

Mars Lander 2007



The Phoenix Mission

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Jet Propulsion Laboratory/California Institute of
Technology

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Outline

- Phoenix Science Goals
- Spacecraft and Instrumentation
- Landing site, landing, and celebration!
- Highlights of the Mission
 - Lander view of Mars
 - Digging and Sampling
 - Weather

Launched: Aug 4, 2007

Landed: May 25, 2008

Operated: May 25 - Nov 2, 2008





Phoenix Goals

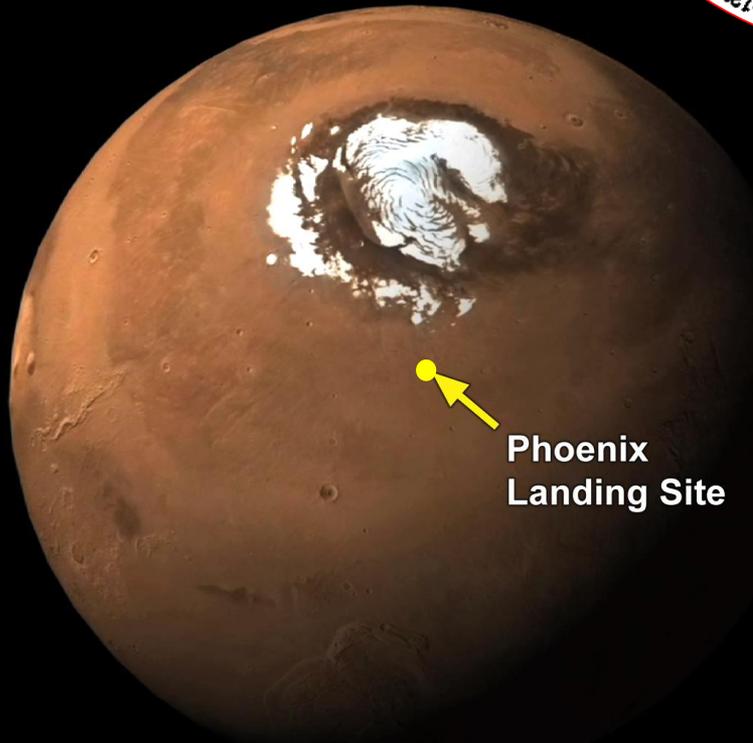
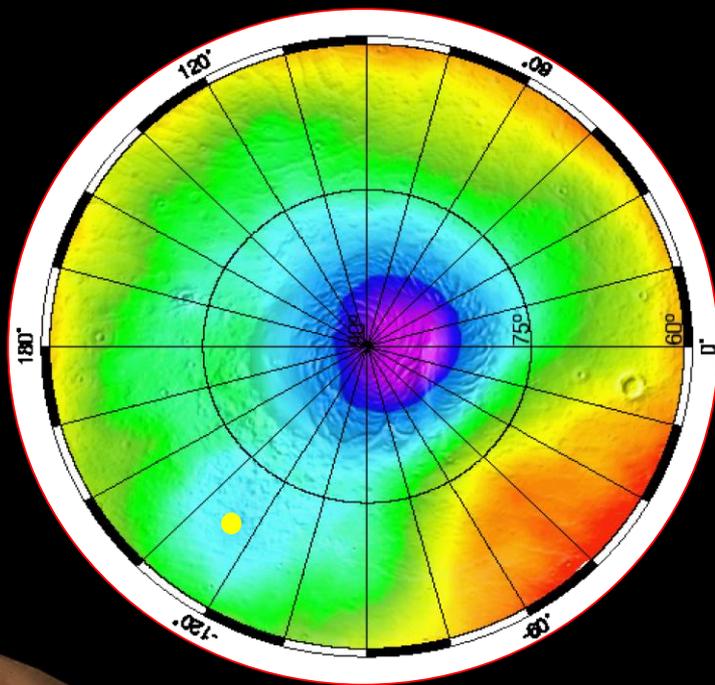
Goal #1: Study the history of and current state of water

- Was there past liquid water?
- Does unfrozen water exist today?
- What processes shape the surface?
- What is the amount and state of water in the atmosphere?
- How much water is in the surface vs. the atmosphere?

Goal #2: Search for habitable zones (not life detection)

- Are there organics in the soil and do they vary with depth?
- Are there other elements of relevance to biology (C, H, O, S)?
- Can unfrozen water layers exist?
- Is the soil acidic or alkaline?

2002 - Odyssey detects subsurface H, presumably in the form of H₂O



Phoenix
Landing Site



Phoenix
68°N 233°E



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Phoenix: Reborn from 2 previous spacecraft

