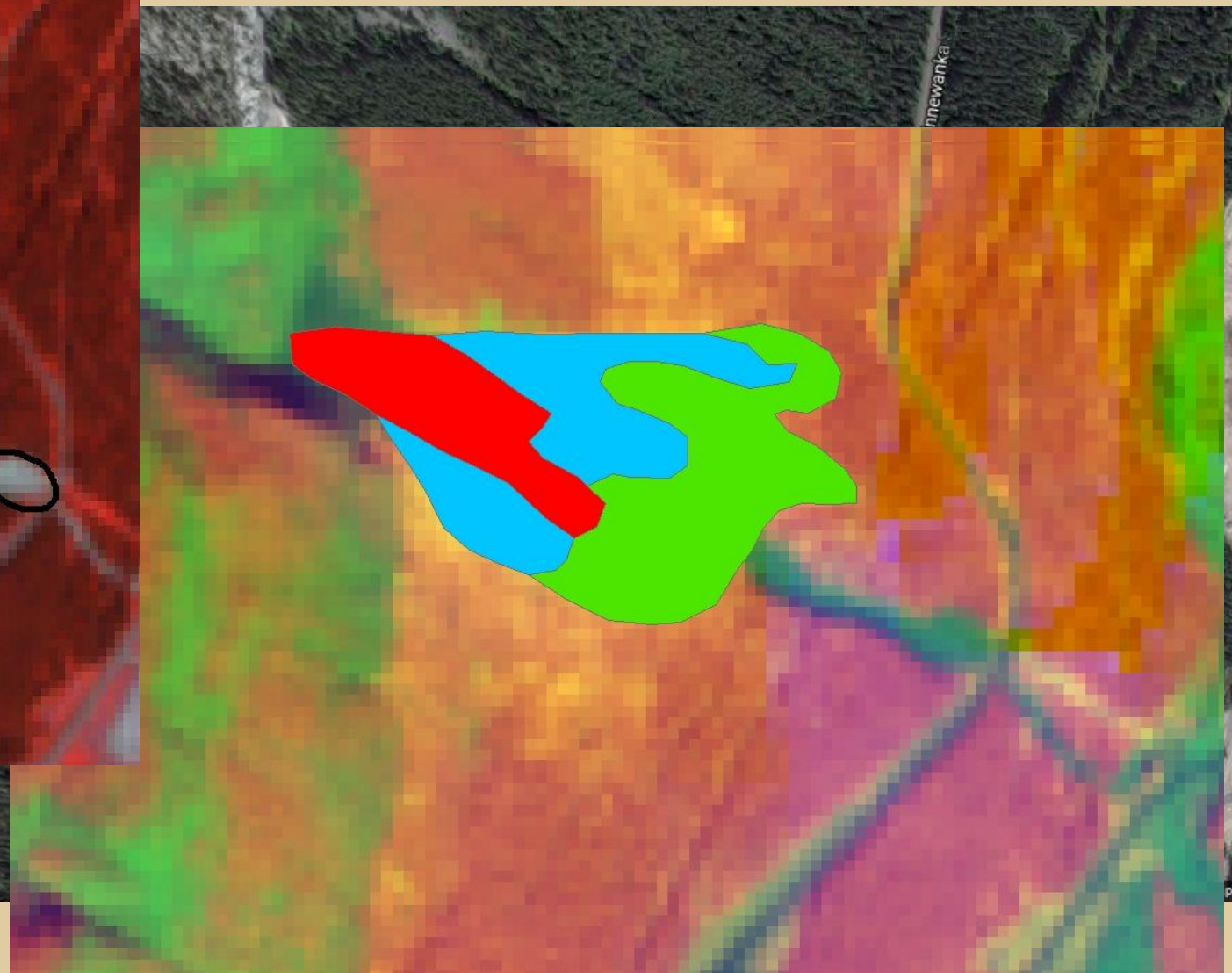

1962 1971 1995

# Avalanche path

## remote sensing






Sentinel 2
Layer stack:
Red: NDVI
Green: NIR
Blue: aspect

# Avalanche frequency-method

## dendrochronology


- Markers of gr
  - Narrow tree ri branches, wounds) slow the growth of the tree
  - Wide tree rings: younger trees benefit from decrease surrounding trees are broken or swept
  - Eccentric tree rings: tilted trees attempt to return to grow reaction wood, forming eccentric tree rings
  - New vertical stems can form from shoots if the tree is tilted or broken
  - Callus tissue forms when avalanche debris hits and scars the uphill side of trees
  - Age of the oldest tree can show the last devastating avalanche

