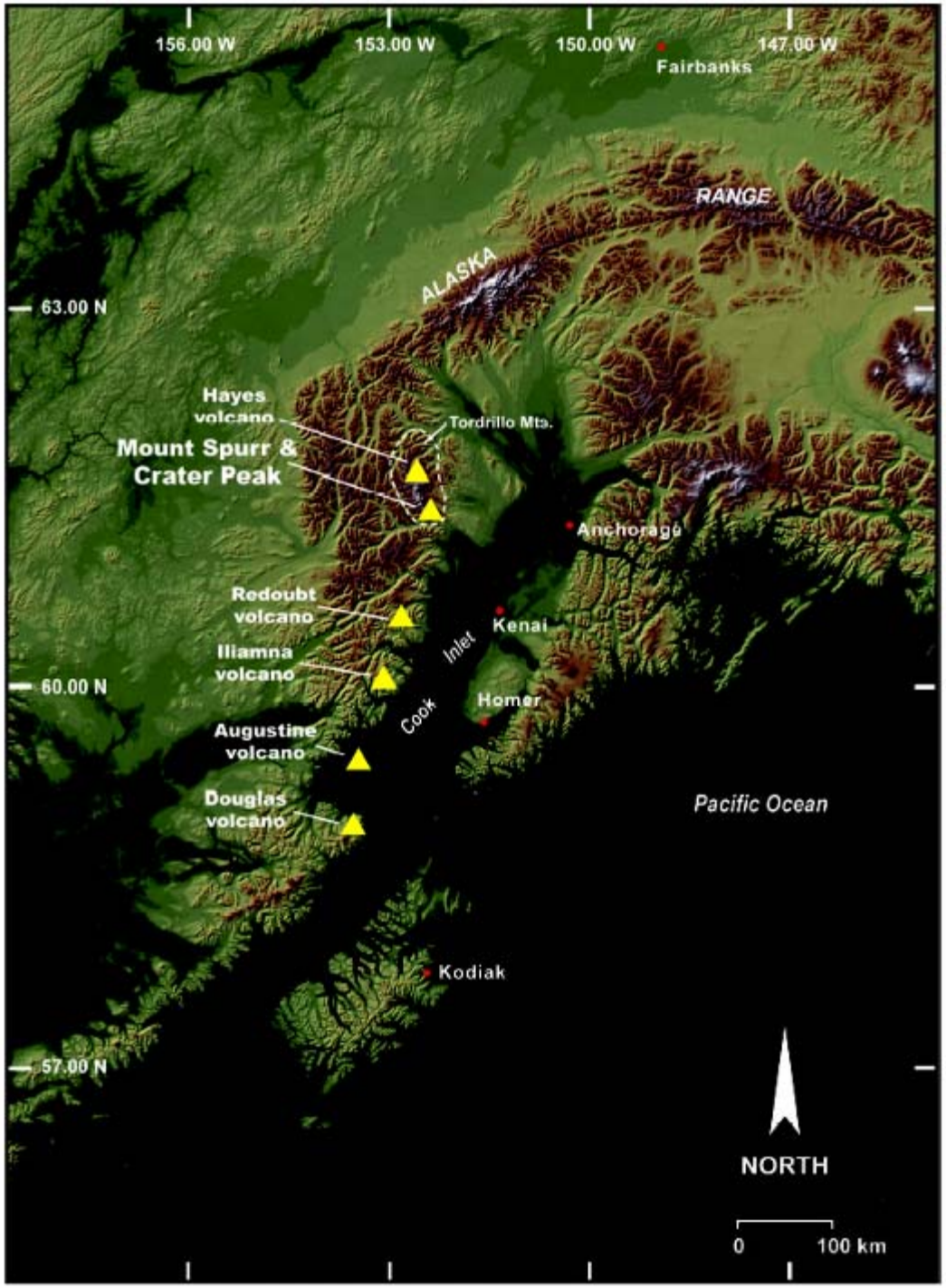


Mount Spurr geothermal workshop
August 27-28, 2007

Geologic Overview & Review of Geothermal Exploration

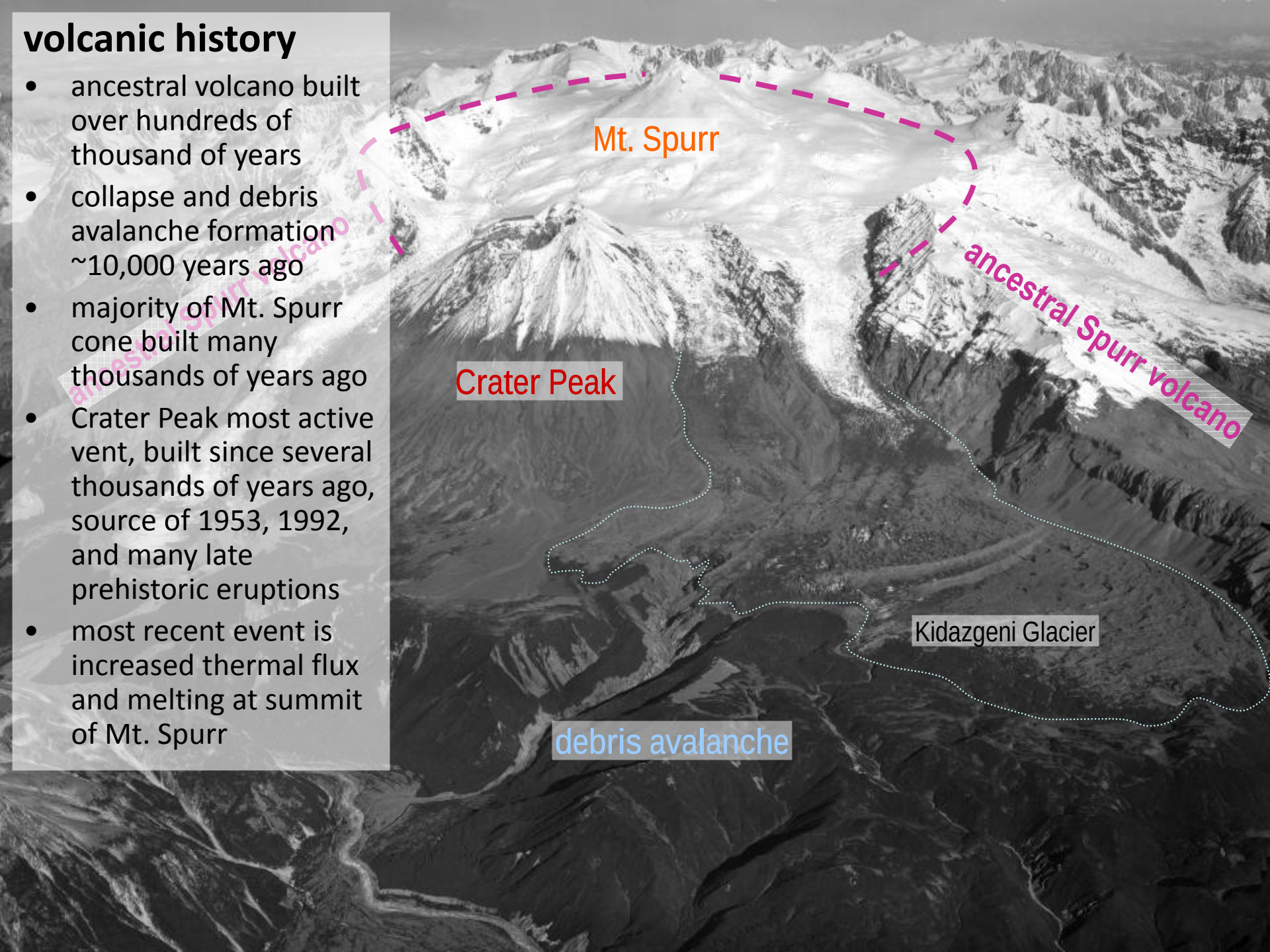
Christopher Nye

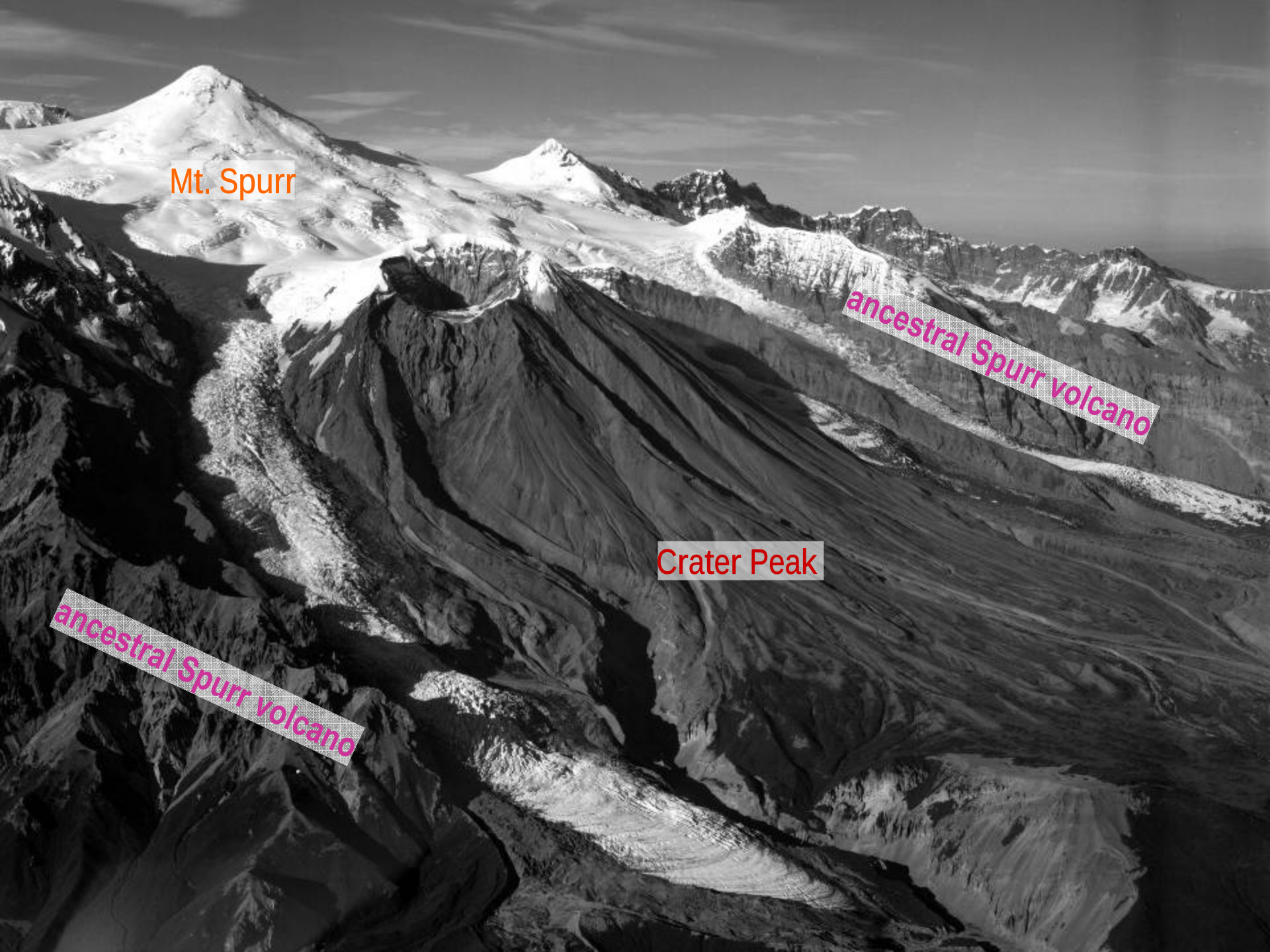
geologist / volcanologist
DNR/GGS & AVO

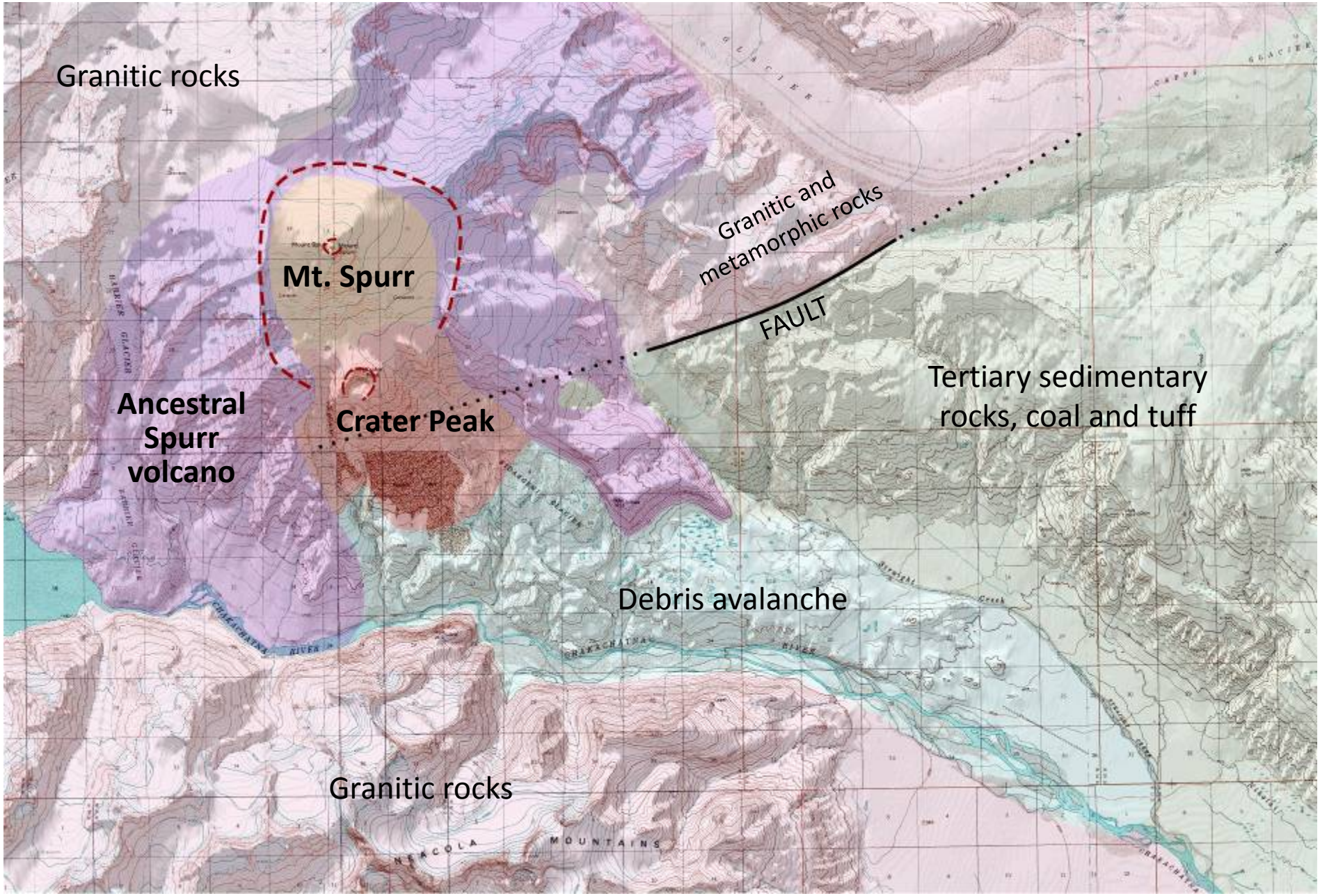
Alaska Division of Geological and Geophysical Surveys
Alaska Volcano Observatory

volcanic history

- ancestral volcano built over hundreds of thousand of years
- collapse and debris avalanche formation ~10,000 years ago
- majority of Mt. Spurr cone built many thousands of years ago
- Crater Peak most active vent, built since several thousands of years ago, source of 1953, 1992, and many late prehistoric eruptions
- most recent event is increased thermal flux and melting at summit of Mt. Spurr

