LUNAR-MARS BASE ACTIVATION

NEEP 533 LECTURE 34

Harrison H. Schmitt

NASA HST IMAGE

VARIOUS CLASS MISSIONS
(REVIEW AT YOUR LEISURE)

- **SPLIT/SPRINT-OPPOSITION CLASS (1988 NASA OFFICE OF EXPLORATION)**
  - **ROBOTIC PRECURSORS**
  - **ONE CARGO VEHICLE/ONE CREW VEHICLE**
  - **14 MONTHS**
  - **30 DAYS IN ORBIT**
  - **20 DAYS ON SURFACE**
  - **4 CREW ON SURFACE / 4 IN ORBIT**
  - **60 TOTAL HOURS OF EVAS BY 2 CREW MEMBERS**
  - **3 MISSIONS**

- **SPLIT/SPRINT-OPPOSITION CLASS (1988 NASA JSC)**
  - **ROBOTIC PRECURSORS**
  - **ONE CARGO VEHICLE/ONE CREW VEHICLE**
  - **14 MONTHS**
  - **30 DAYS IN ORBIT**
  - **<20 DAYS ON SURFACE**
  - **2 CREW ON SURFACE / 1 IN ORBIT**
  - **60 TOTAL HOURS OF EVAS BY 2 CREW MEMBERS**
  - **1 MISSION**

- **VENUS SWING-BY (COLLINS, 1988)**
  - **ROBOTIC PRECURSORS?**
  - **ONE VEHICLE**
  - **22 MONTHS**
  - **30 DAYS IN ORBIT?**
  - **40 DAYS ON SURFACE**
  - **4 CREW ON SURFACE / 4 IN ORBIT?**
  - **120 TOTAL HOURS OF EVAS BY 2 CREW MEMBERS?**
  - **3 MISSIONS?**

- **"MARS DIRECT" CONJUNCTION CLASS (ZUBRIN, 1996, NASA INTEREST, 1999)**
  - **ONE AUTOMATED CREW RETURN VEHICLE/ONE DELAYED CREW VEHICLE**
  - **30 MONTHS**
  - **MANUFACTURE RETURN FUEL AND OXIDIZER PRIOR**
  - **TO CREW LAUNCH**
  - **0 DAYS IN ORBIT**
  - **18 MONTHS ON SURFACE**
  - **4 CREW ON SURFACE / 0 IN ORBIT**
  - **REPEATED MISSIONS**

MINIMUM ENERGY -1

- **MINIMUM ENERGY-CONJUNCTION CLASS (NEAL, ET AL., 1989)**
  - **FINAL RECONNAISSANCE FROM ORBIT / NO ROBOTIC PRECURSORS REQUIRED**
  - **ONE ORBITAL VEHICLE / TWO LANDERS**
  - **32 MONTHS**
  - **18 MONTHS IN ORBIT**
  - **90 TOTAL DAYS ON SURFACE**
  - **4 CREW ON SURFACE / 4 IN ORBIT ALTERNATING TO SURFACE**
  - **1200 TOTAL HOURS EVAS BY 8 CREW MEMBERS AT TWO SITES**
  - **4 MISSIONS / 8 SITES WITH FIFTH MISSION THE CREATION OF A PERMANENT MARS BASE WITH 8 INITIAL INHABITANTS**
    - **SYMMETRY WITH LUNAR ACTIVATION**

MINIMUM ENERGY -2

- **MAJOR POSSIBLE ENHANCEMENT OPTIONS**
  - **LAUNCH FROM THE MOON WITH LUNAR DERIVED CONSUMABLES (GREATER PAYLOAD) (SEE STANCATI, ET AL., 1991)**
  - **He-3 FUSION / NUCLEAR FISSION / SOLAR ELECTRIC PROPULSION (SHORTENED TRANSIT TIME)**
  - **TRAJECTORY SHAPING (FLEXIBLE STAY TIMES AT MARS)**
  - **AERO-BRAKING (MARS ORBIT INSERTION AND ON RETURN TO EARTH**
  - **RETURN PROPELLANT DERIVED FROM MARS ATMOSPHERE (ZUBRIN, ET AL., 1991, AND SEE STANCATI, ET AL., 1991)**

MINIMUM ENERGY -3

FLEXIBILITY IN TRANSIT AND ORBIT

- **LANDING DELAY DUE TO EQUIPMENT OR WEATHER PROBLEMS**
- **SURFACE EXPLORATION DELAY DUE TO EQUIPMENT, WEATHER, ADAPTATION, OR BIOLOGICAL HAZARD PROBLEMS**
- **ASCENT DELAY DUE TO EQUIPMENT PROBLEMS**
- **EARLY ASCENT DUE TO DEGRADING SYSTEMS OR A CREW HEALTH PROBLEM**
- **DESIRE EXPLORE PHOBOS AND / OR DEIMOS(?)**
- **"MISSION CONTROL" AND COMMUNICATIONS RELAY IN MARS ORBIT**
- **LANDING SITE VERIFICATIONS FROM MARS ORBIT SENSORS AND ANALYSIS**

MINIMUM ENERGY -4

- **OTHER ISSUES**
  - **IN-ROUTE, IN-ORBIT, ON-SURFACE SIMULATION AND TRAINING REQUIRED**
  - **MISSION RELEVANT AND VALUABLE SCIENTIFIC ACTIVITIES IN-ROUTE**
  - **NON-TIME CRITICAL MISSION MONITORING AND DATA PROCESSING ON EARTH**
  - **NEED HIGH RATE DATA TRANSMISSION MARS-EARTH-MARS**

- **PROBLEMS**
  - **MASS COST TO SUPPORT CREW OF 8 (COULD REDUCE TO 4 AND ONE LANDING WITH INCREASE OVERALL RISK TO MISSION SUCCESS)**