1998 Mars Polar Lander



2001 Mars Lander Spacecraft



Phoenix



Surface Stereo Imager

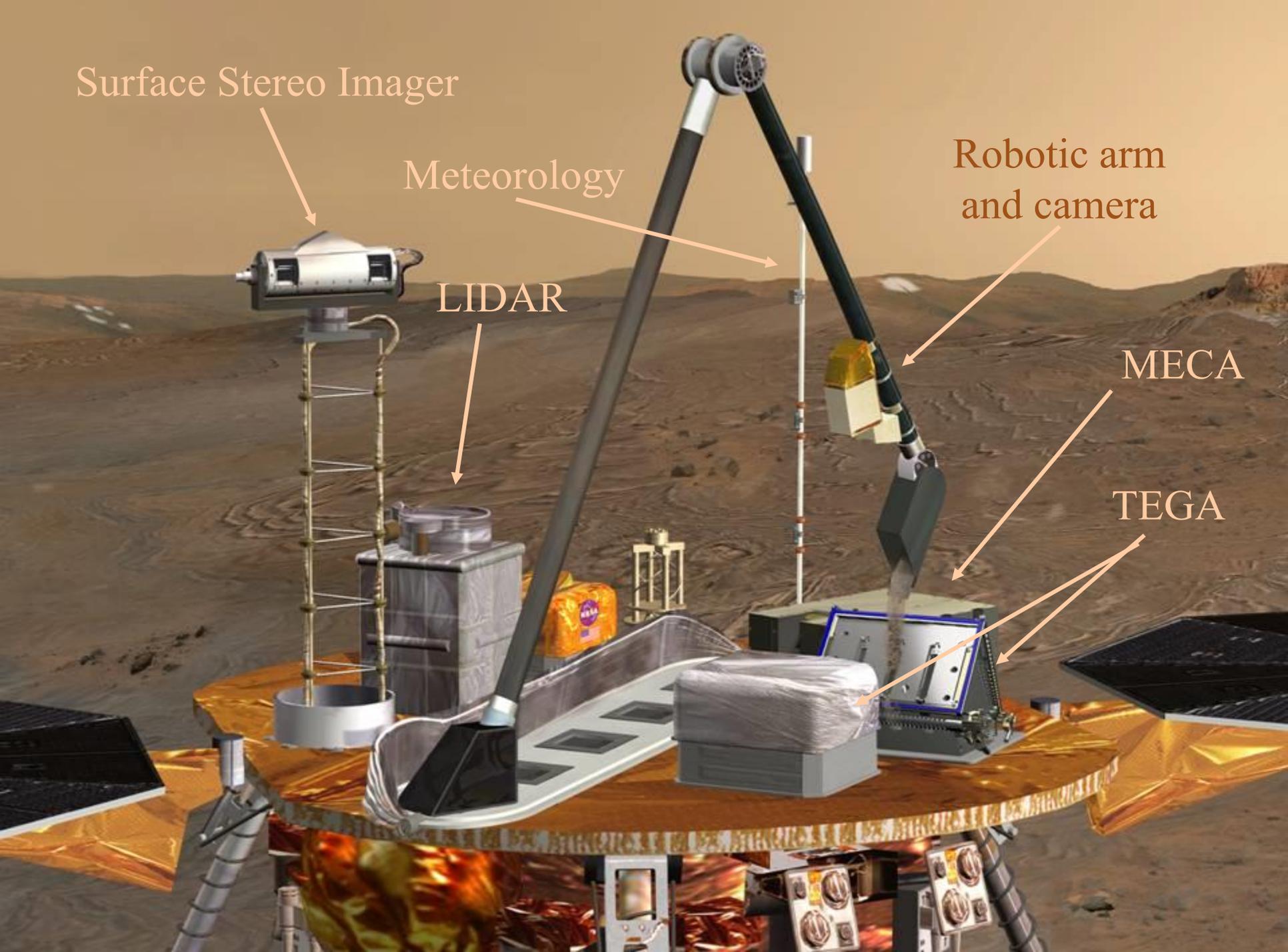
Meteorology

Robotic arm and camera

LIDAR

MECA

TEGA





Outline

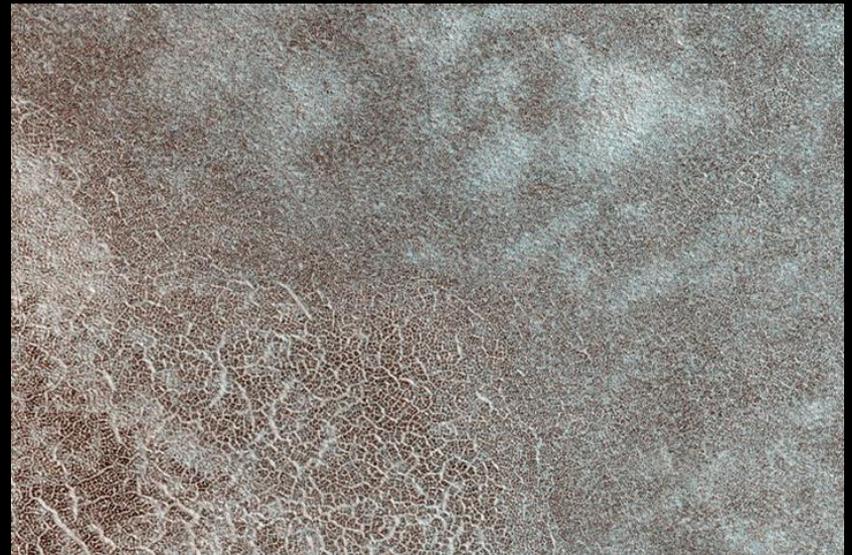
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An ice-rich landing site



Antarctic Dry Valleys

Mars Reconnaissance Orbiter





Landing Day





First view of the Martian northern plains





360° view around the lander





The search for ice





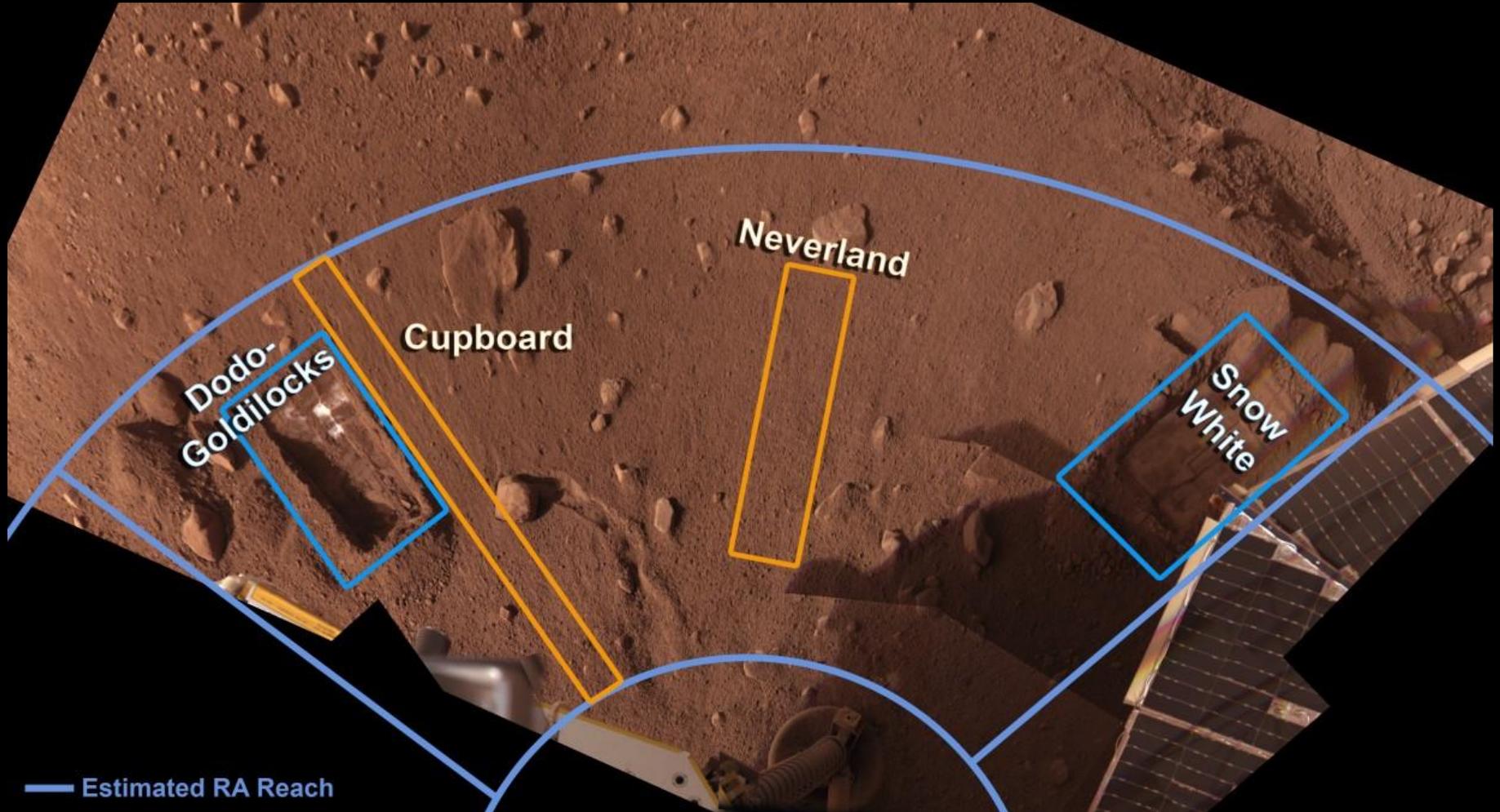
The search for ice

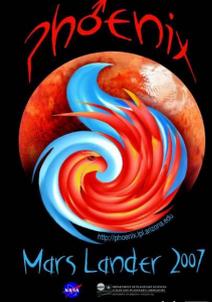


Holy Cow!



