MECA Newsletter May 1984 Number 1

NEW MARS PROGRAM

Welcome! This newsletter is to announce the initiation of the new NASA-sponsored LPI study project entitled "Mars: The Evolution of its Climate and Atmosphere" (MECA) as defined in the Space Science and Applications Notice dated 25 May 1983. The overall goals of this program are given below.

An organizational meeting was held at the Lunar Planetary Institute on March 10–11, 1984. As stated in the Space Science and Applications Notice, the coordination of this program is in itself an experiment and is accomplished by a *Working Group* composed of all the investigators who are funded as part of the program. The first order of business was to establish a Steering Committee (see inset) and to define some general guidelines. Discussion by the Working Group led to the following decisions:

1. *The Study Group* is open to all investigators (funded either through MECA or elsewhere) who have potential contributions toward understanding the volatile evolution and climate history of Mars (see article on *Participation in MECA).*

2. *The Steering Committee* is selected from the Working Group, plus one member from the Study Group as a whole. The function of the Steering Committee is to define scientific questions as the program evolves and to provide guidance to the Projects Office.

3. *The Projects Office* is part of the Lunar and Planetary Institute. Its function is to provide administrative and logistical support, including making arrangements for various topical conferences and workshops.

4. *The Approach* in meeting the objectives of MECA will be to guide the research through a series of *Topical Workshops/Conferences,* each of which will have focused objectives. These workshops will be defined early enough so that investigators may plan their research efforts accordingly. Approximately five topical workshops/conferences will be held during the three-year duration of the program.

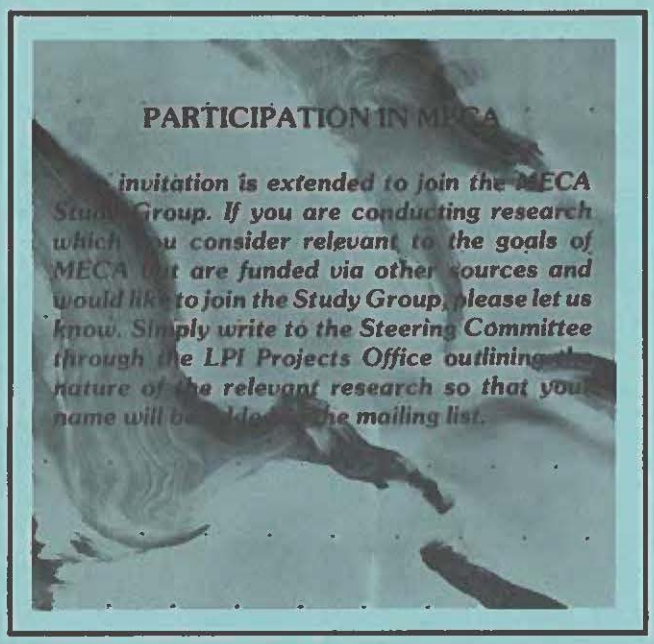
Research will be conducted by individual investigators as stated in their approved proposals; in addition, informal collaboration, such as the formation of research groups, is encouraged. Funds (albeit limited) are available for travel to hold small workshops to address more narrowly focused subjects than those defined by the topical conference/workshops. These may be open to the Study Group as a whole, or by invitation only. Proposals for small workshops may be submitted to the Steering Committee through the Projects Office.

5. *Publications.* The principal mode of reporting MECA results will be via journal publication. Topical conference programs will be derived from abstracts submitted prior to the conference. In most cases, arrangements will be made to publish conference results in special journal issues. Some of the study group members may wish to produce review papers focusing on our present state of knowledge concerning the questions raised during subgroup discussions.

6. *MG/CO Connection.* Most of the goals of MECA are directly relevant to the Mars Geoscience/Climatology Orbiter. As plans for the mission develop, communication will be maintained through Mike Carr, MECA-Steering Committee member and Chairperson for the MG/CO Working Group.

In summary, we look forward to a stimulating program dealing with an exciting topic. On behalf of the Steering Committee, I solicit your support to make this program a success.

Ron Greeley
Chairperson, MECA-Steering Committee



SUBGROUP REPORTS

During the first meeting of the study group, participants broke into four subgroups for more detailed discussions on four different topics. The overall purpose was to formulate questions which each subgroup recognized as important for focusing future discussions. Bob Haberle of NASA Ames Research Center led discussions on processes controlling the present seasonal cycles of dust, water, and CO_2. The second subgroup (guided by Fraser Fanale of the University of Hawaii) considered factors controlling martian climate history principally over the last 10^8 years. Mike Carr of the U.S.G.S., Menlo Park, led the subgroup concerned with volatile inventory and climate history of Mars as revealed by surface features and processes. Bob Pepin of the University of Minnesota focused subgroup discussions on the bulk chemical composition and outgassing history of Mars. The four topic areas are obviously interrelated. As a result of a combined Sunday morning session between the second and third subgroups, the two sets of questions were merged together. The following list summarizes the results of these subgroup meetings.

