XXIII International Cartographic Conference

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Cartography for everyone and for you

Cartographic Mapping of Mars Landing Sites: A Historical Perspective

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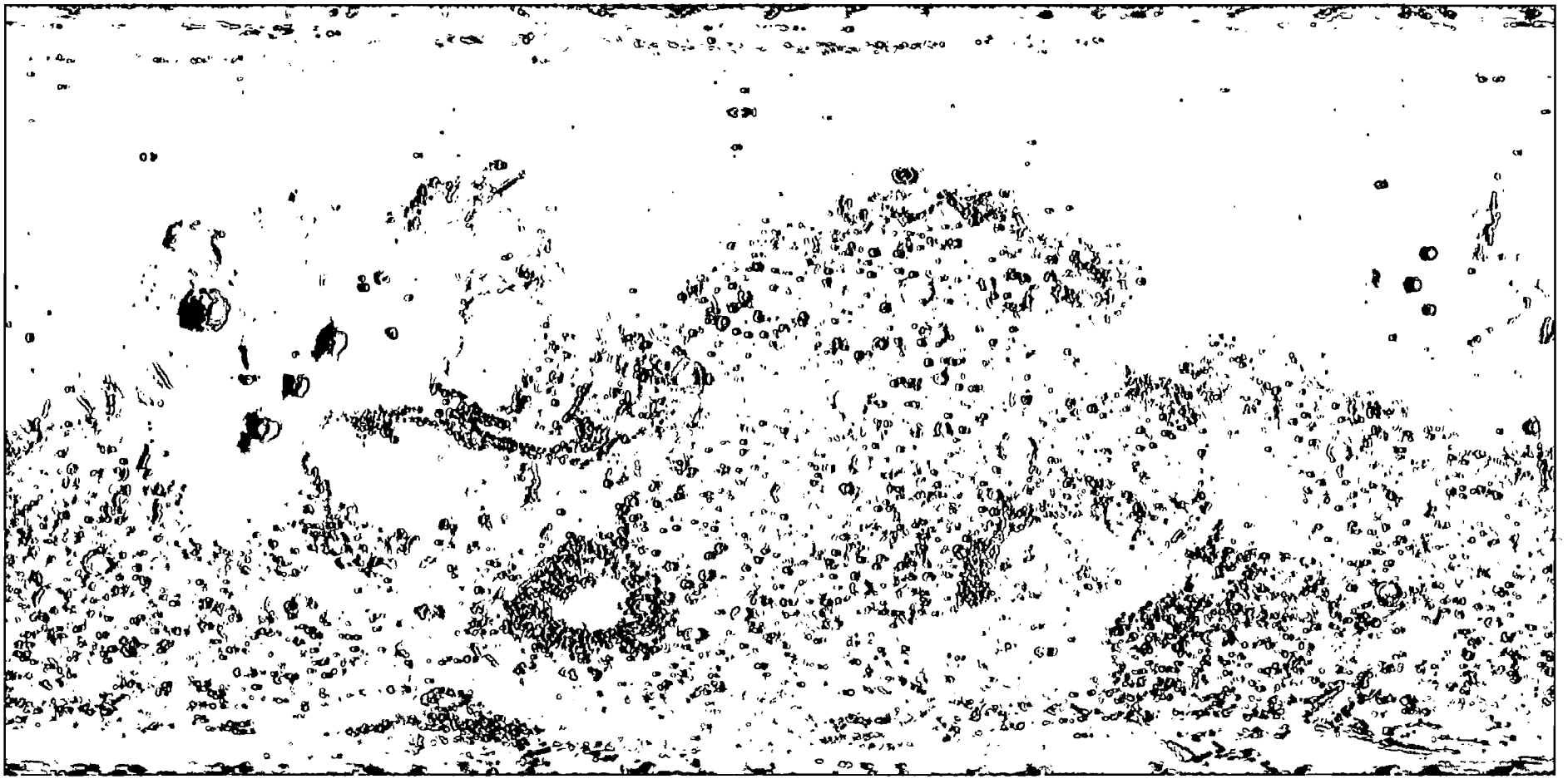
MARS LANDING SITE CARTOGRAPHY