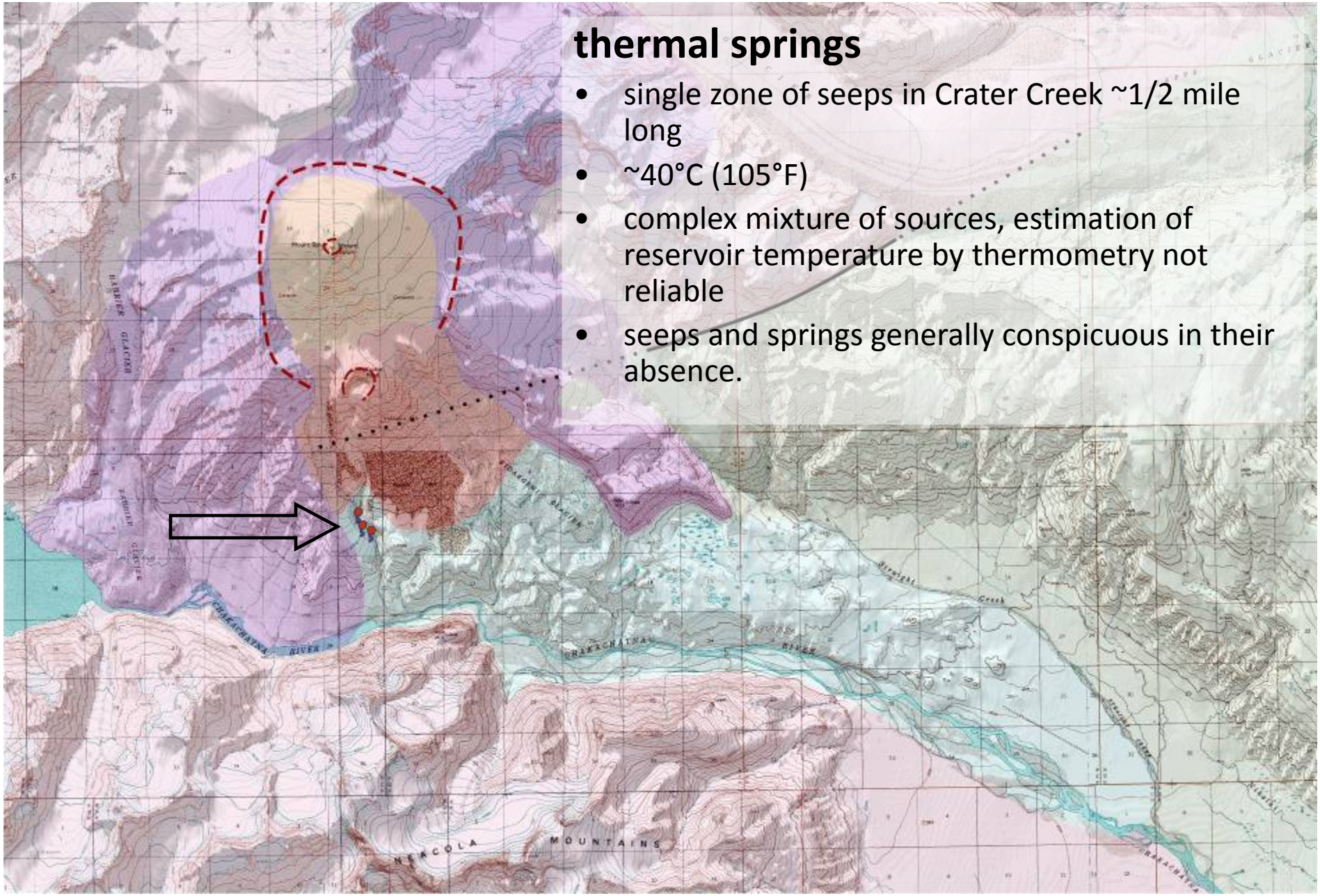



Mt. Spurr
ancestral Spurr volcano
Crater Peak
ancestral Spurr volcano


Granitic rocks
Mt. Spurr
Granitic and metamorphic rocks
FAULT
Tertiary sedimentary rocks, coal and tuff
Ancestral Spurr volcano
Crater Peak
Debris avalanche
Granitic rocks
NEACOLA MOUNTAINS

Geothermal resource evaluation

- Multidisciplinary project with fieldwork in 1985
  - Led by Don Turner and Gene Wescott (UAF/GI) and Chris Nye (ADGGS, then UAF/GI)
  - Funded by DOE state-coupled program
  - Included:
    - Geologic mapping
    - Detailed petrologic and geochemical investigation
    - Self-potential survey (SP)
    - Controlled Source AudioMagnetoTelluric survey (CSAMT)
    - Helium and mercury soil sampling
    - Warm spring and fumarole sampling and analysis
    - Ice thickness measurement by RADAR and VLF
  - Turner, D.L., and Wescott. E.M. (eds.), 1986, Geothermal energy resource investigations at Mt. Spurr, Alaska: University of Alaska Fairbanks Geophysical Institute Report UAG-R 308, 98 p., 5 plates, scale 1:2,860 and 1:6,250.
  - Wescott, E.M., Turner, D.L., Nye, C.J., Motyka, R.J., Moore, P., 1988. Exploration for geothermal resources at Mt. Spurr, Alaska. Geothermal Resources Council Transactions, v. 12, pp., 203-210.
- No subsequent geothermal-specific studies by academic or government scientists
- Geologic studies, especially in response to the 1992 eruptions, have focused on geology, hazards, and volcanology



thermal springs

- single zone of seeps in Crater Creek ~1/2 mile long
- ~40°C (105°F)
- complex mixture of sources, estimation of reservoir temperature by thermometry not reliable
- seeps and springs generally conspicuous in their absence.

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Mercury soil survey

- 202 samples
- Potentially problematic interpretation in that Hg may be of volcanic, rather than geothermal, origin.