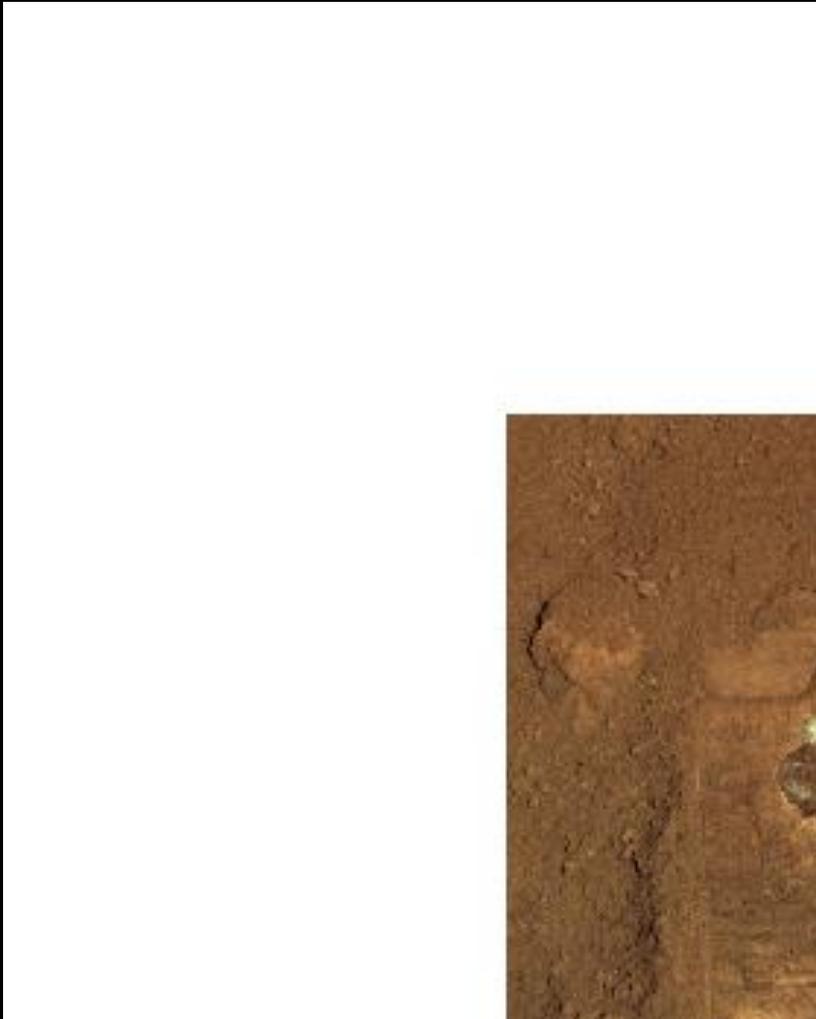
Digging areas





More in the search for ice

“Dodo-Goldilocks” Trench

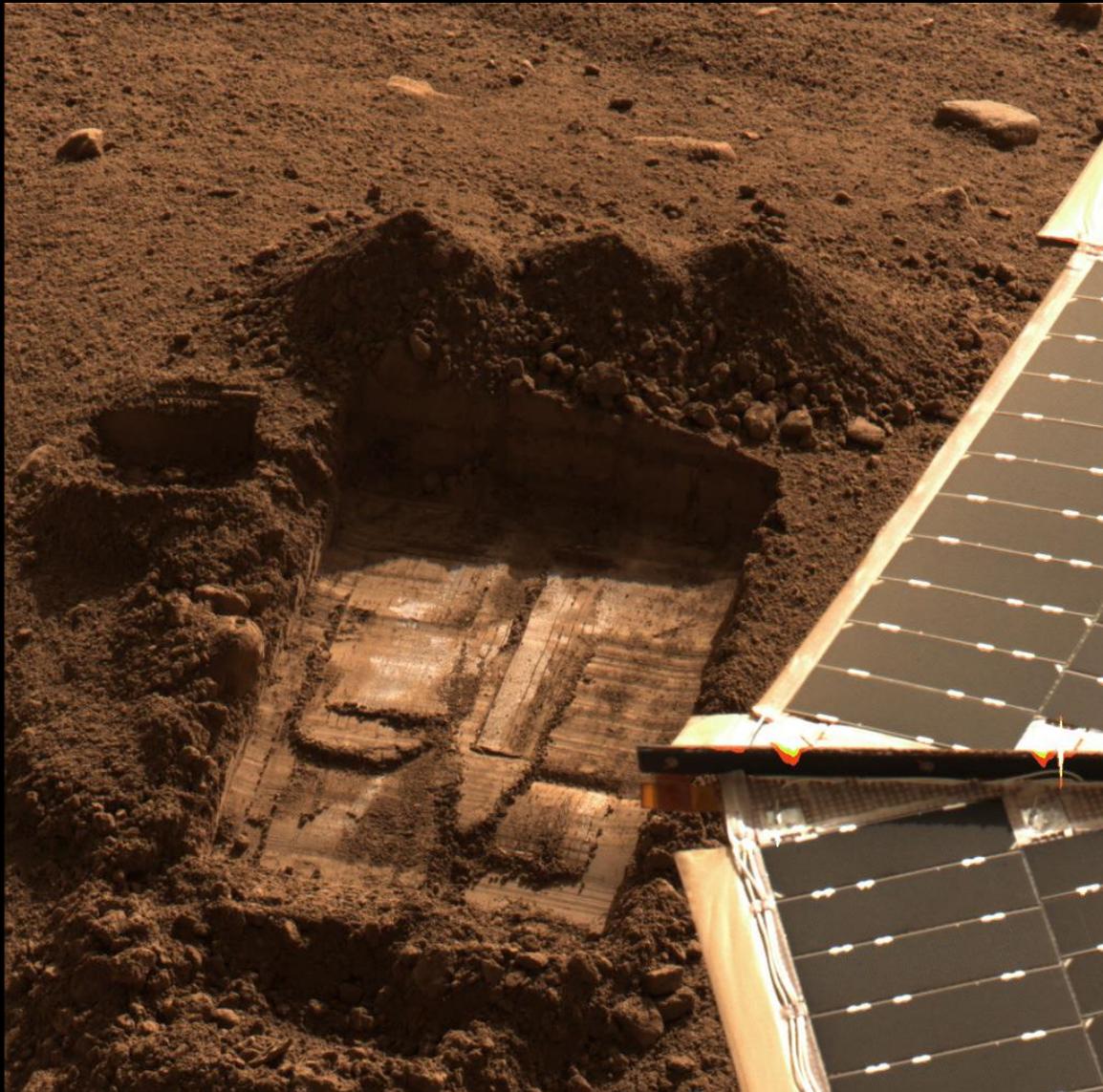


Ice Found!