- The ability to produce precision cartographic products for landing sites needed to assess / select sites and then support mission operations for targeting the landing and roving operations has improved by orders of magnitude since Viking in 1976
  - Inaccurate gravity field yielded inaccurate orbits > a few km
  - Older star trackers gave inaccurate pointing knowledge and control leading to errors on the ground > a few km
  - No absolute control for control network ties to inertial space > a few km
  - Cameras used vidicons having low metric accuracies - 10's to 100's of meters
  - Large errors in spin axis, spin rate and location of prime meridian > a few km

Mars Pathfinder - Classic Stereo Photogrammetry
Viking Orbiter Imaging - no MGS MOLA

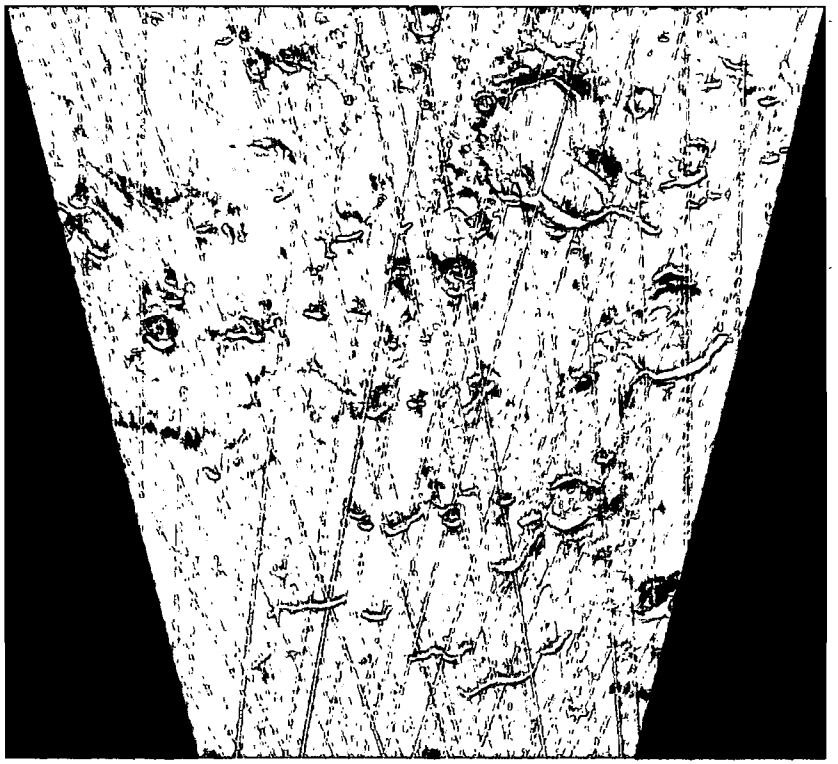
MGS GLOBAL MOLA DTM



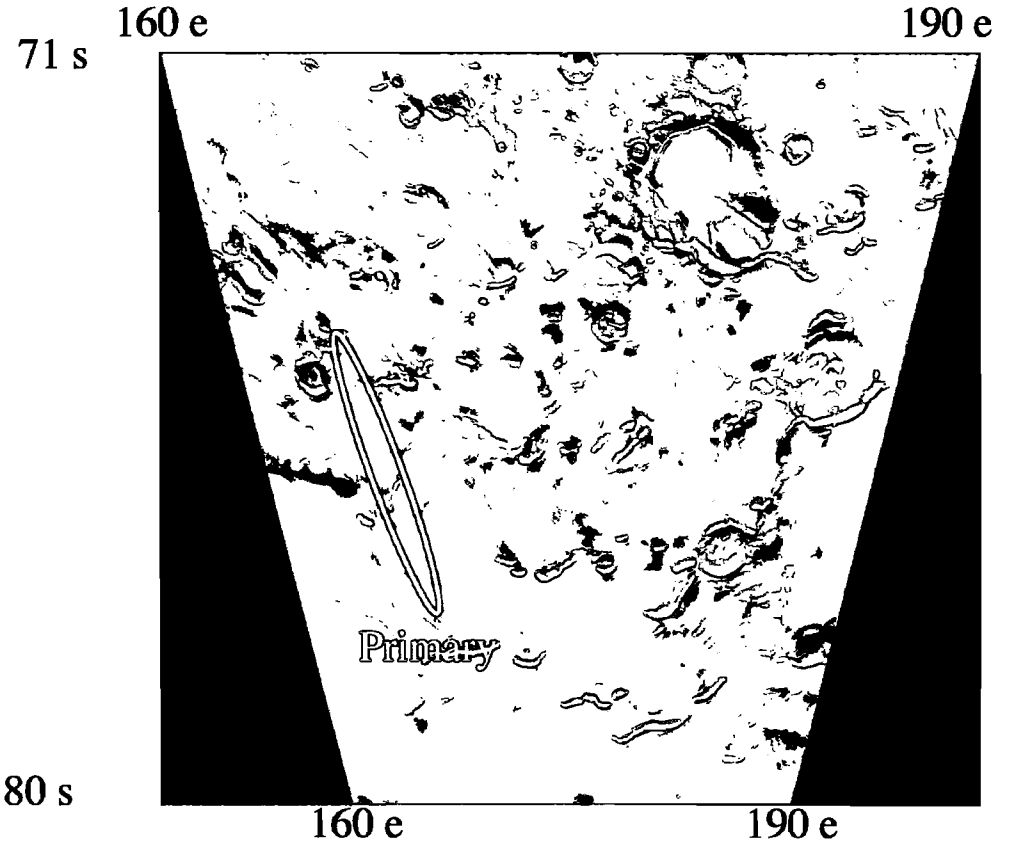
NASA / JPL / MGS / MOLA / GSFC / D. Smith - PI

