EXPEDITION TWO: A MULTI-GOAL MARS ANALOGUE EXPEDITION TO THE ARKAROOLA REGION, AUSTRALIA

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Expedition Two is the second in a series of expeditions to Mars analogue locations worldwide under the auspices of the Mars Expedition Research Council (MERC). The goals of Expedition Two are threefold: research, operations, outreach and education. The expedition will be contained with approximate 100 km radius of Arkaroola in the northern Flinders Ranges in the Australian Outback. There will be six main themes to the expedition within the goals: ***Field Science*** *– Collecting baseline geological and biological data on the field area and its Mars analogue significance.* ***Field Engineering*** *- Trials of the MarsSkin 3 analogue Mechanical Counter Pressure suit.* ***Exploration Operations*** *– evaluation of exploration methodologies, data collection and data loggers, and a site database, and selection of the site for MARS-OZ* ***Human Factors*** *– psychological profiling of an international, multi-disciplinary team of expeditioners, cognitive function, leadership philosophies, and crew social interaction.* ***Outreach*** *– Based on previous expeditions we expect extensive local, national and international interest by web, broadcast and print media.* ***Education*** *– The expedition will be interacting with groups of students from the International Space University's Summer School Program, undergraduates from the University of South Australia and the University of Technology Sydney, and with National Science Week.*

INTRODUCTION

A Mars analogue is an environment or situation on Earth with characteristics, in nature or by simulation, for which there are, or could be, analogous characteristics on Mars. This definition covers both the physical setting of Mars, as well as design considerations for technological challenges and scenarios for human activity. This paper outlines plans for such an expedition to inform delegates to the 2004 Australian Mars Exploration Conference and to allow post-expedition assessment on the degree to which the pre-expedition goals and expectations have been met.

The Mars Society Australia (MSA) selected the Arkaroola region as its prime Mars analogue area as an outcome of its Jarntimarra-1 (JNT-1) Expedition in 2001 (Mann *et al.*, in 2004, Clarke and Mann, in 2004). The survey team used a careful selection process that recorded information on the site name, date visited, coordinates, ownership, access, risks, maps, geology, climate, flora/fauna, history, analogue value and references. Comparative judgments with respect to MSA's specific needs were made on a separate assessment sheet with a list of 9 scientific, 8 engineering, 7 logistic, and 8 visual criteria. The Arkaroola region was selected from a short list of six regions (Figure 1).

The planned follow up to this expedition was JNT-2, whose goals were two fold: selection of the precise site for the Australian Mars Analogue Research Station (MARS-OZ) facility (Clarke 2004) in conjunction with the operators of Arkaroola Resort and discussion of the proposed research program with local landowners and users. The time frame for JNT-2 was tentatively set at late 2003. These plans were changed subsequent to the highly successful Expedition One to the Mars Desert Research Station (MDRS) in Utah during February-March 2003 (Persaud *et al.* 2004). As a result of this expedition, JNT-2 was included within a broader program, Expedition Two, whose goals were to include an extensive research and outreach program.

THE MARS EXPLORATION RESEARCH EXPEDITION SERIES

Recognizing the need for a professional, formal research body, members of the Expedition One crew formed the Mars Expedition Research Council (MERC) in 2003. This council's oversight committee is responsible for the peer review of research proposed for the expeditions, the financial resources of the expedition council, and the selection of host institutions that would oversee logistics and public relations related to the conduct of an expedition.

Mars expeditions planned by science-driven space agencies would be of necessity science-driven missions. The building of spacecraft, the transit to Mars, to setting up of base camp, the specific technology used for life support on Mars, and the return to Earth, these are not the mission. These are necessary components to make the mission happen successfully, but the mission is the scientific exploration of Mars to answer questions of geology, geophysics, climate, biological potential and history. The mission is the science. All the other factors that contribute to accomplishing that mission preceding and succeeding surface exploration operations are not considered by the Mars Expedition Research Council's Mars Analog Program.

However, the results of our program are tools, knowledge and strategies that will affect these other factors. For instance, a science-driven expedition intending to maximize the science-return will require field operations on the Martian surface for as long as possible – in the case of Mars, this mean conjunction class missions rather than opposition class missions.

Conjunction class missions, such as those proposed in the Mars Direct and the NASA Design Reference Mission scenarios, are long-surface stays, between 550 and 720 days depending on annual orbital variations. Opposition class missions, such as those proposed by Rosaviakosmos (round-trip time being 440 days), due to orbital mechanics are short-duration surface stays on the order of 30-60 days, depending on annual orbital variations.