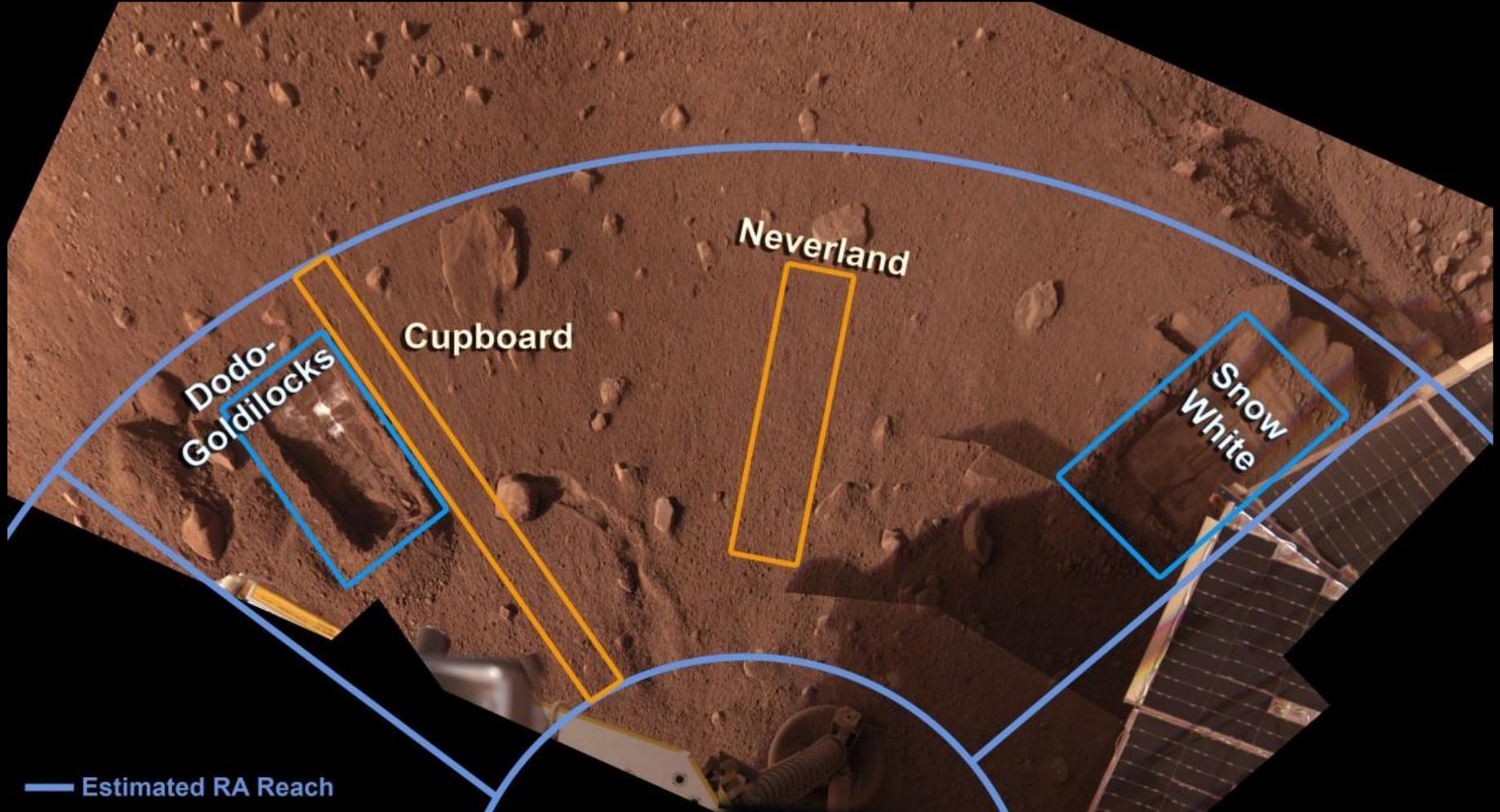


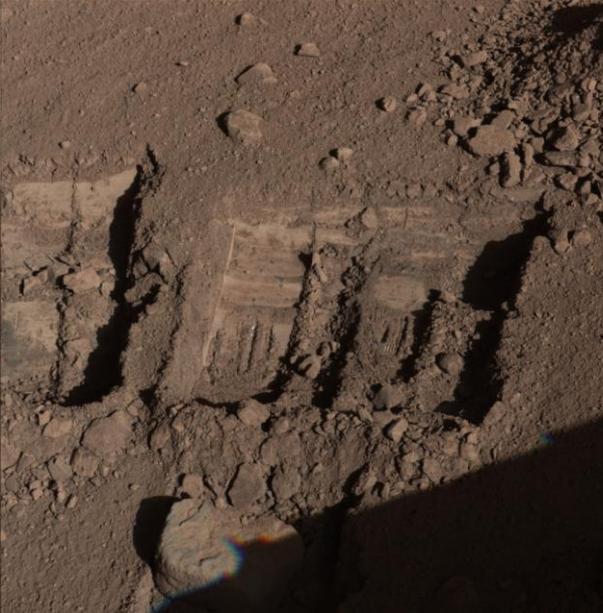
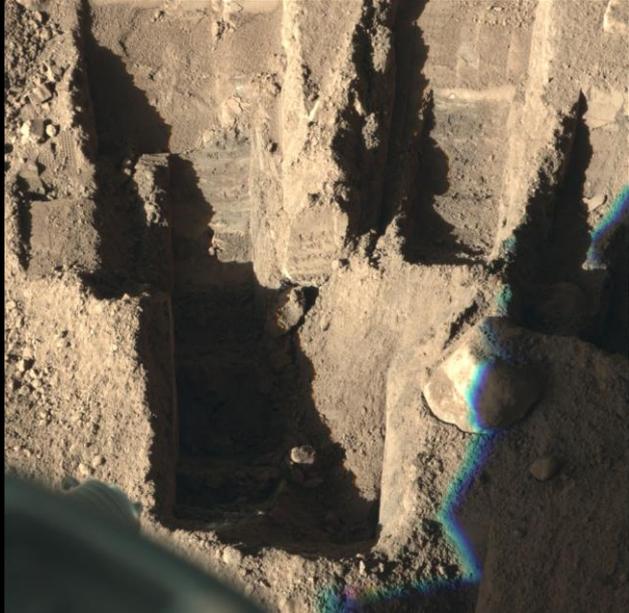
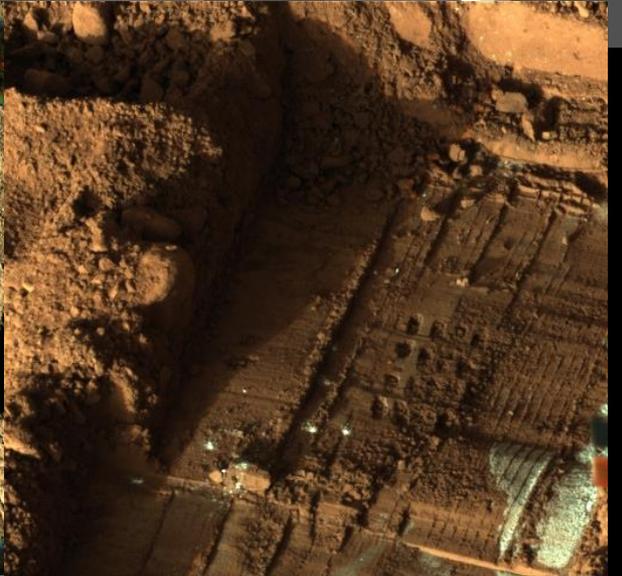
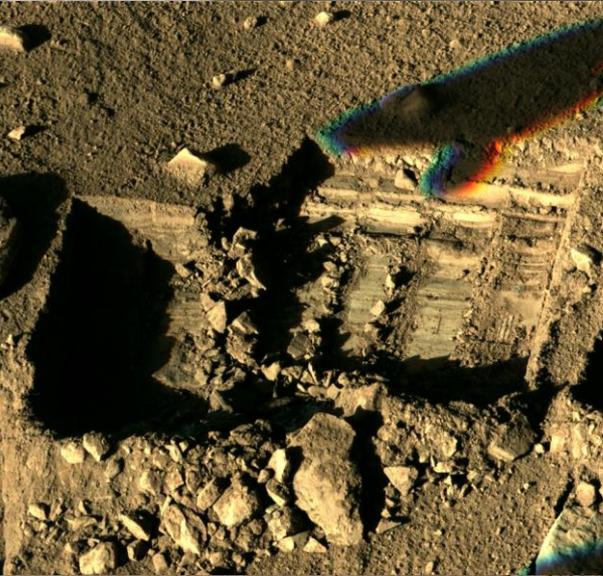
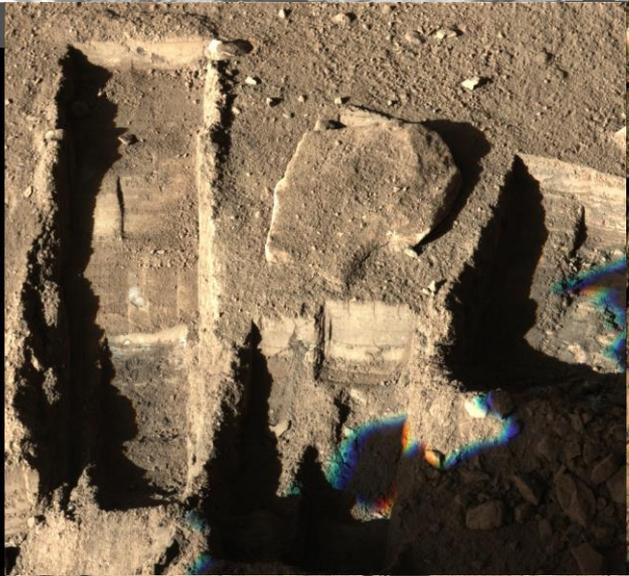
Snow White Trench





