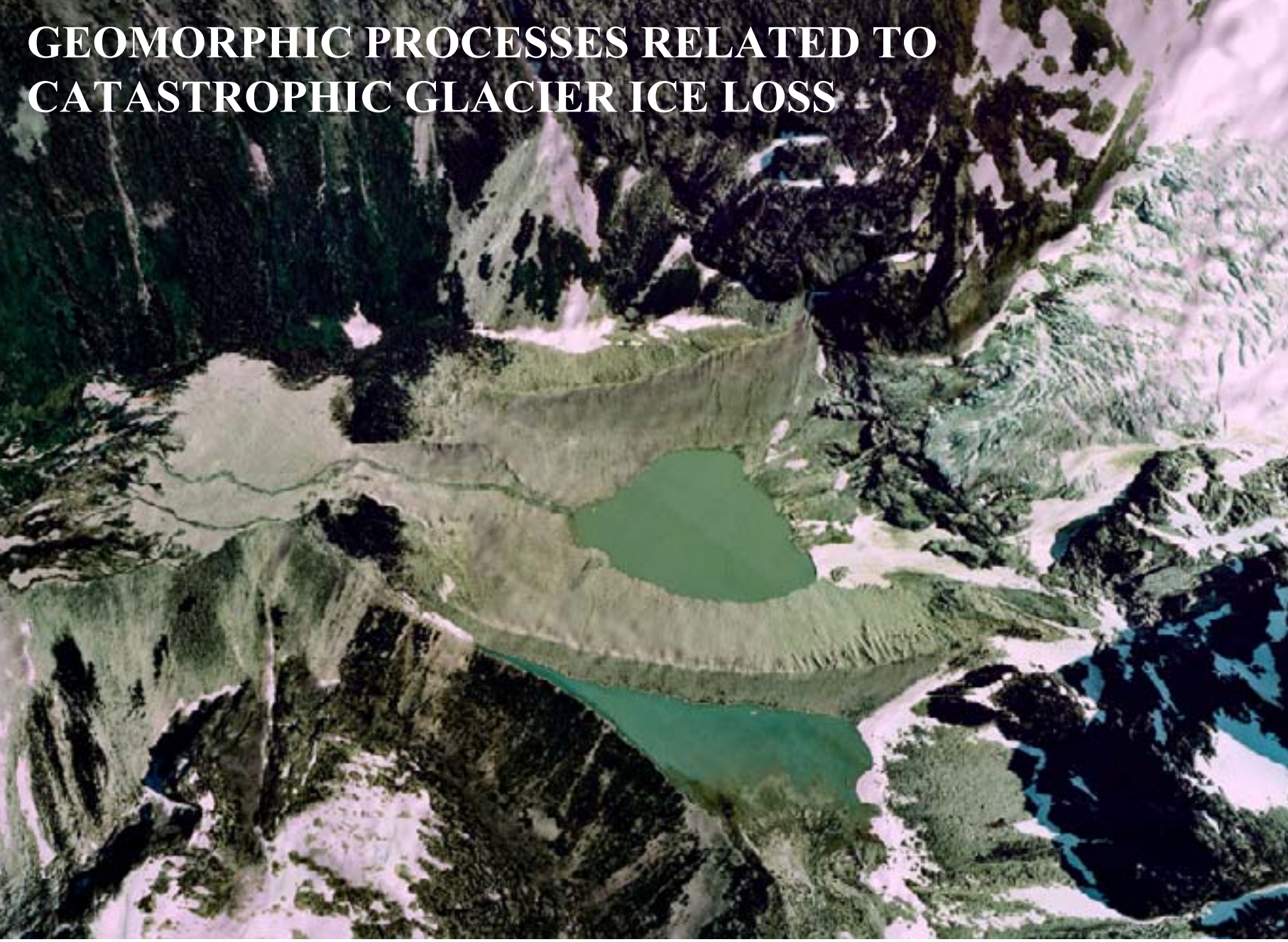
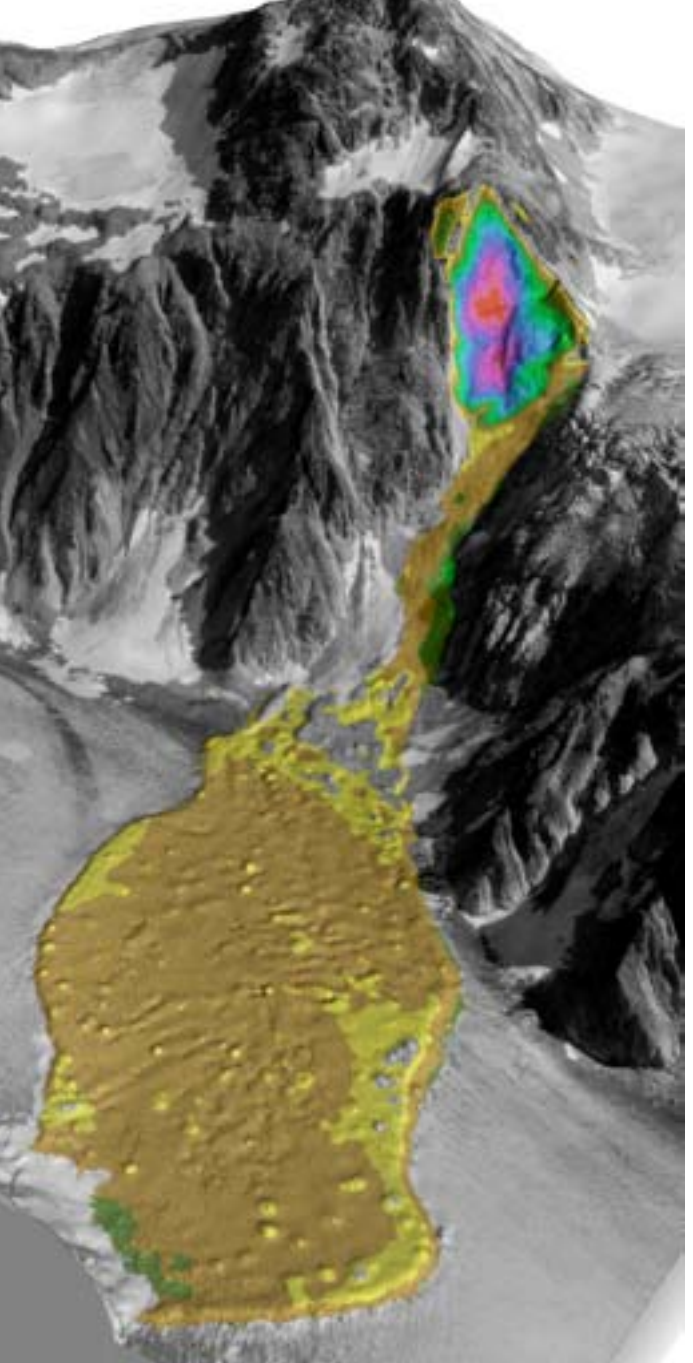
GEOMORPHIC PROCESSES RELATED TO CATASTROPHIC GLACIER ICE LOSS



G. EVANS (Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, Canada)



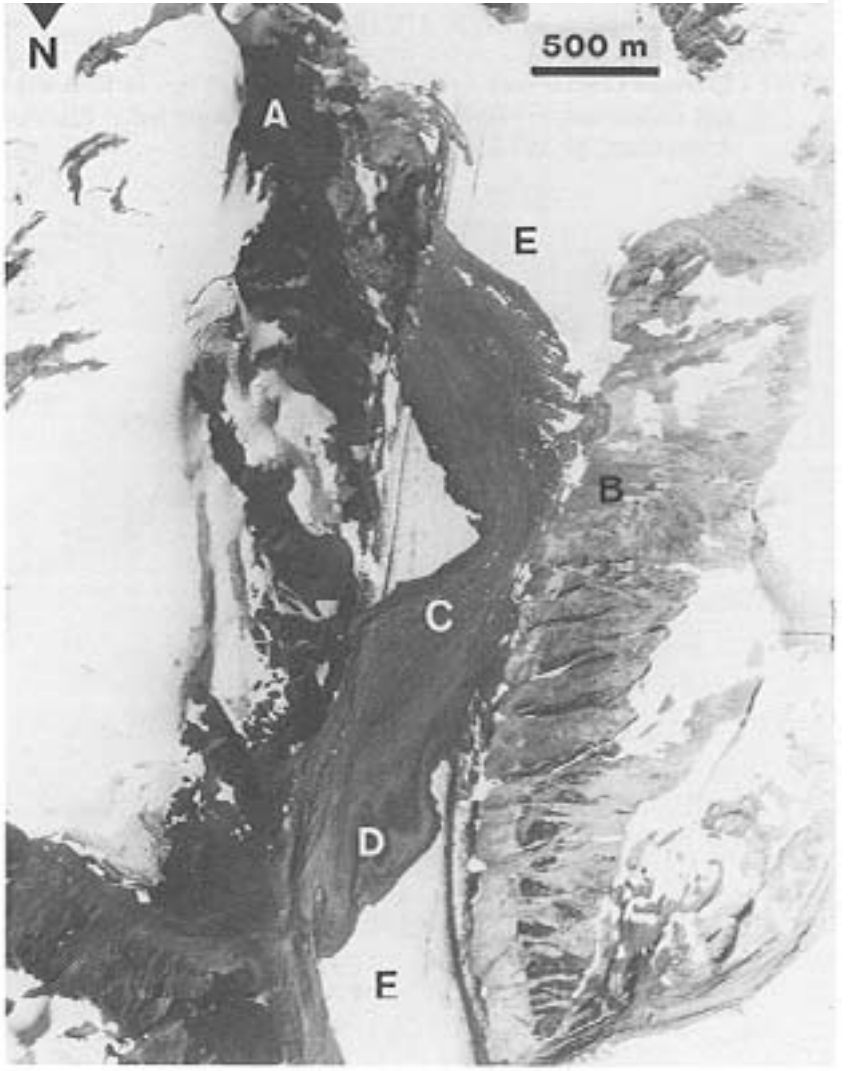
GLACIER ICE LOSS IN THREE DIMENSIONS;

