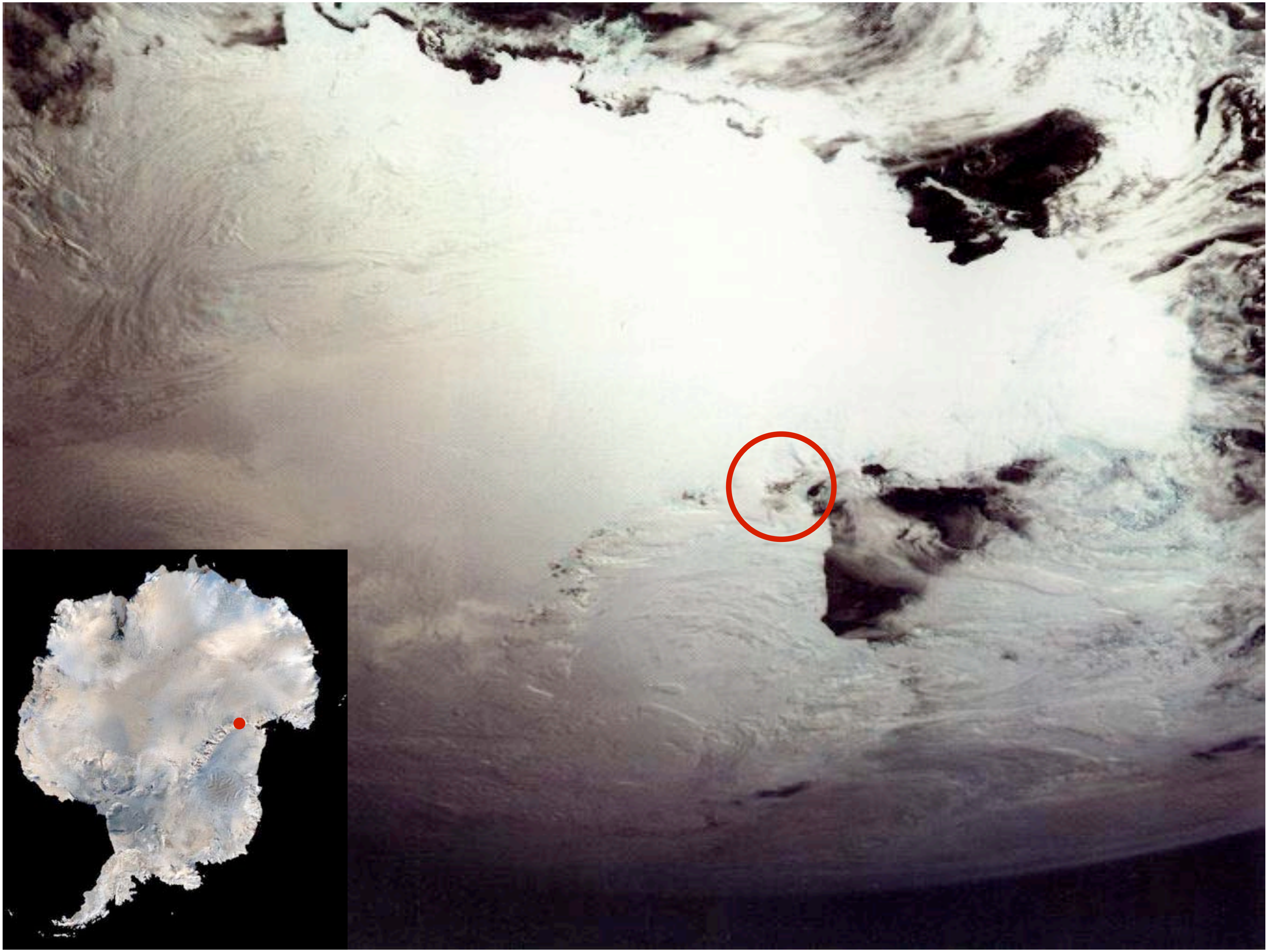
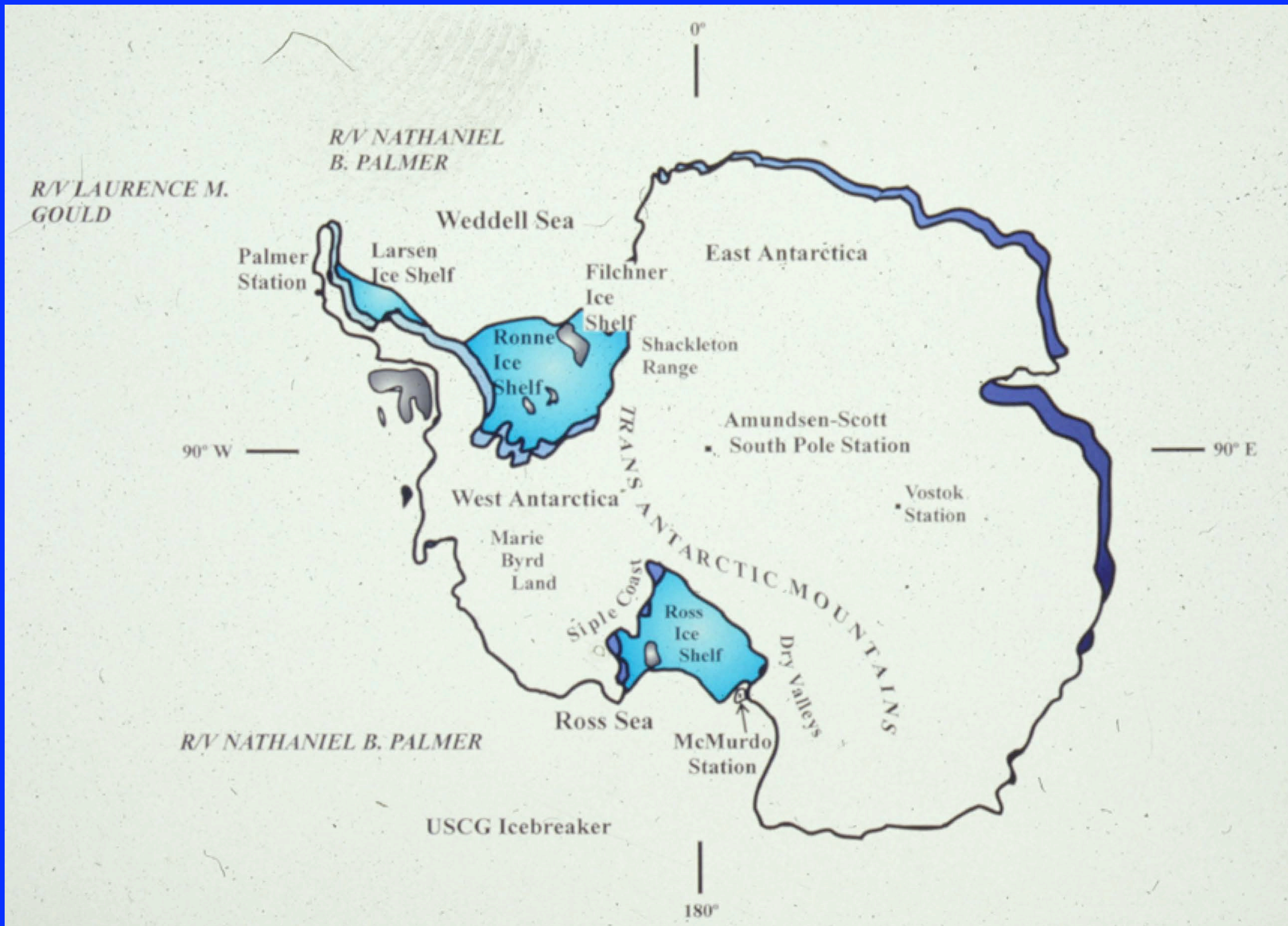
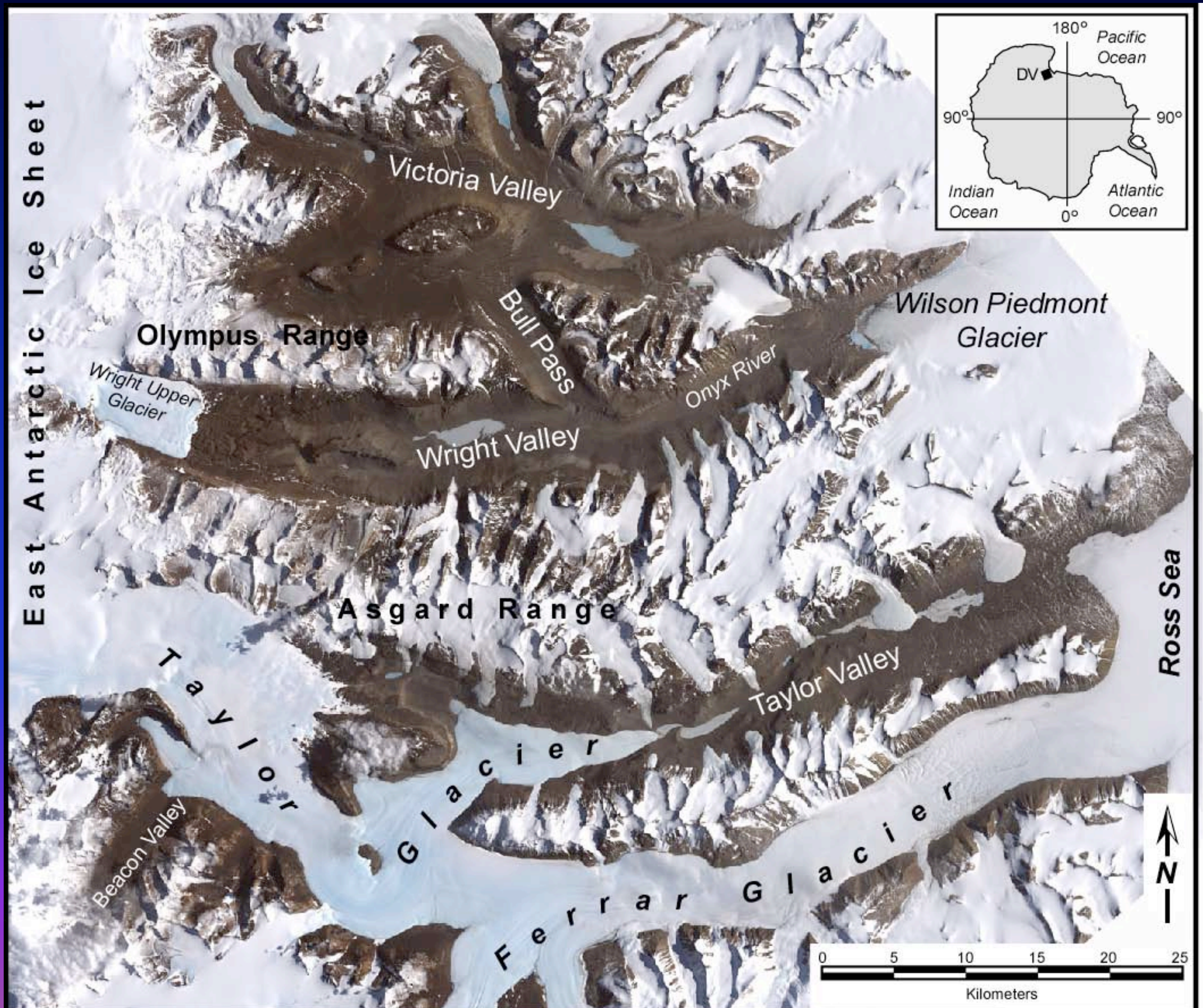
38 Antarctic Dry Valleys:

1. The Antarctic environment and the Antarctic Dry Valleys.
2. Cold-based glaciers and their contrast with wet-based glaciers.
3. Microclimate zones in the Antarctic Dry Valleys (ADV) and their implications.
4. Landforms on Earth and Mars: A comparative analysis of analogs.
5. Biological activity in cold-polar deserts.
6. Problems in Antarctic Geoscience and their application to Mars.

