

# *Exposure history of West-Antarctic nunataks*

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*Center for Remote Sensing of Ice Sheets*  
*University of Kansas*

NSF-ANT-1142162



**CReSIS**  
Center for Remote Sensing of Ice Sheets



COSMOGENIC NUCLIDE LABORATORY

Quaternary Research Center and Department of Earth and Space Sciences  
University of Washington

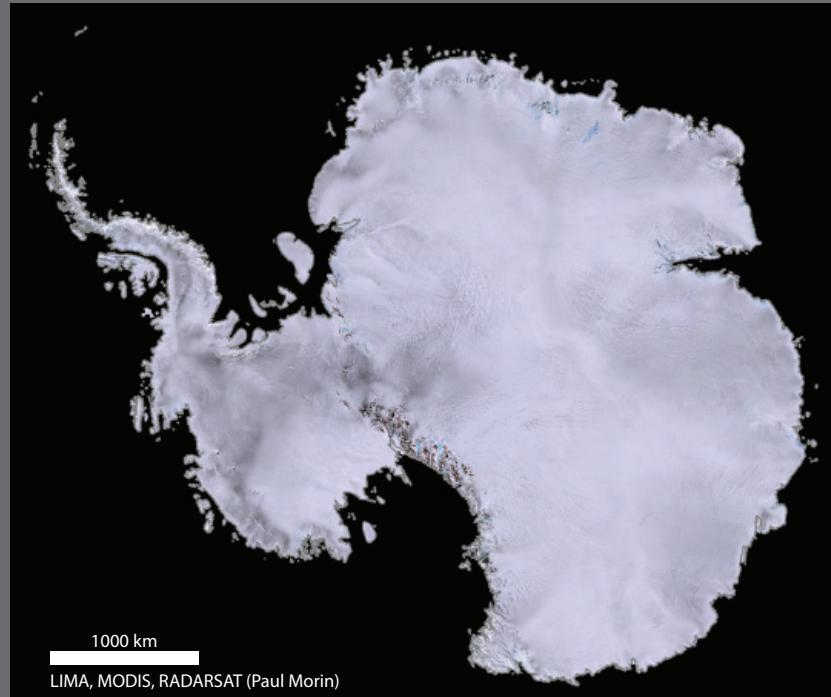
Photo: John Stone

# *Evidence for thinner ice*

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## ***Subglacial records***

- e.g. Scherer et al., 1998
- Late Quaternary marine fossils under the ice sheet
- Uncertain timing



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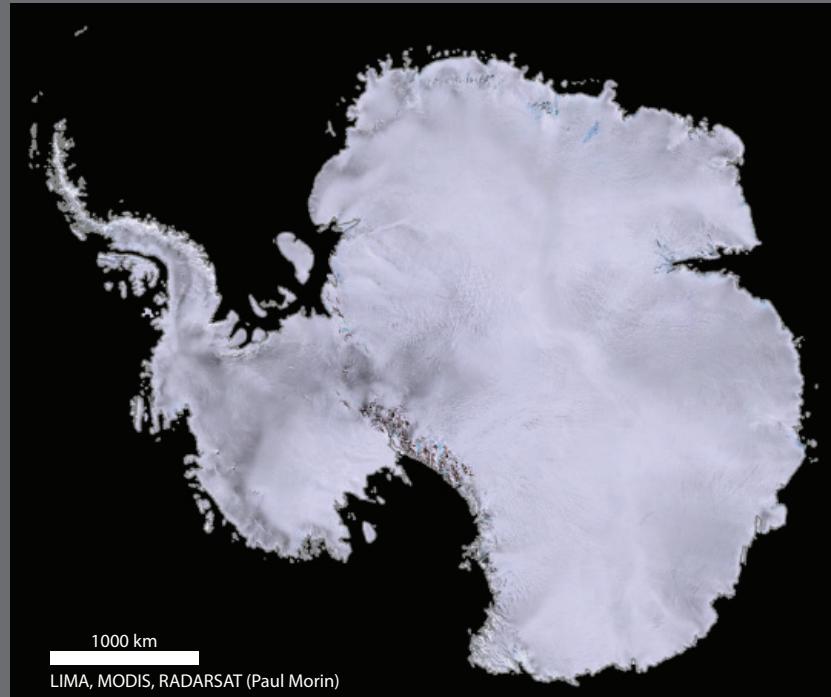
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## ***Sea-level records***

- Smaller WAIS during past interglacials
- Uncertain source of highstand water
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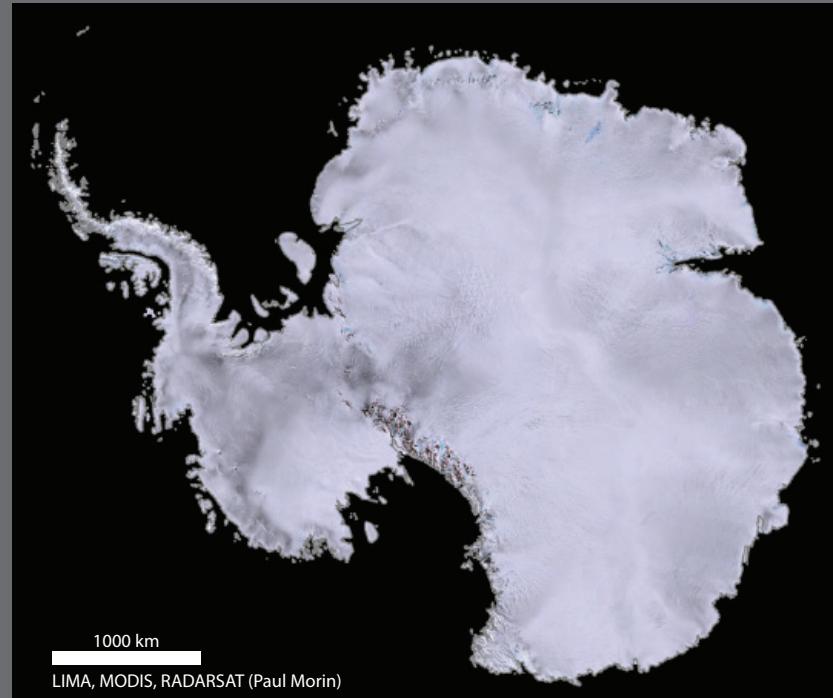
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- Simulate WAIS collapses during interglacials
- Ground-truth needed



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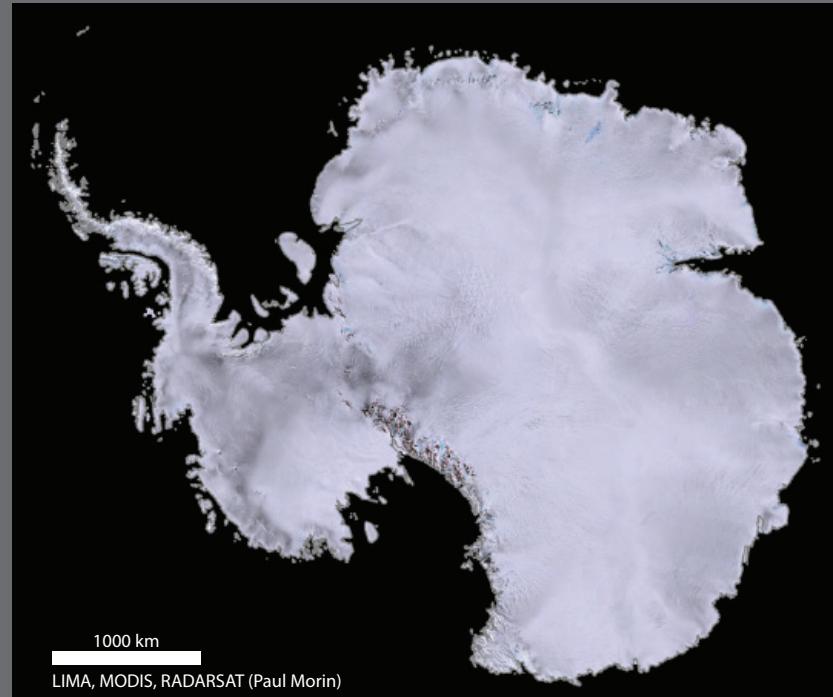
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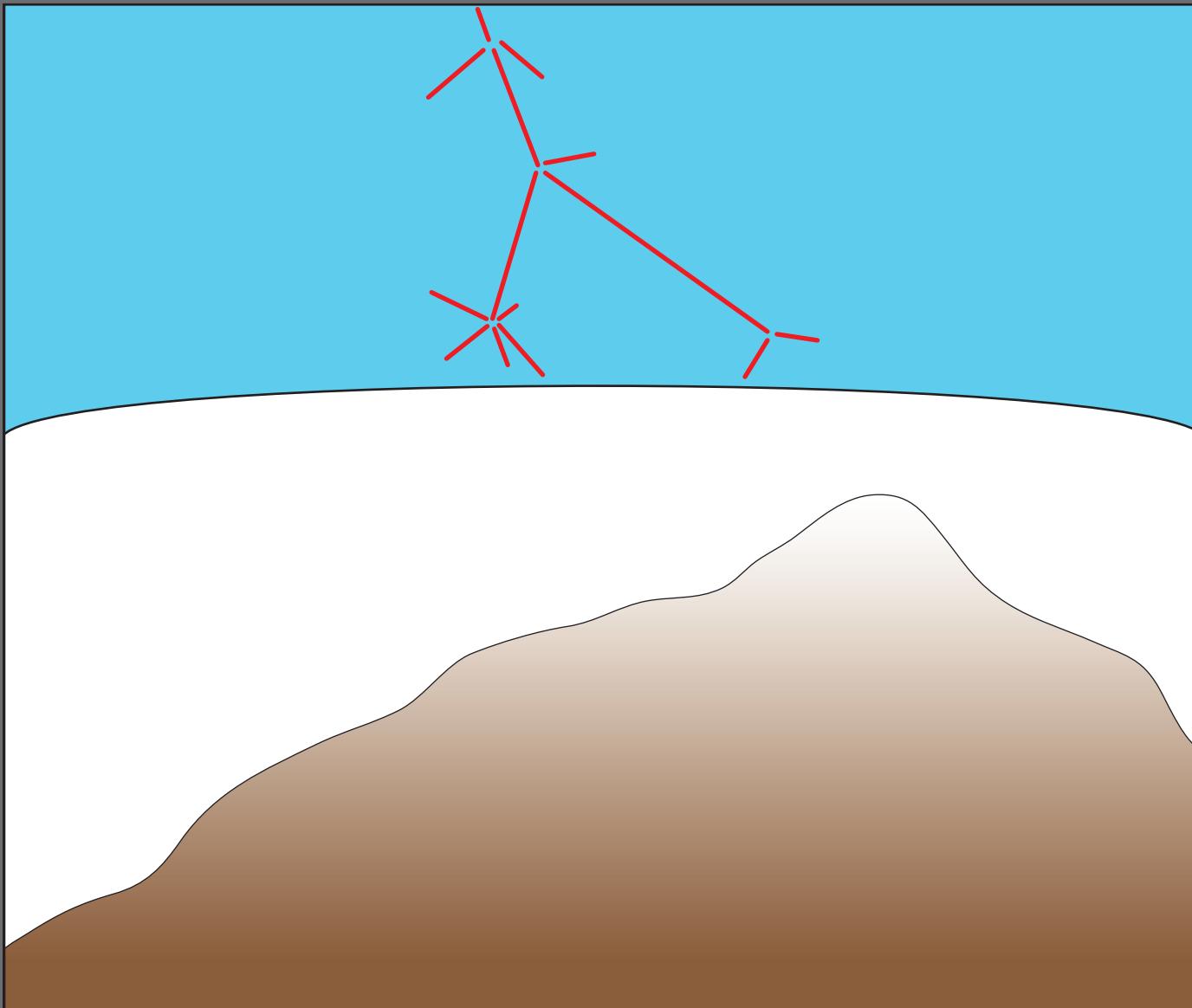
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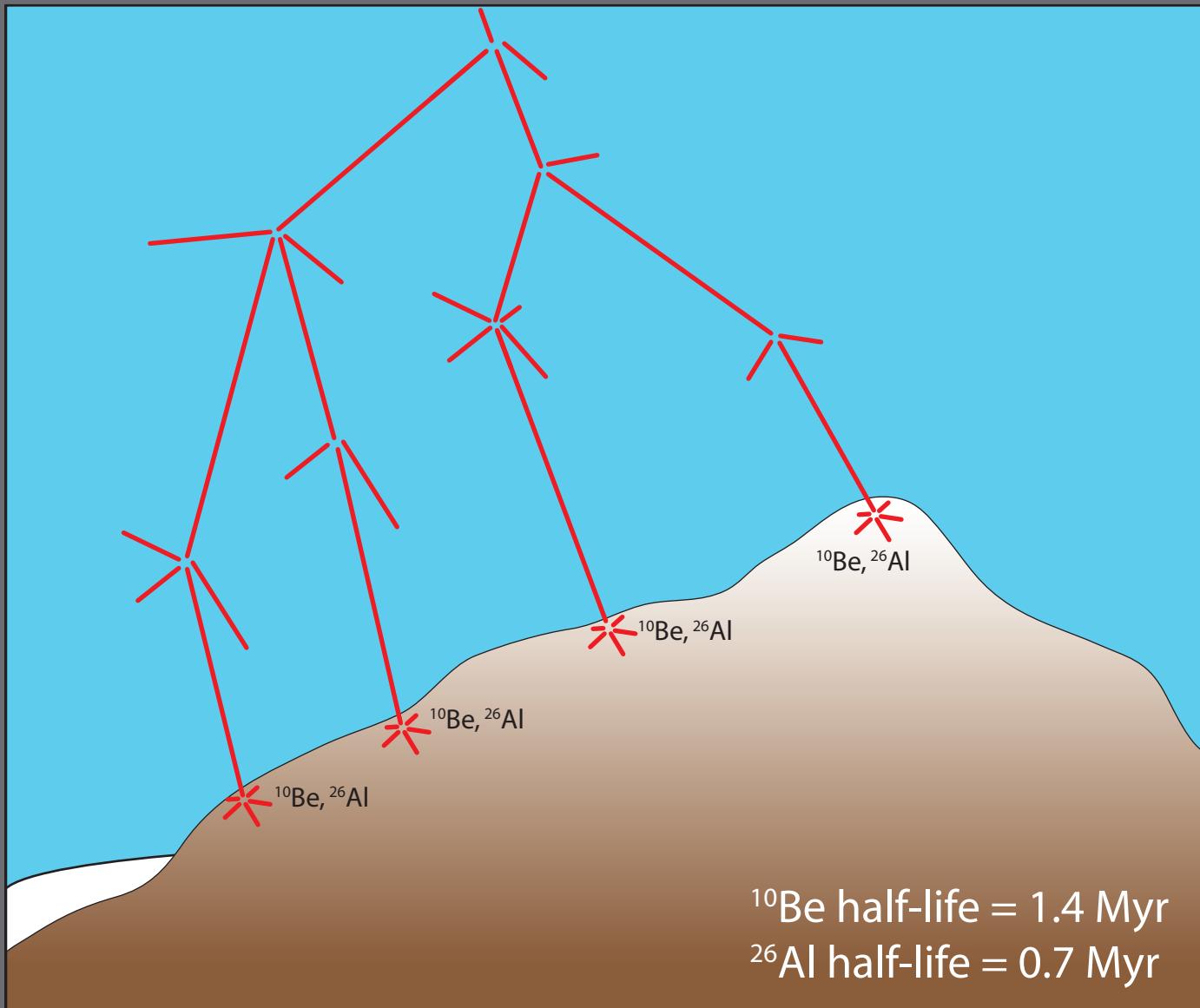
***Measure cosmogenic nuclides in subglacial bedrock surfaces***

