THE PROVENANCE OF GLACIAL TILL DEPOSITED IN ONG VALLEY, CENTRAL TRANSANTARCTIC MOUNTAINS DETERMINED BY LA–ICP–MS OF DETRITAL ZIRCON

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Ong Valley: Location and Geology

Bibby et al. 2016

Geologic Map: Barrett et al. 1970
Motivating Questions:

- How old are the glacial deposits in Antarctic Dry Valleys?
- What was the former extent of past glaciation?
- What is the provenance of these glacial tills?
- Has the source changed over time?
- Will the combination of cosmogenic nuclides and zircon ages prove useful in this geologic setting?
Till Ages – Cosmogenic Nuclide Exposure Dates

**YOUGEST DRIFT**

11-13 ka

**MIDDLE DRIFT**

> 1.1 Ma

**OLDEST DRIFT**

> 1.57 Ma

Bibby et al. 2016
**Methods:**

- Extract bulk sedimentary samples
  - Sieve, hand wash + sonic-bath
- 5% HNO$_3$ + 5% HCl pre-treatment*
- Hand magnet => remove magnetite
- Density separation
  - LST Heavy Liquid [2.85g/cm$^3$]
  - Heavy-mineral fraction
- Frantz Magnetic Separator
  - Up to >1.6amps
  - Non-magnetic samples
- Acid purification treatment – HNO$_3$ + HF + HCl*
- Hand pick zircon grains => mount in epoxy disk
- Grind, polish and carbon coat the mount => SEM
- Determine mineral identity using BSE detector
- Image grains using Gatan MonoCL detector
- In situ analysis by LA-ICP-MS
- Data reduction using Glitter
  - U238/Pb206, U235/Pb207, Pb206/Pb207*
OLD UNIT (Pits 5 & 6), n = 225
MIDDLE UNIT (Pits 1 & 2), n = 97

Number of occurrences vs. age (Ma) for the MIDDLE UNIT (Pits 1 & 2), with relative probability on the right axis.
YOUNG UNIT (Pits 11 & 12), n = 82
ICE BELOW YOUNG UNIT (Pits 11ice & 12ice),
n = 108
### ISOPLOT – Unmix Ages

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| MIDDLE          |            |          |          |            |          |          |          |            |          |          |          |
| Age             | ±2s        | fraction | ±2s      |            |          |          |          |            |          |          |          |
| 564.3           | 3.6        | 0.22     | 0.09     |            |          |          |          |            |          |          |          |
| 870             | 7.9        | 0.12     | 0.07     |            |          |          |          |            |          |          |          |
| 1694            | 22         | 0.10     | 0.07     |            |          |          |          |            |          |          |          |
| 2291            | 43         | 0.03     | 0.04     |            |          |          |          |            |          |          |          |
| 2765.5          | 16         | 0.14     | 0.08     |            |          |          |          |            |          |          |          |
| 3057.9          | 9.1        | 0.38     | ---      |            |          |          |          |            |          |          |          |
| relative misfit |            |          |          | 1972.815   |          |          |          |            |          |          |          |

| YOUNG           |            |          |          |            |          |          |          |            |          |          |          |
| Age             | ±2s        | fraction | ±2s      |            |          |          |          |            |          |          |          |
| 561.8           | 3.7        | 0.26     | 0.11     |            |          |          |          |            |          |          |          |
| 958.8           | 13         | 0.10     | 0.07     |            |          |          |          |            |          |          |          |
| 1666            | 21         | 0.16     | 0.09     |            |          |          |          |            |          |          |          |
| 2008            | 52         | 0.01     | 0.02     |            |          |          |          |            |          |          |          |
| 2489            | 43         | 0.02     | 0.03     |            |          |          |          |            |          |          |          |
| 3022.7          | 8.8        | 0.45     | ---      |            |          |          |          |            |          |          |          |
| relative misfit |            |          |          | 1116.946   |          |          |          |            |          |          |          |

| ICE             |            |          |          |            |          |          |          |            |          |          |          |
| Age             | ±2s        | fraction | ±2s      |            |          |          |          |            |          |          |          |
| 565.4           | 5.2        | 0.12     | 0.07     |            |          |          |          |            |          |          |          |
| 1387            | 23         | 0.07     | 0.05     |            |          |          |          |            |          |          |          |
| 1694            | 43         | 0.03     | 0.03     |            |          |          |          |            |          |          |          |
| 2402.9          | 20         | 0.07     | 0.05     |            |          |          |          |            |          |          |          |
| 2666.5          | 9.5        | 0.25     | 0.10     |            |          |          |          |            |          |          |          |
| 3038.8          | 7.6        | 0.45     | ---      |            |          |          |          |            |          |          |          |
| relative misfit |            |          |          | 1209.313   |          |          |          |            |          |          |          |
In Summary:

- Recovered over 500 zircon grains from:
  - Bulk sedimentary samples
  - Large chunks of ice
- There is a similar population distribution for all three of our tills
  - Suggests flow patterns haven’t changed in >1.57 million years
- Ice from below the young unit is missing grains from ~600-1200Ma
  - Inferred that this is due to a lack of aeolian input
- The pairing of U/Pb and Pb/Pb ages of zircon with cosmogenic nuclide exposure ages is a useful method for determining
  - Provenance data
  - If glacial flow patterns have changed over time
- We will continue to collect and analyze zircon until we have ≥120 grains per sedimentary unit; measure grain size (SEM)