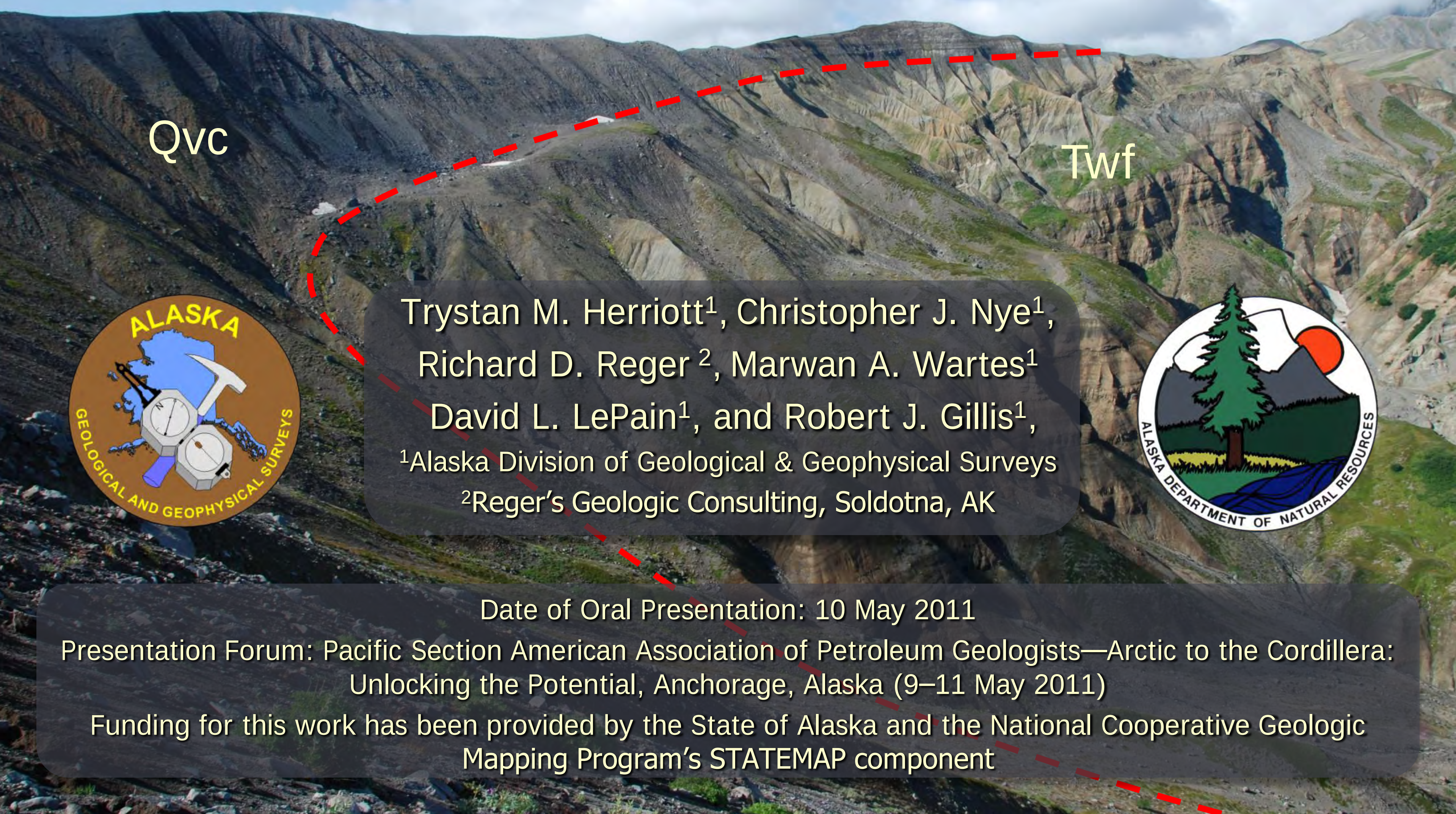
SEDIMENTOLOGY, AGE, AND GEOLOGIC CONTEXT OF A PLEISTOCENE VOLCANICLASTIC SUCCESSION NEAR SPURR VOLCANO, ALASKA



Trystan M. Herriott[1], Christopher J. Nye[1], Richard D. Reger [2], Marwan A. Wartes[1] David L. LePain[1], and Robert J. Gillis[1],