AREAL EXTENT (GLACIAL RETREAT), AND VERTICAL DIMENSION (GLACIER DOWNWASTING)

GEOMORPHIC PROCESSES ASSOCIATED WITH GLACIER ICE LOSS

- LANDSLIDES
- DEBRIS FLOWS
- GLACIER AVALANCHES
- FORMATION AND FAILURE OF MORAINE-DAMMED LAKES
- FORMATION AND FAILURE OF GLACIER-DAMMED LAKES

ROCK AVALANCHES, WITH VOLUMES IN EXCESS OF 1 M m^3, HAVE OCCURRED IN THE COAST MOUNTAINS OF BRITISH COLUMBIA EVERY 3.5 YEARS 1955-1999.

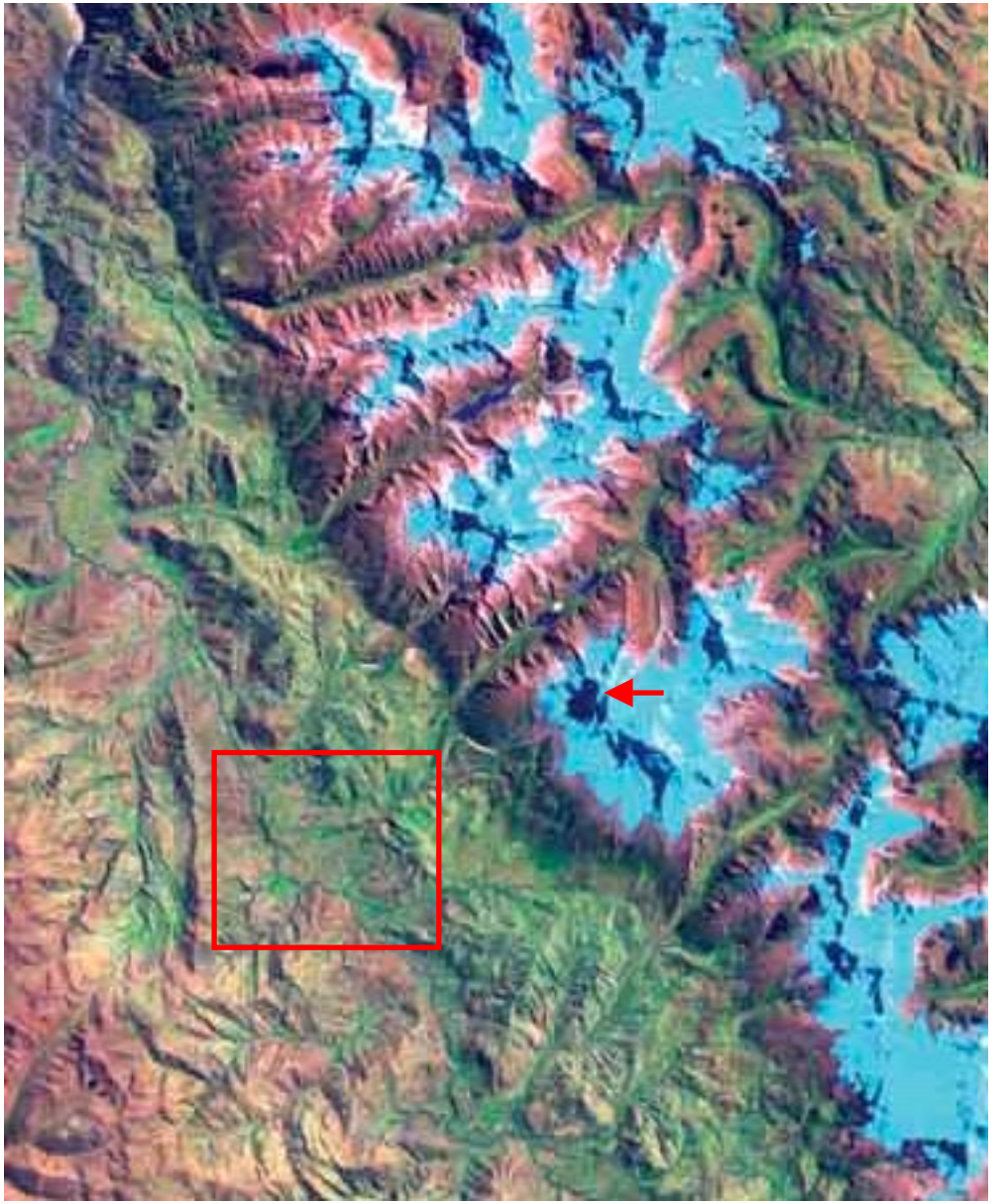


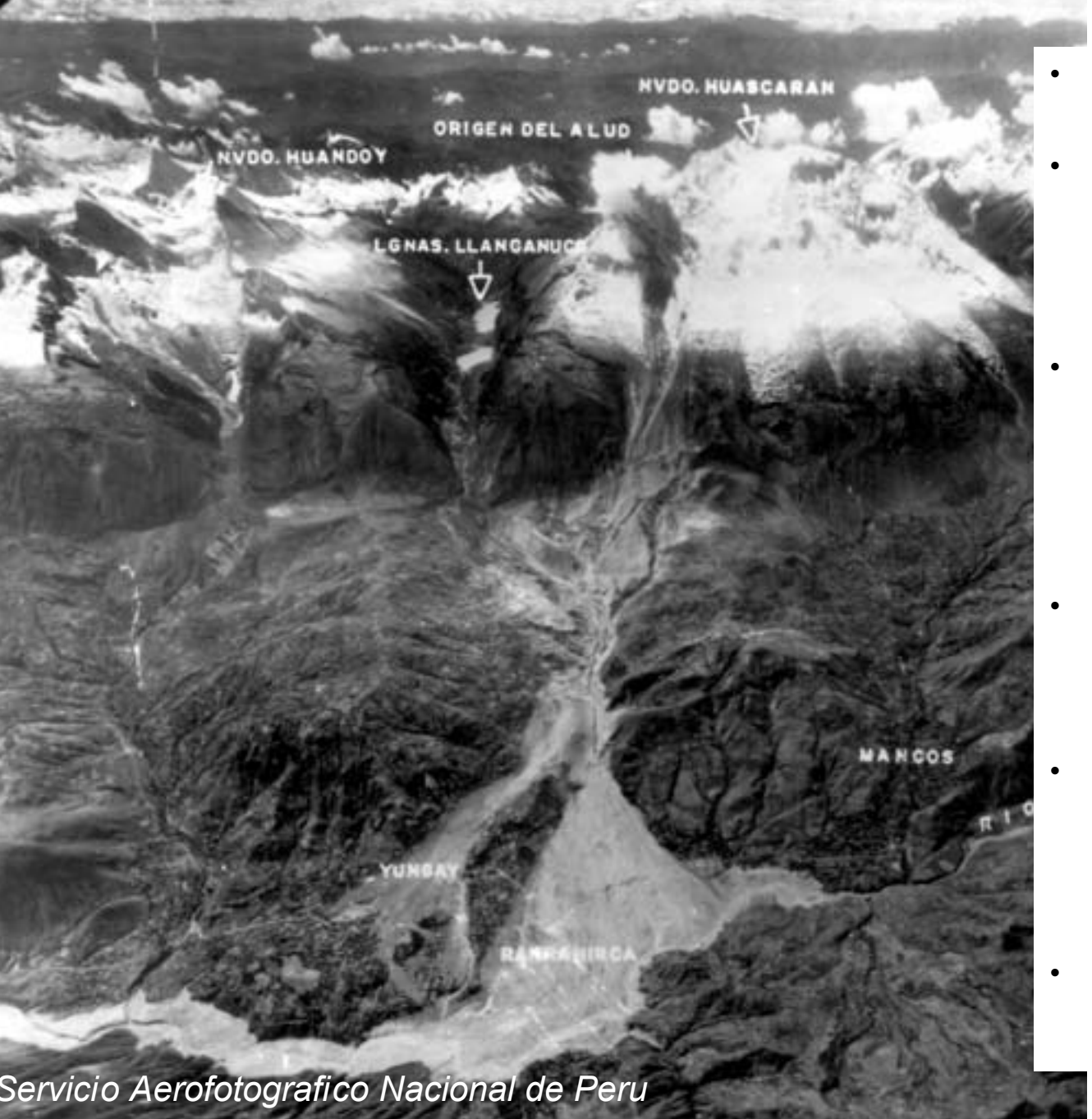
1956 Tim Williams Glacier rock avalanche (3 M m^3)

