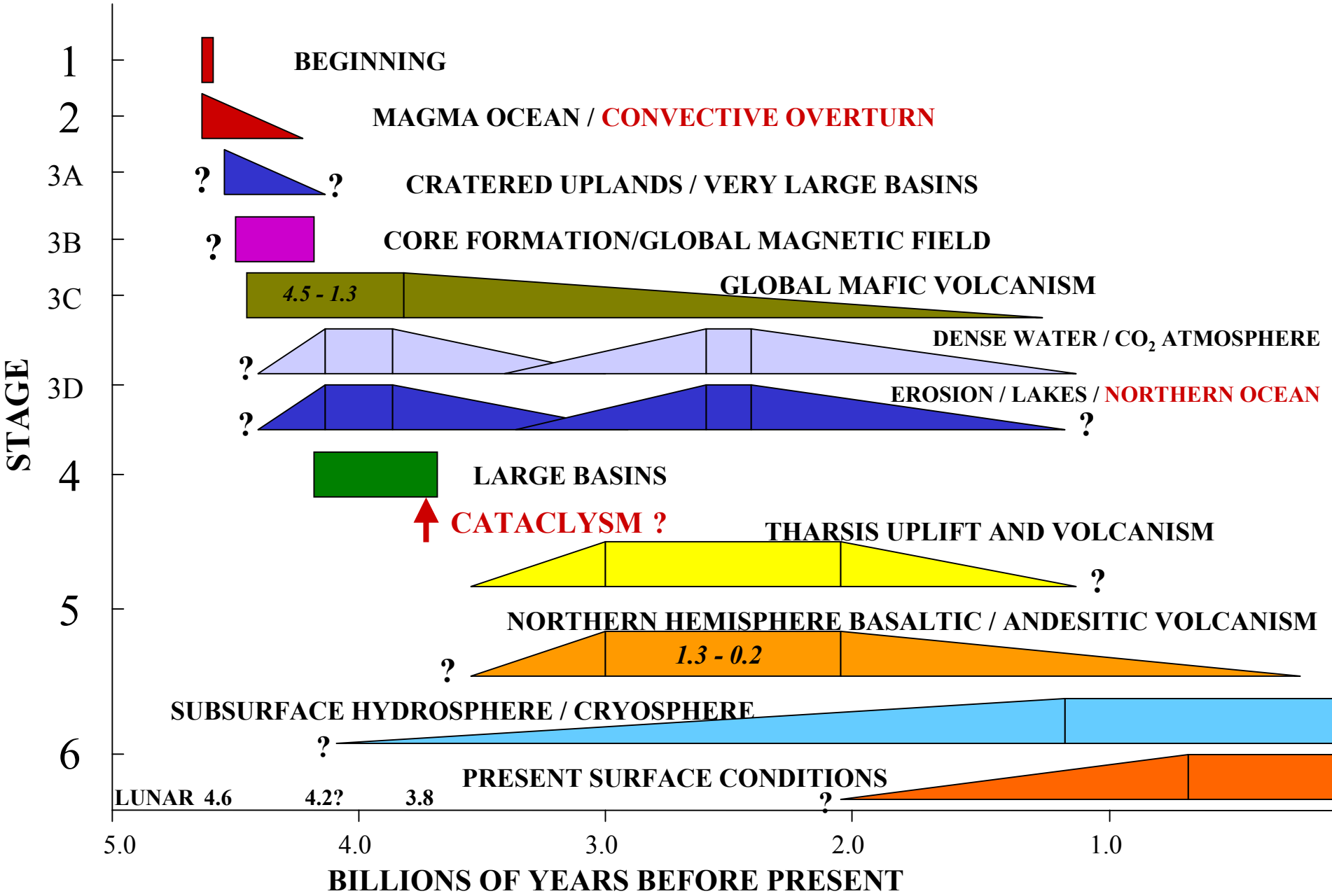
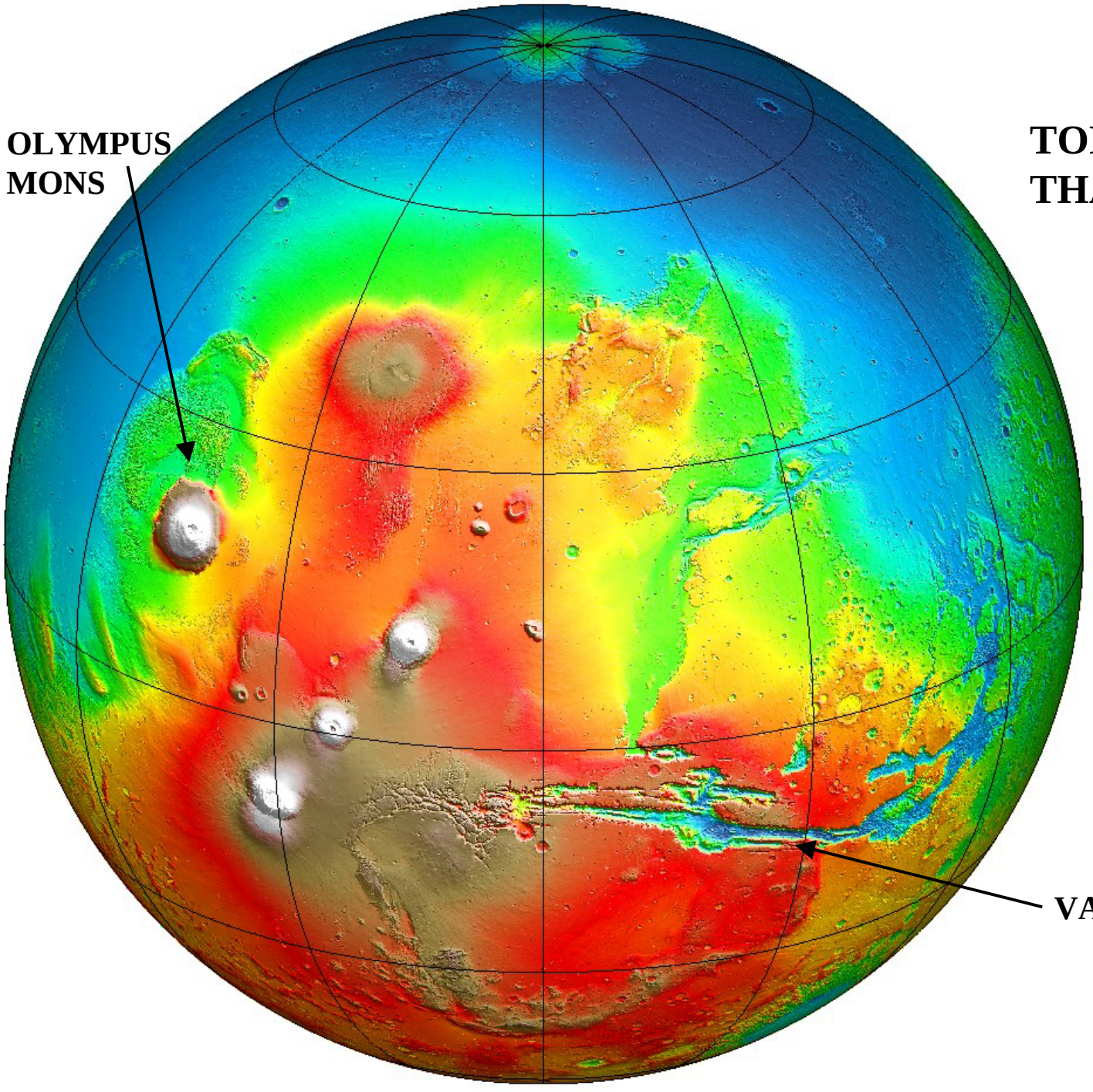
NASA HST IMAGE