Seasonal Cycles

1. What are the physical processes that control the present seasonal cycles of dust, water, and CO_2?
   a. How do atmospheric aerosols (dust or ice) affect the cycles of water and CO_2?
   b. What is the nature and distribution of surface and subsurface reservoirs of water and how do they interact with atmospheric water?
   c. What is the role of atmospheric transport in the water cycle?
   d. How and when does dust enter and how and when is it removed from the polar regions?

2. How do the seasonal cycles change from year to year?
   a. Does the same amount of CO_2 frost survive at the South Pole each year? If so, why is the north residual cap larger than the south residual cap, given that the south polar cap is a cold trap? If not, how does the amount change from year to year?
   b. Why do global dust storms occur in some years but not in others? Does this inter-annular variability affect the water cycle or CO_2 cycle?

3. How can models of the seasonal cycles be extended to long-term variations?
   a. How do the present seasonal cycles change when driven by insolation distributions representative of Mars past?
   b. What additional sources/sinks become operative (e.g. latitudinal shifts in the permafrost boundary)?

Surface Processes and Climate History

1. What are the causative *agents* of climate change on Mars?
   a. obliquity, axial-orientation, and orbital changes
   b. solar radiation
   c. bombardment history
   d. internal thermal history
   e. drive to chemical equilibrium

2. How have the *abundances* of surface volatiles changed with time?
   a. juvenile volatile supply
   b. escape history
   c. weathering and recycling processes

3. What are the major volatile *reservoirs*, and how have they changed with time?
   a. chemically combined materials
   b. caps
   c. atmosphere
   d. condensed volatiles in the ground
   e. absorbed/interlayer volatiles

4. What has been the *climatic history* of Mars and how has it been affected by 1–3?
   a. atmospheric, pressure, temperature, and compositional variations
   b. surface temperature
   c. state of H_2O and other volatiles
   d. dust and aerosol loading
   e. modes of transport

5. What observations and modeling will help resolve 1-4?
   Examples:
   a. changes in crater morphology with location and time
   b. valley origin and changes in valley morphology with location and time
   c. mineralogic/chemical mapping
   d. thermal modeling of regolith
   e. studies of kinetics of volatile migration
   f. experimental weathering studies

Bulk Chemical Composition and Outgassing History

1. What is the range of possible absolute and relative abundances of the initial Mars volatile inventory?
   a. Status of geochemical modeling from nebular condensation assuming thermodynamic equilibrium (function of pressure-temperature, radial distance from sun, nebular composition)? Status of geochemical modeling from multicomponent mixing of meteoritic volatile and nonvolatile components? Status of geochemical information from geophysical modeling?
   b. What new information or modeling constraints on existing volatile inventories in the martian mantle can be obtained from the SNC meteorites, accepting the evidence associating them with Mars?

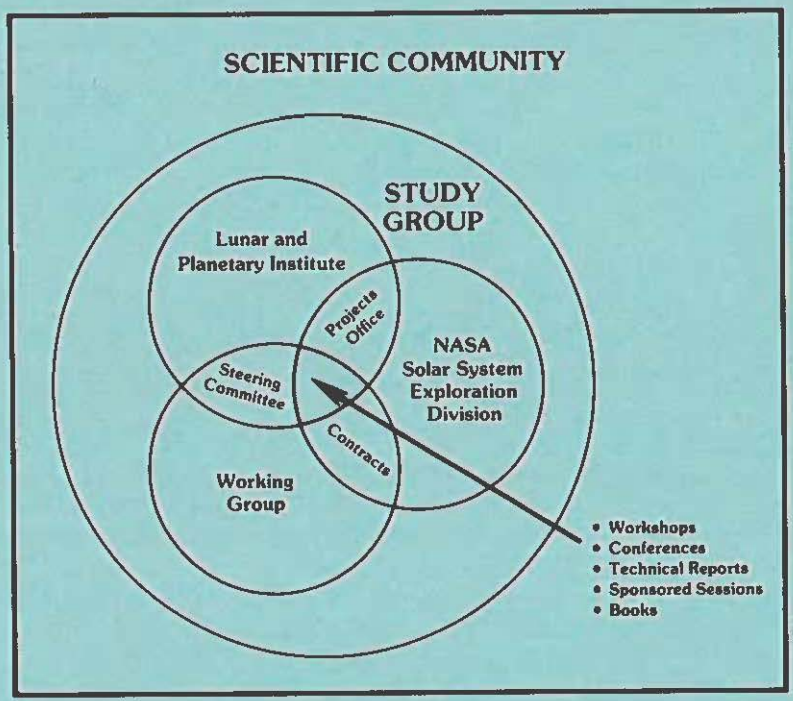
2. What evidence exists that the planet has undergone significant oxidation? Is the oxidation only on the surface? Are there plans to try to measure martian atmospheric D/H? Has the composition of degassed volatiles changed with time?