[1]Alaska Division of Geological & Geophysical Surveys

[2]Reger's Geologic Consulting, Soldotna, AK

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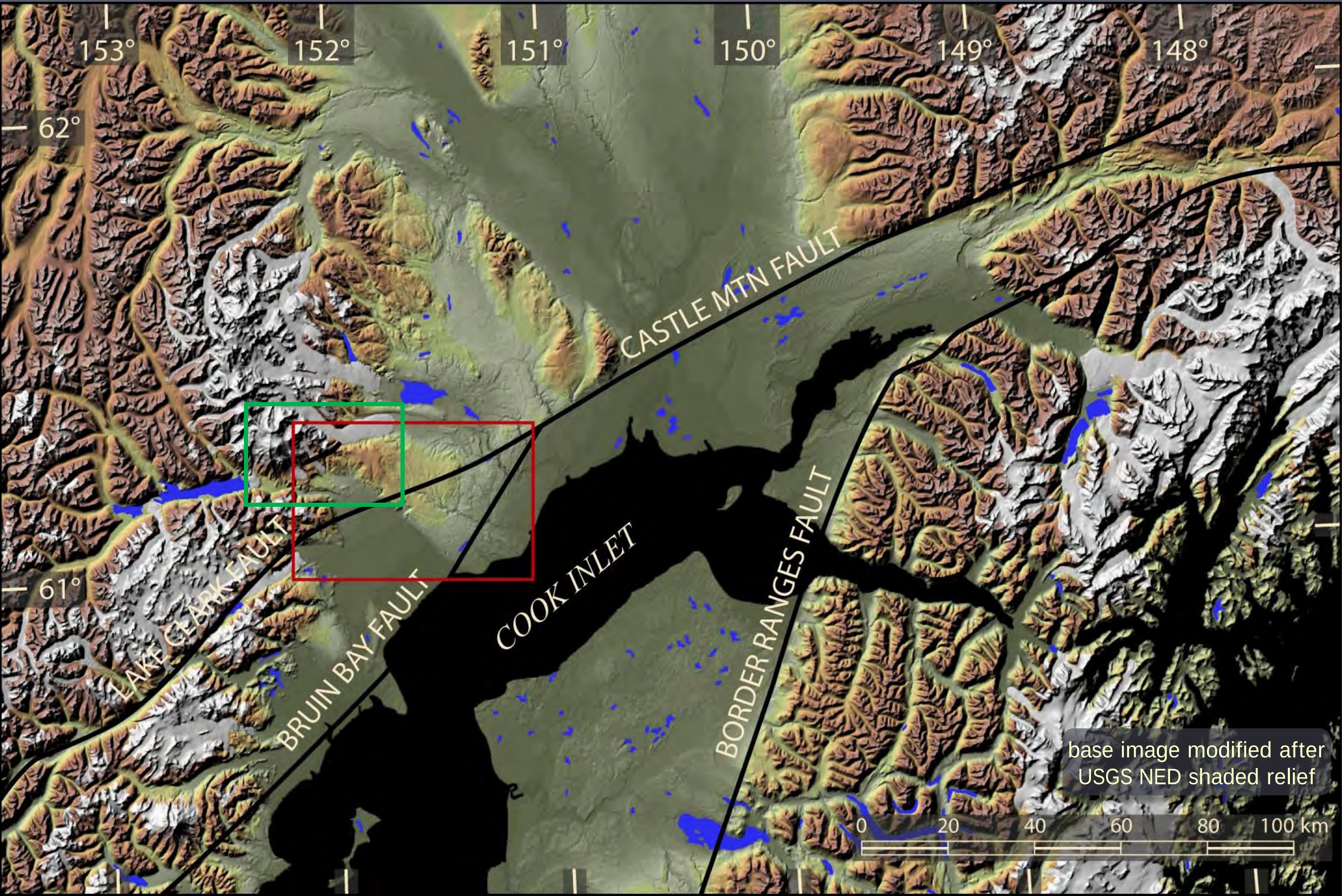
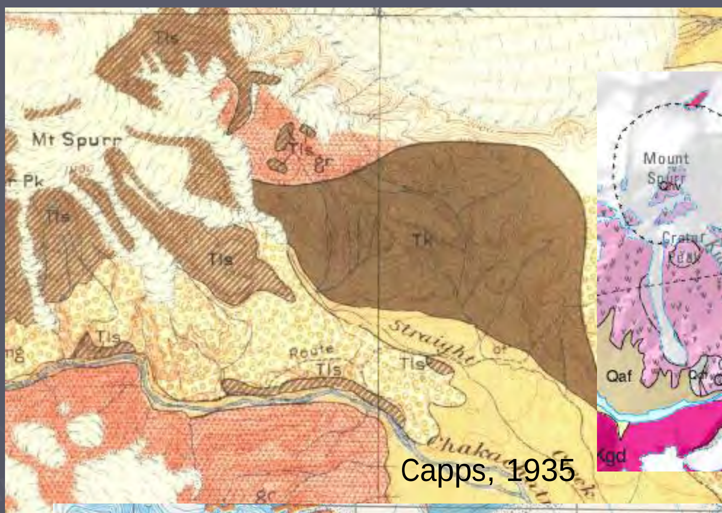
Location Map – Tyonek STATEMAP Project

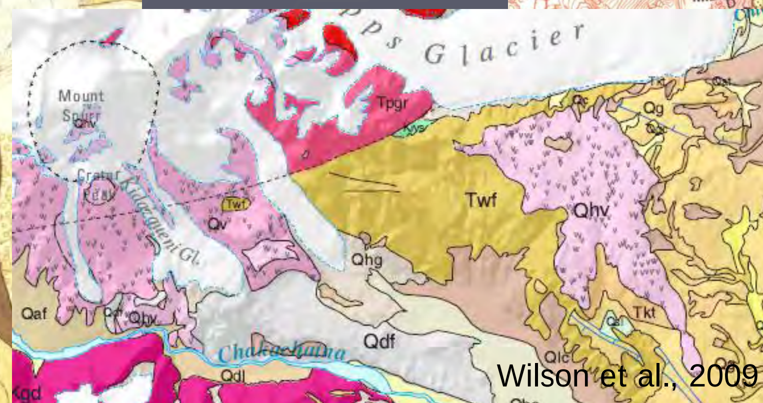


Volcaniclastic Plateau

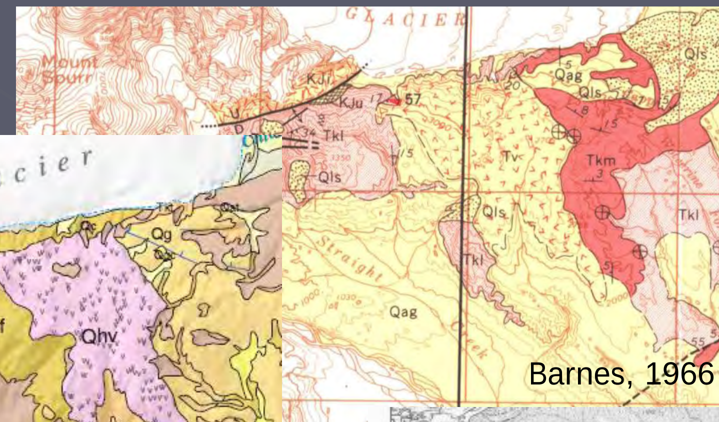
Previous Geologic Mapping of the Volcaniclastic Plateau