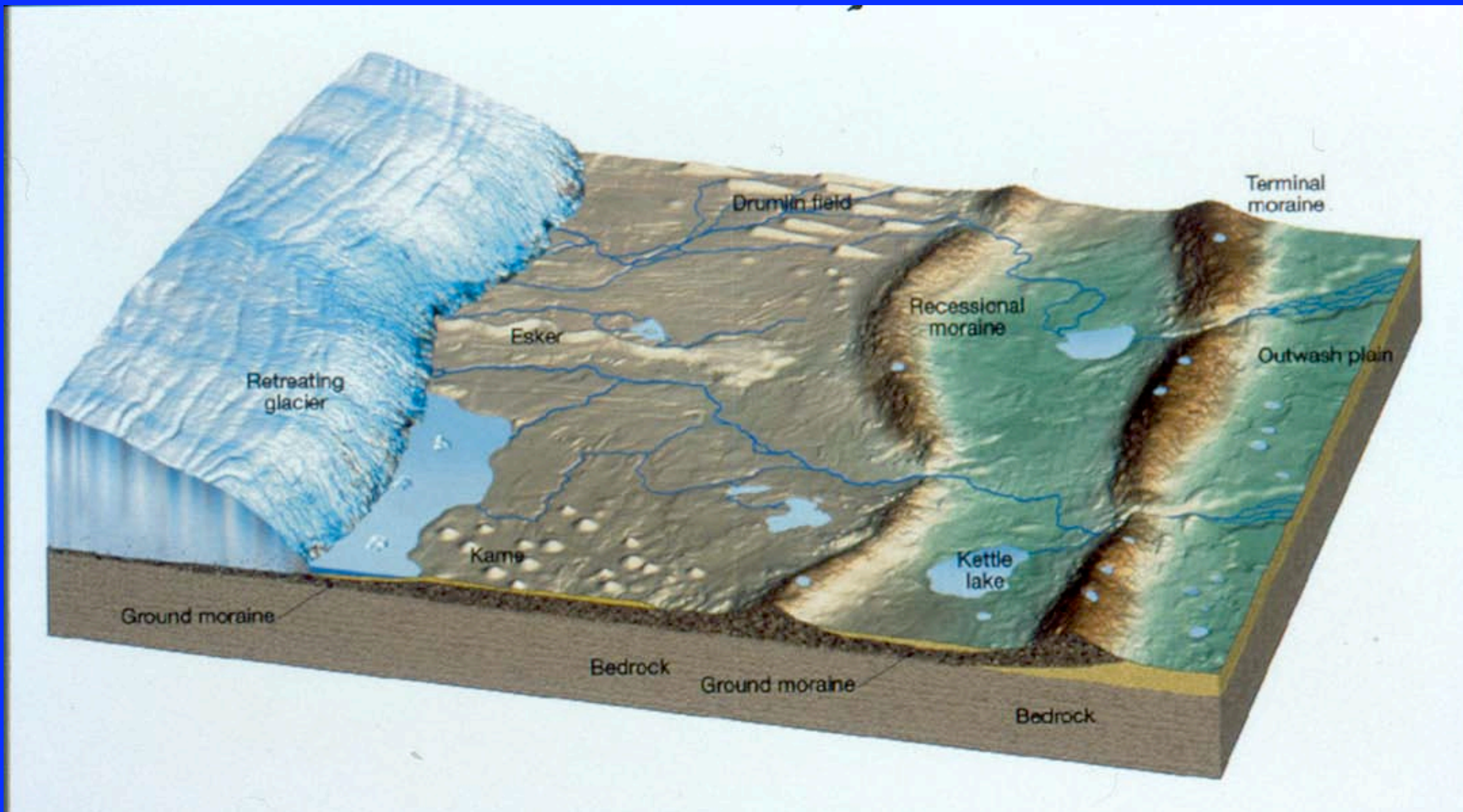



0°
R/V NATHANIEL
B. PALMER
R/V LAURENCE M.
GOULD
Weddell Sea
Palmer
Station
Larsen
Ice Shelf
Filchner
Ice
Shelf
East Antarctica
Ronne
Ice
Shelf
Shackleton
Range
Amundsen-Scott
South Pole Station
90° W
90° E
TRANSANTARCTIC MOUNTAINS
West Antarctica
Vostok
Station
Marie
Byrd
Land
Siple Coast
Ross
Ice
Shelf
Dry Valleys
Ross Sea
McMurdo
Station
R/V NATHANIEL B. PALMER
USCG Icebreaker
180°

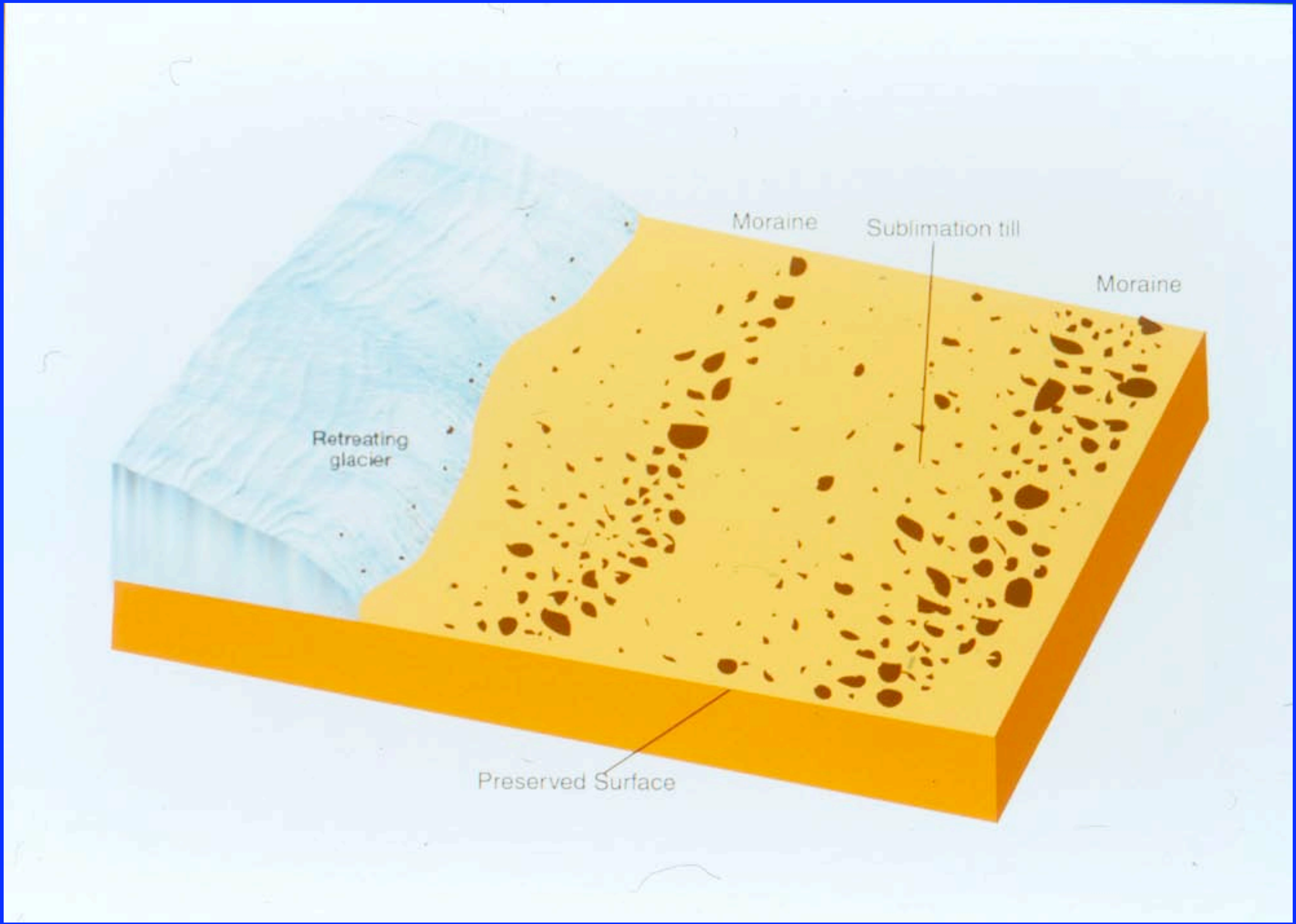
The Dry Valleys: A Hyper-Arid Cold Polar Desert

