New Ar-Ar dating of the East and West Clearwater Lake impact structures, Québec, Canada – Evidence for two separate impact events

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Canadian impact record

- ~30 impact structures in Canada.
- Less than half well-studied (or studied at all!).
- Should be many more awaiting to be discovered!

DEM image: ESRI; Impact crater locations from Earth Impact Database:
http://www.unb.ca/passc/ImpactDatabase/index.html
Target rocks: 2.6 – 2.8 Ga gniesses of the Canadian Shield

D = 36 km

D = 26 km
Previous age constraints

West Clearwater Lake impact structure:
• 285 ± 30 Ma, K–Ar (Wanless et al., 1966);
• 300 ± 30 Ma, K–Ar (Bostock, 1968);
• *271 ± 15 Ma, Rb–Sr (Reimold et al., 1981);
• *284 ± 4 Ma, $^{40}$Ar–$^{39}$Ar (Bottomley et al., 1990);
• *280 ± 12 Ma, U–Th/He (Biren et al., 2013).

East Clearwater Lake structure:
• *293 ± 26 Ma, Rb–Sr (Reimold et al., 1981);
• >460 Ma, $^{40}$Ar–$^{39}$Ar, but problem with excess Ar so data ignored (Bottomley et al., 1990).

*Re-calculated with revised decay constants.
Impactites

- Complete stratigraphic sequence from crater floor to at least mid-way through the impact melt sheet.
West Clearwater:
- Surface samples collected in 1977, from GSC collection.

East Clearwater:
- Drill core 2-63 from 1963/64.
Interpretation of $^{40}$Ar/$^{39}$Ar results for East Clearwater is not straightforward;

The disturbed and U-shaped age spectra suggest an extraneous Ar component:
- $^{40}$Ar incomplete degassing of the Archean target rocks during melting;
- Fluid migration during or after the impact event;

Minima are commonly considered maximum ages for the resetting or crystallization events.
Summary of new ages

West Clearwater Lake:
• 286 ± 2.2 Ma (this study; not shown here).
• 284 ± 4 Ma, ^{40}Ar–^{39}Ar (Bottomley et al., 1990).

East Clearwater Lake:
• 458 ± 5 Ma & 457 ± 10 Ma (this study).
• ~460, ^{40}Ar–^{39}Ar (Bottomley et al., 1990).

=> accounts for different erosional state of the two structures!
Questions?