# *Subglacial cosmogenic nuclides*

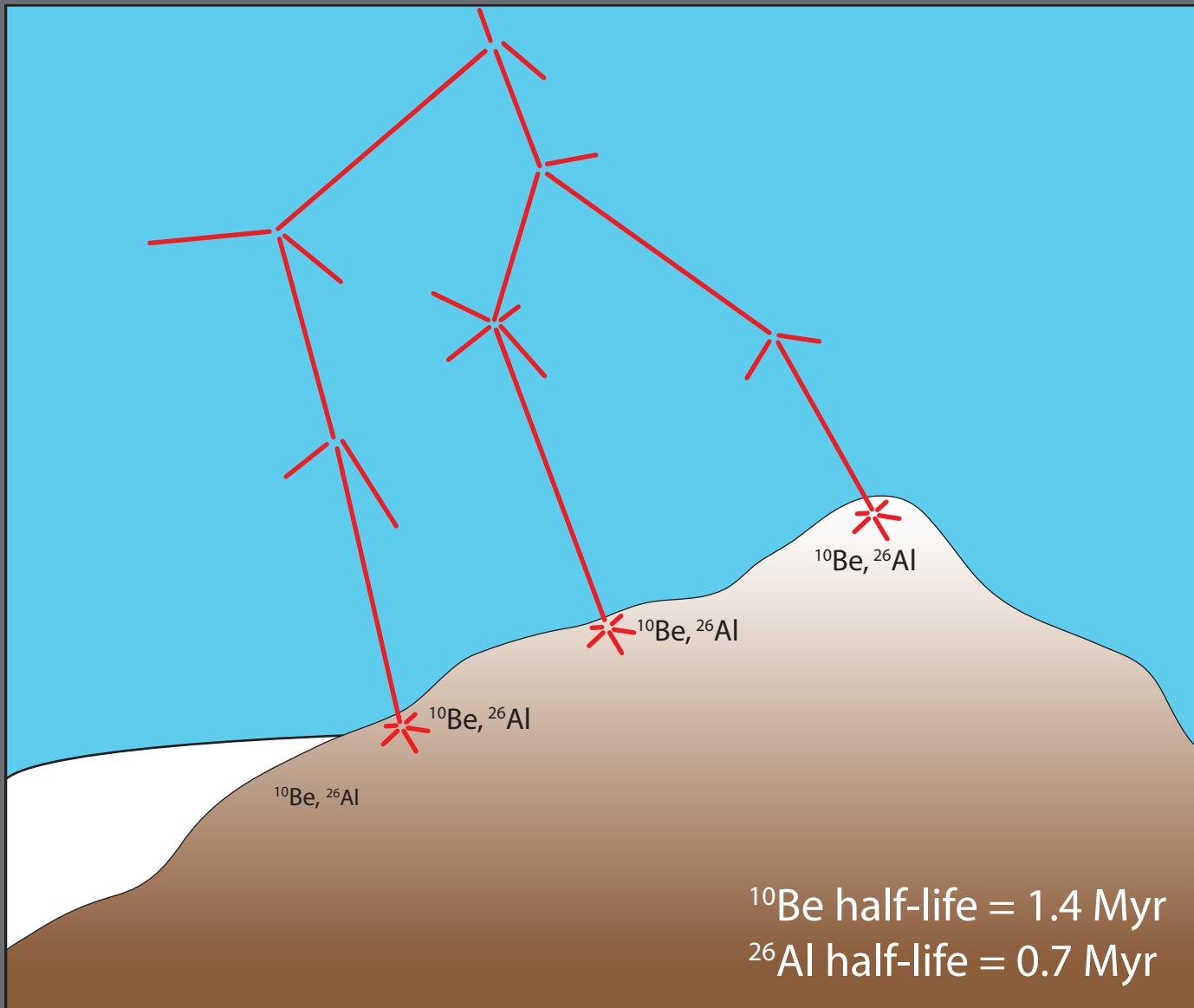
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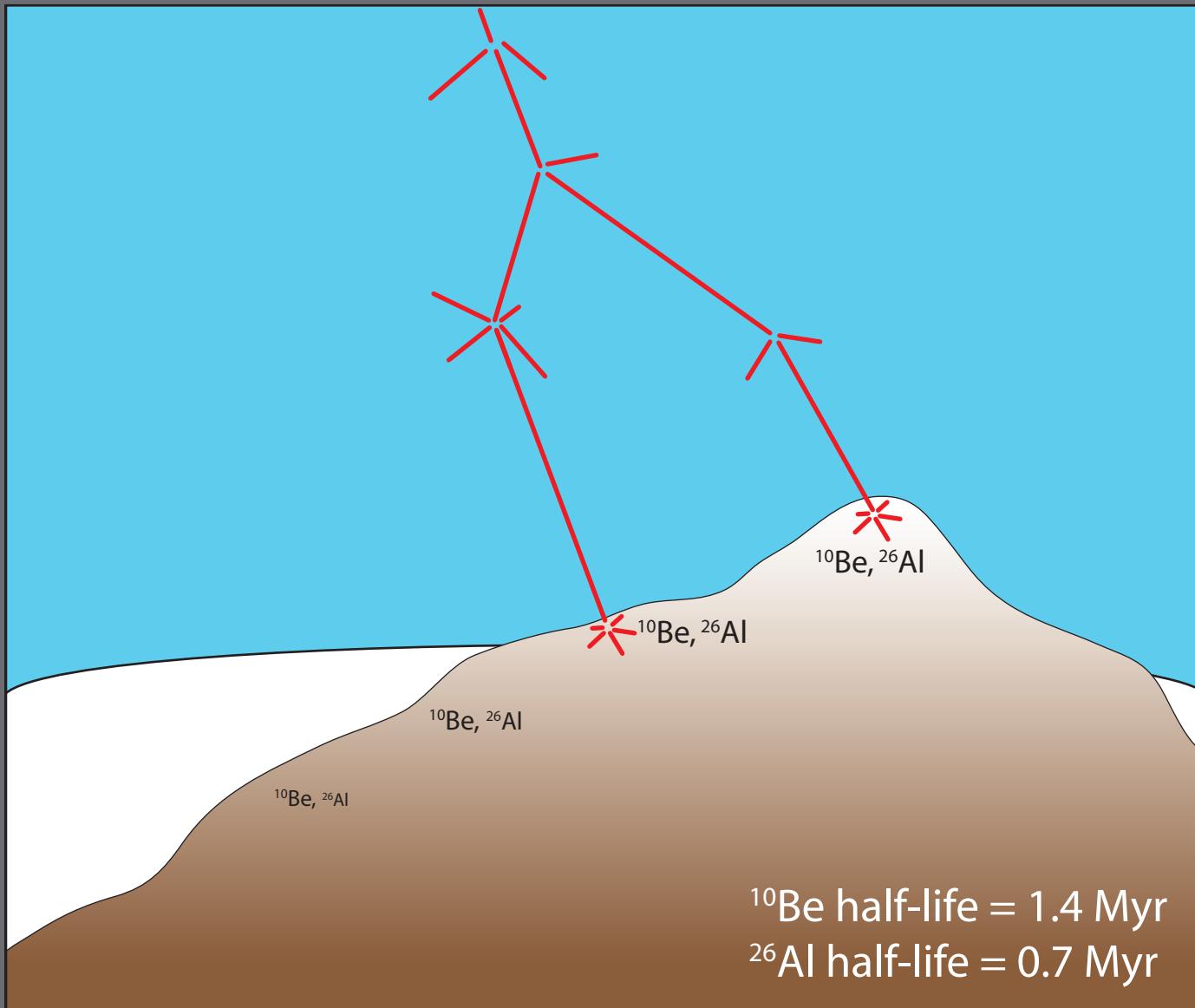


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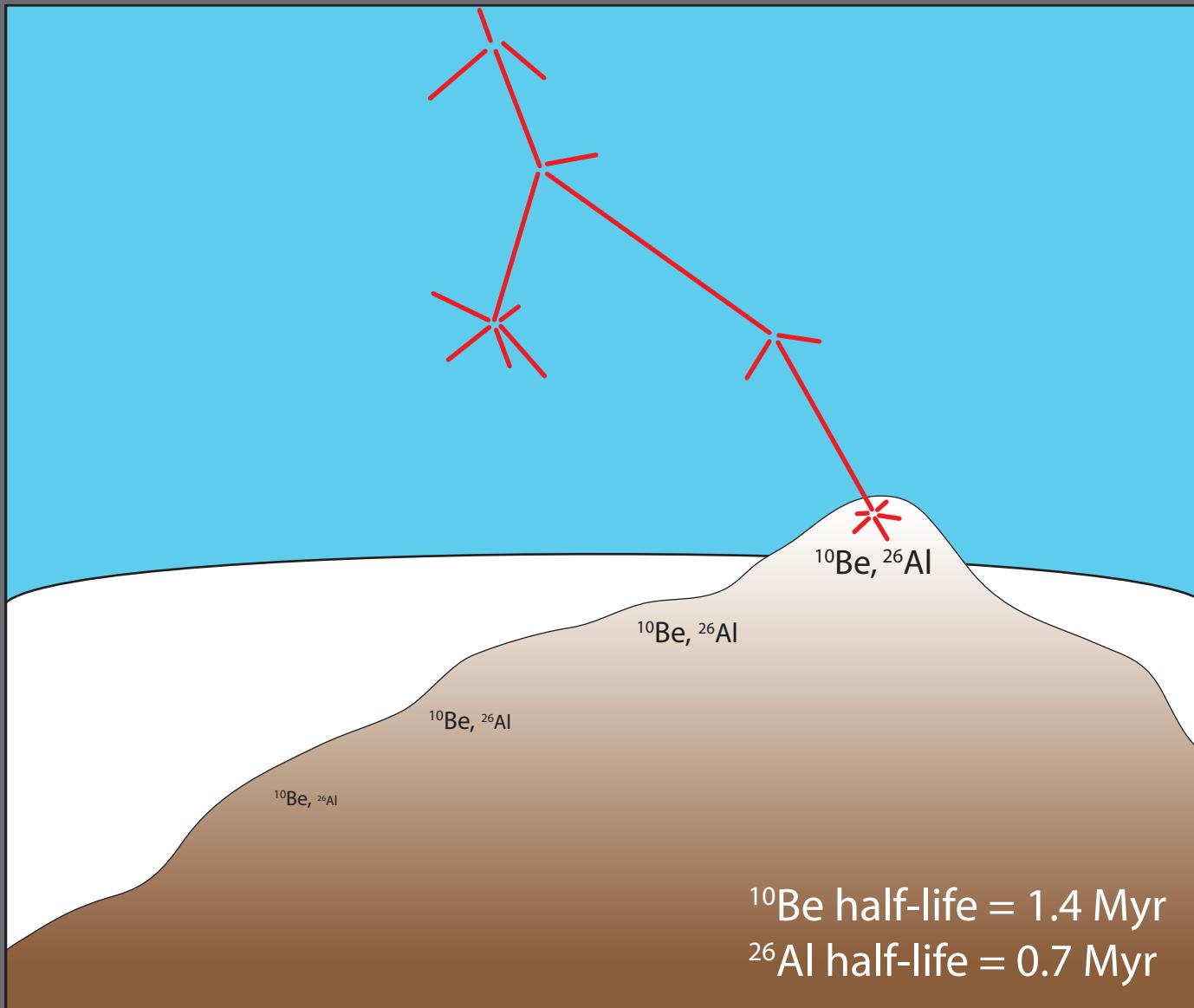
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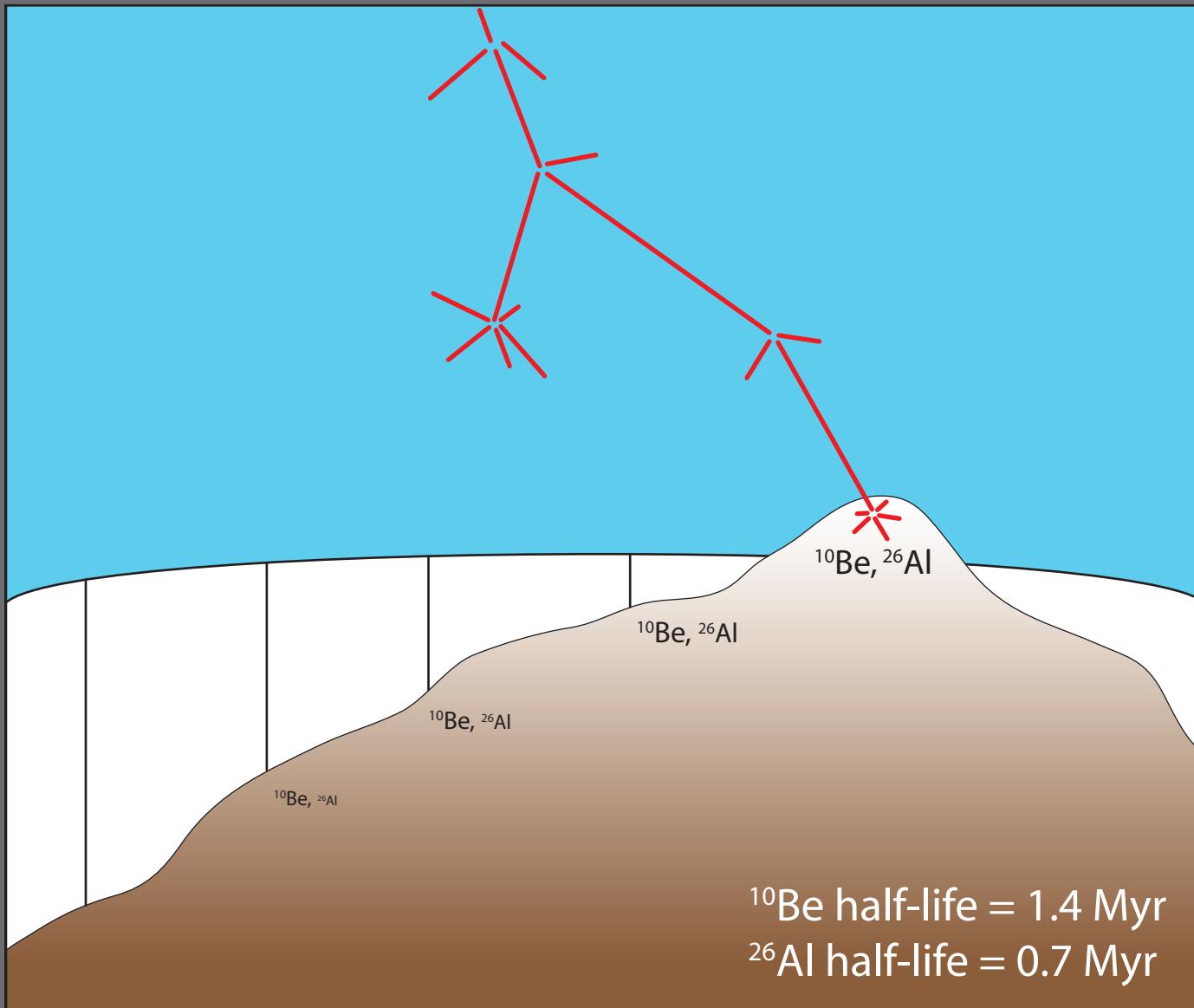