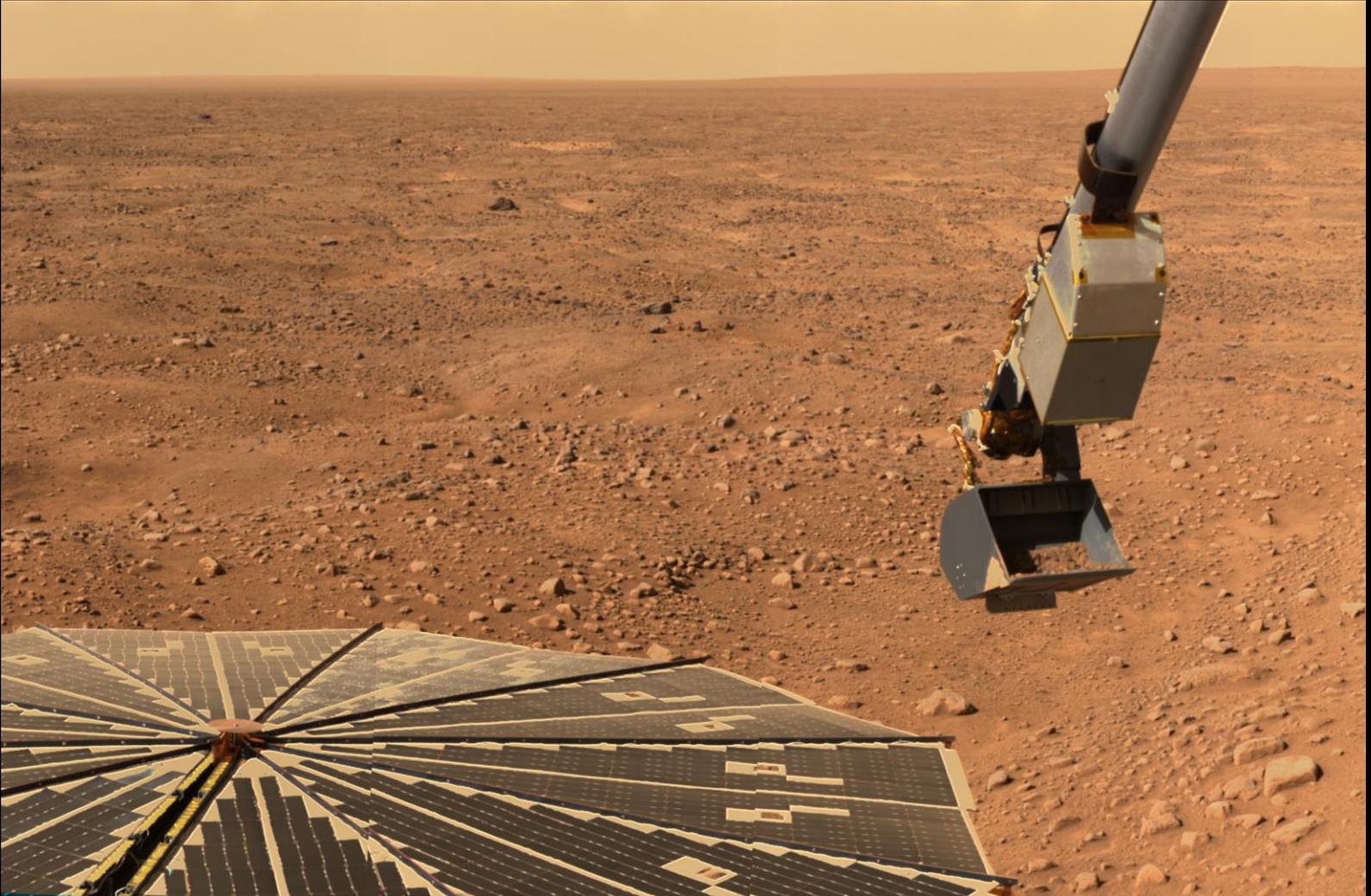
Digging areas



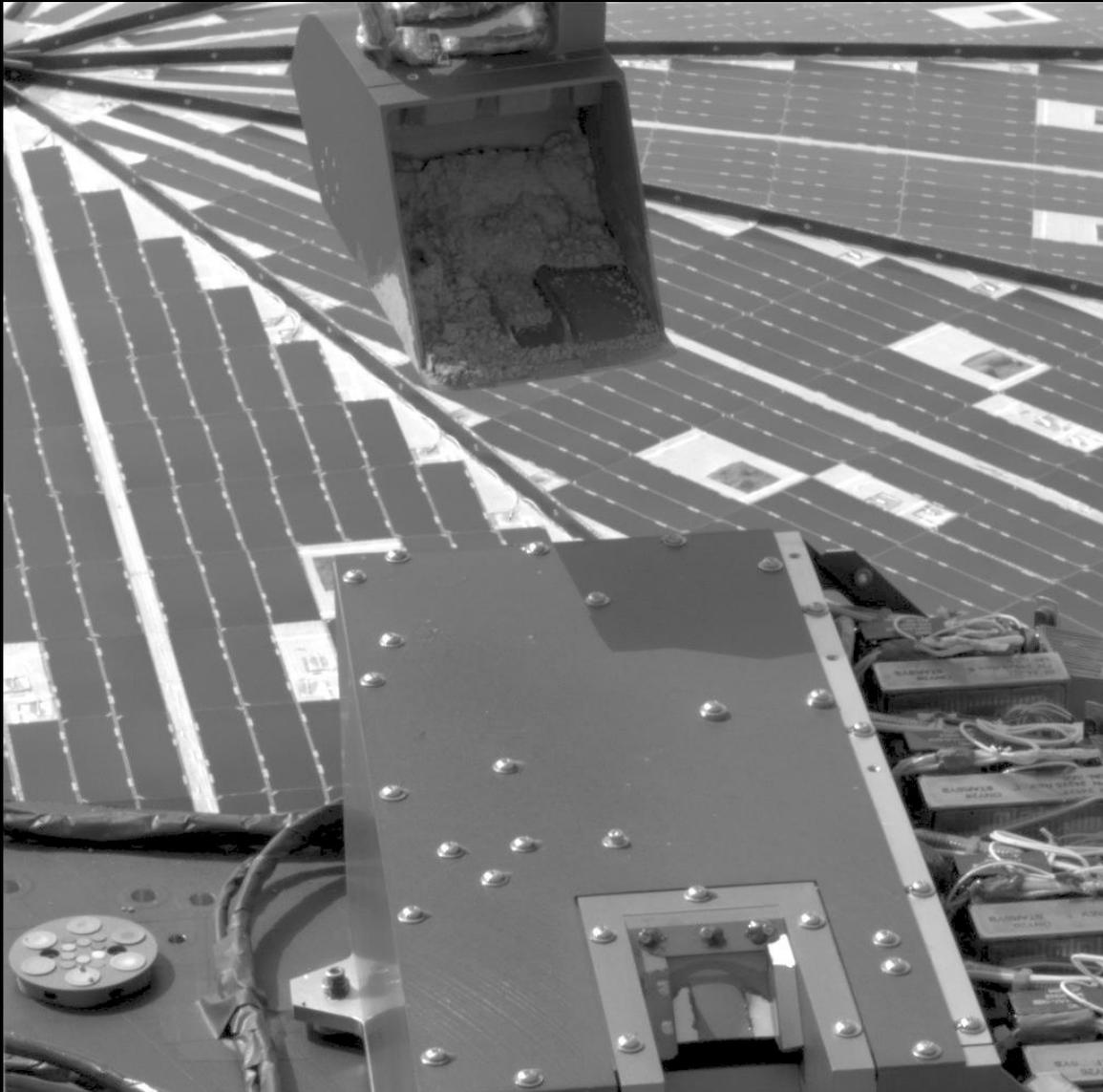




Sampling on Mars



Sample delivery to the microscope

