



CONFERENCE ON THE  
GEOPHYSICAL DETECTION  
OF SUBSURFACE WATER  
ON MARS

AUGUST 6-10, 2001  
LUNAR AND PLANETARY INSTITUTE  
HOUSTON, TEXAS

~ CONFERENCE PROGRAM ~

CONFERENCE ON  
THE GEOPHYSICAL DETECTION OF  
SUBSURFACE WATER ON MARS

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AUGUST 6–10, 2001  
LUNAR AND PLANETARY INSTITUTE  
HOUSTON, TEXAS

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SPONSORS

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Lunar and Planetary Institute  
National Aeronautics and Space Administration

## CONVENERS

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Stephen Clifford, *Lunar and Planetary Institute*  
Jeffrey George, *NASA Johnson Space Center*  
Carol Stoker, *NASA Ames Research Center*

## SCIENTIFIC ORGANIZING COMMITTEE

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Bruce Banerdt, *Jet Propulsion Laboratory*  
David Beatty, *Jet Propulsion Laboratory*  
James Blacic, *Los Alamos National Laboratory*  
Geoffrey Briggs, *NASA Ames Research Center*  
Michael Carr, *U.S. Geological Survey, Menlo Park*  
Angioletta Coradini, *Institute d'Astrophysique Spatiale*  
Francois Costard, *Université de Paris*  
James Cutts, *Jet Propulsion Laboratory*  
James Garvin, *NASA Headquarters*  
John Grant, *National Air and Space Museum*  
Ronald Greeley, *Arizona State University*  
Robert Grimm, *Blackhawk Geometrics*  
Walter Kiefer, *Lunar and Planetary Institute*  
Philippe Lognonné, *Institut de Physique du Globe de Paris*  
Humboldt Mandell, *NASA Johnson Space Center*  
Gary Olhoeft, *Colorado School of Mines*  
Roger Phillips, *Washington University*  
Jeffrey Plaut, *Jet Propulsion Laboratory*  
Larry Soderblom, *U.S. Geological Survey, Flagstaff*

Monday, August 6, 2001

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**TERRESTRIAL BACKGROUND**

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8:30 a.m. — Lecture Hall

Chair: S. Clifford

*WELCOME, INTRODUCTIONS, AND REVIEW OF CONFERENCE AGENDA*

Black P. B. \* [INVITED]

*Basic Concepts in Terrestrial Ground Freezing*

Hallet B. \* [INVITED]

*Characteristics of the Continuous Permafrost Regions of Earth*

Max M. D. \* [INVITED]

*Terrestrial Methane Hydrate*

GENERAL DISCUSSION

10:30–10:45 a.m.      BREAK

Monday, August 6, 2001

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**MARTIAN BACKGROUND**

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10:45 a.m. — Lecture Hall

Chair: J. George

Clifford S. M.\* [INVITED]

*The Expected Nature, Distribution and State of  
Subsurface Volatiles on Mars*

Greeley R.\* [INVITED]

*Mars Subsurface Science Issues: A MEPAG Perspective*

GENERAL DISCUSSION

12:15–1:30 p.m.      LUNCH

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\* Denotes Speaker

*Monday, August 6, 2001*

— **GEOMORPHIC EVIDENCE OF SUBSURFACE VOLATILES ON MARS** —

**1:30 p.m. — Lecture Hall**

**Chair: C. Stoker**

Barlow N. G.\*

*Impact Craters as Indicators of Subsurface Volatile Reservoirs*

Russell P. S.\* Head J. W. III

*The Elysium/Utopia Flows: Evidence for Release of Confined  
Ground-water in the Context of a Global Cryosphere-Hydrosphere System*

Head J. W.\* Kreslavsky M. A.