http://pds-geosciences.wustl.edu/missions/mgs/mola.html

Mars Polar Lander - First Use of MOLA Control

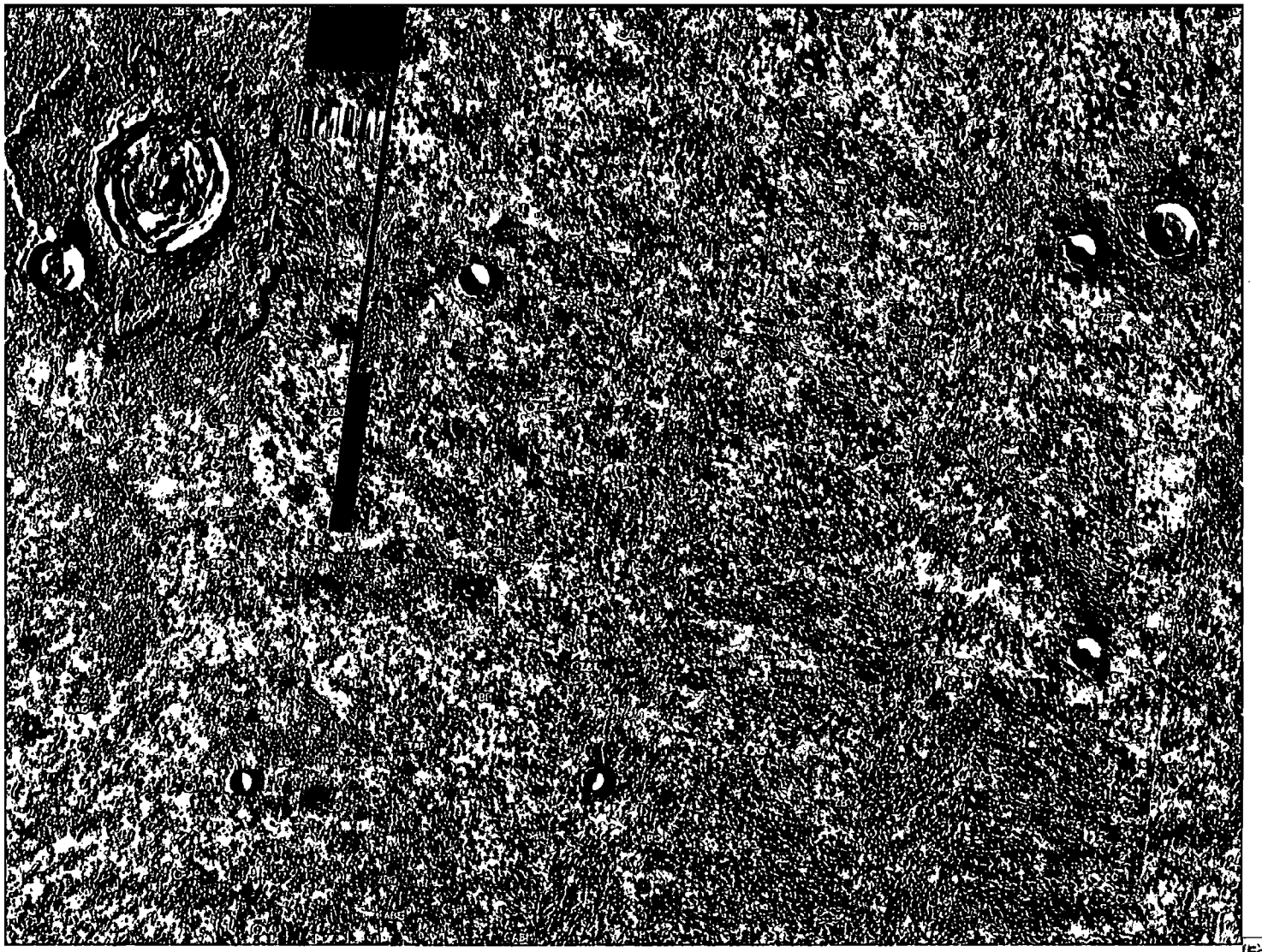


300 MOLA Ground Tracks through June 1999