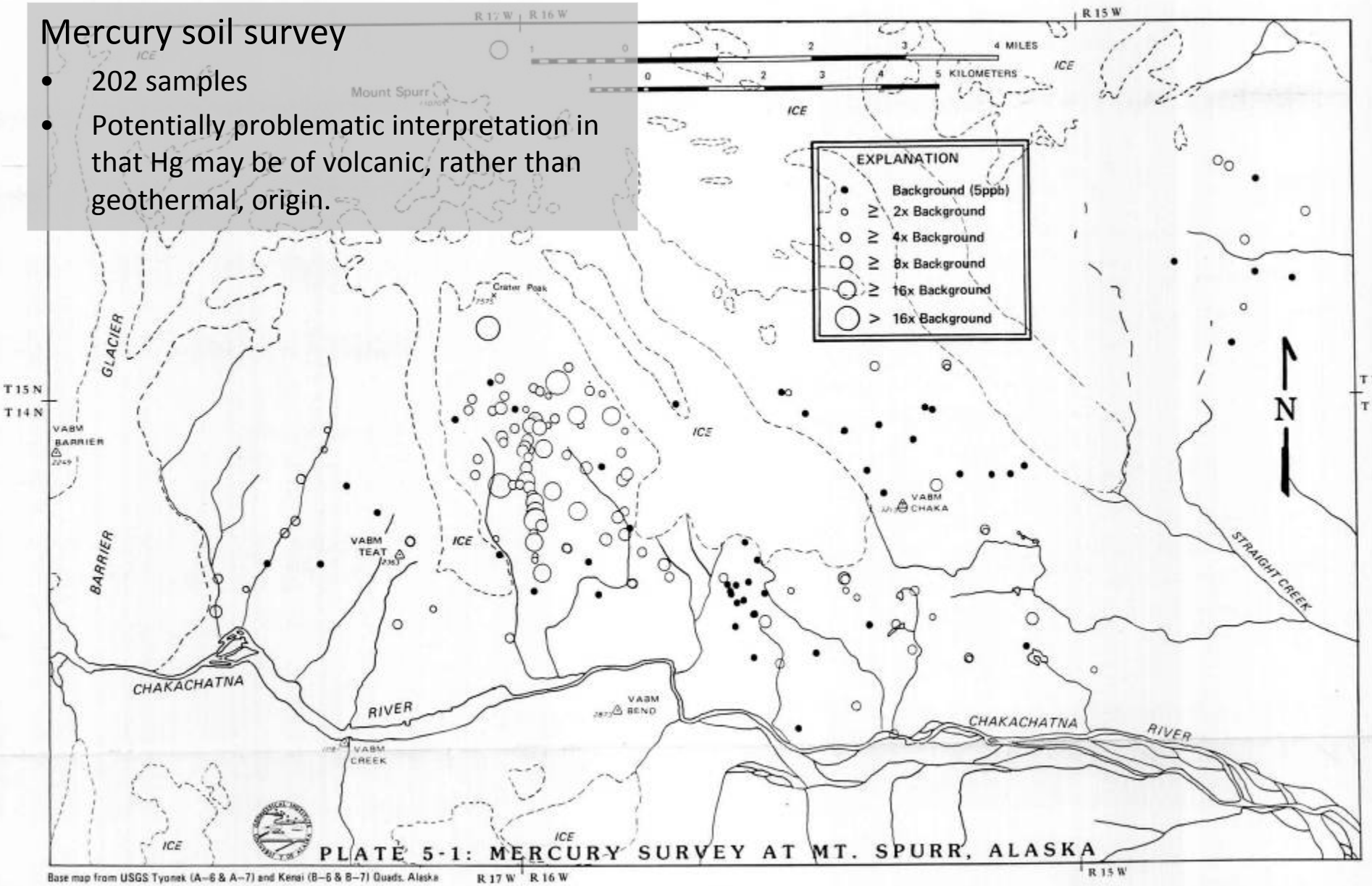


PLATE 5-1: MERCURY SURVEY AT MT. SPURR, ALASKA

Base map from USGS Tyonek (A–6 & A–7) and Kenai (B–6 & B–7) Quads. Alaska

Helium soil survey