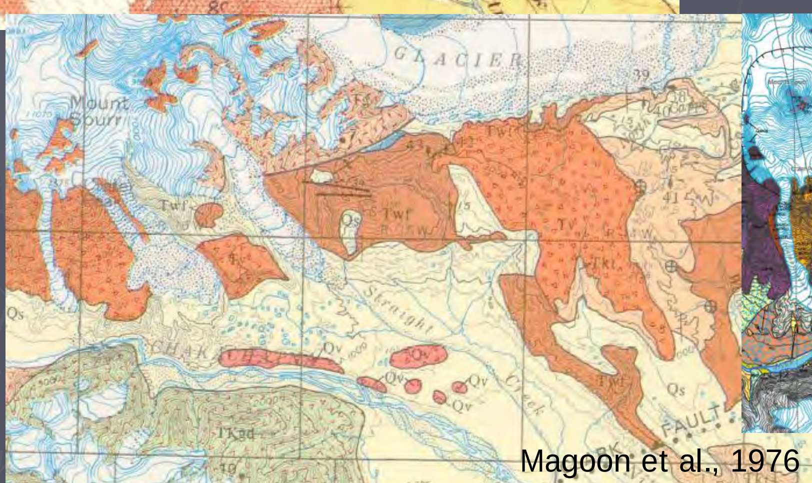
Capps, 1935



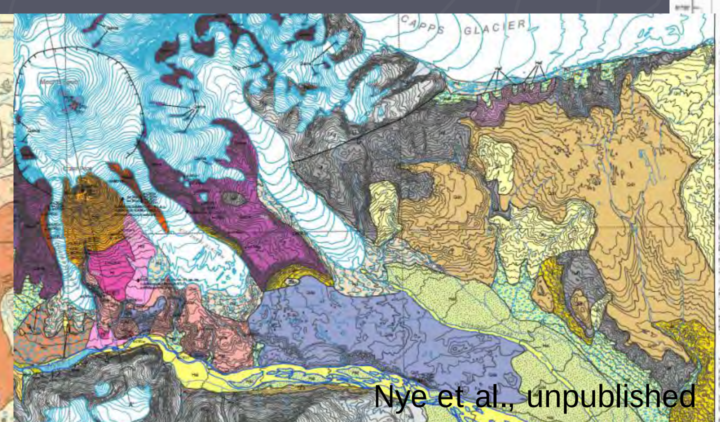
Wilson et al., 2009



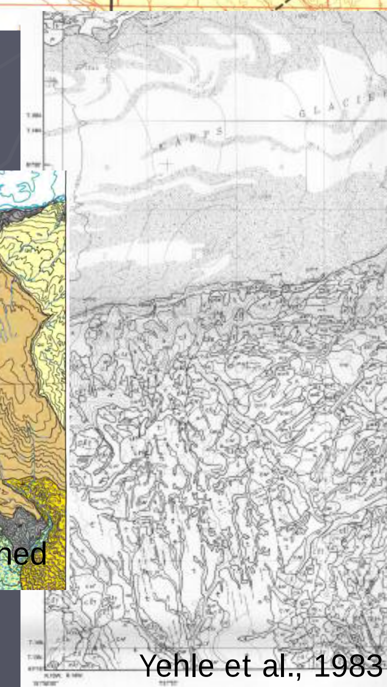
Barnes, 1966



Magoon et al., 1976



Nye et al., unpublished



Yehle et al., 1983

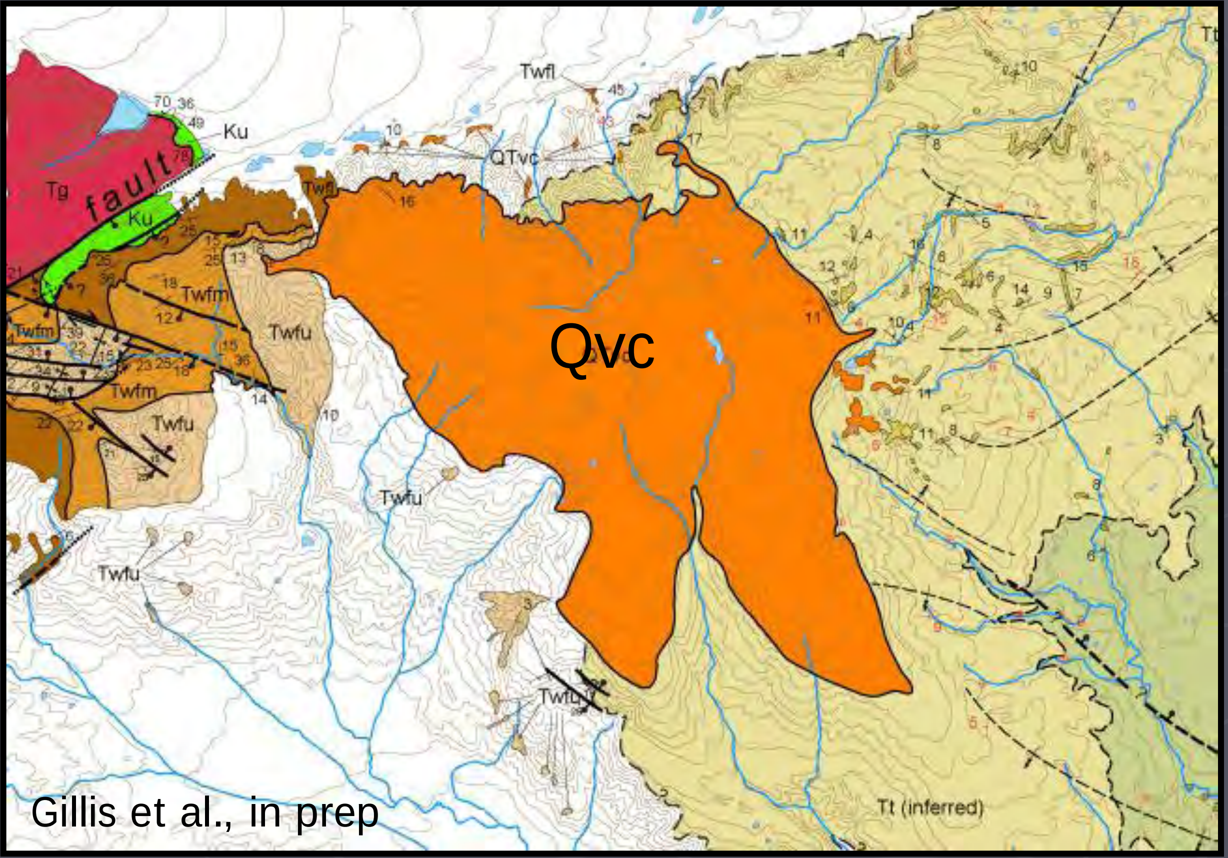
Previous Geologic Mapping of the Volcaniclastic Plateau

Summary of previous age assessments and lithologic descriptions

- Miocene – Holocene age
- Basaltic lava, tuff, and breccia to pyroclastic deposits to volcaniclastic deposits to lahar deposits to glacial deposits

Geologic Mapping – This Study

- Gillis et al., in prep – Qvc: massive volcaniclastic conglomerate and sandstone; conglomeratic beds to ~10 meters apparent thickness
- ~275-m-thick at northern extent of the plateau
- Horizontal to ~6 degree apparent dip (primary?) to ~north
- Overlies, with angular unconformity, West Foreland and Tyonek formations
- Succession is a thicker to the north package of coarse volcaniclastic strata comprising the erosional remnant of incised paleovalley-fill deposits (see also Yehle et al., 1983)