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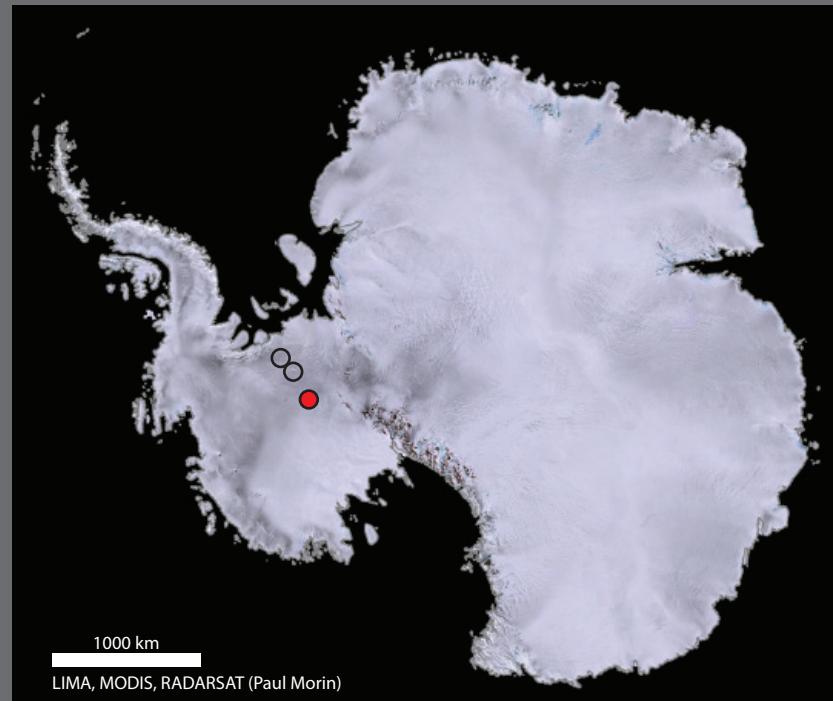
# *Subglacial cosmogenic nuclides*



# Drill site reconnaissance 2012-13

## **Drill-target requirements:**

- Local ice elevation controlled by glacial-interglacial expansion and retreat of WAIS
- Granite bedrock optimal for cosmogenic nuclide measurements
- Survival of cosmogenic nuclide record requires low subglacial and subaerial erosion rates



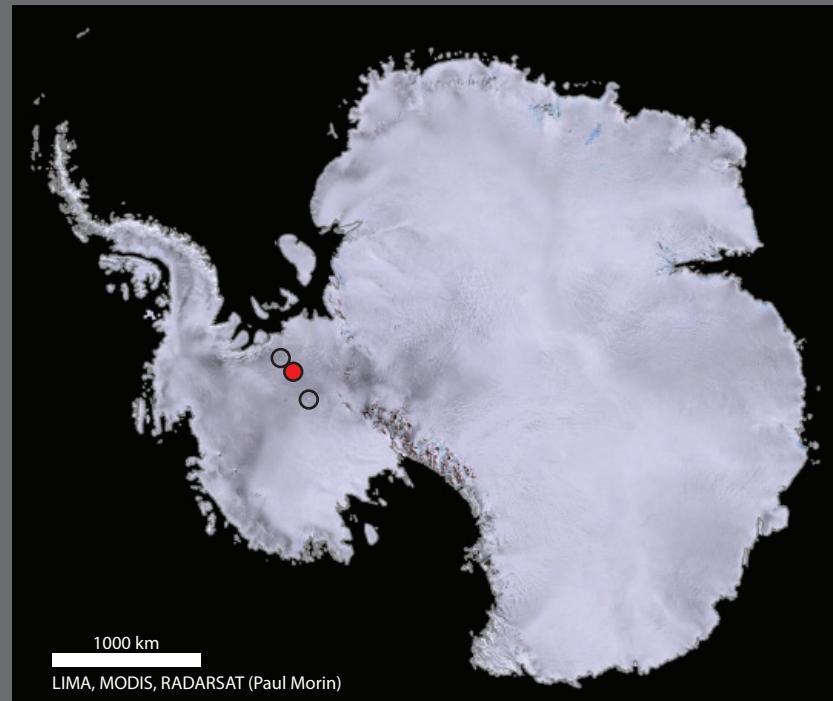
*Whitmore Mountains*



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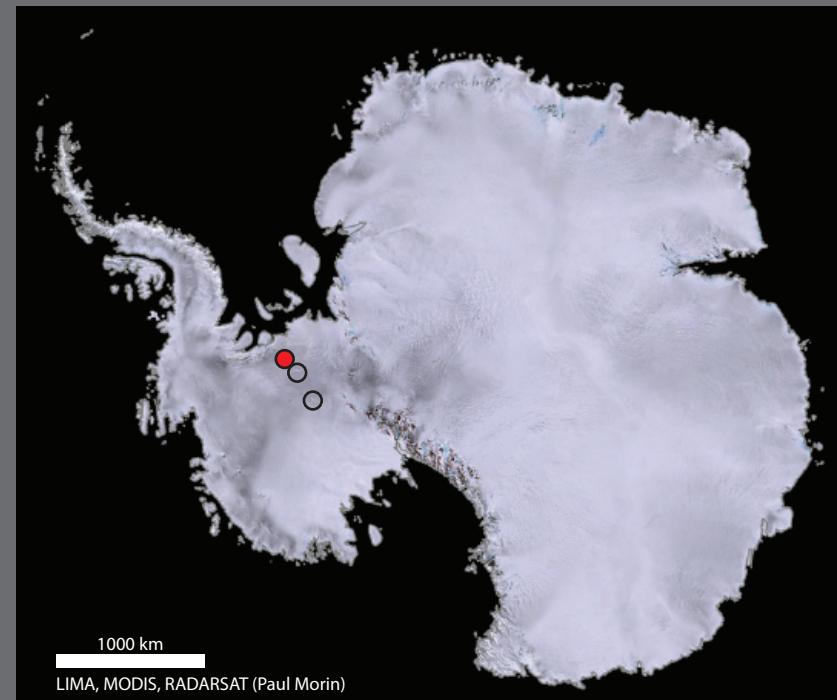
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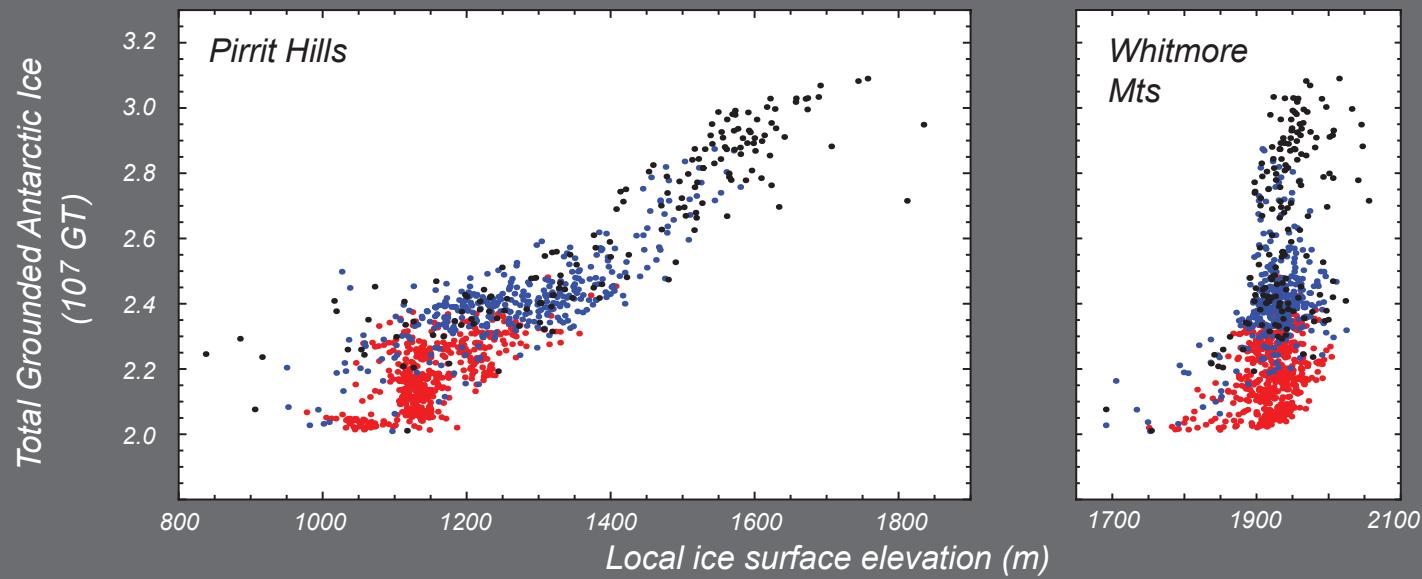
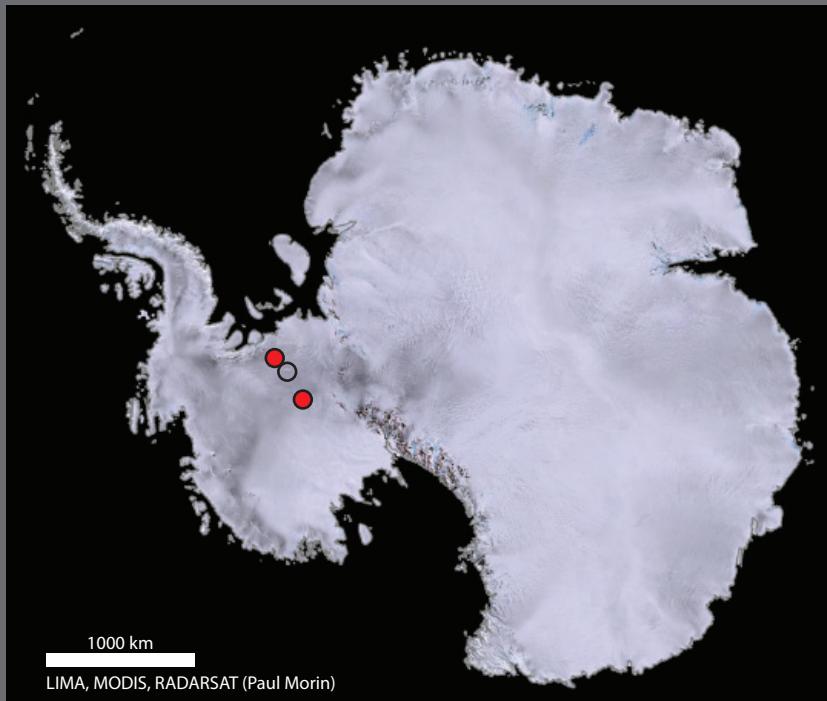
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# *Ice volume correlations*

