

# Dynamic Earth

## probing beneath Antarctic ice

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### why Antarctic research?

*scientific and societal implications*

- distinctive traits of research in Antarctica
  - looking at new data with new eyes
  - integrated view
  - reduced constraints from *mainstream* literature
- international relationships
  - cooperation (logistics) & collaboration (science)
  - challenge (logistics) & competition (science)
  - international credit - a lot of work done in 1985-2015



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# why Antarctic Earth Science research?

## major achievements of PNRA

2015

contributions to  
general Earth Science  
- shifting paradigms-

contributions to  
the knowledge of  
a poorly known continent

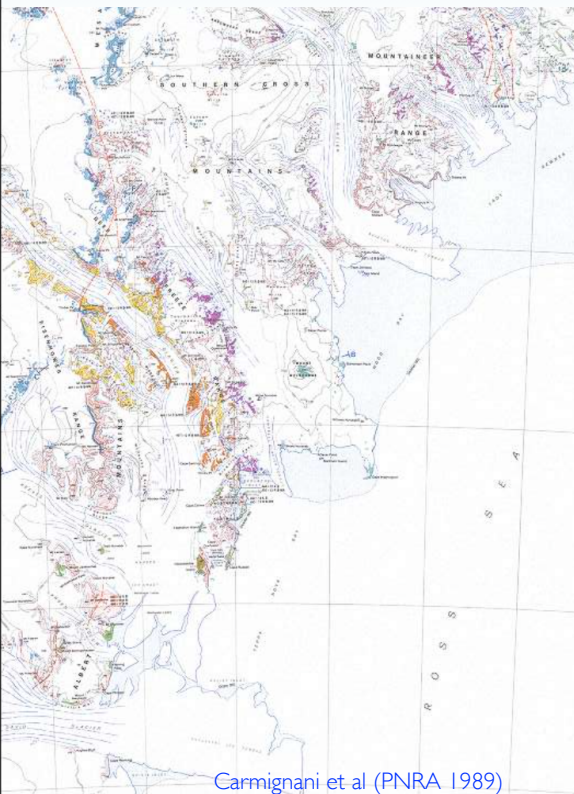
1985

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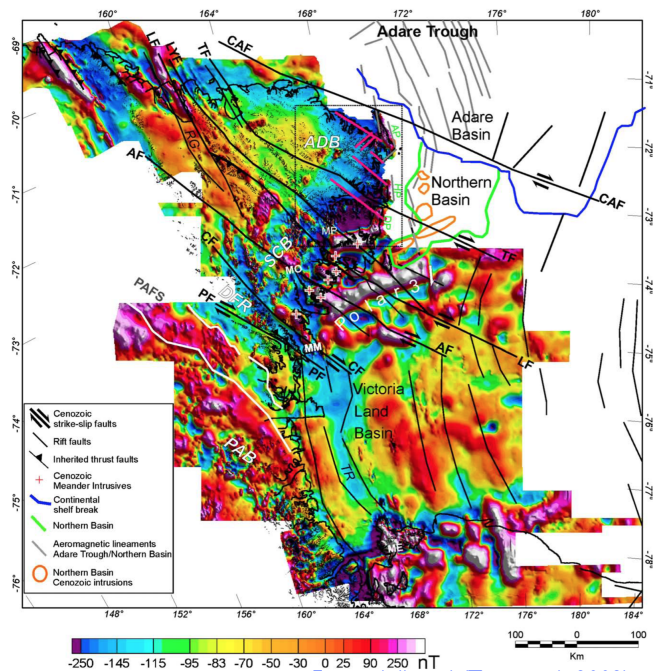
# major achievements of PNRA in Earth Sciences

## mapping - in the field and from sky



Carmignani et al (PNRA 1989)

- geological mapping
- aeromag mapping



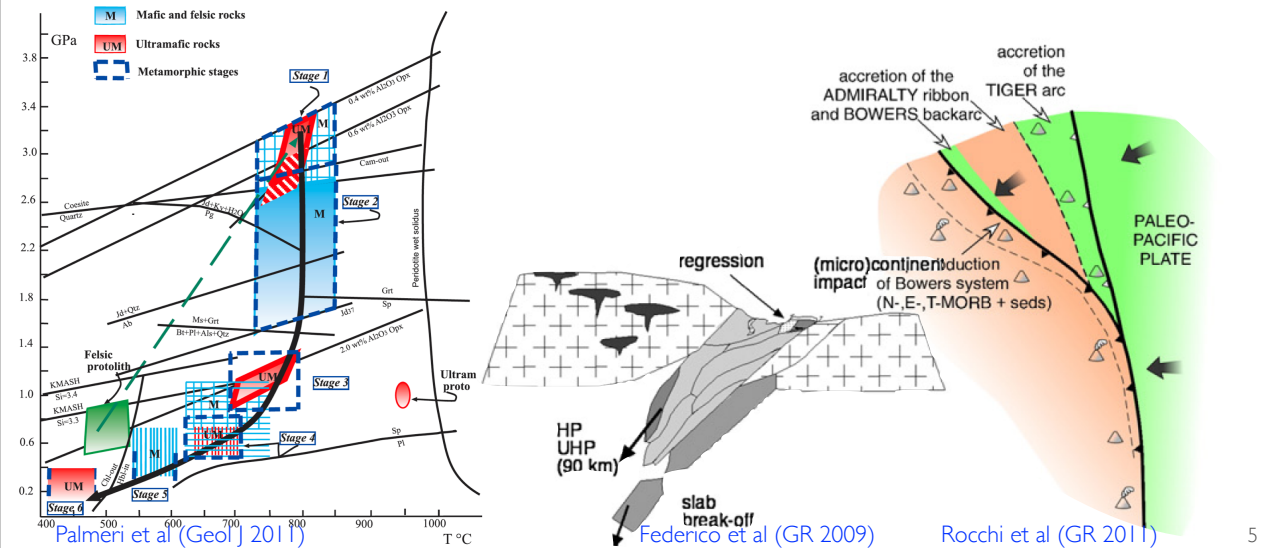
Ferraccioli et al (Tectonoph 2009)