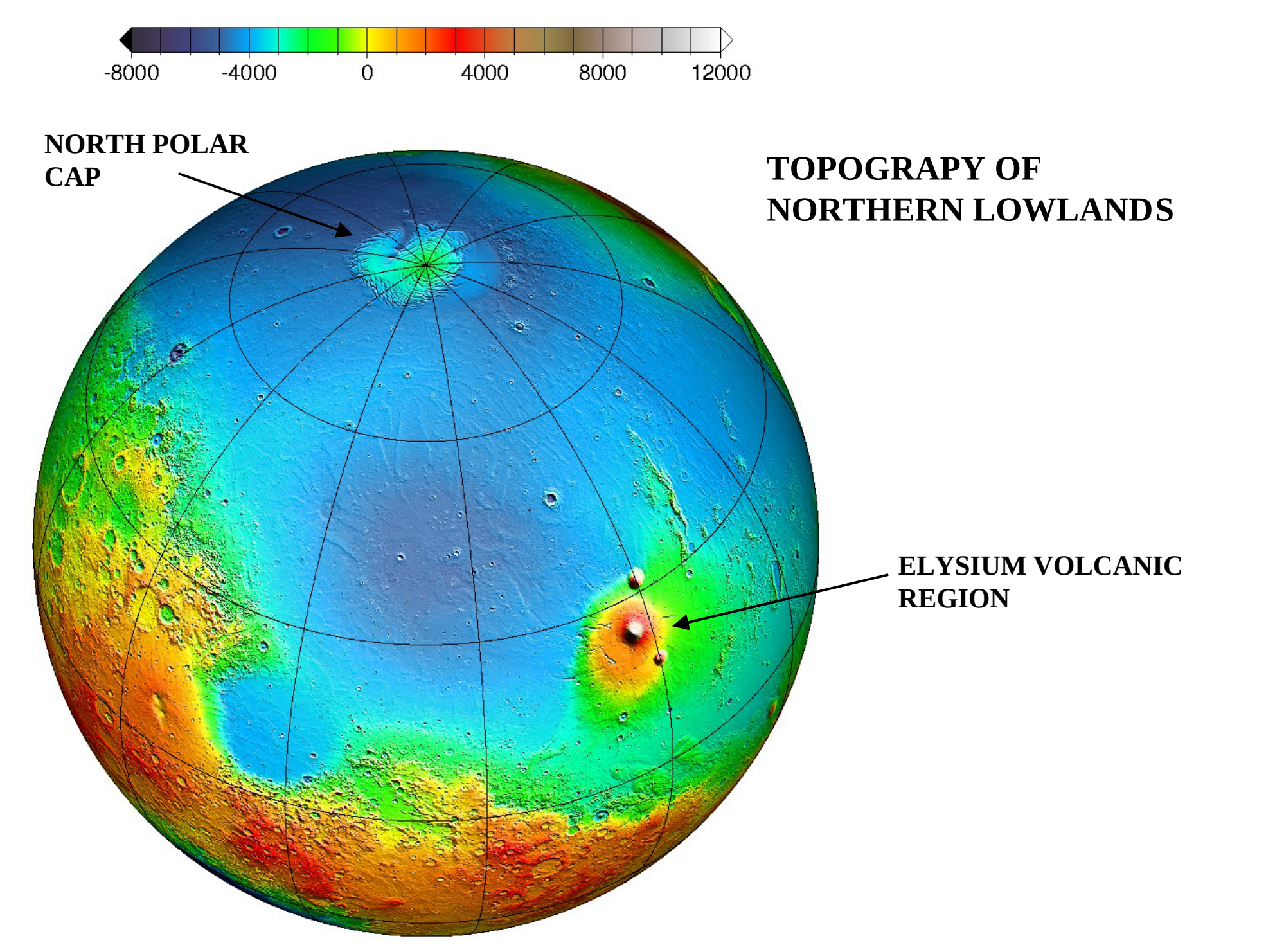
MAJOR STAGES OF MARS' EVOLUTION



ITALICS = SNC DATES

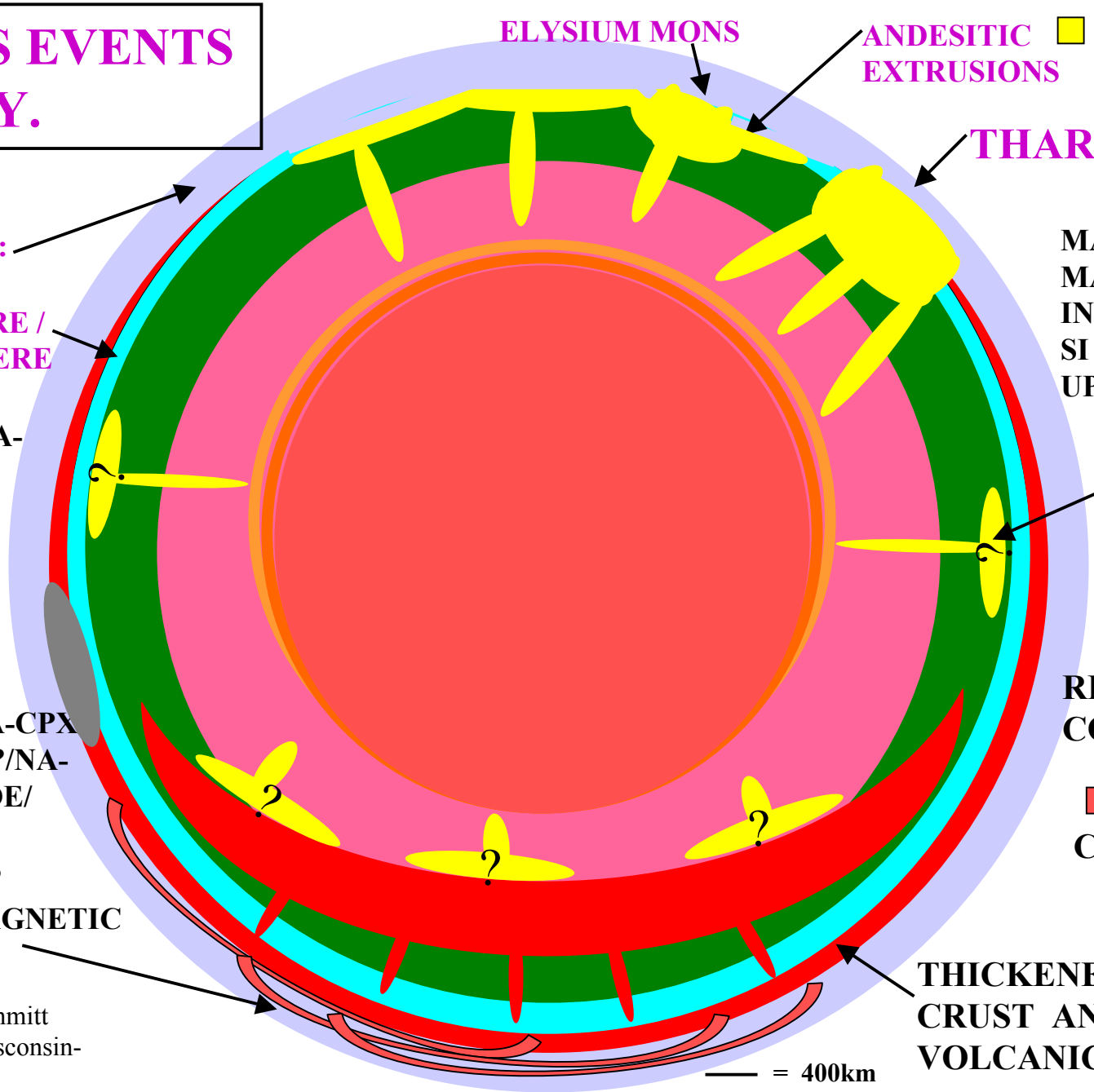
RED = MAJOR UNCERTAINTY


OLYMPUS MONS
TOPOGRAPHY OF THARSIS REGION
VALLES MARINERIS


-8000
-4000
0
4000
8000
12000
NORTH POLAR CAP
TOPOGRAPY OF NORTHERN LOWLANDS
ELYSIUM VOLCANIC REGION

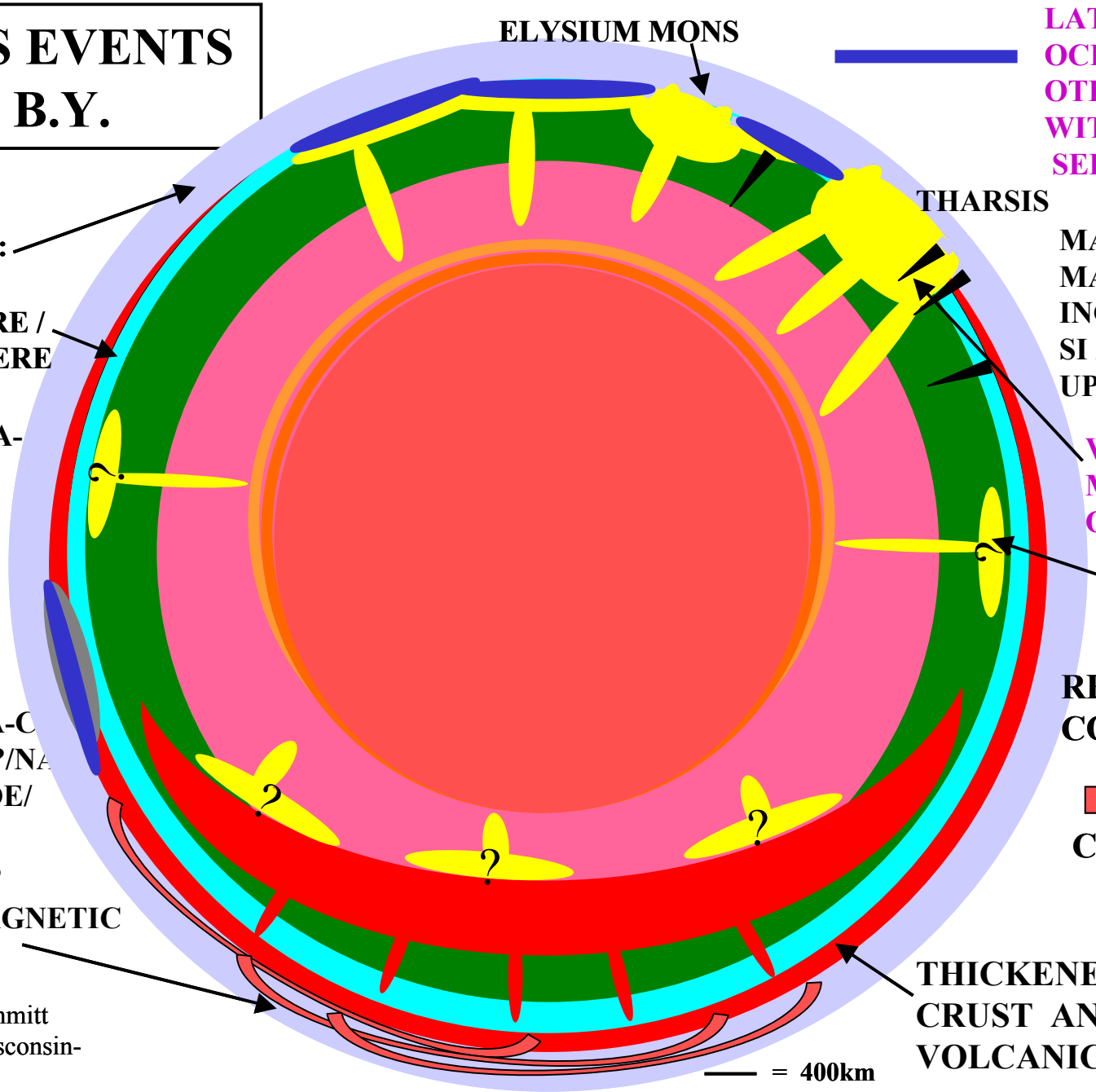
APOLLO MODEL OF MARS EVOLUTION

THARSIS EVENTS <3.8 B.Y.

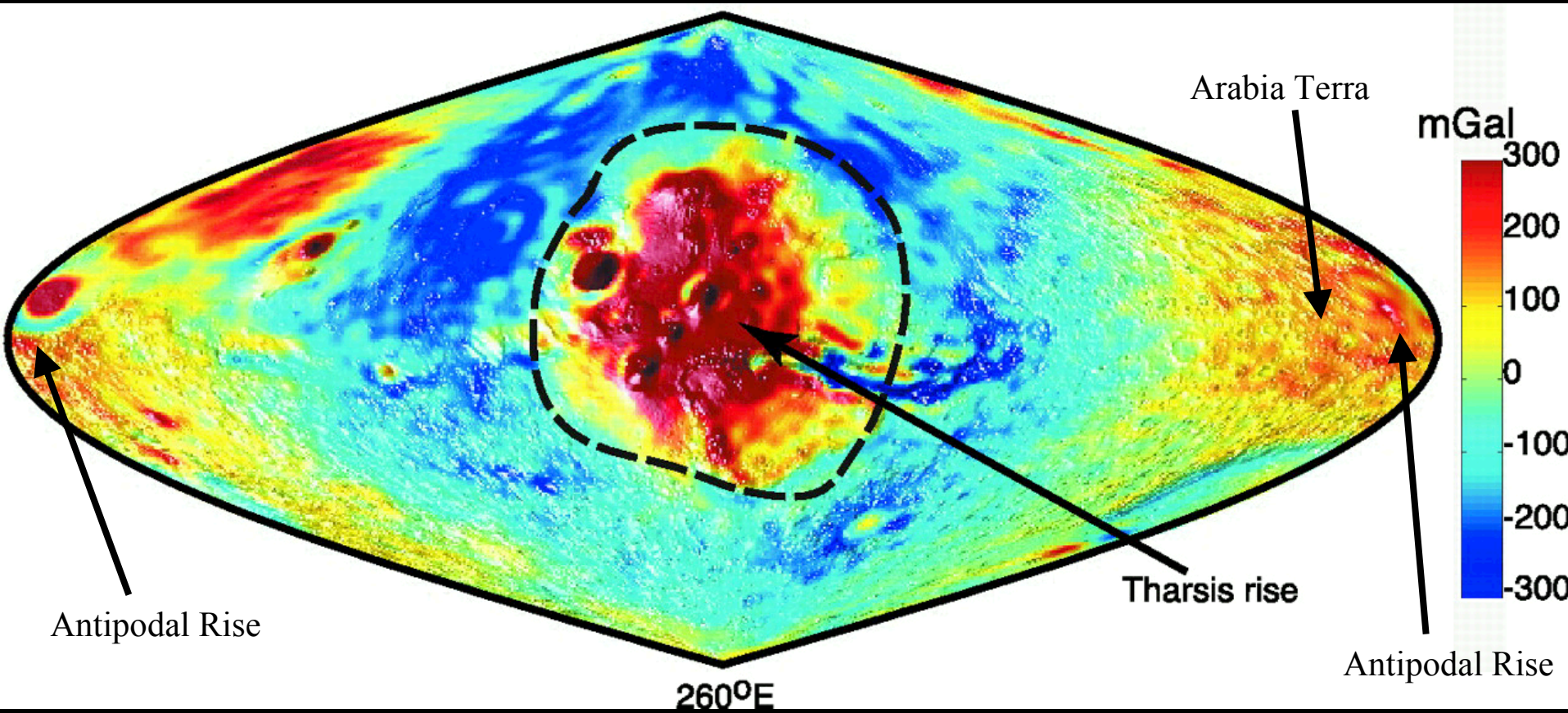


APOLLO MODEL OF MARS EVOLUTION

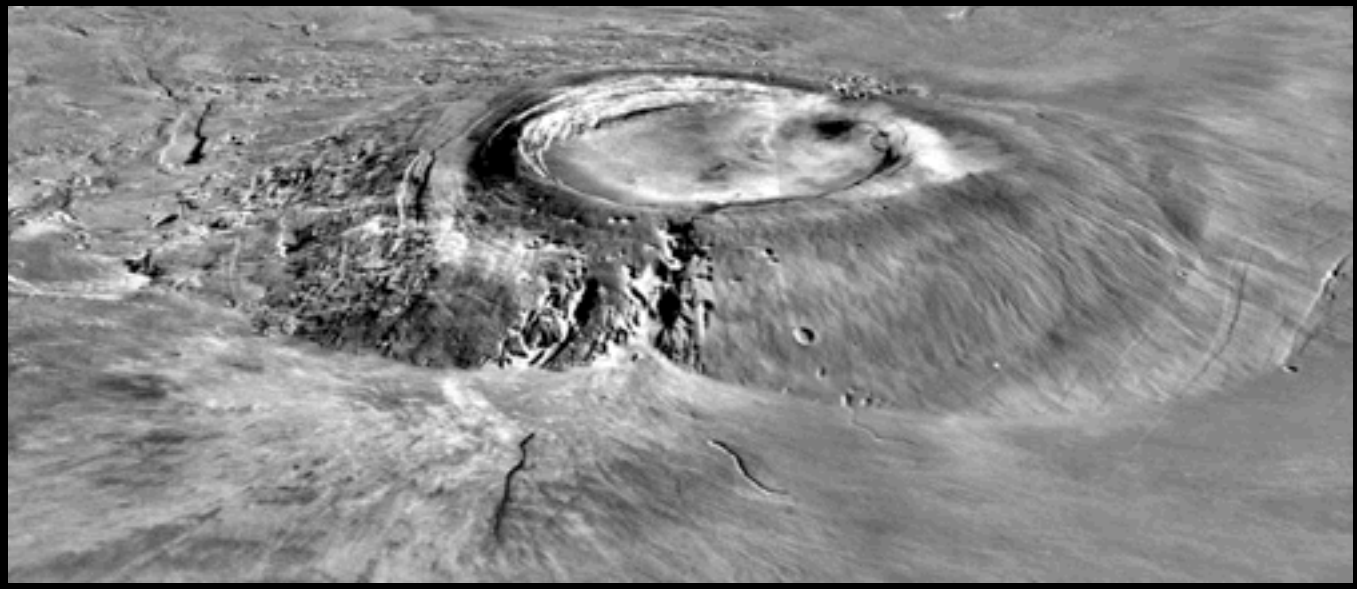
THARSIS EVENTS
<3.8 - ? B.Y.

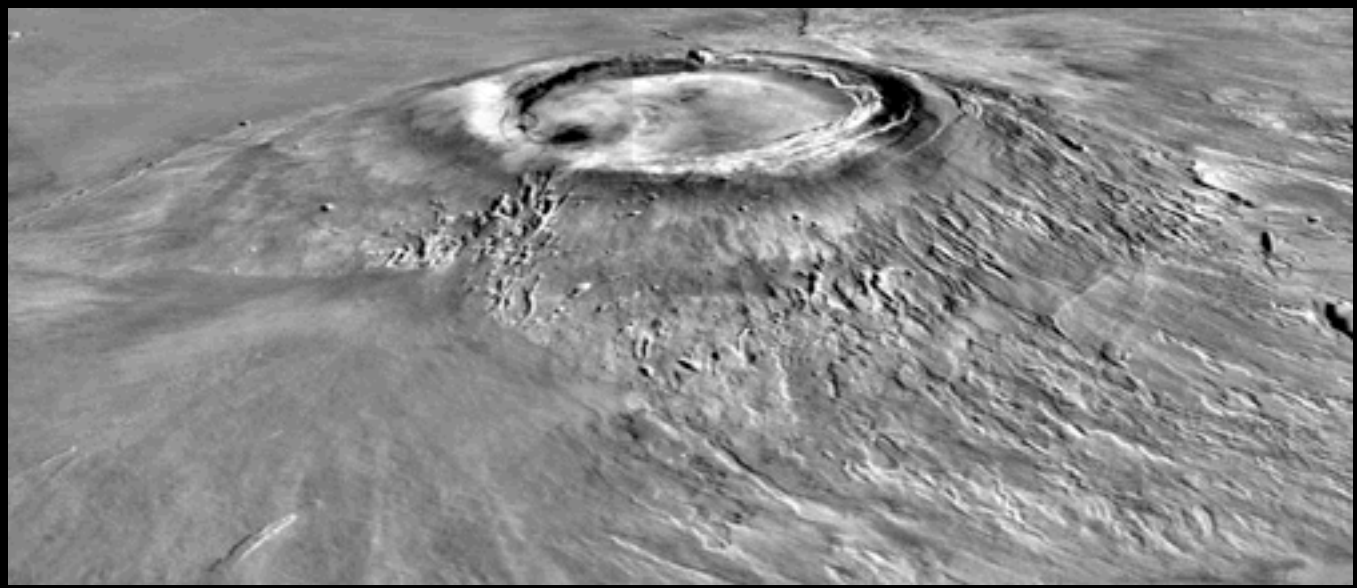


GRAVITY ANOMALY IMAGE
DRAPED OVER A THREE-DIMENSIONAL (3D) VIEW OF TOPOGRAPHY



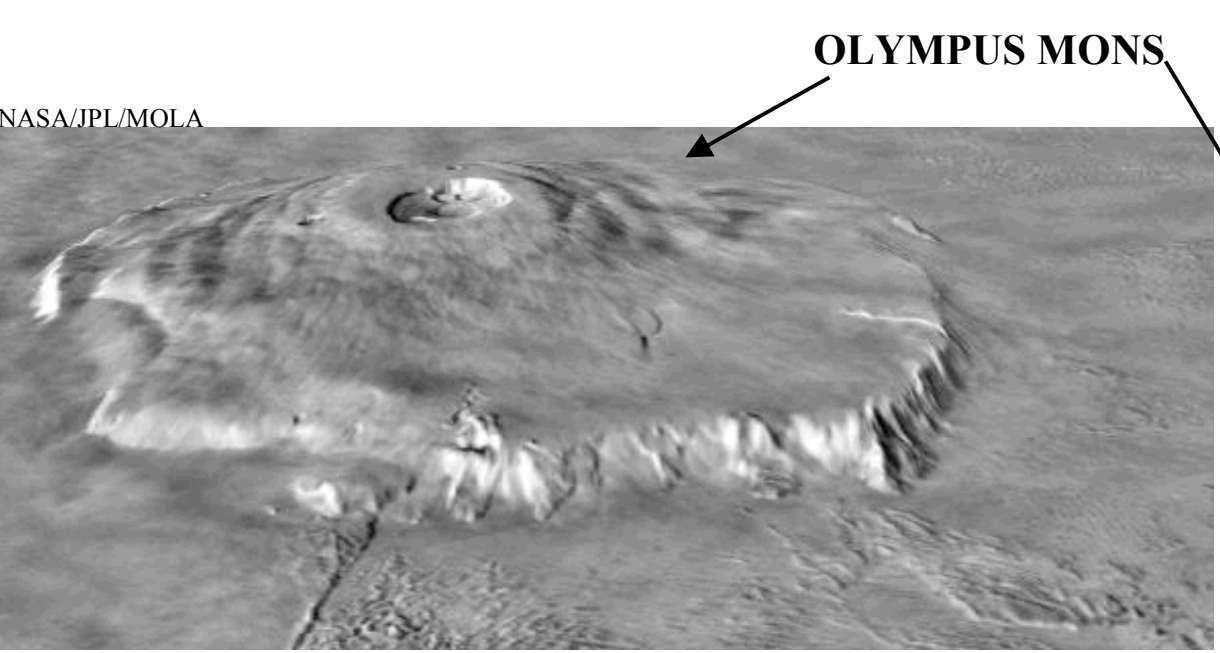
PHIILLIPS, R.J., AND CO-WORKERS, 2001, SCIENCE, 291, 2587-2591