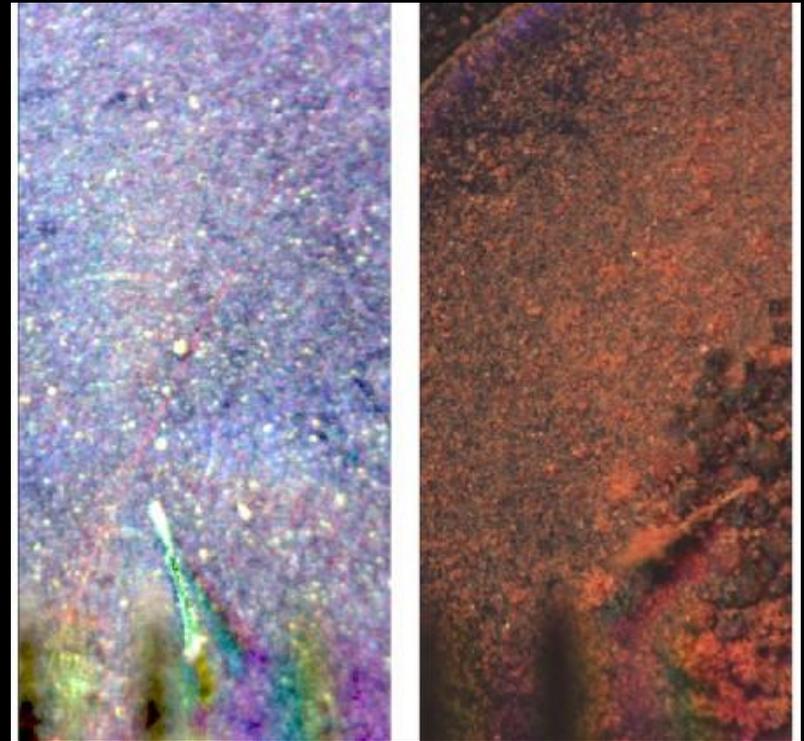
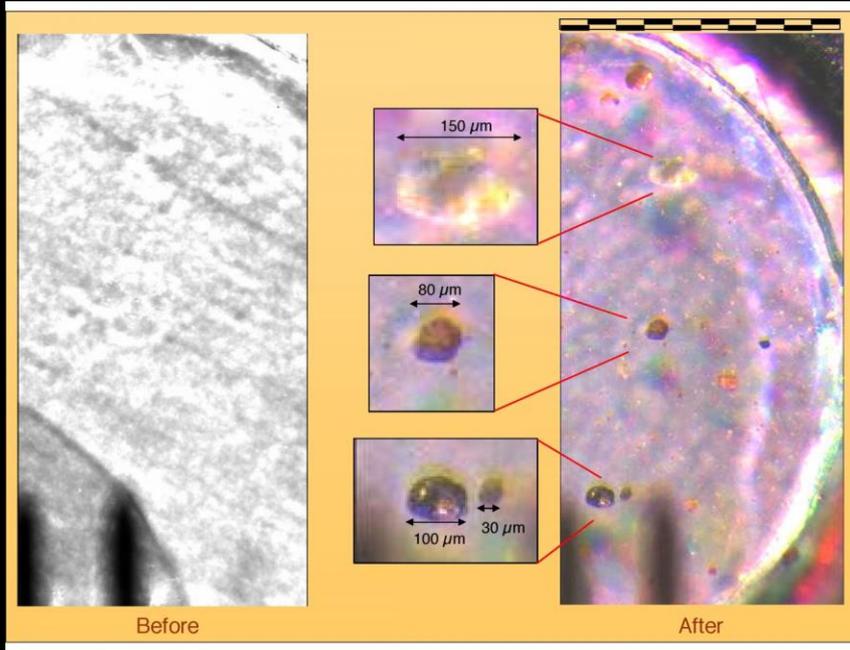




Sample in the scoop

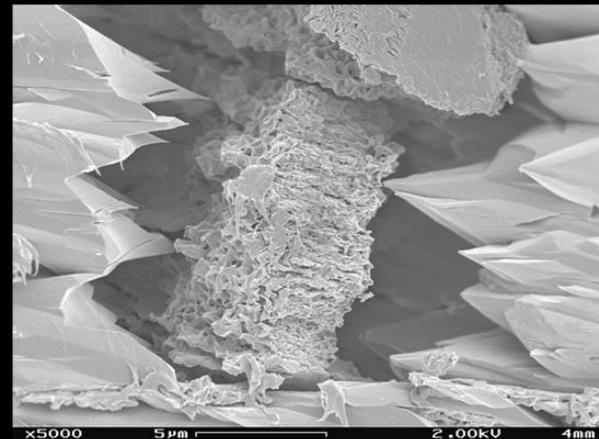
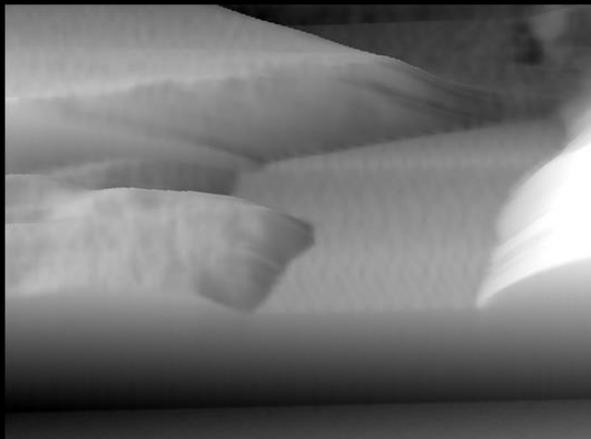


