MARS ANALOGUE TEST SITE PROPOSAL – NORTH POLE DOME, WESTERN AUSTRALIA

Adrian Brown
Australian Centre for Astrobiology
Department of Earth and Planetary Sciences, Macquarie University, NSW 2109
+61 2 9850 6286
Email: abrown@els.mq.edu.au
Project Web Site: http://aca.mq.edu.au/abrown.htm

Abstract

As part of a proposed Australian contribution to the initial European Aurora mission ("ExoMars 2009"), the Pilbara craton of Western Australia is suggested as a possible Mars analogue location suitable for testing of the ExoMars rover. Research continues to be conducted in this area by scientists at the Australian Centre for Astrobiology (ACA). The following abstract provides some of the most compelling reasons for testing a Mars-bound rover in rugged outback Australia.

Introduction

The ExoMars 2009 Rover will require rigorous Earth-bound testing before embarking upon its mission to explore the surface of the Red Planet. A suitable test site for a Mars Rover would have the following characteristics:

- Geology - Well understood and characterized geology, with suitable Astrobiologically interesting sites (eg. fossil and stromatolite locations) for the Rover and Science team to investigate.
- Experiment – suitable ground cover and slope to challenge the engineering team, with minor vegetation.
- Logistics - Suitable facilities to house scientists and engineers and the ability to transport the Rover and associated equipment to the site.
- Visual Characteristics - appear Martian in character (suitably red with abundant Fe-oxides) for realism and field testing of panchromatic cameras.

North Pole Dome, Western Australia

The North Pole Dome (NPD) is home to a diverse range of stromatolitic horizons of Archean age (Groves*, et al.*, 1981; Lowe, 1983; Hoffman*, et al.*, 1999). A particularly suitable site within the NPD has been located that fits the above mentioned requirements to test the scientific and engineering capabilities of the ExoMars 2009 rover. This site is placed in the Barite Range area of the North Pole Dome near Marble Bar in northwest Western Australia. The attractive qualities of the site include:

- good air and road access.
- the opportunity to do double blind science/engineering testing on both sides of a mountain range (joined by a road cutting).
- excellent camp locations.
- good supporting infrastructure including shopping and engineering facilities in Port Hedland (2 hours drive away).
- current research being conducted in the region by the Australian Centre for Astrobiology which includes airborne infrared mapping of the entire Dome from visible to infrared, those providing coverage similar to the OMEGA instrument on Mars Express, but with slightly higher resolution.

Martian and Pilbara Geology

The Pilbara craton is one of the oldest and best preserved sequences remaining in the world. The rocks of the Warrawoona Group, which chiefly comprise the NPD region, were deposited between 3.2 and 3.5 billion years ago. They consist of ultramafic to mafic volcanic sequences, interlayered with minor felsic and volcaniclastic sedimentary units. The Warrawoona group has not been strongly metamorphosed – the most deformed sequences are at the greenschist facies, with some evidence of prehnite-pumpellyite metamorphism (Brasier*, et al.*, 2002). This makes the Pilbara rocks much more attractive for searching for biosignatures than similarly aged rocks in Greenland. The abundance of stromatolites (Walter*, et al.*, 1980) provides more sites of Astrobiological interest than similarly aged and preserved rocks of the Barberton Greenstone Belt (Lowe, 1982). Although some questions have been raised regarding the biogenicity of putative microfossils and stromatolites within the NPD (Brasier*, et al.*, 2002), the region remains one of the most

compelling localities in the search for evidence of the earliest life on Earth (Buick, *et al.*, 1995).

The abundance of mafic basalts with red weathered Fe-rich rinds provides some similarities to the expected Martian flood basalts. A minimum of vegetation also provides for a barren landscape in many areas around the Dome.

Support and Logistics

As part of a continuous series of field campaigns in the Pilbara region, researchers at the ACA have built up a range of contacts in the area. These include local authorities, aboriginal groups and local suppliers.

