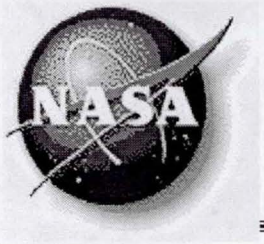


MARS DRILLING STATUS

NASA JSC EXPLORATION OFFICE

March 6, 2002

Humboldt C. Mandell, Jr., Ph.D.

Exploration of Mars Objectives

EXPLORATION OFFICE

Chart Our Destiny

- Send explorers to the limits of technology
- Understand the solar system forces and processes that affect the future habitability of Earth
- Find extraterrestrial resources of human interest
- Assess suitability of selected planetary locales for future human exploration and commercialization
- Conduct in-depth scientific investigations

Origin of Life and its Existence Beyond Earth

- Understand the sources and reservoirs of water and organics … the building blocks of life
- Determine the planetary conditions required for the emergence of life
- Search for evidence of past and present life elsewhere in the solar system

Solar System Formation and Evolution

- Understand the origin of the solar system and the forces that formed Earth and the other planets
- Determine the evolutionary processes that led to the diversity of solar system bodies and the uniqueness of the planet Earth
- Use the exotic worlds of our solar system as natural science laboratories

"FOLLOW THE WATER"

EXPLORATION OFFICE

Subsurface liquid water best chance of finding Martian life

Cycling between subsurface and atmosphere, examine sedimentary record

Water is critical resource for HEDS and permanent Mars presence

The Common Thread

W A T E R

When
Where
Form
Amount

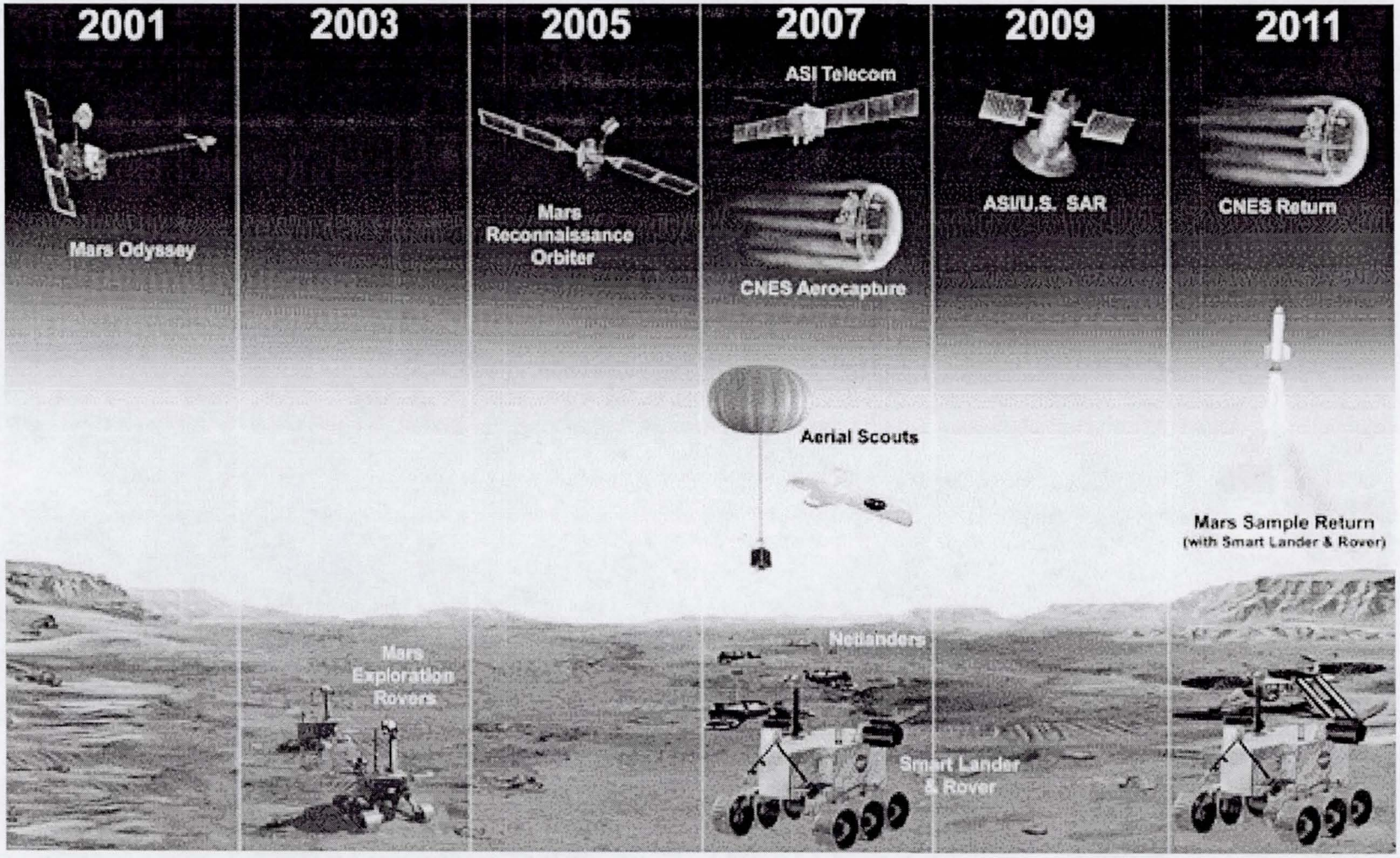
LIFE — Evidence of Life: Past or Present