Dirt in the microscope



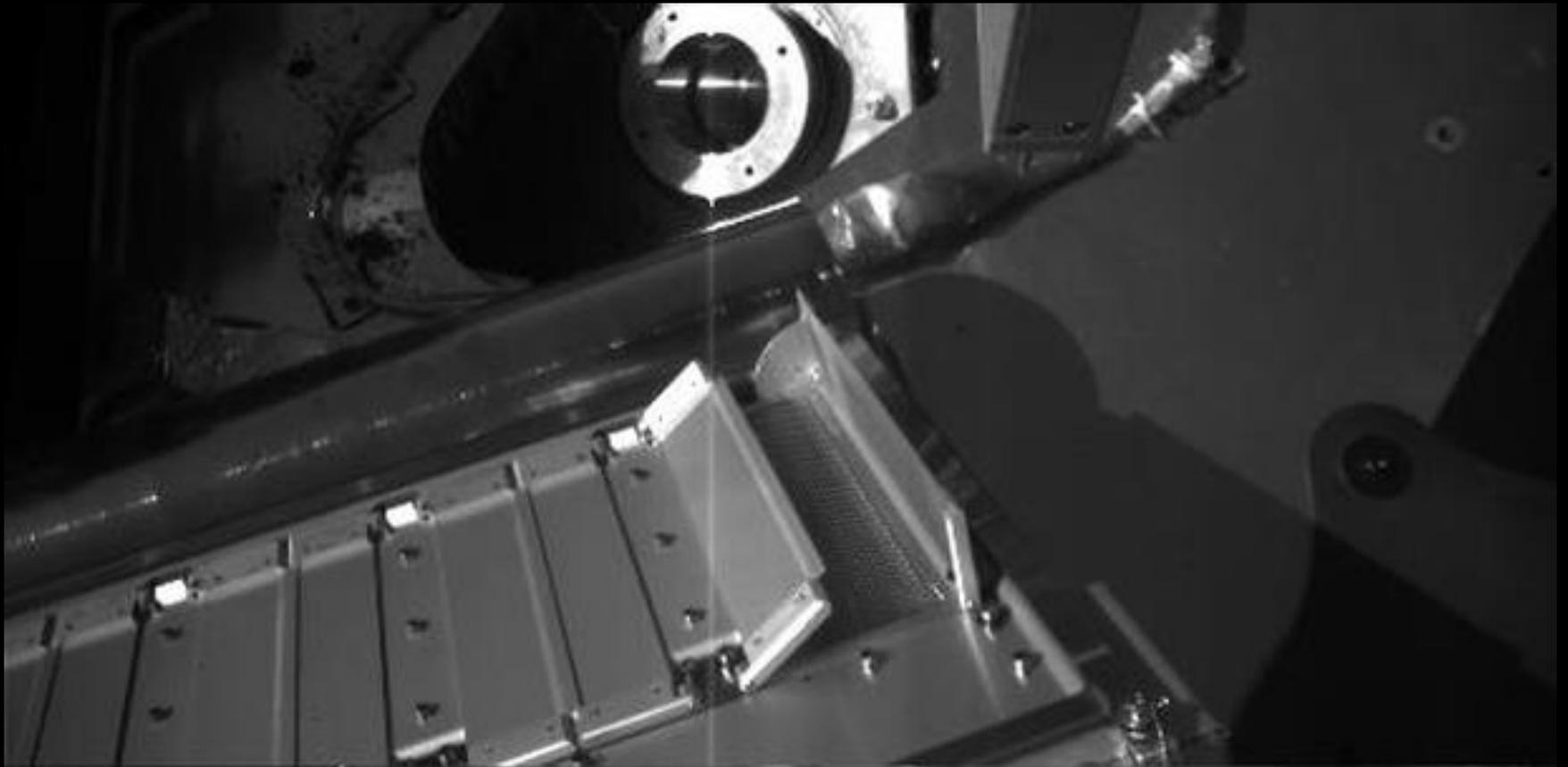
Mars particle

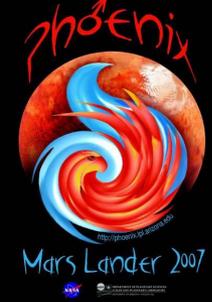
Earth particle



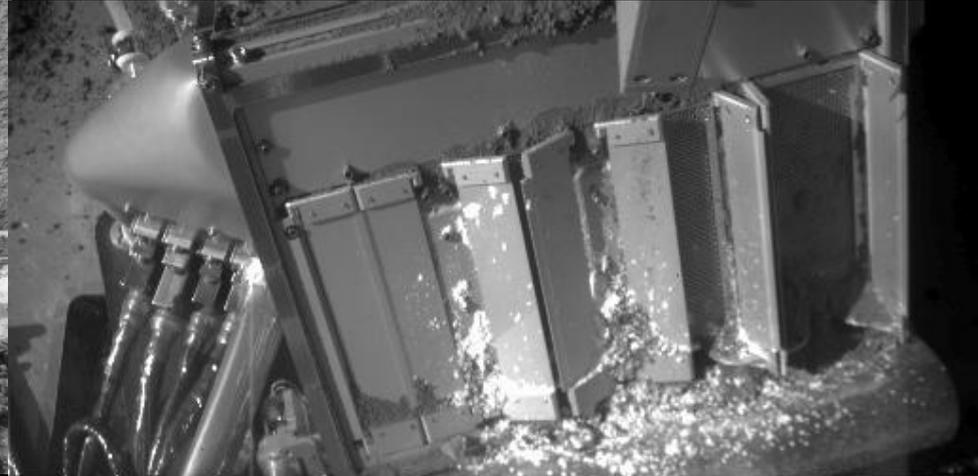


TEGA Soil Delivery





MECA and TEGA final states





TEGA and MECA Wet Chemistry Results

Concentration of Hydrogen ions compared to distilled water	pH	Examples of solutions at this pH
10,000,000	pH = 0	Battery acid, Strong Hydrofluoric Acid
1,000,000	pH = 1	Hydrochloric acid secreted by stomach lining
100,000	pH = 2	Lemon Juice, Gastric Acid Vinegar
10,000	pH = 3	Grapefruit, Orange Juice, Soda
1,000	pH = 4	Tomato Juice Acid rain
100	pH = 5	Soft drinking water Black Coffee
10	pH = 6	Urine Saliva
1	pH = 7	"Pure" water
1/10	pH = 8	Sea water
1/100	pH = 9	Baking soda
1/1,000	pH = 10	Great Salt Lake Milk of Magnesia
1/10,000	pH = 11	Ammonia solution
1/100,000	pH = 12	Soapy water
1/1,000,000	pH = 13	Bleaches Oven cleaner
1/10,000,000	pH = 14	Liquid drain cleaner

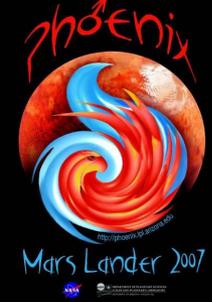
TEGA:

- Ice under dry surface layer
- Calcium Carbonate (Calcite)
- No Sulfate



Wet Chemistry:

- Perchlorate (ClO_4)
- breaks down organics
- nutrient for microbes?
- Alkaline soil: pH 7.8

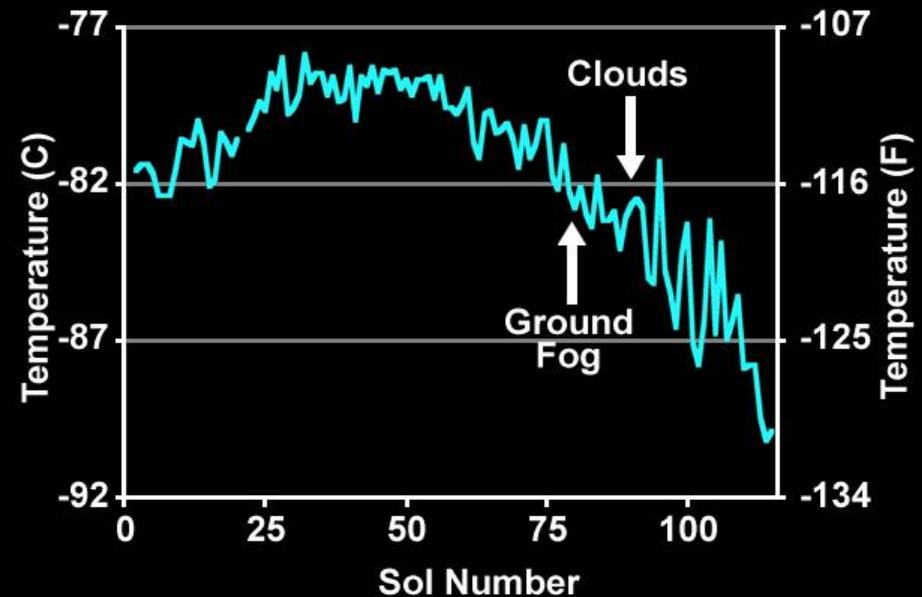
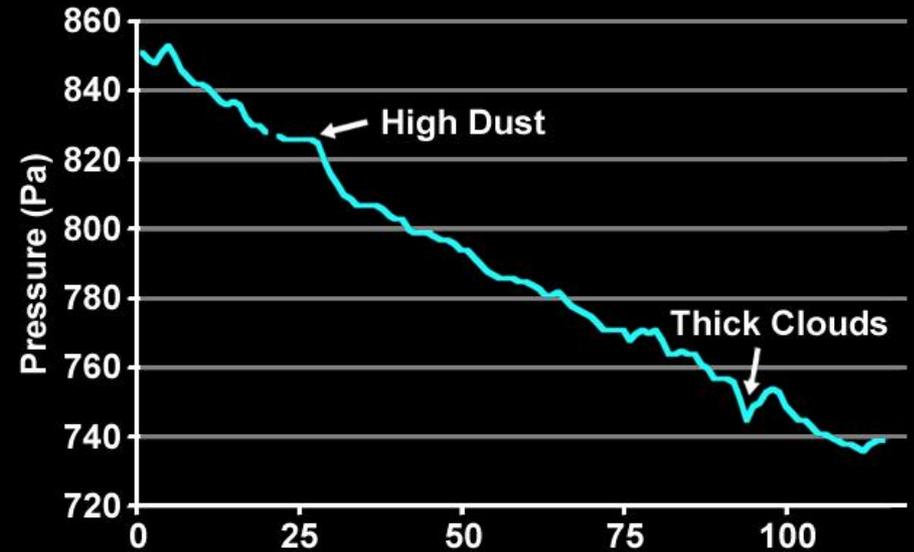


