

The role of anatexis in generating high-grade flake graphite deposits: An example from Graphite Creek, Alaska

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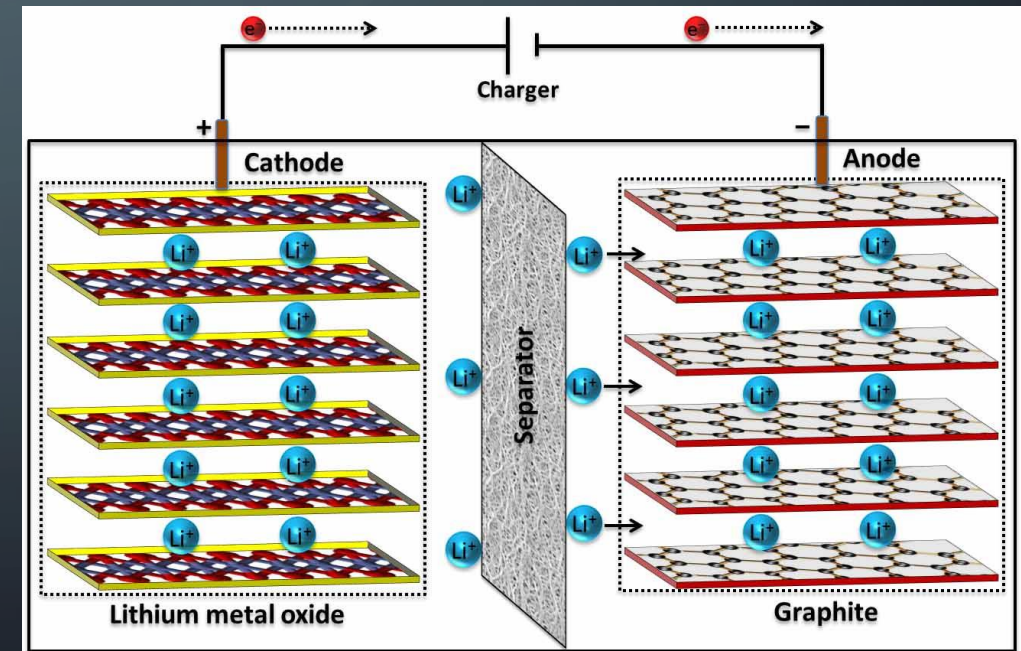
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FLAKE GRAPHITE – A CRITICAL MINERAL



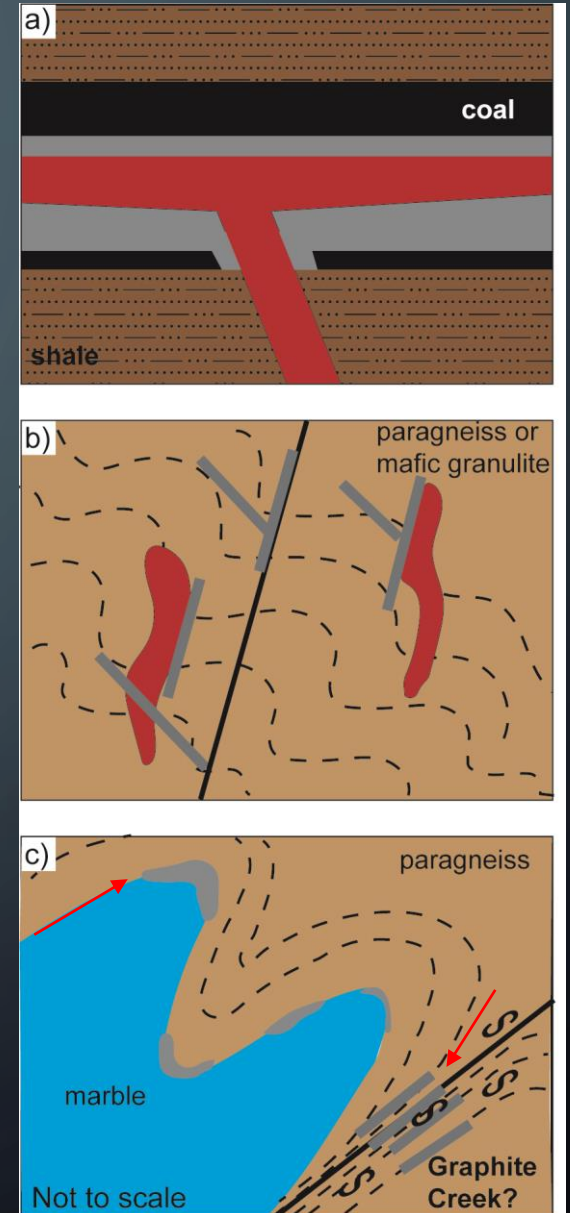
- Anode material in Li-ion batteries needed for EVs, energy storage systems, portable electronics
- U.S. remains **100% net import reliant**
 - Significant consumer
 - Global production dominated by China (MCS, 2021)
- Canada and Australia – potential producers?



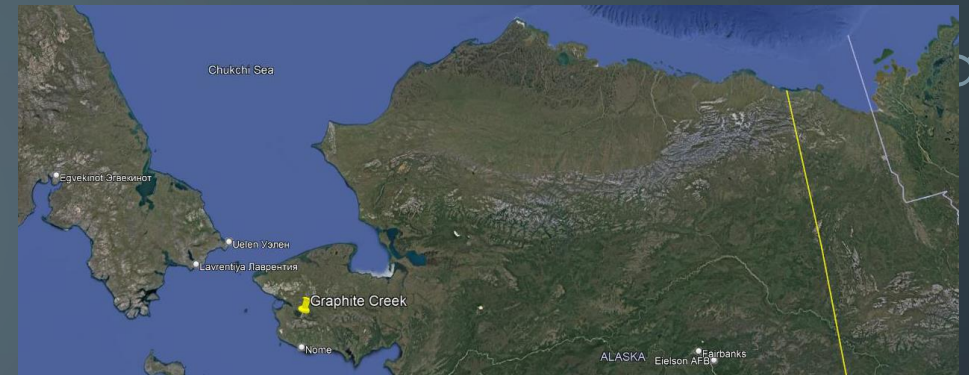
GRAPHITE MINERAL SYSTEM MODELS

- Amorphous: contact metamorphism
- Lump & chip: hydrothermal fluids
 - Large flakes, high grades, small tonnage
 - Metamorphic or even mantle-derived carbon / fluids
- Flake: regional high-T metamorphism $\pm$ fluids?
 - Graphitization of carbonaceous metaseds
 - Devolatilization of marble
 - Medium-large flakes, low grades, high tonnage
 - Other processes??