CLIMATE — Weather Processes & History

RESOURCES — Environment & Utilization

Mars Exploration : Robotic Missions

EXPLORATION OFFICE



Mars Robotic and Human Mission Opportunities

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SCIENCE ENTERPRISE : Mars Surveyor Exploration Plan, UNDER REVISION

ORBITERS:
- Mars Global Surveyor (Currently Mapping Mars)
- Mars Climate Orbiter (Failed)

Options Being Developed

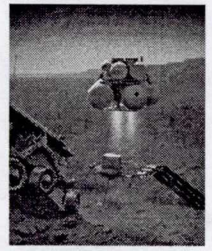
LANDERS:
- Mars Pathfinder
- Mars Polar Lander (Failed)
- Mars Sample Return

BEING REVISED

1996 1997 1998 1999 2000 2001 2010 2011

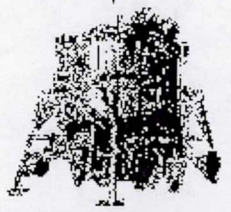
Small-scale demonstration: oxygen production

Mars ISPP Precursor (MIP) Flight Demonstration



Scaled-down utilization: oxygen production

Pre-Deployed ISRU LO2 Plant (40 kg O2/day) POSSIBLY: Deploy Human Infrastructure Spares, Rovers, . .



POSSIBLE Human Mission

Mars ISRU Sample Return (MISR) (2 kg O2/day) POSSIBLY: Deploy Power System for Drill and Later Human Mission

HEDS ENTERPRISE : Mars Robotic Precursor Needs

- Technology demonstrations
- Environment characterization
- Site selection

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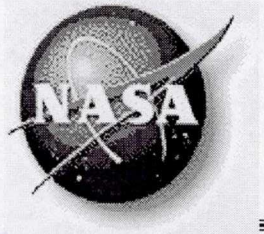
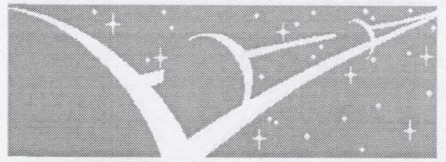
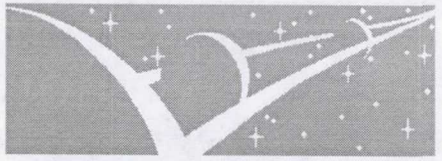


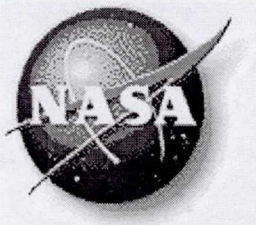


• Why Drill on Mars?