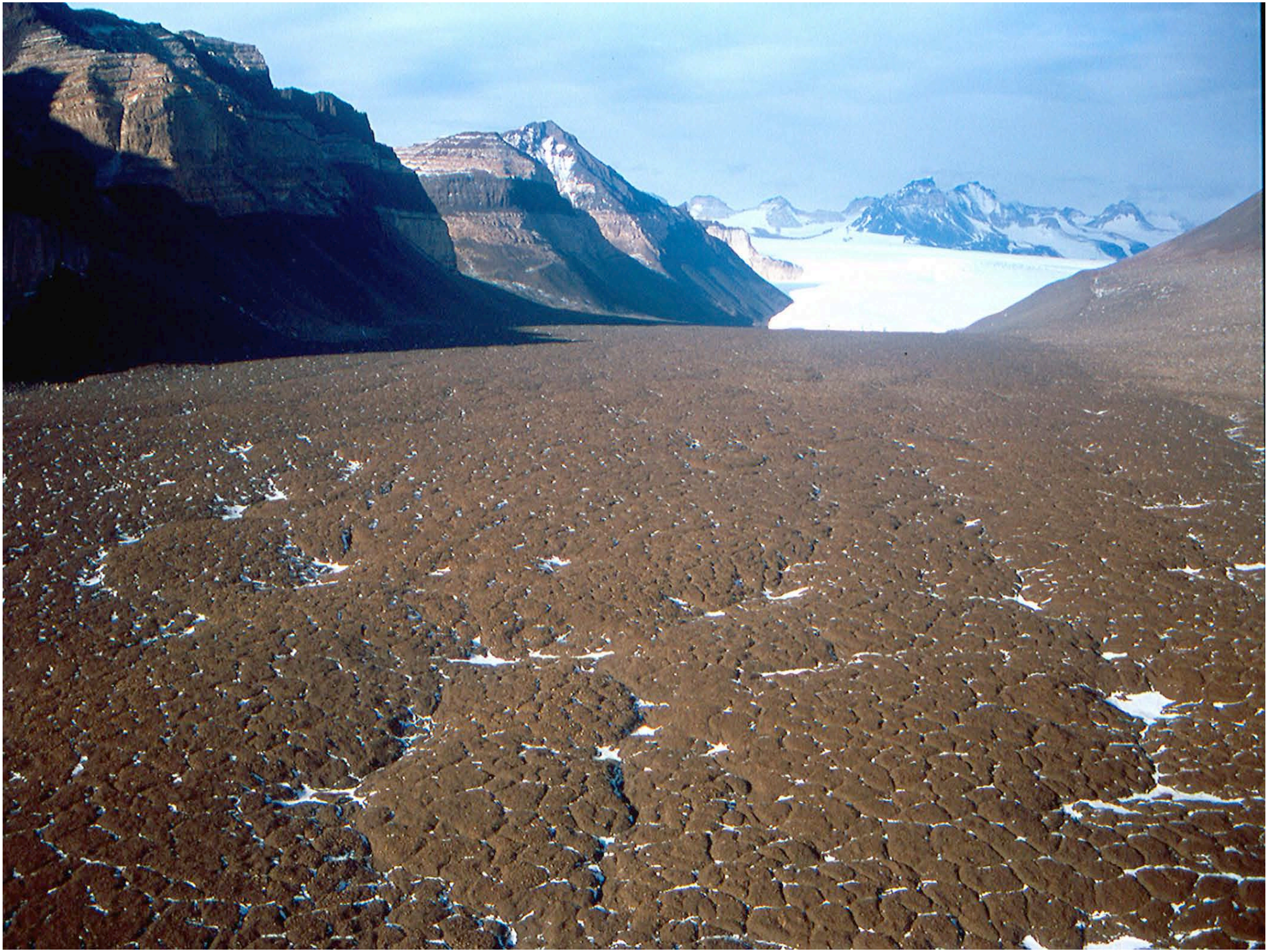


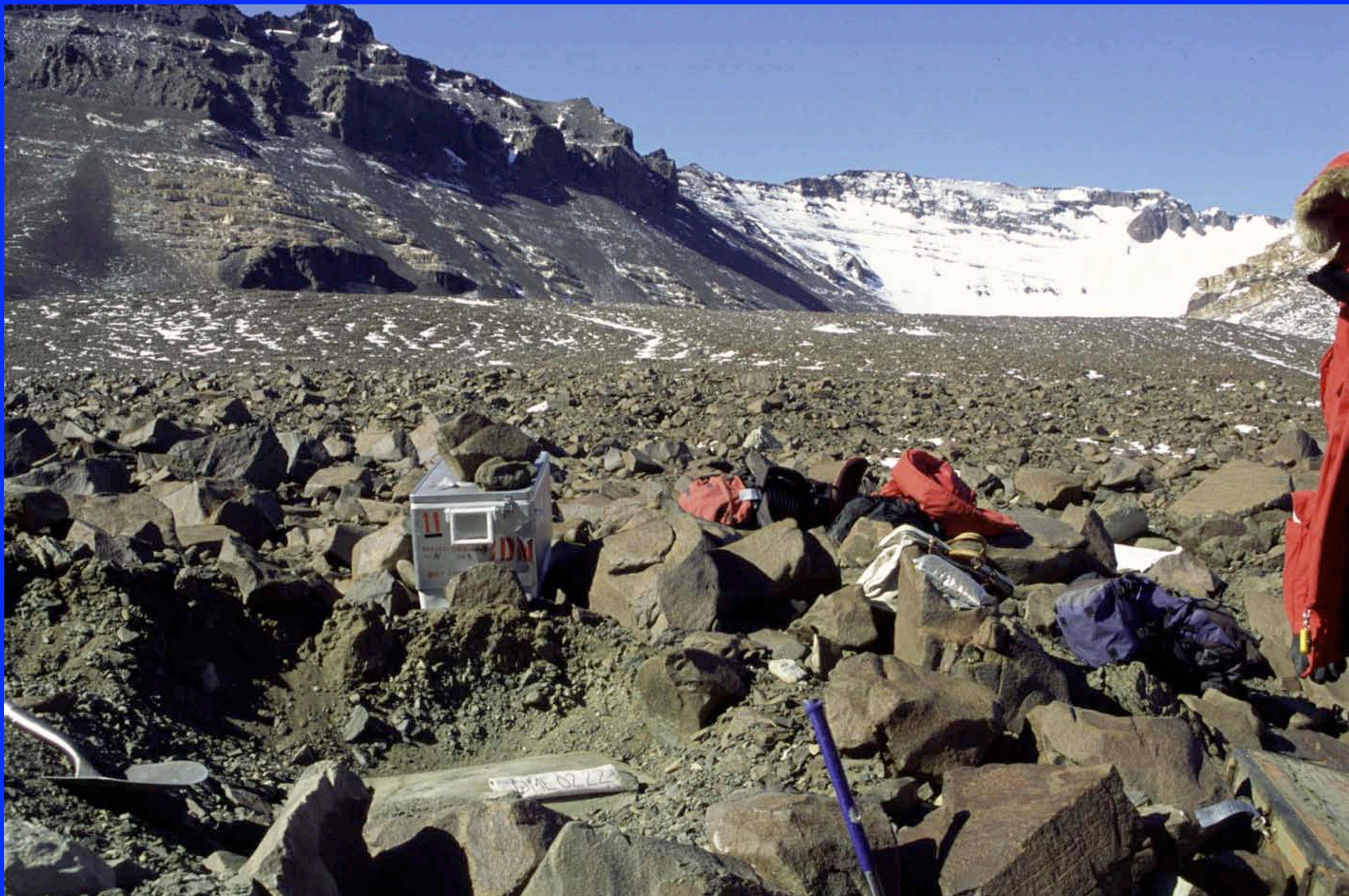
Temperate Wet-Based Glaciers

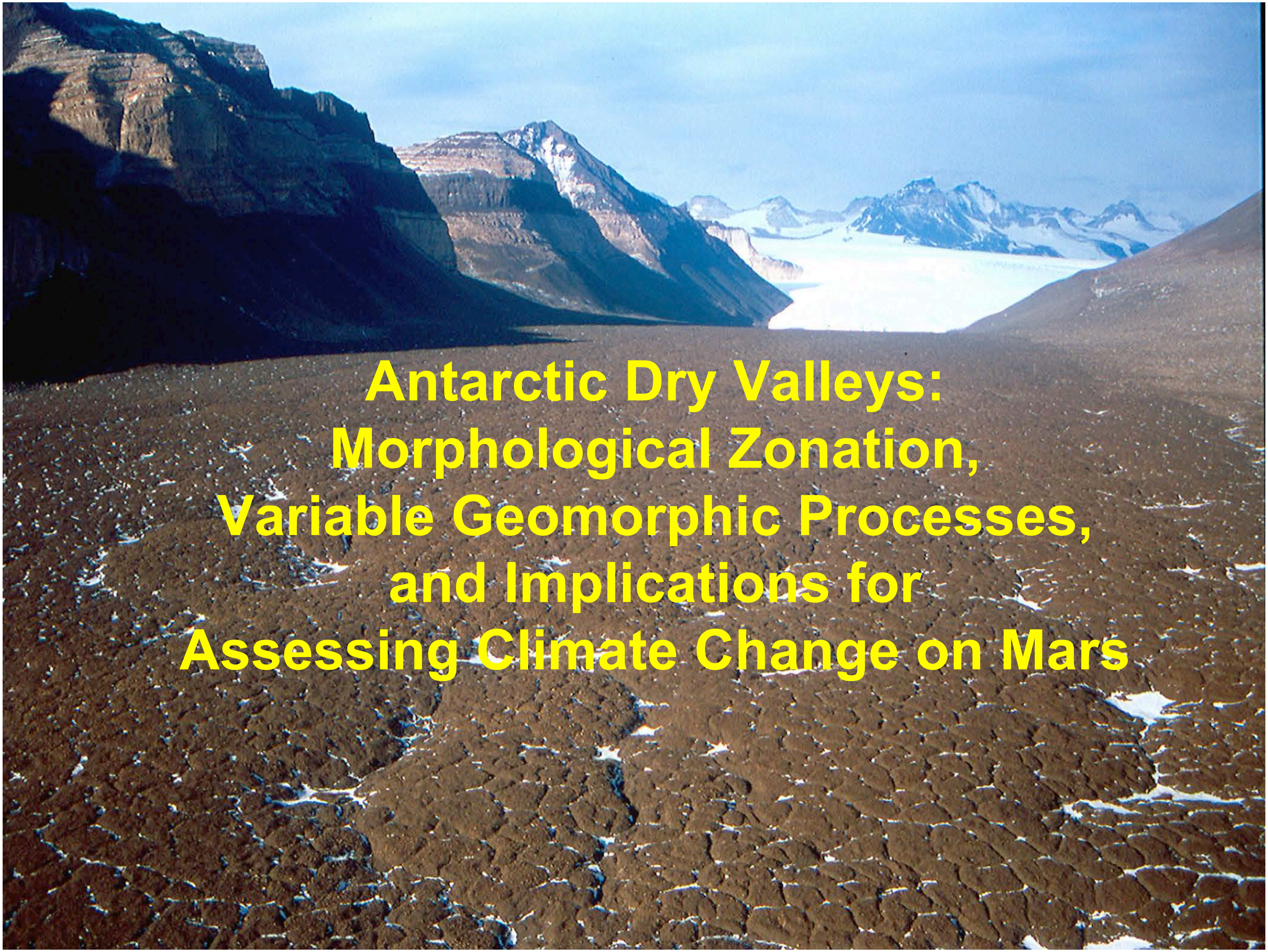


Cold-Based Glaciers



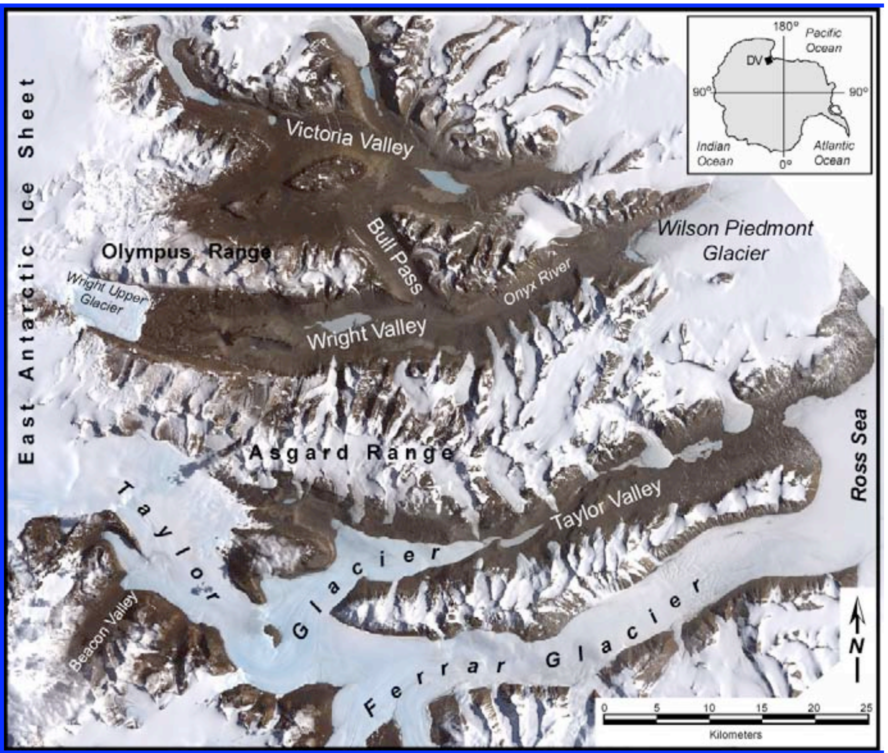





Antarctic Dry Valleys:
Morphological Zonation,
Variable Geomorphic Processes,
and Implications for
Assessing Climate Change on Mars

Antarctic Dry Valleys

- 4000 km^2; Mountain topography
  - (2800 m relief).
- Coldest, driest desert on Earth.
- Mean annual temperature: -20^o C.
- Mean annual snowfall (CWV):
  - Min. = <0.6 cm; Max. = 10 cm.
  - Fate of snow: Sublimate or melt.
- A hyperarid cold polar desert.



- Topography controls katabatic wind flow:
  - Funneled through valleys, warmed by adiabatic compression.
  - Enhances surface temperatures, increases sublimation rates of ice and snow.
- Bedrock topography governs local distribution of snow and ice:
- Biology sparse: ~1 mm “Antarctic mite”; microscopic nematodes.
- Environment very useful for understanding Mars climate change.