Arrows
indicate
movement
of fluids

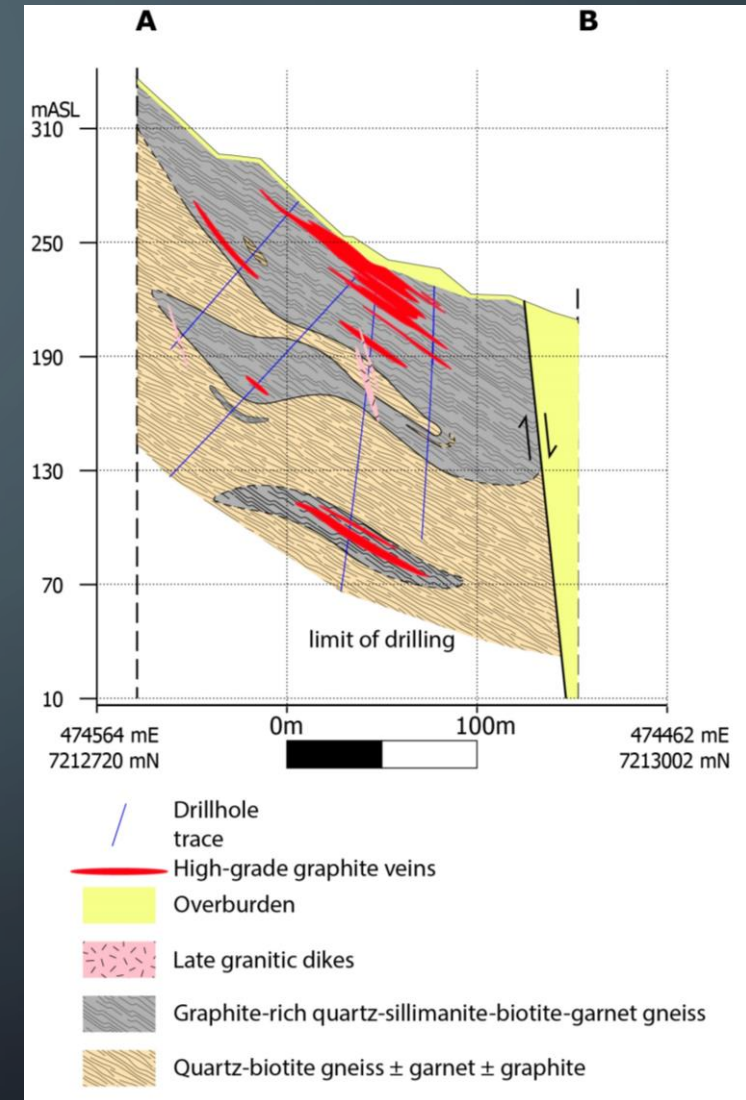
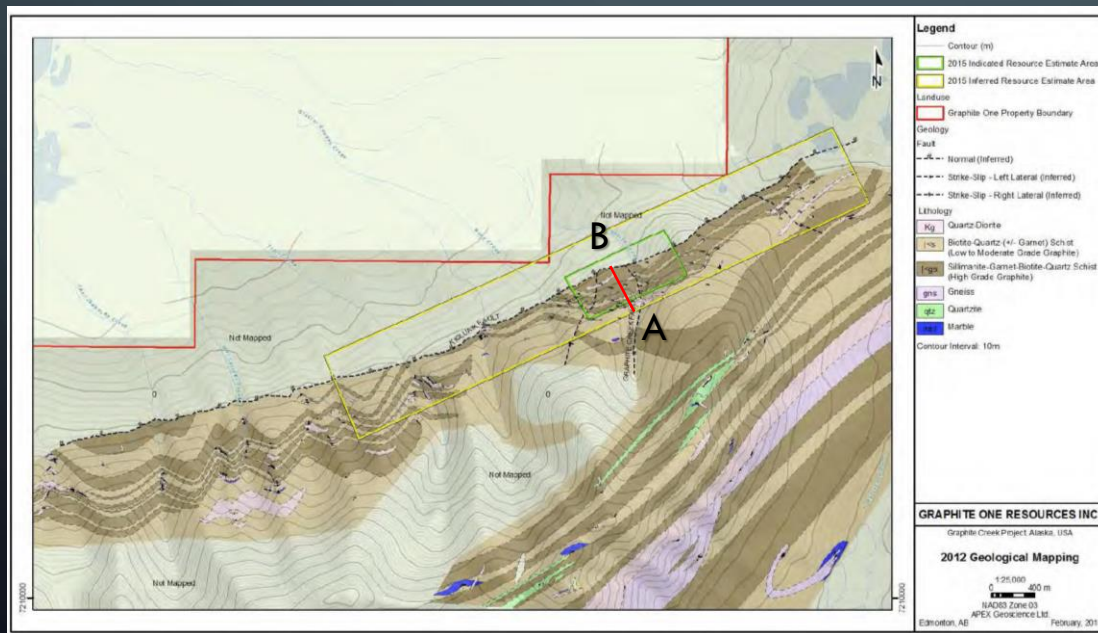