To maximize the amount of knowledge produced by a science-driven mission, the duration of the surface stay must be maximized. This dictates conjunction-class mission architectures, allowing for 550 to 720 days of exploration. MERC's program is not to evaluate mission architectures, but to provide science-driven knowledge of how to make surface operations more efficient, intellectually, physically and socially, in accomplishing its goals. Along the way to determining the output possible within an conjunction class mission architecture, MERC will also determine the output possible within a opposition class mission for comparison.

Mars analogue studies are already significantly contributing to the expansion of knowledge about the requirements for human Mars expeditions, such as research in field science, exploration operations, human factors and exploration technology, as well as other areas. There is enough work to do to occupy several programs over many years by several agencies. The assembly of that body of knowledge into scenarios for human activity is yet to be achieved and tested in a holistic expedition simulation, which would not be possible until the metrics of exploration are defined.

These metrics would be used to measure the quality of exploration on the surface of Mars in order to improve it. The mission is the science; therefore from a framework of scientific fieldwork, studies into how to achieve that mission need to consider the operational factors, social-psychological factors, and technological factors that affect the field work and the field team.

Simulations which are not holistic because they do not incorporate a field science program, such as those by the Institute for Biomedical Problems in Moscow, are confinement studies applicable to social-psychology research of crews in transit between Earth and Mars with little to do and little reason to interact in product work. However, it is quite likely a crew of a Mars expedition will have lots of collaborative pre-landing planning to do as they review their goals, pick research sites, and consider new data from satellites in orbit and robots already on the surface. This puts confinement studies that do not have a crew collaborating daily towards common goals, performing real science mission planning and analysis, as suspect in premise. These still may be useful to develop tools for evaluating crew social-psychology once the correct premise is incorporated.

To be able to conduct a holistic simulation that will test out all scenarios for scientific exploration over a period of the same range as proposed for Mars expeditions (i.e. 550-720 days), research needs to be done now to define the requirements of each science goal and its human considerations from an operational perspective geared towards maximizing efficiency and defining technological support requirements – what may be called science return optimization. The Mars Expedition Research Council, an international, interdisciplinary body of Mars analogue researchers, plans to conduct exactly that program of research at Mars analogue sites around the world.

Plans for mission architectures like the NASA Reference Mission do not consider science return optimization. Rather, engineering constraints determine what the scientist-astronauts may do. A better approach would be to research what the requirements for the scientific exploration of Mars would be, and use them to design exploration strategies that inform engineering decisions and expedition planning. From an operational perspective, we do not yet know how to conduct a Mars expedition so that it maximizes the scientific output.

This research needs to begin now, as the process for learning all we need to discover will take between 15 to 20 years prior to a first human Mars expedition. This timeline was developed in a paper by R. Persaud, *"A Systematic Approach to Investigations at Mars Analog Research Stations,"* (Persaud, 2004). Based on 100 questions divided into categories of field science, field operations, field reconnaissance, human factors, remote mission support, exploration-supporting technologies, data analysis, and habitat design features, the analysis described in the paper concluded that the way these 100 questions relate to each other determines how and in what manner they can be answered.

This produces a progressive Mars Analog Program of six 30-day analog expeditions focused primarily on field operations and reconnaissance in the context of field science; evolving into six 90 to 180 day analog expeditions focused on improving exploration technology design (where technology is abused to test for robustness over long durations and requirements for maintenance, power, support), maximizing data analysis methods (to deal with the quantity of data produced and learn how to work collaboratively with remote mission support), and exploring human factors in more detail (since confinement studies have suggested it takes at least six weeks before serious social problems develop); and finally two to three fully holistic simulations of the same order of duration as proposed conjunction class mission architectures (500+ days), in order to assemble all lessons learned into a workable scenario.

These 100 questions are not claimed to be exhaustive of all possible questions regarding how to design a human exploration program on the surface of Mars, but are of sufficient breadth and scope to provide valid analogies with any question likely to be a factor. With these 100 questions, with this Mars Analog Program, MERC can define the metrics of exploration suitable for evaluating any expedition proposed by any agency. Without this program the possibility will be that expeditions would be planned with systemic problems that would not be found until a crew spends a long duration on the surface exploring Mars – too late to do much about it.

The program considers 15 expeditions (as described above) sufficient to fully define a Mars expedition baseline. The strategy begins with acknowledging that the goal is for the last Mars analogue expedition, prior to a real Mars expedition being launched, is to conduct a 500+ day simulation testing the strategies and employing the exploration technology developed and defined by the prior analogue expeditions. The duration is not important, as what can be learned from a 500-day analog expeditions can be extrapolated to a 720-day analog expedition.