Pollard & DeConto, 2009



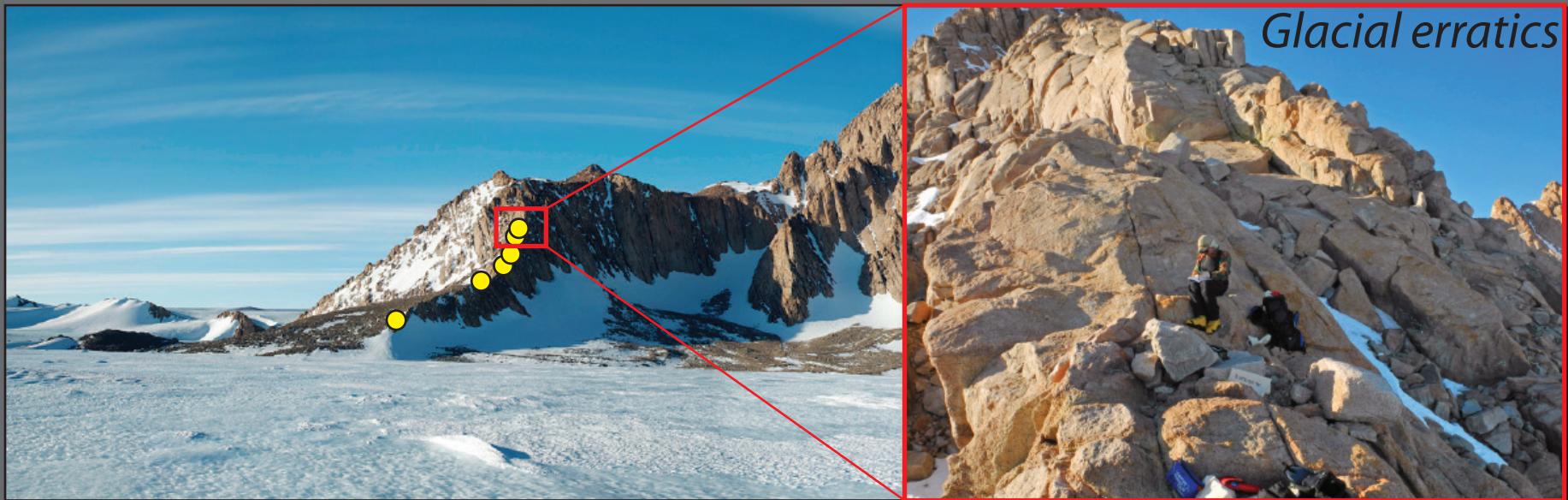
# *Geomorphology: Glacial deposits*



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*Glacial till*



*Whitmore Mtns*



# *Geomorphology: Bedrock weathering*



- *Stained and oxidized bedrock*
- *Fragile cavernous forms*
- *Features extend down to modern ice level*

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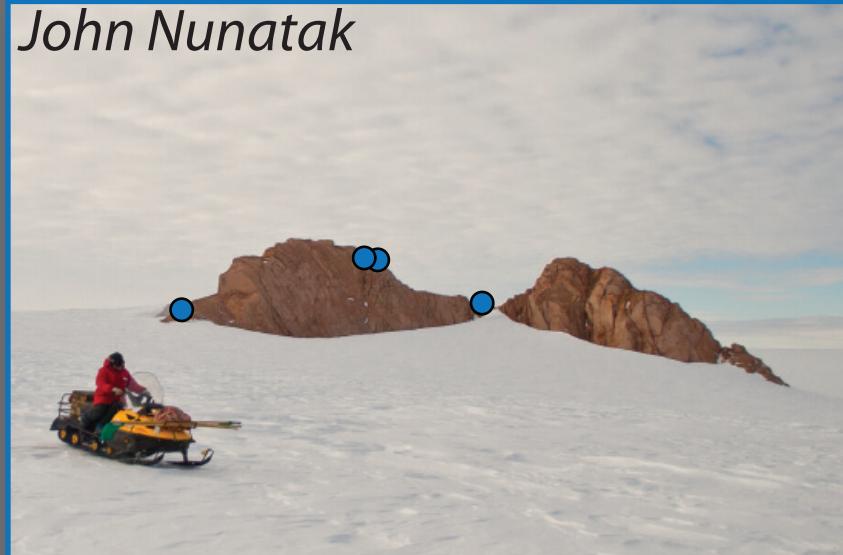
## **Implications**

- *Past ice cover has been cold based and non-erosive*
- *Prolonged subaerial weathering*
- *Weathered bedrock extends below modern ice*

# *Pirrit Hills bedrock samples*



*John Nunatak*



*Harter Nunatak*



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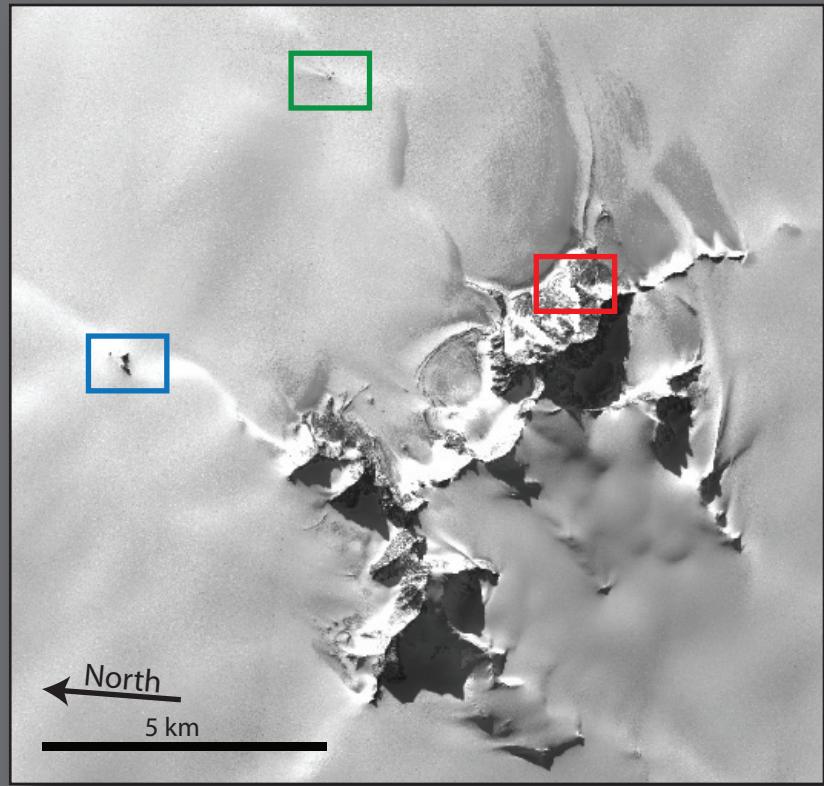


# Pirrit Hills bedrock samples

Pirrit Hills



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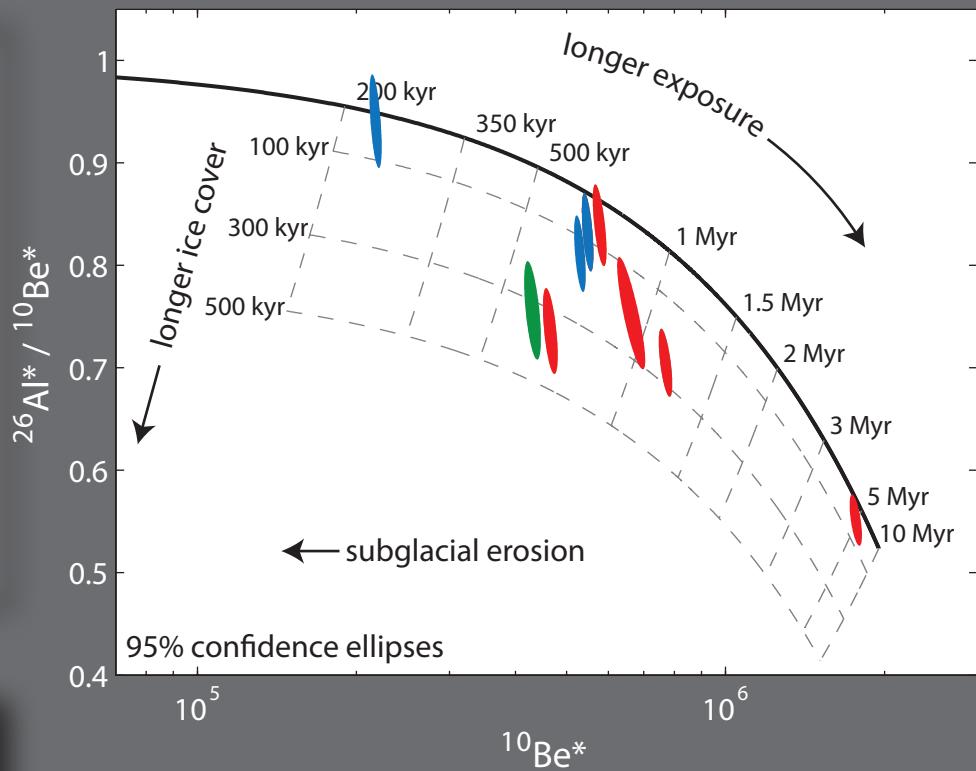


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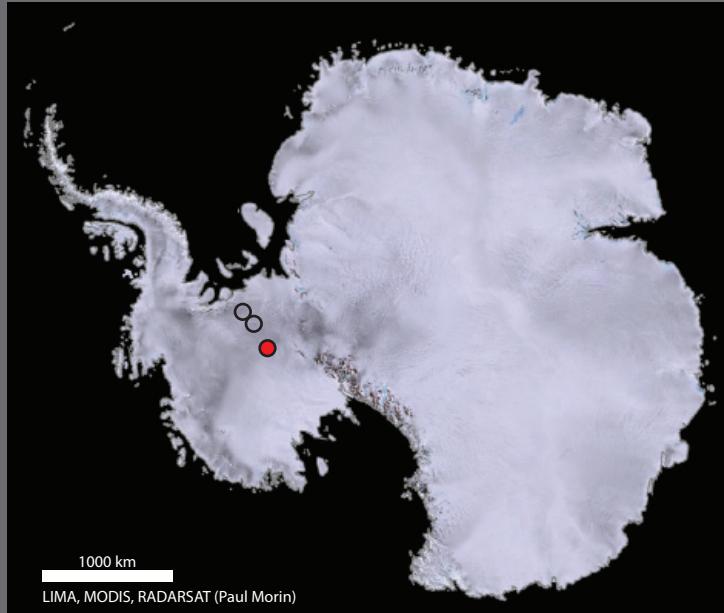