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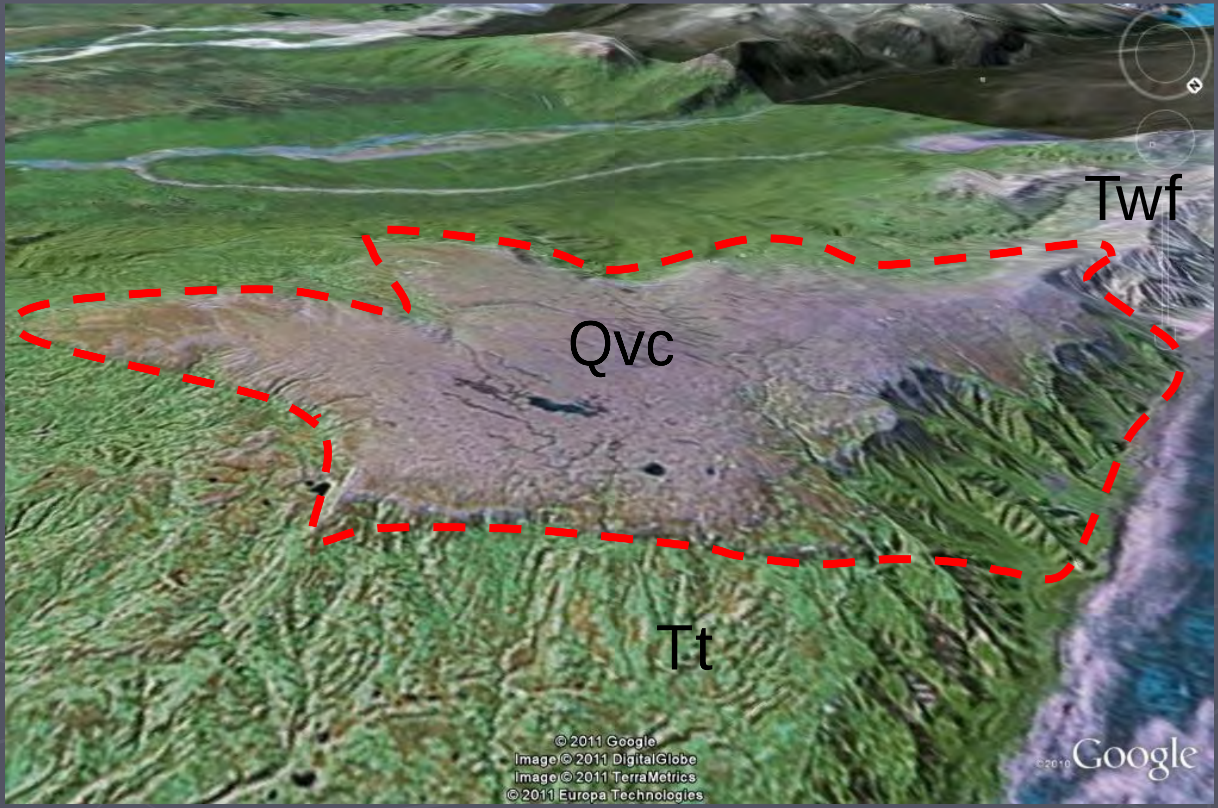


Qvc – Sedimentology

- Volcaniclastic sandy conglomerate and gravelly sandstone with minor pebbly mudstone
  - Clasts and matrix chiefly comprise pumiceous/scoriaceous pyroclasts and vesicular to dense lava
  - Moderately to poorly indurated
- Four lithofacies identified:
  - 1) Matrix-supported, massive conglomerate
  - 2) Clast-supported, massive conglomerate
  - 3) Massive to faintly horizontally stratified sandstone
  - 4) Matrix-supported, massive pebbly mudstone

Lithofacies 1 – Description

- Matrix-supported, very thick-bedded, sandy pebble to boulder conglomerate

- Structureless beds to ~10 m
- Very poorly sorted
- Clasts largely sub-angular
  - Outsized to >5 m^3
- Coarse sand matrix

Lithofacies 1 – Interpretation

- Matrix-supported, massive conglomerate

- Noncohesive debris flow deposits

Lithofacies 2 – Description

- Clast-supported, thick- to very thick-bedded, sandy pebble to cobble conglomerate

- Structureless to crudely stratified
- Very poorly sorted
- Clasts sub-angular to sub-rounded
- Commonly forms channel fill

Lithofacies 2 – Interpretation

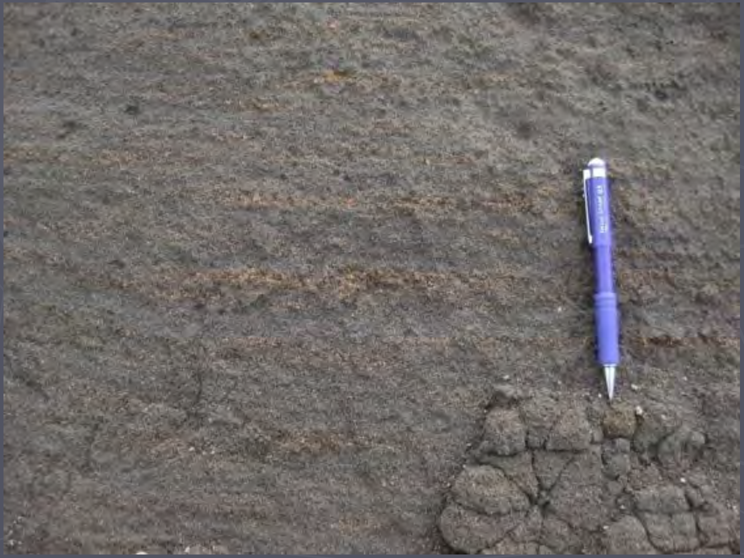
- Clast-supported, massive conglomerate

- Channelized to overbank noncohesive debris flow deposits (see Zernack et al., 2009)

Lithofacies 3 – Description

- Thick-bedded, granule bearing to pebbly sandstone

- Structureless to faintly horizontally stratified
- Moderately sorted
- Sub-angular to sub-rounded
- “Floating” outsized pebbles and cobbles
- Pumice “trains” and silty partings occur locally