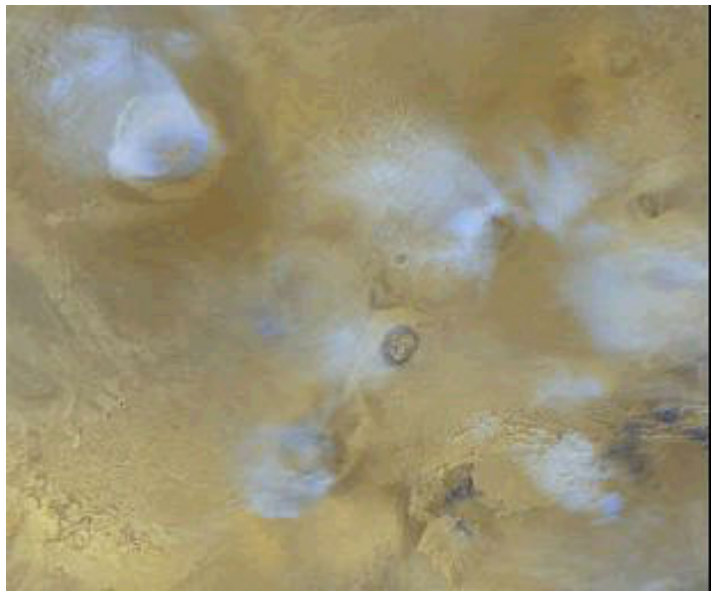




ARSIA MONS (SOUTH THARSIS

MOLA DATA APPLIED TO VIKING IMAGES

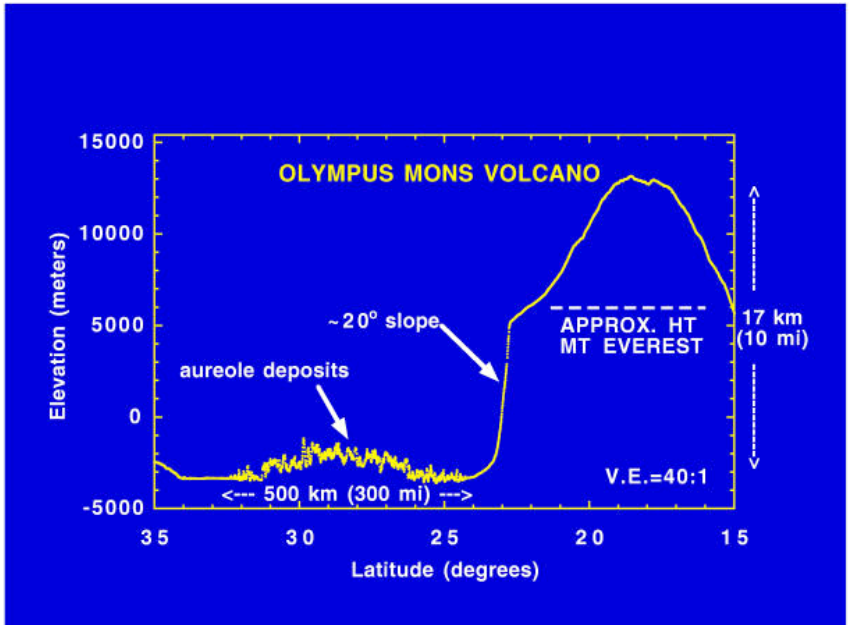


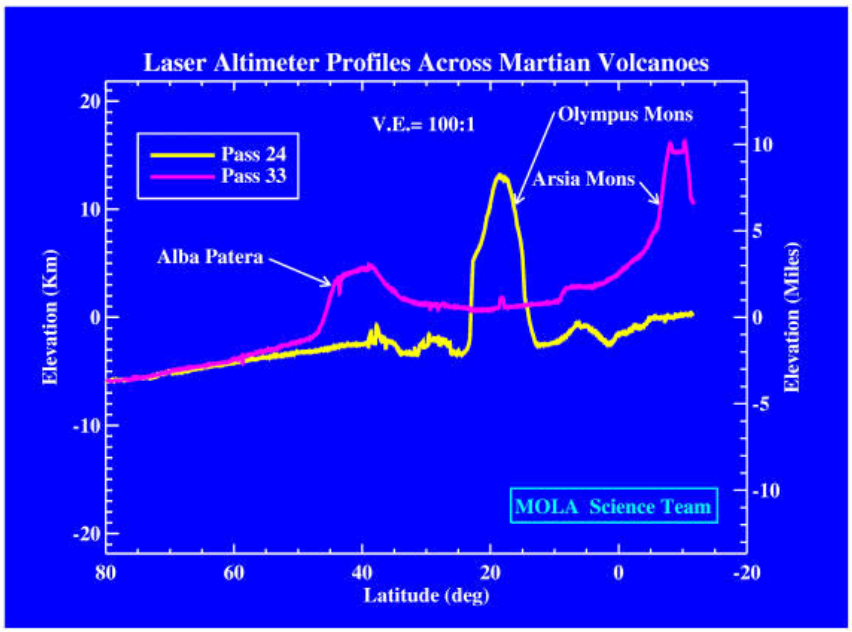


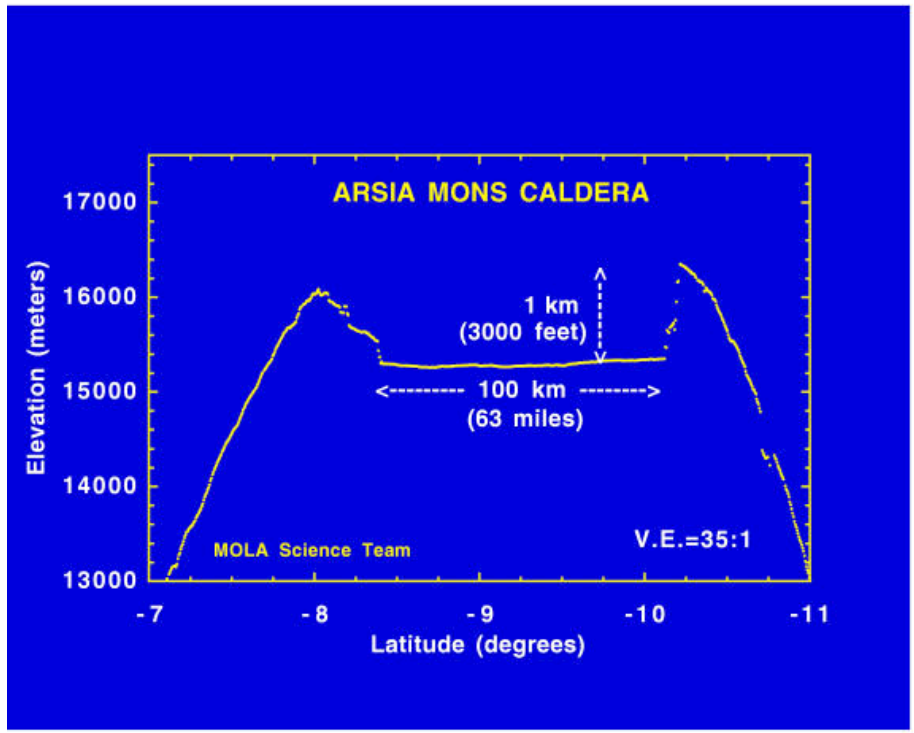
APOLLINARIS
PATERNA

MOLA PROFILES ACROSS
OLYMPUS MONS
ALBAPATERA
ARSIA MONS

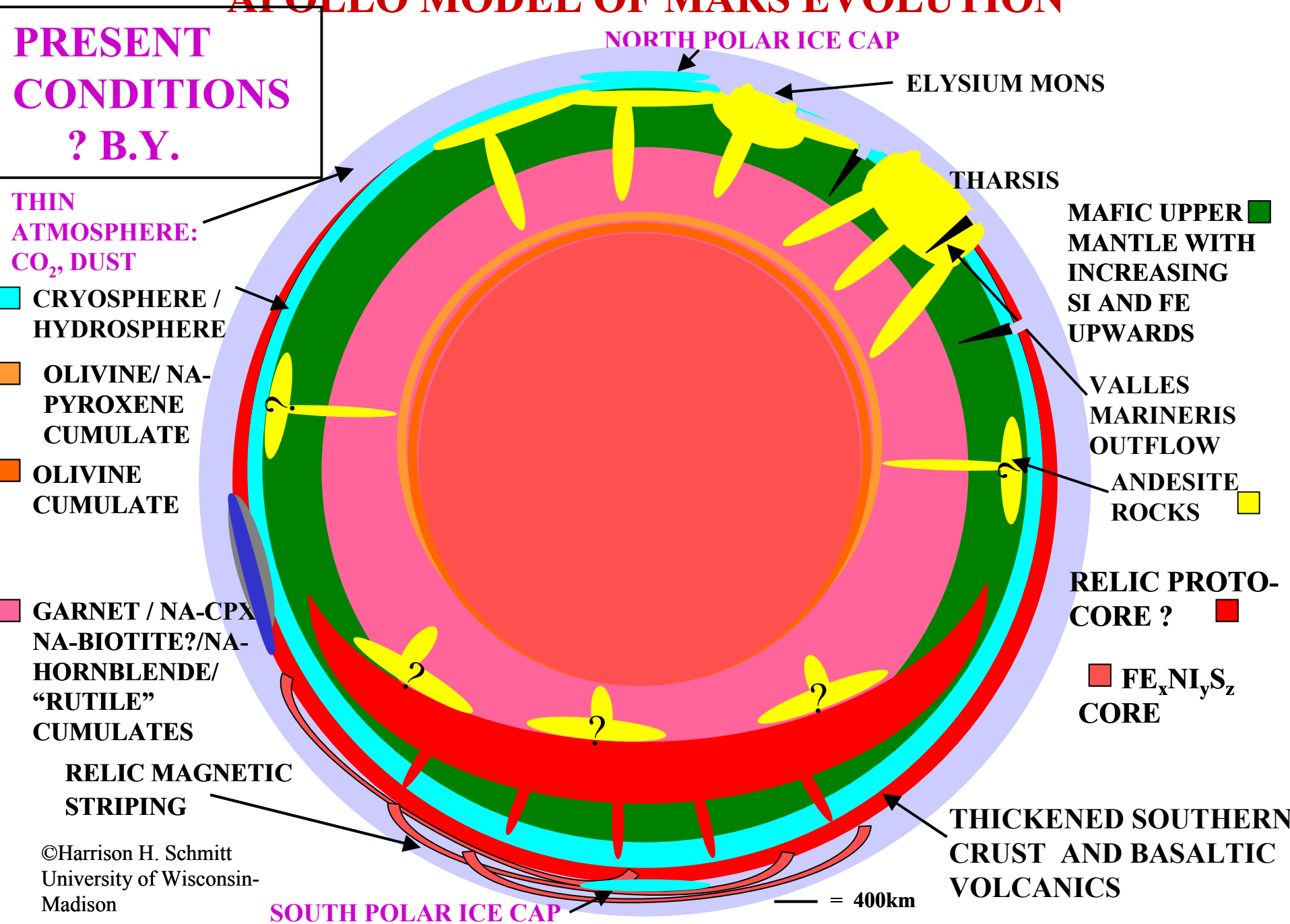
MOLA SCIENCE TEAM





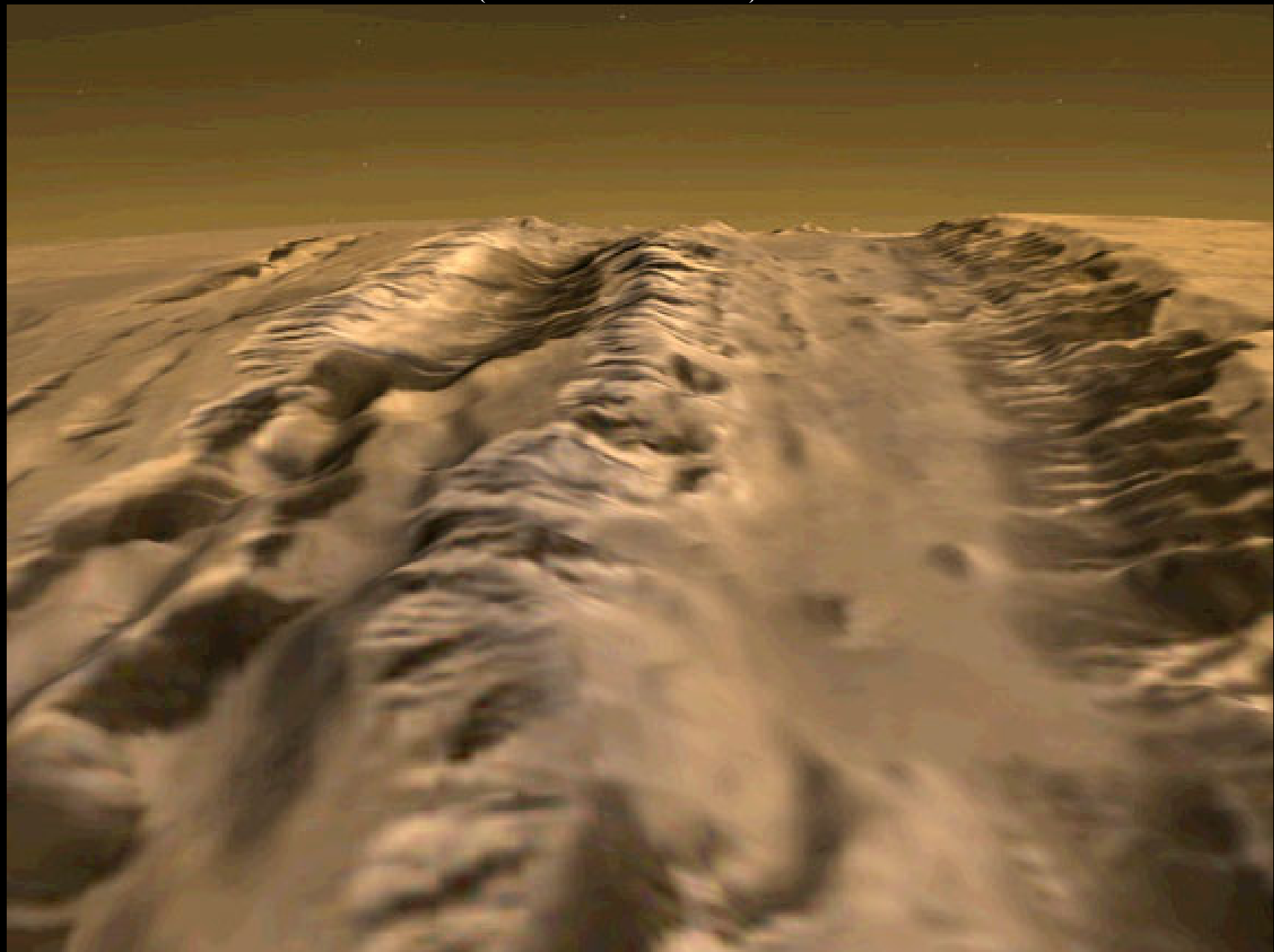


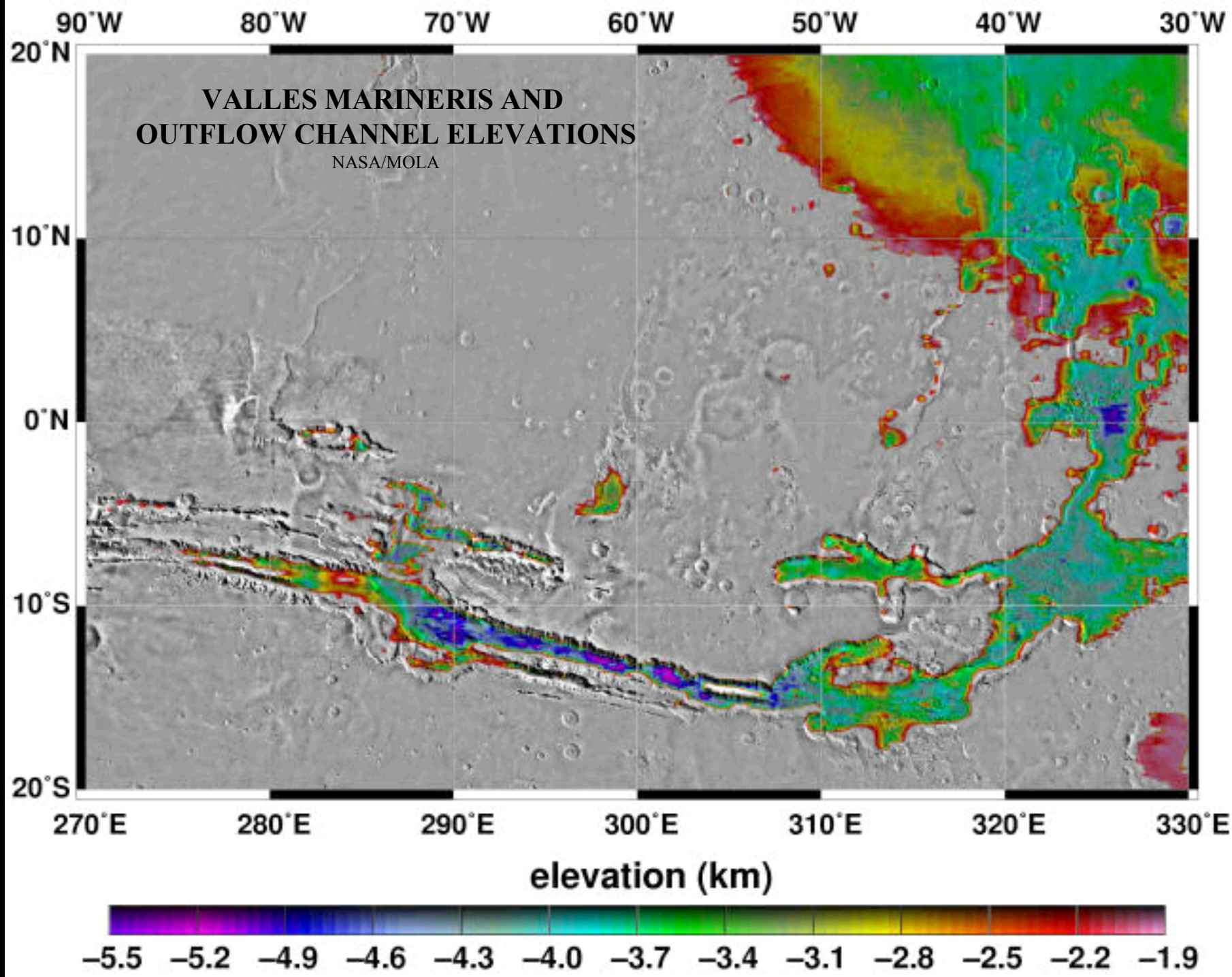
APOLLO MODEL OF MARS EVOLUTION



WESTWARD VIEW DOWN VALLES MARINERIS

(MOLA SCIENCE TEAM)



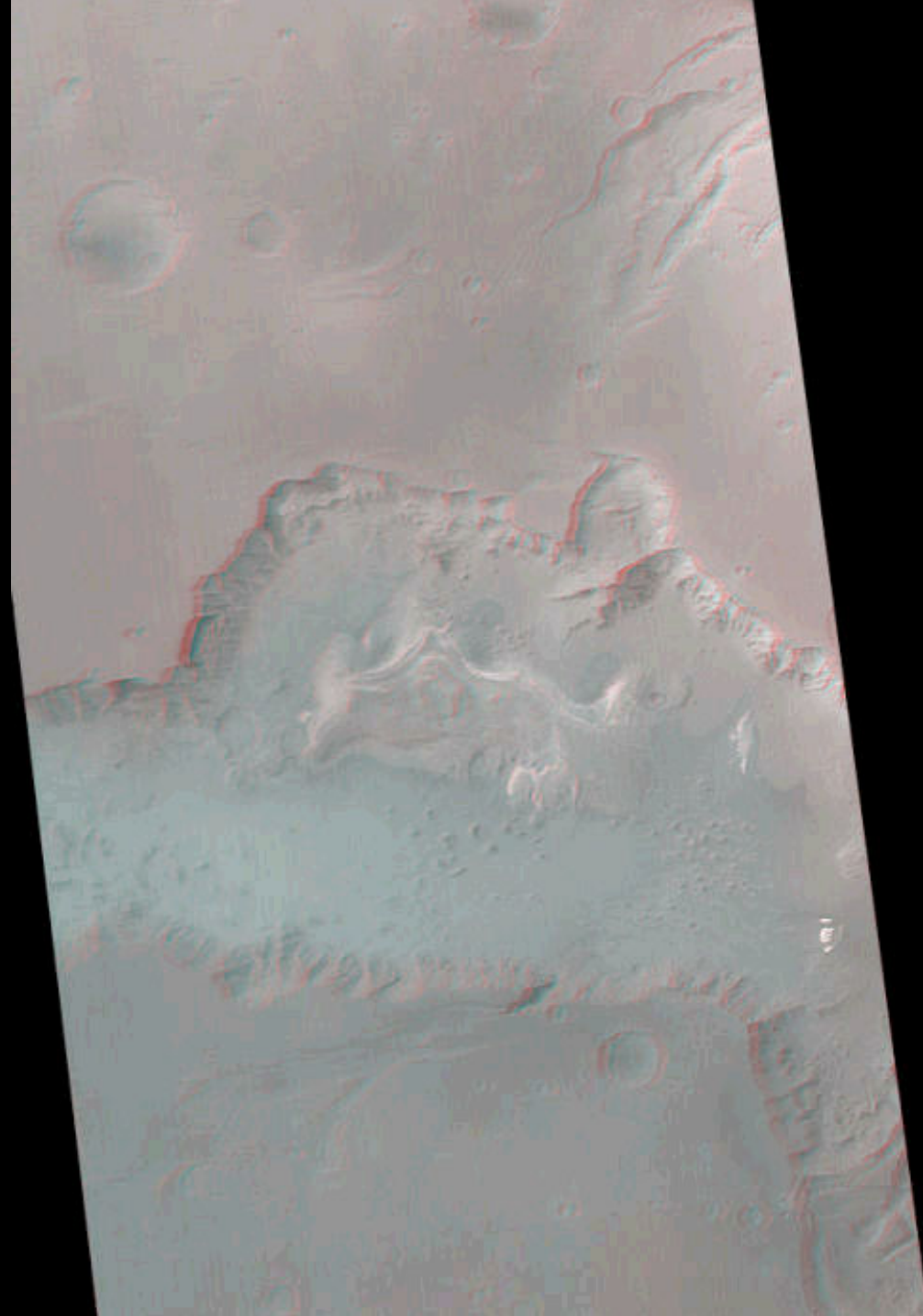

VALLES MARINERIS AND
OUTFLOW CHANNEL ELEVATIONS
NASA/MOLA
90˚W
80˚W
70˚W
60˚W
50˚W
40˚W
30˚W
20˚N
10˚N
0˚N
10˚S
20˚S
270˚E
280˚E
290˚E
300˚E
310˚E
320˚E
330˚E
elevation (km)