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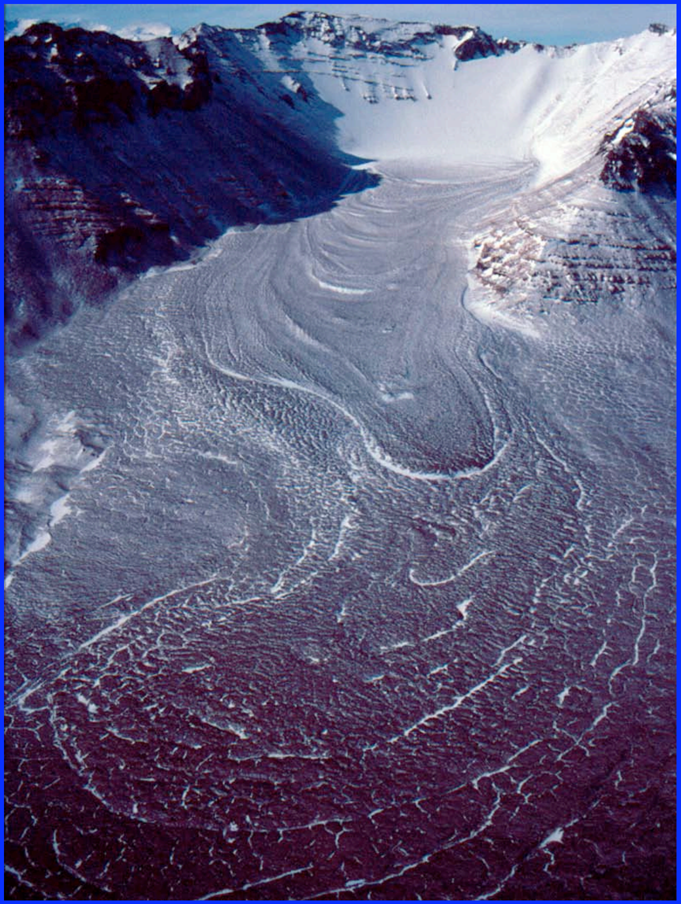

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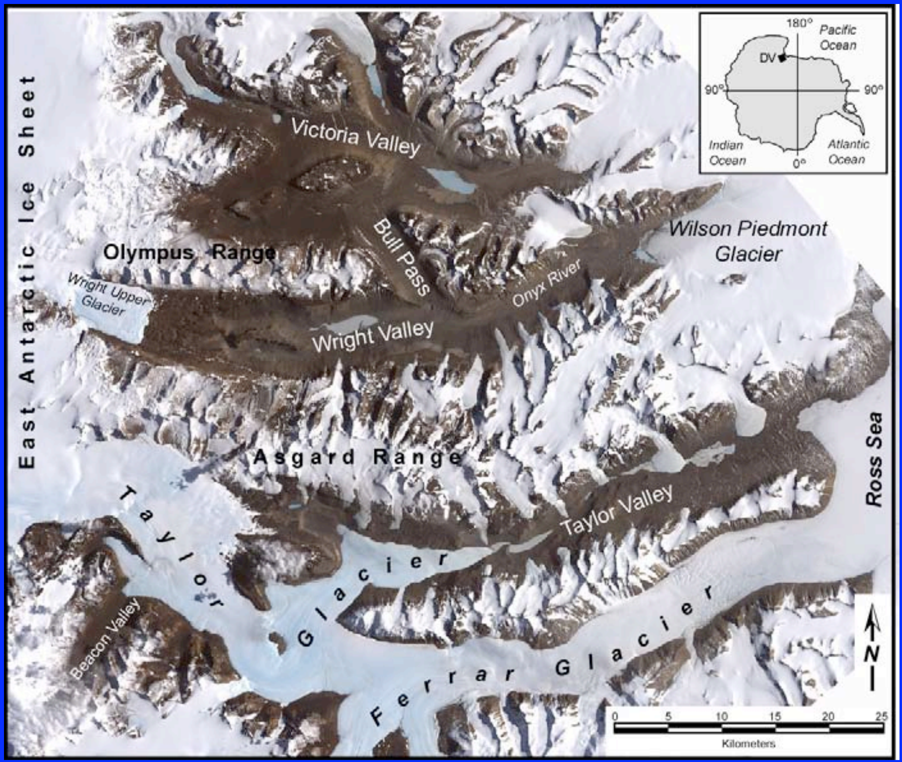
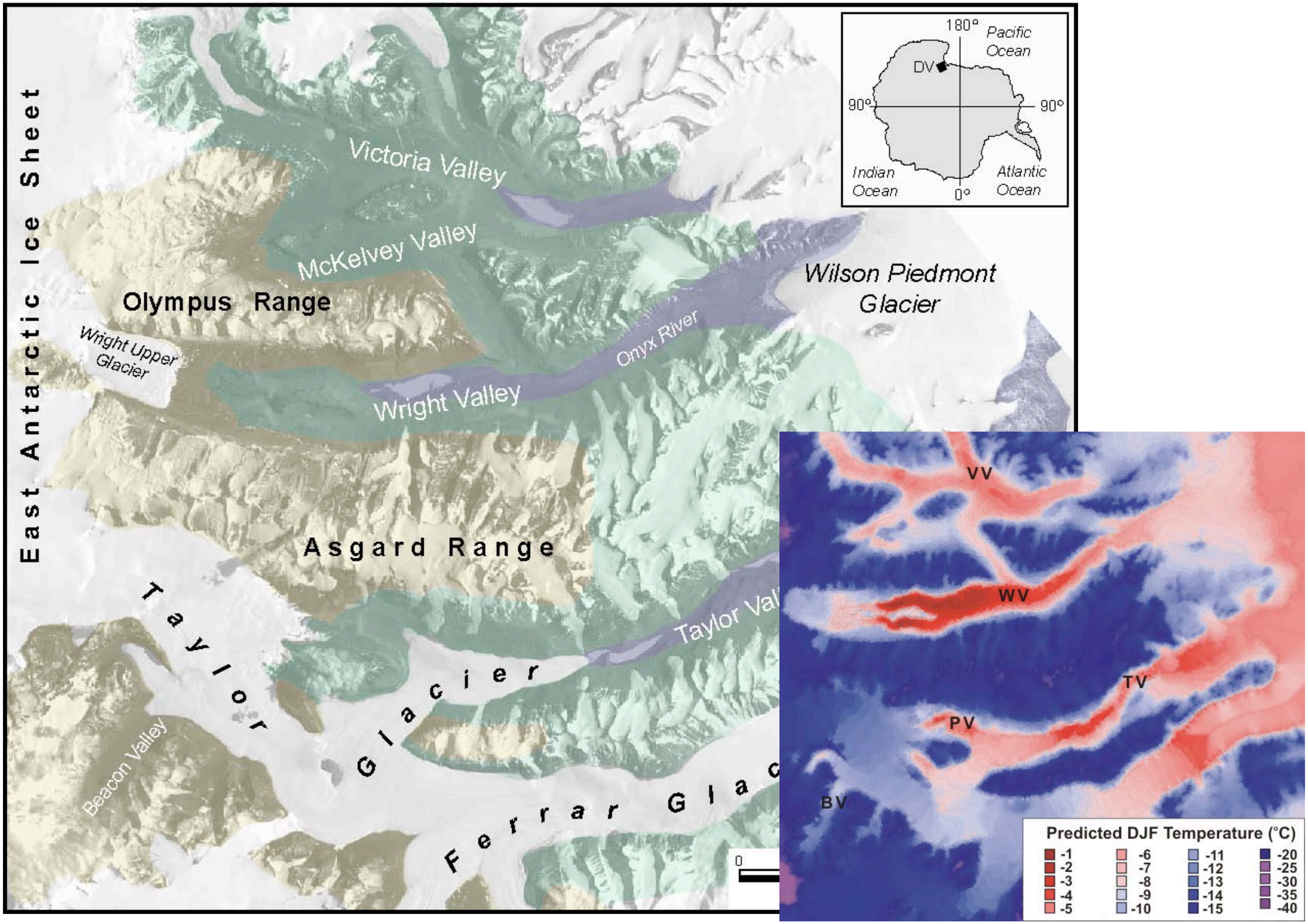
Antarctic Dry Valleys



- Hyperarid cold polar desert.
- But, significant variations within this climate.
- These variations involve small but important differences:
  - Annual surface temperature (meltwater).
  - Relative humidity.
  - Soil moisture (and type of subsurface ice).
- We have defined three different microclimate zones within the Antarctic Dry Valleys.
- These are useful for understanding Mars climate change.

Microclimate Zones

Upland frozen zone *Inland mixed zone* *Coastal thaw zone*



Distribution of surface meltwater

No traditional "active layer"
No seregation ice
Regions with soil moisture < 3%

< -30 C to -35 C

Upland Frozen Zone

Discontinuous A. L.
Ice and sand wedges
Soil moisture variable

-20 C to -27 C

Inland Mixed Zone

Dynamic Active Layer with
segregation ice and wedges
Soil moisture ~ 30 to > 50%

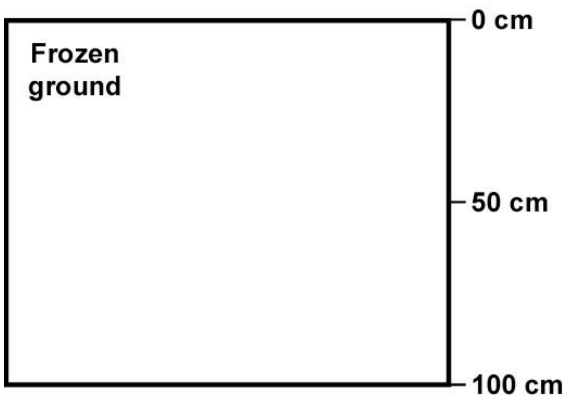
-14 C

Coastal Zone

Origins of subsurface ice?

Distribution of surface meltwater

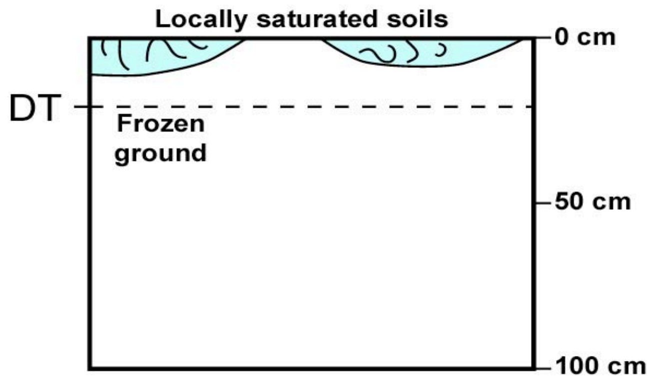
No traditional active layer
No segregation ice
soil moisture <3%



-8°C (<-30 C)

Upland frozen zone

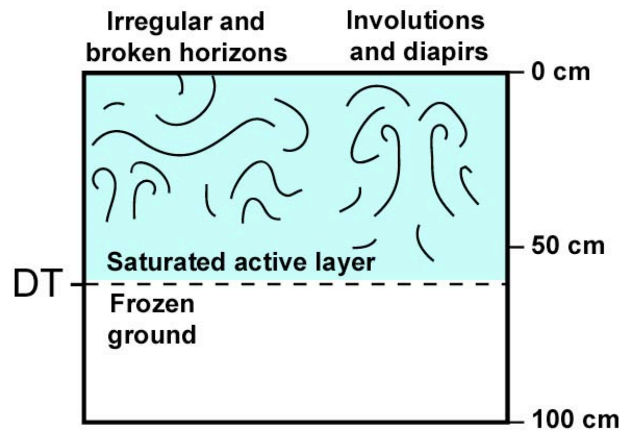
Discontinuous A. L.
sand wedges
Soil moisture
variable



-4°C (-22 C)