- 57 mud and soil samples
- clustered anomalies on south flank of Crater Peak and at eastern edge of survey

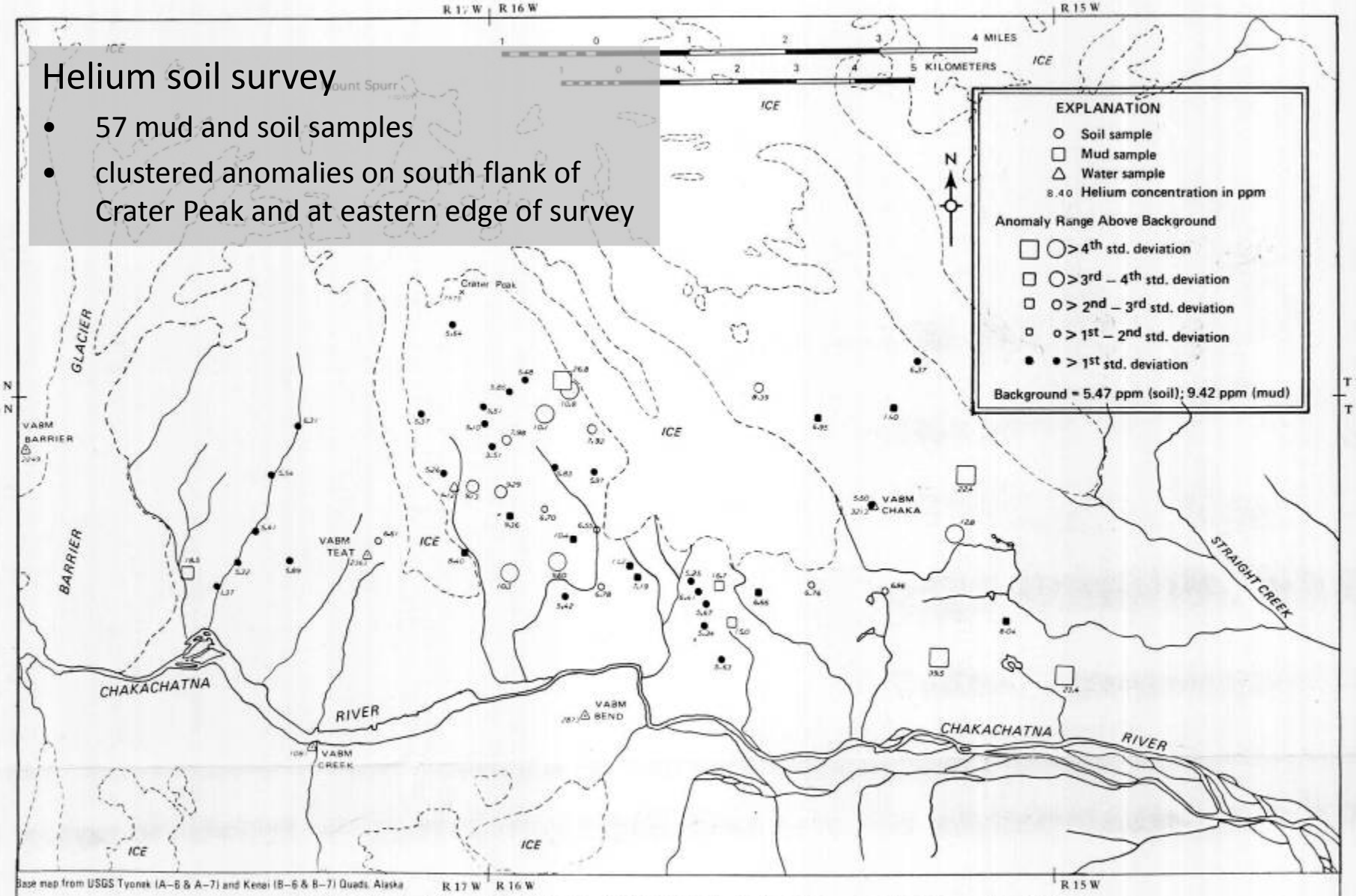
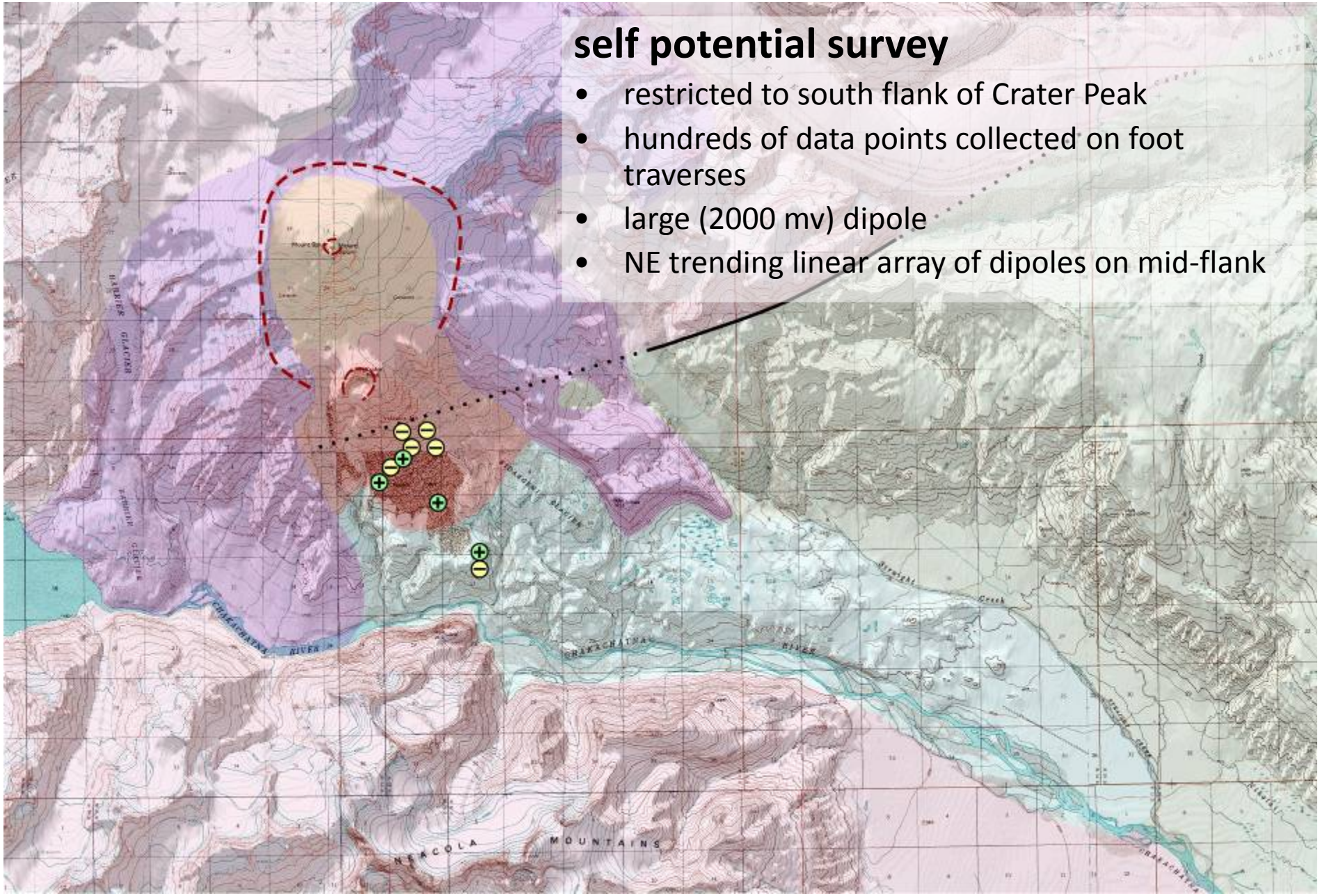