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# major achievements of PNRA in Earth Sciences

## geodynamics - before the Pole

- eclogites and UHP metamorphism
  - rare in the world, unique in Antarctica
  - continental rocks down to 3.3 GPa
  - subduction + collision/overthrusting of crustal segments during accretion
- granites
  - early Paleozoic magmatic arc(s)
  - lithospheric discontinuities
- models: multiple arc accretion

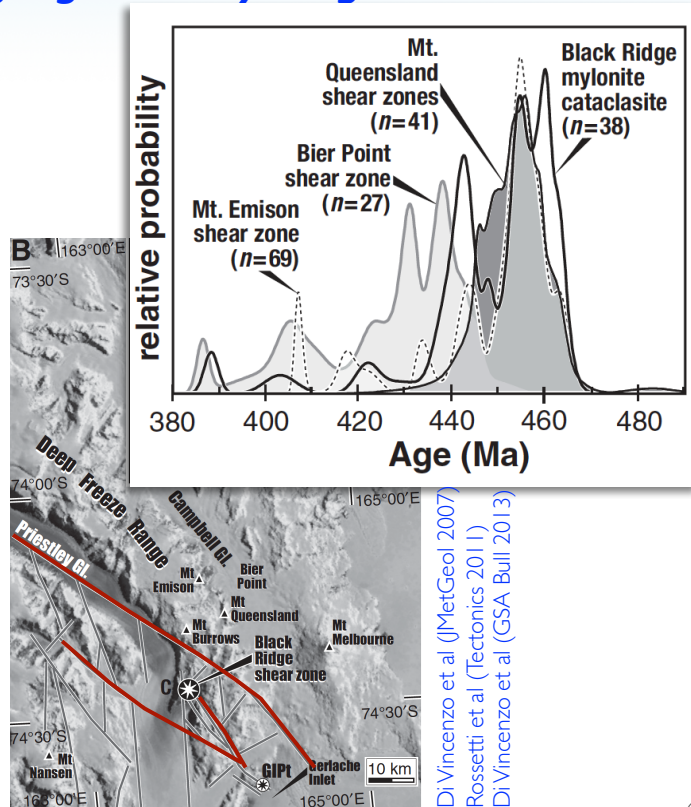


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# major achievements of PNRA in Earth Sciences

## from old-young legs to old-young link

- tectonic inheritance
  - deformational reactivation (460-440 Ma) of early Paleozoic crustal structures
  - influence of Paleozoic crustal structures on the Antarctica-Australia break-up (100 Ma)
  - Eocene (50 Ma) reactivation of compressional ductile Paleozoic lithospheric structures as brittle intraplate dextral strike-slip structures
- effectiveness of integrated old-young view



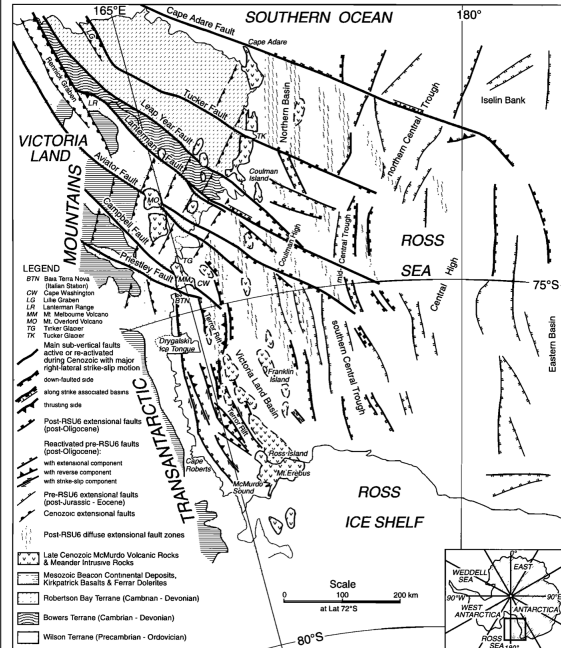
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# major achievements of PNRA in Earth Sciences

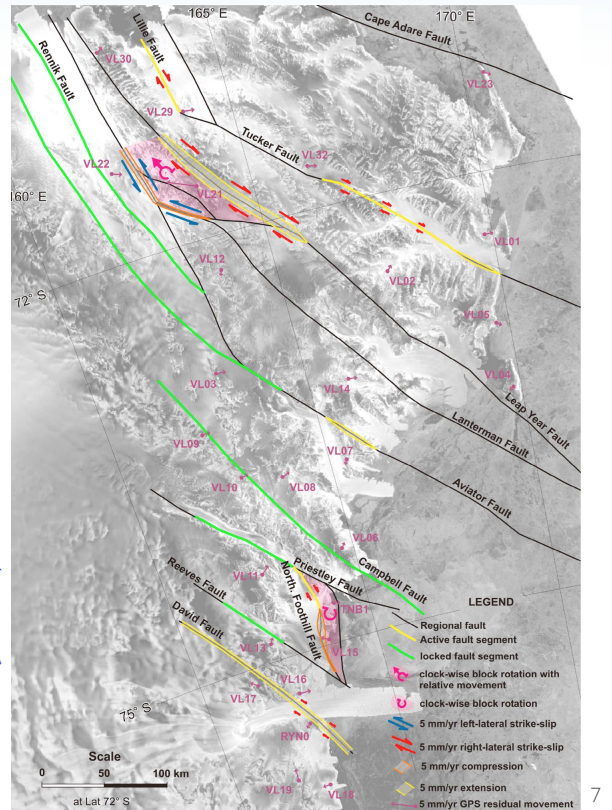
## geodynamics - polar Antarctica

- intraplate faults
- predictive model
- confirmed by GPS



Salvini et al (JGR 1997)

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Dubbini et al (JGR 2010)

