Geophysical Research Abstracts, Vol. 7, 01741, 2005
SRef-ID: 1607-7962/gra/EGU05-A-01741

Optimising planetary instrumentation for in-situ astrobiology: preliminary results from laboratory based "field" experiments on specimens exhibiting morphological biosignatures

D. Pullan

Space Research Centre, Department of Physics and Astronomy, University of Leicester, UK. (dpu@star.le.ac.uk / Fax: +44 116 252 2464 / Phone: +44 116 258 2141)

Of particular relevance to the exploration of the terrestrial planets (especially Mars) is the discovery of life in whatever form it might take. Dedicated systems for the detection of extant or extinct life are being developed (e.g. isotopic gas analysis, molecular based instruments etc) and are likely to form the basis for future missions. However, any correctly equipped in-situ lander/rover would (or should) also be equipped with the fundamental requirements for geological site investigation. These include methods a competent field geologist would employ such as spectral/macro/micro/panoramic imaging (i.e. visual perception enhanced with microscope/hand lens), mineralogical/elemental analysis (i.e. knowledge of petrology) and geotechnics (i.e. dextrous use of a hammer). Such techniques, often collectively packaged and deployed on the end of a robotic arm for close scrutiny of targets, have the ability to accumulate evidence (extinct life signatures specifically) by directly identifying morphological biosignatures (if present) plus provide a means of assessing the palaeo-environmental context and optimising sample targeting for the life detection instruments.

For in-situ astrobiology, spectral/spatial imaging is the primary method for evaluating biological features displaying morphology ranging in scale from microscopic (um-mm), macroscopic (mm-cm) to contextual (cm-m). However, non-imaging techniques such as spectroscopy (i.e. Mössbauer, XRF, Raman etc) help to characterise the material being studied and can corroborate whether observed features are likely to be biotic or abiotic (or at least reduce any ambiguity). Also controlled surface preparation (grinding/chipping/splitting) can provide important information on the nature of coatings and the interior fabric of rocks including bio-habitat suitability plus provide a means of exposing otherwise concealed endolithic communities.

The scientific payload on Beagle2 was particularly well equipped for in-situ astrobiology. The instruments and tools on the deployable PAW were capable of tackling all these aspects to a degree (including rock splitting!). Recently, a laboratory programme has commenced to investigate the relationships between selected techniques and the practical aspects of field measurements at planetary surfaces. As a starting point the programme utilises spare instruments and tools from the PAW (some of which have been enhanced for the laboratory setup) and prototype instruments currently being developed for future planetary missions. To account for the many variables involved, imaging, analytical and geotechnical studies are being conducted on thematic sub-collections of well characterised terrestrial materials (planetary analogues) derived from a centrally coordinated specimen library called PALI, a physical sample and experimental data resource established by the author (with the help of fellow researchers) and open to the planetary community. A sub-collection of samples for the study of morphological biosignatures forms part of the library. From this sub-collection a number of samples have been selected for this study on the basis of texture, morphology and scale.

The preliminary results presented here relate to a selection of scale-variable experiments (employing a number of techniques) on specimens exhibiting biological features such as microbial filaments, epilithic and cryptoendolithic manifestations and relict structures associated with ancient and modern microbial activity (including stromatolites). Where possible each sample was sequentially imaged and analysed using the full suite of instruments to hand. For practical reasons all experiments were performed in air at room temperature (most instruments having already been cross-calibrated to the Martian environment). Imaging was performed under controlled well characterised lighting conditions. The work is ongoing and forms an important part of the main laboratory programme mentioned above.

Given adequate funding, the programme itself has the potential to provide both a valuable facility and knowledgebase for the planetary community (not just Mars specific) to support future instrument development (i.e. AOTF optics, Raman-AFM, XRD etc), mission operations planning and sample focused research.