

PMCS - MORIE

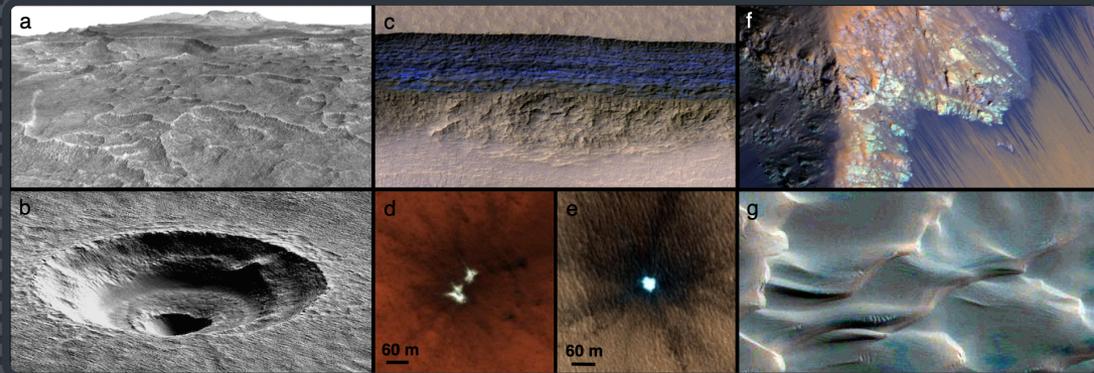
PLANETARY MISSION CONCEPT STUDY: MARS ORBITER FOR RESOURCES, ICES AND ENVIRONMENTS

Wendy Calvin for MEPAG April 16, 2020

TEAM

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Note: Although MORIE was “merged” with MOSAIC for budget reasons, these concepts are distinct and will result in 2 separate reports.



MOTIVATION:

- **NEW DISCOVERIES IN ICE AND CLIMATE**
 - REGIONAL-SCALE BURIED ICE SHEETS IN THE MID-LATITUDES
 - SCARPS EXPOSE BURIED GROUND ICE
 - IMPACTS EXPOSE ICE DOWN TO 39° N
 - ICE IS UBIQUITOUS IN LOBATE DEBRIS APRONS
- **A MORE COMPLICATED HISTORY AND DIVERSE AQUEOUS ENVIRONMENTS**
 - MER, MRO, MSL SHOW MULTIPLE AQUEOUS, HABITABLE ENVIRONMENTS IN THE 1ST BILLION YEARS
 - MAJOR UNCERTAINTY IN TIMING, DURATION AND NATURE OF EARLY AQUEOUS PROCESSES ON MARS AND TRANSITIONS BETWEEN THEM
- **NUMEROUS PAST STUDIES HIGHLIGHT THIS SCIENCE**
 - NEX-SAG (DISTRIBUTION/ORIGIN ICE RESERVOIRS, ENV TRANSITIONS, WATER + MINERAL RESOURCES)
 - CAPS, DECADAL MIDTERM REVIEW, ASTROBIO STRATEGY
 - ICE-SAG ORBITER
- **RESOURCE MAPPING IDENTIFIES A SENSING GAP FROM 5 TO 20M**
 - THE MARS SUBSURFACE WATER ICE MAPPING (SWIM) PROJECT INTEGRATES BEST AVAILABLE DATA
 - **BETTER MAPS USE THE SAME TECHNIQUES AS THE SCIENCE**

SCHEDULE/ACTIVITIES

- CONFERENCE CALLS
 - SORT OUT SCIENCE TRADE SPACE
 - RADAR, SPECTROSCOPY, IMAGING
 - UPDATE MORIE SPECIFIC SCIENCE QUESTIONS
 - DEFINE INSTRUMENTS AND MISSION REQUIREMENTS
- TEAM X ARCHITECTURE FEB 4, 5
 - SCOPED COSTS USING EXISTING INSTRUMENTS
- FACE TO FACE MEETING FEB 11, 12
 - PAYLOAD AND OPERATIONS SCENARIOS
- TEAM X MISSION DESIGN MARCH 3-6
- PUBLIC PRESENTATIONS MAY 26, 27
- FINAL REPORTS DUE JULY 28