GRAPHITE CREEK, ALASKA



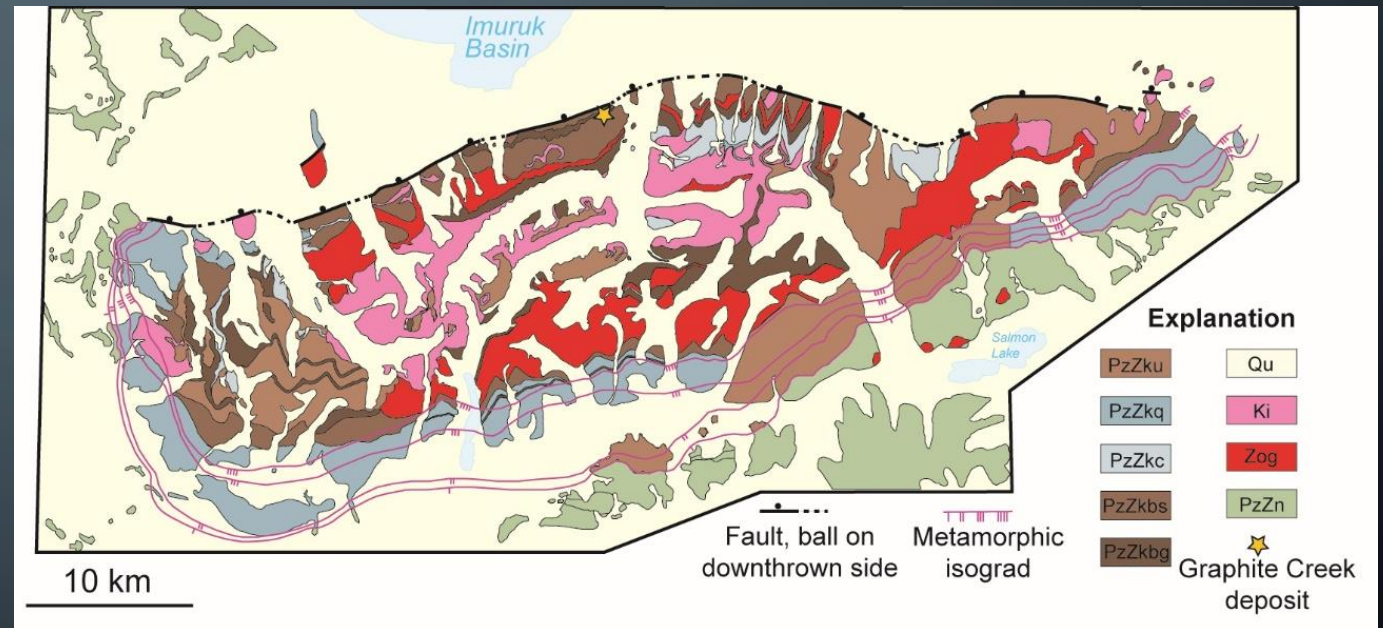
GRAPHITE CREEK, ALASKA

- Resource (King et al. 2019)
 - **10.95 Mt @ 7.8% C_g** (measured + indicated)
 - **91.89 Mt @ 8% C_g** (inferred)