in MPL Site giving > 400,000 Altimetry Points



Beagle 2 in ISIDIS

ODYSSEY THEMIS IR / MGS MOLA



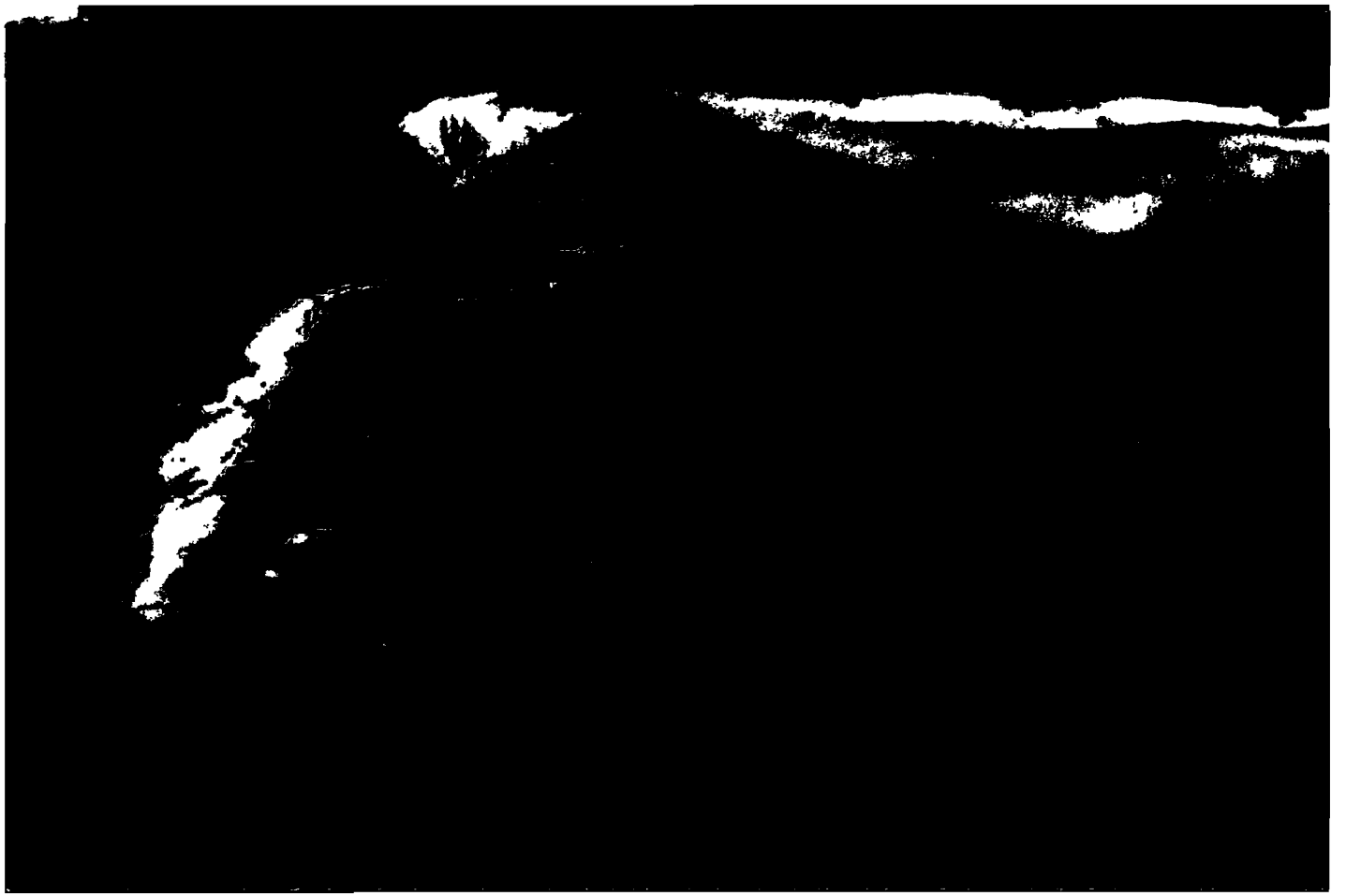
MER A Spirit in Gusev Crater
Viking Orbiter Imaging / MGS MOLA

