Disturbing the time capsule: Hydrothermal effects on zircon U-Pb ages

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Introduction:
Zircon is generally considered a robust mineral for geochronology, as it can preserve its ages through high temperature metamorphism, partial melting, and weathering. In this study, we analyze zircons for U/Pb isotopes and trace elements via LA-ICP-MS at the University of New Brunswick. Our results are consistent with several origins of zircons, including crystallization from igneous precipitates, granite and pegmatite, and hydrothermal dissolution-reprecipitation. The textures and occurrences of altered zircons are consistent with other minerals, like monazite, which are susceptible to alteration.

Regional geology:
- North Caribou greenstone belt in North Caribou terrane of Superior Province
- Samples from TTO outcropping the North Caribou greenstone belt
- Muskelehite (structurally controlled, BIF-hosted, oregenic lode Au deposit) at center of belt
- Evidence for fluids include: isotopic and chlorine alteration and quartz veins
- Zircon textural evolution: 3-2.8 Ga formation of North Caribou terrane
- 3.7-2.6 Ga amalgamation of Superior craton

Igneous zircon:
- Outcrops may have complex textures (51, 52, 62, 63)
- Zircon textures
  - Oscillatory zoning
  - May have overgrowths (52)
  - Th/U ratios >0.3
  - May have many age populations
  - LREE depleted
  - Typical TTG compositions

Legend:
- Igneous zircon: Young cores
- Pegmatite with altered rims: Typical TTG compositions
- Pegmatite samples: Young age found only in rims
- Lower Th/U ratios in young zircon
- Enriched LREEs in young zircon

Zircon with altered rims:
- No pegmatite in outcrop
- Multiple age populations
- Young age found only in rims
- Lower Th/U ratios in young zircon
- Enriched LREEs in young zircon
- Old ages in some rims
- Pb trapped in rims
- Seen in altered monazite
- Cloudy resorption rims
- Parallel to zoning
- Crosscut zoning around cracks and inclusions
- Zoning in other minerals
- Typical TTG compositions

Pegmatite samples:
- Pegmatite intermingled with host rock in outcrop
- Rocks true granites
- One date from pegmatite (54)
- Multiple LA-ICP-MS dates
- Lower Th/U ratios in young population
- Young age found in both rims and cores
- Young ages in cores from neotectonic areas (53, 71)
- Depleted and enriched LREEs in young zircon
- Possible alteration associated with pegmatite intrusion? (54 zircons SEM shows altered cracks)

Summary:
- There is no single characteristic that can be used to discriminate between altered and pegmatitic zircons
- Source of LREEs: RC-bearing fluids relative to pegmatites (Van & Williams-Jones, 2013)?
- There is no single characteristic that can be used to discriminate between altered and pegmatitic zircons
- Enriched LREEs: Young cores Pegmatite
- Disrupted zoning in zircons

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