Harter Nunatak

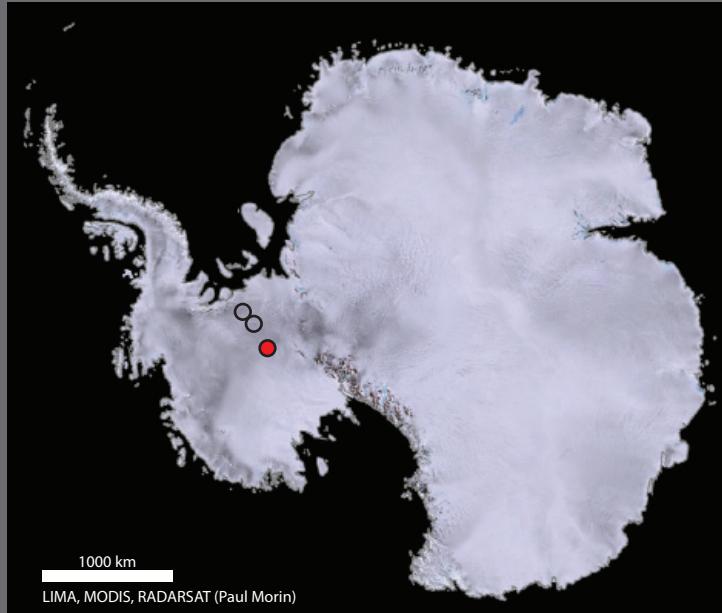


# Whitmore Mountains bedrock samples

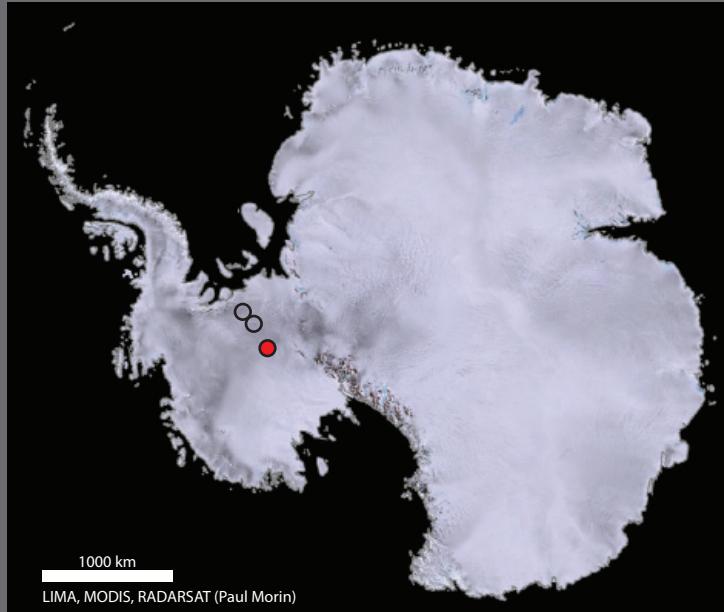
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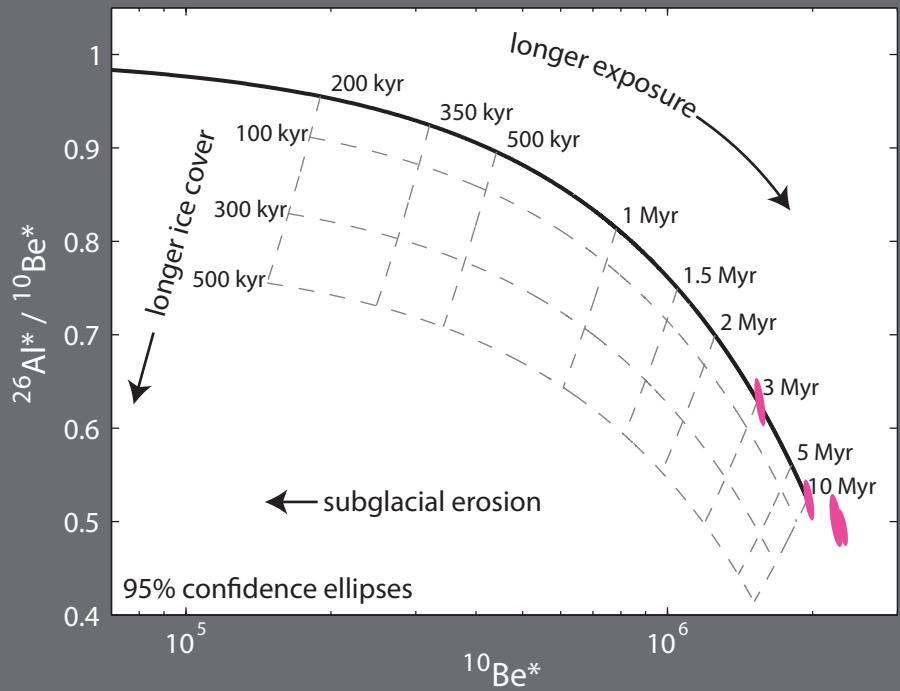
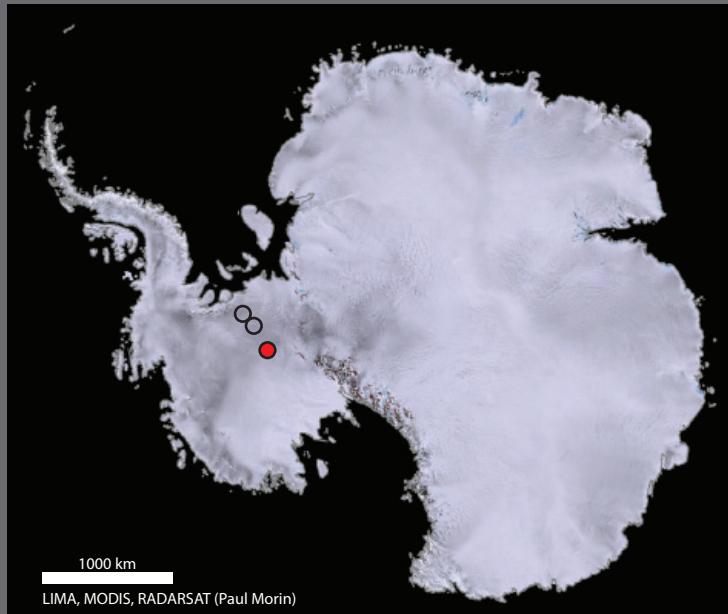
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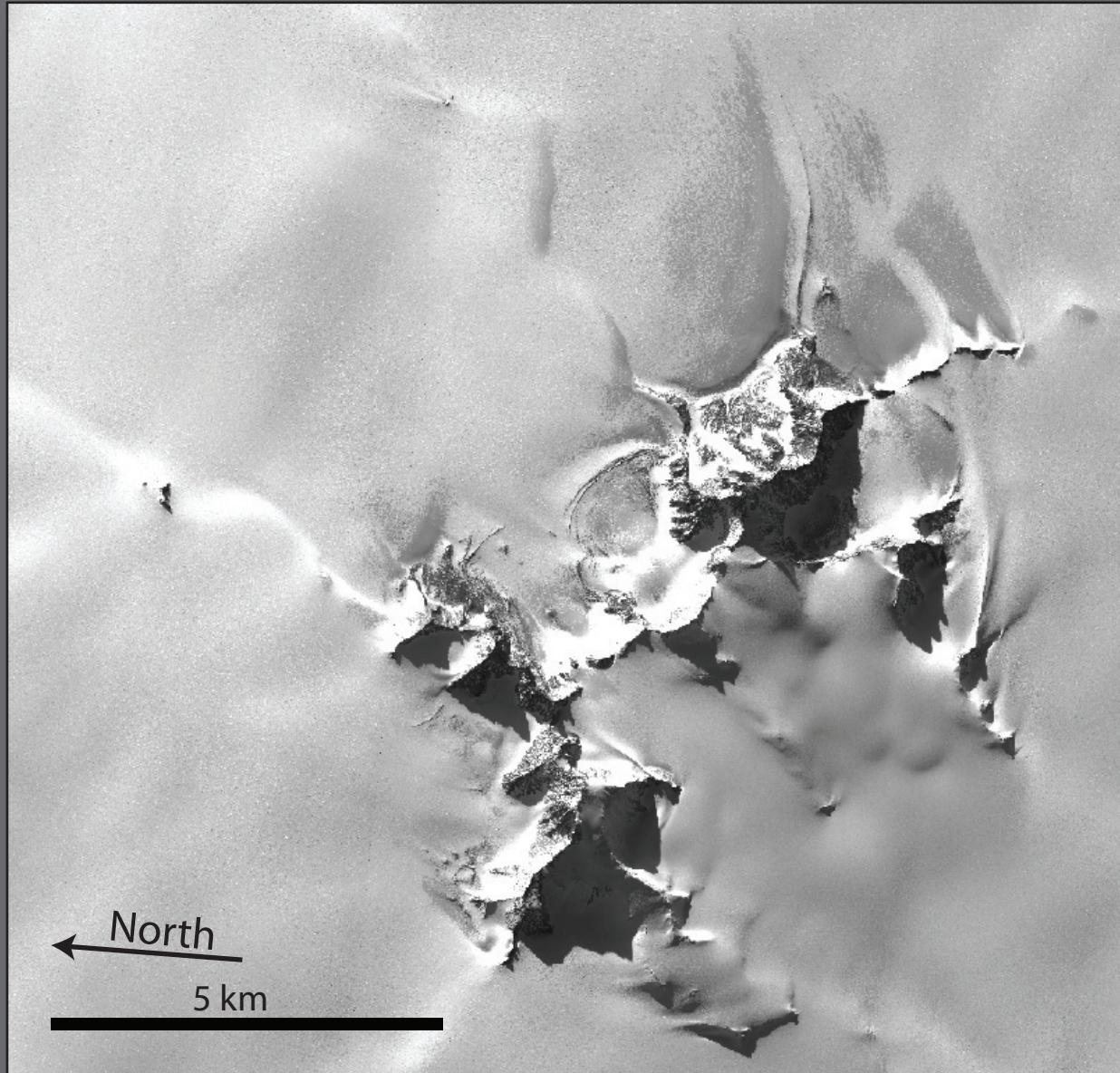
# Pirrit Hills radar results

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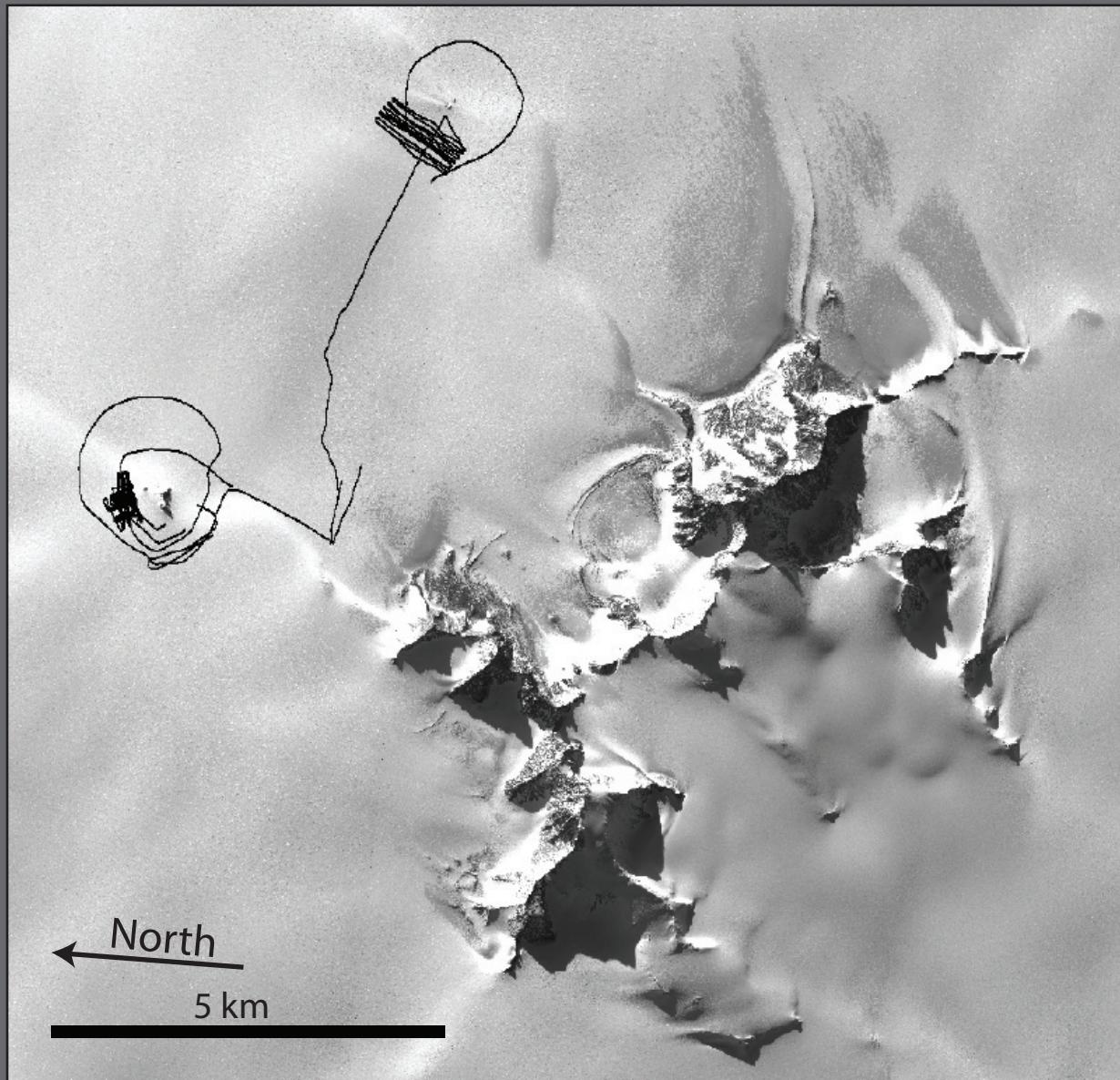
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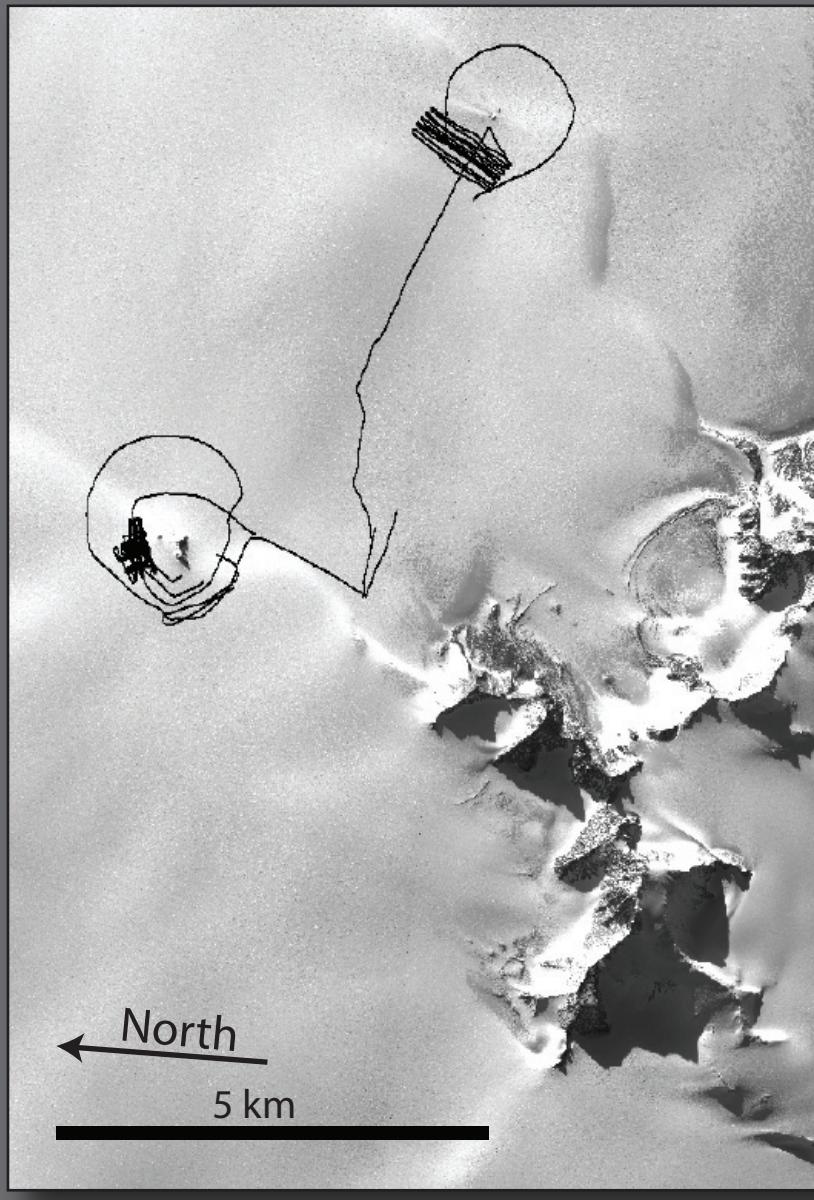