Lithofacies 3 – Interpretation

- Massive to faintly horizontally stratified sandstone

- Hyperconcentrated flow deposits
- Silty partings within med. to coarse sand possibly reflect dewatering (see Vallance, 2000)
- Pumice trains commonly observed within HF deposits (see Zernack et al., 2009)

Lithofacies 4 – Description

- Matrix-supported, very thick-bedded, pebbly clay-rich mudstone

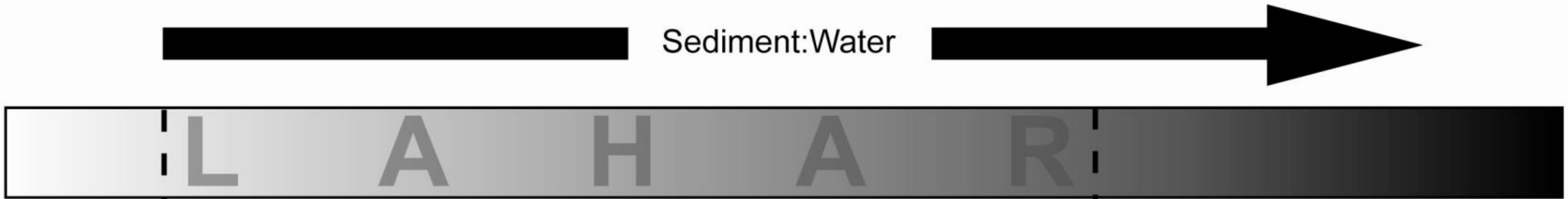
- Structureless
- Moderately to poorly sorted
- Clasts chiefly volcanic and sub-angular; rounded granitic pebbles to boulders occur locally
- Silt- to clay-rich matrix

Lithofacies 4 – Interpretation

- Matrix-supported, massive, pebbly clay-rich mudstone

- Cohesive debris flow deposits
- Clay-rich volcaniclastic debris commonly sourced from hydrothermally altered rock within volcanic edifice (Crandell, 1971; Scott et al., 1995; see also Vallance and Scott, 1997)

Flow Types, Sediment Suspension Processes, and Deposit Characteristics of Sediment-Water Mixtures in Volcanic Settings



Flow Type	Water Flow	Hyperconcentrated Flow	Debris Flow	Debris Avalanche
Suspension Mechanisms	-Turbulence	-Turbulence -Fluid viscosity -Fluid density -+/-Dynamic grain interactions	-Dynamic grain interactions -Fluid density -Fluid viscosity -+/-Cohesive matrix strength	-Dynamic grain interactions -Cohesive matrix strength
Deposit Characteristics	-Clast supported -Mud to sand to rounded gravel -Moderately to well sorted, with poor sorting in rapidly aggraded sequences -Horizontally- to cross-stratified to massive -Lenses of cross-stratified sand and pebbly sand common	-Sand to pebbly sand -Poorly to moderately sorted -Massive to faintly horizontally-stratified to well bedded -Outsize clasts to boulder-size occur	-Matrix supported -Pebble- to boulder-sized clasts in sandy to clayey matrix -Very poorly to poorly sorted -Massive, commonly lacking internal stratification -Meter-sized boulders occur	-Matrix supported, commonly clay-rich -Clasts to tens of meters and debris blocks to hundreds of meters -Very poorly sorted -Massive and unstratified -Deposits commonly have hummocky surface morphology

Figure modified after Smith and Lowe, 1991
Water flow parameters after Smith and Lowe, 1991; Pierson, 2005; and Zernack, et al., 2009
Hyperconcentrated flow parameters after Vallance, 2000; Pierson, 2005; and Zernack et el., 2009
Debris flow parameters after Vallance, 2000 and 2005; and Zernack et al., 2009
Debris avalanche parameters after Smith and Lowe, 1991; Glicken, 1996; and Iverson, 2005

modified after Smith and Lowe, 1991

Modern Analogous Environments of Deposition(?)