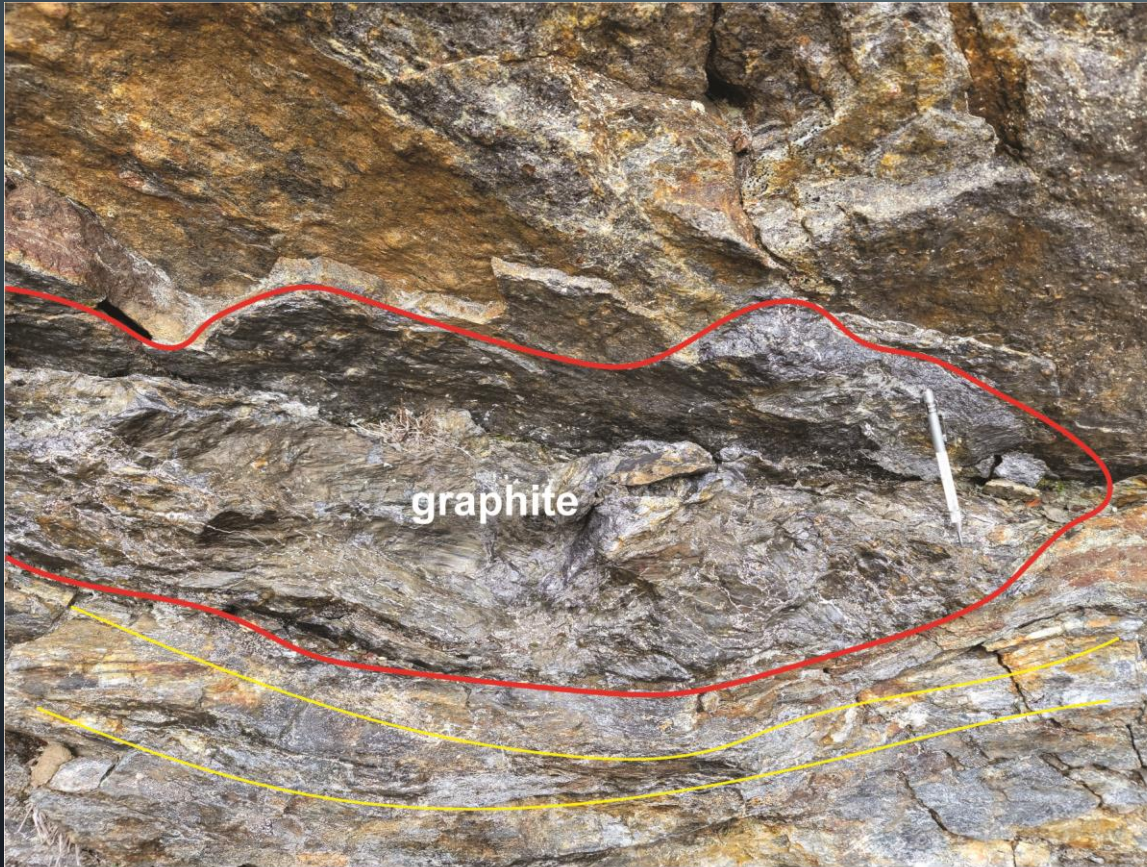


REGIONAL GEOLOGY

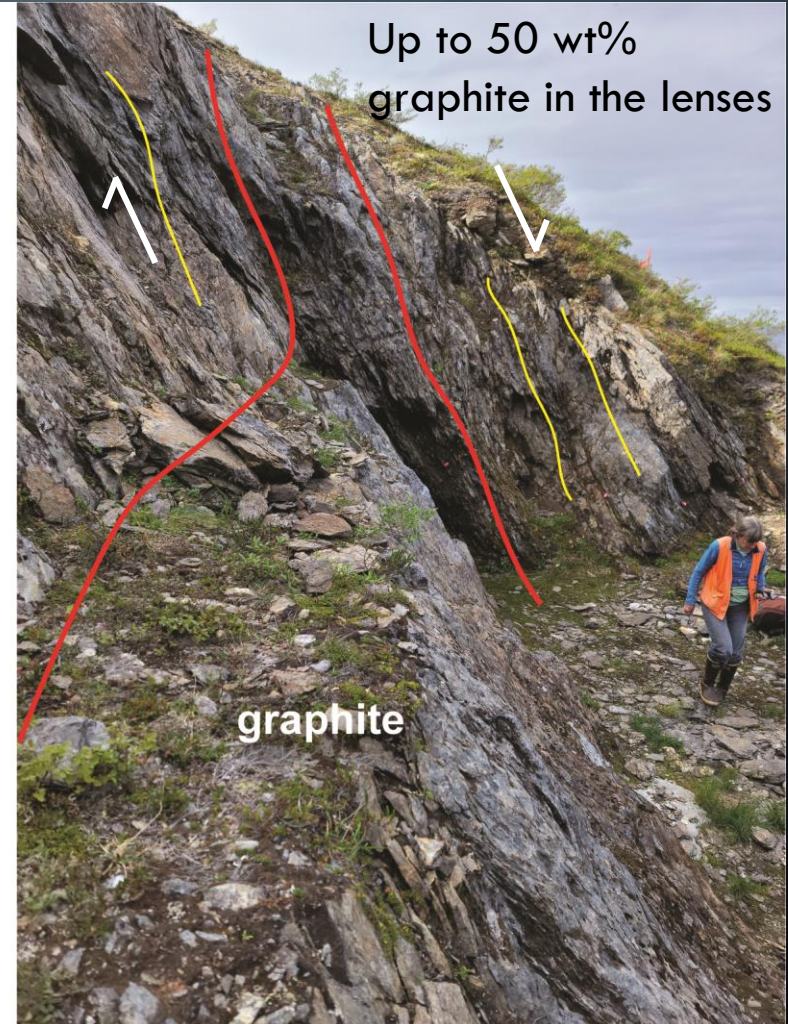
- Kigluaik Mountains gneiss dome
- Neoproterozoic – Mesozoic? metasedimentary rocks of the Kigluaik Group (Nome Complex?)
- Magmatism & granulite-grade metamorphism around 100 – 90 Ma



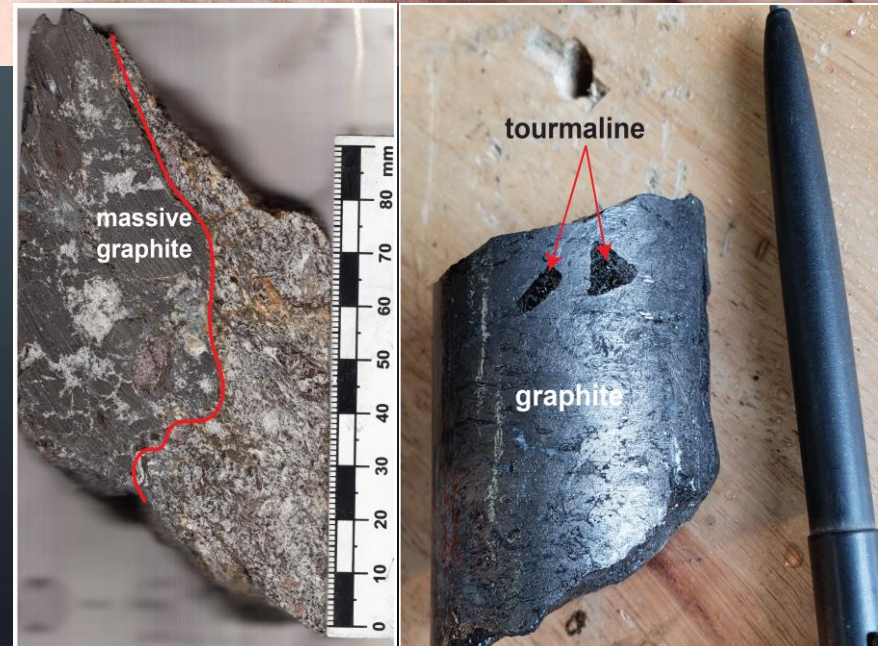
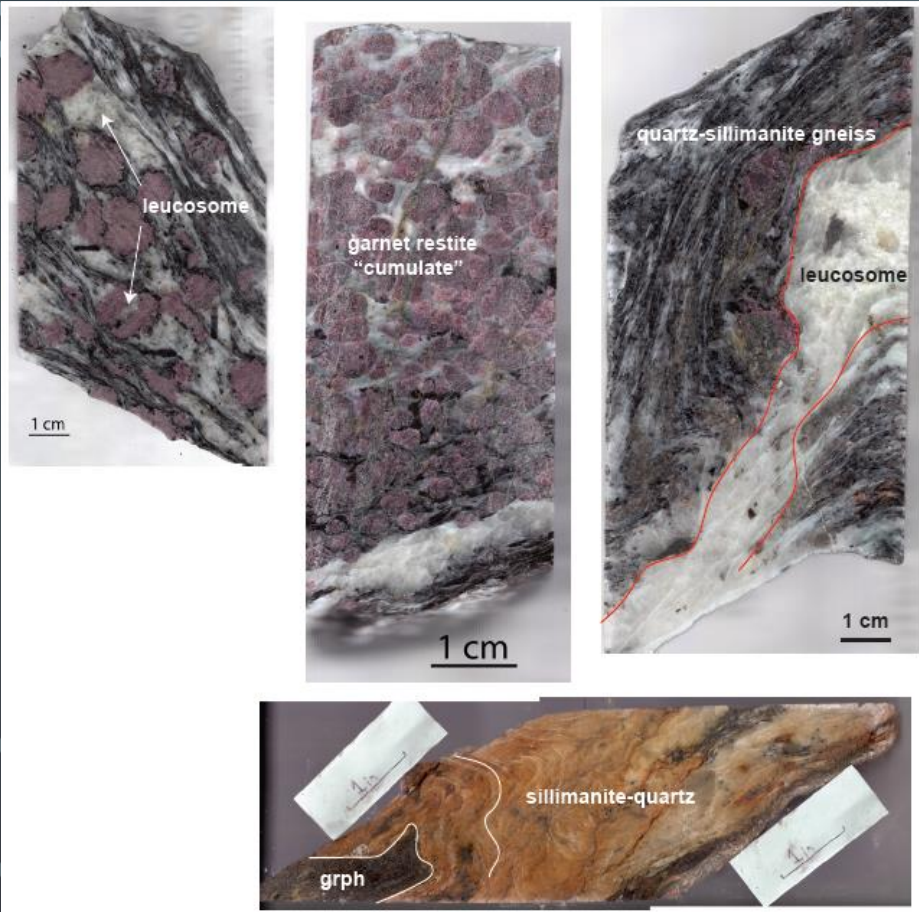
OREBODY