← 1997 Mount Munday rock avalanche (3.2 M m^3)

CORDILLERA BLANCA; ELEMENTS OF ENGINEERING GEOMORPHOLGY

- Active tectonics
- High relief
- Glacierised mountains
- Glaciers have undergone dramatic retreat since Little Ice Age





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- **Occurred May 31, 1970 at 3:23 pm local time**
- **Initiated as a rockfall triggered by M7.7 offshore earthquake at an epicentral distance of 130 km**
- **Travelled 16 km at extremely high velocity to the Rio Santa and then downstream as a distal debris flow that swept down to the sea.**
- **Debris split into two lobes one of which buried the town of Yungay**
- **Total number of deaths could be as much as 20,000 people (some estimates are much lower)**
- **Site of a similar smaller event in 1962 which had buried Ranrahirca**

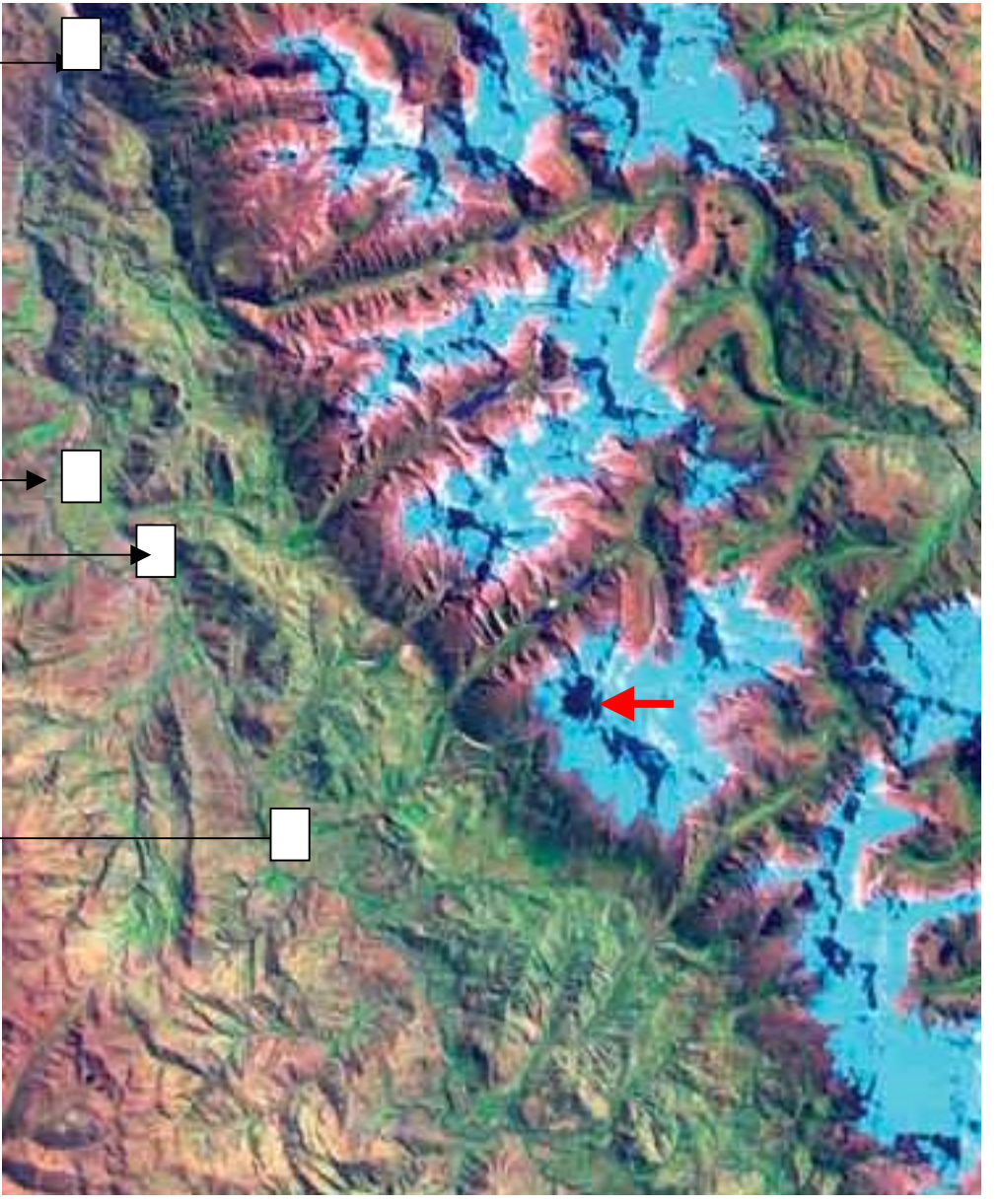
Exposures of 1970 debris at Yungay Cemetry; matrix-supported debris flow deposit

CANON DEL PATO
(40 km)

CHAQUECOCHA
BRIDGE (25 km)

CARAZ (18 km)