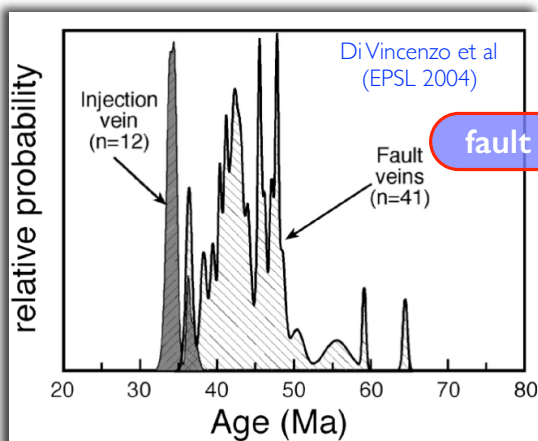
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# major achievements of PNRA in Earth Sciences

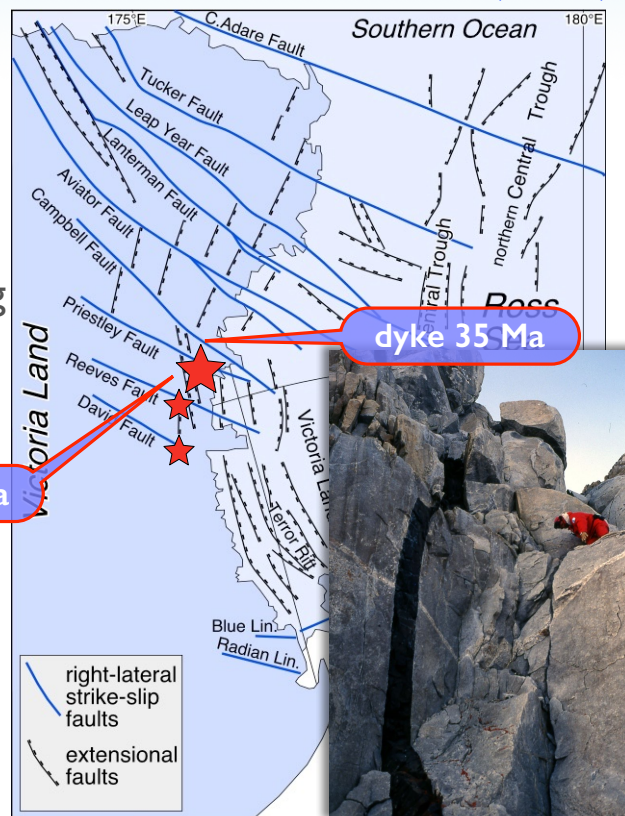
## geodynamics - polar Antarctica

Rossetti et al (JGSL 2006)

- Cenozoic plutons, dykes, pseudotachylytes
- geometric link between magma emplacement and faults
- chronologic link between magma emplacement and coseismic faulting



fault 34 Ma



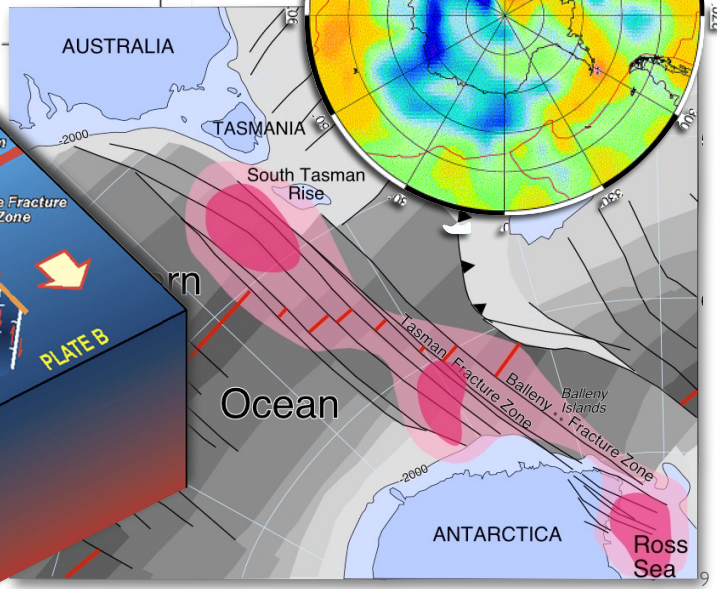
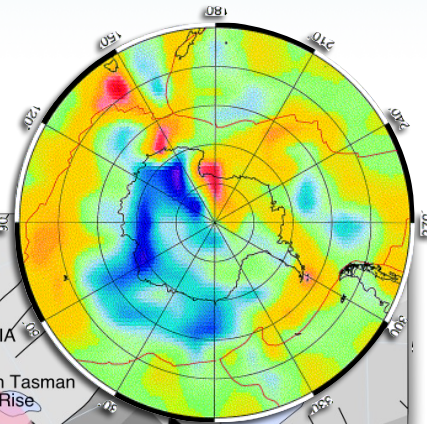
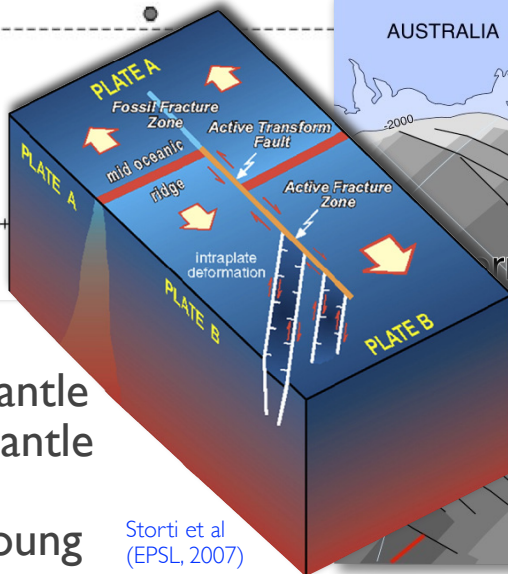
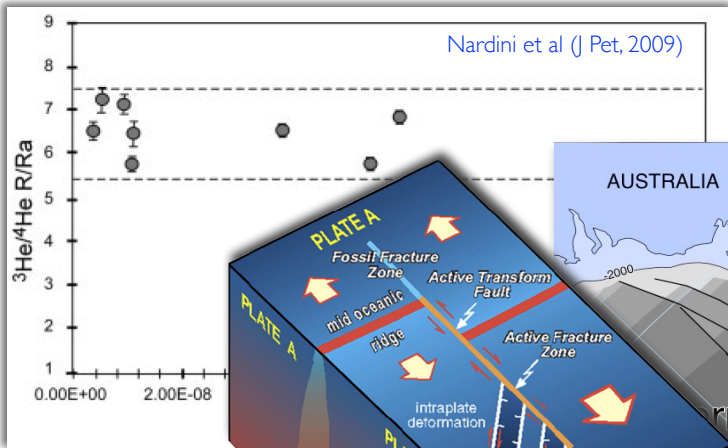
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# major achievements of PNRA in Earth Sciences