–5.5 –5.2 –4.9 –4.6 –4.3 –4.0 –3.7 –3.4 –3.1 –2.8 –2.5 –2.2 –1.9

OUTFLOW CHANNEL, KASEI VALLES

NASA VIKING MOSAIC

OUTFLOW CHANNEL FEATURES

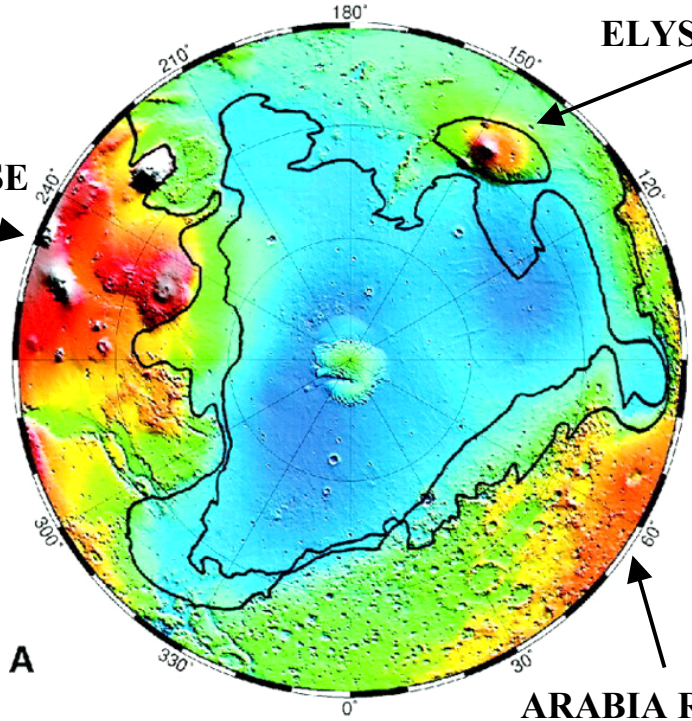
GANGES CHASMA OUTFLOW 3D



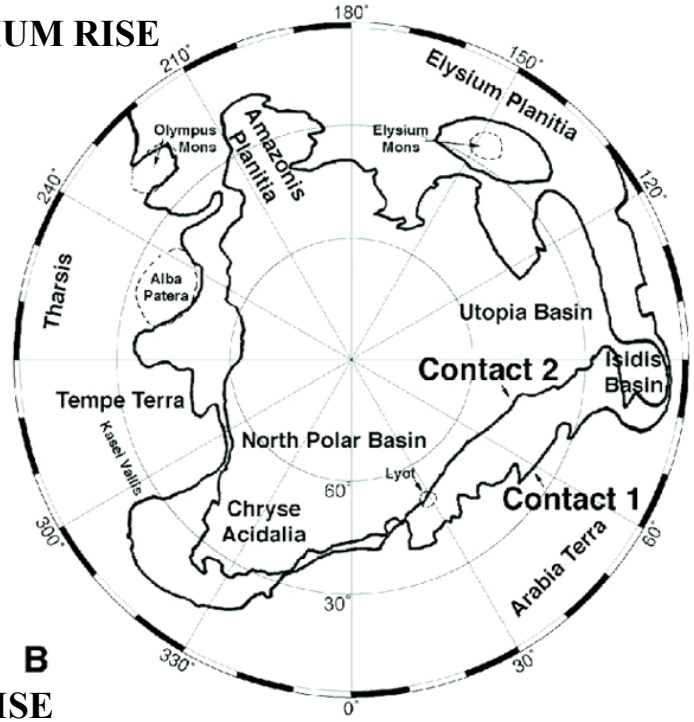
NASA/JPL/MALIN SCIENCE SYSTEMS

ELYSIUM RISE

THARSIS RISE



A

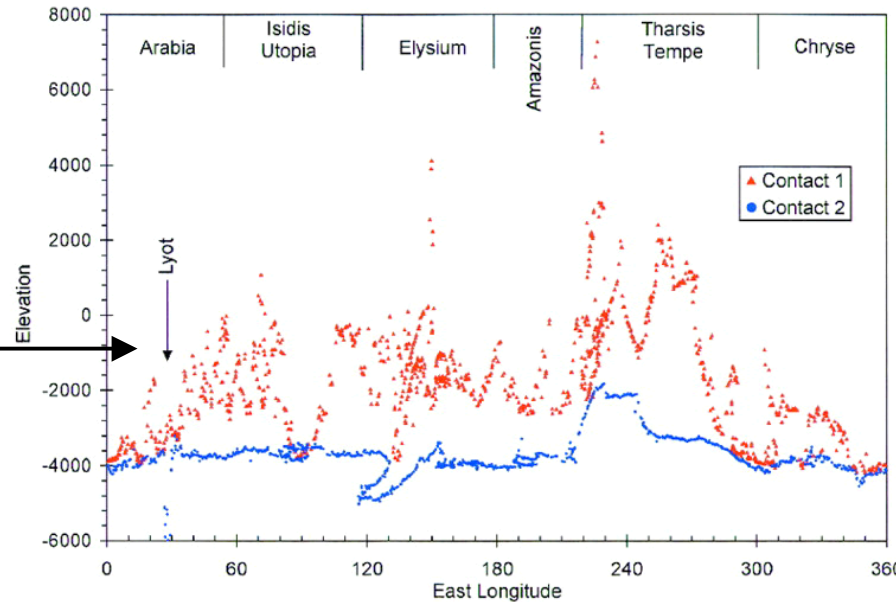


B

ARABIA RISE

PROPOSED SHORELINES FOR A NORTHERN OCEAN ON MARS

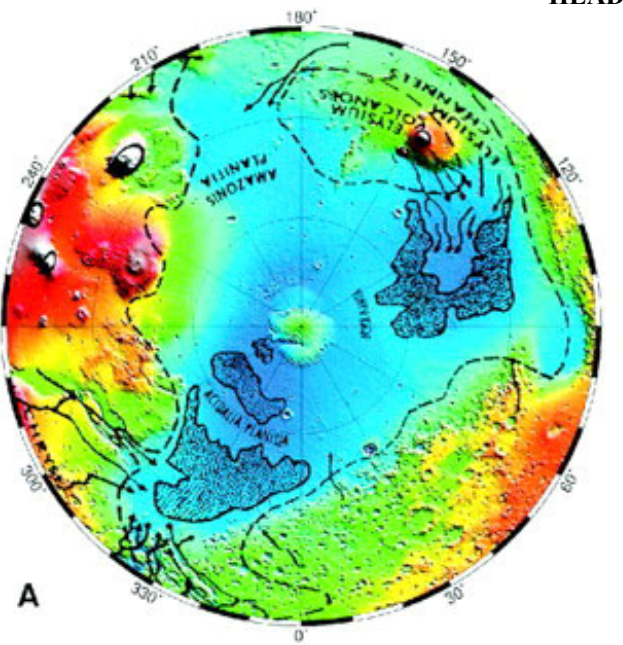
HEAD, J.W.,III, AND CO-WORKERS, 1999, SCIENCE, 286,2134-2137



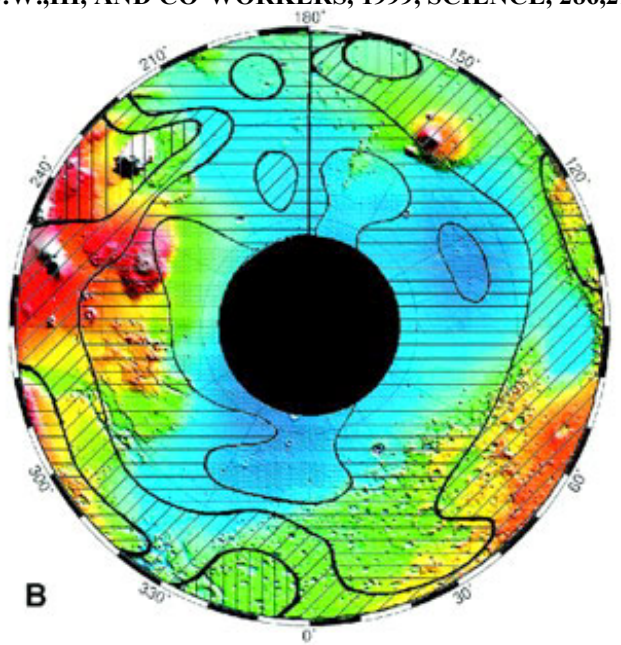
NOTE: OLDER, CONTACT 1, AND TO A LESSER DEGREE, CONTACT 2 ARE MOST DISPLACED UPWARD IN AREAS OF THE THARSIS, ARABIA, AND ELYSIUM RISES WHICH MUST POST-DATE A POSSIBLE "EARLY" NORTHERN OCEAN.