SPACE BIOMEDICAL ISSUES IN MICROGRAVITY

- **MAJOR KNOWN PROBLEMS**
  - **MUSCLE ATROPHY** →
    - **HEART**
    - **SUPPORT**
  - **BONE AND OTOLITH DE-MINERALIZATION** →
  - **RATE OF RE-ADAPTATION TO GRAVITY ENVIRONMENT** →
  - **IMMUNE SYSTEM COMPROMISE (?)** →
  - **RADIATION PROTECTION** →

- **COUNTER-MEASURE OPTIONS**
  - **HEAVY, ANAROBIC EXERCISE**
  - **CENTRIFUGUL FORCE**
  - **DRUG THERAPY**
  - **EXERCISE**
  - **CENTRIFUGAL FORCE**
  - **DRUG THERAPY**
  - **EXERCISE IN GRAVITY**

  ALL OF THE ABOVE

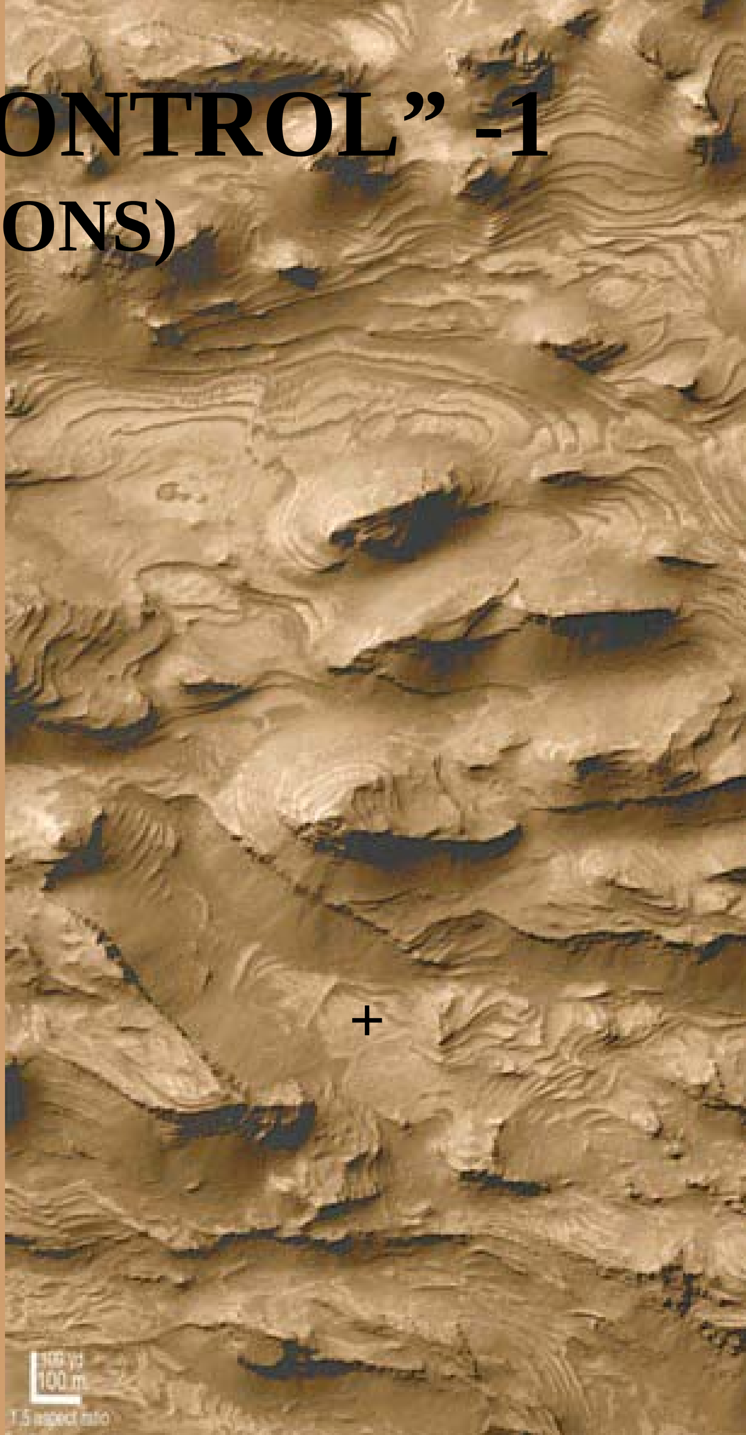
  IN-TRANSIT AND IN ORBIT
  - **“WATER” SURROUNDED STORM CELLAR**

  ON-SURFACE
  - **“REGOLITH” COVER FOR ZENITH**

NOTE: NO SCIENTIFICALLY CREDITABLE UNDERSTANDING OF THESE PROBLEMS AND OPTIONS HAS BEEN DEVELOPED TO DATE DUE TO THE LACK OF A SYSTEMATIC RESEARCH PROTOCOL AND USE OF INAPPROPRIATE TEST SUBJECTS.