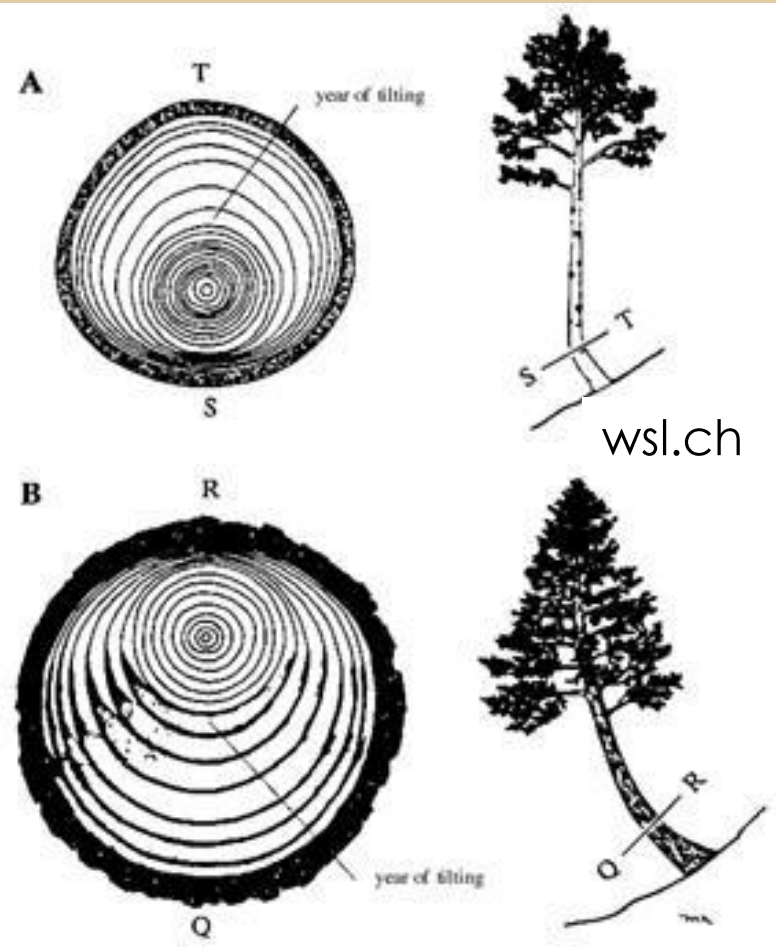
# Avalanche frequency - method

***Reaction wood*** *forms in place of normal wood as a response to gravity, where the cambial cells are oriented other than vertically.* (*wikipedia*)

- Conifers
  - Wide, dark, reddish-brown rings on the downhill side of the tree
- Decidious trees
  - Wide, light rings on the uphill side of the tree

**Method**

- Few decidious trees at the site, so cores were taken from conifers (spruce) with increment borer.
- 14 cores were taken, 6 on the less, 8 on the more frequently used part.



# Tree ring analysis at Ursus Hole

| Number of tree | Total number of rings | Number of rings since avalanches | Date of avalanche |
|---|---|---|---|
| More frequently used part | | | |
| #1 | 13 | 9 | 1991 |
| #2 | 16 | 12 | 1988 |
| #3 | 14 | 9 | 1991 |
| #4 | 19 | 5, 18 | 1995, 1982 |
| #5 | 24 | 5, 18 | 1995, 1982 |
| #6 | 18 | 9 | 1991 |
| #7 | 26 | 15 | 1985 |
| #13 | 18 | 9 | 1991 |
| Less frequently used part | | | |
| #8 | 23 | 9, 18 | 1991, 1982 |
| #9 | 24 | 22 | 1978 |
| #10 | 39 | 28 | 1972 |
| #11 | 33 | 28 | 1972 |
| #12 | 26 | 22 | 1978 |
| #14 | 33 | 9, 28 | 1991, 1972 |

# Avalanche frequency - results

- Most frequently used runout (zone 0):
  - Only herbaceous vegetation, avalanches in each year
- More frequently used runout (zone 1):
  - Herbaceous, young spruce, wolf willow, scattered trees
  - avalanches in every 3 years, in 1982, 1985, 1988, 1991, 1995
  - Oldest tree ~30 years old, average age ~21 years
- Less frequently used runout (zone 2):
  - Sparce spruce forest
  - avalanches in every ~6 years (std 3,6), in 1972, 1978, 1982, 1991
  - Oldest tree ~42 years old, average age ~33 years

The avalanches in 1982 and 1991 affected all zones. Before 1982, the vegetation in zone 1 was probably still too young to get any marks from avalanches.

# Conclusion

- The runout zone of the avalanche path can be divided into 3 categories based on remote sensing imagery
- The date of the avalanches can be determined based on dendrochronlogical clues.
  - Most frequently used part (zone 0) Return interval: 1 year
  - More frequently used part (zone 1) Return interval: 3 years
  - Less frequently used part (zone 2) Return interval:~6 years (std 3,6)

# Thank you for your attention!