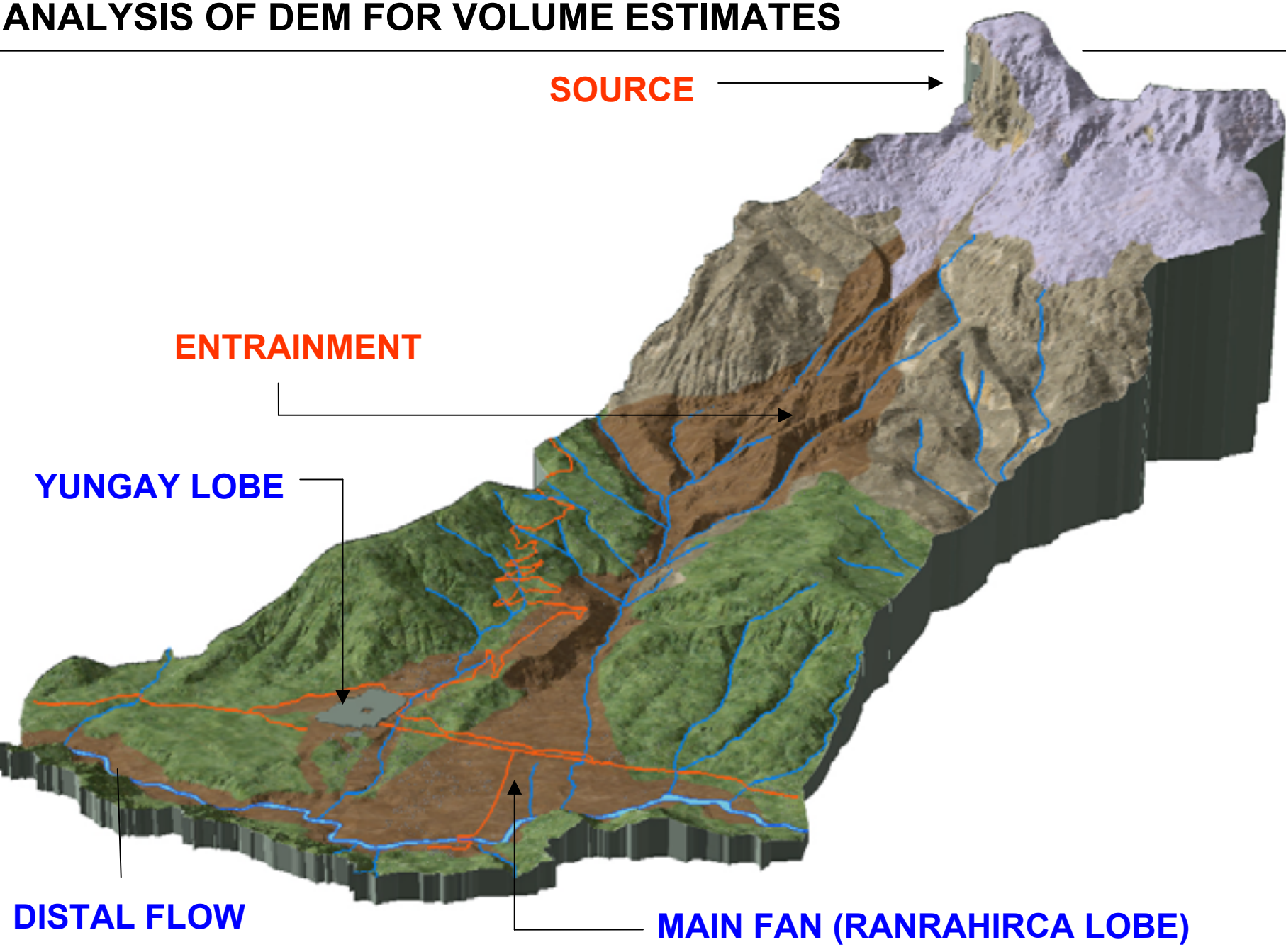
RANRAHIRCA

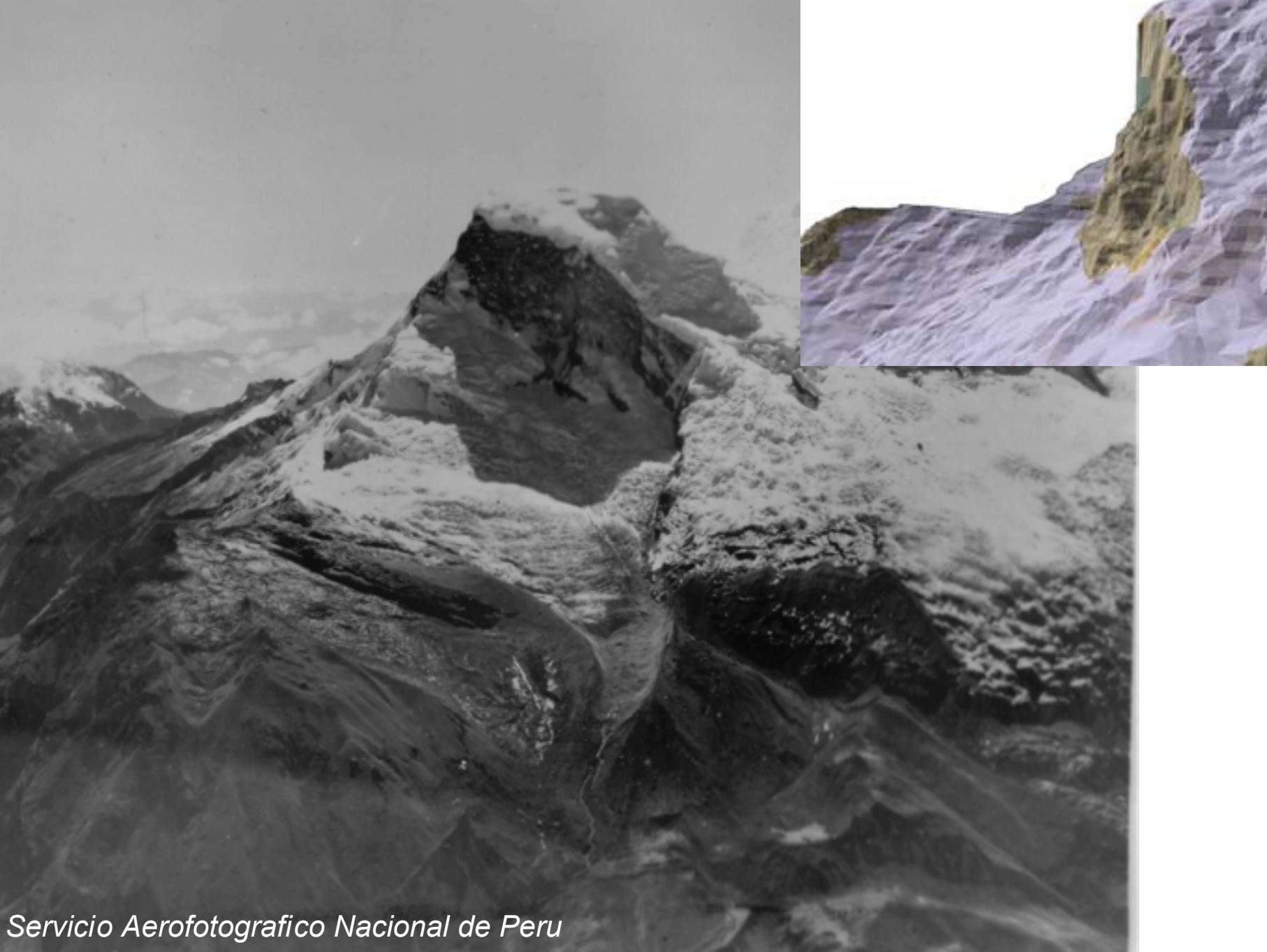


DISTAL DEBRIS FLOW IN RIO SANTA

Distances are from Ranrahirca

ANALYSIS OF DEM FOR VOLUME ESTIMATES





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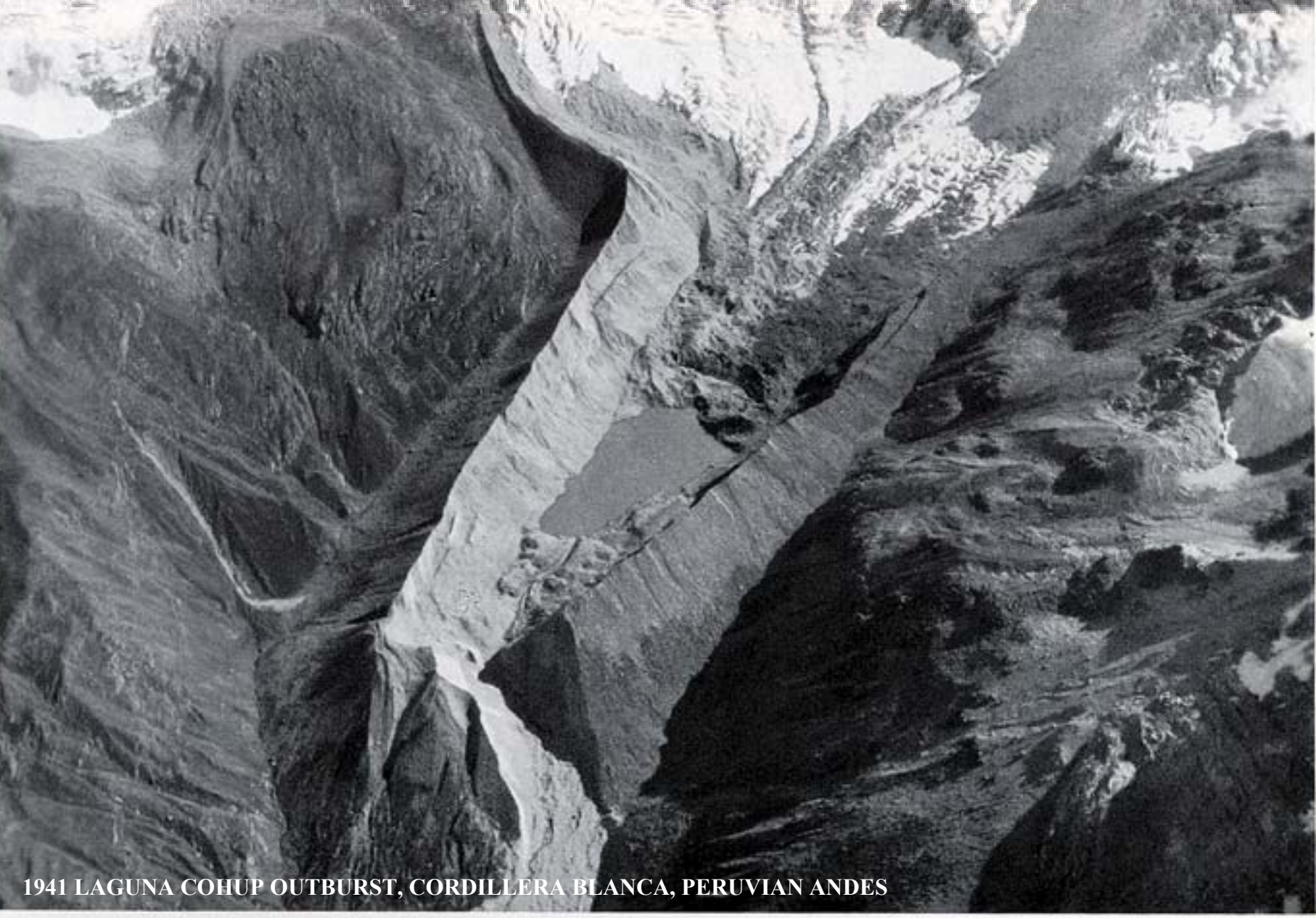
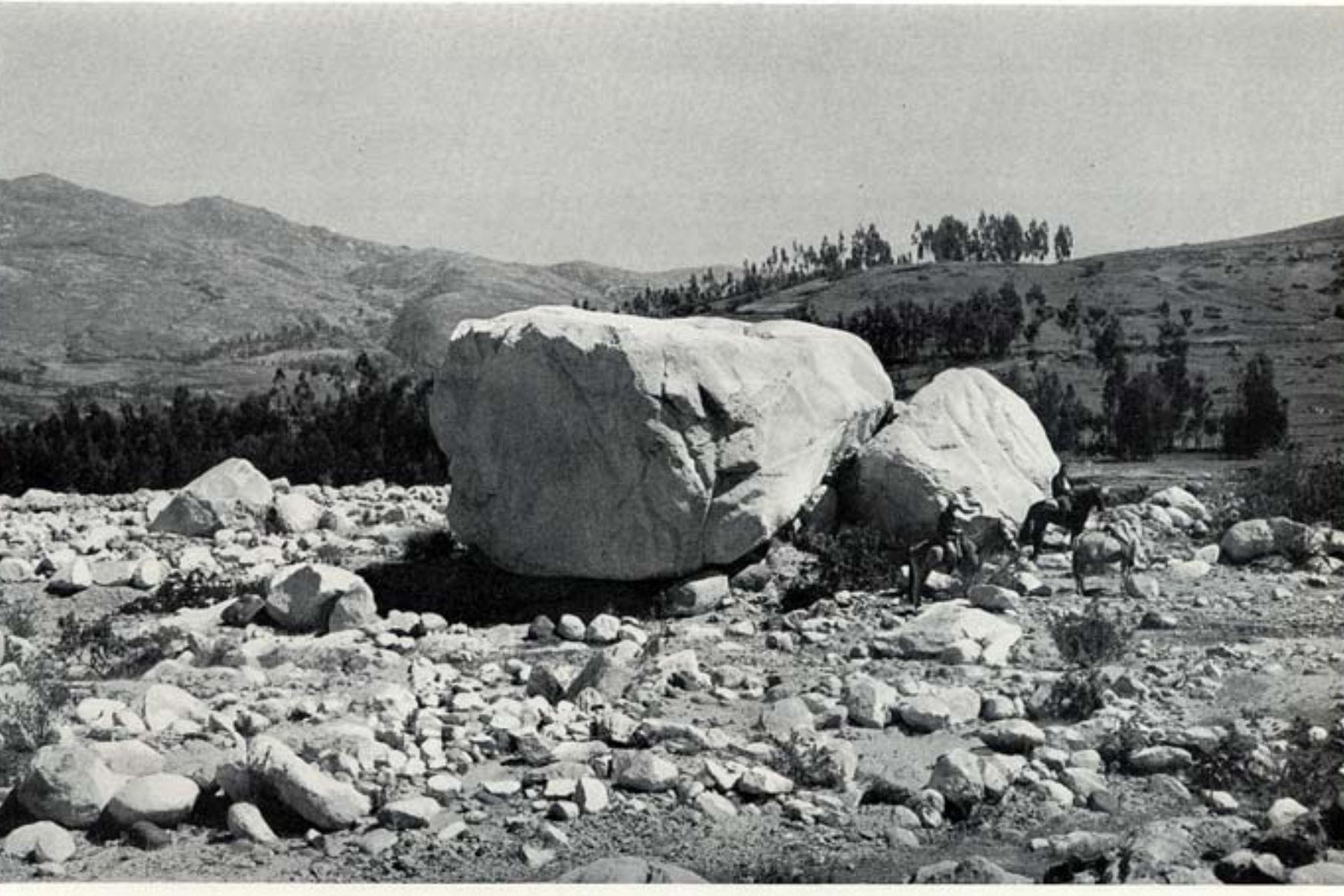
FUTURE HAZARD ?