Port Hedland is the nearest international airport to the NPD. Four hour flights from Perth arrive twice daily. From Port Hedland, North Pole Dome is 160km to the south east. This is a 2 hr drive, or 30 minutes by light plane. There are two airstrips in the centre of the Dome, including one approximately 1km from the Dresser Barite Mine.

The abandoned Dresser Barite Mine provides a unique locality for basing a scientific investigation team. Nestled in the hills of the Barite Range, it provides access to both east and west sides through a cutting fashioned by the mining crews in the mid twentieth century. Camp sites are good in this region.

Remote Sensing Datasets

The Pilbara has been the target of many remote sensing studies and the resultant datasets are often available. In particular, a gamma ray dataset collected in 1997 by Geoscience Australia (formerly AGSO) is available at kilometer scale spatial resolution. Recent geological mapping at 1:100,000 has been conducted throughout the Pilbara by the Geological Survey of Western Australia (GSWA) (eg. (Van Kranendonk, 2000)). These maps are available digitally. Parts of the Pilbara have also been covered by the ASTER instrument (http://asterweb.jpl.nasa.gov) and these datasets are also in the public domain.

In addition, the ACA is conducting a project ot map the entire North Pole Dome using Visible-Near Infrared hyperspectral technology. The dataset was collected by the Hymap instrument (http://www.intspec.com) and covers 600 sq. km at 5m spatial resolution from 400-2400nm.

These datasets would contribute to the body of information available to the science team. Their obvious relation to datasets of Mars would improve the fieldtrip experience for the science team.

Timeline

The proposed timeline would see the rover and support team in Australia in 2007-8. Until this time, annual field trips will be conducted by teams within the ACA, with possible ESA scouting opportunities in 2005-6.

Conclusion

In order to search for signs of life on Mars, familiarity with the evidence of early life here on Earth is of critical importance. Testing the ExoMars rover and the support team in the most scientifically challenging environment will provide assurance that the team will be well prepared for the Martian environment. For further details and updates on ACA projects in this region, the reader is referred to the project website (http://aca.mq.edu.au/abrown.htm).

References

Brasier, M. D., Green, O. R., Jephcoat, A. P., Kleppe, A. K., Van Kranendonk, M. J., Lindsay, J. F., Steele, A. and Grassineau, N. V. (2002) Questioning the evidence for Earth's oldest fossils. *Nature*, 416 (6876), 76-81.

Buick, R., Thornett, J. R., McNaughton, N. J., Smith, J. B., Barley, M. E. and Savage, M. (1995) Record of emergent continental crust ~3.5 billion years ago in the Pilbara Craton of Australia. *Nature*, 375 (6532), 574-577.

Groves, D. I., Dunlop, J. S. R. and Buick, R. (1981) An early habitat of life. *Scientific American*, 245 (4), 56-65.

Hoffman, H. J., Grey, K., Hickman, A. H. and Thorpe, R. I. (1999) Origin of 3.45 Ga coniform stromatolites in Warrawoona Group, Western Australia. *GSA Bulletin*, 111 (8), 1256-1262.

Lowe, D. R. (1982) Comparative sedimentology of the principal volcanic sequences of Archaean greenstone belts in South Africa, Western Australia and Canada: implications for crustal evolution. *Precambrian Research*, 17, 1-29.

Lowe, D. R. (1983) Restricted shallow-water sedimentation of early Archaean stromatolitic and evaportic strata of the Strelley Pool Chert, Pilbara Block, Western Australia. *Precambrian Research*, 19, 283-293.

Van Kranendonk, M. J. (2000) Geology of the North Shaw 1:100 000 Sheet, Geological Survey of Western Australia, Department of Minerals and Energy, Perth, WA.

Walter, M. R., Buick, R. and Dunlop, J. S. R. (1980) Stromatolites 3400-3500 Myr old from the North Pole area, Western Australia. *Nature*, 284, 443-445.