## geodynamics - polar Antarctica

Danesi & Morelli (PEPI, 2000)

- ideal plates to non-ideal plates



- revised mantle plumes: mantle recycling: shallow-young

Storti et al (EPSL, 2007)

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# major achievements of PNRA in Earth Sciences

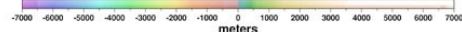
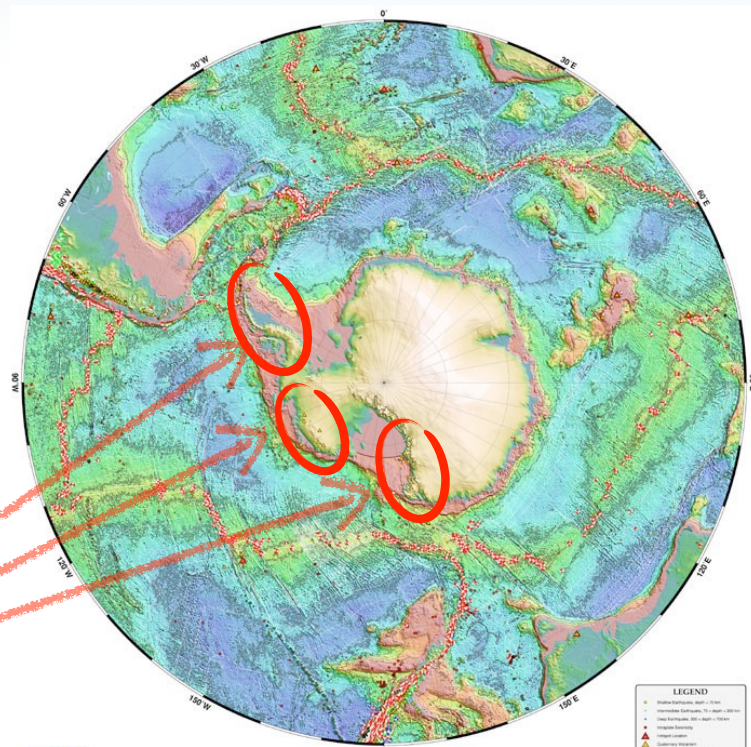
## paleoenvironment

### • CORING

- ice cores
  - ~0.8 million years
  - drilling on plateau
- sediment cores
  - ~ 20 million years
  - only off-shore (proxy)

### • TERRESTRIAL

- glacial geomorphology
  - Oligocene
- volcanic rocks
  - 20 million years



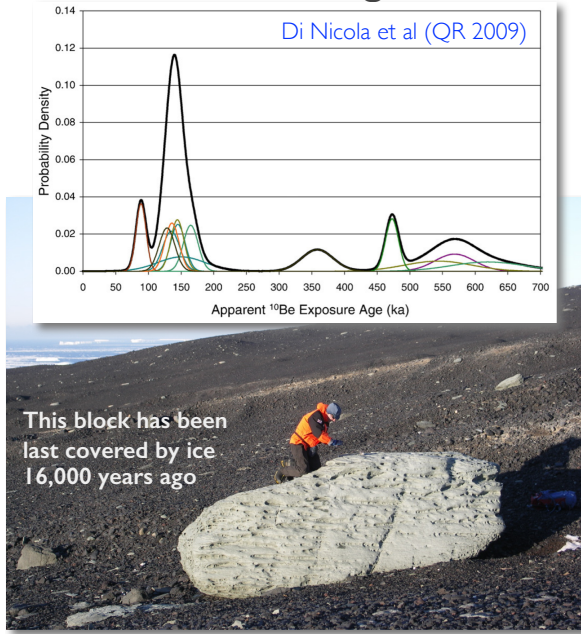
LEGEND	
•	Plateau Station, 1987 - 1988
•	Plateau Station, 1992 - 1993
•	Plateau Station, 1997 - 1998
•	Plateau Station, 2001 - 2002
•	Plateau Station, 2005 - 2006
•	Plateau Station, 2009 - 2010
•	Plateau Station, 2013 - 2014
•	Plateau Station, 2017 - 2018
•	Plateau Station, 2021 - 2022

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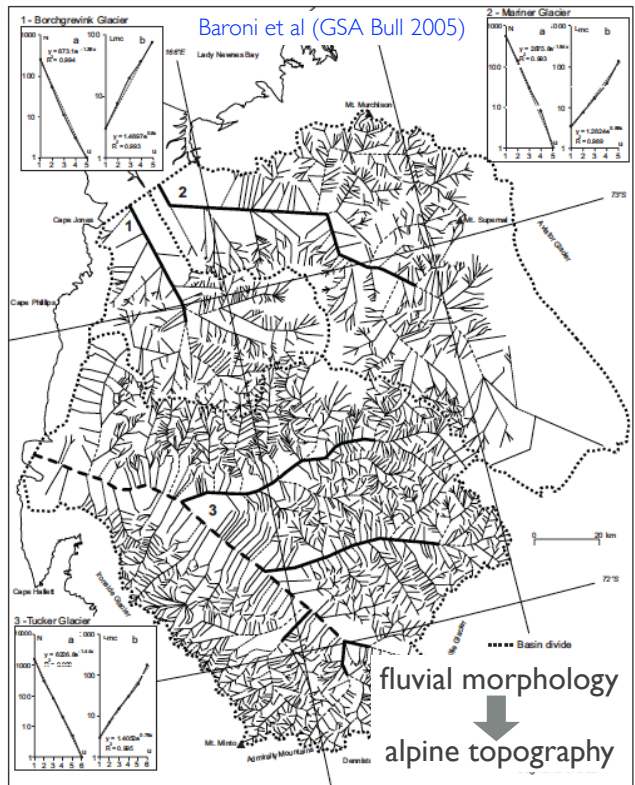
# major achievements of PNRA in Earth Sciences