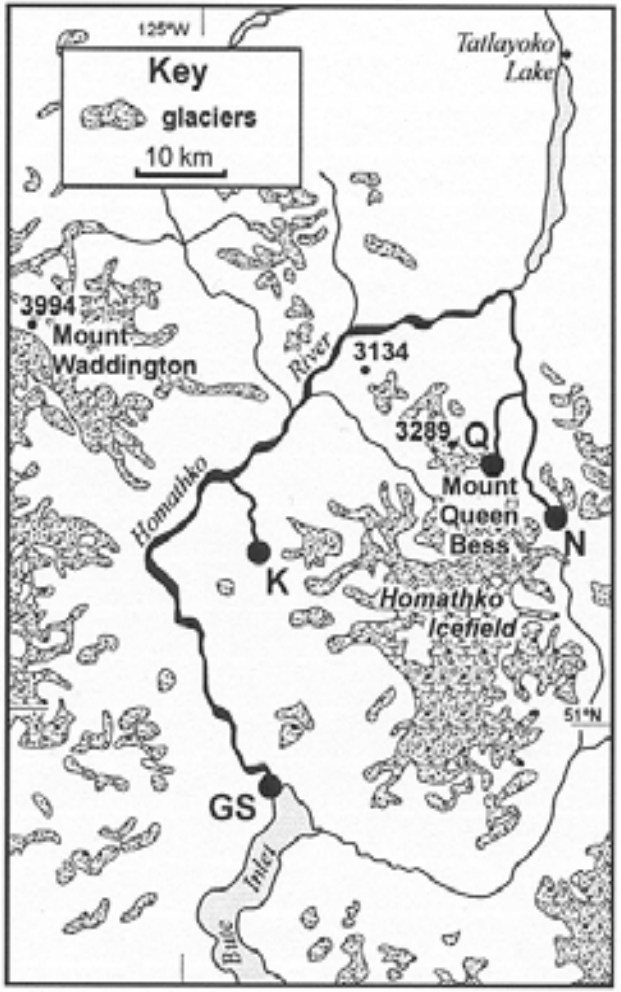


48. Die am 13. XII. 1941 ausgebrochene Laguna Cohup, die einen Teil der Stadt Huaras wegriß (7. IX. 1947).

51. Die von der Sturzflut der Laguna Cohup teilweise zerstörte Stadt Huaras. Flugbild von Westen (24. VI. 1947).

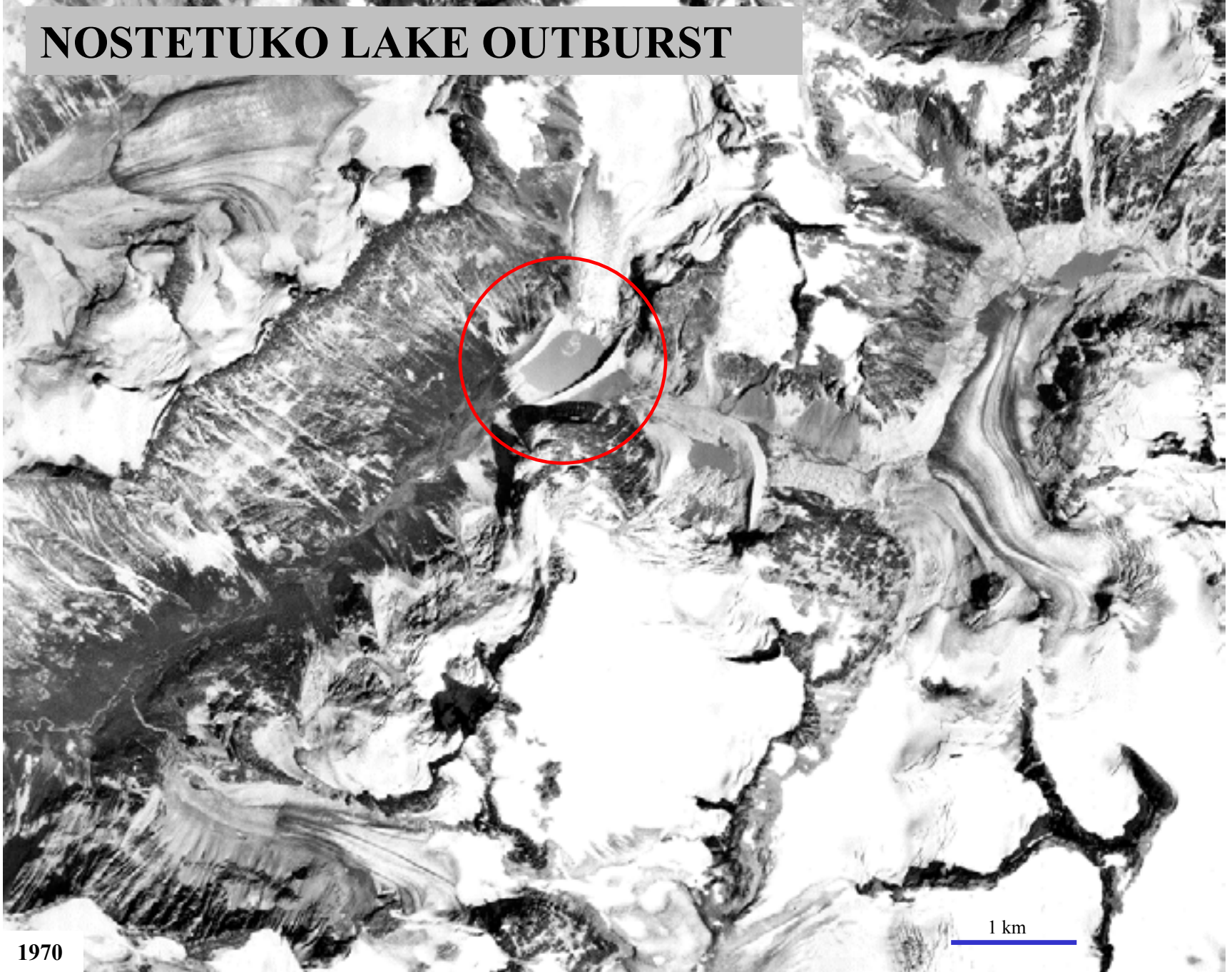


52. Der größte Granitblock in der Sturzflut von Huaras, rund 3 km oberhalb der Landstraße. Im Hintergrund Eukalyptuswald (18. VIII. 1947).