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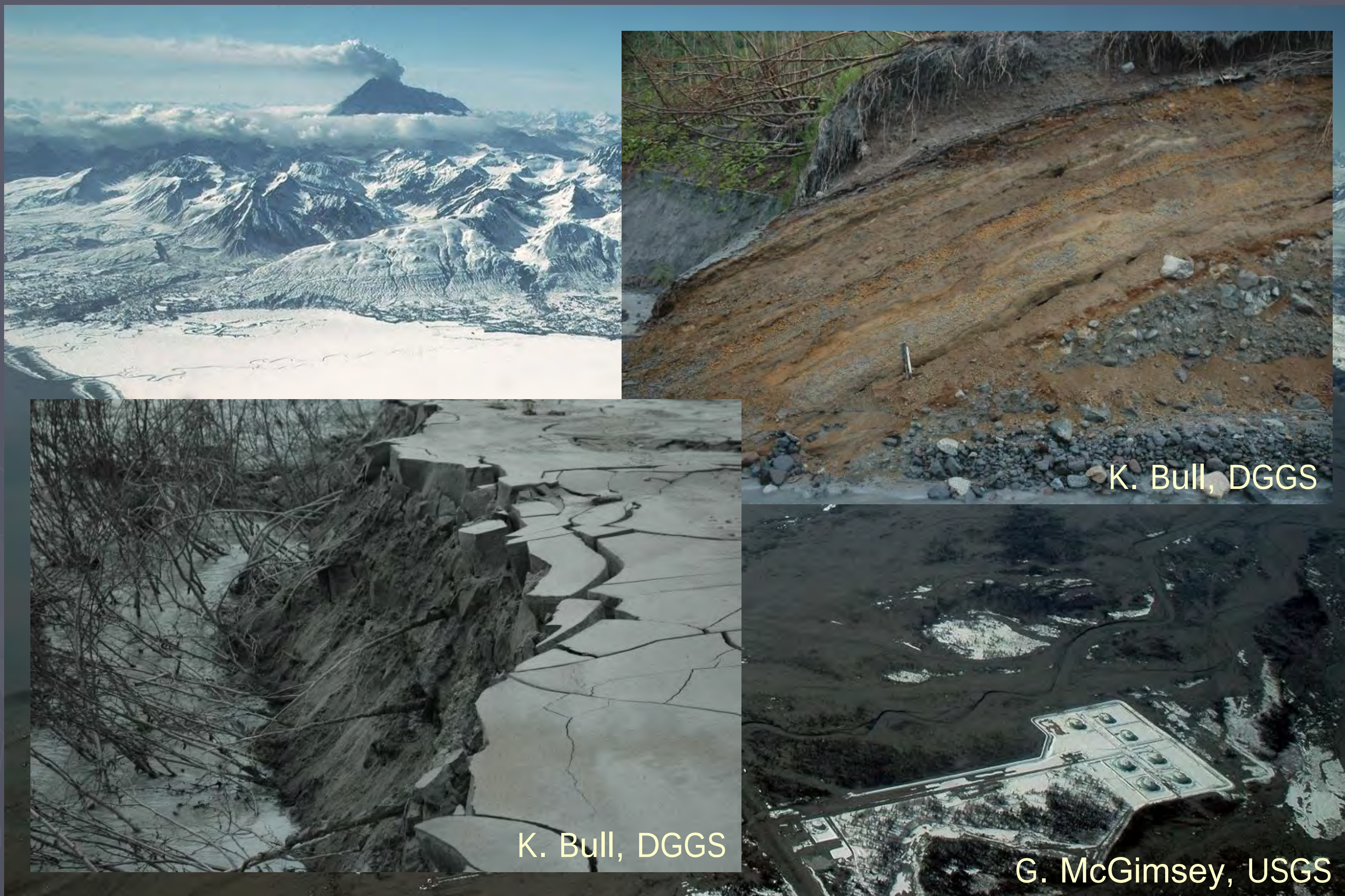
