

INSTRUMENTS, METHODS, AND MISSIONS FOR ASTROBIOLOGY VIII

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**Remote and In Situ Detection of Aqueous and Biotic Alteration: Cyanobacteria in  
Archean and Modern Australia**

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**Abstract:** Proposed geochemical histories for the evolution of Mars offer the possibility that the planet may have experienced conditions remarkably similar to those faced by life on Earth during Archean and Proterozoic eons<sup>1</sup>. For almost two billion years microbial mat communities dominated by photosynthetic cyanobacteria were the dominant life forms on Earth. Descendants of these complex communities and the fossil remnants of the Archean communities can be found today in Northwestern Australia. These sites offer a unique testing ground for integrated remote and *in situ* instrumentation capable of identifying aqueous and biotic alterations in surface geology. Ground-truthing such systems is of critical importance for the exploration of Mars, the Jovian or Saturnian satellites, or neighboring extra-solar planetary systems. We are currently performing remote and *in situ* analyses of spectral and image data from the Trendall locality of NW Australia, an area rich in hydrothermally altered basalts, stromatolites (extant and fossil), and pillow basalts.<sup>2, 3</sup> 126-band hyperspectral images were obtained from an altitude of two kilometers. Data-driven cluster analysis and Artificial Neural Network Bayesian probabilistic estimators were able to identify UV-Vis-NIR spectral signatures of aqueous alteration. During *in situ* exploration, complexity analysis techniques were able to identify stromatolite formations from the surrounding rock matrix. The strategy presented offers a systematic methodology for both the remote selection of landing sites most likely to contain targets of geobiological interest, and the *in situ* identification biologically altered samples.

**Keywords:** Cyanobacteria, stromatolites, Mars, aqueous alteration, remote sensing, in situ biosignatures, bioinformatics, artificial neural networks, Bayesian probabilities

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