Six 30-day expeditions and six 90-to-180-day expeditions would be sufficient to prepare for 500-day expedition simulations. These simulations may be at any of the Mars Society's Mars Analog Research Station, or the Antarctic Dry Valleys. The Moon would provide opportunities for some analog research (in field operations, tools, technologies, strategies), but Earth is a better analog to Mars than the Moon (regarding the field sciences). These last long-duration expeditions would require major contributions from several space agencies. Since American, European, and Russian space agencies are considering or have proposed using the Moon as a trial for Mars and beyond, MERC's research program is well aligned to lead up to those activities. The Mars Expedition Research Council's program is a roadmap, which it encourages those space agencies to adopt and develop. Assuming one analog expedition per year, or otherwise reasonable amounts of time to prepare for long duration simulations, this program will require 15 to 20 years to accomplish t completion.

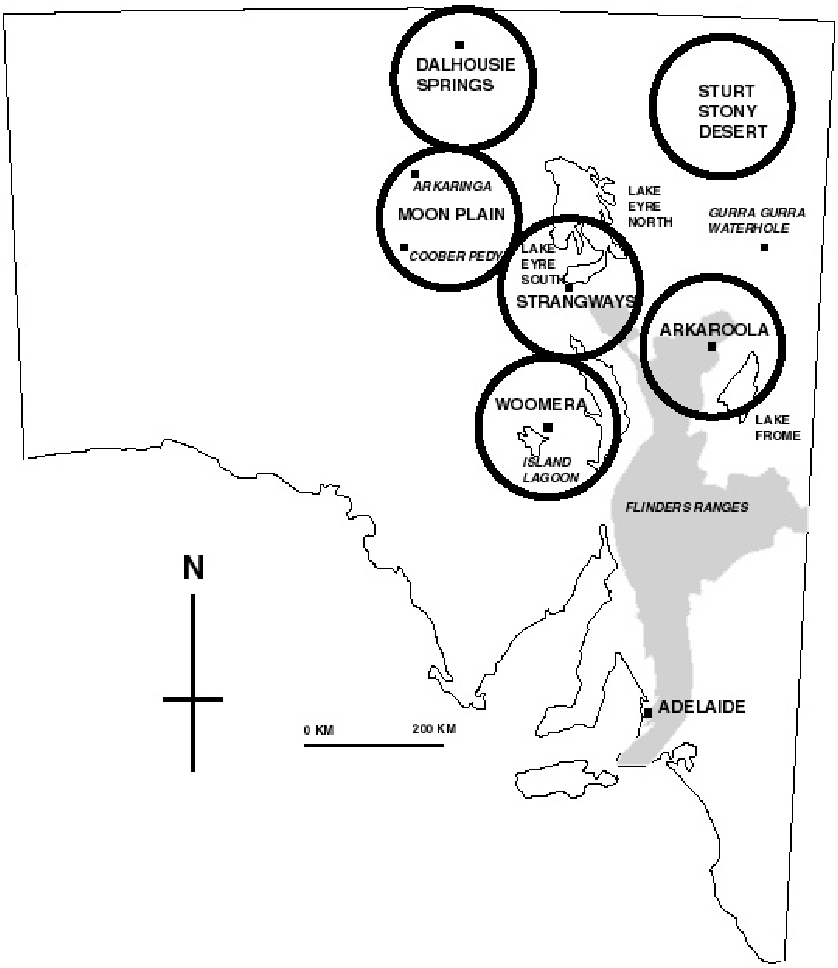

Figure 1. Arkaroola and the six other Mars analogue regions investigated during JNT-1 (after Mann *et al.* 2004).

Figure 2. Aerial view of the eastern margins of the Flinders Ranges and the adjacent Lake Frome Plain. Photo courtesy G. Mann.

ADVANTAGES OF THE ARKAROOLA REGION

The Arkaroola region is of considerable scientific interest, both generally and because of its potential as a Mars analogue site (Clarke *et al.* 2004). Areas of scientific interest include geology, geomorphology and regolith studies, palaeontology, hydrology, microbiology, geophysics, and remote sensing. The diverse landscape (Figure 2) of the region also allows testing of equipment in diverse arid environments.