- Resources: Vast quantities of liquid groundwater are theorized at depths of 3-5 km
- Would "Enable" Advanced Human Missions
- Search for Extant Life: Deep aquifers represent best hope for harboring current life
- Extinct Life: Ancient lake and geothermal sites best chance for fossil life
- Climate/Geologic/Hydrologic History: Stratigraphy records Mars evolution
- Sampling: Allows detailed topside analysis



- Challenges for Drilling on Mars:
  - Remote / Robotic Operations
  - Verifying location, distribution of subsurface water
  - Source of Drilling Fluids
  - Mass
  - Power
  - Precision Landings
  - Environment / Climate



- Required Advances in Terrestrial Drilling:
  - 3-D Seismic Data Collection and Analysis
  - Automated Command and Control
  - Automated Rigs
  - Mass for Down Force (3/8 g)
  - "Dry" Drilling
  - Downhole Instrumentation
  - Communications

200 Meter Drill Mission

EXPLORATION OFFICE

Mission:	***200 meter Drill***
Opportunity:	***2005-2012***
Description:	*First Access of Mars Subsurf. to 200 m; Technology Precursor for 4000 m Groundwater Mission*
Objectives:	•*Demonstrate ~200 m class drilling technology directly applicable to later 3-5 km Groundwater Mission* •*Drill 200 m into Mars Subsurface* •*Charaterize downhole environment* •*Astrobiology: core and sample Paleolake or Geothermal site, or* •*Climate/Hydrology: core and sample Flood Channel or Polar Layered dep.* •*Store cores topside for subsequent analysis or sample return*
Approach:	•*EELV-M to C3=11.0 (1879 kg)* •*Baker Hughes dry coring drill concept* •*Acquire core samples from drill* •*Downhole instr. for stratigraphy, water*
"Significance" to Public:	•*Drilling - "Breaking new ground"* •*Astrobiology potential*

Major System Elements

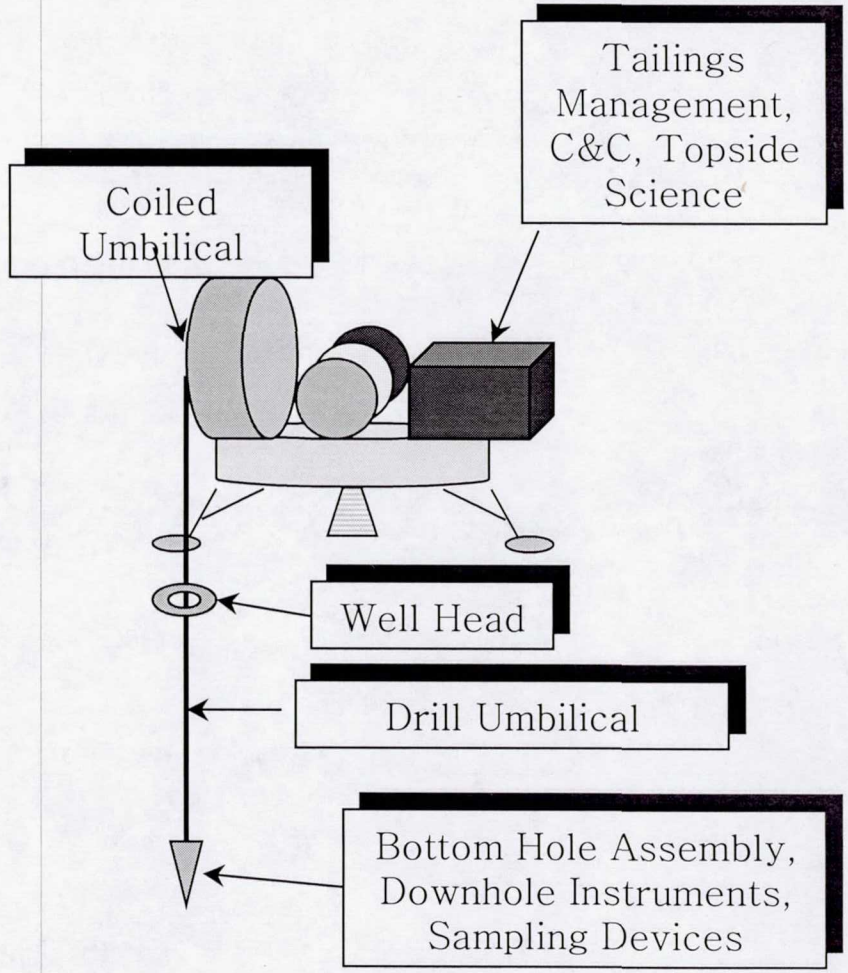
- EELV-M Launch Vehicle
- Carrier, Aeroshell, Chute
- Lander
- 200 meter class Drill
- Core Sample Analysis
- Core Sample Storage