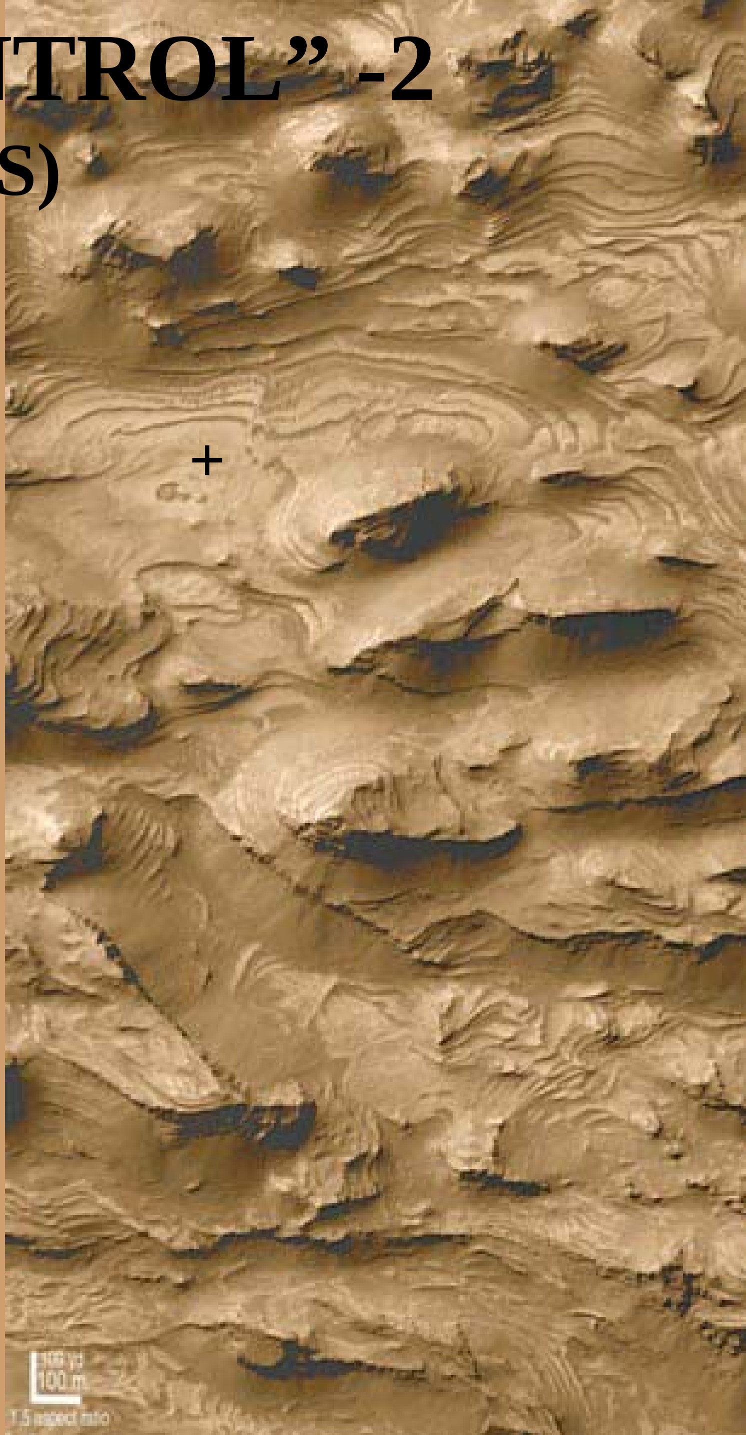
ORBITAL "MISSION CONTROL" -1
(FIRST FEW MISSIONS)

- **OVERALL SUCCESS NOT DEPENDENT ON SUCCESS OF PRECURSORS**
- **COMMUNICATIONS DELAY OF 8-40 MINUTES AND SUN PUTS EARTH "OUT OF THE LOOP"**
- **TAKE ADVANTAGE OF CONJUCTION CLASS MARS-STAY REQUIREMENT**
  - **16 MONTHS IN ORBIT**



ORBITAL “MISSION CONTROL” -2
(FIRST FEW MISSIONS)

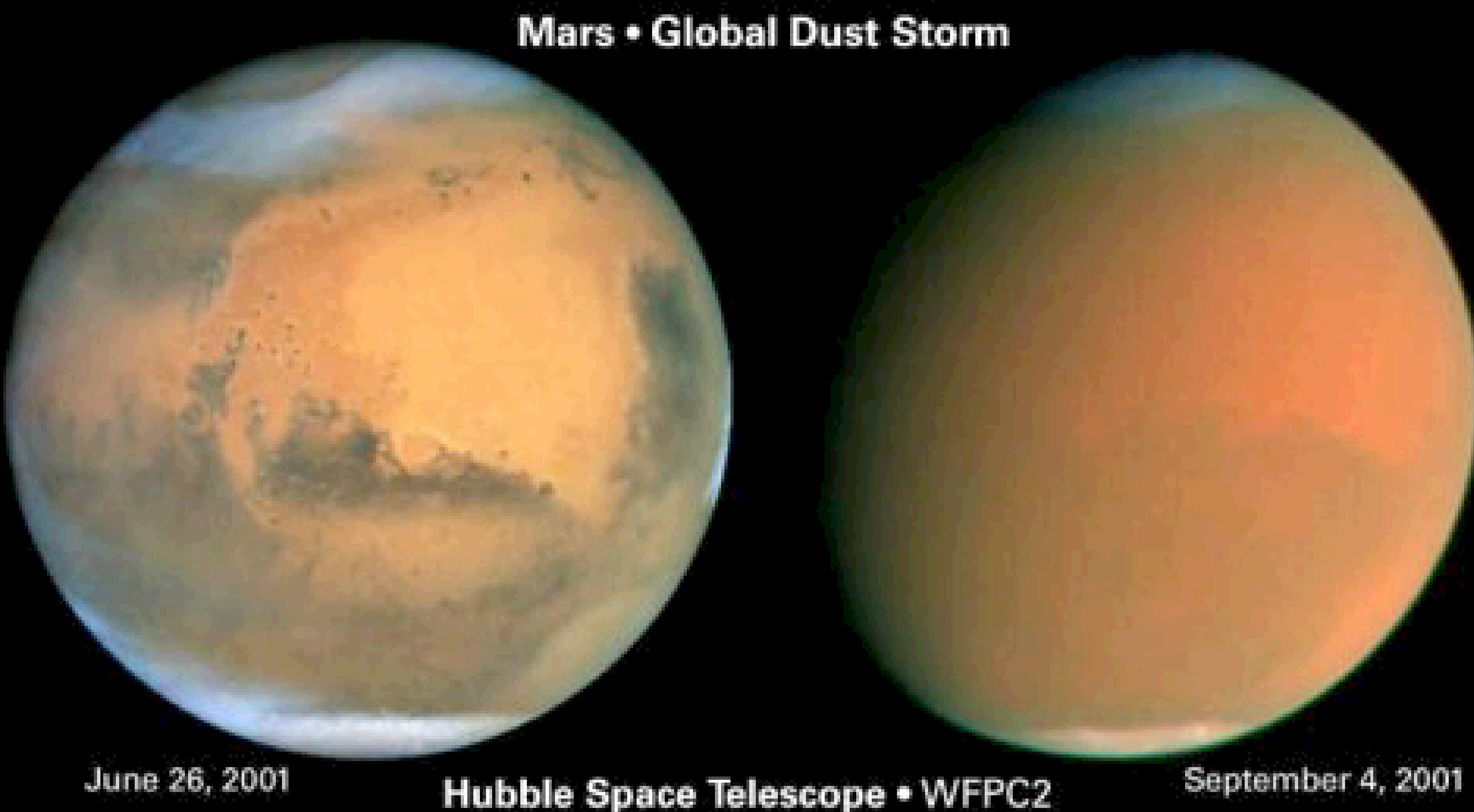
- **PROVIDES CURRENT LANDING DATA AND HUMAN COGNITIVE ANALYSIS**
  - **LANDING SITE SELECTION AND VERIFICATION AND DETAILED SURFACE MISSION PLANNING**
  - **SPECTRAL DATA**
  - **RADAR DATA**
  - **SURFACE PROBES**
  - **LANDING BEACON DEPLOYMENT**
  - **LANDING TRAJECTORY PRECURSORS THROUGH ATMOSPHERE**
  - **DATA FUSION SOFTWARE**
  - **SAMPLE RETURN TO ORBIT VS. TESTS AFTER LANDING (?)**
  - **REFINE LANDER PAYLOAD**