Geology

The Arkaroola area is a region of considerable interest with respect to geology alone (Sprigg 1984). The haematite-rich fossil hydrothermal system of Mount Gee (Thomas and Walter 2002) provide as possible analogue to putative haematite-depositing hydrothermal systems on Mars (Catling and Moore, 2003). The Neoproterozoic sediments of the Adelaide Geosyncline of the region record a number of events of interest to planetary-scale geology, including the Marinoan and Sturtian glacial deposits that form the basis of the "Snowball Earth" hypothesis (Hoffman and Schrag 2002) and the Acraman impact ejecta horizon (Gostin *et al.* 1986).

Geomorphology and regolith

The landscapes of the Northern Flinders Ranges and the Cainozoic history of the Lake Frome Plain record a complex history of landscape evolution under differing climate riches (Twidale and Bourne 1996, Wells 1996, Krieg *et al.* 1990, Wright *et al.* 1990, Twidale and Wopfner 1990). The various surfaces, duricrusts and sediments provide an analogue for the type of complexity that would need to be interpreted on Mars. Some of these deposits such as the mobile sand dunes at Gurra Gurra Waterhole (Bishop 1999) have already been used as Mars analogues.

Palaeontology

The Neoproterozoic sediments in the region contain many stromatolitic horizons and cherts that may contain microfossils (Coats 1972). The younger Neoproterozoic successions host the world-famous Ediacara fauna, the controversial assemblage that is believed to represent the first assemblage of large animals on earth Jenkins (1996). Slightly younger sediments to the south of Arkaroola contain records of the Cambrian explosion, the radiation of skeletal organisms that transformed the interaction between organisms and sediments (Bengtson 1990).

Hydrology

There are a number of hydrological issues that could be studied. These include the hydrology of the Paralana Hot Spring (Coats and Blissett 1971), the hydrology and hydrochemistry of uranium bearing waters of the Lake Frome Plain, hydrochemistry of the major salt lakes such as Lake Frome, and the mound springs along the eastern margin of Lake Frome (Peake-Jones 1952).

Biology

Numerous opportunities exist for the study of dry land ecology, endolithic and cryptoendolithic organisms and microbiotic crusts. Of particular interest is the presence of radiation resistant extremophiles in the waters of Paralana hot spring (Anitori *et al.* 2001, Trott *et al.* 2001). Numerous other occurrences of radioactive minerals occur in the Mount Painter complex (Coats and Blissett 1971), these also may provide niches for radiation resistant extremophiles, but are completely unstudied. The extremophile populations of the various salt lakes in the study area are largely unknown. The nature of the biota in ephemeral water bodies (Boulton and Williams 1996) could also shed light on the dynamics of such systems and how they, and their putative Martian equivalents, might be studied.

Geophysics

Many of the faults in the Arkaroola area are seismically active. One potential research topic would be to establish a local seismometer net to pinpoint the zones of greatest activity. Another project would be the monitoring of radon emissions along faults and fracture systems. Lastly, the different aquifers, including those associated with the radiogenic and mound springs, as well as perched and shallow ground waters, would serve as excellent targets to test a range of geophysical techniques.

Remote sensing

Potential projects include evaluation and comparison of various remote sensing systems for mineral mapping including Aster, HYMAP, and LANDSAT. Ground truthing of remotely sensed data is also important, using instruments such as PIMA and especially actual XRD analyses of surface mineralogy (Thomas and Walter 2002).

Scale of Investigations

Unlike other such sites elsewhere, such as Devon Island or Hanksville Utah, the selected area consists of an entire region, rather than one spatially constrained sites or cluster of sites. Although the Arkaroola analogue region was nominally constrained to a radius of 100 km from the site, there are few constraints on vehicles traveling further afield to other areas of interest, such as Sturts Stony Desert (Mann *et al.* 2004, Clarke and Mann in 2004). Therefore, compared to other Mars analogue sites, the Arkaroola region provides a unique venue for large scale studies, whether of geological or biological systems, or of long range surface reconnaissance and mobility.

Outreach and education

The Arkaroola resort is Australia's first and largest private nature preserve (Spring 1984). The Sprigg family has a long history of scientific research and interest in ecotourism. They are supportive of the establishment of a Mars analogue facility and the many visitors to the region provide an excellent opportunity for outreach (Laing *et al.* in press).

GEOGRAPHICAL RESEARCH AREAS

Five areas will be visited during Expedition Two (Figure 3). They consist of:

1) The Mount Painter province and Adelaide Fold Belt in the Arkaroola area. This features radiogenic hot springs, weathered uranium (and other metals) prospects, the Cambrian-Precambrian boundary, Acraman impact layer, Proterozoic glacials, and stromatolite horizons

2) The eastern fans. These drain from the northern Flinders ranges and have deposited a range of both modern and relict fans and their associated drainage systems. These discharge into the large playa of Lake Frome. Associated with these deposits are localised minor dunes.