SEQUENCIAL FLOODING OF NORTHERN LOWLANDS

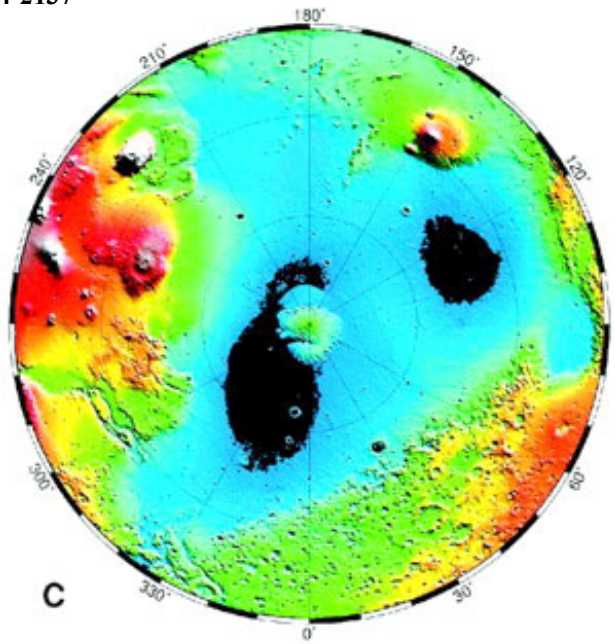
HEAD, J.W.,III, AND CO-WORKERS, 1999, SCIENCE, 286,2134-2137



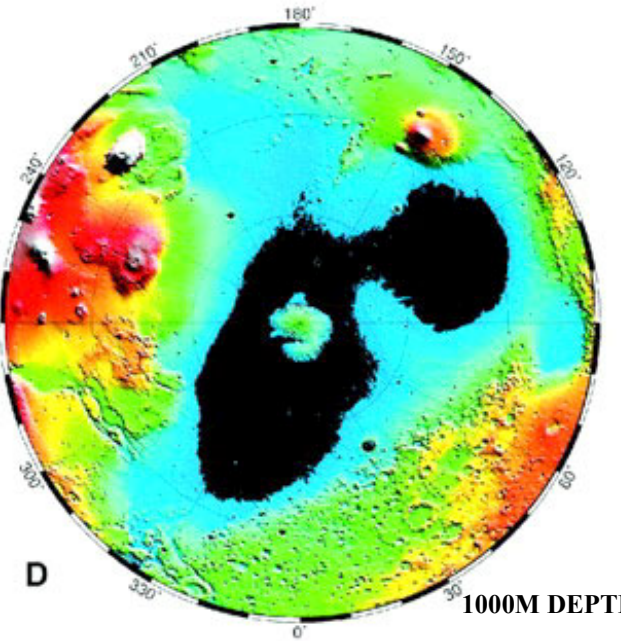
STIPPLED SHOWS POLYGONAL GROUND



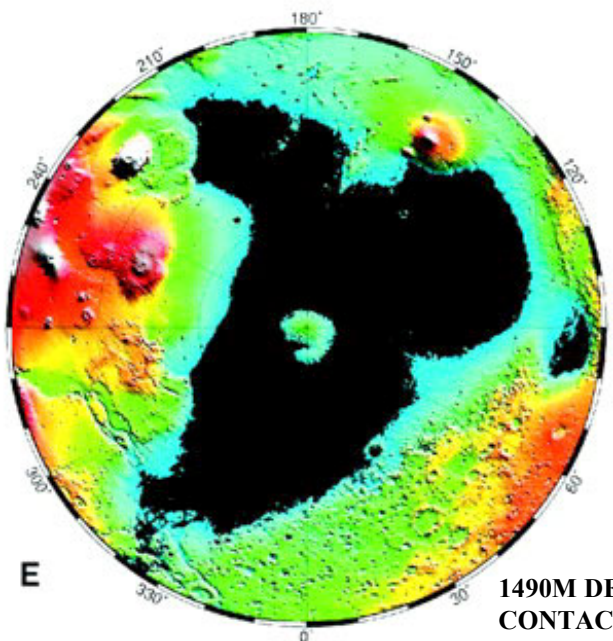
CRATER ONSET DIAMETERS INCREASE RADIALLY



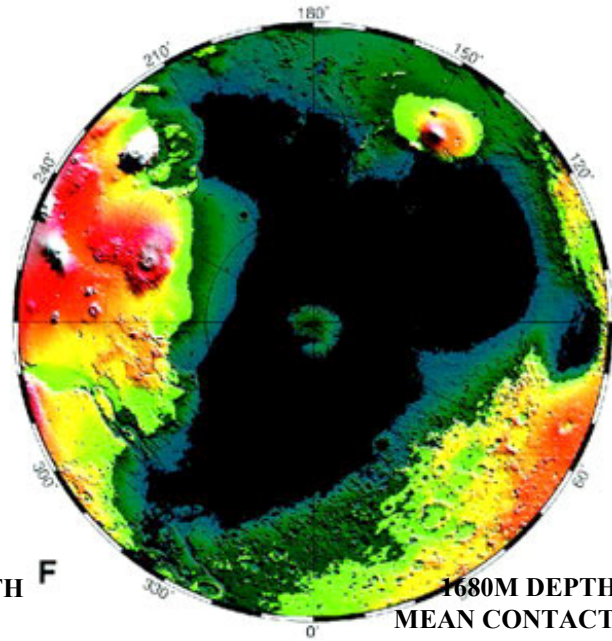
500M DEPTH



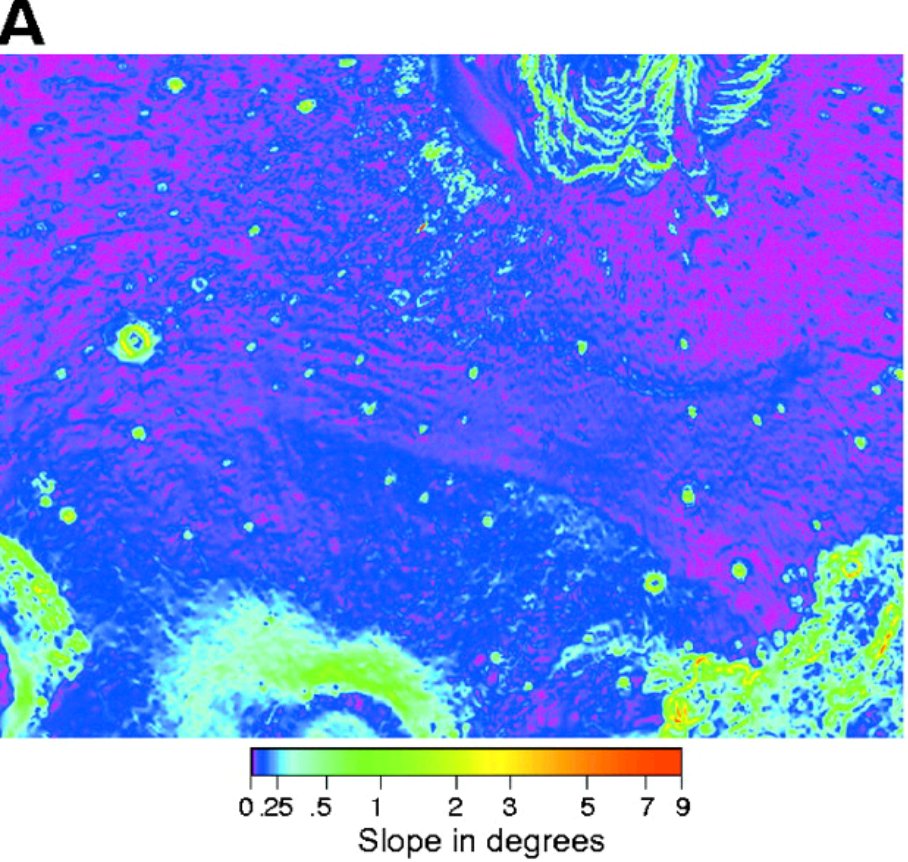
1000M DEPTH

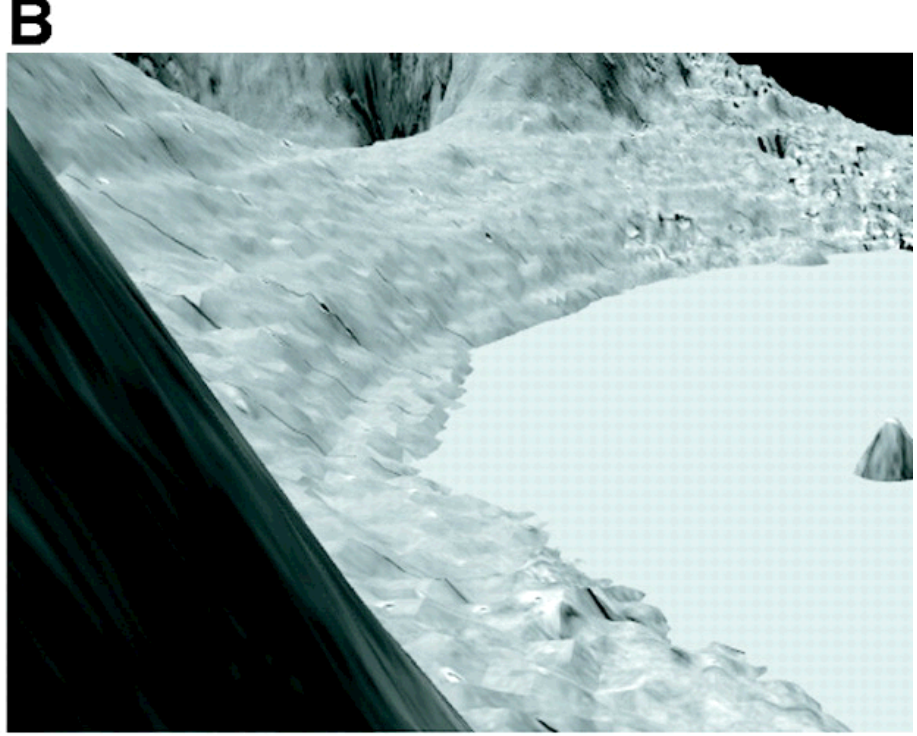


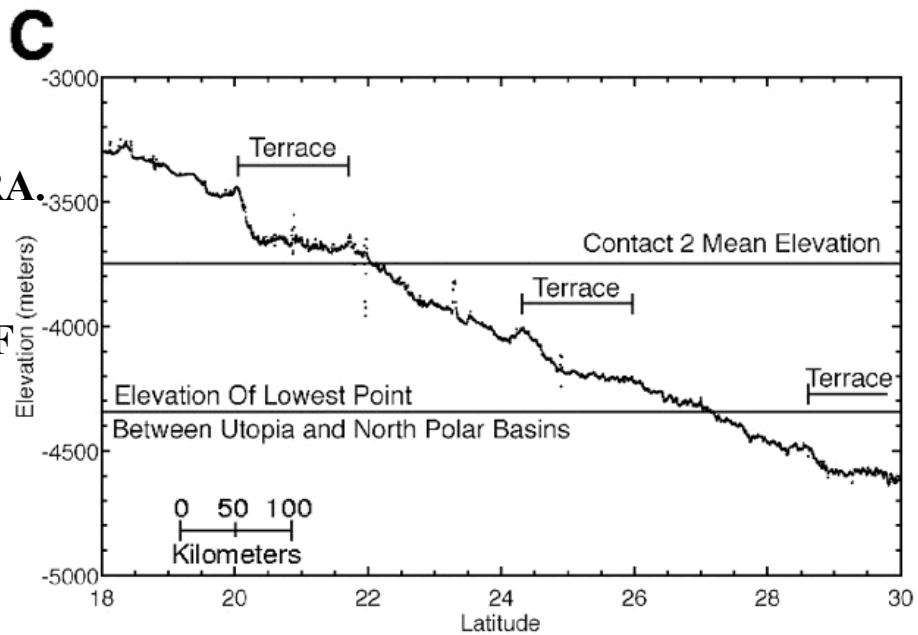
1490M DEPTH
CONTACT 2



1680M DEPTH
MEAN CONTACT





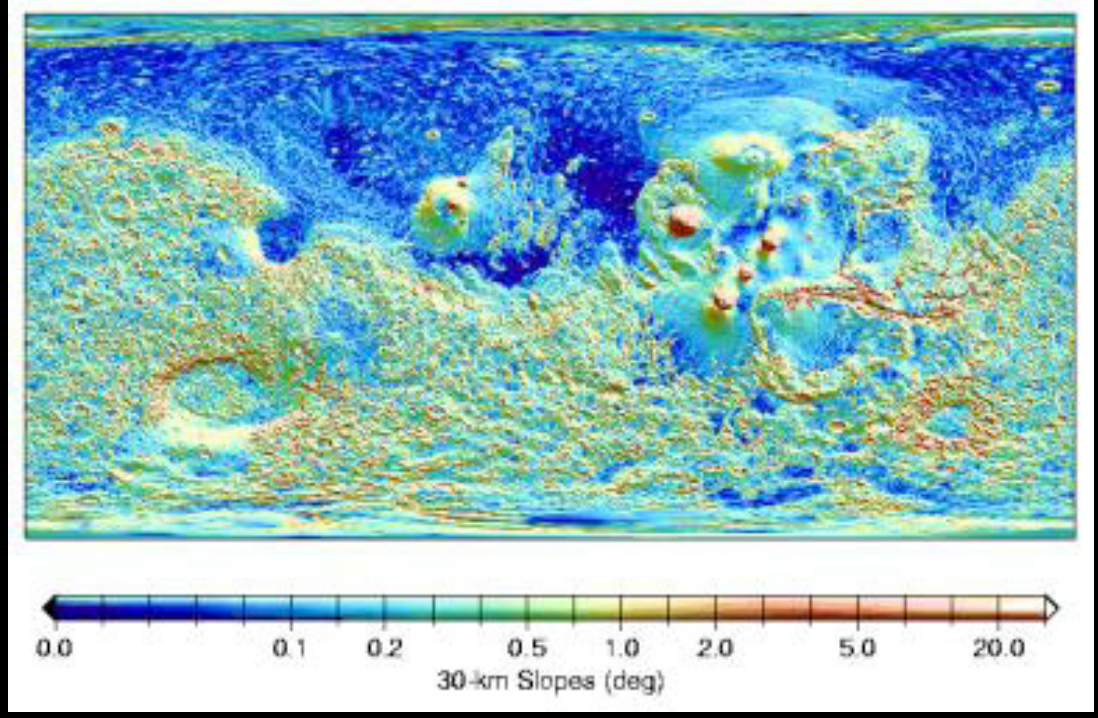


A. LINEAR SLOPE CHANGES ON ALBA PATERA.

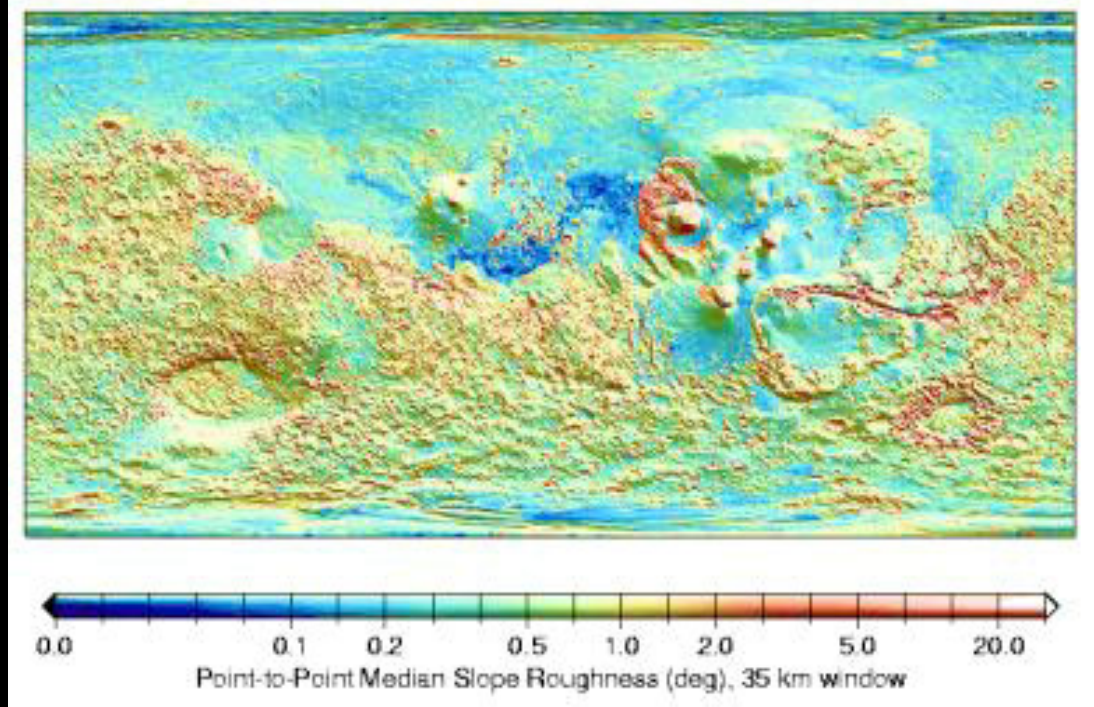
B. MOLA PERSPECTIVE VIEW OF APPARENT TERRACES AT THE SOUTHERN MARGIN OF UTOPIA PLANITIA.