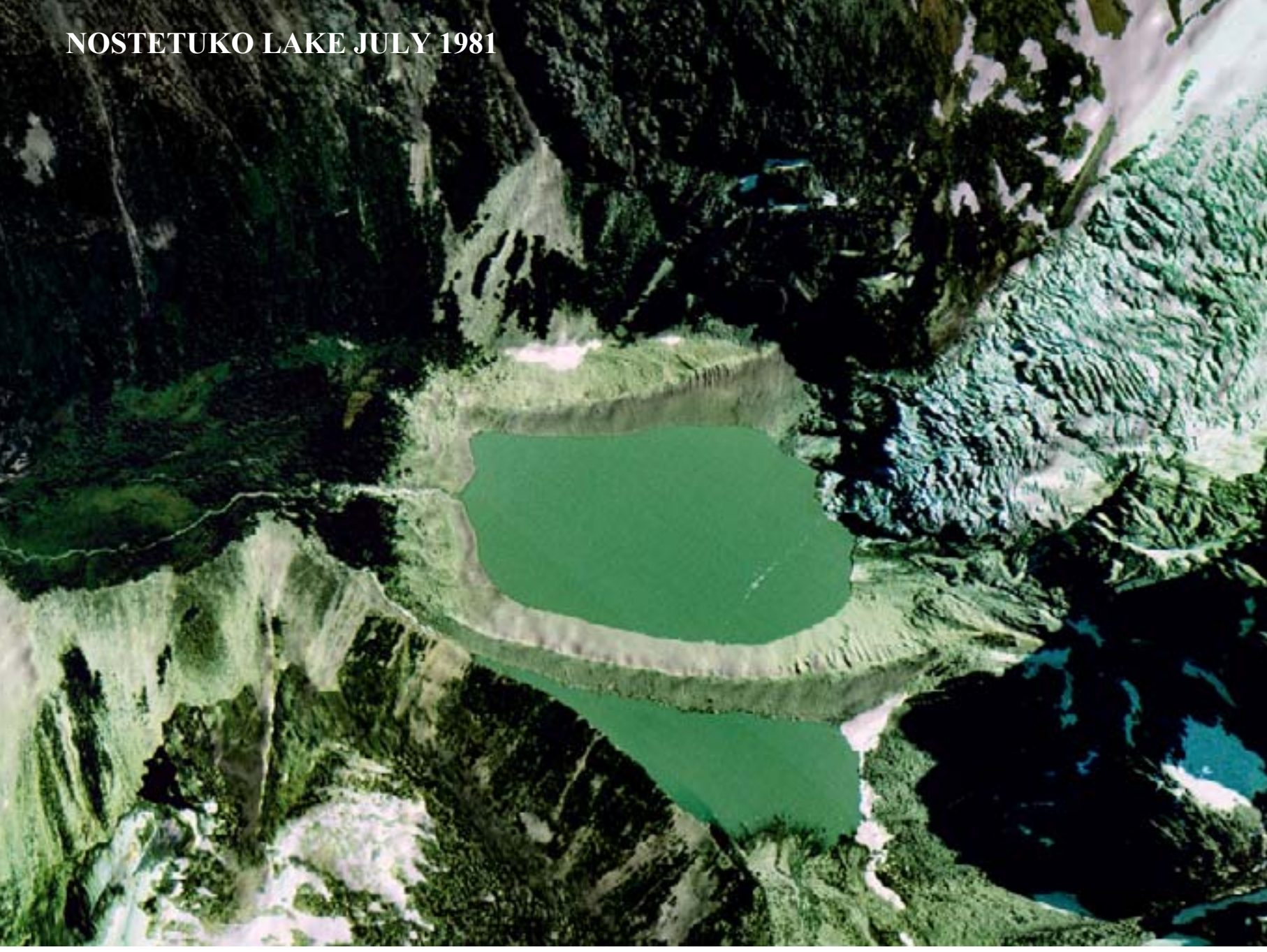


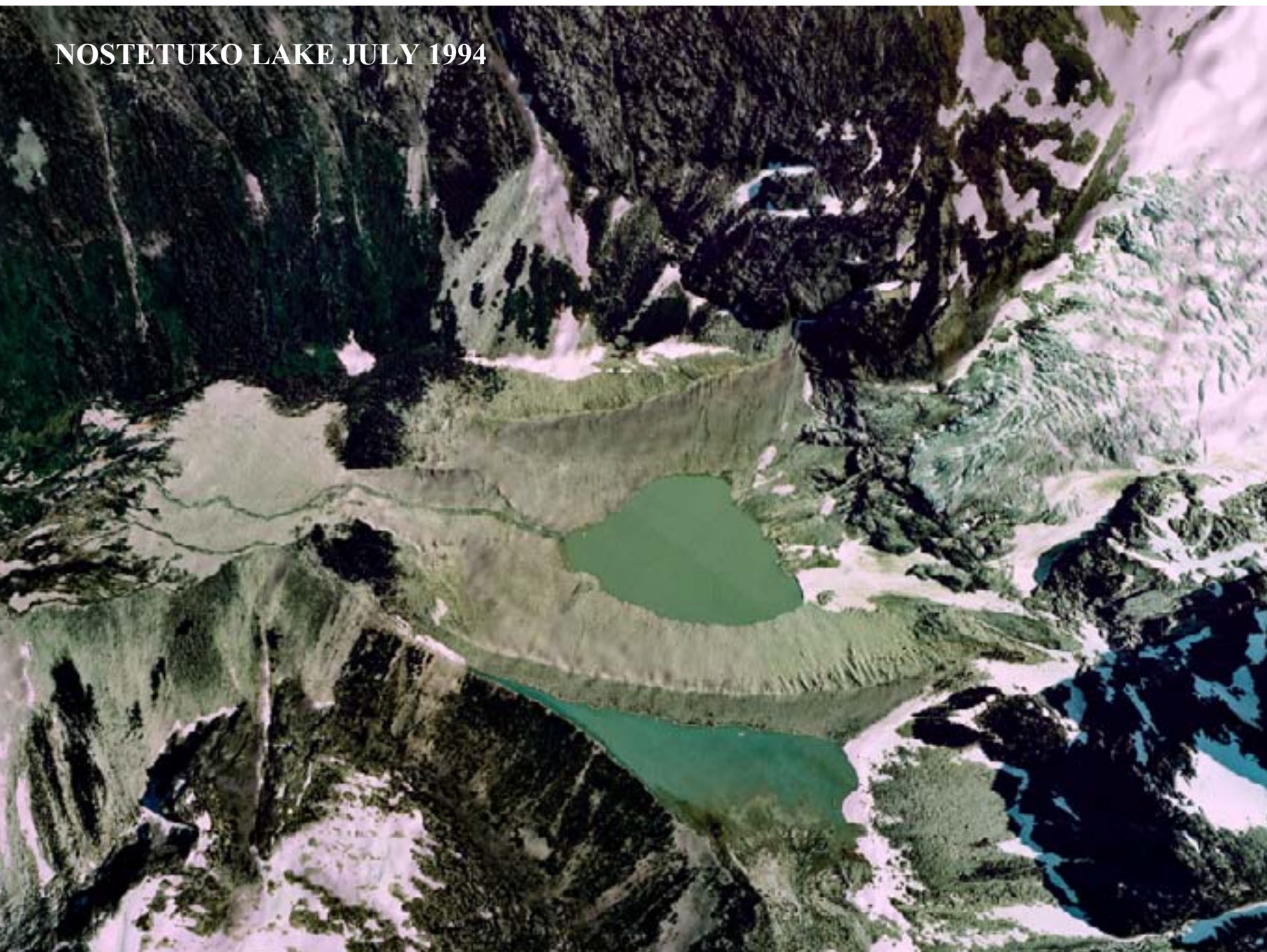
K : Klattasine (ca. 1971)
N : Nostetuko Lake (1983)
Q : Queen Bess (1997)
GS : Gauging Station at mouth of Homathko