3) The Strzelecki Desert. This is a major sand sea of longitudinal dunes. At Gurra Gurra waterhole on Strzelecki Creek there are both aeolian erosional features (yardangs) and crescentic dunes that have been used as a Mars analogue. Also in the area are ephemeral rivers, evidence of high lake level shorelines, salt pans, gibber plains, and several mound springs

4) The Mount Babbage Inlier. This is the northern-most end of the Flinders Ranges and features four or five clusters of mound springs, fans, excellent exposures of glacial-marine Cretaceous, duricrusts, and an exhumed Mesozoic landscape.

5) Northern fans and surfaces. This area consists of deposits formed by drainages flowing north and west from the Flinders Ranges. Features of interest include modern and relict fans and surfaces, duricrusts, gibber plains, sand dunes, and floodouts.

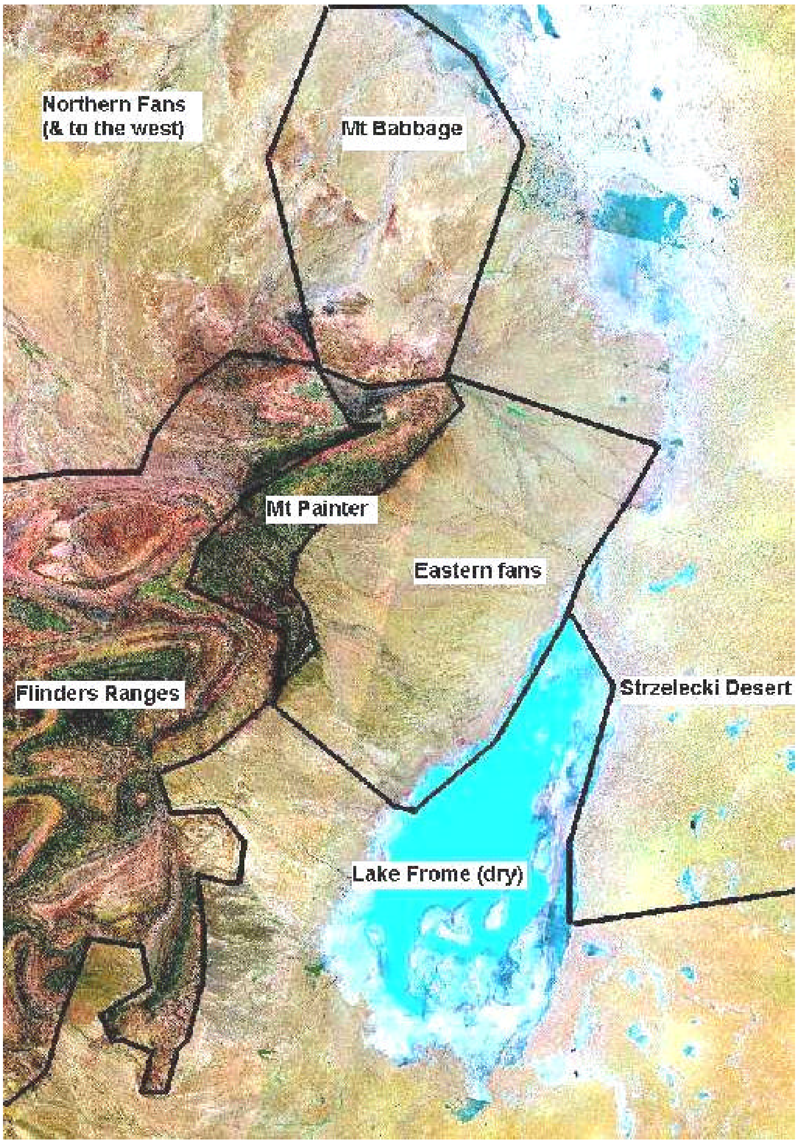

Figure 3. Approximate boundaries of the Expedition Two study regions in the northern Flinders Ranges and adjacent areas.

EXPEDITION THEMES

Expedition Two has the following goals:

- **Field Science:** Preliminary research into sites geological, biological, and hydrological analogue potential of the Arkaroola region. This will provide a foundation for future research programs.
- **Field Engineering** Evaluate the performance of the latest development of the MarsSkin (version 3) analogue Mars Counter Pressure suit.