Massive graphite lenses in outcrop: up to 1m thick, several meters across; pinch and swell

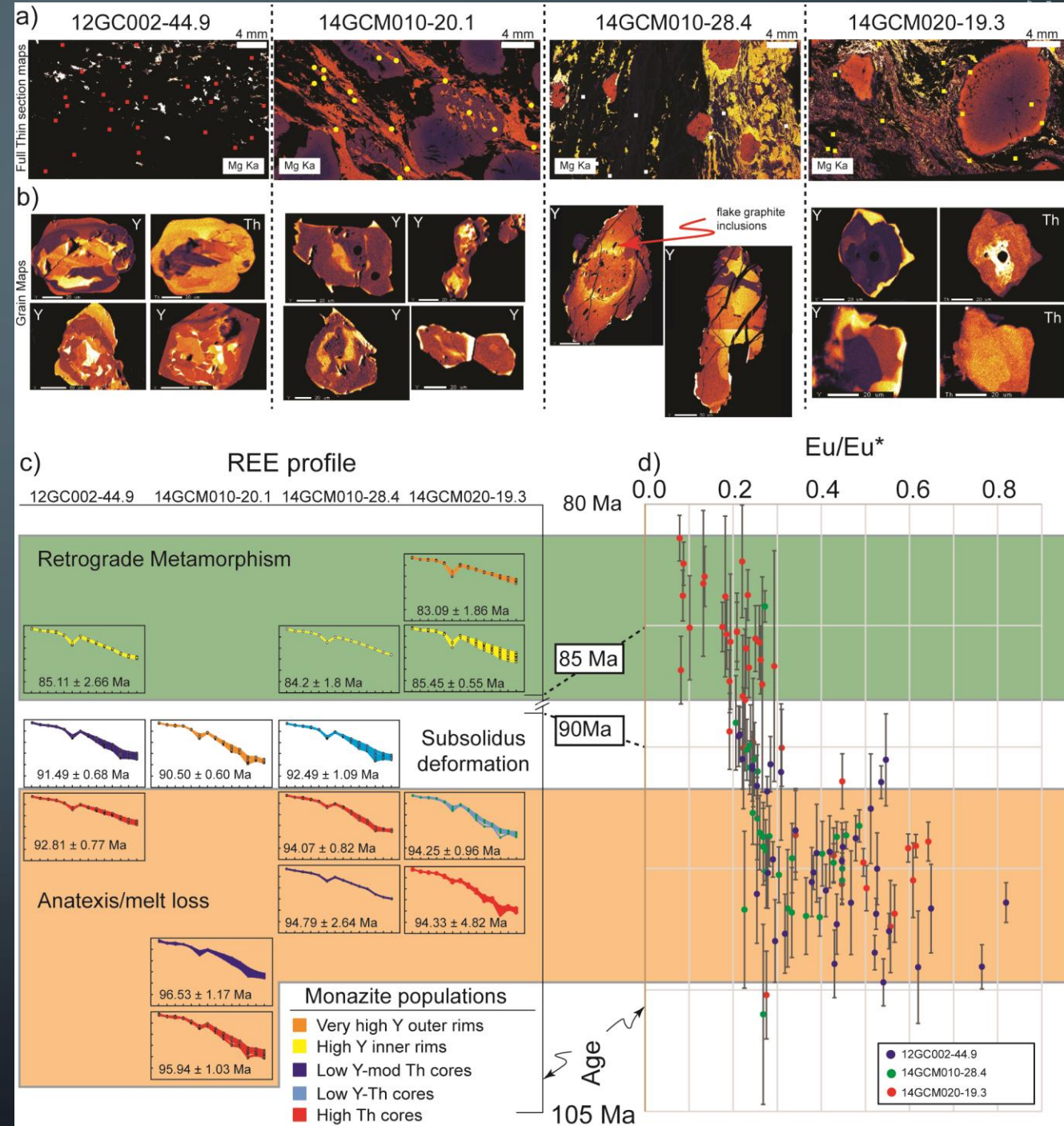


RESTITIC TEXTURES



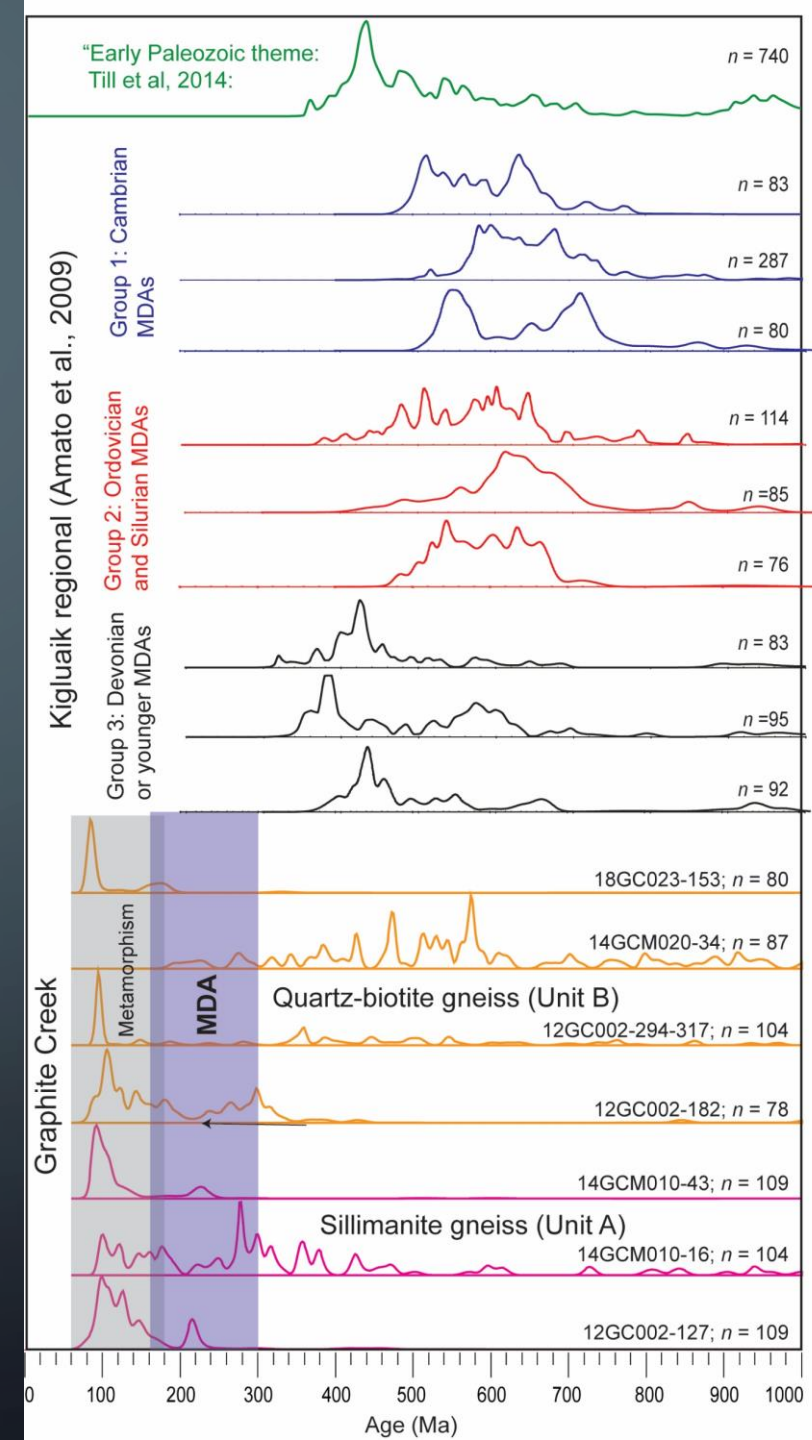
MONAZITE PETROCHRONOLOGY

- WDS & laser ablation split-stream (LASS)
- Monazite characterized by yttrium depletion of old (~95 Ma) cores
- Retrograde event ~85 Ma