Total Injected Mass =	***1,879 kg***
• Drill	231 kg
• Instruments	70 kg
• Lander, Dry	560 kg
• Contingency	111 kg
• Propellant, Press.	240 kg
• Heatshield, Backshell	481 kg
• Carrier	103 kg
• Launch Vehicle Margin	84 kg

Mars "Deep Core" Mission

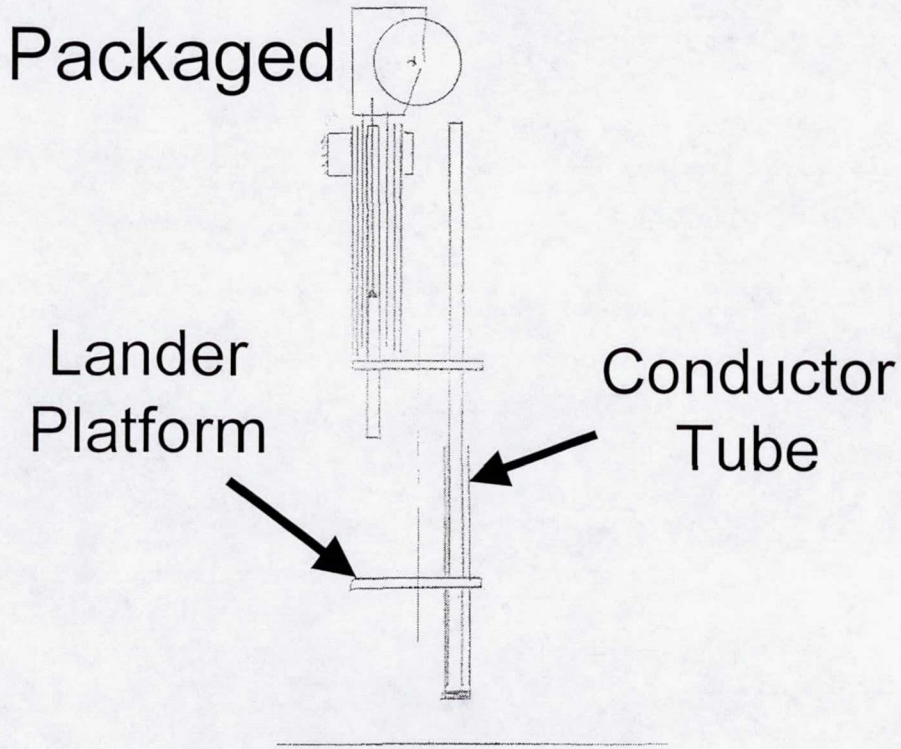
EXPLORATION OFFICE

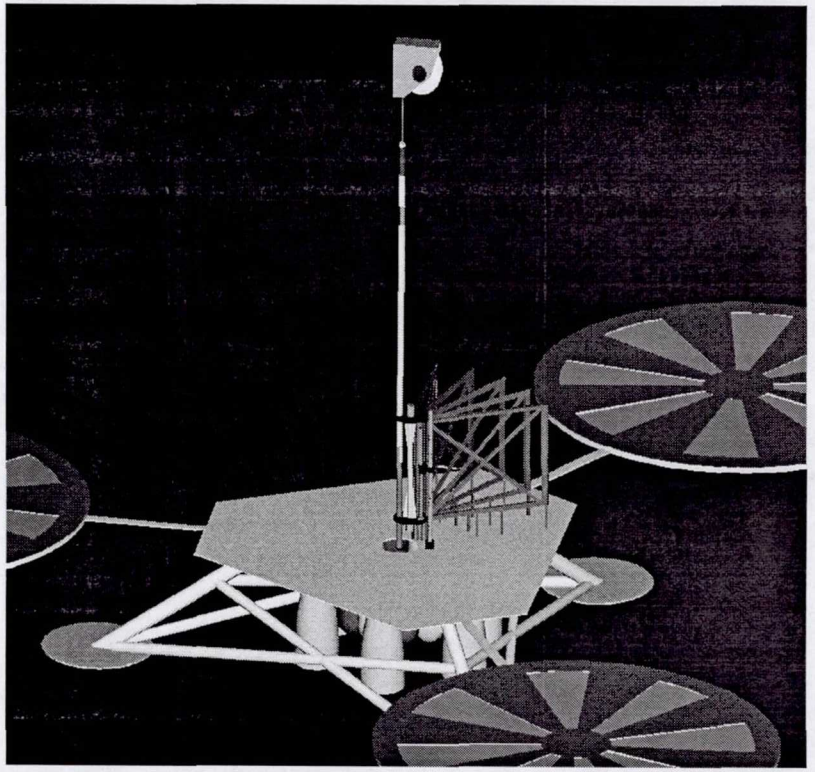
- Description
  - -Challenge to Reach Mars' Deep Aquifers and Search for Life
  - -4,000 - 6000 m Deep Drilling Mission
  - -Establish initial water/power "oasis" to serve future human missions
- HEDS Objectives
  - -Locate and "tap" native water supply
  - -Store water cache in empty lander prop. tanks
  - -Provide water supply for future mission needs (prop., rover fuel, human consumption, ECLSS)
- Science Objectives
  - -Access and sample liquid groundwater region
  - -Search for living or fossil life
  - -Examine subsurface stratigraphy, chemical, and physical properties
  - -Penetrate and explore permafrost zone
- Approach
  - -Drill to ~ 4000 - 6000 m depth
  - -Perform downhole investigations
  - -Sample for topside analysis
  - -Target EELV-H LV (~3000 kg total surf. P/L mass)



Drill Overview

EXPLORATION OFFICE





- Conductor tube [surface casing] serves as a support for the anchor mechanism during initial drilling operations and as storage during Earth-Mars transit.
- Deployment may also include unfolding the drill that is stored in a horizontal position on the lander. This will be dictated by payload envelopes on the lander.
- These issues are still TBD, the focus of work to date has been the actual drilling operation.