*Medusae Fossae Formation as Volatile-rich Sediments Deposited  
During High Obliquity: An Hypothesis and Tests*

**PANEL DISCUSSION**

**THE NATURE OF THE CRYOSPHERES OF THE EARTH AND MARS**

Moderators: C. Stoker, S. Clifford, J. George

Panelists: M. Carr, B. Hallet, N. Hoffman

3:30–3:45 p.m.      **BREAK**

*Monday, August 6, 2001*

———— **MARS EXPLORATION: PLANS AND POSSIBILITIES** ————

**3:45 p.m. — Lecture Hall**

**Chair: S. Clifford**

Beatty D.\* [INVITED]

*Mars Subsurface Exploration: A Review of Recent Studies*

**MODERATED DISCUSSION**

Moderators: D. Beatty, M. Carr, D. McCleese, S. Arcone

Monday, August 6, 2001

CONFERENCE RECEPTION AND POSTER SESSION

7:00-9:30 p.m. — Great Room

Coleman N. M.

*Geophysical Methods to Detect Ground Ice Produced by Recent Fluid Flows on Mars*

Ozorovich Y. R. Linkin V. M. Fink J. Smythe W. D. Zoubkov B. V. Babkin F. V.

*Possibilities of Using MARSSES Instrument for Long-Term Monitoring and Subsurface Studies in Arctic and Arid Lands*

Counil J. L. Ferri F. Lognonné Ph. Marsal O. Rocard F. Bonneville R.  
*The Netlander Mission: A Geophysical Network Aimed at Investigating Mars Atmosphere, Sub-Surface and Deep Interior*

Mangold N.

*Lobate Debris Aprons as Potential Targets for Ground Ice Detection Analogs to Terrestrial Rock Glaciers*

Jean J.-S. Yang C.-H.

*Future Explorations on Chemical Compositions of Seepage Water and Ground Ice on Mars Detected by Gamma-Ray Spectrometer, GC-MS, and Ion Chromatograph*

Hamelin M. Trautner R.

*Localization of Mars Sub-Surface Ice/Water by Means of a Mobile Ground Penetrating Radar in Combination with a Mutual Impedance Probe*

Reineix A. Martinat B. Berthelier J. J. Ney R.

*FDTD Method for the Theoretical Analysis of the NETLANDER GPR*

Costard F. Forget F. Mangold N. Mercier D. Peulvast J. P.

*Debris Flows on Mars: Comparison with Terrestrial Analogs*

Pletser V. Lognonné Ph. Diament M. Ballu V. Dehant V. Lee P. Zubrin R.

*Subsurface Water Detection on Mars by Active Seismology: Simulation at the Mars Society Arctic Research Station*

Costard F. Berthelier J. J. Grandjean G. Heggy E. Mangold N. NEY R. Paillou Ph.

*Proposed Model of the Martian Subsurface for the GPR Experiment on Netlander*

Pellenbarg R. E. Max M. D. Clifford S. M.

*Methane and Carbon Dioxide Hydrates on Mars: Are There Sufficient Natural Resources on Mars to Sustain Human Habitation?*

Kereszturi A.

*Theoretical Assumptions on Subsurface Ice Melting on Mars*

Cummer S. A. Farrell W. M.

*Modeling the Complete Planetary Subsurface Radio Remote Sensing Problem*

Knauth L. P. Burt D. M. Tyburczy J. A.

*Highly Conductive Eutectic Brines Rather than Water Expected in the Martian Subsurface*

Plaut J. J. Jordan R. Safaenili A. Picardi G. Seu R. Orosei R.

*Subsurface Sounding of Mars: The Effects of Surface Roughness*

Aprea C. M. Alde D. M. Rutledge J. T.

*Regional Imaging of the Subsurface of Mars Using Teleseismic Events*

Banerdt W. B. Pike W. T.