3. Styles of volcanism in time and space (inputs from climate history/ surface morphology)?
   a. Information from styles of eruption on volatiles in magma? On sizes and depths of magma chambers?
   b. How do we evaluate the effectiveness of various degassing mechanisms and processes (free or excess volatiles, volatiles dissolved in magmas, eruption and subsequent oxidation of species such as FeS and C)?

4. What does the present atmosphere tell us about integrated outgassing, modified by loss processes to the regolith and to space over martian geologic time? Implications of isotopic signatures ($^{15}N/^{14}N$, $^{129}Xe/^{132}Xe$, $^{40}Ar/^{36}Ar$)?

REVIEW PAPERS

The questions raised by the four subgroups may stimulate members of the Study Group to identify and perhaps to consider writing review papers that would summarize our present state of knowledge. Several excellent review papers, special journal issues, and books already exist, but the readership may identify areas that have not been previously synthesized or old areas that would benefit from a different perspective or focus. Although it is not the purpose of the study project to presuppose the



STEERING COMMITTEE

Ronald Greeley, Arizona State University, Chairperson
Michael Carr, U.S. Geological Survey (Surface Processes)
Fraser Fanale, University of Hawaii (Climate Change)
Robert Haberle, NASA-Ames Research Center (Seasonal Cycles)
Robert Pepin, University of Minnesota (Bulk Chemistry)
Peter Schultz, Lunar and Planetary Institute (Project Scientist)

Joseph Boyce, NASA Headquarters (ex officio)
Kevin Burke, Lunar and Planetary Institute (ex officio)
Pam Jones, Lunar and Planetary Institute (Project Administrator)

outcome of the next three years of research and scientific interaction, such reviews may prove useful for group members with diverse backgrounds but common goals. Individuals or groups of individuals are encouraged to embark on such an effort and may wish to contact R. Greeley about the matter. Obviously, the purpose of the project is to do science rather than to do review papers; nevertheless, the group would benefit by dedicated individuals wishing to complement their research.

Recent Review Articles

1. Carr M. H. (1982) Periodic climate change on Mars: review of evidence and effects on distribution of volatiles. *Icarus* **50**, 129-139.
2. Carr M. H. (1981) *The Surface of Mars*. Yale University. 232 pp.
3. Baker V. R. (1982) *The Channels of Mars*. U. Texas Press. 198 pp.
4. Fanale F. P. and Jakosky B. M. (1982) Regolith-atmosphere exchange of water and carbon dioxide on Mars: Effects on atmospheric history and climate change. *Planetary and Space Science* **30**, 819-831.
5. Fanale F. P., Salvail J. R., Banerdt B. W., Saunders R. S. (1982) Mars: The regolith-atmosphere-cap system and climate change. *Icarus* **50**, 381-407.
6. Pollack J. P. (1979) Climatic change on the terrestrial planets. *Icarus* **37**, 479-553.
7. Pollack J. P. and Toon O. B. (1982) Quasi-periodic climate changes on Mars: A review. *Icarus* **50**, 259-287.
8. Rossbacher L. A. and Judson S. (1981) Ground ice on Mars: Inventory, distribution, and resulting landforms. *Icarus* **45**, 35-39.
9. Toon O. B., Pollack J. B., Ward W., Burns J. A. and Bilski K. (1980). The astronomical theory of climate change on Mars. *Icarus* **44**, 552.
10. Ward W. R., Burns J. A. and Toon O. B. (1979) Past obliquity oscillations of Mars: Role of the Tharsis uplift. *Journal of Geophysical Research* **84**, 243-259.

MECA PROGRAM SCOPE

For the benefit of readers not aware of the Space Science and Applications Notice of May 25, 1983, we include below an excerpt describing the scope of the program. Although the problem is focused, the number of different approaches and basic data sets requires involvement from a variety of disciplines.

The Mars Data Analysis Program will support a variety of scientific investigations in a focused study that will address the provenance and evolution of martian volatiles. The goals of the study are to define the present inventory and distribution of martian volatiles and to unravel the history of their evolution so that we may understand the original volatile content of Mars as inherited from the proto-planetary nebula; the processing of primary volatile components by the martian interior; the evolution of the martian atmosphere; the interchange between the surface and the atmosphere through geologic time; and secular or non-secular changes in climate and the processes responsible for any changes. Proposed investigations that directly address any of the above stated goals or that will contribute to the attainment of them will be considered scientifically responsive to this Notice.

"WATER ON MARS" THE FIRST TOPICAL CONFERENCE ABOUT MARS: The Evolution of its Climate and Atmosphere

The first MECA topical conference will be held Friday and Saturday (November 30 and December 1) prior to the Fall American Geophysical Union meeting in San Francisco. The two-day meeting will be hosted by Bob Haberle at NASA Ames Research Center. Although the detailed format of the meeting is still being formulated, contributed papers from the Study Group probably will form the core of the program. "Water on Mars" represents one of the fundamental issues that the MECA Study Group must face. What is the evidence for the existence of water in the past? How much water was there? Where is it today? How did it evolve? What is the physical state of water and how has it changed? Such questions should generate active participation and perhaps a better understanding of the problem.