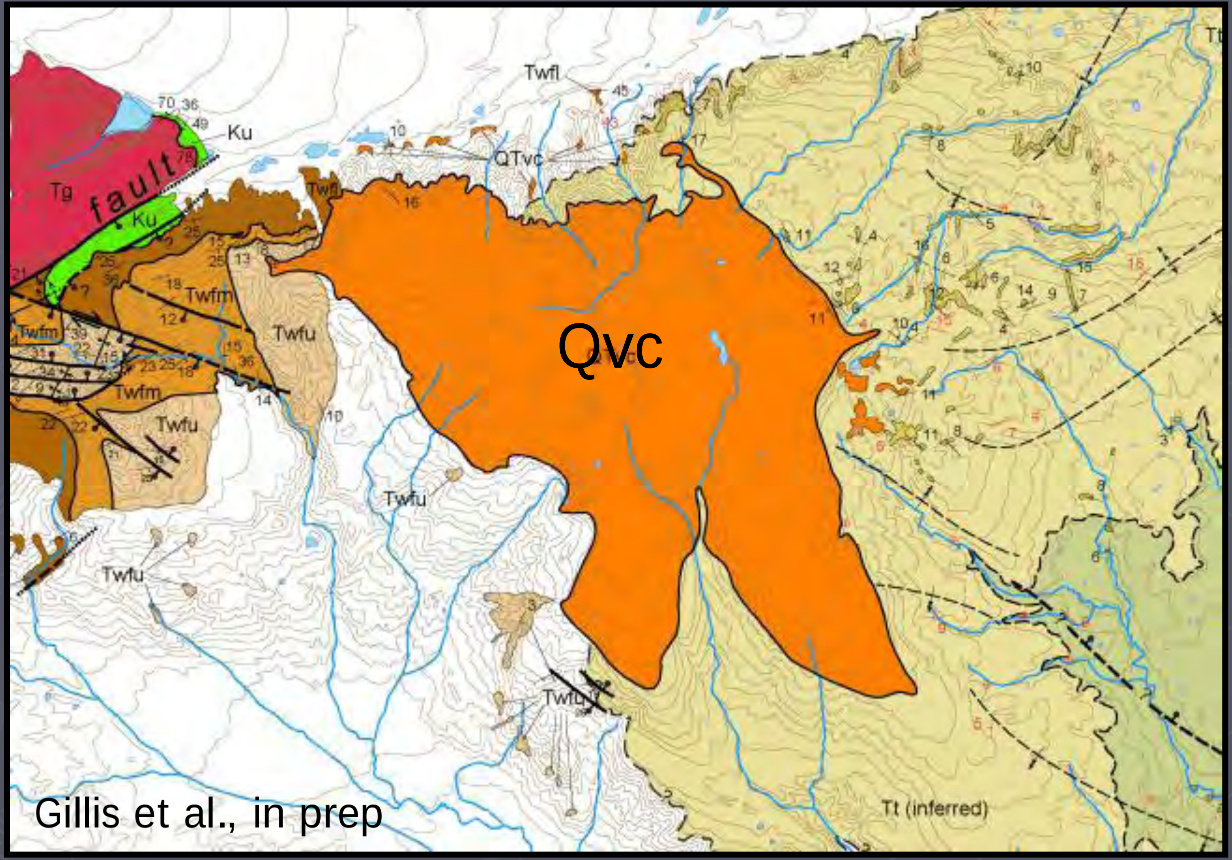
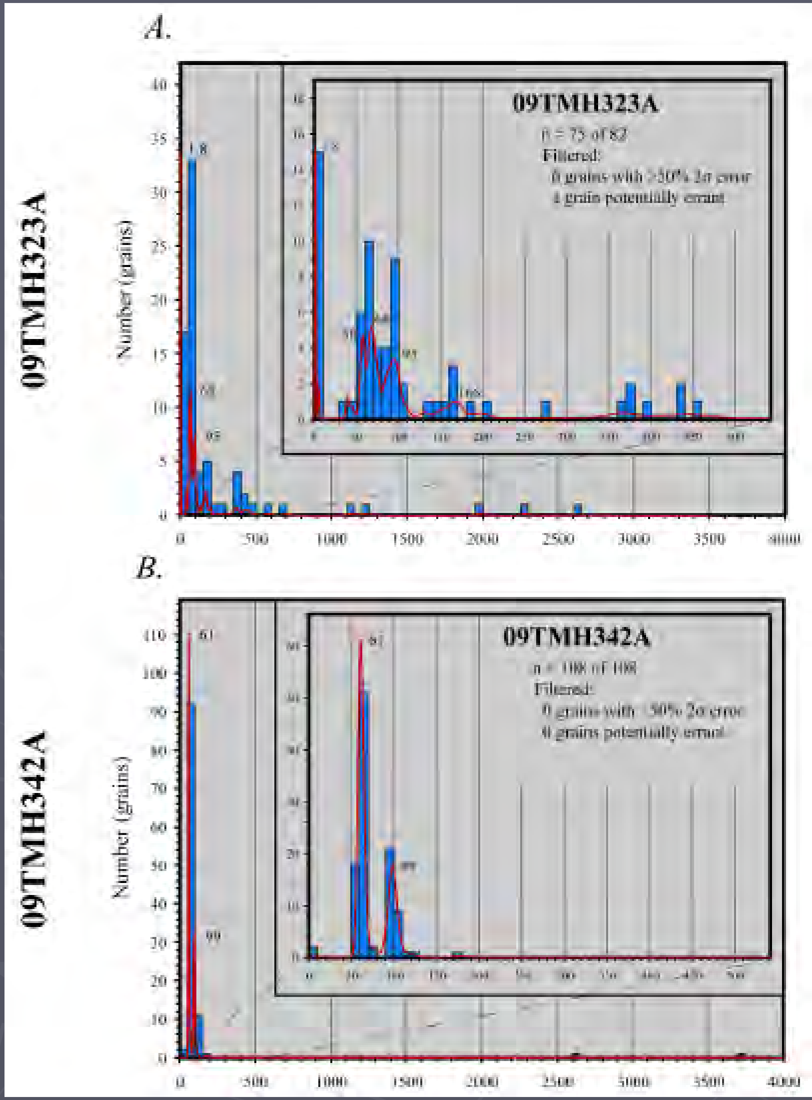
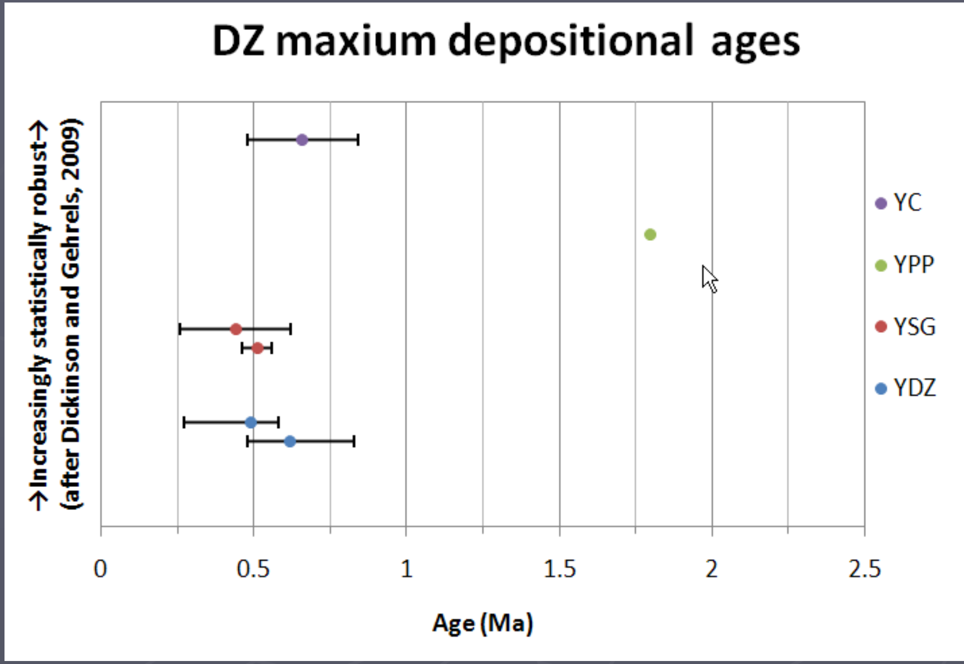