## *paleoenvironment - ice dynamics in the past*

- glacial geomorphology
- surface exposure dating by terrestrial cosmogenic nuclides



Johnson et al (AS, 2008)

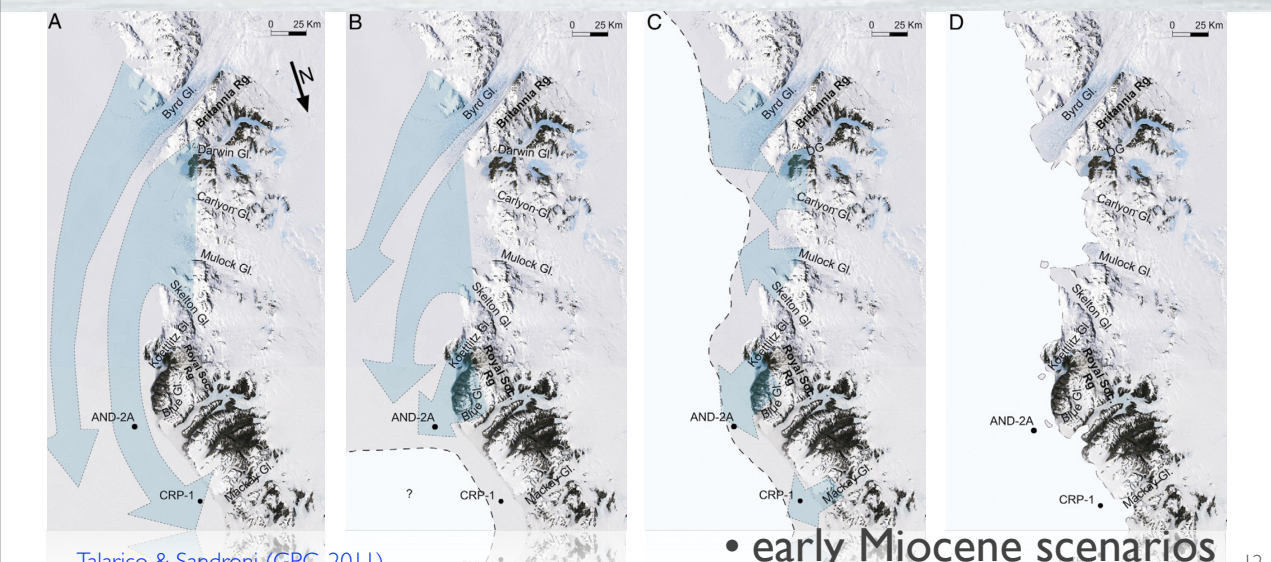


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# major achievements of PNRA in Earth Sciences