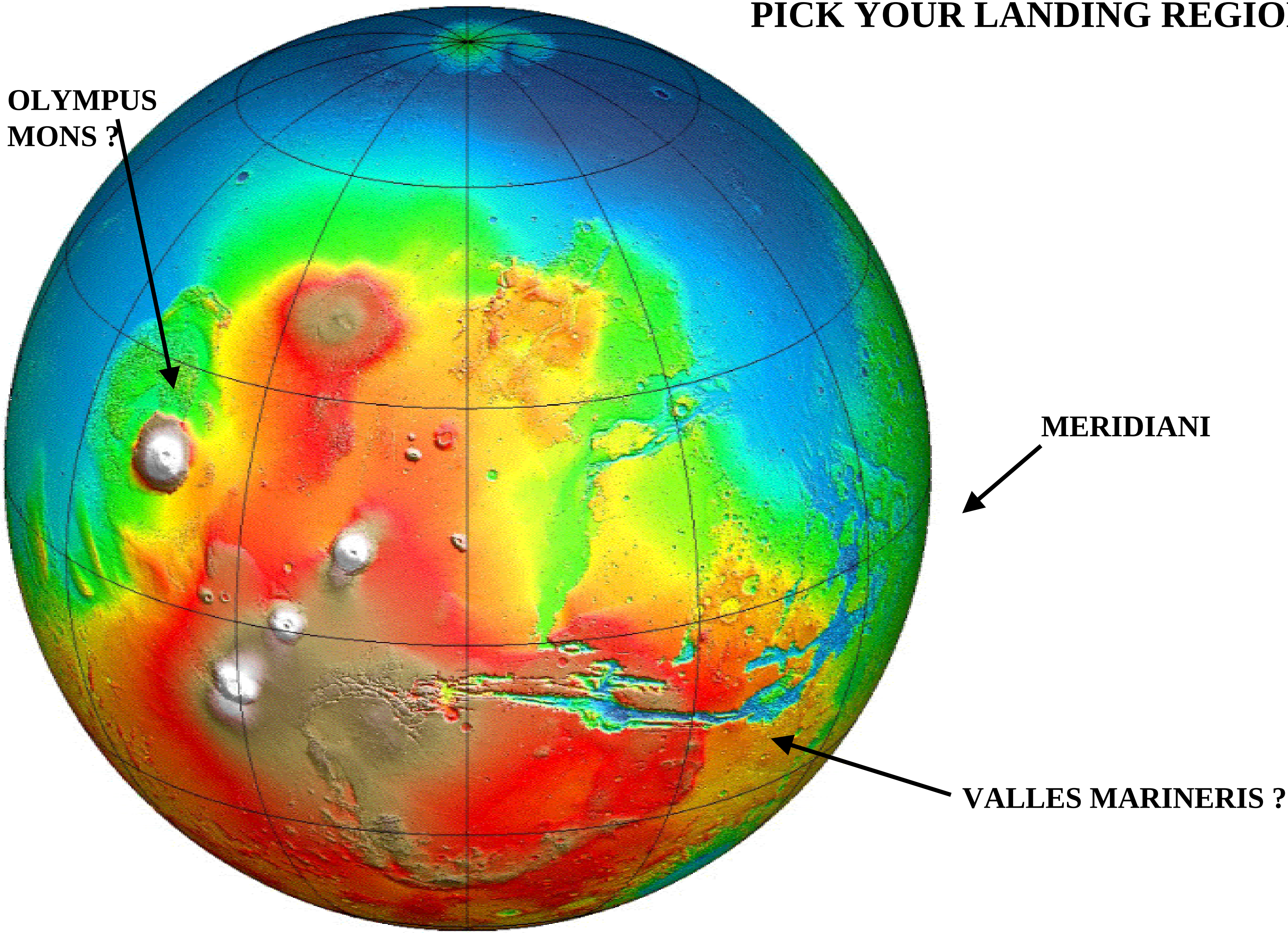
ORBITAL "MISSION CONTROL" -3
(FIRST FEW MISSIONS)

