A continuous thermal history for southern Baffin Island, Canada over the past 1.8 billion years
Implications for the assembly of Rodinia and the rifting of Greenland

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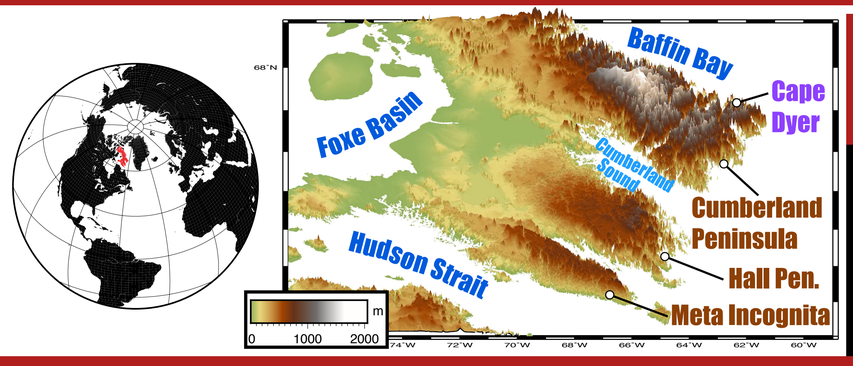
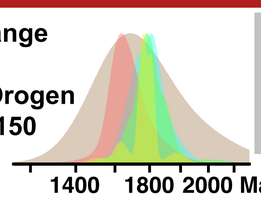
BAFFIN ISLAND | NEW THERMOCHRONOLOGY | K-FELDSPAR $^{40}Ar/^{39}Ar$ MDD

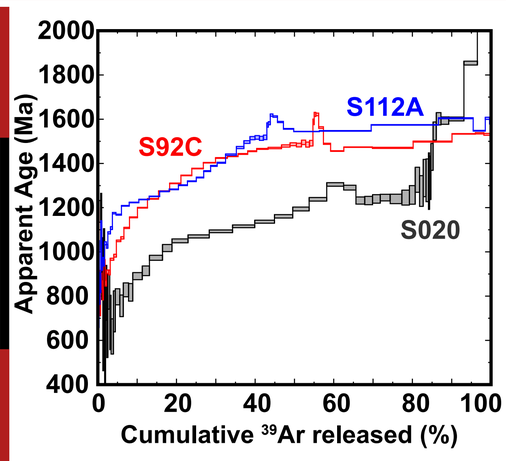


ICPMS U-Pb APATITE AGES

New apatite U-Pb ages range from ca. 1650-1800 Ma. Suggest Trans-Hudson Orogen remained >400ºC for ca. 150 Ma after peak heating.



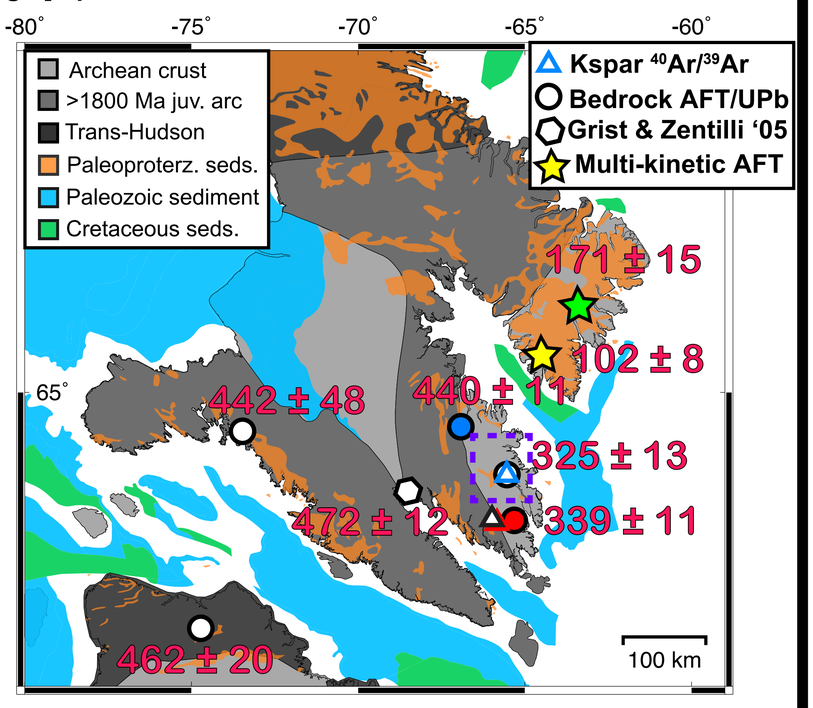
1796 ± 75 Ma (n=18)
1782 ± 38 Ma (n=25)
1754 ± 53 Ma (n=23)
1674 ± 35 Ma (n=28)
1668 ± 194 Ma (n=12)