## *paleoenvironment - ice dynamics in the past*

### CRP & ANDRILL projects



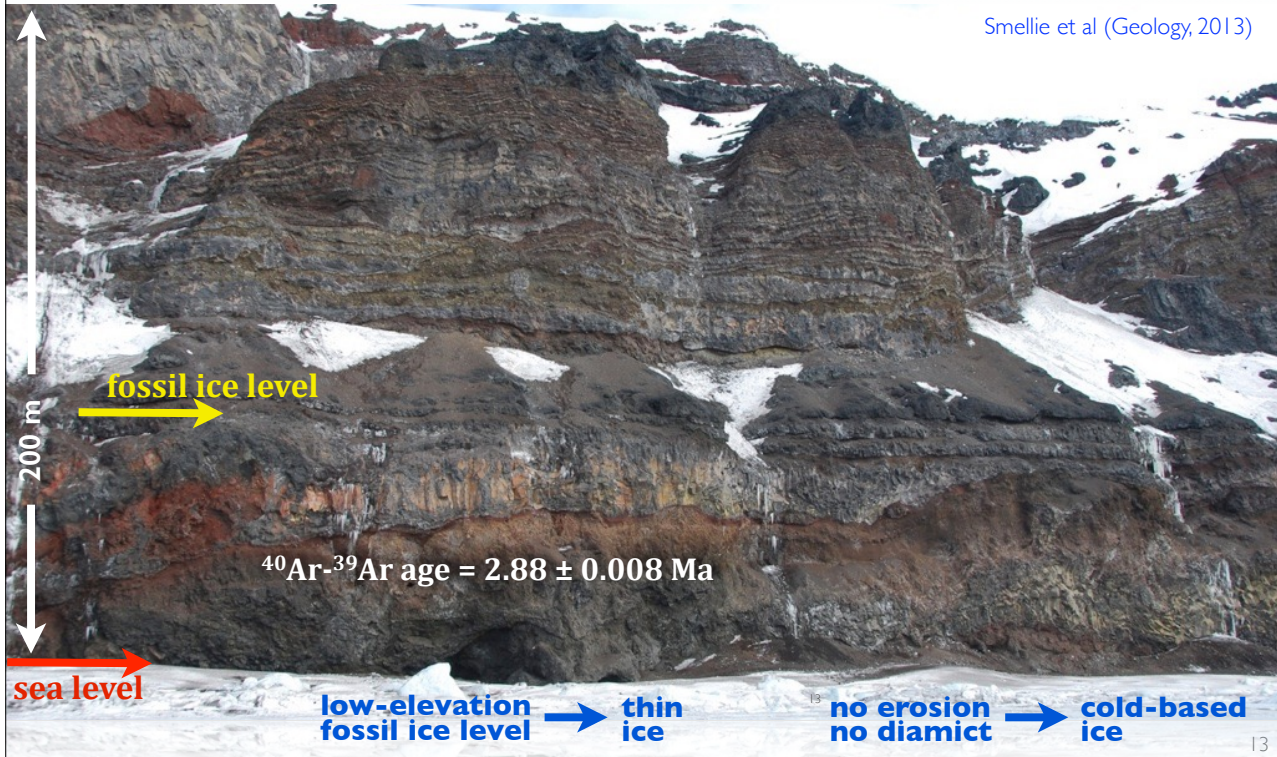
- early Miocene scenarios

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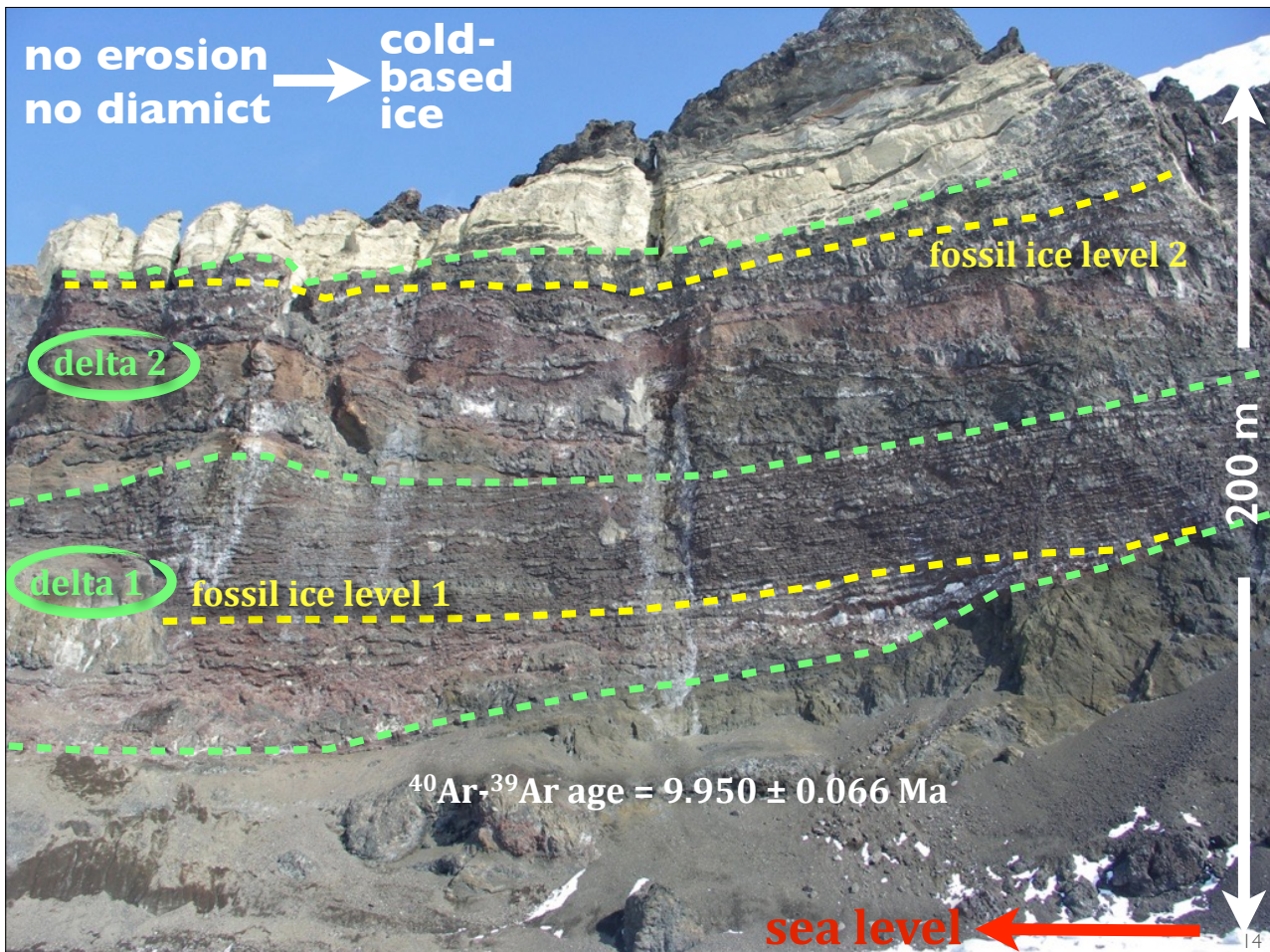
# major achievements of PNRA in Earth Sciences

## *paleoenvironment - ice dynamics in the past*

- glaciovolcanism



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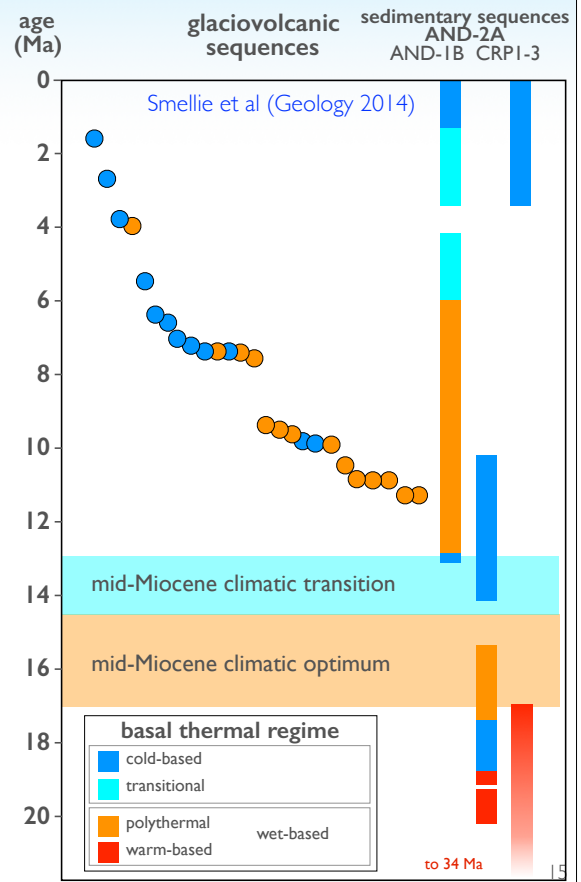


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# major achievements of PNRA in Earth Sciences