MER B Opportunity in Meridiani
ODYSSEY THEMIS IR / MGS MOLA

Federal agency of geodesy and cartography

Airy 0 - Mars Prime Meridian Reference
ODYSSEY THEMIS IR / MGS MOLA

Mars Express HRSC / SRC

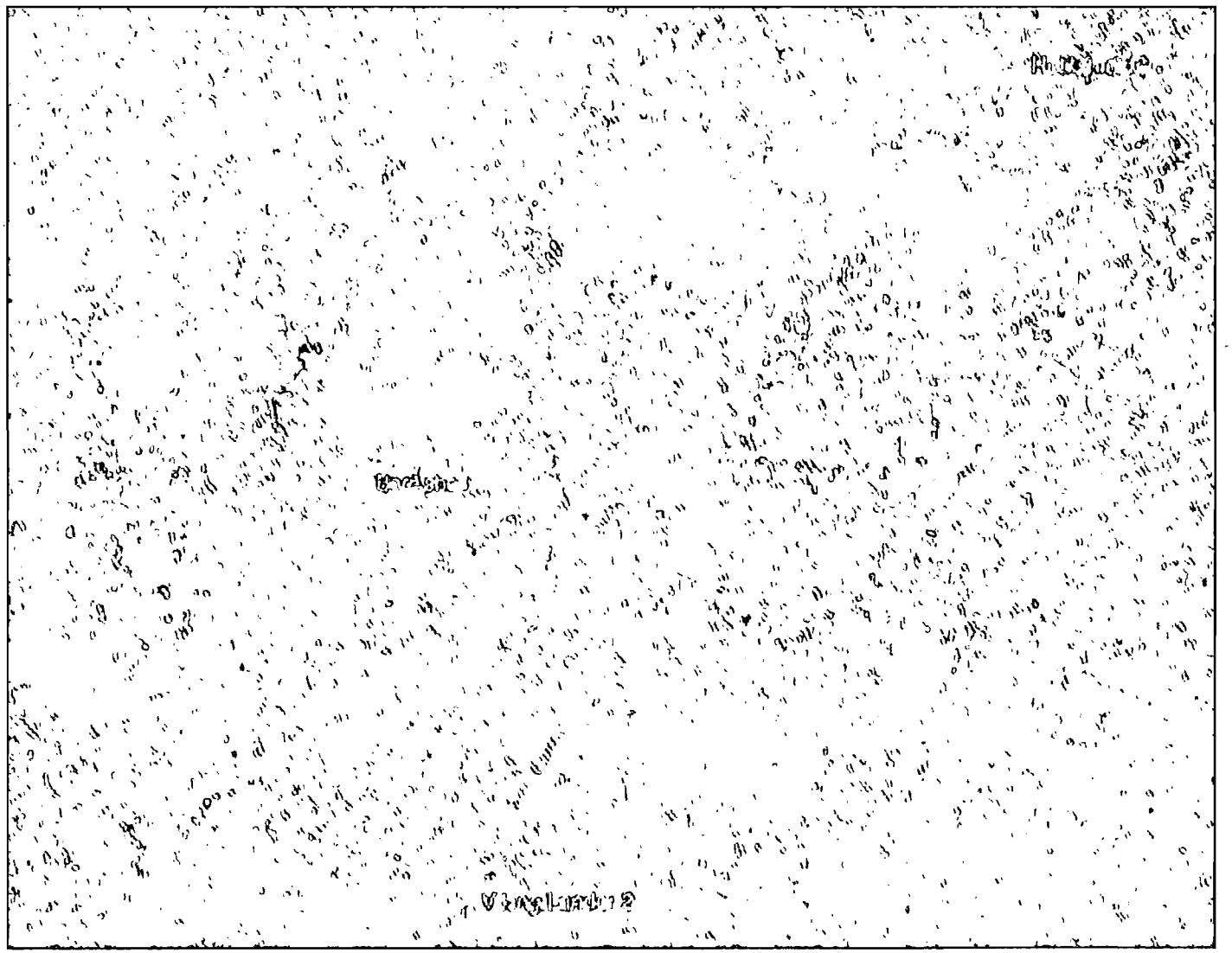


ESA / MEX / Freie University / HRSC / G. Neukum - PI

Viking Lander 1 as seen by MRO HiRise

NASA / JPL / MRO / Univ of AZ / HiRise / A. McEwen - PI

Viking Lander 2 as seen by MRO HiRise



NASA / JPL / MRO / Univ of AZ / HiRise / A. McEwen - PI

Conclusions

- Precision cartography for Mars landing sites is now common place
  - Global MOLA DTM exists for absolute control to < 100 m
  - Precision gravity field exists to compute orbits to < meters
  - Precision star cameras exist to provide control / knowledge to 100 m
  - Precision camera CCD detectors exist having negligible metric errors
  - THEMIS IR global coverage at 100 m / pixel exists
    - Replaces Viking Orbiter MDIM's by USGS @ 230 m / pixel
  - Precision absolute control points exist < meters
    - MRO HiRise images of VL-1, VL-2, MPF, MER A and B against Mars background (surface features in global control network)
  - Precision overlapping, stereo, and multispectral imaging of sites
    - ODY THEMIS VIS and MRO CRISM - 18 m / pixel
    - MEX HRSC - stereo at 15 m / pixel
    - MGS MOC and MEX SRC < a few m / pixel
    - MRO HiRise - 35 cm / pixel

