

THE AERIAL REGIONAL-SCALE ENVIRONMENTAL SURVEY (ARES) MISSION TO MARS: J.W. Head¹, J.S. Levine, the ARES Science Team (D.L. Blaney, J.E.P. Connerney, R. Greeley, J.H. Hoffman, B.M. Jakosky, C.P. McKay, C. Sotin, M.E. Summers), C.I. Fassett, and J.L. Dickson. ¹Dept. of Geol. Sci., Brown Univ., Providence, RI 02912 USA, james_head@brown.edu.

Mission Summary: ARES is a proposed Mars Scout Mission designed to use an airplane platform to fly over the surface of Mars and make measurements of key science objectives. ARES extends and complements NASA's Mars Exploration Program (MEP) by returning benchmark measurements in two critical scientific themes: 1) Crustal Magnetism and 2) Near-Surface Atmospheric Chemistry which embody six primary science objectives:

1. High spatial resolution crustal magnetic survey.
2. Crustal magnetism source structure.
3. Underlying geology and mineralogy
4. Role of water vapor in the Mars atmospheric chemical cycle.
5. Chemical coupling between the atmosphere and surface.
6. Atmospheric chemical and isotopic composition and evolution.

ARES provides a fundamental scientific insight into the origin and evolution of magnetic fields, early planetary crustal formation processes, the role of water in the Mars atmospheric chemical cycle, Mars' volatile and climate history, and the viability of Mars as a biosphere conducive to past or present life.

ARES offers the opportunity to target and explore specific regions of highest scientific interest, returning previously unobtainable measurements from a vantage point 1.5 km above the surface across 500 to 850 km of diverse terrain.

ARES provides NASA with the opportunity to elicit an immediate and significant science response while inspiring the next generation of explorers through a large and complementary Education and Public Outreach (E/PO) effort.

Science Payload: A comprehensive suite of science instruments provides critical, high-priority COMPLEX and MEPAG measurements:

- *Magnetometer (NASA GSFC)* Magnetic field with 2 km spatial resolution and 1 nT sensitivity.
- *Context Camera (Malin Space Science Systems)* Contiguous imagery of science traverse over 3 km horiz. swath.
- *Point Spectrometer (NASA LaRC)* Surface spectra of ground track with 2.0 x 2.7 m spatial resolution, 430-1020 nm spectral range with 9 nm spectral resolution.
- *Mass Spectrometer (Univ. of Texas, Dallas)* Atmospheric constituents measured in-situ with 1 ppb sensitivity.
- *Atmospheric Data System (Aurora Flight Sciences)* Regional-scale pressure, temperature, density and wind.
- *Video Camera (Malin Space Science Systems)* Nar video rate imagery of critical deployment events, aerial platform and science traverse.

Science Advancements: ARES science objectives, measurement requirements and data products flow directly from NASA's strategic plan for Mars Exploration, the COMPLEX and MEPAG reports. ARES' science return is derived from orders of magnitude improvement in spatial resolution and precision.

- Two orders of magnitude higher spatial resolution magnetic survey than provided by Mars Global Surveyor (MGS), with the ability to resolve the crustal magnetism source structure.
- One order of magnitude higher spatial resolution spectroscopy than Mars Reconnaissance Orbiter (MRO) CRISM instrument.
- First direct measurement of near surface water vapor and chemically active gas concentrations.

- More than one order of magnitude higher precision isotopic ratio measurement than Viking Landers.

Mission Architecture: ARES implementation includes robust technical margins and flight proven systems to achieve flexibility and success. The ARES mission delivers an airplane to Mars with a spacecraft derived from Genesis heritage, and an entry and descent system derived from Pathfinder and Mars Exploration Rover. The rocket-propelled airplane autonomously completes a 500 to 850 km pre-planned, inertially-navigated science traverse. Science and critical event data is relayed to the ARES spacecraft as it performs a Mars flyby and is returned to Earth within 18 hours of the airplane flight through the 34 m DSN subnet. All data is disseminated and archived within 6 months of receipt.

Launch Vehicle: Delta 2925

- Launch Dry Mass: 522 kg
- Launch Wet Mass: 678 kg wet (35% margin)

Mission Design:

- Flyby spacecraft design and operations
- Direct entry trajectory
- Critical events link margin: 7 dB
- Airplane to S/C link margin: 12 dB
- S/C to Earth link margin: 3 dB

Airplane

- Mass: 66.5 kg dry (32% reserve), 125 kg wet
- Altitude: 1.5 km AGL, Ground Speed: 140 m/s
- Wing span: 6.2 m
- Maximum Duration: 101 min
- Maximum Range: 850 km
- Peak Power Margn: 53%, Cost Reserve: 49%

Airplane Robustness: ARES airplane size allows:

- Use of traditional design, test and manufacturing techniques.
- Credible aerodynamic performance and stability predictions.
- Flight-proven systems and a large payload volume margin.
- A majority of the implementation risk to be contained in a single well-defined and testable event: airplane deployment.
- Robust stability and control margins to accommodate large uncertainties in the Mars environment.
- margin (49%) ensure delivery of a robust, flight qualified system.

Management Approach: Streamlined, effective management approach ensures rapid decision-making with strict accountability. ARES team members have well defined responsibilities.

- *NASA LaRC:* Principal Investigator, Airplane Management, Science Payload Management, Science Team Management, Education and Public Outreach (E/PO), Point Spectrometer.
- *JPL:* Project Management, Project Engineering, Mission Assurance, Mission Design and Navigation, Mission Operations.
- *Lockheed Martin Astronautics:* Spacecraft, Entry System.
- *Aurora Flight Sciences:* Airframe, Airplane Power and Propulsion, Atmospheric Data System.
- *Charles Stark Draper Laboratory:* Airplane GN&C, Flight Software, Avionics.