C. MOLA PROFILE ACROSS SOUTHERN UTOPIA PLANITIA

HEAD, J.W.,III, AND CO-WORKERS, 1999, SCIENCE, 286,2134-2137



MOLA SLOPE MAP (OVER 30 KM)



MOLA ROUGHNESS MAP (OVER 35 KM WINDOW

NASA MARS GOLBAL SURVEYOR/MOLA

THARSIS / ELYSIUM VOLCANISM UPLIFT CONSEQUENCES - 1

- THARSIS / ELYSIUM VOLCANISM
  - PARTIAL MELTING OF MANTLE
    - CONCENTRATION OF RADIOISOTOPES IN HIGH PRESSURE MANTLE (?)
  - 3×10^3 KM^3 MAGMA IN SURFACE EXPRESSION OF THARSIS RISE
  - DENSE $C0_2$ AND H_20 ATMOSPHERE
    - ACTIVATION OF HYDROSPHERE, CRYOSPHERE AND CARBONATE DEPOSITS
    - PRIMARY WATER FROM HYDROUS MINERALS IN LOWER MANTLE (?)
  - ANDESITIC RESURFACING OF NORTHERN LOWLANDS

THARSIS / ELYSIUM VOLCANISM UPLIFT CONSEQUENCES -2

- THARSIS RISE BEGAT ARABIA TERRA RISE
  - EXTENTIONAL FRACTURING TO GIVE GIANT RIFT VALLEYS
    - BECAME OUTFLOW CHANNELS
  - HEAT TO ACTIVATE THE HYDROSPHERE/CRYOSPHERE
    - SOURCE FOR OUTFLOW FLOODS
  - TROUGH SURROUNDING THARSIS
    - NORTHWARD FLOW FROM MAJOR OUTFLOW CHANNELS
    - ERODED MATERIALS DEPOSITED ON NORTHERN OCEAN BED
  - UPWARD DEFORMATION OF THE EARLY NORTHERN OCEAN SHORELINE
    - LATE, LOCAL DEFORMATION OF LATE NORTHERN OCEAN SHORELINE

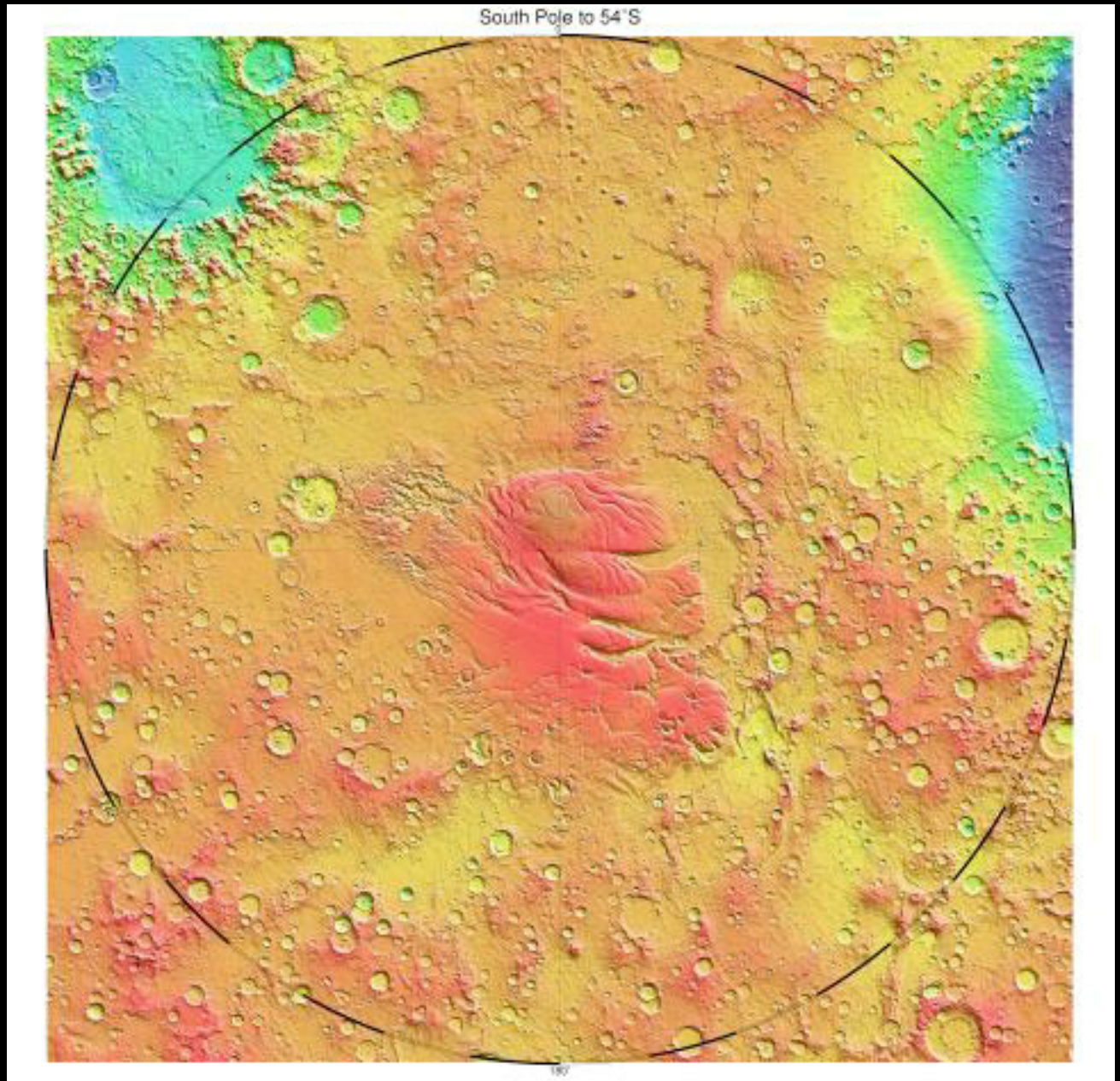
NORTHERN LOWLANDS/OCEANS

- LARGE, IRREGULAR BASIN
  - SEVERAL VERY LARGE IMPACTS(?)
  - INTERNAL PROCESS THAT THINNED CRUST(?)

- EVIDENCE FOR NORTHERN OCEAN(S)
  - DRAINAGE FROM VALLEY NETWORKS (EARLY VOLCANISM)
    - ABUNDANCE OF OLD LAYERED ROCKS
  - DRAINAGE FROM OUTFLOW CHANNELS (THARSIS VOLCANISM)
  - SHORELINE/STANDSTILL TERRACES(?)
  - SMOOTH TOPOGRAPHY RELATIVE TO SOUTHERN UPLANDS
  - VOLUME ENCLOSED PLAUSIBLE RELATIVE TO POTENTIAL WATER VOLUME
  - EVIDENCE FOR RECENT OR CURRENT GROUND ICE OR GROUND WATER
    - POLYGONAL GROUND
    - RAMPART CRATER EJECTA

