Detrital Cosmochronology of the Greenland Ice Sheet

Lee Corbett
Progress Report
12/3/08
Overview

Unanswered Questions:

• Has the Greenland Ice Sheet been stable in size over time?
• If not, how many times has it melted significantly?
• How extreme are melting events?
• What is the spatial distribution of melting?
Overview

Goals:

• Use cosmogenic burial dating to investigate times when the Greenland Ice Sheet was reduced in size
• Understand how the ice sheet behaves during interglacial periods
Cosmogenic Nuclide Dating Basics

Cosmogenic Nuclides:
- $^{10}$Be (half life = 1.3 Ma), measured in quartz
- $^{26}$Al (half life = 0.7 Ma), measured in quartz
- $^{36}$Cl (half life = 0.3 Ma), measured in potassium feldspar
- $^{14}$C (half life = 0.005 Ma), measured in quartz

Burial Dating: Use cosmogenic nuclide concentration to determine how long a surface has spent exposed versus how long it has spent shielded
Sampling

Northernmost:  
*Upernavik, 72°N*  
Hypothesized melting: small  
98 ice-bound clasts

Middle:  
*Ilulissat, 69°N*  
Hypothesized melting: ?  
73 ice-bound clasts

Southernmost:  
*Kangerlussuaq, 66°N*  
Hypothesized melting: great  
100 ice-bound clasts
Kangerlussuaq
Kangerlussuaq: “Dead Ice” Zone
Kangerlussuaq: Drained Lake
Upernavik: Inclined Ice Faces
Upernavik: *Vertical Ice Faces*
Ilulissat
Ilulissat: *Inclined Ice Faces*
Additional Sampling

**Bedrock Samples**
1 from Kangerlussuaq
20 from Upernavik
16 from Ilulissat

**Boulder Samples**
13 from Upernavik
15 from Ilulissat

**Holocene Exposure Clasts**
3 from Kangerlussuaq
3 from Upernavik
4 from Ilulissat
Laboratory Work

Physical Preparation

- Crushing
- Grinding
- Sieving for 250-710μm grain size fraction
- Magnetic separation

170 samples during August
Laboratory Work

Chemical Preparation

- Two 24-hour etches in hot HCl
- Three 24-hour etches in hot HF/HNO₃
- Density separation
- One 72-hour etch in hot HF/HNO₃

75 samples (all bedrock, boulder, and Holocene exposure clasts) during September, October, and November
## Timeline

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Bedrock, Boulders, and Holocene Exposure Clasts</th>
<th>Burial Dating Clasts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fall 2008</strong></td>
<td>Make quartz</td>
<td>Finish crushing, grinding, etc.</td>
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<tr>
<td><strong>Winter 2008/2009</strong></td>
<td>Perform dissolutions, isolate Be and Al, perform isotopic analysis</td>
<td>Etch all samples in HCl, isolate kspar if possible, begin HF/HNO₃ etches</td>
</tr>
<tr>
<td><strong>Spring 2009</strong></td>
<td>Analyze data, begin writing manuscript</td>
<td>Continue HF/HNO₃ etches, begin dissolution and isotopic analysis</td>
</tr>
<tr>
<td><strong>Summer 2009</strong></td>
<td>Finish manuscript</td>
<td>Continue with etches and isotopic analysis</td>
</tr>
<tr>
<td><strong>Fall 2009</strong></td>
<td>Present results at GSA or AGU</td>
<td>Continue isotopic analysis, begin data analysis, present preliminary data at AGU(?)</td>
</tr>
<tr>
<td><strong>Winter 2009/2010</strong></td>
<td>Begin writing thesis</td>
<td>Continue data analysis, begin writing thesis</td>
</tr>
<tr>
<td><strong>Spring 2010</strong></td>
<td></td>
<td>Finish data analysis, finish writing thesis, present and defend</td>
</tr>
<tr>
<td><strong>Summer 2010</strong></td>
<td>***</td>
<td>Write manuscript</td>
</tr>
<tr>
<td><strong>Fall 2010</strong></td>
<td>***</td>
<td>Present results at AGU</td>
</tr>
</tbody>
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