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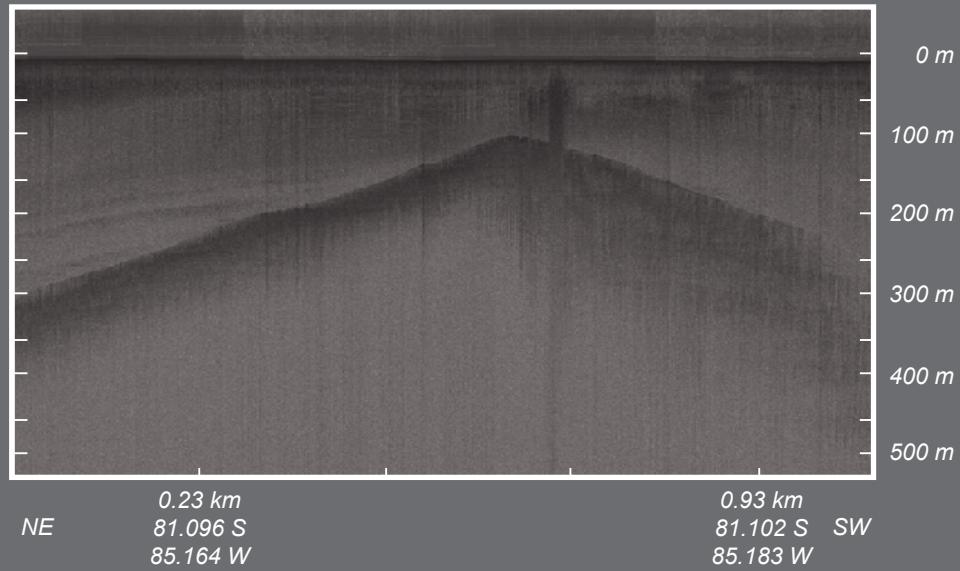
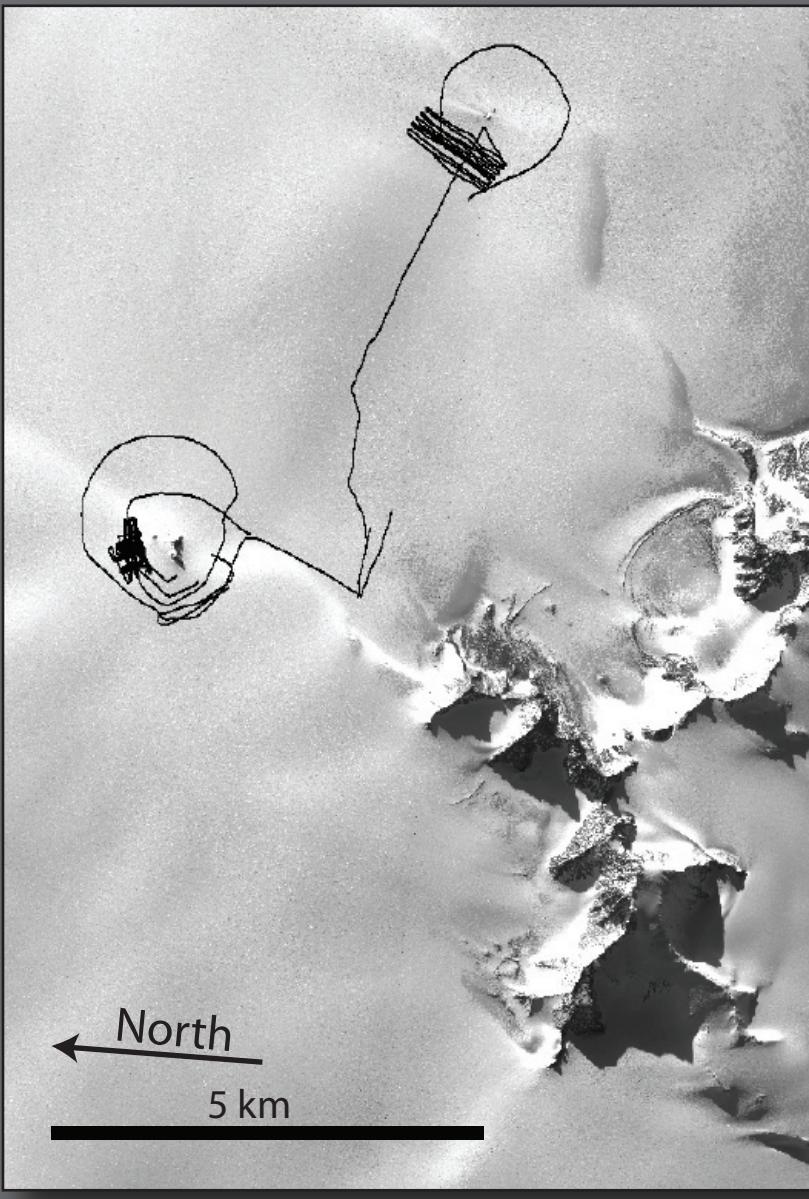
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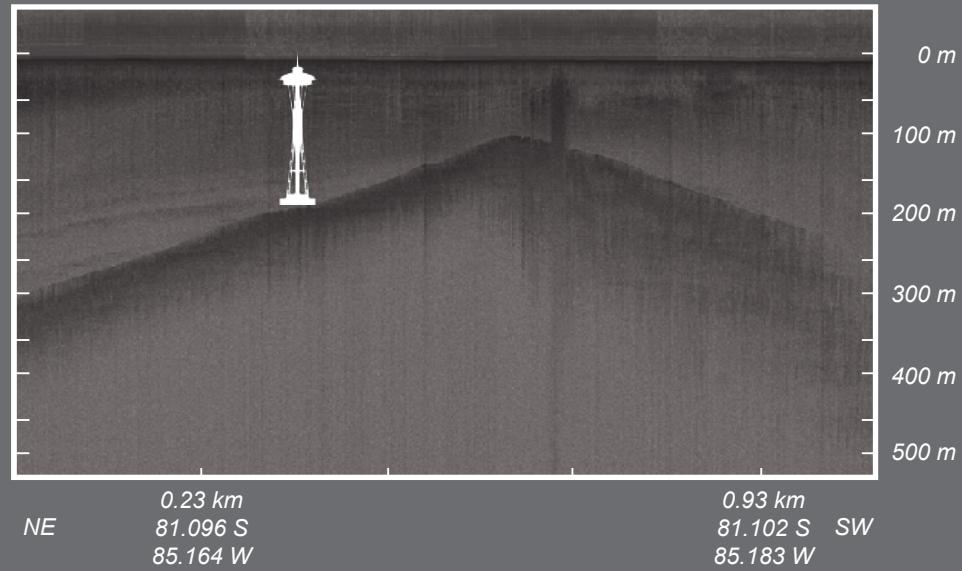
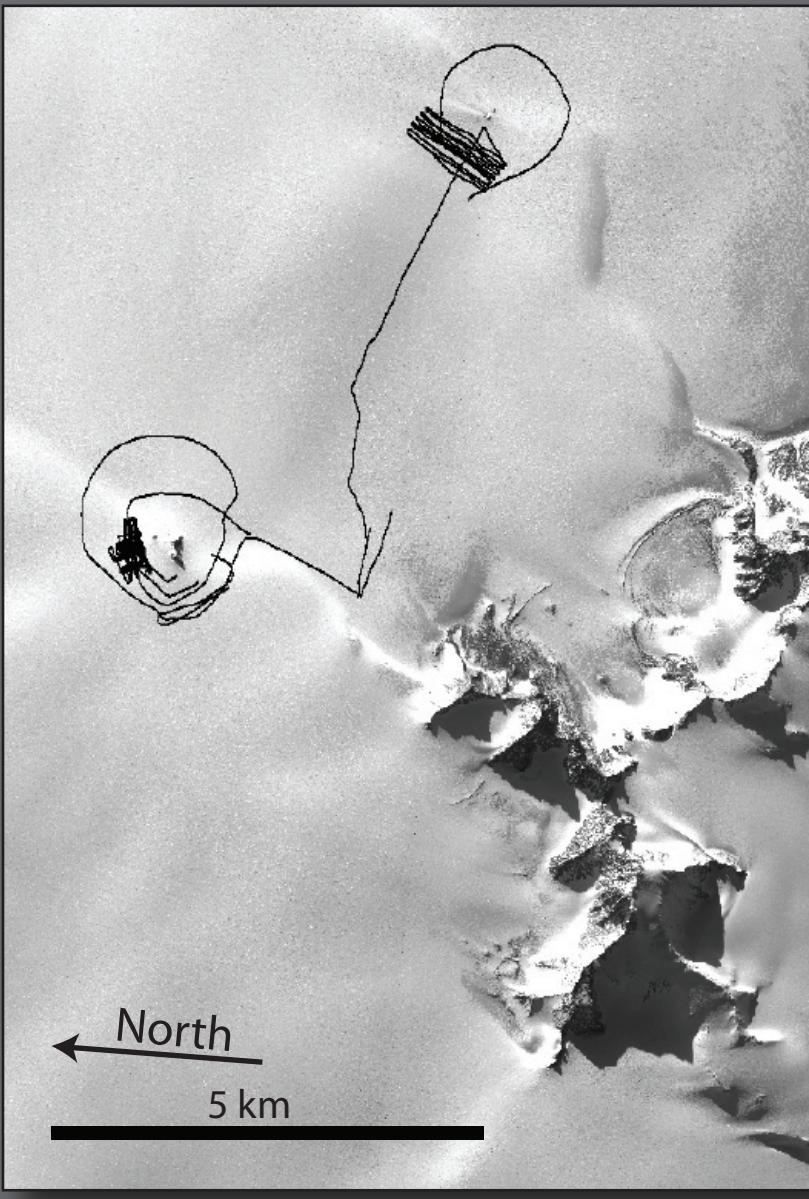
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# Conclusions

*Cosmogenic nuclides in subglacial bedrock contain information about past ice-free conditions*

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## ***Glacial history:***

- *Generally exposed, rarely ice covered*
- *Past ice cover has been cold-based, non-erosive*
- *Very likely that ice has been thinner during past interglacials*
- *Very likely that shallow subglacial bedrock has been protected from erosion*

# Conclusions

*Cosmogenic nuclides in subglacial bedrock contain information about past ice-free conditions*

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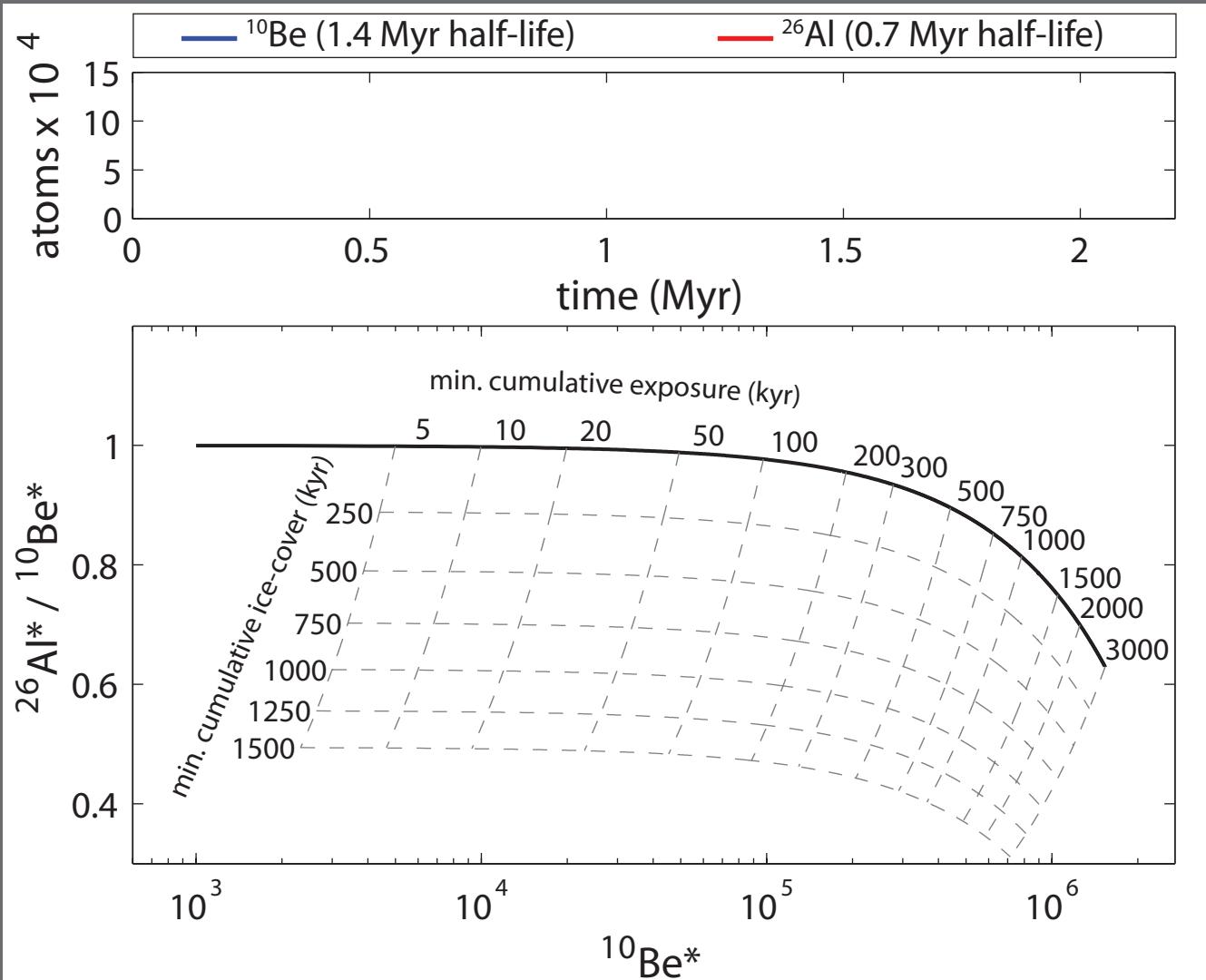
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## ***Field sites:***