- **Operations:** Perform operational research of significance to field science data logging (using digital photo, voice and text records each stamped with precise time and GPS locations) for assisting the field scientist with mapping and data documentation protocols, develop exploration methodologies, and select the site for MARS-OZ.
- **Human Factors:** Investigate crew interactions and leaderships in a normal field expedition. This will provide a basis for comparison with future research of crew interactions under varying levels of simulation.
- **Outreach:** Interviews with web, print, and broadcast media organisations, updates on society web sites.
- **Education:** Interaction with the International Space University, the University of Technology Sydney, the University of South Australia, and the Australian Science Teacher's Association during Australia's National Science Week

These goals provide a means of assessing the success of the expedition after its completion.

EXPEDITION PROGRAM

Expedition Two will operate in four phases, each of approximately one week's duration. Expeditioners will come and go at the start of each phase, but the crew structure will be fixed during each. The goals and regions studied in each phase are outlined below.

Phase 1

This phase will consist of five main activities: orientation and familiarization, initial trials of the MarsSkin 3 suits, selection of the prime site for MARS-OZ, flights of the Aerosonde UAV, and interaction with students from the International Space University (ISU) and the University of Technology, Sydney (UTS). During this phase expeditioners will work as a group and be accommodated in the Arkaroola Shearer's quarters, which will serve as the main base throughout the expedition. The areas visited during this phase will be primarily area 1 and parts of area 2.

Phase 2

In this and subsequent phases the group will divide into two subgroups: a base team that will work out of the shearer's quarters on a daily basis and an away team that will camp in vehicles at remote sites for periods of up to 6 days. The weekend will consist of a 1-2 day rest and relaxation period during which time crew changes will occur.

During phase 2 the away team will visit sites in the Strzelecki Desert (area 3). The base team will investigate areas 1 and 2.

Phase 3

During the third phase of the expedition the away team will work in the region of Mt Babbage (area 4). The base team will focus on areas 1 and 2.

Phase 4

The away team in the final phase of the expedition will work in the most distant region, the northern fans (area 5) in the vicinity of Apollinaris Well. Depending on contingencies and crew numbers, it is possible that the bas team may join the away team on this part of the expedition.

RESEARCH PROJECTS

Research during expedition one occurs in 16 projects in four main areas: field science (biology and geology), exploration methodologies, human factors, and engineering.

Biology

Project 1: A proposal for a Mars Analog Microbial Observatory and the need for baseline biodiversity studies at MDRS, FMARS, Euro-MARS, and MARS-OZ. The researchers are: Shannon Rupert-Robles (MiraCosta College, Department of Physical Sciences, San Diego) and Edward Martinez (California State University, Sacramento, Department of Environmental Studies). The work will focus on areas 1, 2, and 4. Objectives of the study are to conduct baseline surveys that include transect monitoring of terrestrial plant communities, macroinvertebrate identification counts, and water quality measurements. By accomplishing these objectives we will be one step closer to the establishment of a worldwide Mars Analogue Microbial Observatory network.

Project 2: Characterization of Extremophile Population Surrounding Arkaroola using 16S rRNA based Molecular Probes. The researcher is Fathi Karouia (University of Houston, Department of Biology and Biochemistry). The prime areas will be 1 and 2. The research proposal is a field test of a comprehensive bacterial detection system based on 16S ribosomal RNA (rRNA) targeted probes to identify organisms at both the genus and species level. This system has been adapted to a variety of assays that exploit advanced solution hybridization technologies such as molecular beacons and microarrays.

Geology

Project 3: Geological, hydrological, and meteorological characterization of springs in the Arkaroola region. The researcher is Jennifer Heldmann (NASA Ames Research Centre). This project is part of a post-doctoral fellowship. The prime areas will be 2, 3 and 4. Questions to be addressed are: 1. What is the history of the fluvial and aeolian landscape? 2. What is the history of water in the area? These questions are vital to NASA analysis of Mars landing sites, and the applying them to key sites in the Arkaroola region will enable the researcher to better engage the application of these questions to Mars.

Project 4: Remote methods for detection of hydrothermal activity in the Mt. Painter District, northern Flinders Ranges, South Australia. The researchers are: Adrian Brown (Australian Centre for Astrobiology Macquarie University), Matilda Thomas (Geoscience Australia / Australian Centre for Astrobiology Macquarie University), and Michael West (Dept. Mechatronics Engineering, University of Sydney). This project will be centred on area 1 but will also cover part of areas 2 and 4. It proposes to bring a variety of remote mapping techniques to bear on resolving the problem of mapping hydrothermal alteration in the Mt. Painter district near Arkaroola. The field component of this research will be conducted for two weeks of the Exped 2 mission to Arkaroola. This will involve a directed sampling mission to collect samples from areas identified as interesting after analysis of the remote datasets.