PLATE 5-2: HELIUM SURVEY AT MT. SPURR, ALASKA

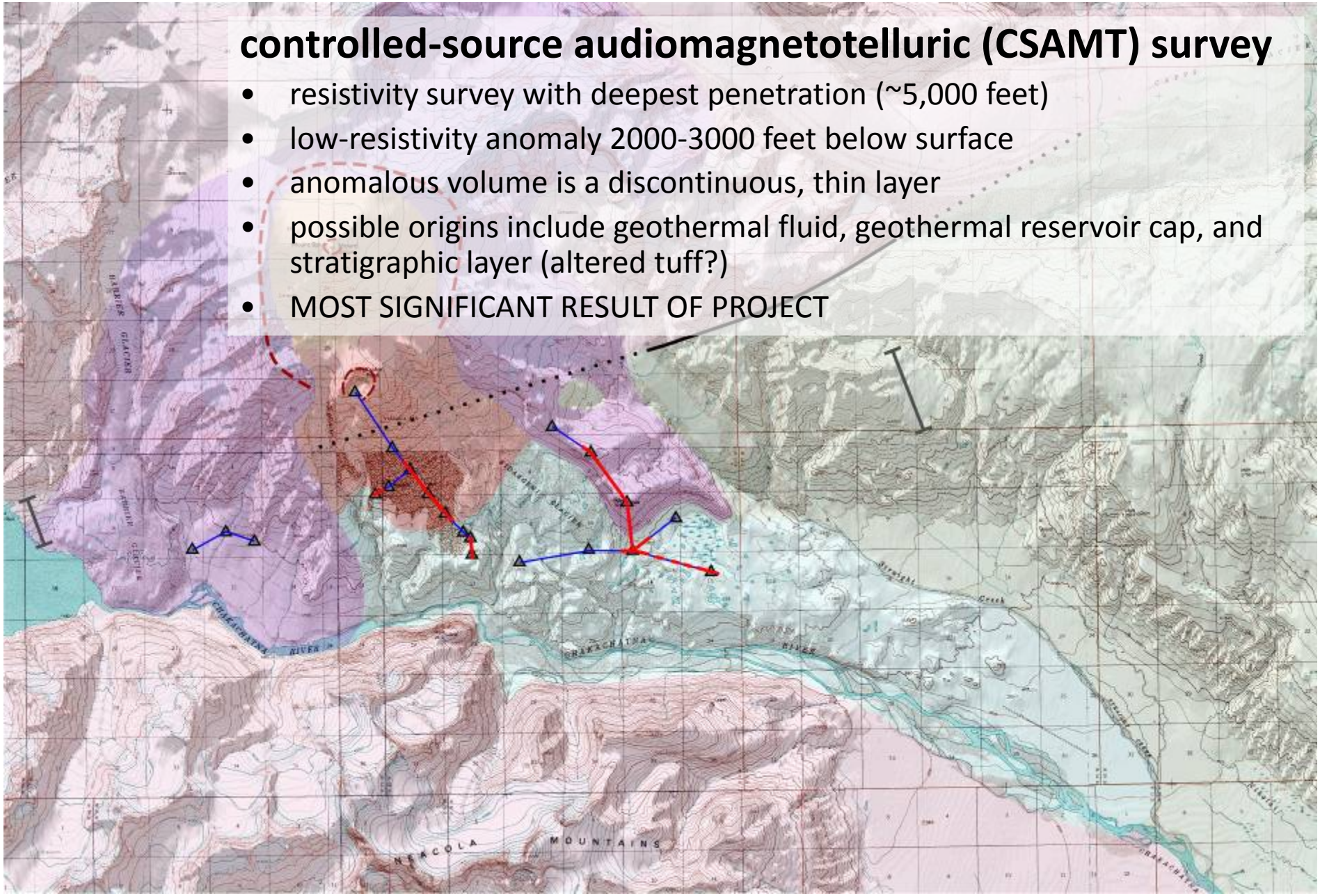


self potential survey

- restricted to south flank of Crater Peak
- hundreds of data points collected on foot traverses
- large (2000 mv) dipole
- NE trending linear array of dipoles on mid-flank

controlled-source audiomagnetotelluric (CSAMT) survey

- resistivity survey with deepest penetration (~5,000 feet)
- low-resistivity anomaly 2000-3000 feet below surface
- anomalous volume is a discontinuous, thin layer
- possible origins include geothermal fluid, geothermal reservoir cap, and stratigraphic layer (altered tuff?)
- MOST SIGNIFICANT RESULT OF PROJECT