K-feldspar MDD $^{40}Ar/^{39}Ar$ results from Hall Peninsula (McDannell, 2017) demonstrate cooling from ~350-150ºC from Meso- to Neoproterozoic. Modeled thermal history scenarios imply cooling to the (near) surface during Grenville time & heating during the Neoproterozoic or remaining at elevated temps. and exhuming during latest Grenville.

GEOLOGY & SAMPLES

Problem: The Proterozoic thermal history of Baffin Island is mostly unknown. Can multiple thermochronometers and regional geologic data better resolve the Proterozoic-Phanerozoic thermal history of southern Baffin Island? The majority of previous thermochronology studies model data as simple linear cooling and do not find any evidence to definitively support Mesozoic-early Cenozoic [passive margin] uplift.

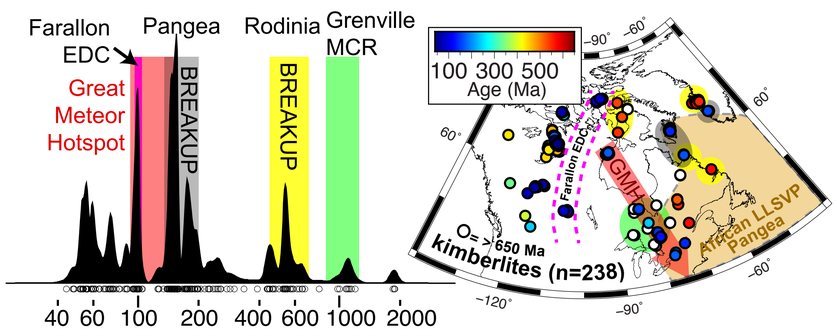


New apatite fission track samples (circles) with central ages & 1σ errors. ICPMS U-Pb analysis also done on AFT samples. Triangles are locations of bedrock K-feldspar samples analyzed for $^{40}Ar/^{39}Ar$ MDD.

AFT central ages suggest Paleozoic exhumation, while Paleoproterozoic Hoare Bay sediments (orange) exhibit multi-kinetic AFT behavior (see middle panel). Ordovician-Silurian sediments (blue) demonstrate current Baffin bedrock was likely near the surface in the late Paleozoic.

Chidliak kimberlite field (dashed box) on Hall Peninsula dated at 156-138 Ma (Heaman et al., 2012) contain Ordovician carbonate xenoliths (Zhang and Pell, 2014) — suggesting a few hundred meters of sedimentary cover existed in the late Paleozoic.

Regional kimberlites and dikes in W. Greenland suggest initial North American-Greenland crustal stretching drove uplift from ca. 220-150 Ma (Larsen et al., 2009), prior to final Paleocene continental breakup and opening of Davis Strait.



CONCLUSIONS

Integrated thermochronometers resolve ca. 1.8 Ga of Baffin Island thermal history over >400°C.

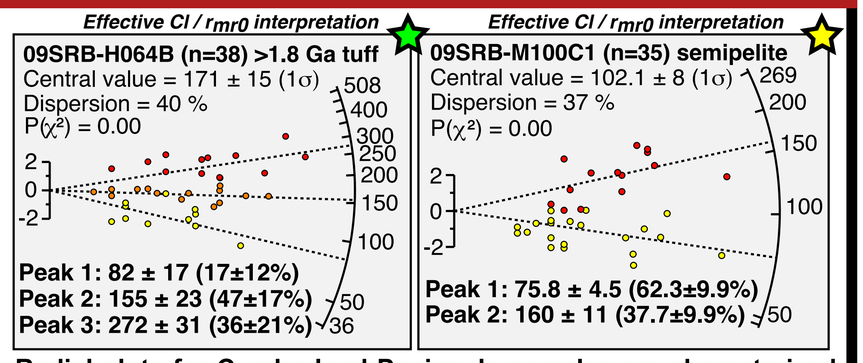
Major exhumation during terminal Grenville orogeny or during Rodinia breakup on Baffin

Rocks were near surface or buried under thin sediments (< 2 km) through Paleozoic.