- REE profiles consistent with **biotite dehydration melting**
 - Biotite + plagioclase + sillimanite + quartz = garnet + K-feldspar + **melt**



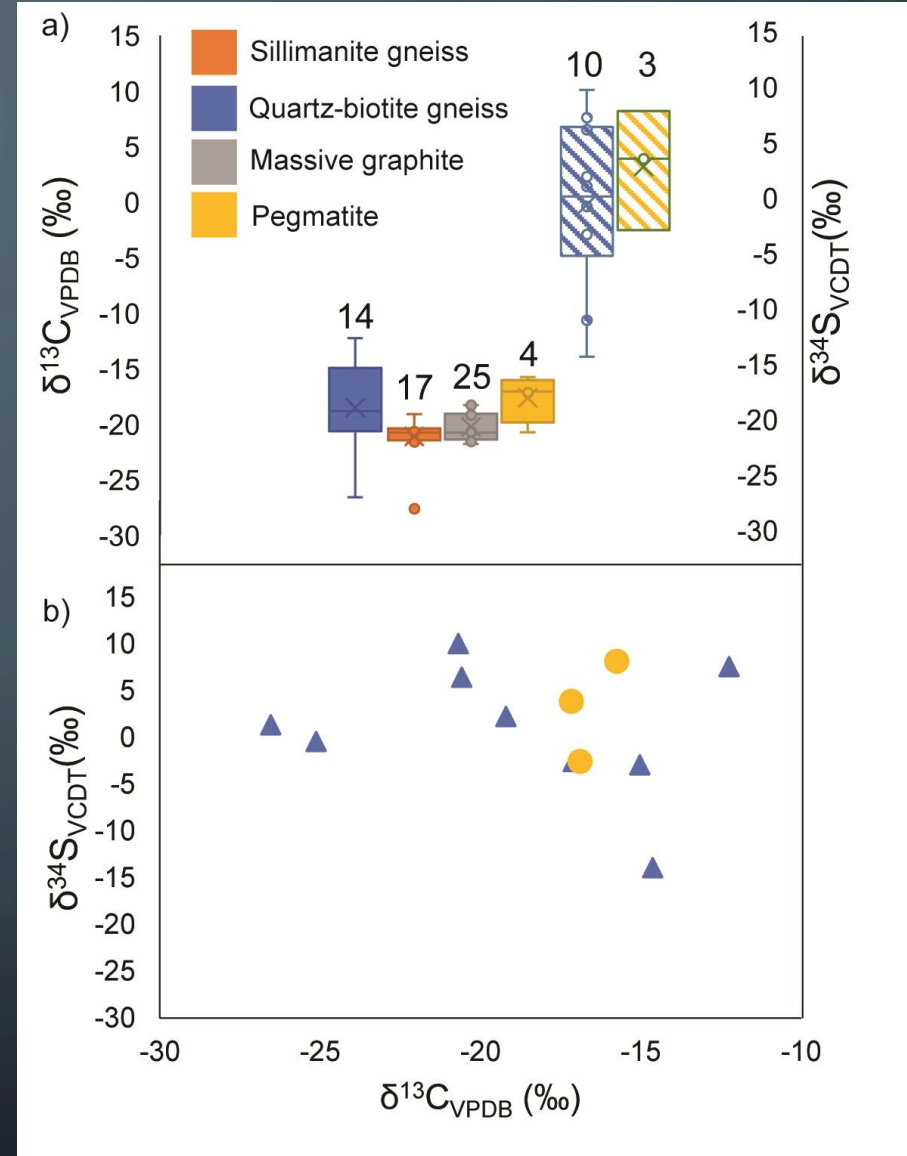
DETRITAL ZIRCON GEOCHRONOLOGY

- Unusually young Mesozoic maximum depositional ages
- Strong 90-100 Ma population – anatectic zircons
- Neither are recognized elsewhere in the Nome Complex or Kigluaik Group