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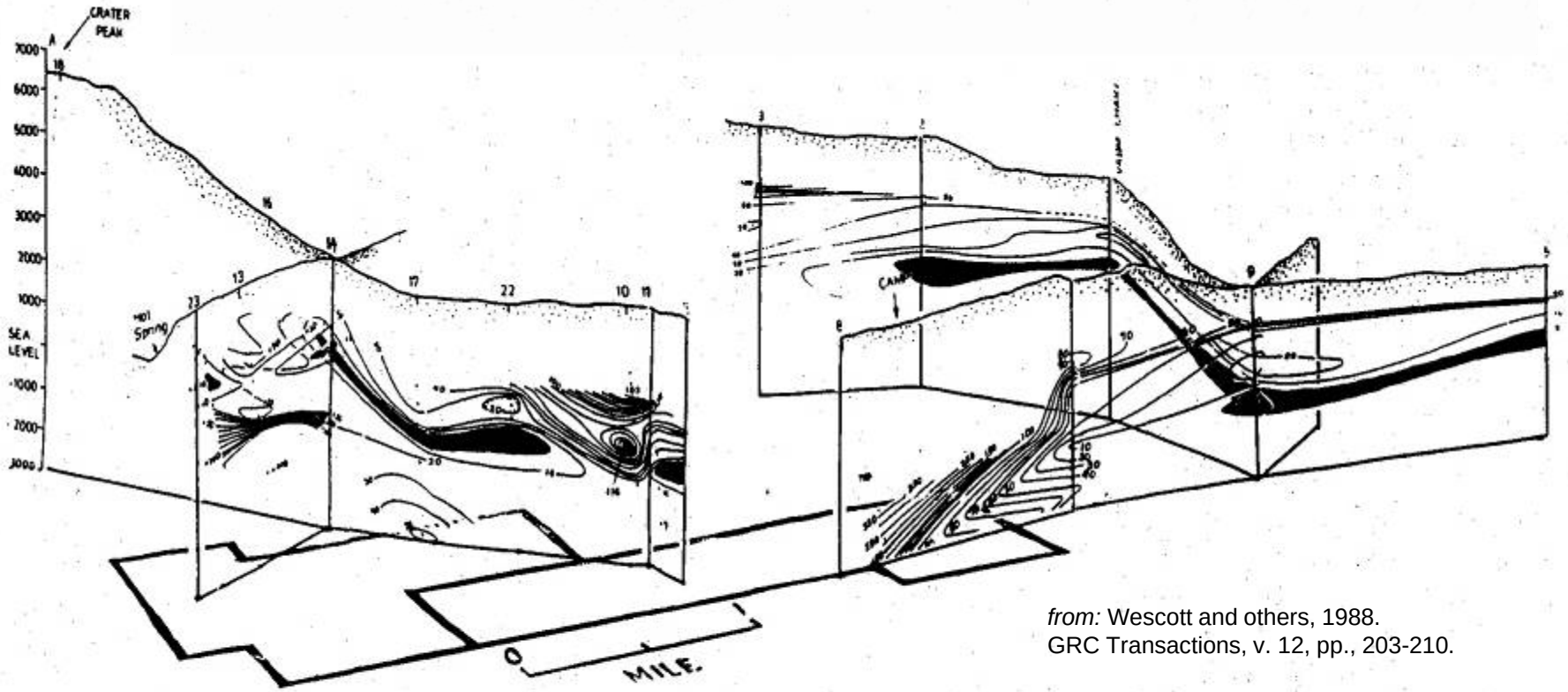
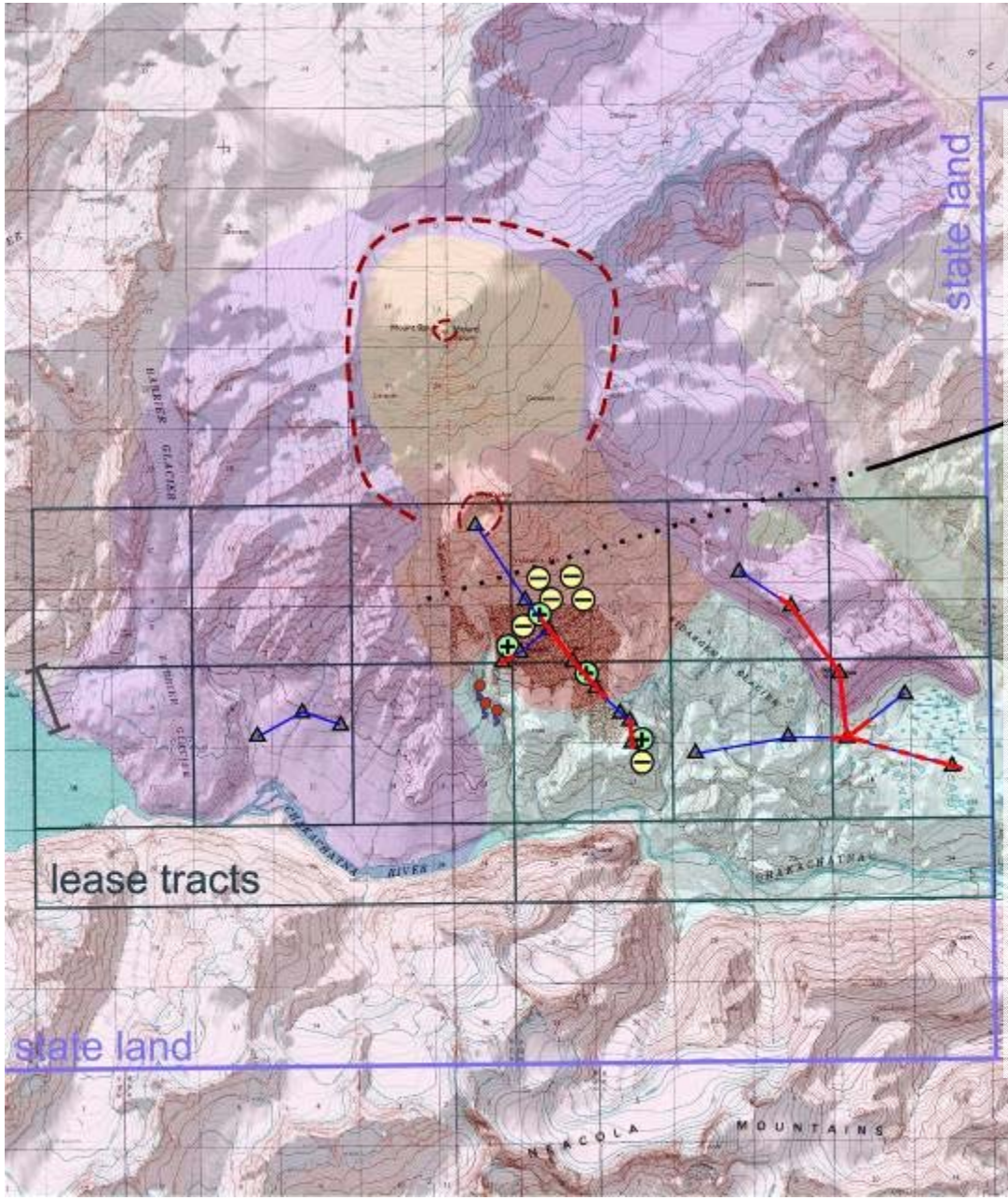