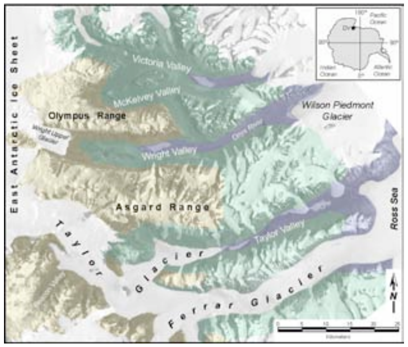
Inland mixed zone

Dynamic active layer with
segregation ice and wedges
Soil moisture ~30 to >50%



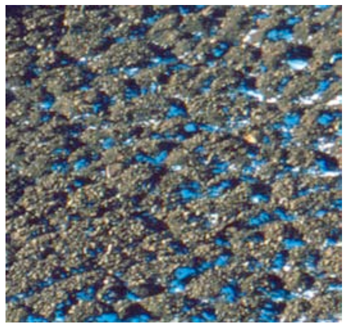
-2°C (-14°C)

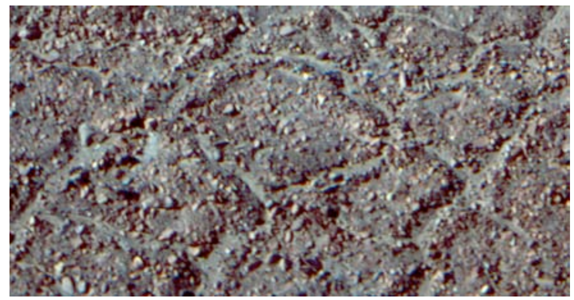
Coastal thaw zone

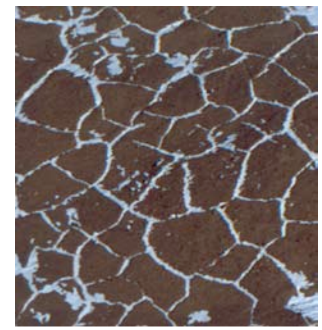


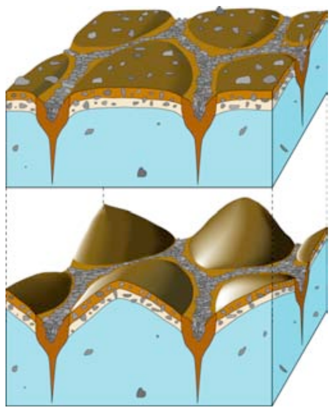
POLYGONS

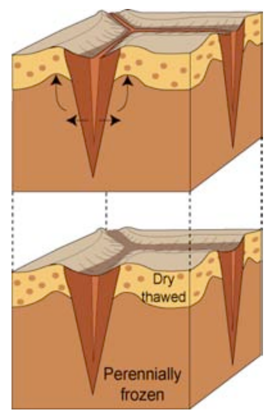
Upland frozen zone | *Inland mixed zone* | *Coastal thaw zone*

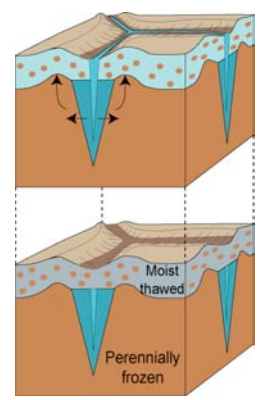








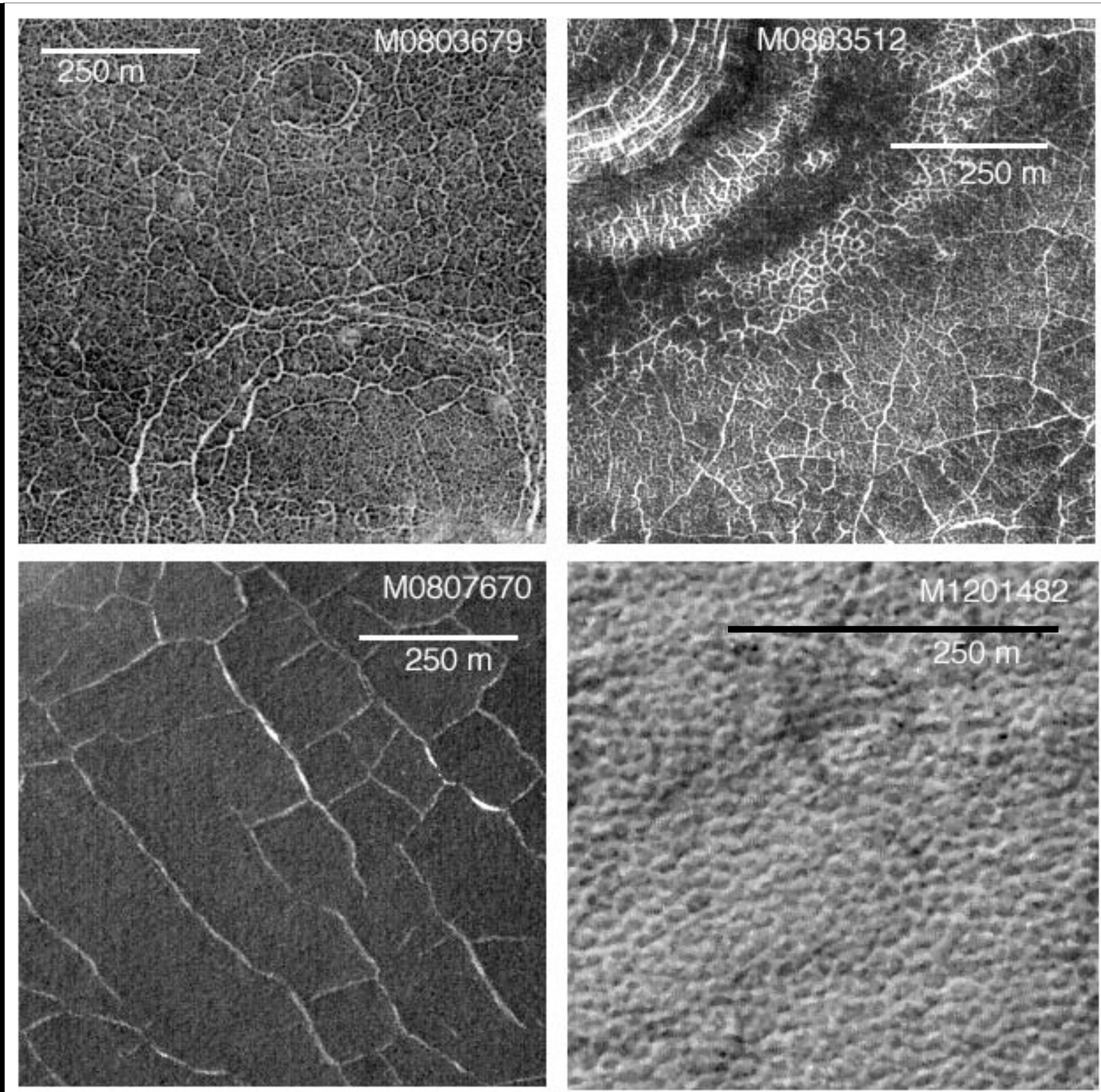




Sublimation

Sand-wedge

Ice wedge



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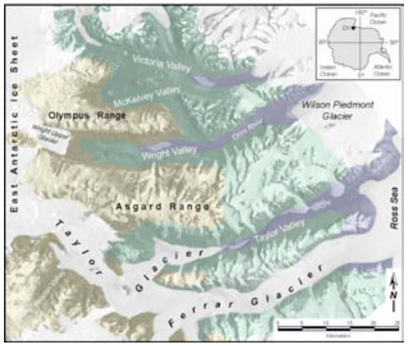
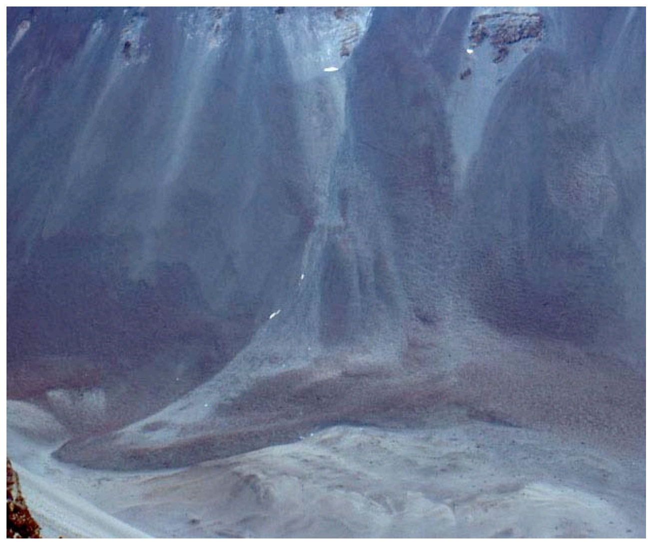


Viscous-flow features

Upland frozen zone | *Inland mixed zone* | *Coastal thaw zone*

Debris-covered glaciers



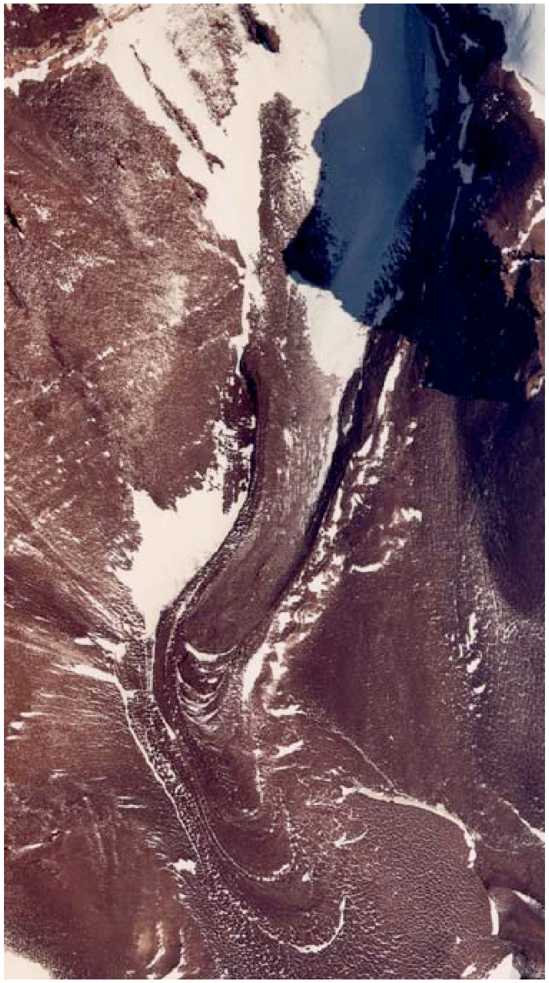
Gelifluction lobes

Solifluction lobes

Applications to Mars

Debris covered glaciers as analogs for viscous flow features on interior of Crater walls