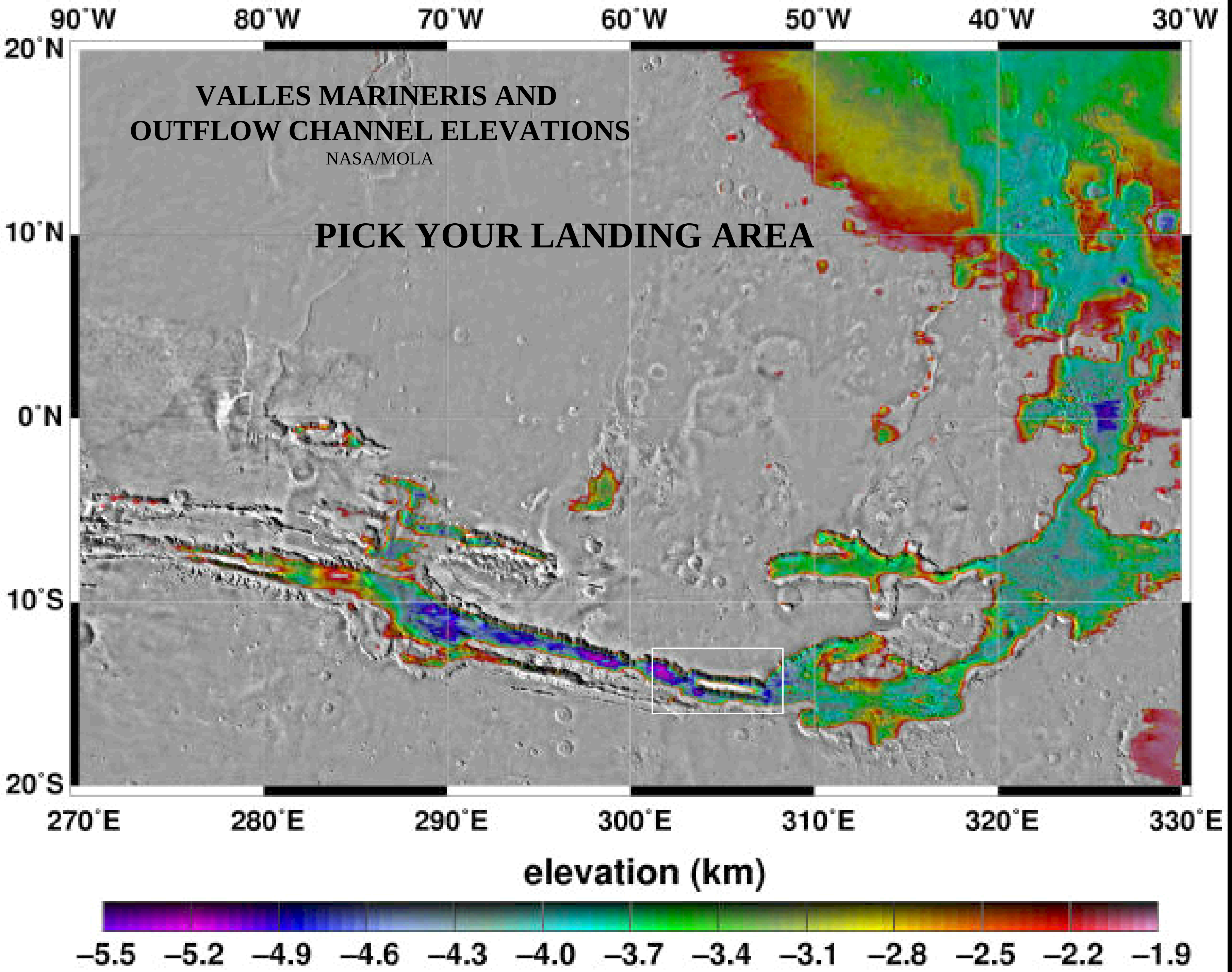
- **BUILD ON EXISTING ROBOTIC DATA BASE**
- **USE EARTH DATA PROCESSING AND CONSULTATION**
- **MARS ENVIRONMENT AND SURFACE BETTER CHARACTERIZED THAN BEFORE APOLLO 11**
  - **EXCEPT FOR POTENTIAL PATHOGENS IN ISOLATED ECOSYSTEMS**
- **LANDING SYSTEMS MONITORING**
- **LANDER-EARTH DATA RELAY AS REQUIRED**
- **EVA PLANNING ASSISTANCE**
- **PHOBOS-DEIMOS EXPLORATION (SEE NEAL, ET AL, 1989)**

IMAGINE, YOU ARRIVE IN MARS ORBIT AND THIS IS WHAT HAS HAPPENED SINCE LEAVING EARTH!