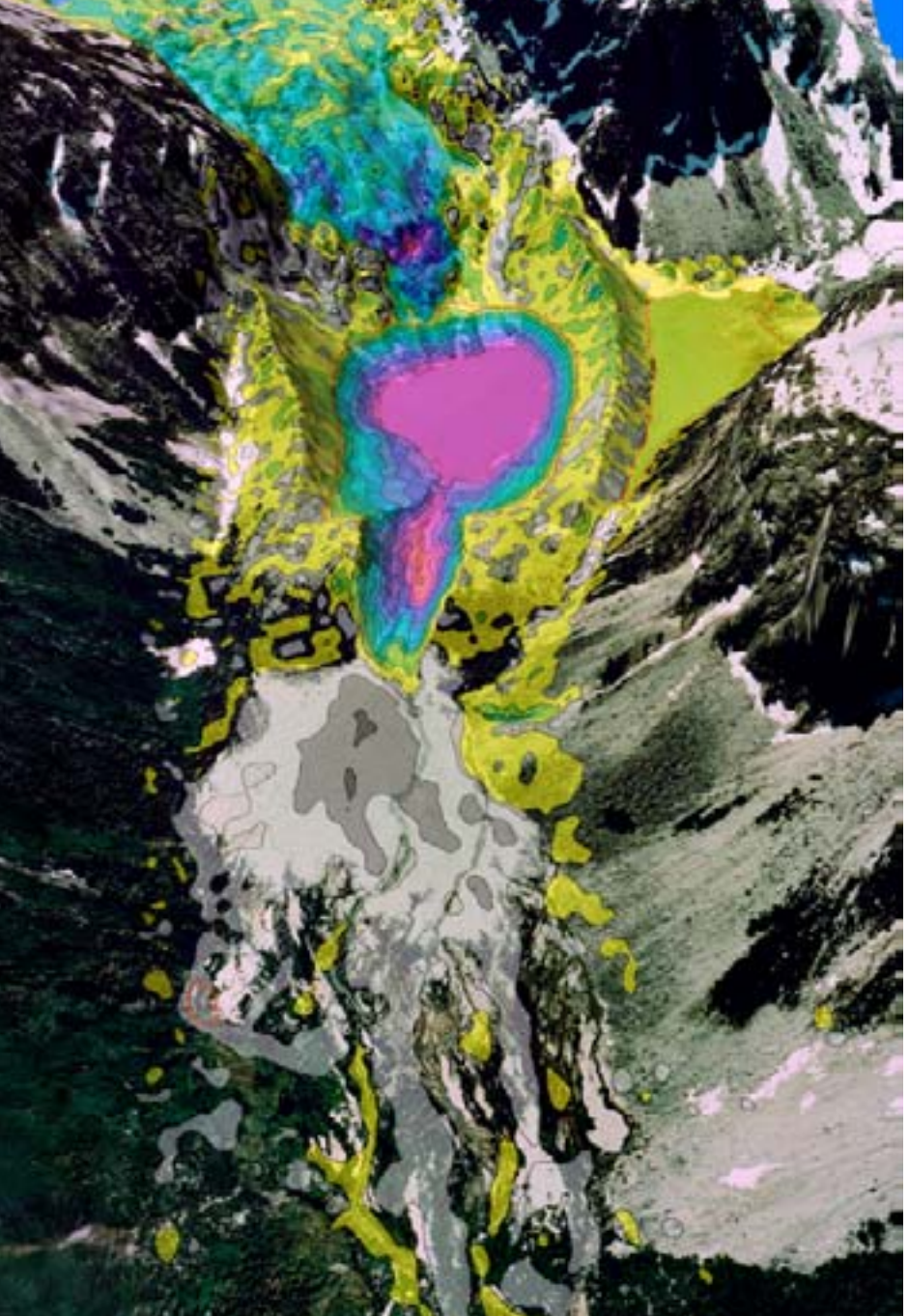
NOSTETUKO LAKE OUTBURST



1970


NOSTETUKO LAKE JULY 1981


NOSTETUKO LAKE JULY 1994



NOSTETUKO LAKE OUTBURST SUMMARY

Date: July 19, 1983

Outburst Volume: 6.5 M m^3

Breach Loss Volume: 1.6 M m^3

Max. Discharge: ca. 10,000 m^3/s

Max. Wave Run-Up: 11.7 m

Wave Velocity:15 m/s