*A Miniaturized Seismometer for Subsurface Probing on Mars*

*Tuesday, August 7, 2001*

— **TECHNIQUES IN TERRESTRIAL GEOPHYSICAL EXPLORATION** —

**8:30 a.m. — Lecture Hall**

**Chair: J. George**

*REVIEW OF DAY'S AGENDA*

Olhoeft G. R.\* [INVITED]

*Subsurface Geophysical Detection Methods to Uniquely Locate Water*

Grimm R.\* Blohm M. [INVITED]

*Practical Geophysical Exploration for Groundwater*

Mosher C.\* [INVITED]

*Advanced Geophysical Techniques in the Search for Oil and Gas*

10:30–10:45 a.m. **BREAK**

*Tuesday, August 7, 2001*

— **TECHNIQUES APPLIED TO THE TERRESTRIAL PERMAFROST** —

**10:45 a.m. — Lecture Hall**

**Chair: C. Stoker**

Arcone S.\* [INVITED]

*Permafrost Investigations with Ground-Penetrating Radar in Northern and Interior Alaska, and in the Antarctic Dry Valleys*

Hoekstra P.\* [INVITED]

*Electromagnetic Probing of Permafrost*

12:15–1:30 p.m. **LUNCH**

Tuesday, August 7, 2001

— TERRESTRIAL INVESTIGATIONS OF SOIL, PERMAFROST, —  
AND ICE SHEETS

1:30 p.m. — Lecture Hall

Chair: S. Clifford

Daniels J.\* Blumberg D. G. Freiliker V. Vulfson L. D. Kotlyar A. L.  
Neta T. Ben-Asher J. Sprintsin M. Ronen G. Linestky M.

*Radar Penetration in Soils: The Potential for Sub-Surface Observation  
of Both Earth and Mars*

Calvert H. T.\* Dallimore S. R. Hunter J. A.

*Application of Geophysical Techniques for Mapping Ice-bearing  
Sediments, Mackenzie Delta, Western Arctic, Canada*

Peters M. E.\* Blankenship D. D. Morse D. L.

*Imaging Subglacial Water Systems with Coherent Airborne Radar  
Sounding Techniques*

Doebbler J. A.\* Blankenship D. D. Morse D. L. Peters M. E.

*A Model for the Dielectric Absorption of the Central West Antarctic  
Ice Sheet at Radar Sounding Frequencies*

GENERAL DISCUSSION

3:30–3:45 p.m. BREAK

Tuesday, August 7, 2001

— PLANNED ORBITAL GEOPHYSICAL INVESTIGATIONS I —

3:45 p.m. — Lecture Hall

Chair: S. Clifford

Jordan R.\* Biccari D. Bombaci O. Gurnett D. Johnson W. T. K.

Kirchner D. Picardi G. Plaut J. Safaeinili A. Seu R. Zampolini E.

*The System and Implementation Aspects of the Mars Advanced Radar  
for Subsurface and Ionospheric Sounding (MARSIS)*

Safaeinili A.\* Biccari D. Bombaci O. Gurnett D. Johnson W. T. K.

Jordan R. L. Orosei R. Picardi G. Plaut J. Seu R. Zampolini E.

Zelli C.

*Radar Sounding of Mars: A Focus on MARSIS*

Biccari D.\* Picardi G. Seu R. Corradini A. Orosei R.

*The Mars High Resolution Advanced Radar for 2005 Space Mission*

MODERATED DISCUSSION

Moderators: D. Beatty, M. Carr, D. McCleese, S. Arcone



6:30–9:00 p.m.

CONFERENCE DINNER:  
VILLA CAPRI, CLEAR LAKE

MODERATED DISCUSSION (continued)

Moderators: D. Beaty, M. Carr, D. McCleese, S. Arcone

*Wednesday, August 8, 2001*

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**AMBIGUITIES AND COMPLICATIONS IN THE  
INTERPRETATION OF GEOPHYSICAL DATA**

**8:30 a.m. — Lecture Hall**

**Chair: C. Stoker**

*REVIEW OF DAY'S AGENDA*

Leuschen C. J.\* Gogineni S. P. Clifford S. M. Raney R. K. [INVITED]

*Design of a Ground-Penetrating Radar for Mars: Simulations  
and Experiments*

Orosei R.\* Bianchi R. Coradini A. Espinasse S. Federico C.  
Ferriccioni A.

*Characterization of the Martian Surface Scattering at  
Decametric Wavelengths*

Heggy E.\* Paillou Ph. Ruffié G. Malézieux J.-M. Costard F.  
Grandjean G.