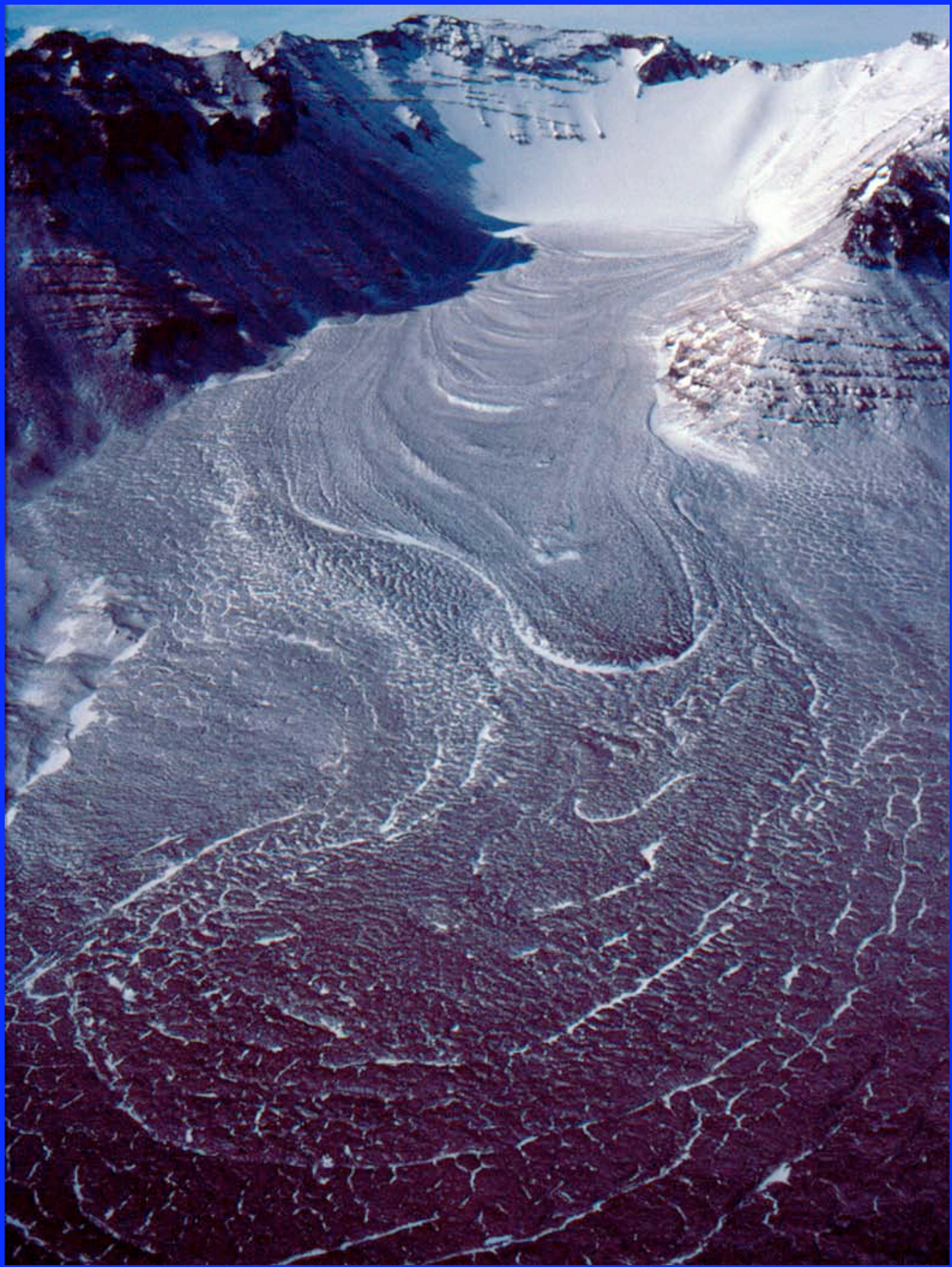
Crater wall
248 W/ 36 S   M04/02881



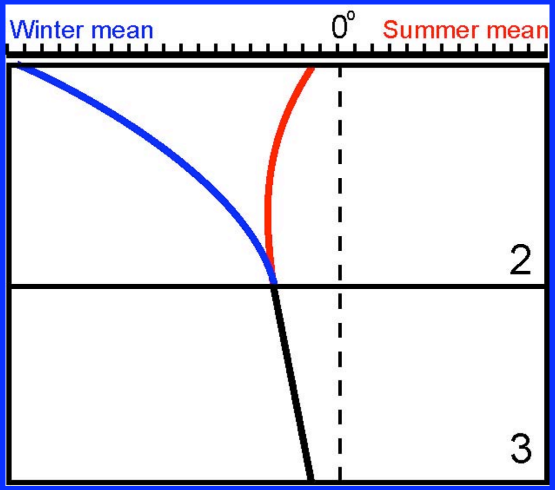
161 E / 78 S

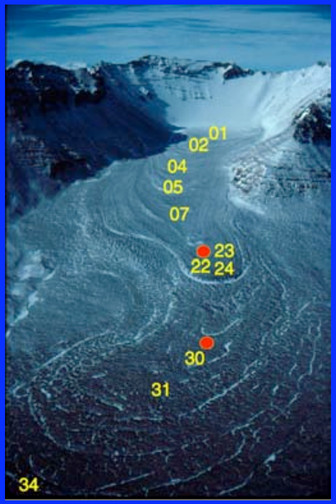
Crater wall
247 W / 38 S M18/00898

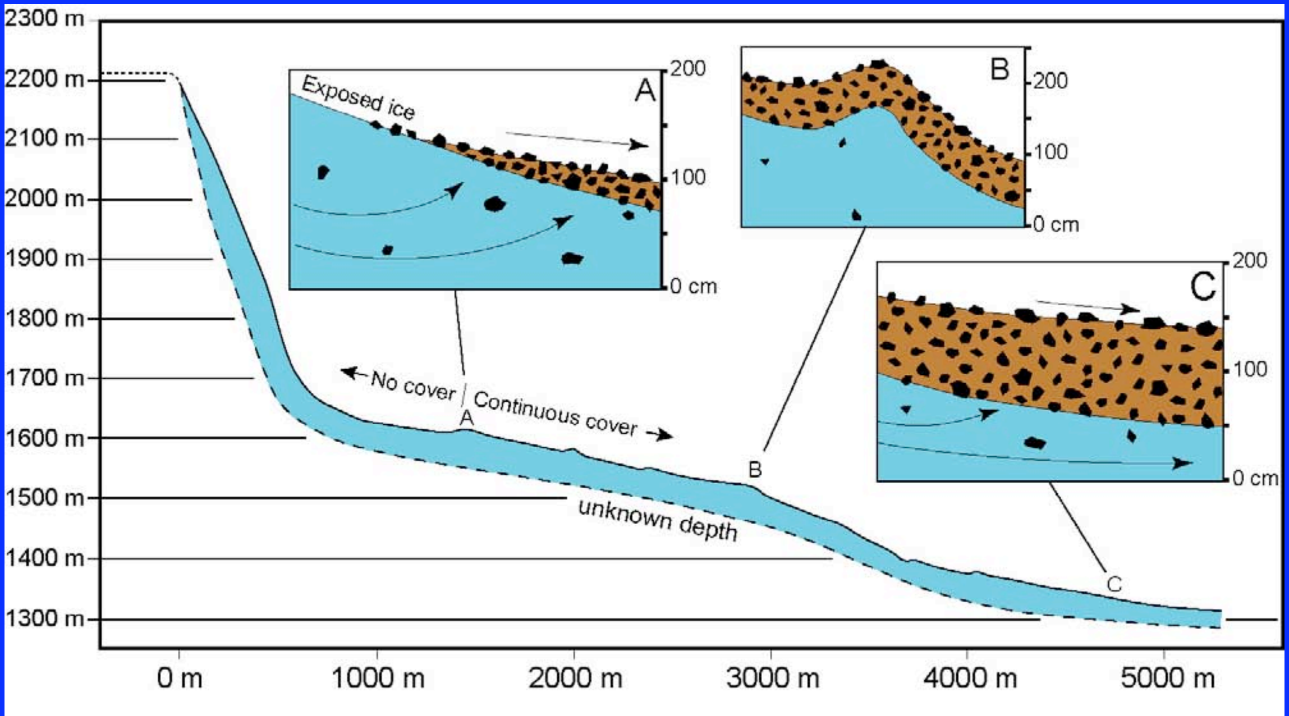
Mullins
Debris-Covered Glacier, Beacon Valley, Antarctica



Origin of debris-covered glaciers in upland zone

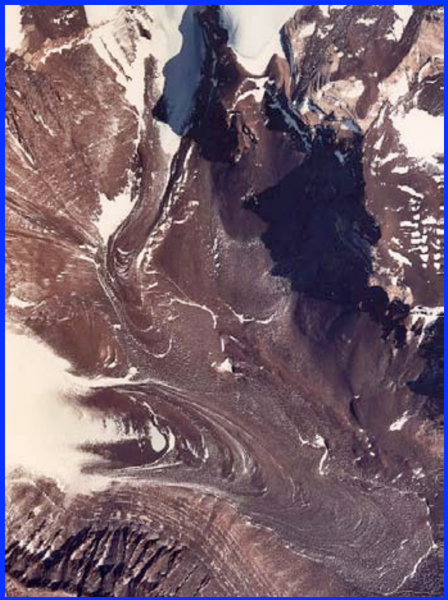




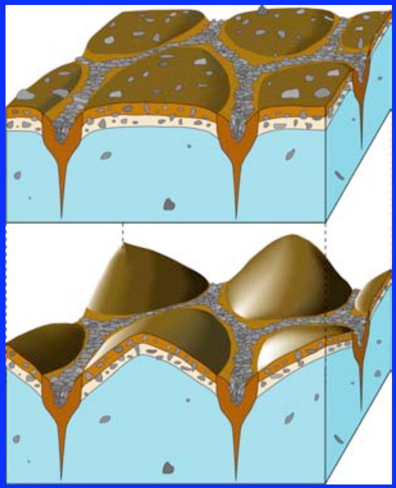


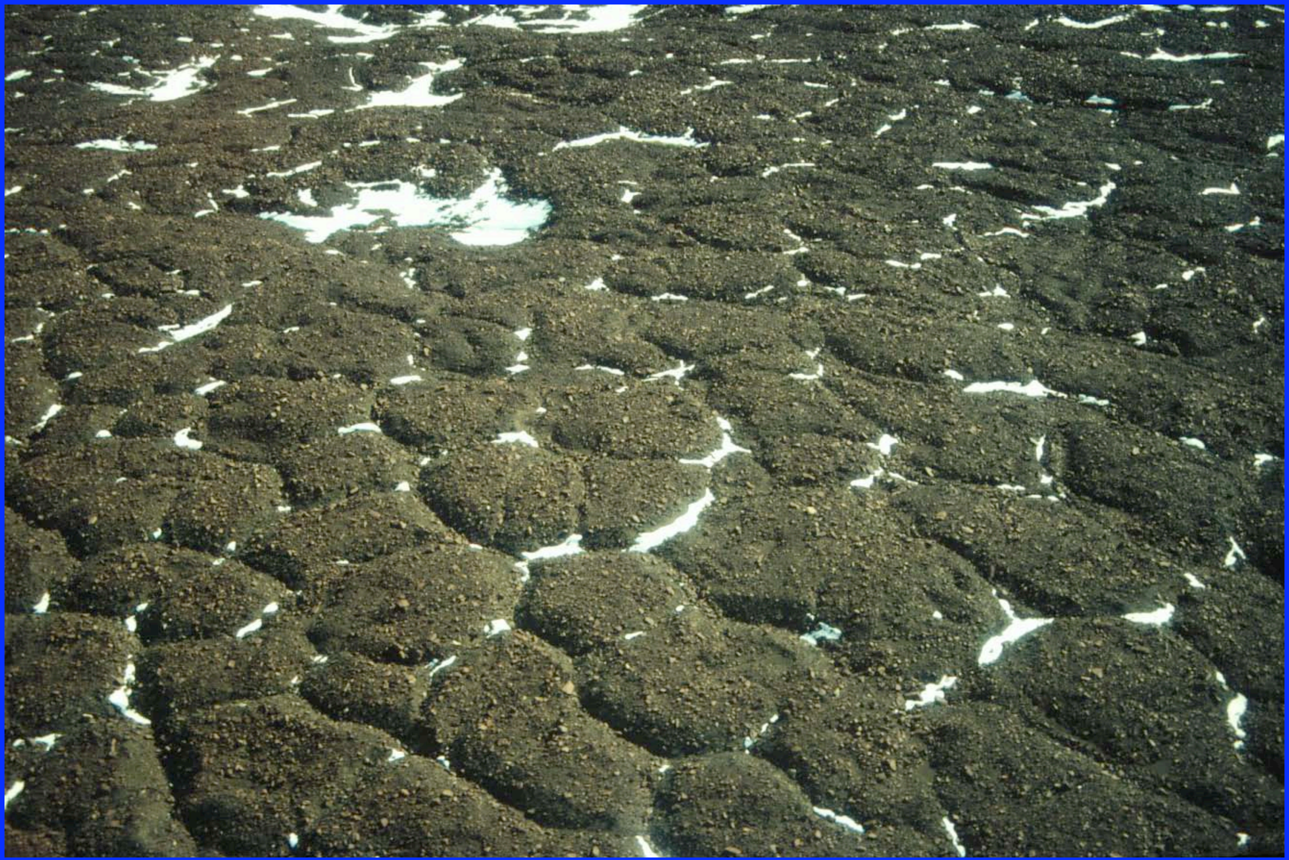
Protective lag of sublimation till

Fate of debris-covered glacier ice?