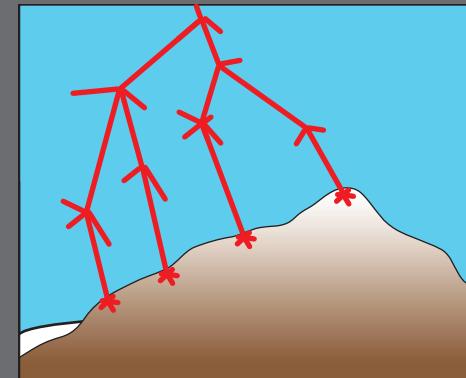
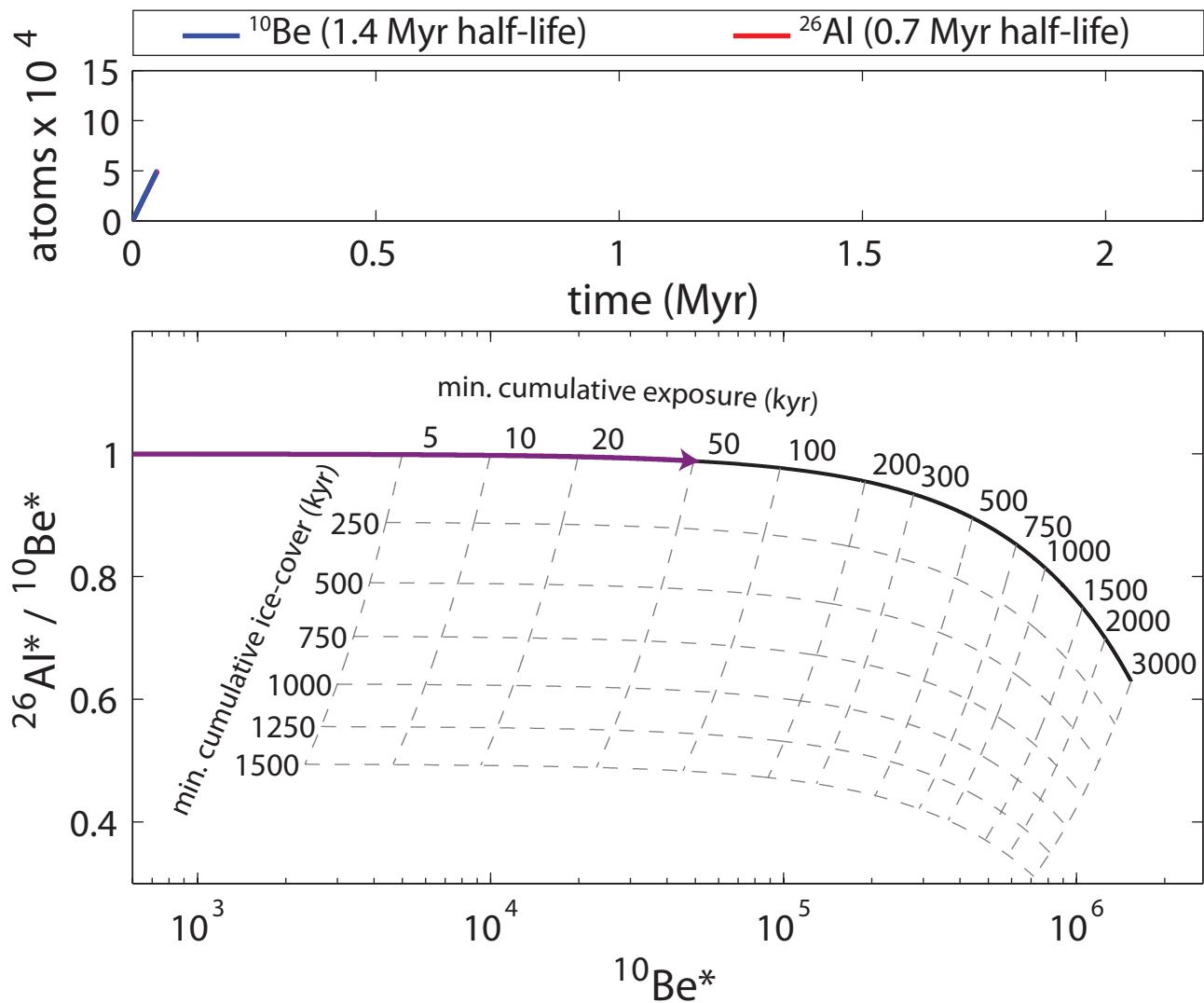
- *Pirrit Hills*
  - *Favored drill site*
  - *Well-correlated with changes in ice-sheet dynamics*
  - *High quality radar data of a promising drill target*
- *Whitmore Mtns*
  - *Local ice elevation insensitive to broader ice-sheet behavior*
- *Nash Hills*
  - *Complex bedrock geology precludes subglacial drilling*



# Exposure and ice-cover

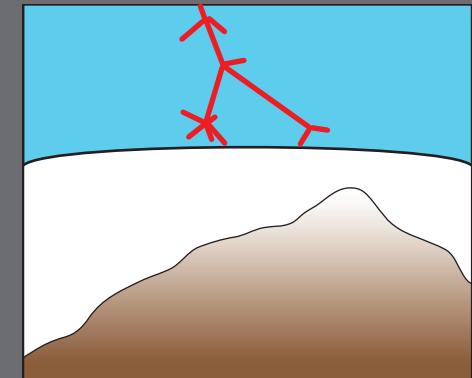
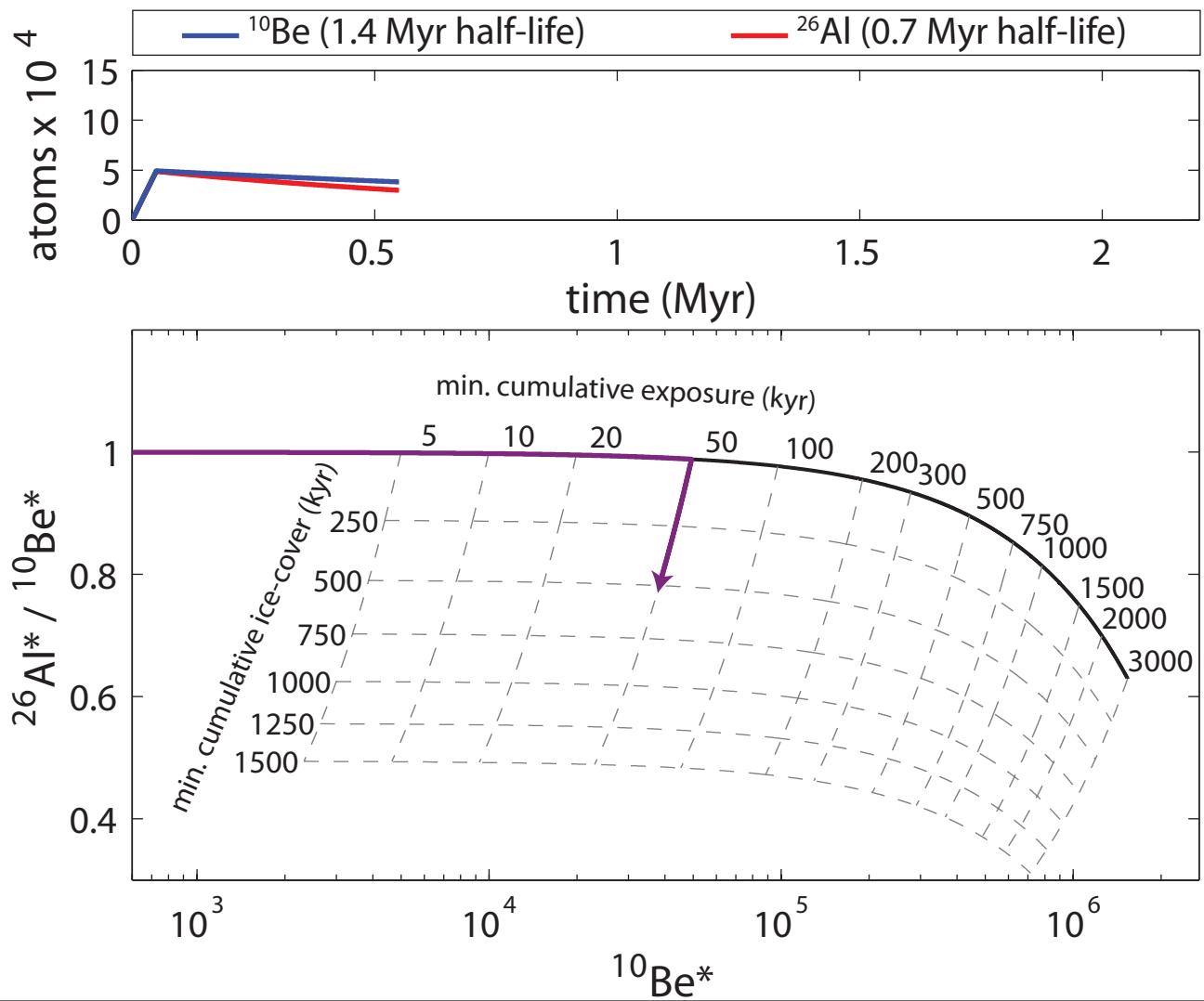


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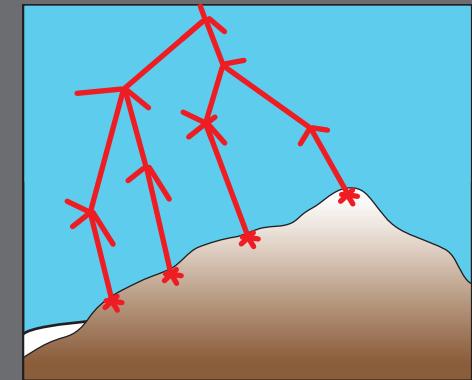
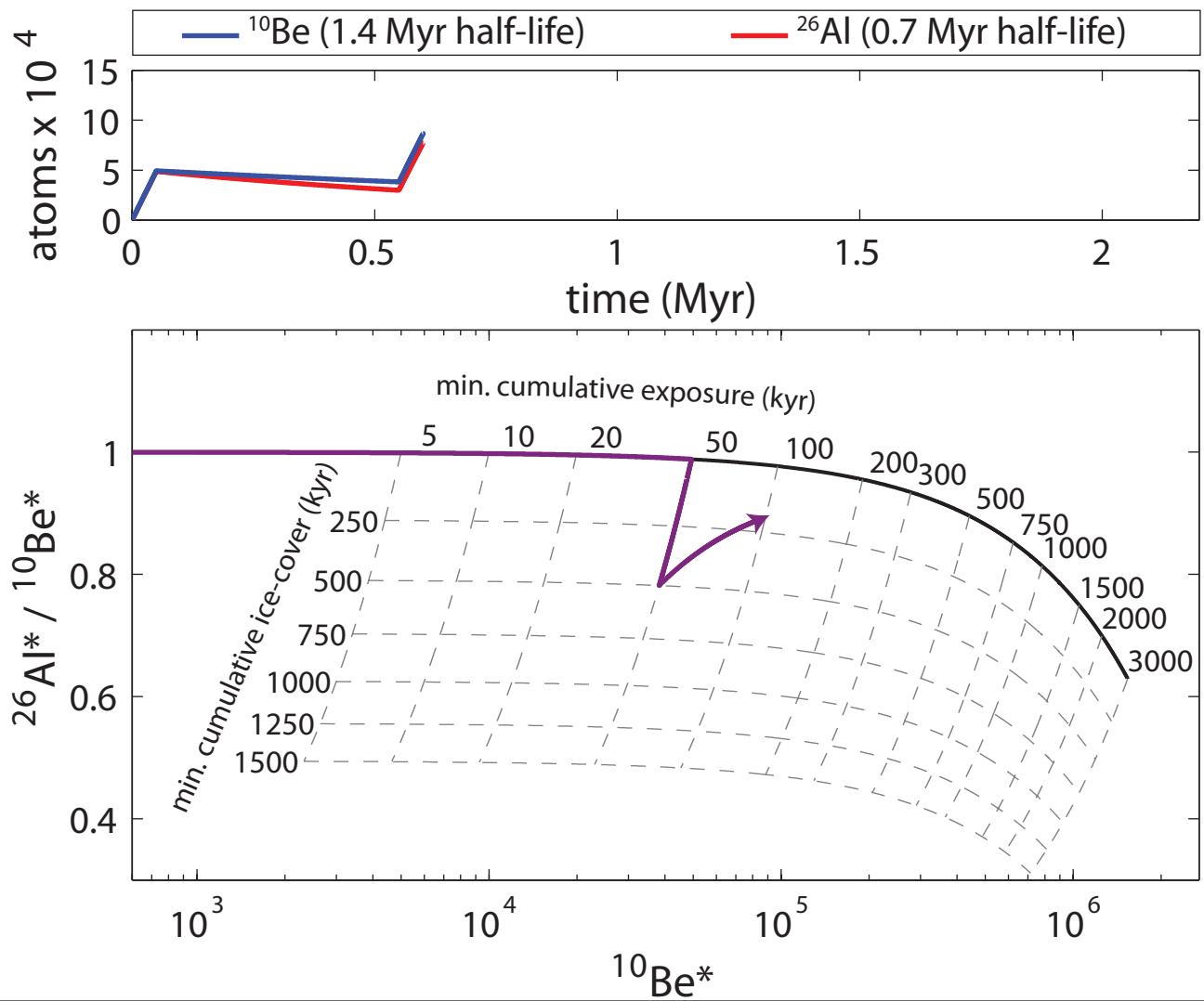
Expose: 50 kyr

