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Raman spectroscopy of extremophiles and their biogeological modifications

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Raman spectroscopy has several advantages for the molecular characterisation of biological systems and geological substrates ; it is nondestructive of specimen , requires little or no mechanical or chemical pretreatment of sample , it is capable of microscopic analysis down to one cubic micron and it has a spectral range that covers the key signatures of both inorganic minerals and organic biochemicals. The latter is particularly relevant for the examination of the interfaces between organisms and their local geological environments without detachment or extraction of the sample ; this can provide useful information about the deposition of biological chemical materials at an interface and also identify biogeological changes that have occurred there which can act as indicators of previous colonisation even when the biology is extinct. The adoption of Raman spectroscopic techniques for instrumentation of planetary landers is now being seriously evaluated for future space missions and the testing and evaluation of potential miniaturised spectroscopic systems for this application is being undertaken . Although the main thrust of the evaluation is currently afforded in a geological context, it is clear that the testing of Raman spectroscopy on terrestrial extremophiles and their special geological niches will be necessary for the full appreciation of the range of information and analytical data that can be obtained .

In this paper we shall include examples of the Raman spectra that have been obtained from several diverse terrestrial situations that have parallels with planetary surfaces and subsurfaces , such as the Antarctic cold desert epiliths , chasmoliths and endoliths , Arctic halotrophs and cyanobacterial colonies ; we shall evaluate the Raman data that

have been derived from these laboratory studies for application to field experiments using remote and miniaturized instrumentation , paying special attention to the characteristics required for laser Raman excitation and detection conditions which will eventually be essential for the detection of relict or extant life signatures.

This will inform also the type of scenario that will be required for the evaluation terrestrially of a Raman instrument that is being proposed for Mars exploration and for other space missions where the detection of biochemicals relevant to life is envisaged .