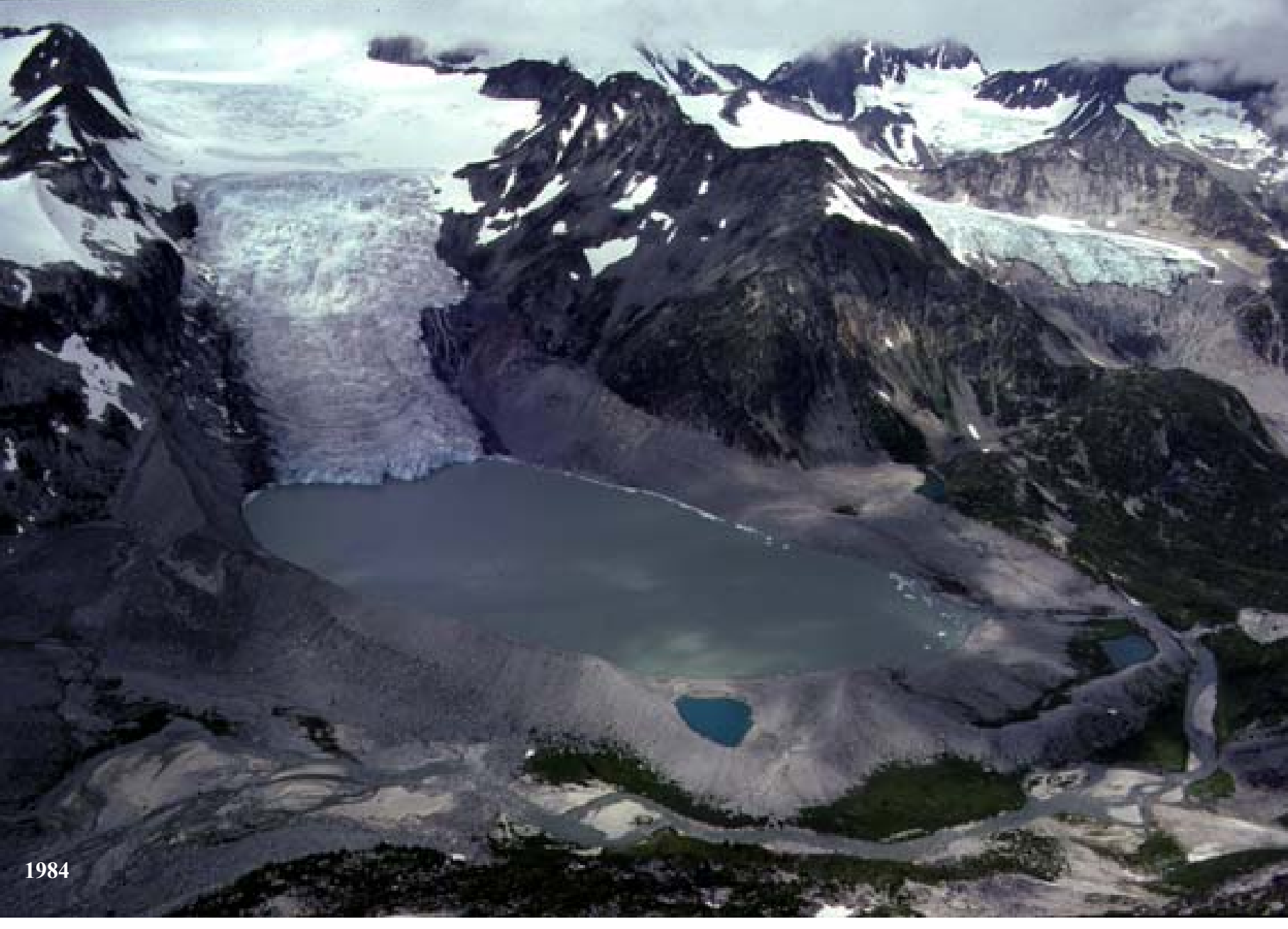
Drawdown: 38 m

Cause: glacier avalanche

Volume of Glacier Avalanche: ca. 1.5 M m^3

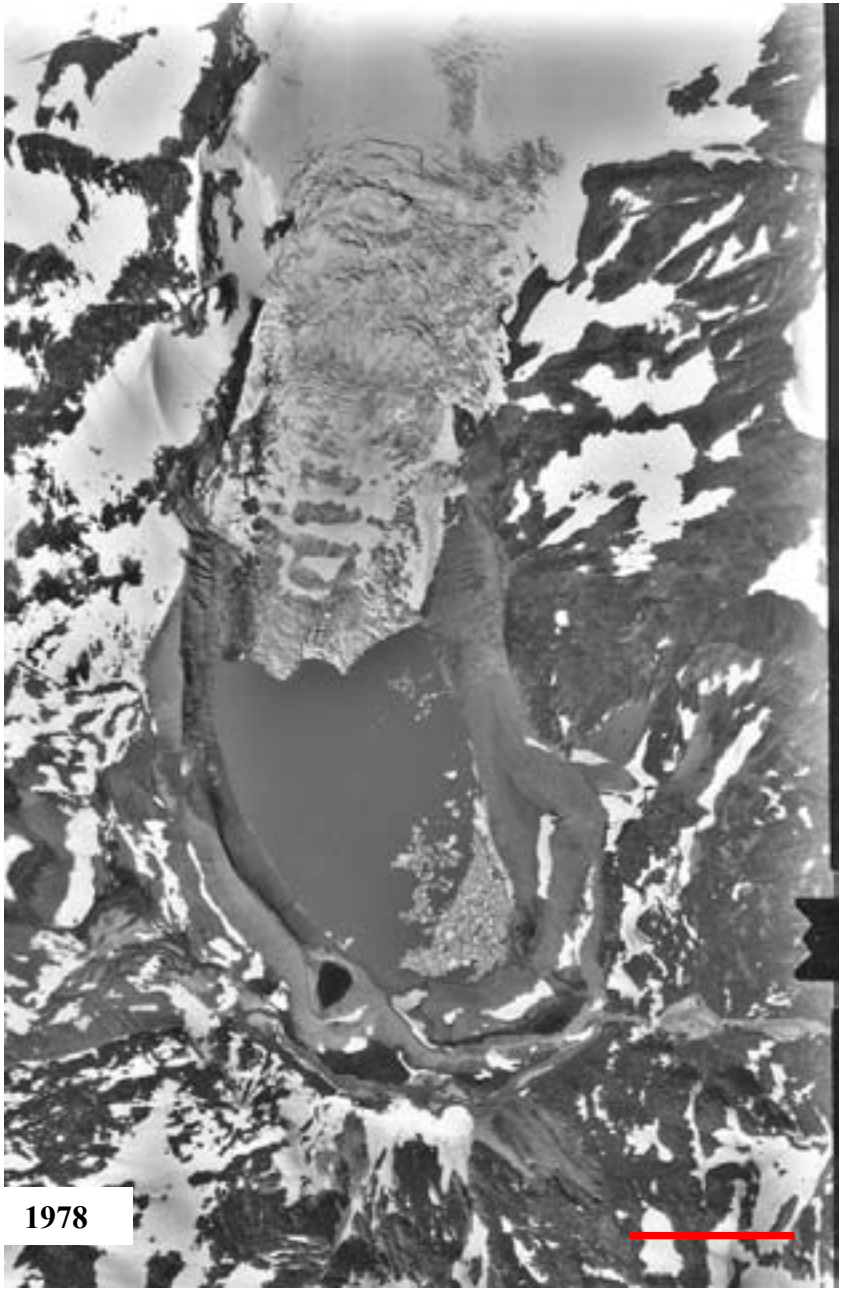
1997 QUEEN BESS LAKE OUTBURST

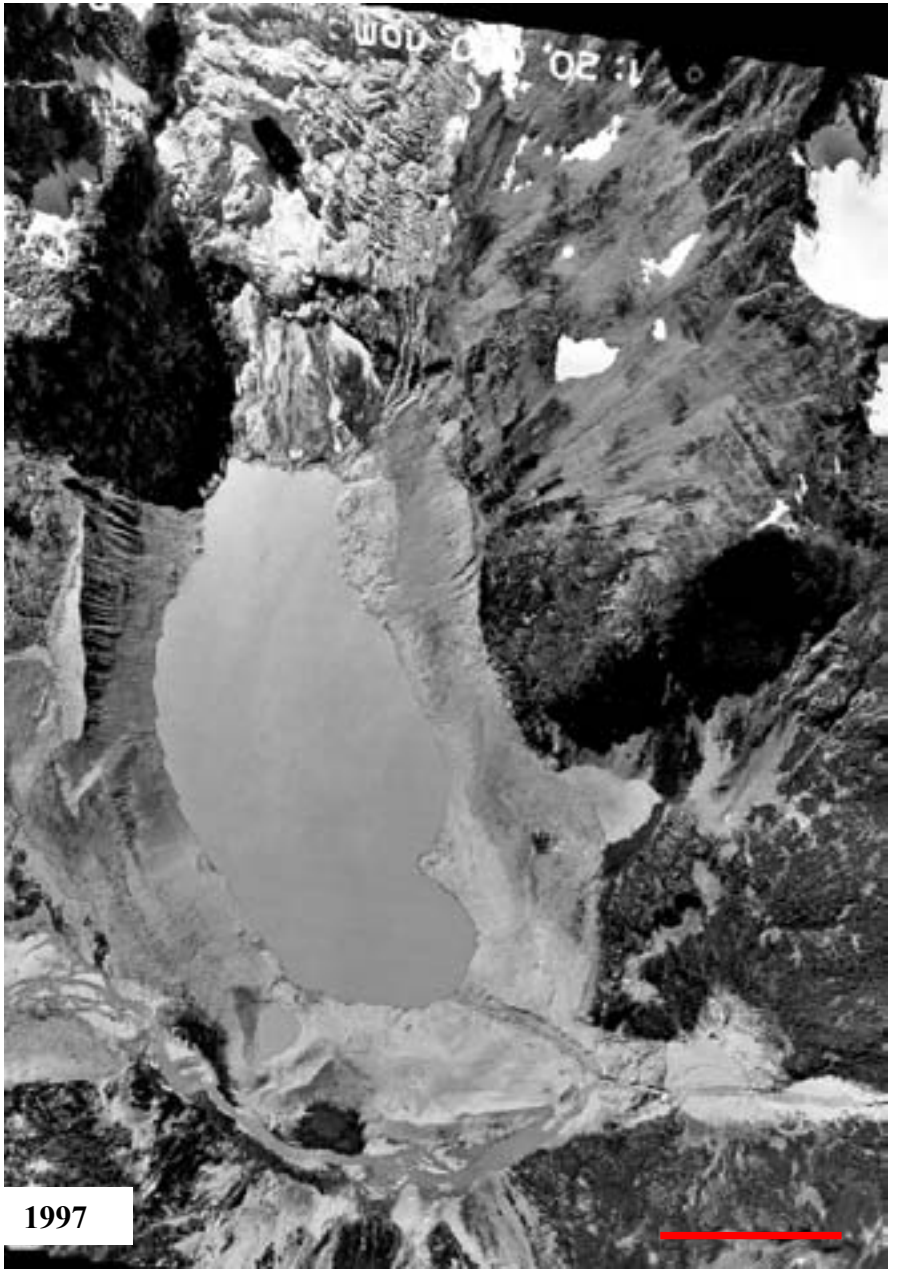
1987

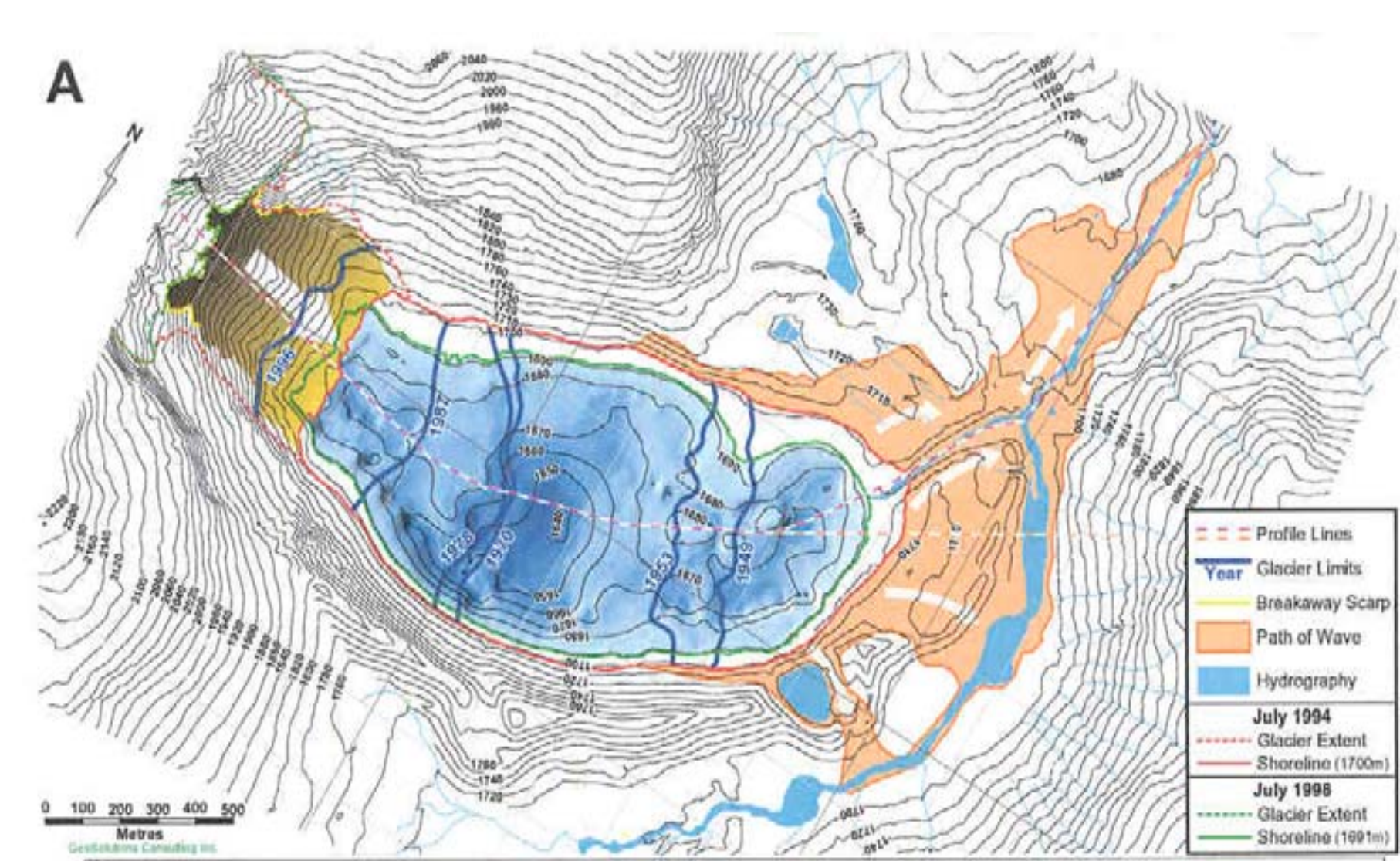

1984

1987


500 m
1998


1978


1997



(from Kershaw et al., 2005)