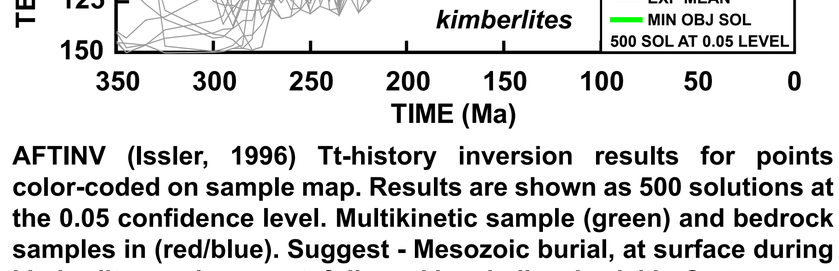
Multi-kinetic AFT models suggest unroofing at ~200-150 Ma during initial Greenland-North America rifting and later during opening of the Atlantic.

AFT data require burial after kimberlite emplacement - suggests more widespread Late Cretaceous sediments on eastern craton.

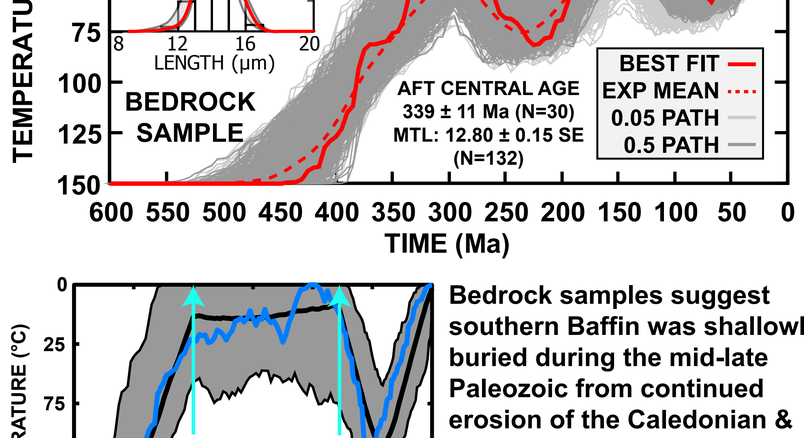
APATITE FISSION-TRACK



Radial plots for Cumberland Peninsula samples are characterized by high age dispersion & fail the chi-squared test, suggesting multiple age populations. The kinetic age populations are based on separation via radial plot peaks and chemical composition, i.e. effective Cl (r_{mr0}).



Three kinetic populations show overlap in effective Cl. This sample is relatively homogeneous in composition and makes separation of kinetic populations difficult. However, typical errors associated with eff. Cl measurements can be ~0.03 apfu. Duplicate measurements of age and length grains for this sample confirm this. Length grains better resolve kinetic populations based on eff. Cl concentration.

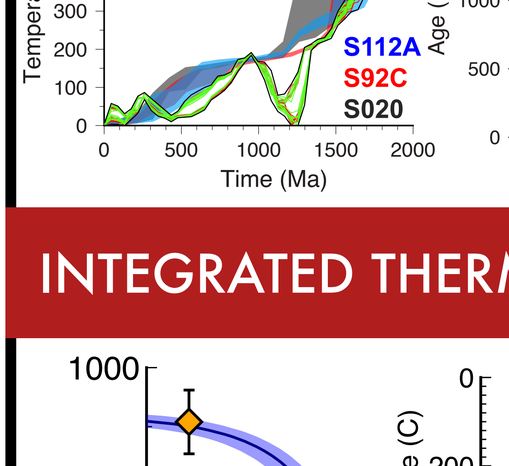


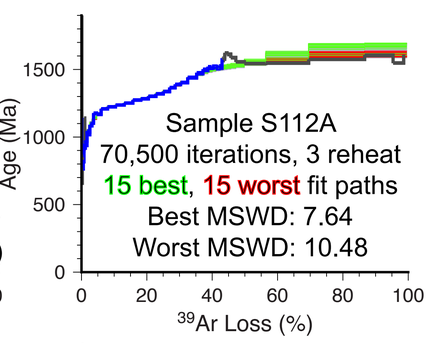
AFTINV (Issler, 1996) Tt-history inversion results for points color-coded on sample map. Results are shown as 500 solutions at the 0.05 confidence level. Multikinetic sample (green) and bedrock samples in (red/blue). Suggest - Mesozoic burial, at surface during kimberlite emplacement, followed by shallow burial in Cretaceous.