## ice dynamics in the past

- surface exposure - landscape evolution
  - diverse timing for supposed step-change transition to a cold-based ice sheet
- glaciovolcanism
  - no unique time switch between basal ice thermal regimes
- Neogene EAIS = mosaic of transient patches of frozen-bed and thawed-bed ice (polythermal ice sheet)
- Neogene EAIS similar to EAIS today
- *record of atmospheric temperature in O, H isotopes of volcanic products / hydrothermal systems*

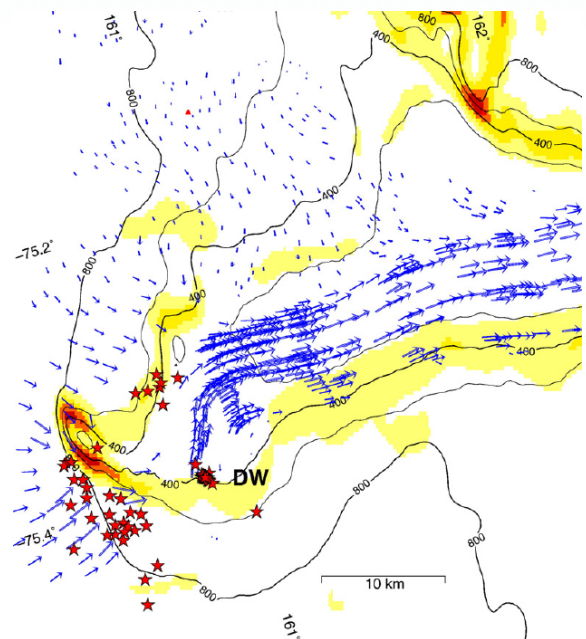
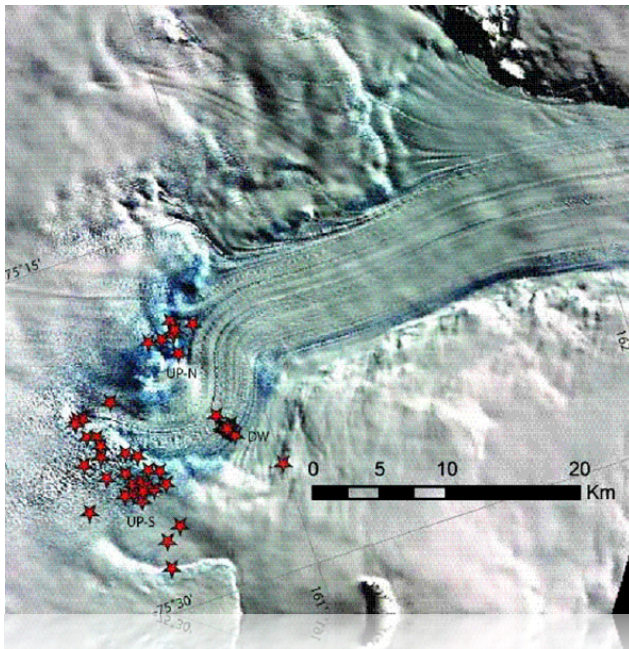


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# major achievements of PNRA in Earth Sciences

## paleoenvironment - ice dynamics today

- iceberg calving
- ice flow



Danesi et al (EPSL, 2007)

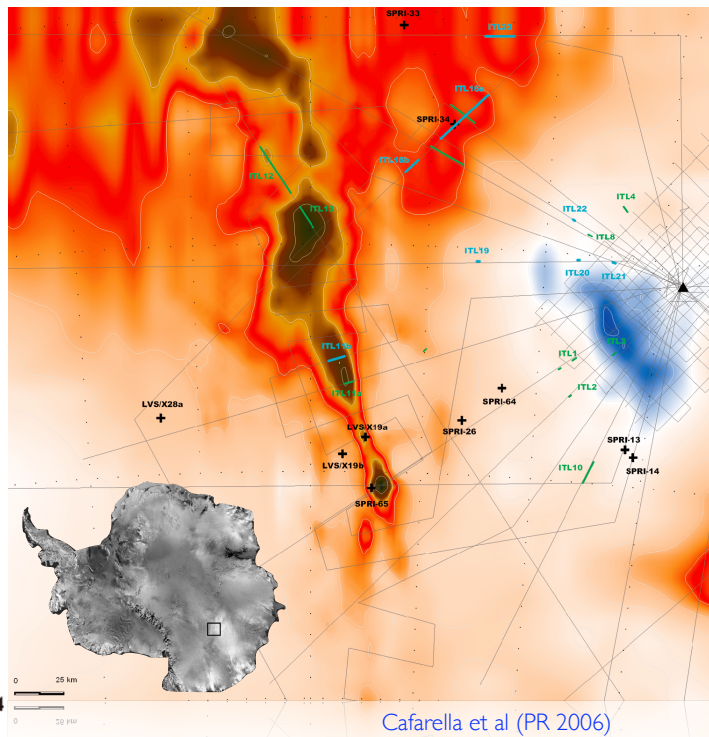
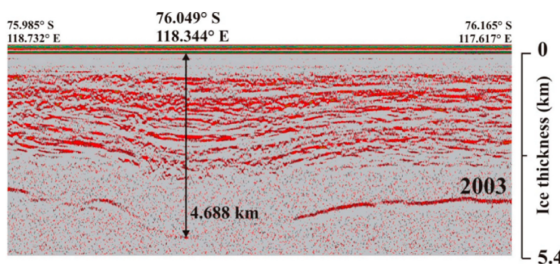
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## major achievements of PNRA in Earth Sciences

### *paleoenvironment - ice dynamics today*

- subglacial lakes
- ice thickness
- ice-bedrock interface
- *radio-echo sounding*