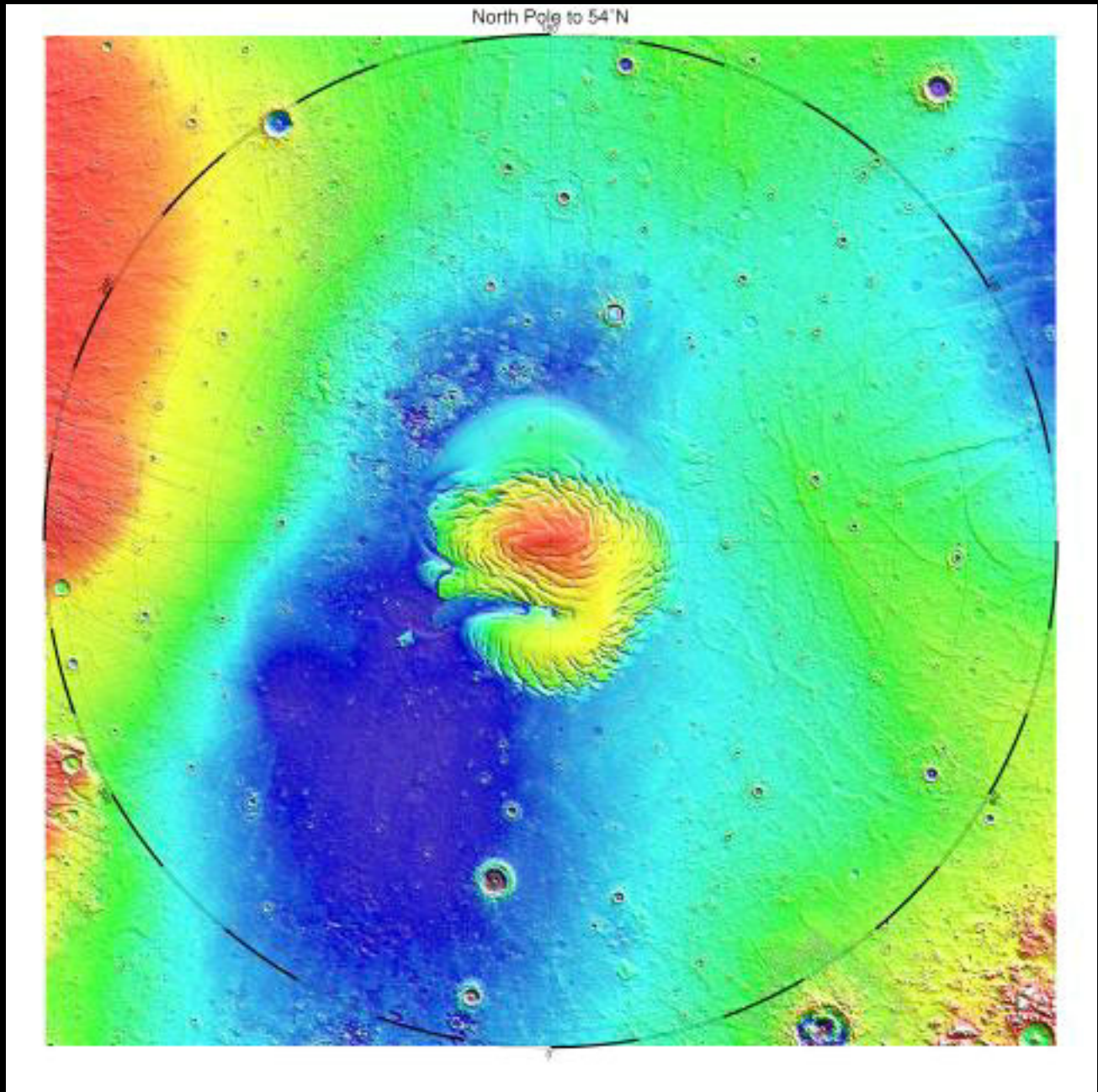
SOUTH POLE TOPOGRAPHY

MOLA SCIENCE TEAM



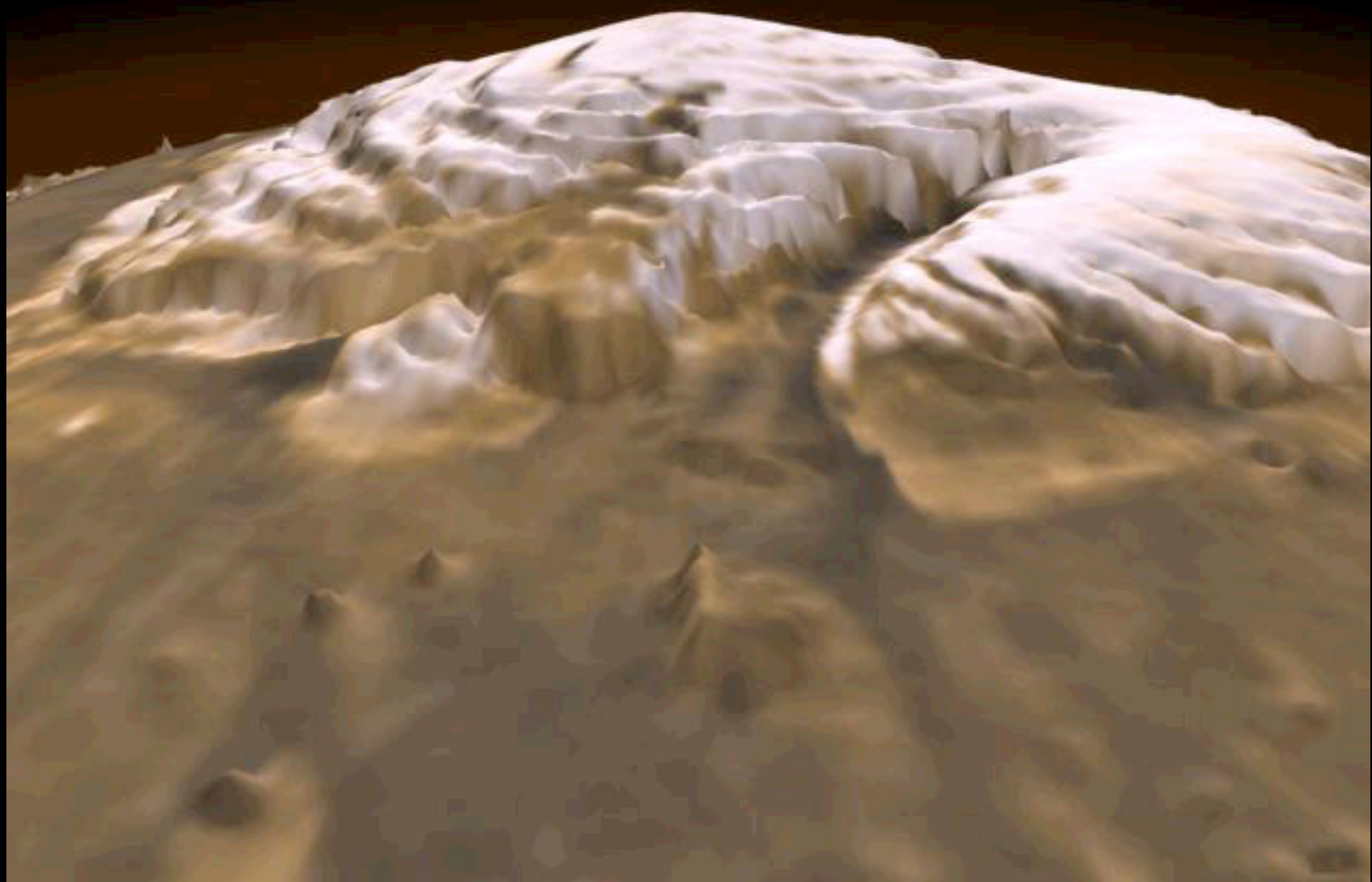
NORTH POLE TOPOGRAPHY

MOLA SCIENCE TEAM



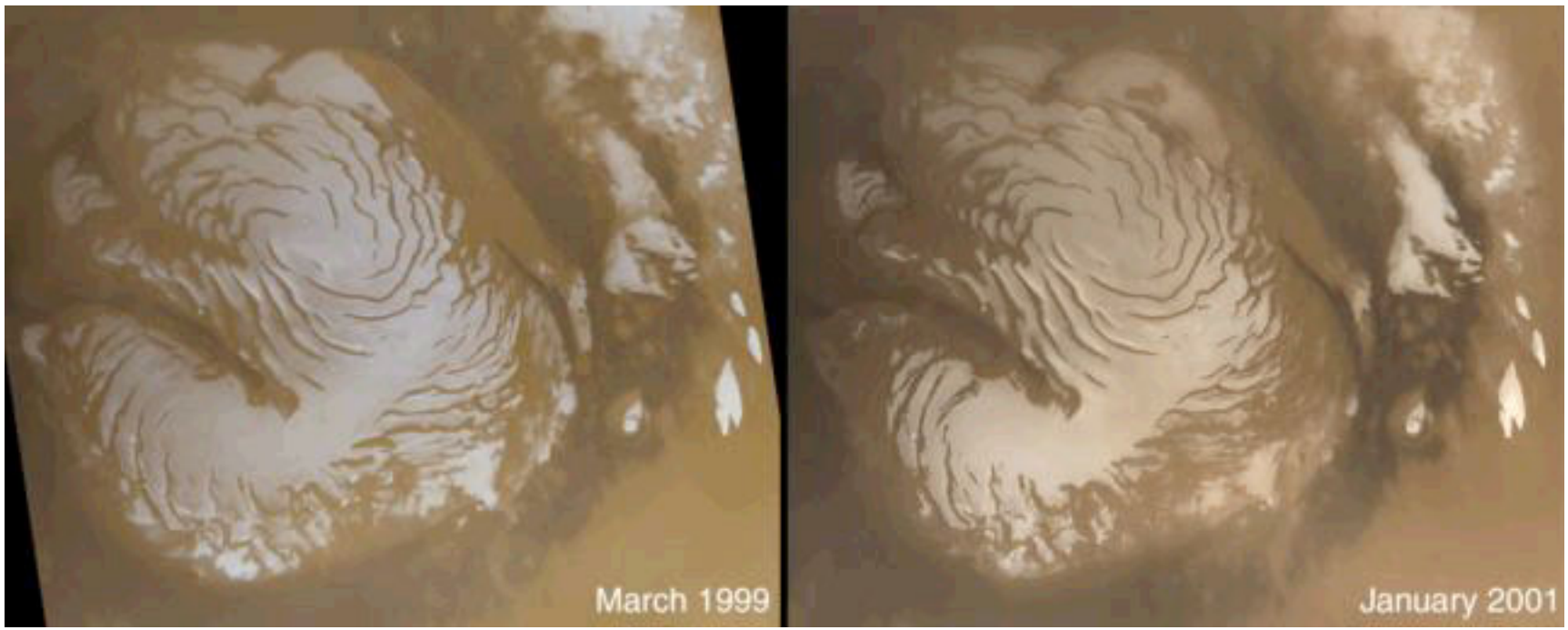
3D VIEW OF NORTH POLAR CAP

MOLA SCIENCE TEAM/ NASA/GFSC SVS

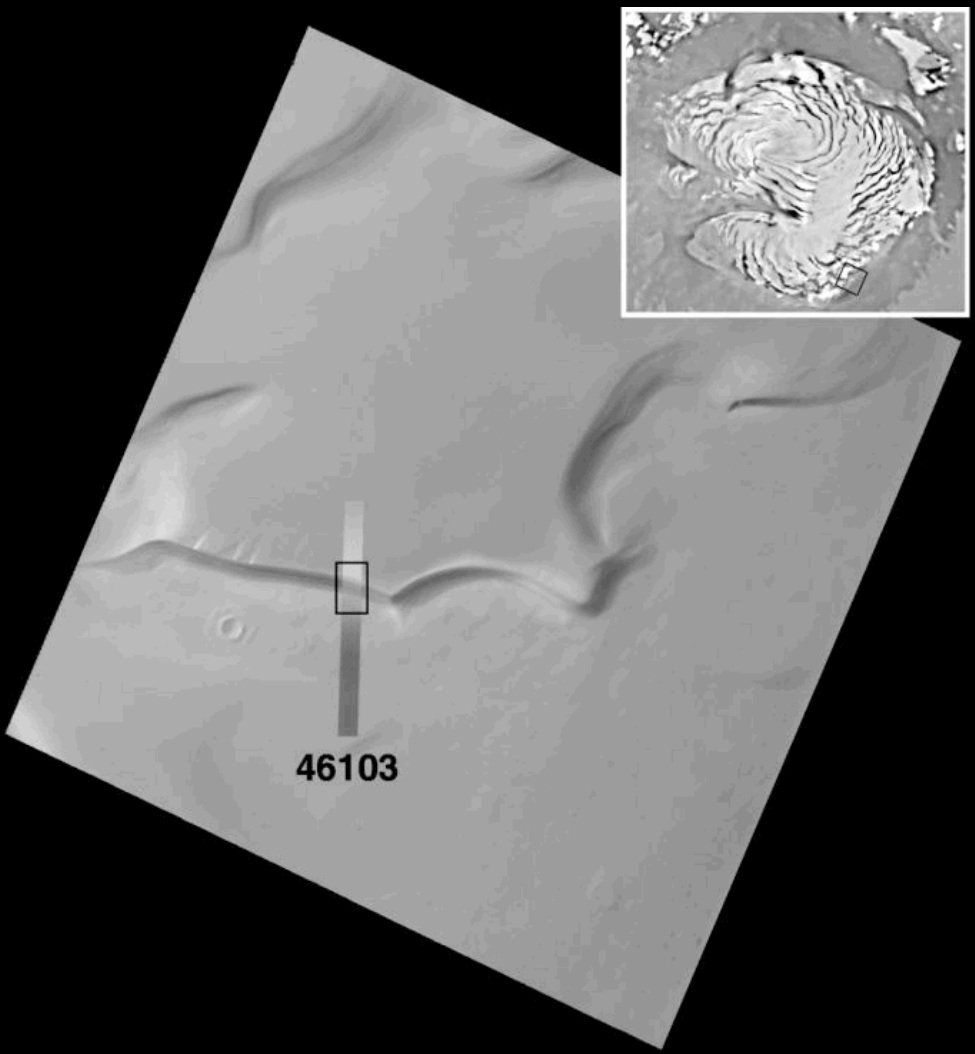


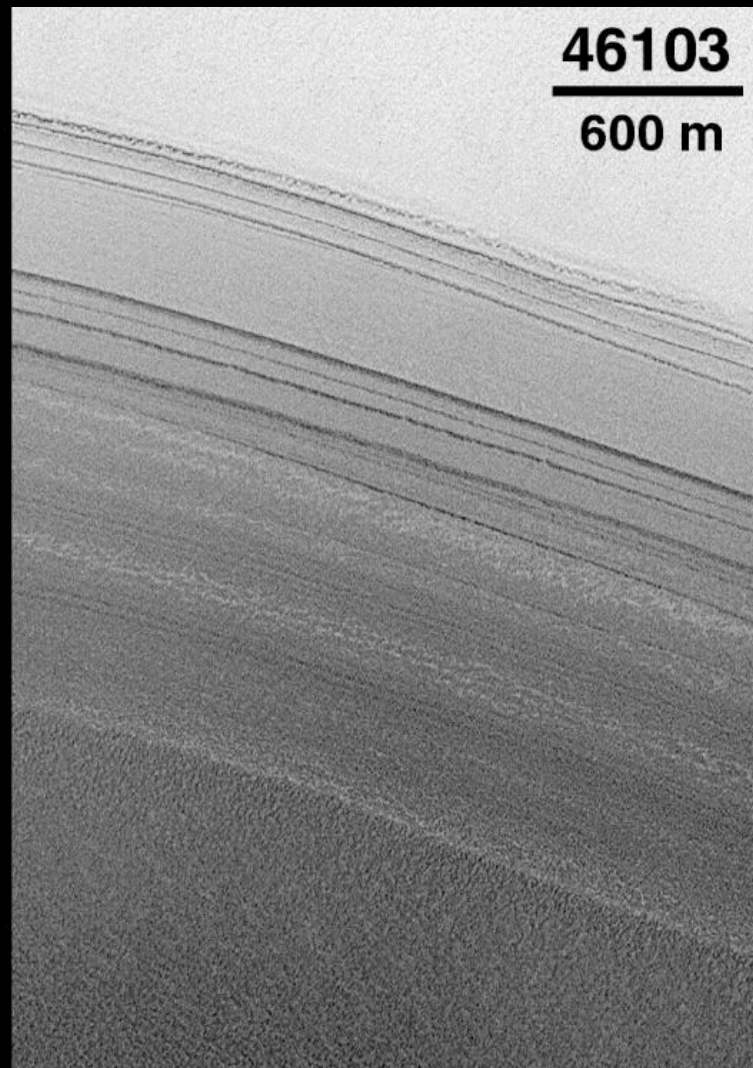
SOUTH POLAR CAP

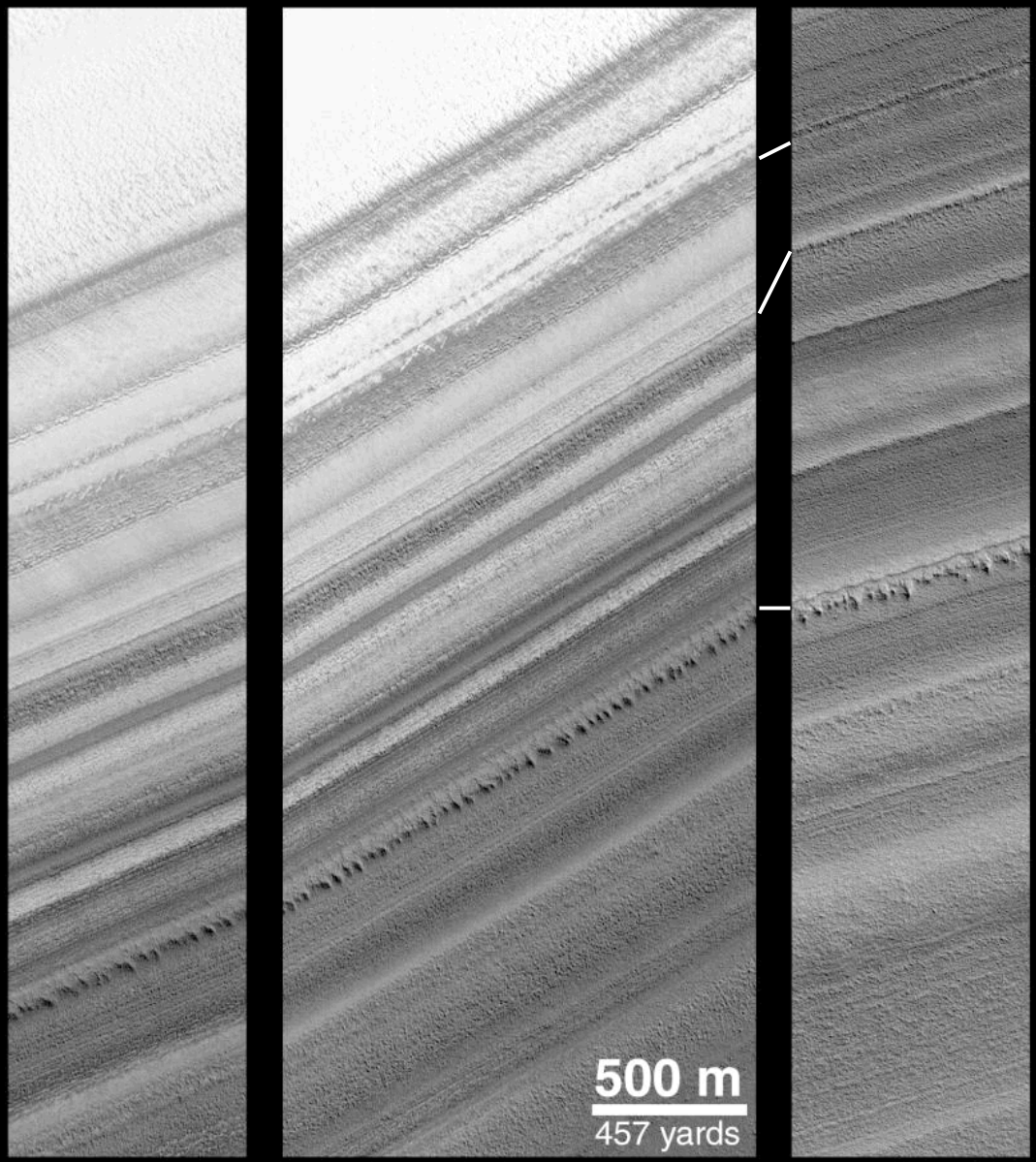
NASA/JPL/MALIN SCIENCE SYSTEMS


March 1999
January 2001

NORTH POLAR CAP LAYERS



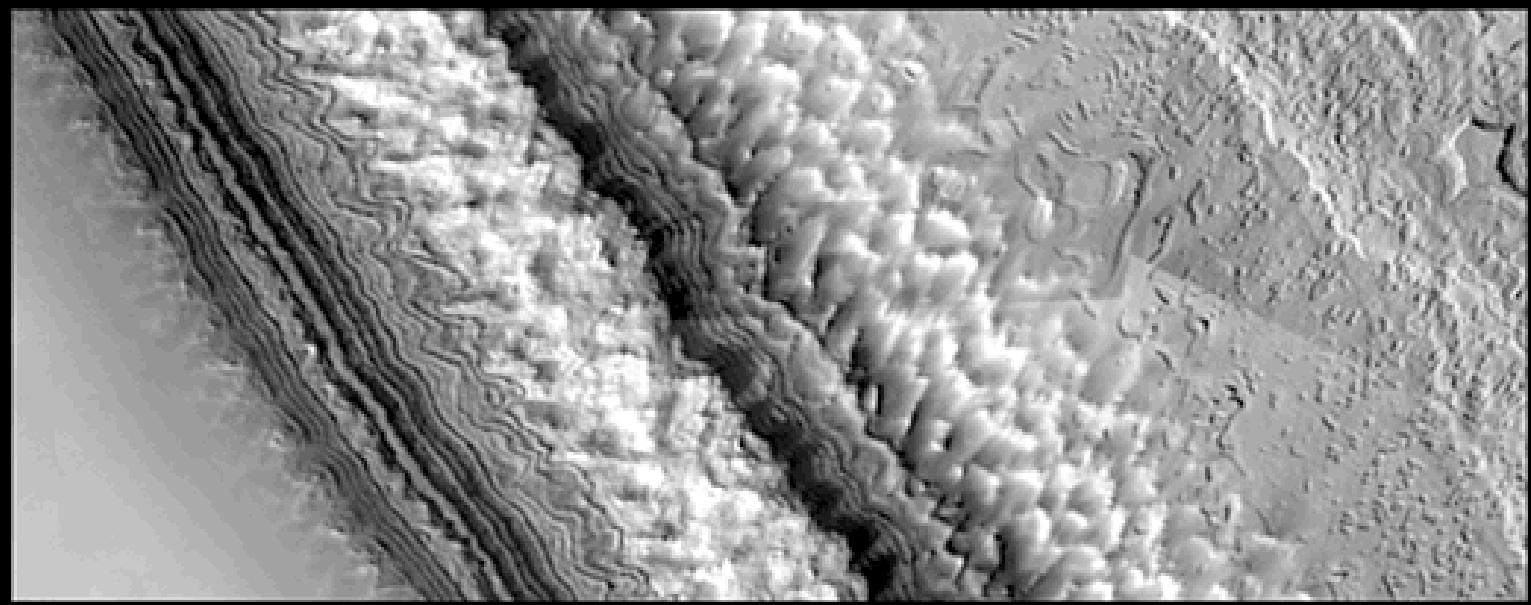