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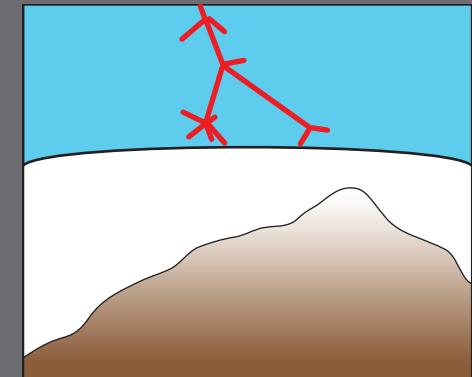
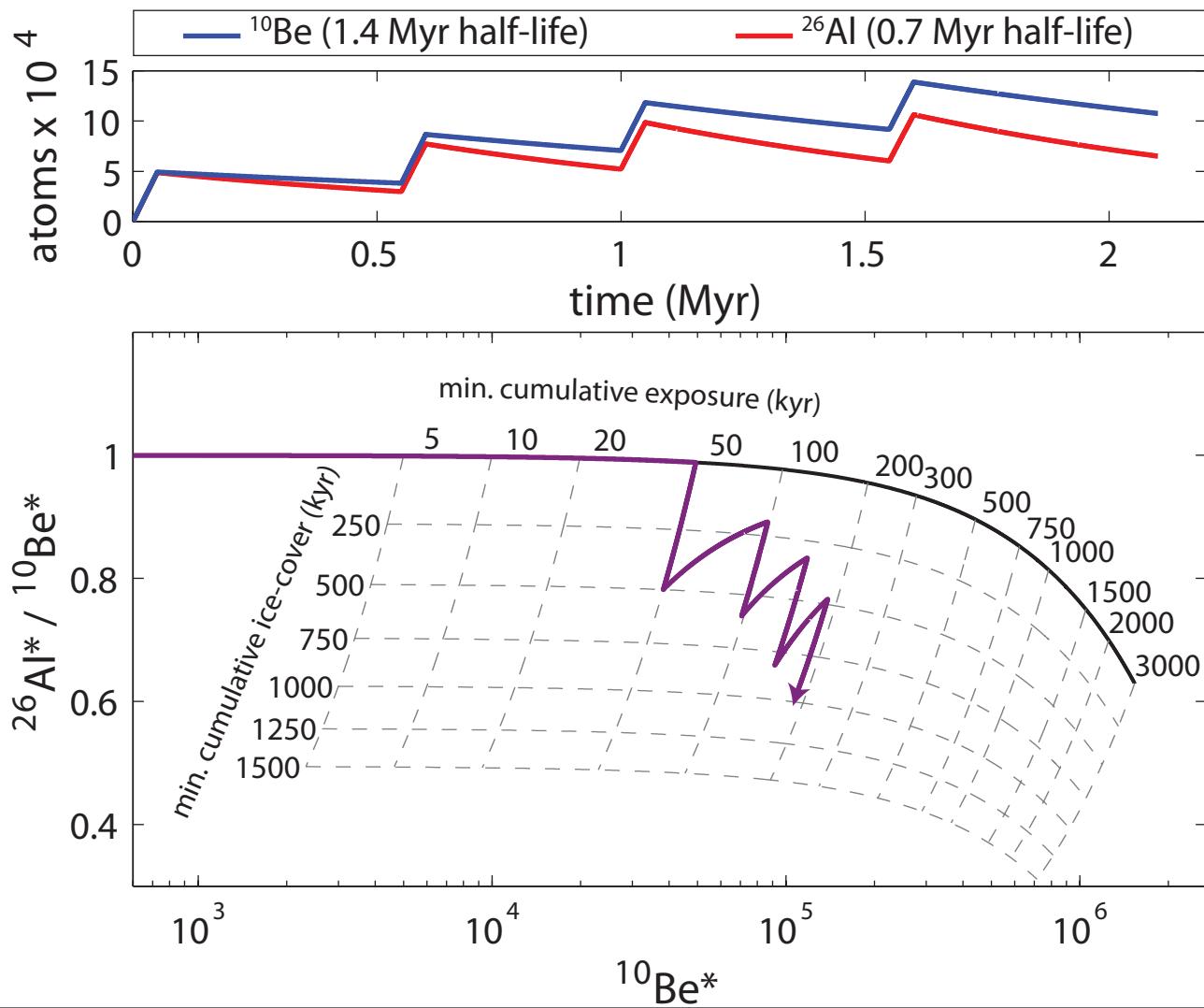
Ice cover: 500 kyr

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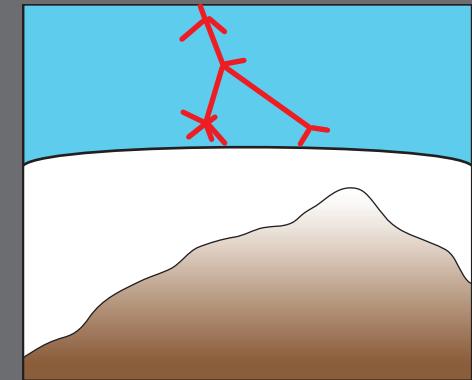
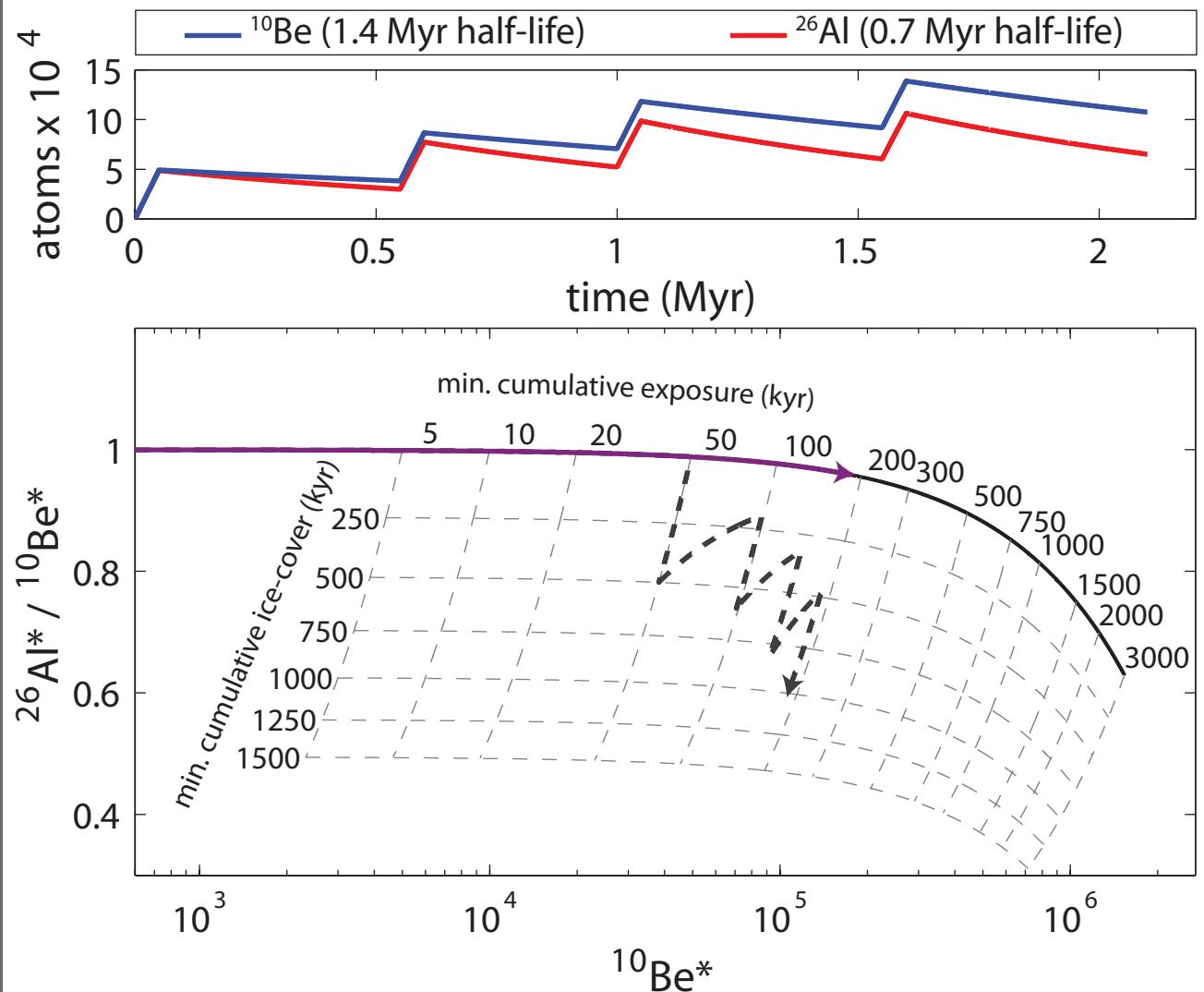


Re-expose: 50 kyr

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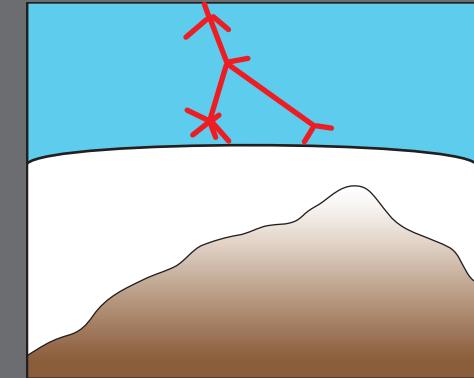
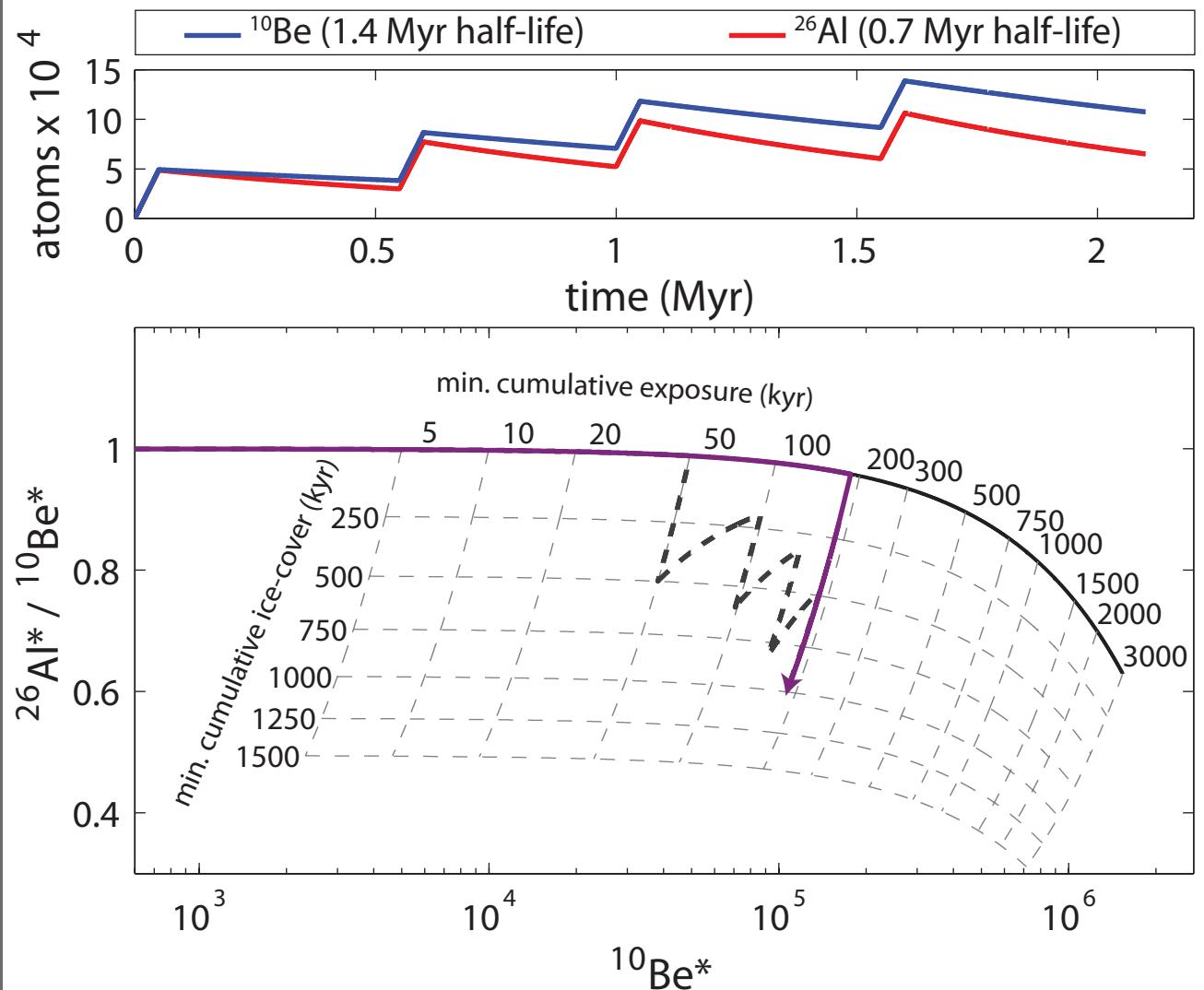


# Exposure and ice-cover



- 2-stage exposure time: lower limit of cumulative exposure time

# Exposure and ice-cover



Repeat cycle

- 2-stage exposure time: lower limit of cumulative exposure time
- 2-stage burial time: lower limit of cumulative burial time