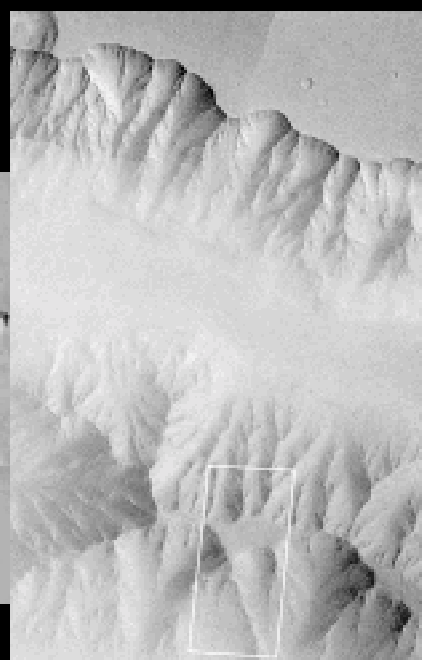
PICK YOUR LANDING REGION

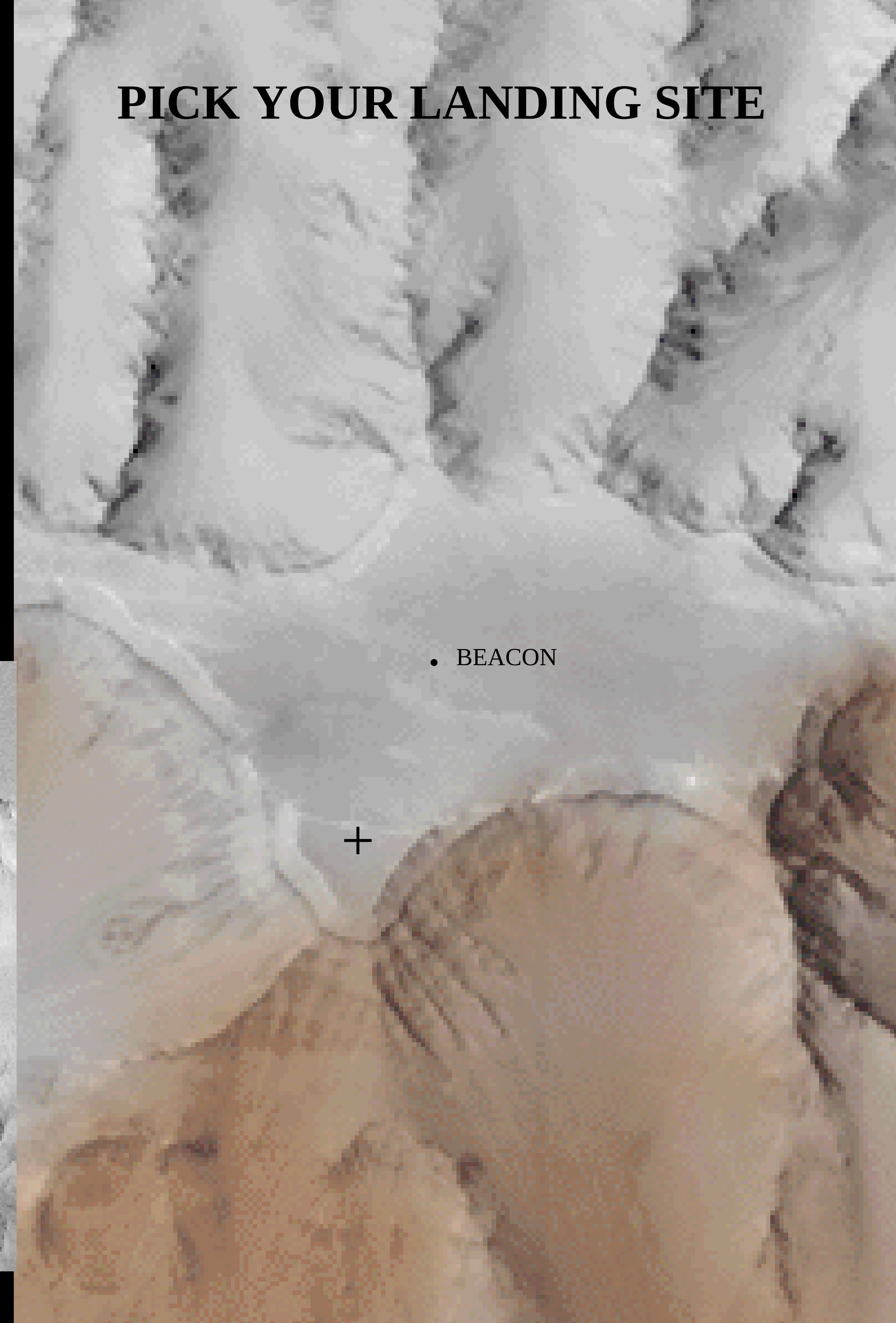




VALLES MARINERIS AND
OUTFLOW CHANNEL ELEVATIONS
NASA/MOLA
PICK YOUR LANDING AREA
90˚W
80˚W
70˚W
60˚W
50˚W
40˚W
30˚W
20˚N
10˚N
0˚N
10˚S
20˚S
270˚E
280˚E
290˚E
300˚E
310˚E
320˚E
330˚E
elevation (km)
–5.5
–5.2
–4.9
–4.6
–4.3
–4.0
–3.7
–3.4
–3.1
–2.8
–2.5
–2.2
–1.9

...VALLES MARINERIS MAY PRESENT AN EXCITING APPROACH, LANDING, AND EXPLORATION TARGET!