*On Sounding Radar Performances for Martian Subsurface  
Water Detection*

Pettinelli E.\* Della Monica G. Bella F. Losito G. Di Maio R.  
Vannaroni G. Storini M. Orsini S. Cerulli-Irelli R.

*High and Low Frequency Electrical Measurements of Martian  
Soil Simulants*

Shchuko O. B. Kartashov D. V.\* Orosei R. Picardi G.

*Martian Underground Water Detection: Thermal Model and  
Simulations of Radar Pulse Propagation*

GENERAL DISCUSSION

10:30–10:45 a.m.      **BREAK**

Wednesday, August 8, 2001

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MARS GEOPHYSICAL EXPLORATION STRATEGY

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10:45 a.m. — Lecture Hall

Chair: S. Clifford

Clifford S. M.\* George J. A. Stoker C. R. Briggs G. Beaty D. W.

*A Proposal for an Integrated Geophysical Strategy to "Follow the Water" on Mars*

**DEEP SOUNDING ORBITAL RADAR,  
GLOBAL RECONNAISSANCE CONCEPTS**

Gogineni P.\* [INVITED]

*Orbital Radar Sounding of Mars: Technical Challenges and Solutions*

GENERAL DISCUSSION

12:15–1:30 p.m. LUNCH

Wednesday, August 8, 2001

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SAR ORBITAL SOUNDERS

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1:30 p.m. — Lecture Hall

Chair: J. George

Campbell B. A.\* Campbell D. B. Grant J. A. Hensley S. Maxwell T. A.

Plaut J. J. Rosen P. Shepard M. K. Simpson R.

*Orbital Imaging Radar and the Search for Water on Mars*

Paillou Ph.\* Thompson T. W. Plaut J. J. Rosen P. A. Hensley S.

Elachi Ch. Massonnet D. Achache J.

*MEEM: An Orbital Synthetic Aperture Radar for Mars Exploration*

Kofman W.\* Herique A. Costard F.

*The P-band Radar to Study Polar Caps, the Shallow Sub-Surface and Paleo-Channels on Mars*

GENERAL DISCUSSION

**PANEL DISCUSSION**

**MARS ORBITAL SOUNDING: A VIABLE METHOD OF  
GLOBAL RECONNAISSANCE FOR SUBSURFACE WATER?**

Moderators: D. Beaty, M. Carr, D. McCleese

Panelists: G. Olhoef, S. Arcone, P. Gogineni, C. Leuschen, K. Raney,  
C. Mosher

3:30–3:45 p.m. BREAK

Wednesday, August 8, 2001

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PANEL DISCUSSION

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**MARS ORBITAL SOUNDING: A VIABLE METHOD OF  
GLOBAL RECONNAISSANCE FOR SUBSURFACE WATER? (continued)**

3:45 p.m. — Lecture Hall

Moderators: D. Beaty, M. Carr, D. McCleese

Panelists: G. Olhoeft, S. Arcone, P. Gogineni, C. Leuschen, K. Raney,  
C. Mosher

**PLANNED ORBITAL GEOPHYSICAL INVESTIGATIONS II**

Chair: J. George

Squyres S.\* [INVITED]

*The Gamma-Ray/Neutron Spectrometer Onboard the  
2001 Mars Orbiter*

6:30–9:00 p.m.

CONFERENCE DINNER:

CADILLAC BAR AND GRILL, KEMAH BOARDWALK

Featured Speaker: A. Frolov

*On the Nature and Geophysical Investigation of the  
Continuous Permafrost of Siberia*

Thursday, August 9, 2001

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NETLANDERS

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8:30 a.m. — Lecture Hall

Chair: S. Clifford

REVIEW OF DAY'S AGENDA

Costard F. Lognonné Ph.\* Banerdt B.

*Martian Volatile-Rich Reservoirs: A Review of the Netlander  
Payload Contribution*

Berthelier J. J.\* Ney R. NETLANDER/GPR Team

*The GPR Experiment on Netlander: Objectives, Description of  
the Instrument and Simulated Performances*

Ciarletti V.\* Berthelier J. J. Ney R. Reinex A. Martinat B.