Weather on Mars: Winds



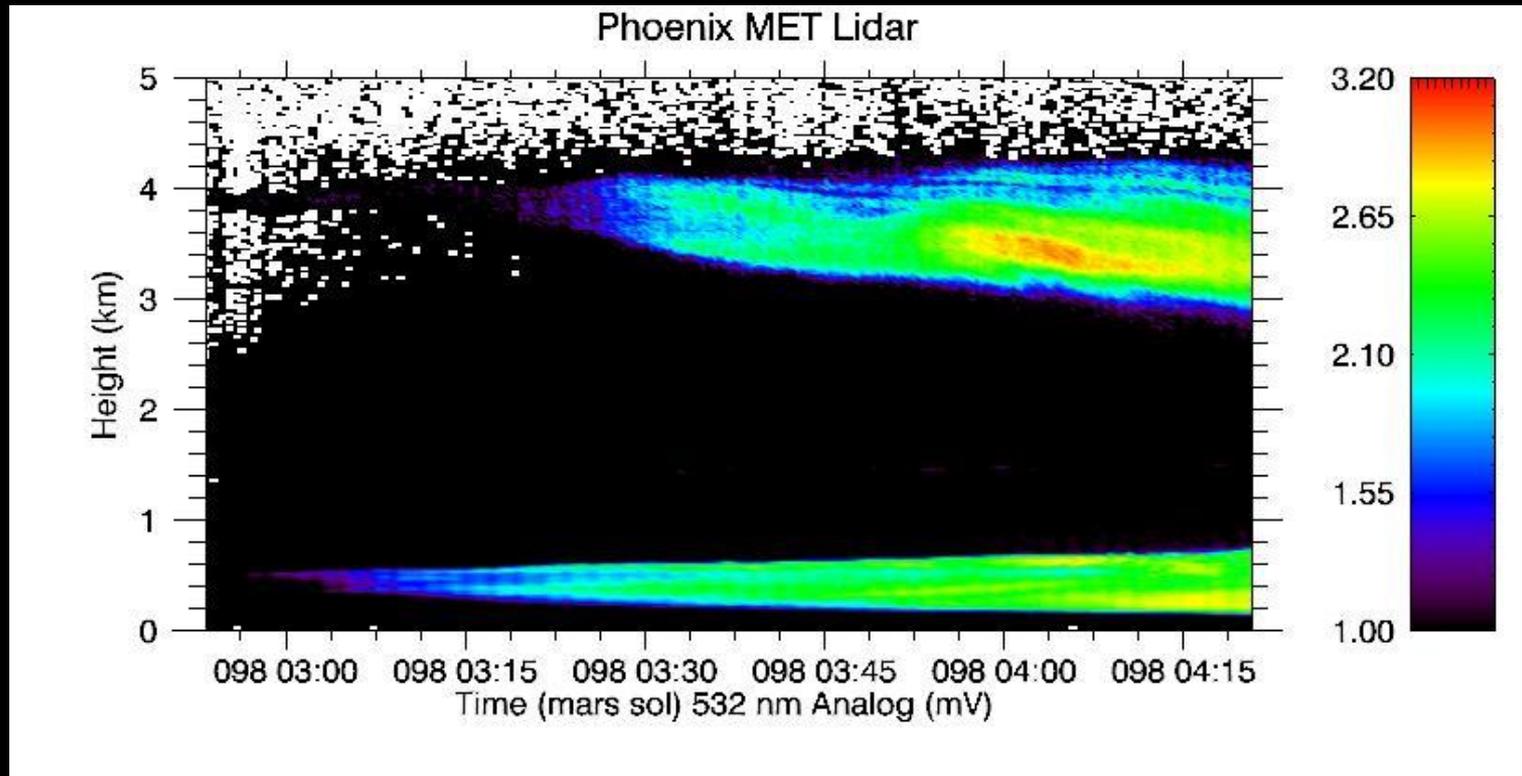
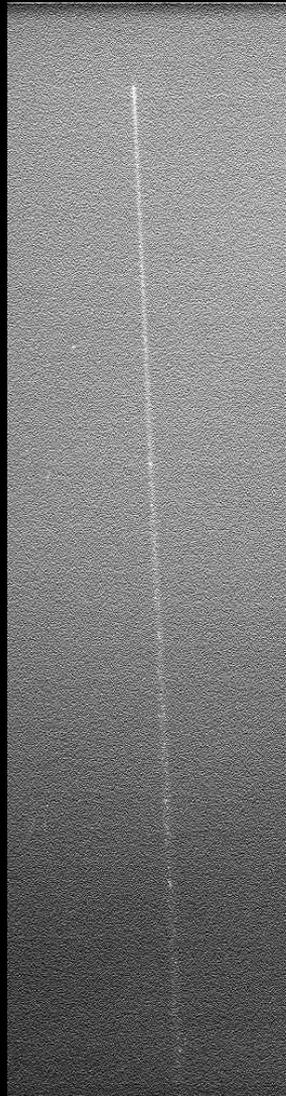


Watching the environment change over time



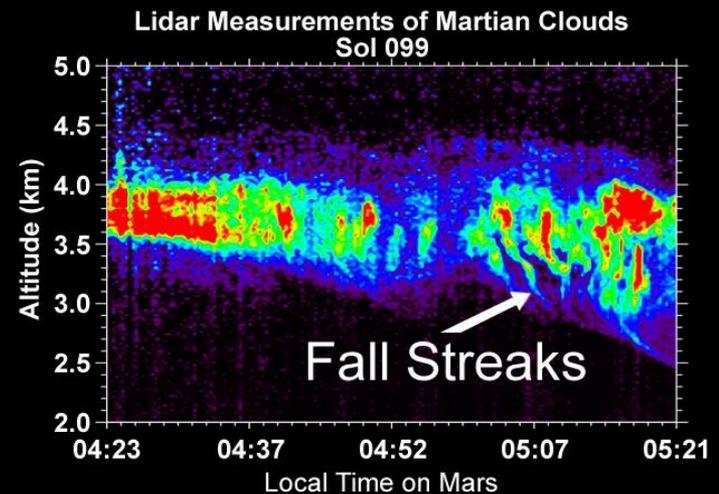
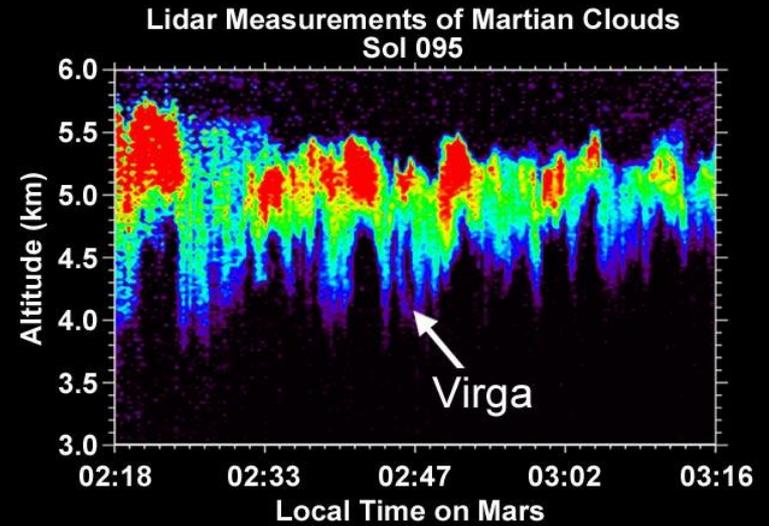


Lidar view of Clouds and Ice-Fog





Lidar Measurements of Precipitation



Figures courtesy Jim Whiteway



In Summary, Phoenix Found...

Goal #1: Study the history of and current state of water

- Ice only a few inches below the surface
- Two distinct types of ice
- Snowfall
- Calcite

Goal #2: Search for habitable zones (not life detection)

- Alkaline soil (pH~7.8)
- Salts, including perchlorate (ClO_4)
- Calcite



Phoenix returned its last data on Nov 2, 2008

- Phoenix operated for 152 Martian days and accomplished its mission objectives
- Phoenix provided a wealth of data on a site very different than any other visited before that will keep scientists busy for years to come
- For more information go to
<http://phoenix.lpl.arizona.edu>