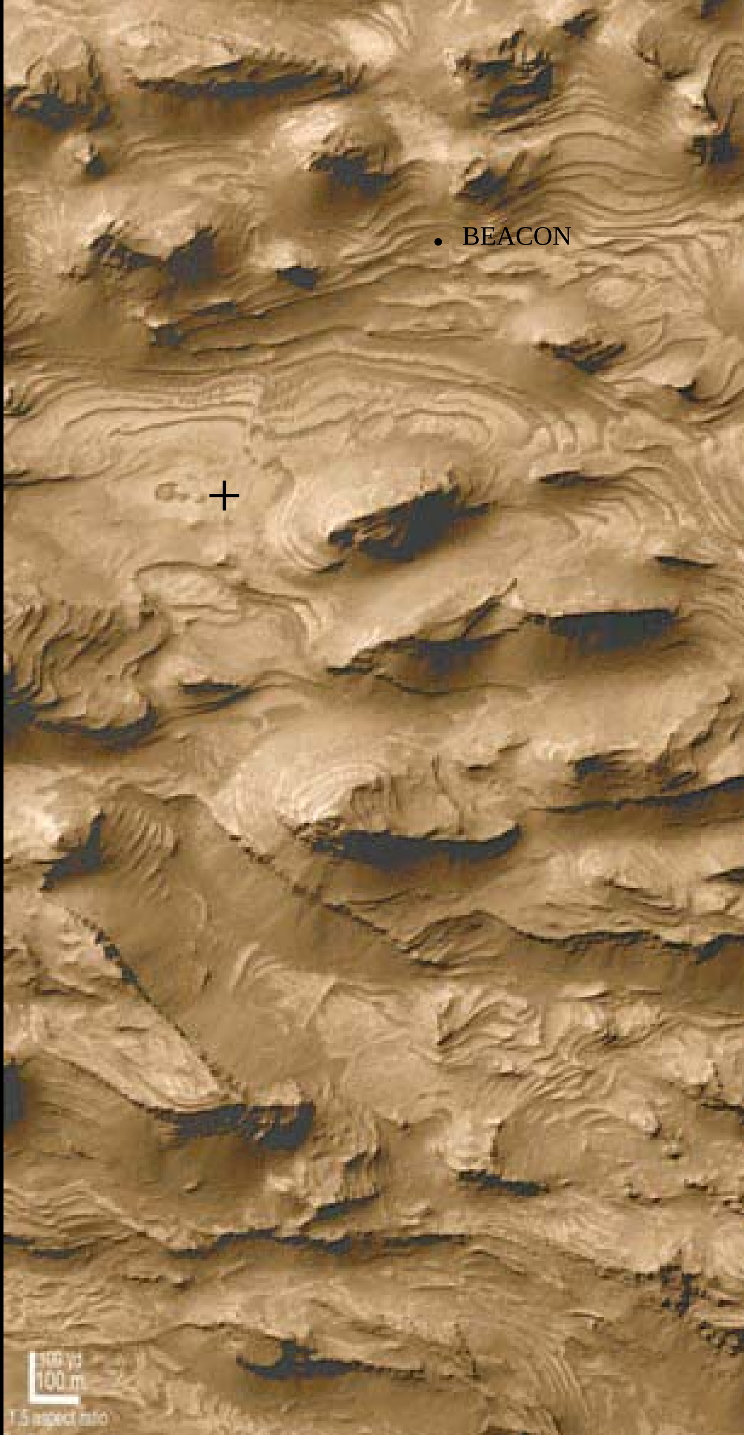




NASA/JPL/MALIN SPACE SCIENCE SYSTEMS.