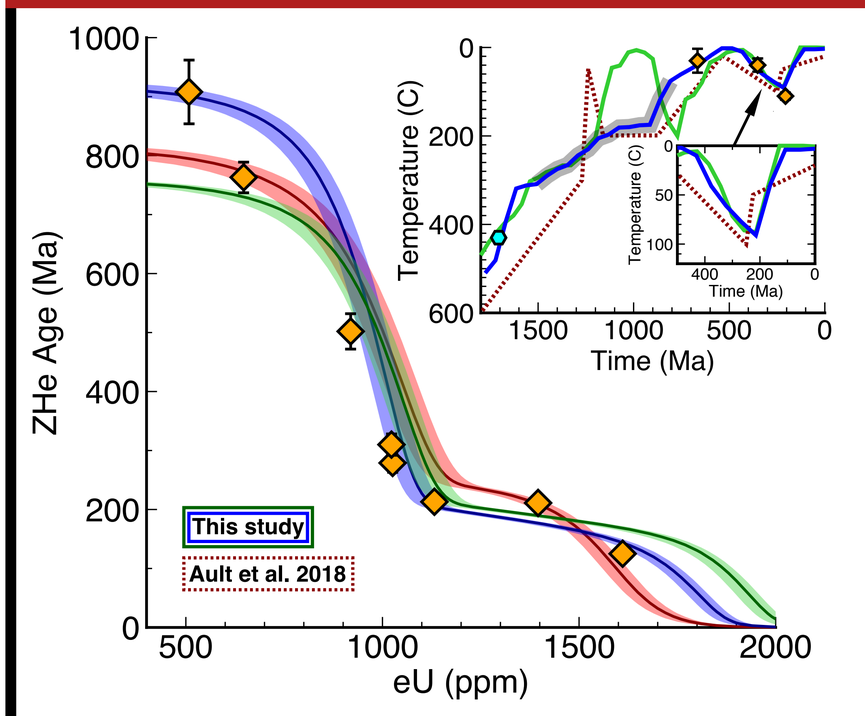
Bedrock samples suggest southern Baffin was shallowly buried during the mid-late Paleozoic from continued erosion of the Caledonian & Franklinian? orogens

Later Cretaceous burial supported by preserved (remnant) onshore/offshore sediments

INTEGRATED THERMAL HISTORY



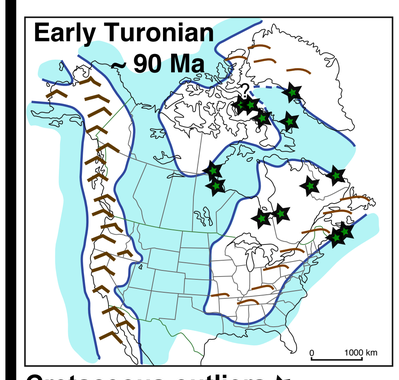




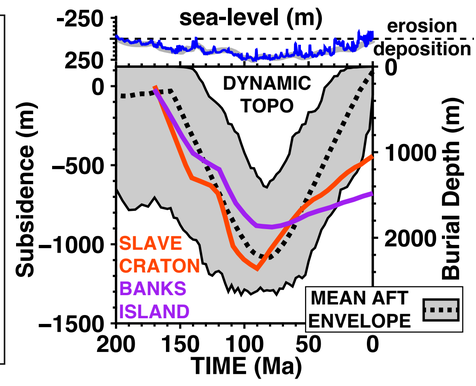
Ault et al. (2018) zircon U-Th/He data from ca. 1.8 Ga Cumberland Batholith range from 0.91-0.125 Ga. ZrDAAM forward models use best-fit *Arvert* Tt-histories.

Jointly modeled apatite U-Pb, K-feldspar MDD, & ZHe ages suggest major exhumation of Baffin occured from temperatures of ~200ºC during terminal Grenville and/or Rodinia breakup.

Suggest maximum burial of central Baffin due to erosion of the Caledonian Mountains & recycled Devonian/Silurian Clastic Wedge sediments



Cretaceous outliers
after Schröder-Adams, 2014



Heating (burial) in the Cretaceous is required to shorten track lengths. Implies that Cretaceous strata were more widespread across Canada during sea-level rise, rift shoulder thermal subsidence, and broad mantle-driven subsidence in the Arctic (e.g. Shephard et al., 2014; purple/red curves).