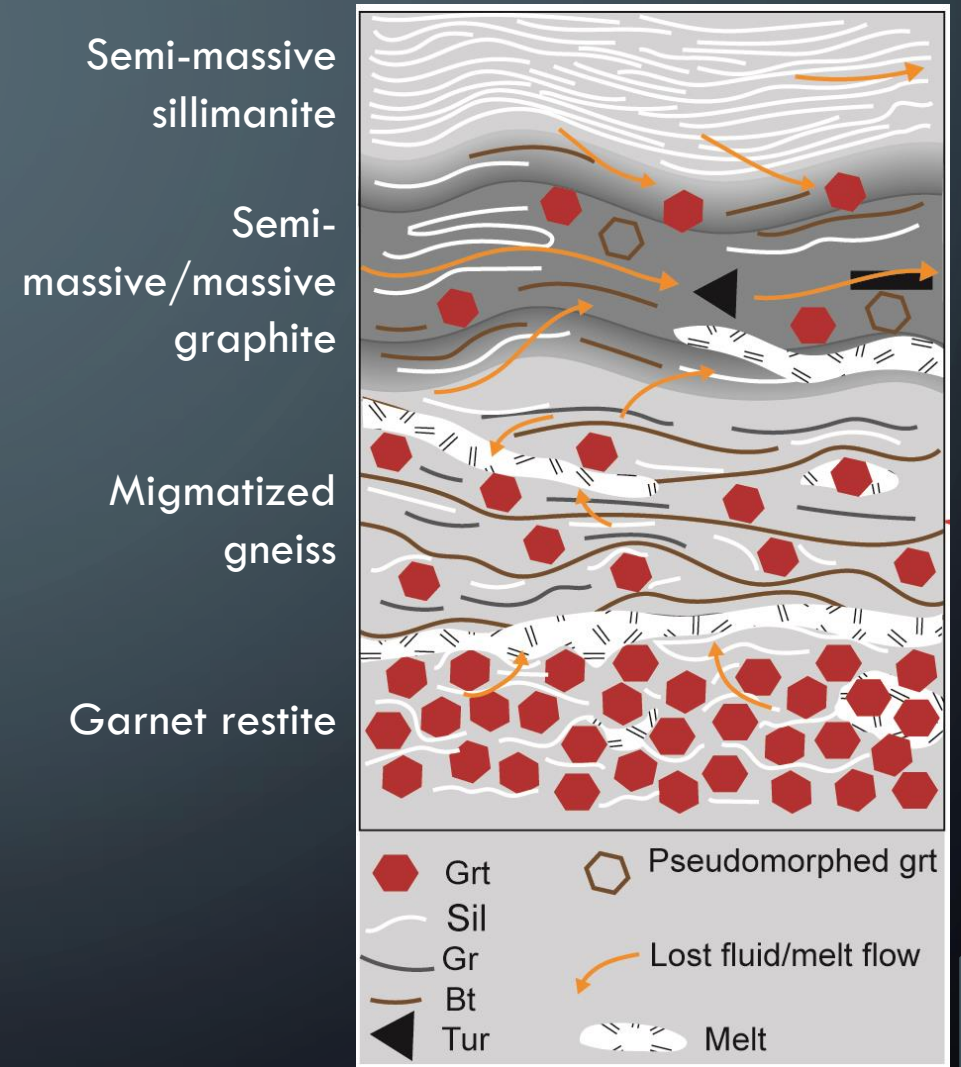
STABLE ISOTOPES

- Values of -20 to -15‰ consistent with organic source
- Sedimentary sulfur: -5 to +5‰
- Consistent between rock types
- Carbon derived locally from protolith