Project 5: The evolution and dynamics of desert dunes in the Lake Eyre Basin, South Australia. The researchers are: Kathryn Fitzsimmons and Vjeko Matic (Dept. Earth and Marine Sciences, Australian National University). This work is part of Kat Fitzsimmon's research towards a PhD and therefore will be carried out in area 3. The project will examine the dunes and yardangs at Gurra Gurra water hole (Bishop 1999) and carry out a reconnaissance of those east of Lake Frome.

Project 6: Neotectonics of the alluvial fans of the Lake Frome Plains. The researcher is Vic Waclawik (Dept. Earth and Environmental science, University of Adelaide). This work is towards Vic Waclawik's PhD. This project will focus on area 2. During field work the researcher will examine the signature of neotectonic events on the geomorphology, sedimentology, and induration of the fans draining east from the northern Flinders Ranges

Project 7: Structural measurements from satellite imagery, with ground-truthing in the field, in order to create a structural model of the Flinders Ranges in area surrounding the Expedition Two research sites. The researcher is Rocky Persaud (University of Toronto Department of Geology). The prime region is therefore area 1. Comparison of remotely sensed data with ground observations will better develop interpretation methodologies application to basin studies on Mars.

Human Factors

Project 8: Social Psychological and Leadership and Group Intervention Issues Relevant to a Human Mission to Mars. The researchers are: Steve Dawson & Phil Krins (School of Psychology, Australian National University), Nishi Rawat (Department of Emergency Medicine, Johns Hopkins University Hospital, Baltimore), and Sheryl Bishop (University of Texas Medical Branch, Galveston). The project is not area specific but draws on experience during Expedition One in Utah. It will investigate the impact of group and sub-group identity and goal alignment on motivation, effort to achieve group goals, and effective communication both within a particular group and between subgroups (including "mission control"). There will also be a number of personal well-being measures will be included (e.g., stress, mental health). In addition to this there will be a number of measures, which will attempt to assess, which self categorizations are utilized by individuals in the course of a day. Other issues to be investigated will include group polarization and ostracism.

Exploration Operations

Project 9: Scouting exploration methodologies study (SEMS) to optimize field science with remote collaborations. The researchers are: Stacy Sklar (Dept of Geology, University of Arizona), Shannon Rupert-Robles (MiraCosta College, Department of Physical Sciences, San

Diego), Aurora Rupert (student, San Diego), Rocky Persaud (University of Toronto Department of Geology), Steve Jordan (Mars Society) and Jonathan Clarke (Geoscience Australia / Australian Centre for Astrobiology, Macquarie University). This project is not area specific. The project will evaluate the effectiveness of non specialists in the collection of field geological and biolo gical observations and speciments.

Project 10: Arkaroola Mars analogue data base. The research coordinator is Jonathan Clarke (Geoscience Australia/Australian Centre for Astrobiology, Macquarie University). This project builds on experience with the construction of the Jarntimarra database during the JNT-1 expediton. The database will contain information on all sites visited, including a description of its geology, geomorphology, biology, and hydrology, its GPS coordinates, a photograph, and a summary of work performed, and any publications on the site or area. The purpose of the database is to aid future researchers in the selection of research topics and study sites.

Project 11: Field science, field mapping and scouting time/motion operational studies using EVA data-logging functional prototypes. The researchers are: John Roesch (Mars Society Canada), Rocky Persaud (University of Toronto, Dept. of Geology), and Steve Jordan (Mars Society). This project is not area specific. Note Projects 10, 11 and 12 will often be conducted together.

Engineering

Project 12: MarsSkin 3: its validity as an analogue MCP suit. The researchers are: James Waldie and Natalie Cutler (BAe Systems). This project is not area specific, as the MarsSkins will be used in all areas. This version of the MarsSkin includes lessons from development of version 2 during Expedition One to Utah. It will feature new inner and outer compression suit, a new bubble helmet, and a new back back for the associated ventilation and electronic systems

Table 1 lists the different research projects in the context of each phase or the mission.

OUTREACH

In addition to the above science and engineering projects there are a number of outreach and education programs that form a key part of Expedition Two. These include programs with the International Space University (ISU), University of technology Sydney (UTS), and the Australian Science Teacher's Association (ASTA).