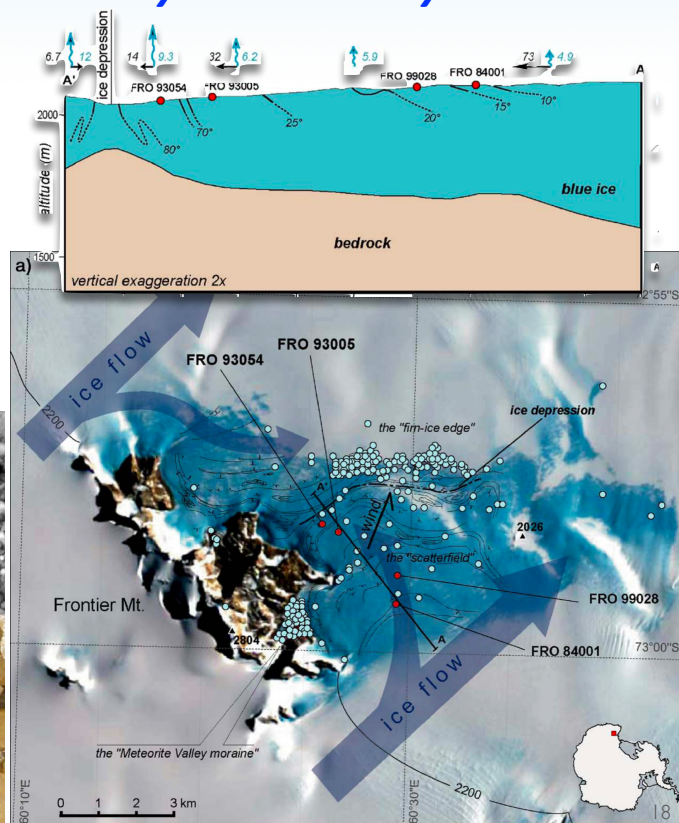
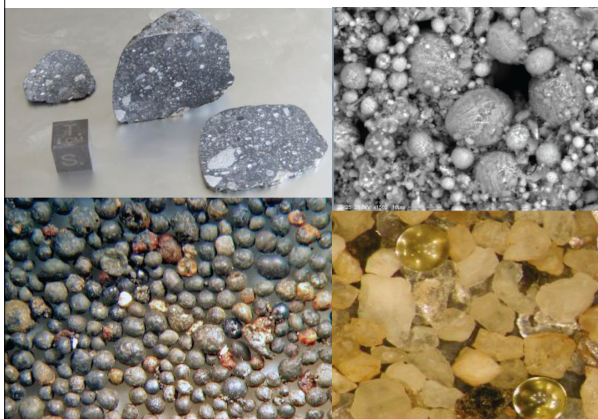


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## major achievements of PNRA in Earth Sciences

### *paleoenvironment - ice dynamics today*

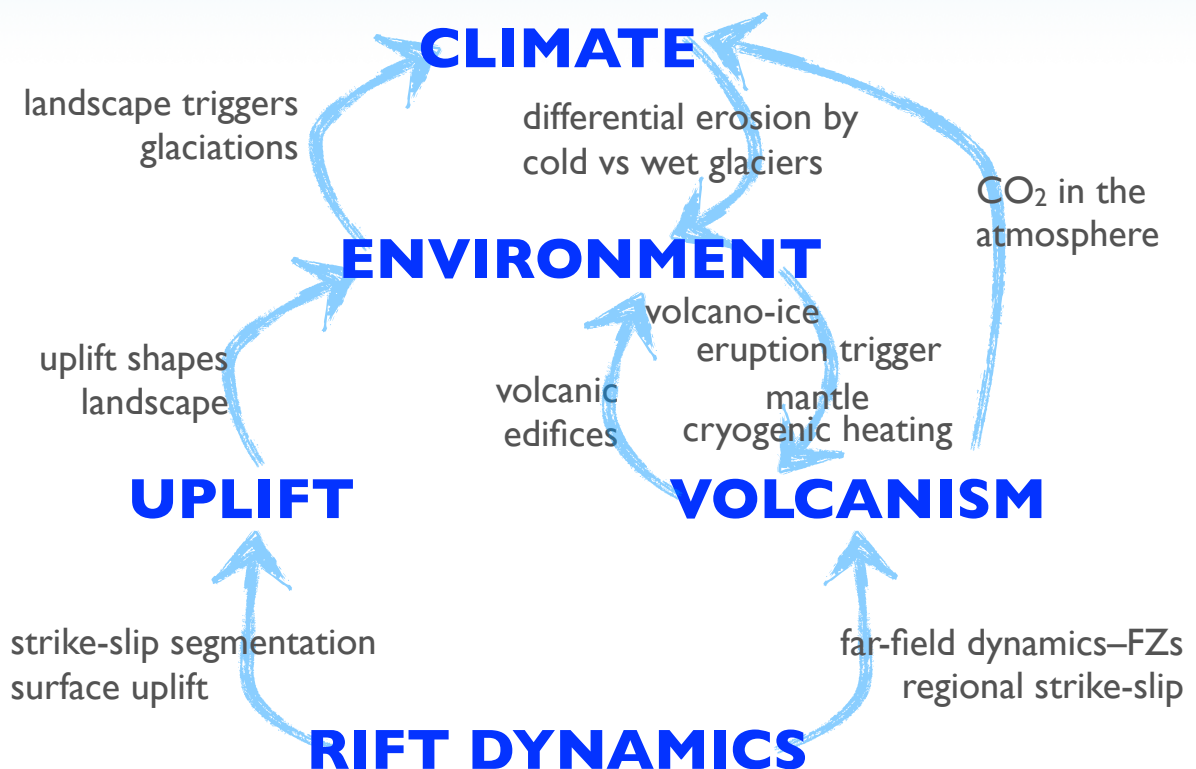
- blue ice meteorite traps
  - unique cold desert
  - ice dynamics and age
- cosmochemistry
  - > 1250 meteorites
  - micrometeorites
  - microtektites



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## major achievements of PNRA in Earth Sciences

*feedback*



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## looking into the future

*critical needs*

### • cooperations

- PAST - EPICA, CRP, ANDRILL
- TODAY - shallows to fog
- FUTURE - need for stable funding framework and time schedule

### • brains

- PAST - research grants from PNRA
- TODAY - young researchers - a generation lost
- FUTURE - need to support PhD programs, MNA

### • technology

- PAST - GIC & SIA - a bright idea
- TODAY - analytical instruments - a generation lost
- FUTURE - need for reviving GIC & SIA

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