from: Wescott and others, 1988.
GRC Transactions, v. 12, pp., 203-210.

Figure 4. Three-dimensional, one-to-one-scale fence diagram of the CSAMT contoured resistivity values of profiles AA', BB', CC', and DD'. The zone of very low resistivity (less than 5 Ω-m) is shown in black. The State geothermal lease block boundaries are also shown. Base line is –3000 ft. elevation.



summary

- petrologic studies suggest that magmas rise from several 10's of kilometers rather than a shallow magma chamber
- coincident SP, CSAMT, soil He anomalies are ***consistent with*** a geothermal system at depths of a few thousand feet
- unequivocal existence of a geothermal resource has not been established
- Spurr is an active volcano, with attendant hazards

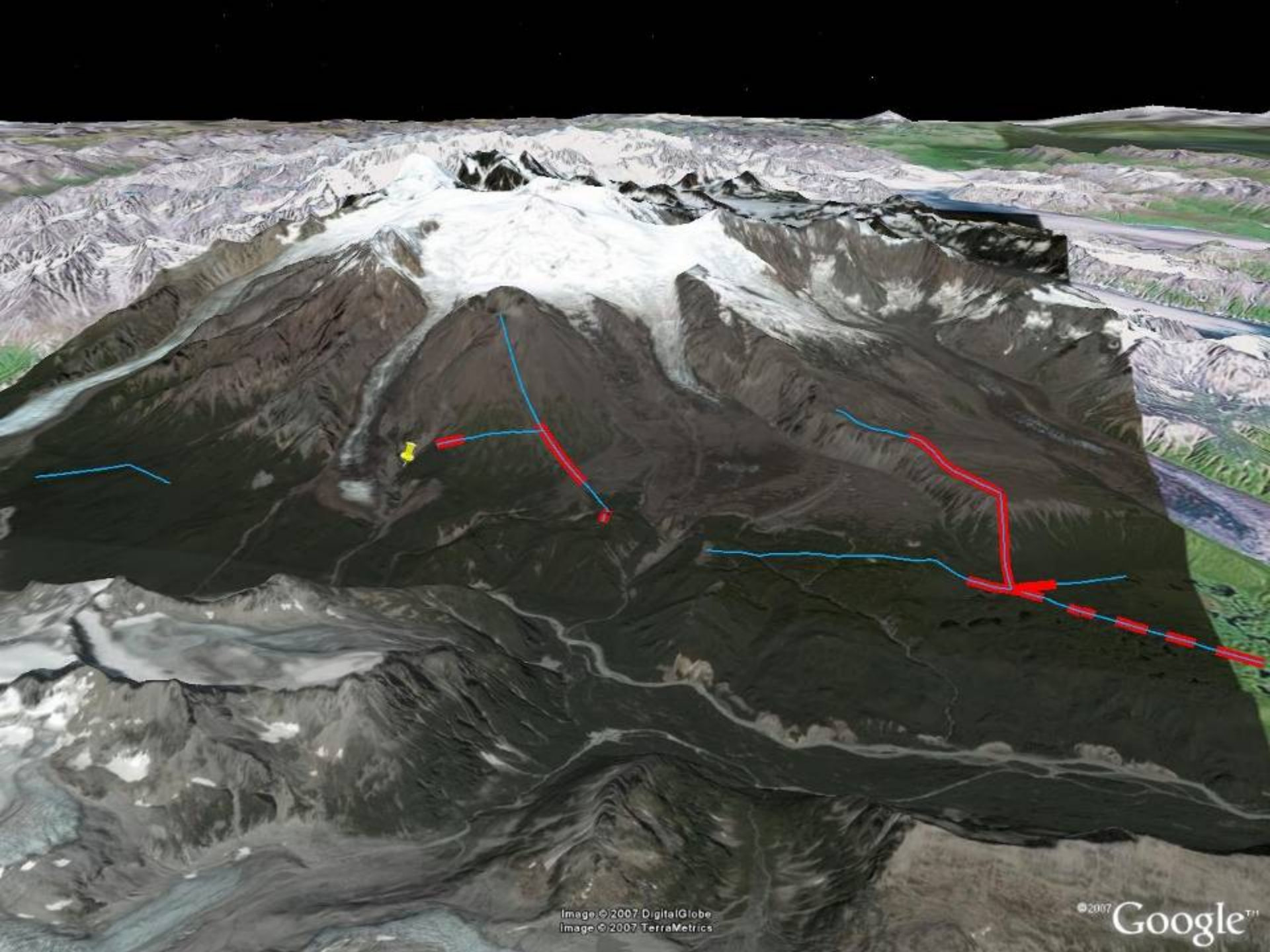

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Image © 2007 TerraMetrics
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Spurr from Anchorage, October 1992, M Doukas, USGS