*The GPR Experiment on NETLANDER: Preliminary Results on the  
Determination of the Propagation Vector of Reflected Waves*

Lognonné Ph.\* Banerdt B. Giardini D. Costard F.

NL-SEIS Team

*An Idea for an Active Seismic Experiment on Mars in 2008*

10:30–10:45 a.m. BREAK

Thursday, August 9, 2001

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ALTERNATIVE PLATFORMS

10:45 a.m. — Lecture Hall

Chair: J. George

Stoker C.\*

*Rovers, Airplanes, & Balloons: Capabilities & Limitations*

Brownlow L. W. Dorn G. A. Mosher T. J.\*

*A Proposal for Detailed Mapping of Martian Aquifers  
Using Penetrators*

Grant J. A.\* Campbell B. A. Schutz A. E.

*A Rover Deployed Ground Penetrating Radar on Mars*

GENERAL DISCUSSION

12:15–1:30 p.m. LUNCH

Thursday, August 9, 2001

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ALTERNATIVE INVESTIGATIONS

1:30 p.m. — Lecture Hall

Chair: C. Stoker

Grimm R. E.\* [INVITED]

*Low-Frequency Electromagnetic Exploration for Groundwater on Mars*

Connerney J. E. P.\* Acuna M. H.

*Detection of Sub-Surface Water on Mars by Controlled and Natural  
Source Electromagnetic Induction*

Trautner R. Grard R.\* Hamelin M.

*Localisation and Characterisation of Subsurface Ice and Water Deposits  
by Means of Mutual Impedance (MI) Instruments*

Smith P. H.\*

*Mars Oasis Detector*

Kiefer W. S.\*

*Water or Ice: Heat Flux Measurements as a Contribution to  
the Search for Water on Mars*

3:30–3:45 p.m. BREAK

*Thursday, August 9, 2001*

**PANEL DISCUSSION**

**SURFACE AND AIRBORNE GEOPHYSICAL INVESTIGATIONS IN  
THE SEARCH FOR SUBSURFACE WATER ON MARS  
3:45 p.m. — Lecture Hall**

Moderators: D. Beaty, M. Carr, D. McCleese, S. Arcone

Panelists: C. Stoker, R. Grimm, P. Hoekstra, R. Grard, N. Coleman

6:30–9:00 p.m.

CONFERENCE DINNER:

LANDRY'S SEAFOOD, KEMAH BOARDWALK

**PANEL DISCUSSION**

**COLLATERAL SCIENCE OPPORTUNITIES OFFERED BY  
THE GEOPHYSICAL EXPLORATION FOR SUBSURFACE WATER ON MARS**

Moderators: D. Beaty, M. Carr, D. McCleese, S. Arcone

Panelists: B. Banerdt, Ph. Lognonné, C. Mosher, G. Olhoeft

*Friday, August 10, 2001*

**ACCESSING VOLATILE TARGETS: DRILLING ON MARS**

**8:30 a.m. — Lecture Hall**

**Chair: J. George**

Briggs G.\* [INVITED]

*The Scientific Goals and Technical Challenges of Drilling on Mars*

Coradini A.\* Angrilli F. De Sanctis M. C. Espinasse S. Flamini E.

Orosei R. Re E.

*An Integrated Technological Proposal for Drilling and In-Situ Science  
for the 2007 Mars Lander Mission*

Mandell H.\* [INVITED]

*A Proposal for Going Deep and Early*

**GENERAL DISCUSSION**

10:30–10:45 p.m.

**BREAK**

*Friday, August 10, 2001*

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**SUMMARY PANEL DISCUSSION**

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**DEFINING THE BEST STRATEGY TO  
"FOLLOW THE WATER" ON MARS  
10:45 a.m. — Lecture Hall**

S. Clifford, C. Stoker, J. George

Beaty, M. Carr, D. McCleese, S. Arcone, J. Garvin, C. Mosher

EMARKS

CONFERENCE ADJOURNS