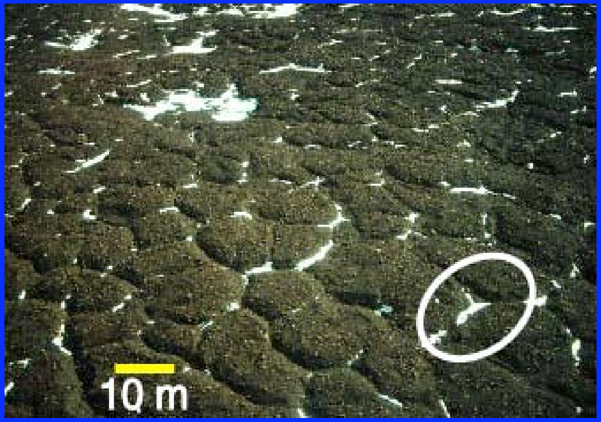


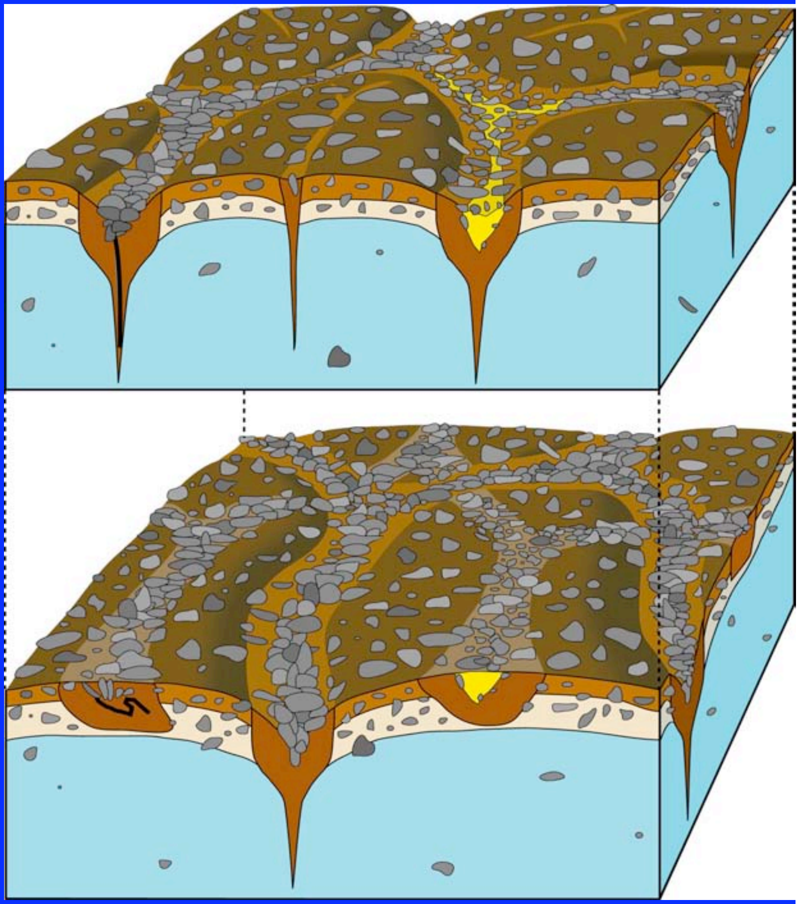
Sublimation Polygons





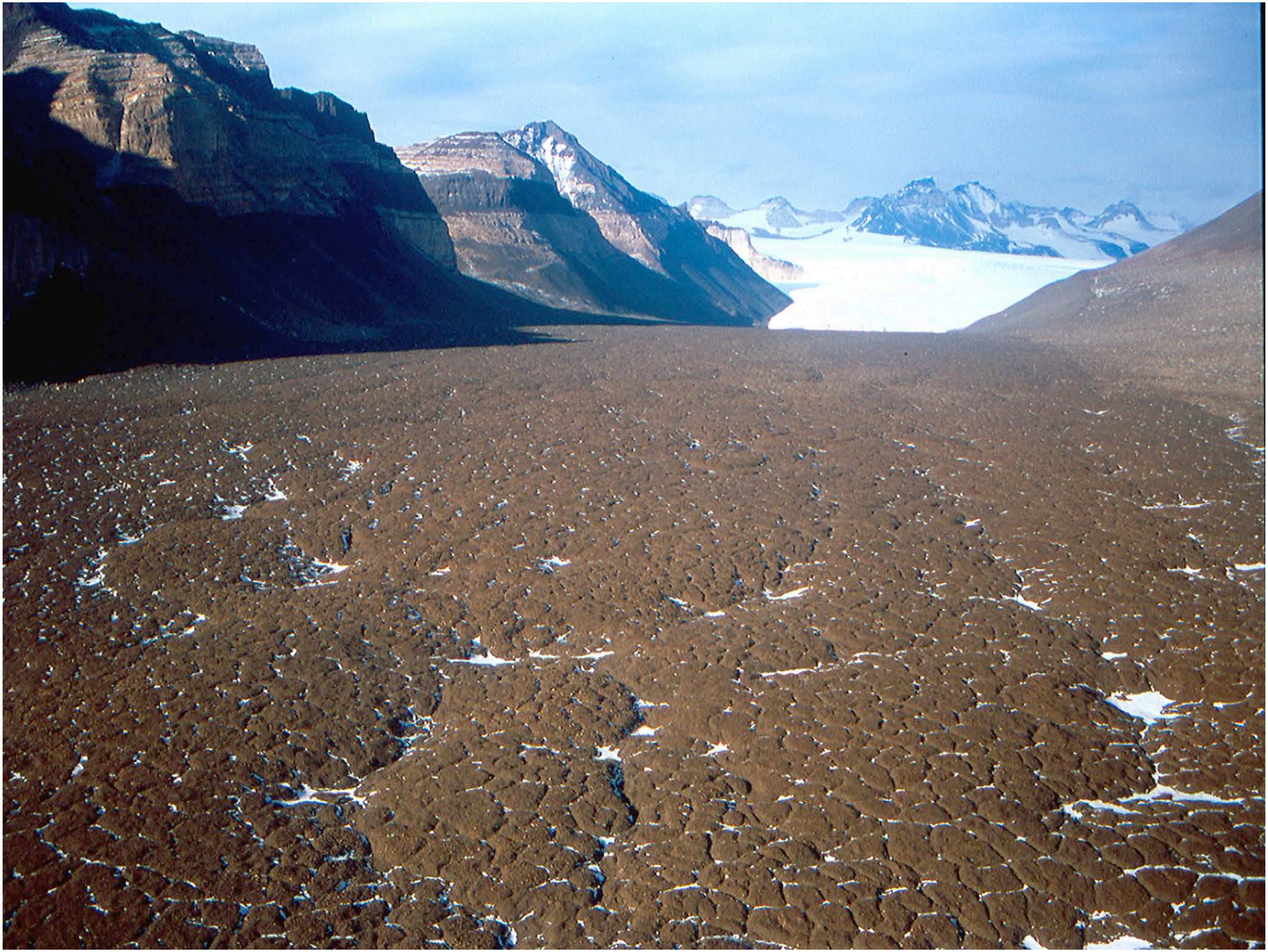
POLYGON AGE: in-situ ashfall





LU1017/EMS 98 13A/pkt. W   J = 0.00049301

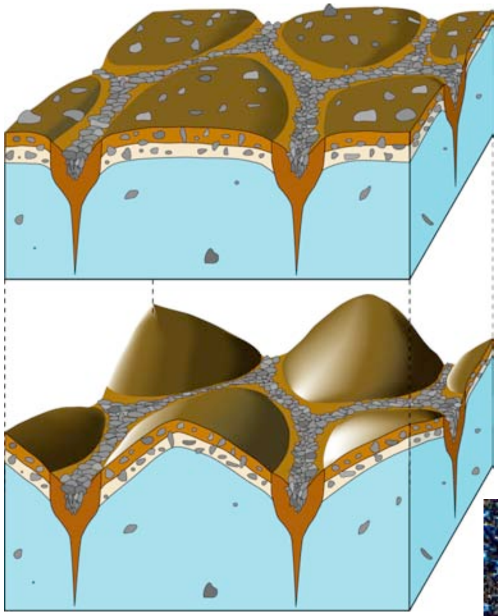
Grains	*Ar40/Ar39*	*Ar38/Ar39*	*Ar37/Ar39*	*Ar36/Ar39*	*Ar39 (moles)*	*% Ar40**	*Ar40*/Ar39K*	*Age (Ma)*	*Error (Ma)*
1	12.839	0.01792	0.0373	0.01448	3.11E-16	66.55	8.545	7.58	0.08
1	9.972	0.01284	0.0325	0.00422	2.89E-16	87.35	8.711	7.73	0.08
1	11.385	0.01565	0.0565	0.00996	2.99E-16	74.03	8.429	7.48	0.07
2	9.148	0.02338	0.0433	0.00152	5.21E-16	94.93	8.685	7.71	0.08
2	13.401	0.01518	0.0410	0.01518	3.03E-16	66.41	8.900	7.90	0.08
2	10.557	0.01518	0.3368	0.00626	4.56E-16	82.56	8.719	7.74	0.06
								7.69	0.10