Promising Sites for Mars Groundwater Mission

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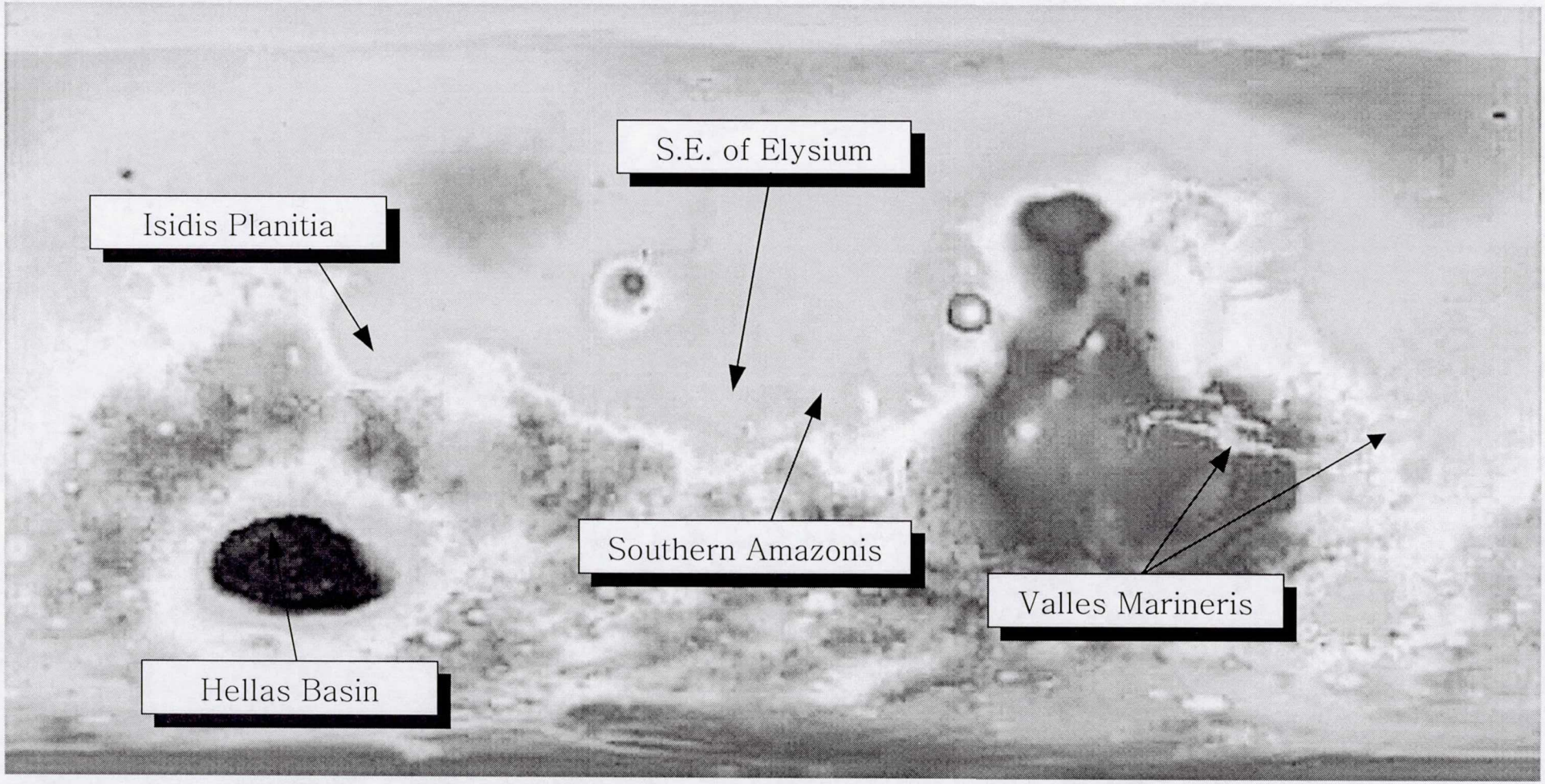

(S. M. Clifford and T. J. Parker, submitted to Icarus, *7/99)*

CURRENT ACTIVITIES

EXPLORATION OFFICE

- NASA JSC ACTIVITIES
  - Bring in private sector expertise
  - Utilize existing technologies
  - Early mission
- NASA AMES DRILLING STUDY
  - "Development of capability to access samples 100+ m deep into the Martian regolith for astrobiology, geosciences, and in situ resource research"
  - Mars "subsurface" team formed, includes JSC
- BUILDING AND TESTING A PROTOTYPE
  - Baker Hughes Design
  - Joint Partnership Manufacturing, NASA Test
- MARS SCOUT MISSIONS
  - $300 Million Mission
  - JSC/Ames proposal is to deploy a drill in 2007 Opportunity

When Will People Go to Mars?

EXPLORATION OFFICE

- When our customers want us to go!
- When is that?
  - When people like you take an active role in the public debate and develop a consensus
  - Or, when a strong economic incentive is found
  - Or, when a National Security issue is involved
- When CAN People Go?
  - Within 7 years of "permission" from the customers