How young are these rocks?



Detrital Zircons – Maximum Depositional Age





- 16 Pleistocene zircons (n=16/190)
- 9 zircons are younger than 1 Ma
- Robust indicator of 660–440 ka maximum depositional age

~~QTvc~~……Qvc

Detrital Zircons – More Than Maximum Depositional Age

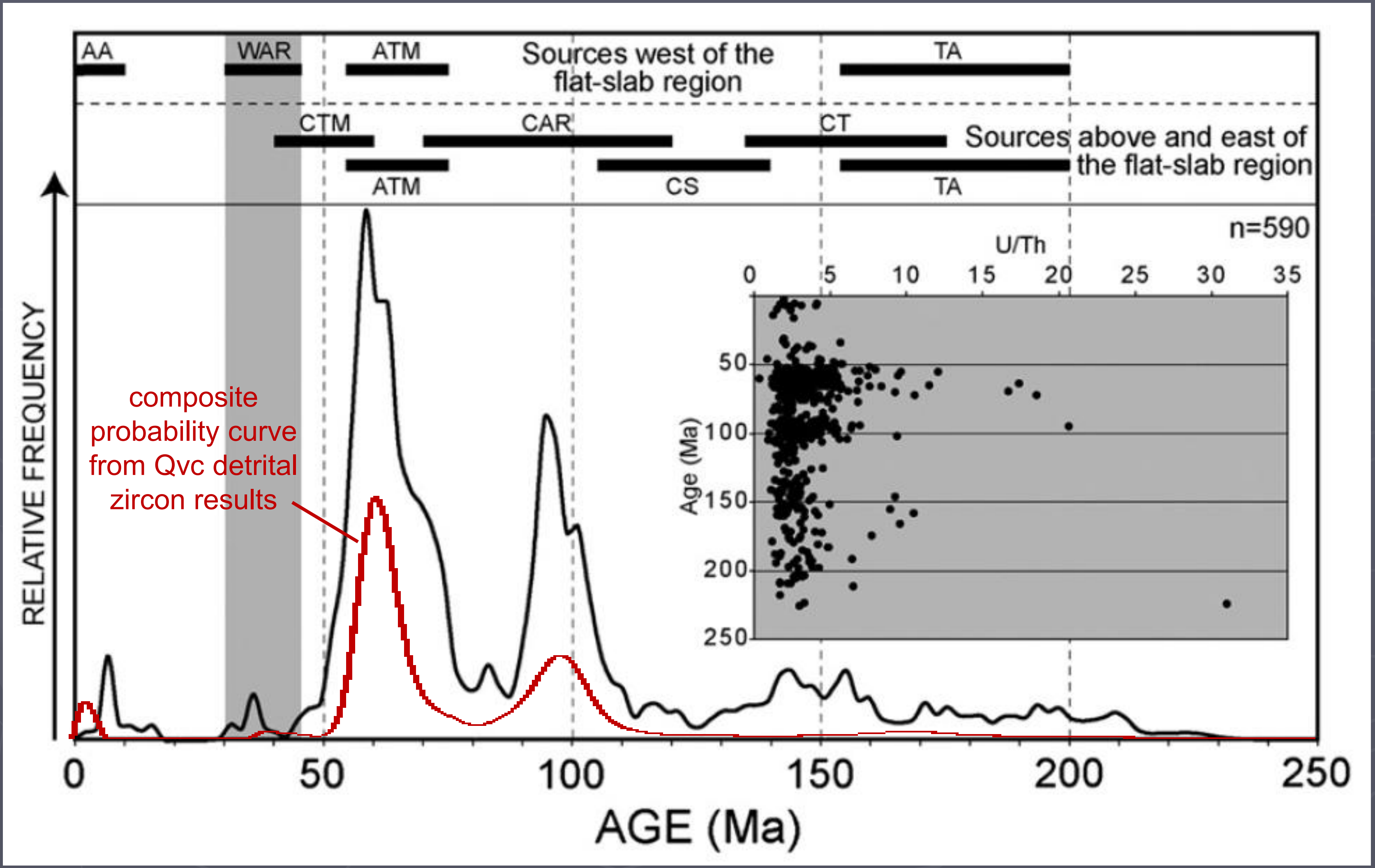
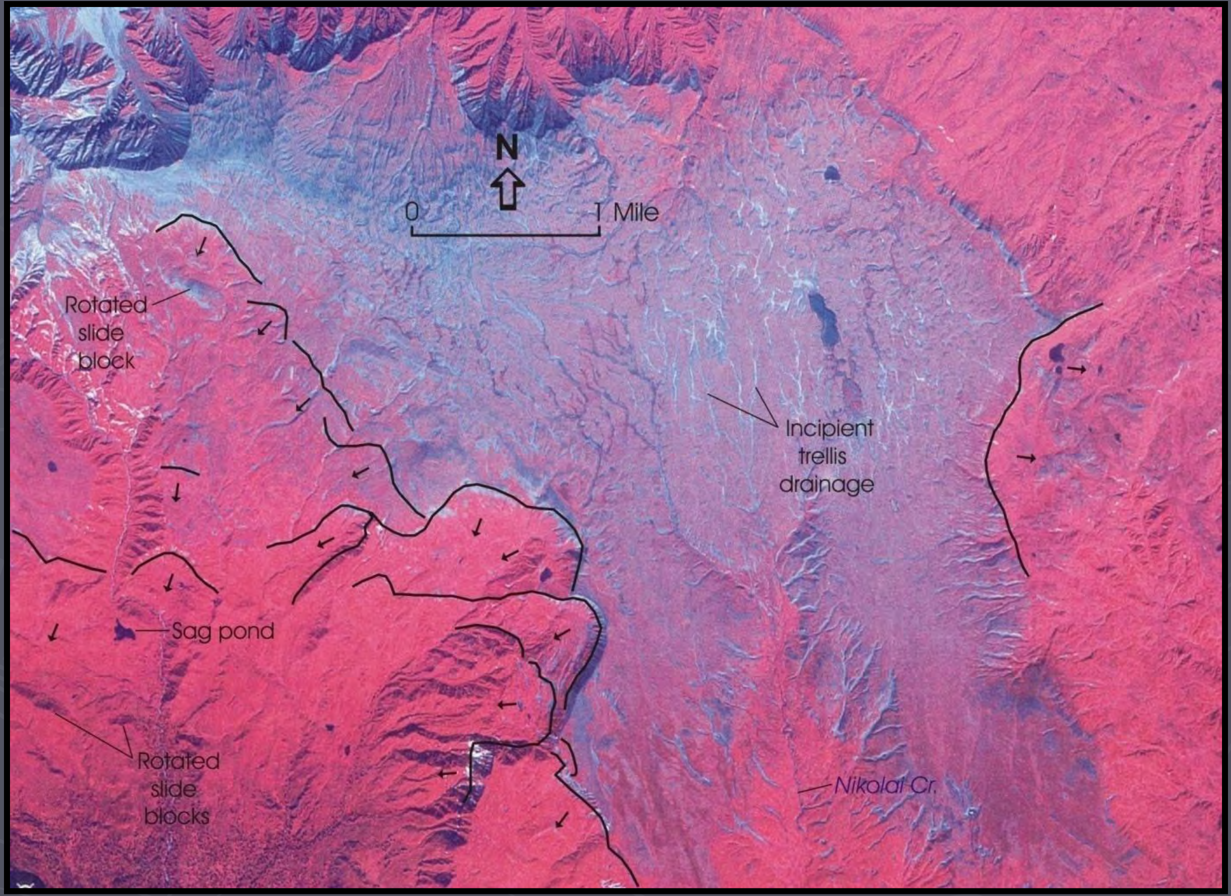


figure from Finzel et al., 2011, EPSL

Glacial Deposits – Minimum Depositional Age

- MIS 4 glacial deposits overlie Qvc along western and eastern plateau escarpments/margins (R. Reger, unpublished data)
- MIS 4 minimum depositional age (~70–55 ka)



R. Reger, unpublished

Deformed Strata

- Moderately dipping to overturned bedding: soft sediment deformation?

Soft Sediment Deformation.

- Sand injection features locally observed; evidence of fluidization/liquefaction of water saturated sandy horizons
- Likely trigger? Volcanogenic or tectonic seismicity, high instantaneous sedimentation rates, unstable slopes, or combination thereof

Summary and Conclusions

- Qvc is ~ 275-m-thick section of poorly-sorted, thick-bedded, conglomeratic volcaniclastic strata
    - Interpreted to record lahars transported as debris and hyperconcentrated flows
- Maximum age of Qvc is 660–440 ka (DZ)
- Minimum age of Qvc is ~70–55 ka (MIS 4 glacial deposits)
- Evidence of fluidization/liquefaction suggests soft sediment deformation

Summary and Conclusions – Significance(?) and Some Unanswered Questions

- Fundamental geologic questions are addressed in this study
- General societal impacts of laharic processes
- Similar volcanogenic processes have local implications for energy infrastructure

- What are the paleogeographic implications of these deposits?
- What are the tectonic implications of the Oligo-Miocene detrital zircon gap in Cook Inlet?

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Thank You