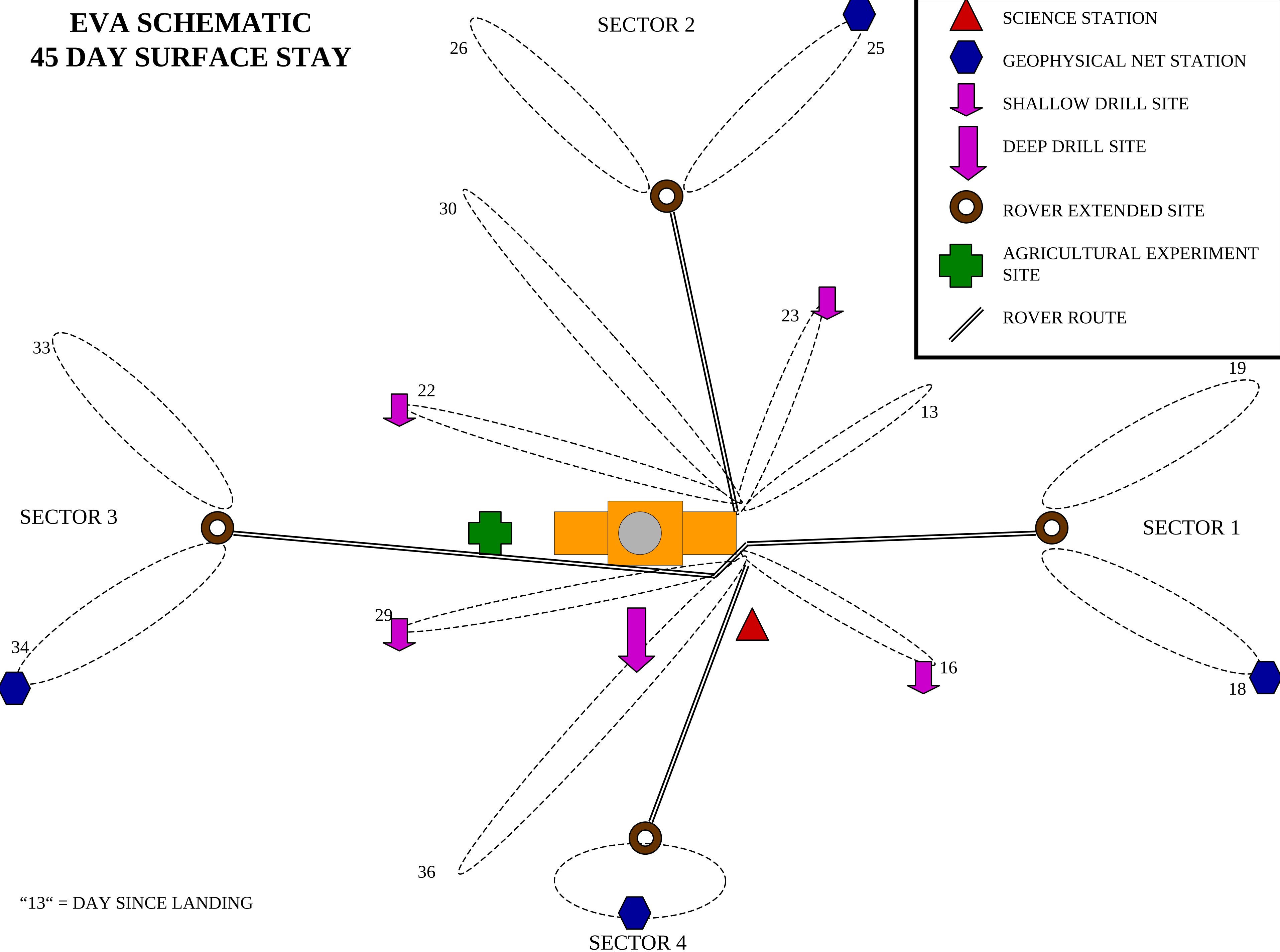
WITH A LANDING AMONG THE LAYERS AND FOSSILS (?) OF CANDOR CHASMA

100 METERS OR A LITTLE LESS THAN A SATURN V OR A LITTLE MORE THAN A FOOTBALL FIELD



NASA/JPL/MALIN SPACE SCIENCE SYSTEMS

EVA SCHEMATIC
45 DAY SURFACE STAY



“13“ = DAY SINCE LANDING

45 DAY HUMAN EXPLORATION FOR MARS BASE SITE EVALUATION

- WEEK ONE (DAYS 1-6)
  - READAPTATION
  - ENVIRONMENTAL TESTS
  - ACTIVATION OF EXTERIOR SENSORS
  - PHYSICAL MONITORING
  - PLANNING
- WEEK TWO (DAYS 8-13)
  - SHORT/SIMPLE PROXIMITY EVAS
  - DEPLOY COMM ANTENNA / SCIENCE STATION / AGRICULTURAL TEST STATION
  - START DEEP DRILL SYSTEM
  - SELECTED SAMPLE ANALYSIS
  - PHYSICAL MONITORING
  - PLANNING SESSIONS
- WEEK THREE (DAYS 15-20)
  - SECTOR 1 EXPLORATION
  - MID LENGTH EVAS USING ROVER
  - EXTENDED RANGE EVA WITH TWO ROVERS
  - SHALLOW DRILLING/DEPLOY GEO. NET
  - SELECTED SAMPLE ANALYSIS
  - PHYSICAL MONITORING
  - PLANNING SESSIONS
- WEEK FOUR (DAYS 22-27
  - SECTOR 2 EXPLORATION
  - DITTO WEEK THREE
- WEEK FIVE (DAYS 29-34)
  - SECTOR 3 EXPLORATION
  - DITTO WEEK THREE
- WEEK SIX (DAYS 36-41)
  - SECTOR 4 EXPLORATION
  - ASCENT SIMULATIONS
  - DITTO WEEK THREE
- WEEK SEVEN (DAYS 43-45)
  - MOTHBALL FACILITY
  - PREPARE ROVER FOR REMOTE OPERATION
  - FINAL ASCENT SIMULATIONS
  - SAMPLE SELECTION AND STORAGE

- NOTE: ONE REST DAY PER WEEK
  - FOUR PERSON CREW
  - TWO PERSON EVAS, ALTERNATE BETWEEN PAIRS

EARLY LANDINGS STRATEGY
GOAL: PERMANENT BASE

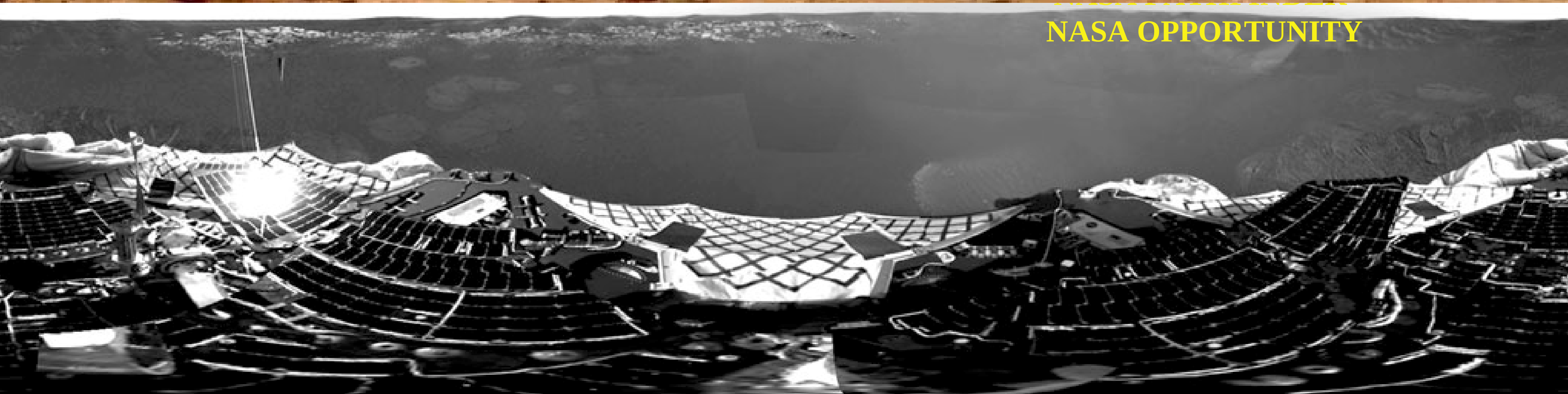
- FIRST AND SECOND MISSIONS (POSSIBLE FOUR LANDINGS)
  - GENERAL EXPLORATION AND RECONNAISSANCE
    - AUTOMATED ROVER AFTER CREW DEPARTURE
  - DEVELOPMENT OF CRITERIA FOR BASE SELECTION
  - POTENTIAL TO ACCELERATE DECISION ON BASE SITE SELECTION
    - CORRELATION OF ORBITAL RECONNAISSANCE WITH DATA FROM SURFACE
- THIRD AND FOURTH MISSIONS (POSSIBLE FOUR LANDINGS)
  - EXAMINATION OF CANDIDATE BASE SITES
    - AUTOMATED ROVER AFTER CREW DEPARTURE
  - USE FOURTH LANDING TO SET UP CONSUMABLES PLANT AT SELECTED BASE SITE
  - GENERAL EXPLORATION AND RECONNAISSANCE

IF A LUNAR HELIUM-3 INITIATIVE BEGAN BY 2005 WITH ASSURED FUNDING, THE FIRST HUMAN MISSION TO MARS COULD BE LAUNCHED BY 2020, LARGELY USING TECHNOLOGY PAID FOR BY THE HELIUM-3 INITIATIVE.

ENJOY THE VIEW WHEN YOU GET THERE!!!!!

"TRUE COLOR OF MARS"
PATHFINDER LANDER VIEW
NASA/JPL

A POSSIBLE REPRESENTATIVE VIEW FROM THE “MARTIAN MODULE”
BEFORE THE FIRST EVA, HOWEVER….
VALLES MARINERIS WILL BE A TAD MORE SPECTACULAR



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