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Presentation Type:	**Oral Presentation**
Main Topic:	**24. Planetary Cartography**
Abstract Title:	**Cartographic mapping of Mars landing sites: a historical perspective**
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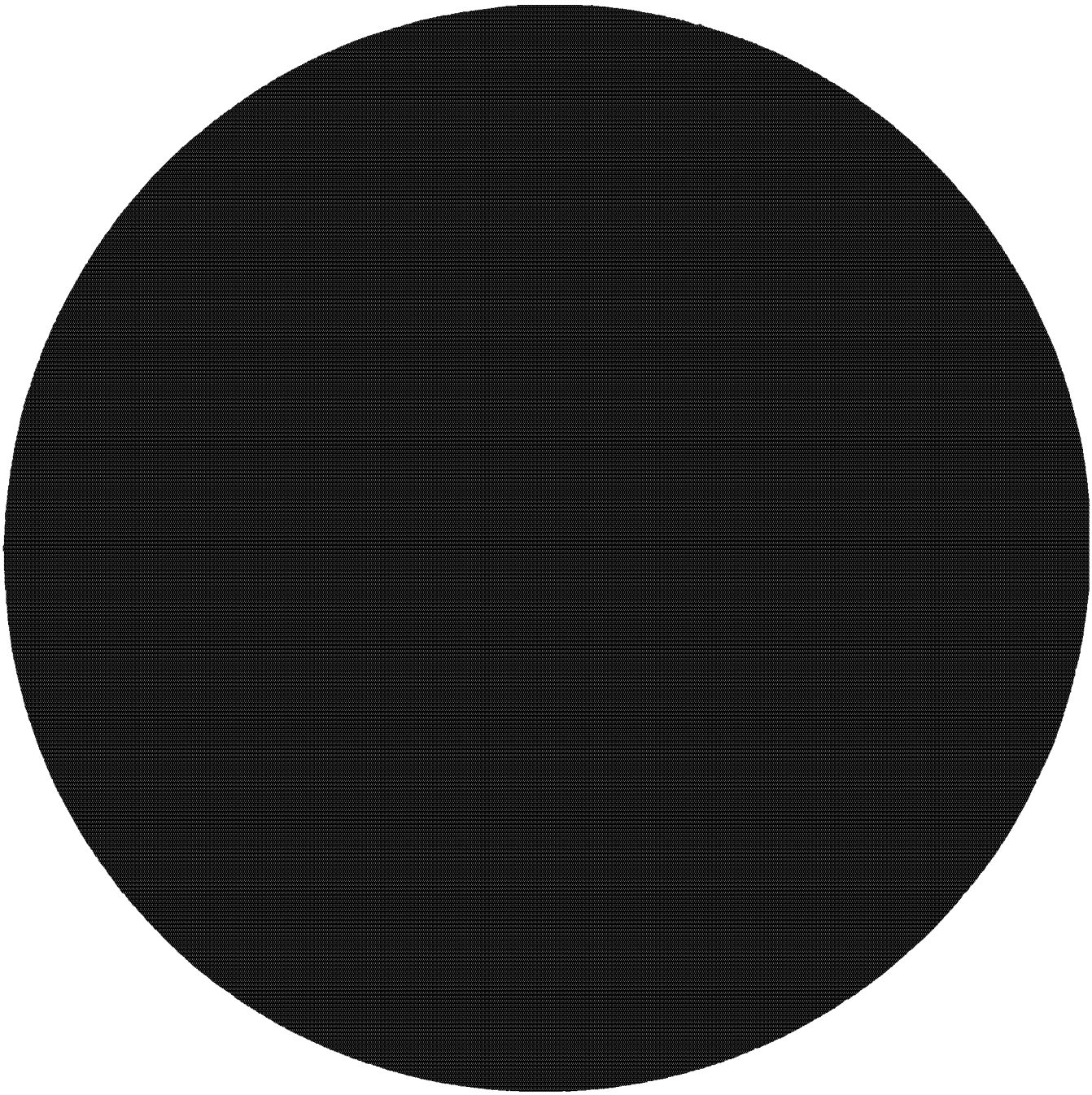
Initial mapping of Mars began with the early Mariner 4, 6 and 7 flybys in the 1960's. Mariner 9 obtained the first global coverage of Mars in 1971. Viking Orbiters 1 and 2 added new and higher resolution global coverage. The US Geological Survey produced the first digital global cartographic map products in black and white and in color, the mosaicked digital image models (MDIMs). In 1989, the Phobos 88 mission added imaging as well as multispectral mapping of Mars in the equatorial region. The Mars Global Surveyor (MGS) added to the black and white and color global coverage. The most important development for Mars cartography occurred on MGS with its global coverage of Mars using the Mars Observer Laser Altimeter (MOLA) producing precision ground control in latitude, longitude and radius. The next version of the MDIM was produced at 230 m spatial resolution using MOLA precision cartographic control. The Mars Odyssey mission THEMIS instrument has completed its global infrared mapping of Mars at 100 m spatial resolution. The Mars Express mission is completing its global coverage of Mars in stereo at 100 m spatial resolution or better. MGS, Odyssey and Mars Express continue to provide limited surface coverage at the 1 to 20 m resolution. Currently the new Mars Reconnaissance Orbiter is producing images at the 10's of cm level. All of these datasets provide a rich and historic perspective of Mars covering nearly five decades and allow global cartographic map products to be produced in visual and infrared at the 100 m level with specialized cartographic maps being produced for landing sites at the meter or sub-meter spatial resolution level. This work was produced at the Jet Propulsion Laboratory, California Institute of Technology under contract to the National Aeronautics and Space Administration, NAS 7-7120.5d, within the NASA Mars Data Analysis Program and the MGS, Odyssey, Mars Express and MRO Participating Scientist Programs.

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