100 KM BETWEEN LEFT AND RIGHT IMAGES

SOUTH POLAR CAP LAYERING AND EROSION

1 KM

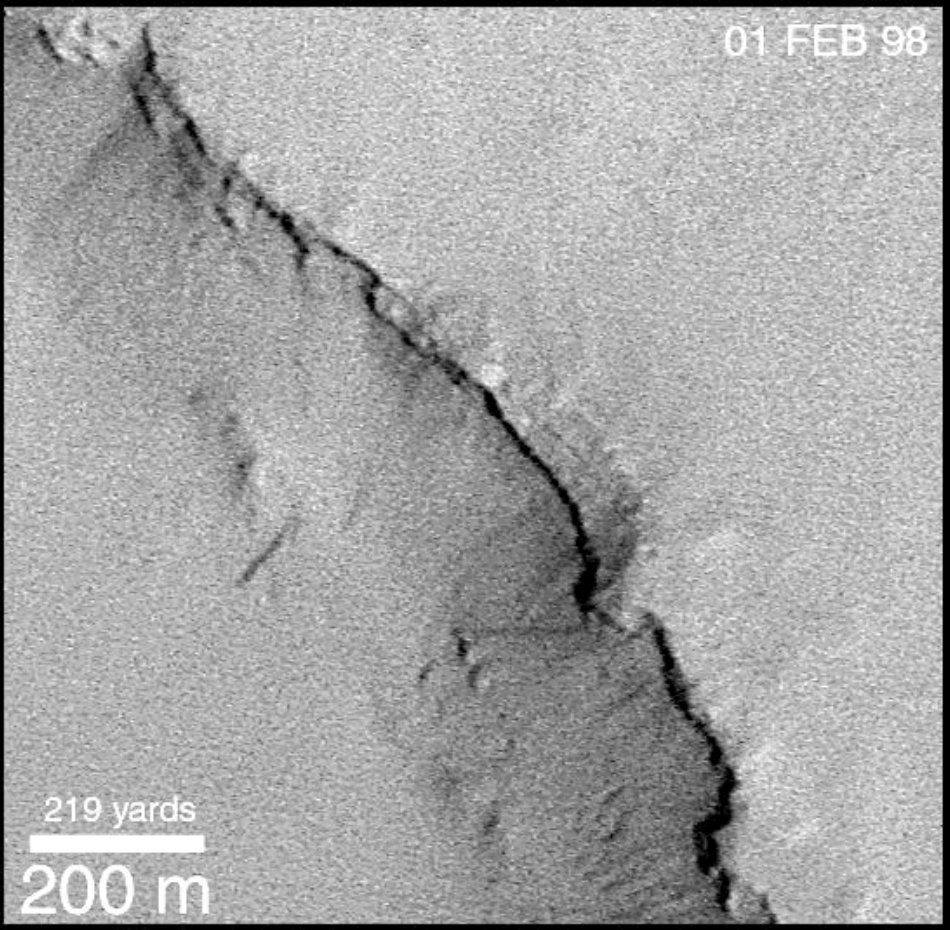


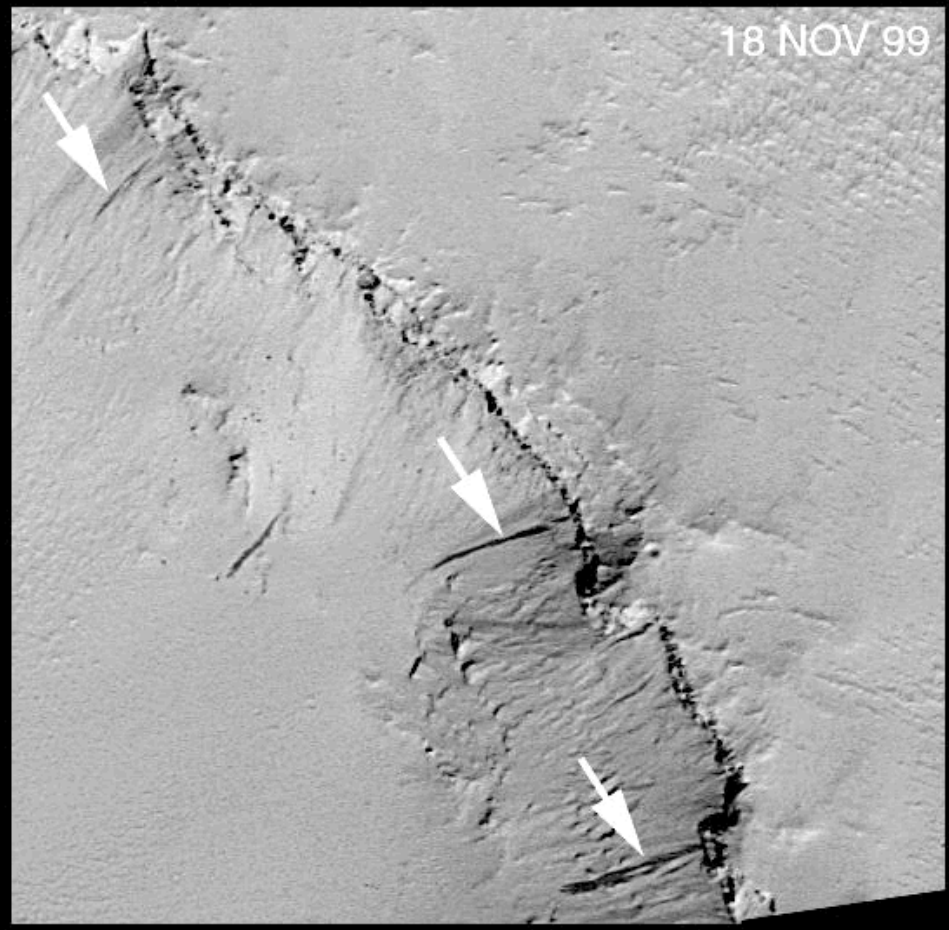
PIA02391

PIA02392

NASA/JPL/MALIN SCIENCE SYSTEMS

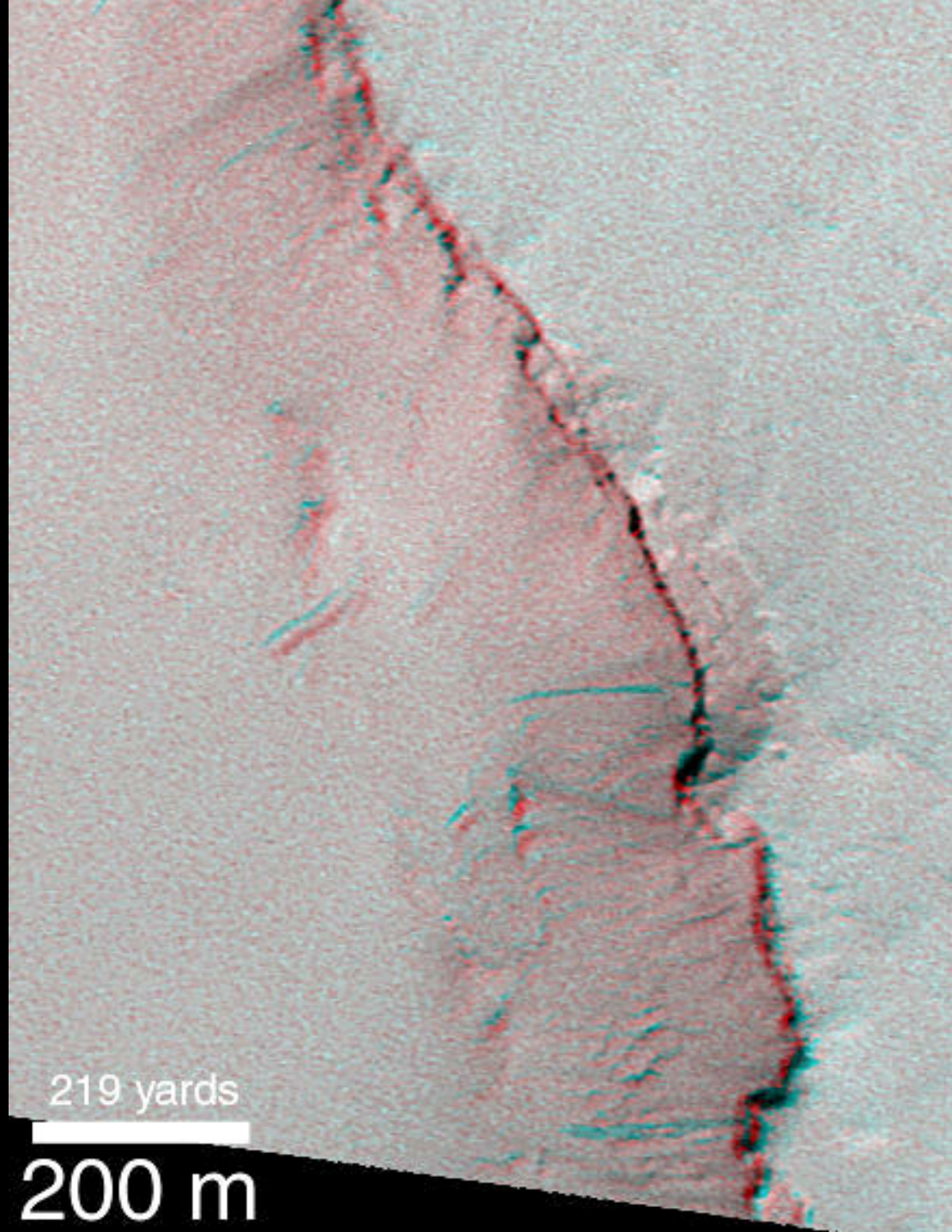
NEW MARTIAN LANDSLIDES
(DARK STREAKS ON INNER WALL OF CRATER



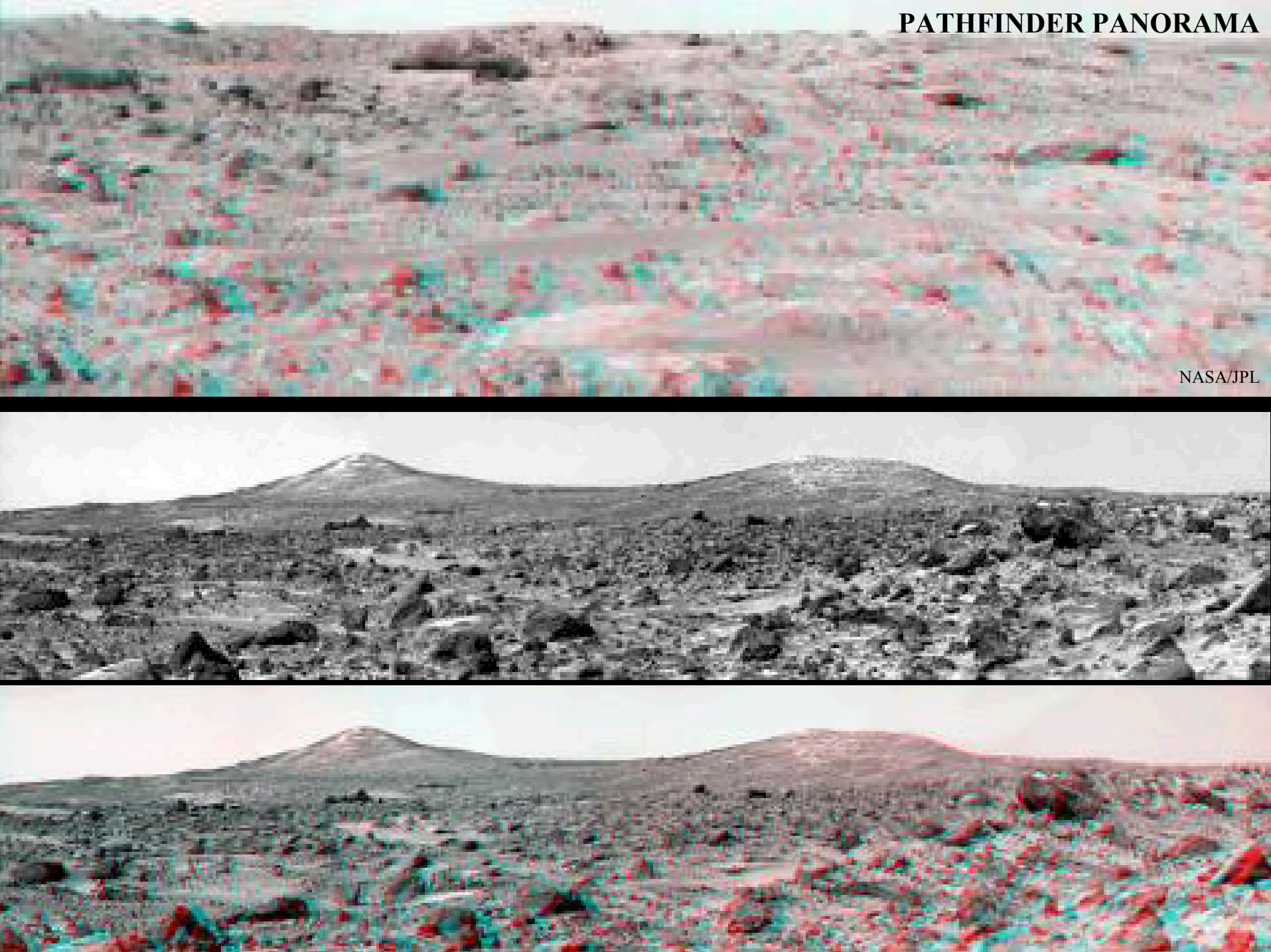


NASA/JPL/MALIN SCIENCE SYSTEMS

LANDSLIDE IN 3D



NASA/JPL/MALIN SCIENCE SYSTEMS


PATHFINDER PANORAMA
NASA/JPL

PATHFINDER/SOUJOURNER

NASA/JPL

“TRUE COLOR OF MARS”
PATHFINDER LANDER VIEW

NASA/JPL