International Space University

In phase 1 Expedition two will be joined by a group of faculty and students from the ISU. The ISU are holding their annual Summer School Program (SSP) for 2004 in Adelaide. The SPP will visit the Arkaroola region for three days and have the Mars analogue significance and the Expedition Two research program exp lained two them in the field. Jonathan Clarke is the prime link with the SSP. However, we expect a number of individual expedition members to lecture and demonstrate aspects of their work.

Table 1

Research Project Schedule

	Phase 1		Phase 2		Phase 3		Phase 4	
Biology	*Project*	*PI(s)*	*Project*	*PI(s)*	*Project*	*PI(s)*	*Project*	*(PI(s)*
			1	Rubert-Robles/ Martinez	1	Rubert-Robles/ Martinez		
Geology	2 3	Karouia Heldmann	2 3	Karouia Heldmann	3	Heldmann		
	4	Brown/ Thomas/West	4	Brown/ Thomas/West	4	Brown/ Thomas/West		
			5 6	Fitzsimmons Waclawik				
Human Factors	7 8	Persaud Dawson/ Krins	7 8	Persaud Dawson/ Krins	7 8	Persaud Dawson/ Krins	7 8	Persaud Dawson/ Krins
Exploration Operations	9	Sklar/Rupert/ Rupert-Robles/ Persaud/ Jordan	9	Sklar/Rupert/ Rupert-Robles/ Persaud/ Jordan	9	Sklar/Rupert/ Rupert-Robles Persaud/ Jordan	9	Sklar/Rupert/ Rupert-Robles/ Persaud/ Jordan
	10	Clarke	10	Clarke	10	Clarke	10	Clarke
	11	Persaud/Jordan	11	Persaud/Jordan	11	Persaud/Jordan	11	Persaud/Jordan
Engineering	12	Waldie/ Cutler	12	Waldie/ Cutler				

University of Technology Sydney

A group of geology students for the UTS will also be interacting with the expedition during phase 1. Their interest will primarily be in the geological and bio logical significance of the area and how research in these disciplines can better facilitate understanding of Mars and possible abodes for life elsewhere in the solar system. Expedition members will guide the UTS students to sites of specific interest without interfering with other research activities. The principle link to them will be Jonathan Clarke but, as with the ISU, several expedition members will be lending their time and expertise. In particular, the UTS students will be providing subjects for Project 12, and will be performing a number of additional evaluative tests.

Australian Science Teachers Association

Phase 3 and 4 of expedition Two will also see development of an online diary and Q&A forum aimed specifically at school students, with potential for live, moderated web chats and one-way video-conferencing. This would also be used on future expeditions. The facility would allow students to follow the work of researchers "on Mars" for the duration of the Expedition (or part thereof). The project would interact with the Australian Science Teachers' Association (ASTA) for National Science Week (NSW) that coincides with phase 3. This year's NSW topic is, appropriately, "Investigating Space". Jeffery Candiloro and Michael West will manage this project with the assistance at Arkaroola of two students from Canberra Ros and Jennifer Clarke.

Other media

Lastly there will be a many opportunities for outreach through the extensive print, web and board media interest that already been shown in the expedition. MSA's Publicity director, Jennifer Laing, will coordinate these opportunities. MSC's Communications Director, Reyna Jenkyns, will coordinate in Canada.

APPLICATION OF OUTCOMES TO FUTURE EXPEDITIONS

Each expedition in MERC's progressive Mars analogue expedition series leads into subsequent projects. Geological and biological investigations provide the situational context for all human factors research (work psychology, cognitive studies, social-psychology and ergonomic design), operational investigations (exploration strategies, field work processes, efficiency optimization), and engineering studies (science instruments, exploration technology, life sustaining and work enhancing technologies, habitat design). Some investigations need necessarily be accomplished before others. Progressively linked, all these investigations proceed towards refining the choices available for Martian expedition planning.

Results from the operational studies of Expedition Two will directly influence the research program of future expeditions. For Expedition Three and beyond, Expedition Two will provide advancement over Expedition One on the near-term goals of understanding expedition operations, and for the long-term goals of learning how to design an appropriate mission simulation of at least 500 days. With numerous science goals each reduced to sequences of tasks and functions, optimizing each will improve overall mission scenarios, definition of technical and human factors, and expedition planning. Indexing science goals to the tools and tasks used to accomplish them, their products and data-inputs, their human requirements, and their technical requirements will allow Martian expeditions to be planned for maximizing science return and optimizing the use of crew time over a limited-duration surface mission.

ACKNOWLEDGEMENTS

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