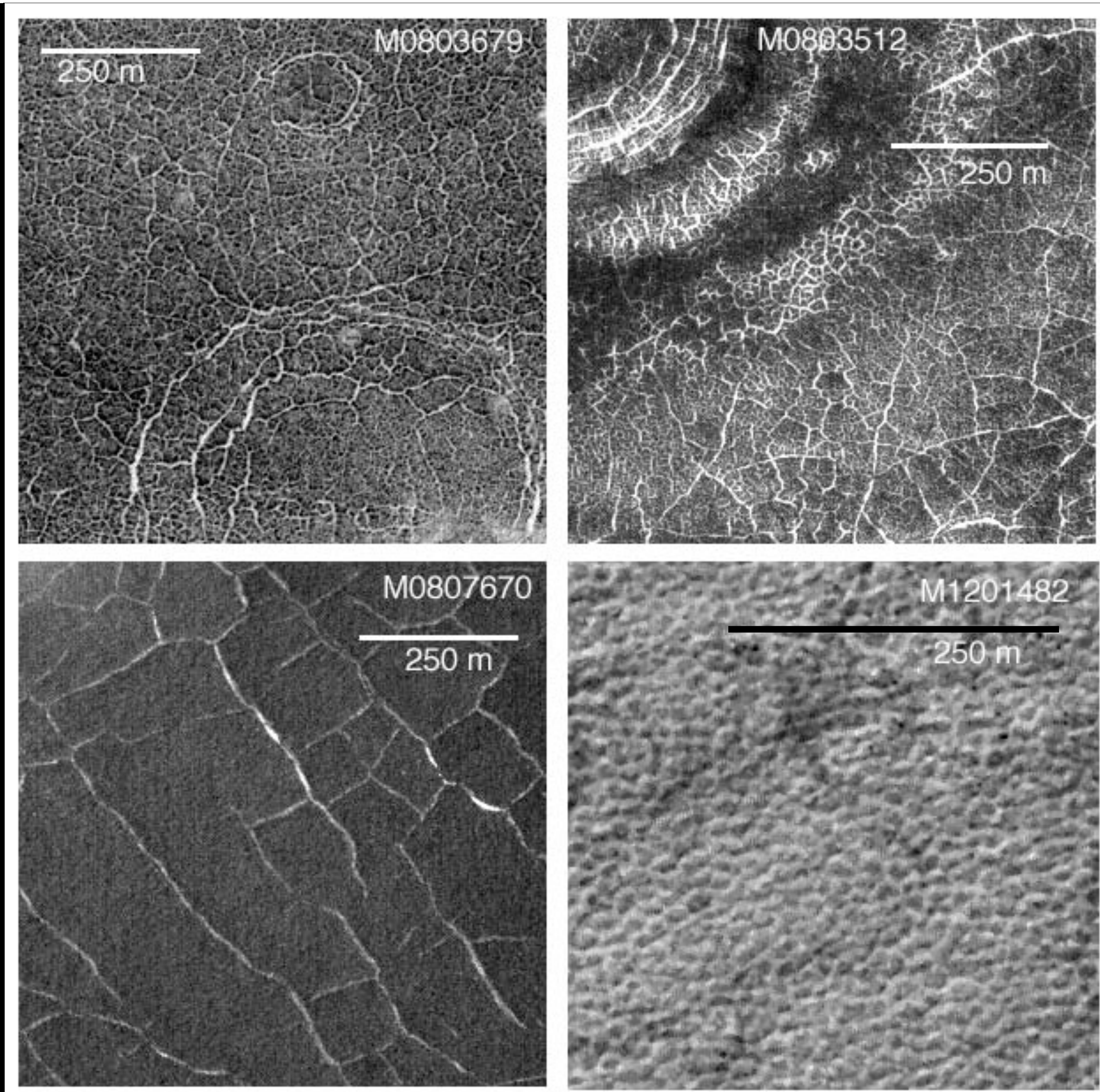




Applications to Mars

Sublimation polygons as an analog for basketball-textured terrain on Mars





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Applications to Mars

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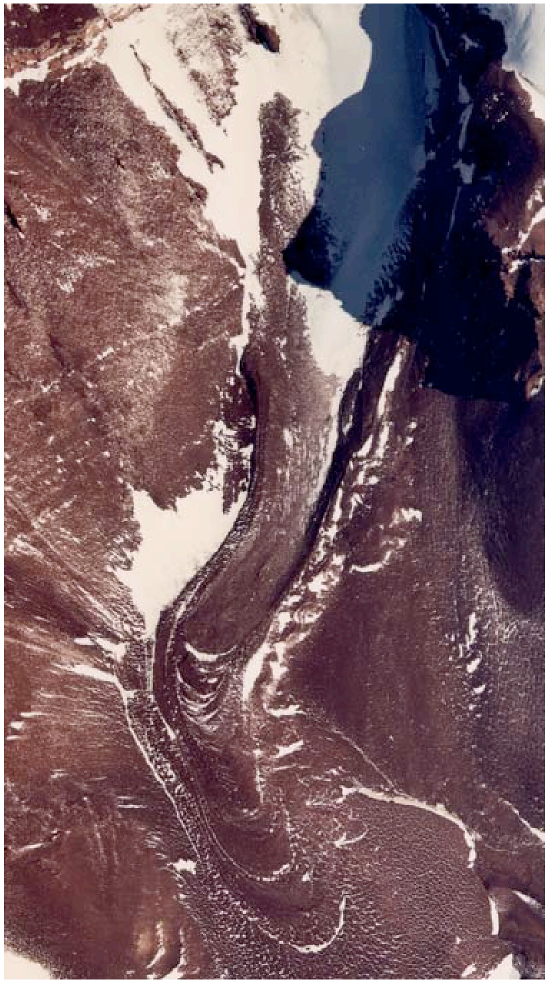
248 W/ 36 S   M04/02881

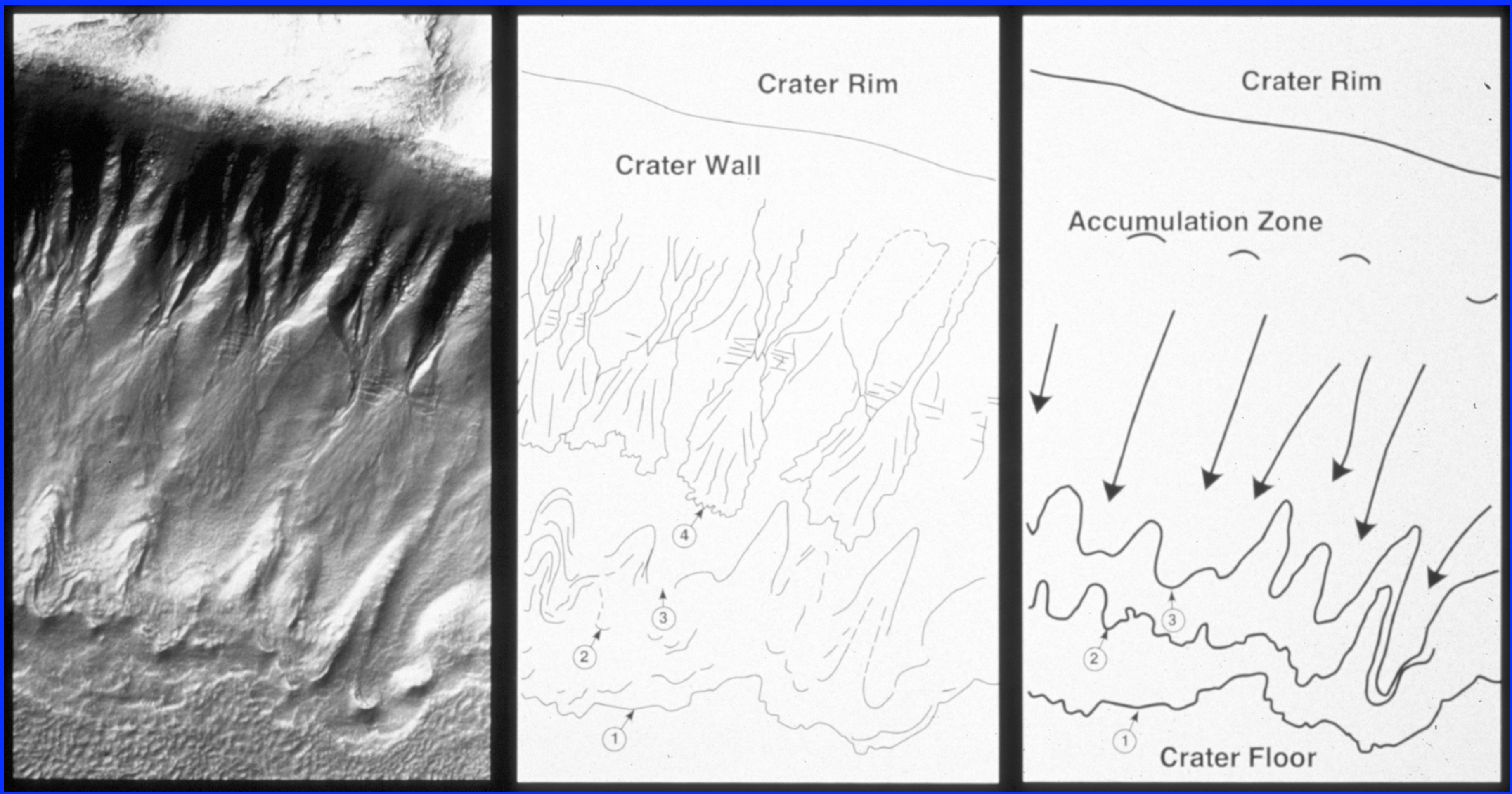


161 E / 78 S

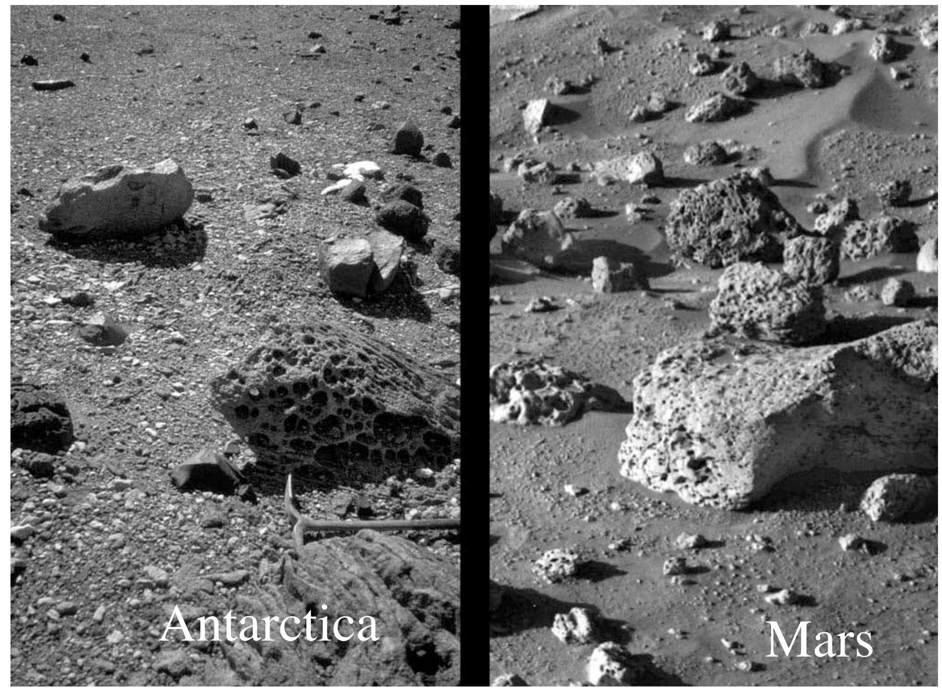
Crater wall
247 W / 38 S M18/00898

OBLIQUITY VARIATIONS AND CLIMATE CHANGE ON MARS

History of Climate Change of Mars: Superposed Geomorphological Climate Indicators



Rock Weathering In Antarctica and Mars



Key Issues in Antarctic Dry Valley Geoscience

- Age of landscapes, surfaces and weathering rates.
- Modes of rock weathering and soil formation.
- Stability of microclimate zones; effects of global warming.
- Debris-covered alpine glaciers: Formation and evolution.
- Sublimation till: Modes of formation and evolution.
- Role of sublimation till in inhibiting vapor diffusion, ice loss.
- Age of ancient ice in subsurface: Oldest ice on Earth?
- Analysis of ancient climate record in buried ice.
- Polygon origin and evolution.
- Implications for Antarctic and global climate change.
- Provide clues to map changing climate on Mars.
- Exobiological studies on Earth, application to Mars.

Sampling for life detection in extreme environments: Antarctic Dry Valleys

- **Buried ice ancient microbial communities:**
  - Paul Falkowski and Kay Bidle, Rutgers.
- **Lipid biomarkers and isotopic ratios from soil profiles:**
  - Yongsong Huang, Brown University.
- **Amino Acid Racemization (AAR):**
  - Alexander Tsapin (JPL)
- **Molecular biological and Limulus Amebocyte Lyste (LAL) Analyses:**
  - Rebecca Gast, WHOI.
- **Ribosomal RNA:**
  - Linda Amaral Zettler, MBL.

The Dry Valleys: A Hyper-Arid Cold Polar Desert