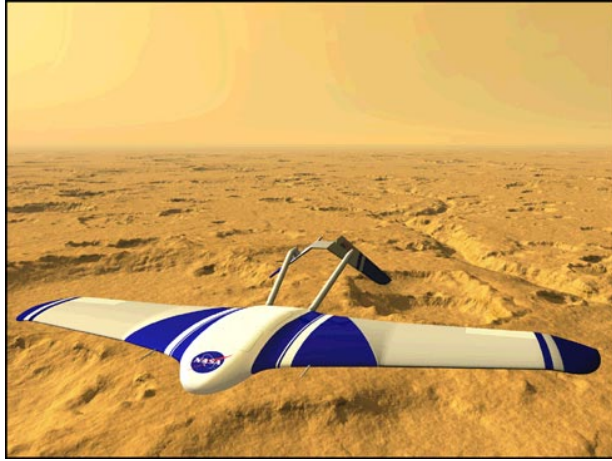


Figure 1. Artist's conception of ARES performing its survey over the surface of Mars.



Figure 3. Video still from the successful deployment of a half-scale model of ARES at Mars-relevant atmospheric pressure above Oregon, USA.

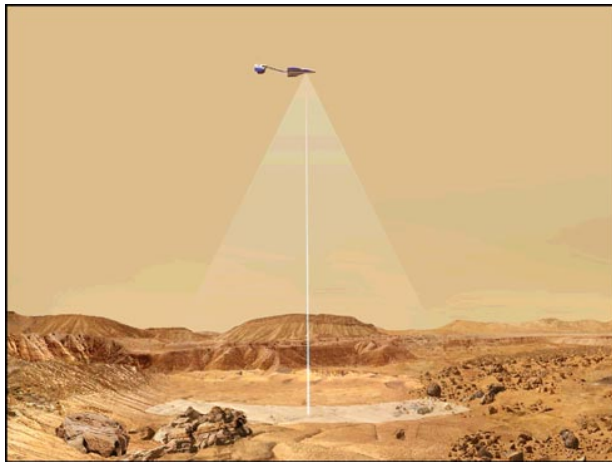


Figure 2. Artist's conception of ARES collecting data over the surface of Mars.

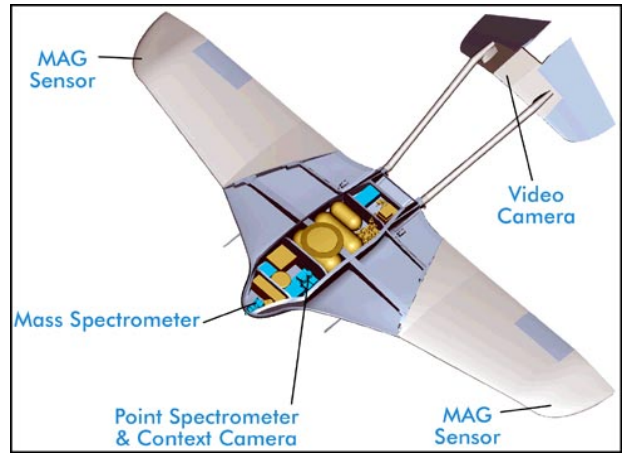


Figure 4. Scientific payload onboard ARES.

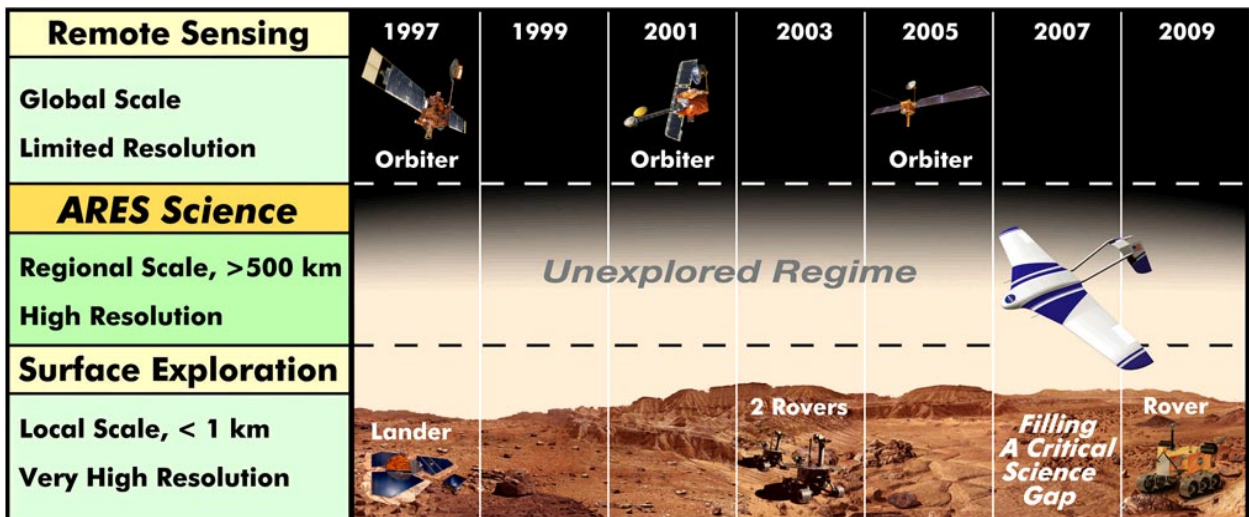


Figure 5. ARES bridges critical scale and resolution measurement gaps in the core MEP.