Relation to NASA Goals	Theme	Key Question	Objectives
MEPAG 2020 ICE-SAG NEX-SAG	<i>Science: Evolution of a habitable world</i>	When did elements of the cryosphere form and how are ice deposits linked to current, recent and ancient climate?	Determine the global distribution and volume of subsurface ice, especially near the surface (1-20m).
Identify the vertical and lateral structure of ice deposits at the poles and mid-latitudes.			
Record the annual cycling of volatiles and dust between the surface and atmosphere.			
Link ice reservoirs to their formation processes and history.			
MEPAG 2020 NEX-SAG		How does the crust record the evolution of surface environments and their transition through time?	Constrain the nature and timing of ancient aqueous deposits and major environmental transitions.
Observe which intervals in the geologic record preserve environments that were conducive to the possible origin and evolution of life.			
Identify how igneous rocks record the evolution of magmatic sources and crustal modification over time.			
Observe how modern processes are reshaping the surface today.			
MEPAG 2020 NEX-SAG SKG: Water resources, ISRU, Civil Eng	Resources: Fueling Future Exploration	Where could ground ice serve as a resource for landed missions?	Determine the near-surface distribution and depth of mid-latitude ice.
Can hydrated mineral deposits provide a viable resource for landed missions?		Determine the type, distribution, abundance and volume of hydrated minerals at the surface.	
How do materials at the surface affect landing site trafficability and access to resources?		Constrain geotechnical properties of the near surface to characterize landing sites and resource accessibility.	

These objectives were traced to measurement approach and requirements.

MORIE PAYLOAD

- RASO
 - P-BAND RADAR SOUNDER WITH 0.5 M VERTICAL RESOLUTION IN ICE
- POLAR-SAR
 - FULL POLARIZATION P-BAND SAR, 100 M SPATIAL RES W/ SPOTLIGHT MODE
- C-IMG
 - 1-M COLOR IMAGER 0.4 TO 1.7 μM , 20 CHANNELS AT 10-60 NM BAND PASS, + SUPER-RES MODE
- NGSWIS (NEXT GEN SHORT-WAVE INFRARED IMAGING SPECTROMETER)
 - 1.3 TO 4.2 μM SPECTROMETER, ≤ 10 NM SPECTRAL, ≤ 5 M SPATIAL,
- MARS-FIRE (FAR INFRARED EMISSION IMAGER)
 - SHARED TELESCOPE WITH NGSWIS
 - 6-25 μM , TIR MULTI-CHANNEL, < 1 μM BANDPASS, 20 CHANNELS, ≤ 100 M SPATIAL
- MAVRIC
 - WA CAMERA FOR DAILY GLOBAL MAP WITH FILTERS FOR H₂O+CO₂ ICES
- MID-S-CAM
 - DUAL B/W CAMERAS FOR STEREO-DEM ~ 5 M/PIXEL / CLUTTER MITIGATION

TEAM X RESULTS

- SHORT FUSE TIMELINE - SINGLE BAND SAR + SOUNDER WAS INPUT DELIVERED TO TEAM X
- COMBINED TELESCOPE NGSWIS + MARS-FIRE
- SOLAR ELECTRIC PROPULSION
 - ALLOWS PLANE CHANGE TO 90 DEG TO SOUND POLES
- DESCOPE 1, REMOVED ONE SPECTROMETER, C-IMG, AND STEREO B/W
- DESCOPE 2, "ICE ONLY" WITH DUAL BAND SOUNDING+SAR & MID-S-CAM
- FITS ON A FALCON 9
- USING HQ REQUIRED COST PARAMETERS*
- DETAILED TEAM X OUTPUT NOT YET AVAILABLE

Option	PolarSAR	RaSo	C-Img	NGSWIS	Mars-FIRE	MAVRIC	Mid-S-Cam	FY25 50% Margin A-D
MORIE Full Payload	✓	✓	✓	✓	✓	✓	2	\$1.42B
Descope 1	✓	✓		✓		✓	1+Color	\$1.25B
Descope 2	✓	✓ (200, 400 MHz)	✓				2	\$1.12B

*This mandated use of FY25 \$ and 50% margin on A-D Costs

MORIE TAKE AWAYS

- TO BEST ADDRESS GLOBAL DISTRIBUTION OF ICE RESERVOIRS SOUNDING + SAR IN DIFFERENT BANDS IN P-BAND IS RECOMMENDED.
- ADDRESSING MULTIPLE SCIENCE GOALS APPEARS TO BE OUT OF THE NEW FRONTIERS COST BOX WITHOUT SIGNIFICANT CONTRIBUTIONS (INSTRUMENTS OR HARDWARE).
- SINGLE SCIENCE THEMES ARE STRONG AND CREDIBLE FOR NEW FRONTIERS OR DISCOVERY
 - THESE THEMES HAVE BEEN DISCUSSED AND PROMOTED IN MANY RECENT REPORTS
- THE MARS EXPLORATION ICE MAPPER COULD ADDRESS SIGNIFICANT HIGH PRIORITY, WELL-VETTED, SCIENCE GOALS AS WELL AS HUMANS TO MARS GOALS BUT AS CURRENTLY ENVISIONED WILL NOT.