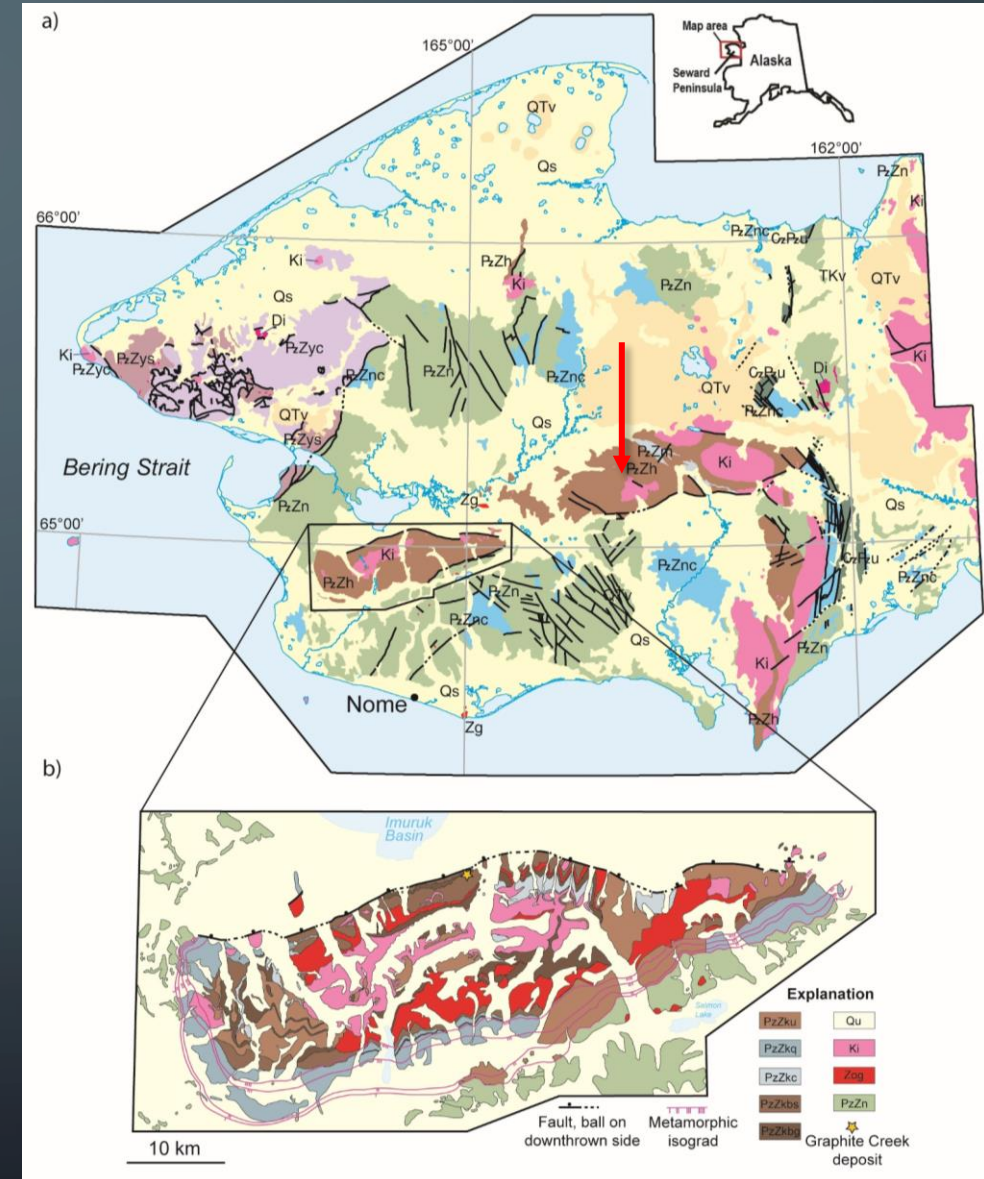
MINERALIZATION MODEL

- Protolith: carbonaceous shale w/ high TOC
- High-temperature metamorphism
- Anatexis / partial melting & melt+fluid loss
- Graphite left behind as restitic phase, silicate phases lost = concentration



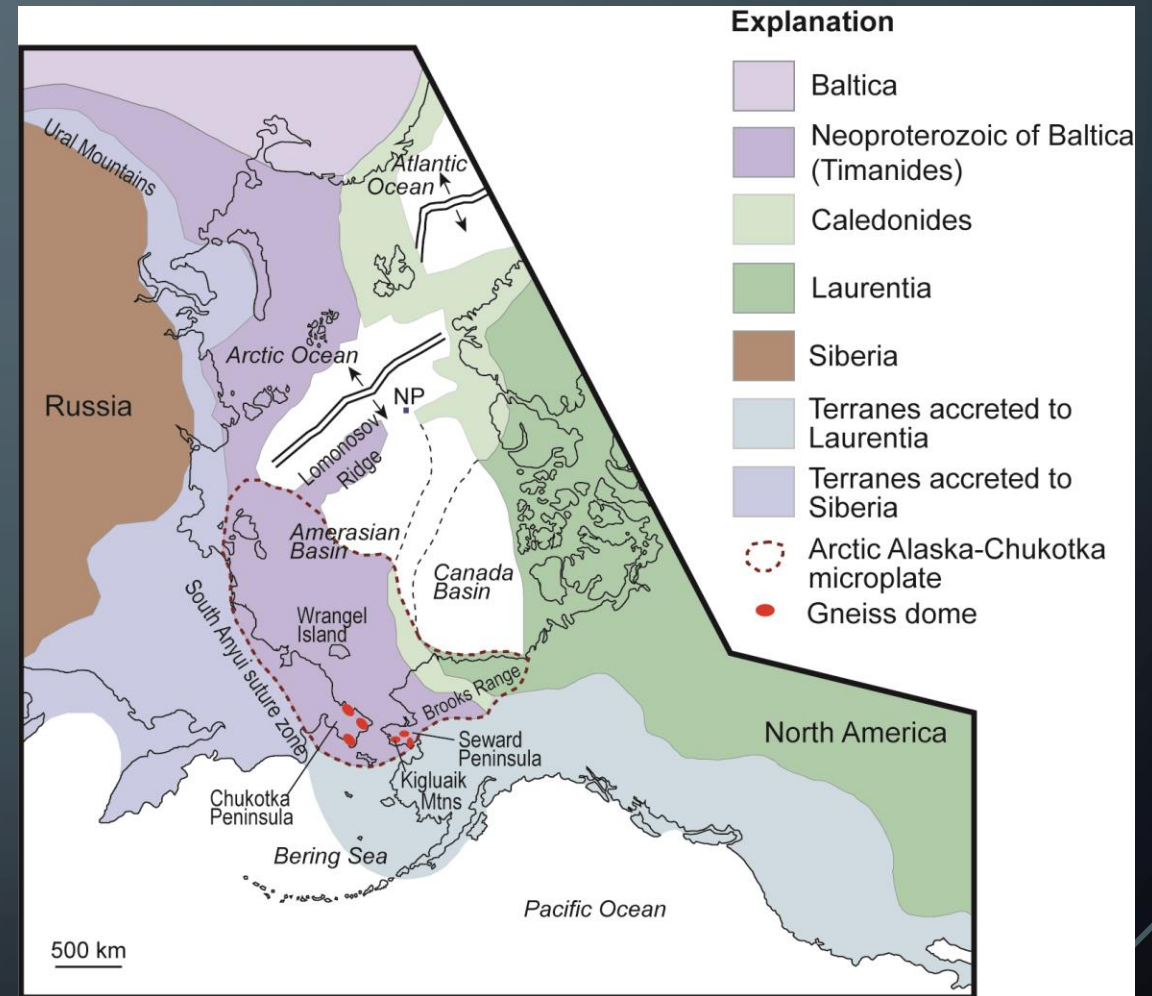
MAPPABLE CRITERIA

- Carbonaceous sedimentary protoliths
 - Anoxic depositional setting
- Evidence of high-T metamorphism
 - sillimanite + K-feldspar assemblage
- Evidence of partial melting
 - Migmatite; khondalite
 - Anatectic zircons
 - Shear zones: **melt loss?**



MAPPABLE CRITERIA

- Brooks Range, though not known to have granulites, has correlative rocks
- Gneiss domes in Chukotka



THANK YOU!