DISTRIBUTION OF CARBON IN MARS-ANALOGUE VOLCANIC SEDIMENTS. F. Westall[1], F. Foucher[1]., K.Campbell[2], A. Hubert[1], P. Gautret[3], F. Gaboyer[1], C.S. Cockell[4]. [1]CNRS-Centre de Biophyisique Moléculaire, Rue Charles Sadron, 45071 Orléans cdedex, France (frances.westall@cnrs-orleans.fr). [2]Geology - School of Environment, University of Auckland, Private 92019, Auckland 1142, New Zealand. [3]CNRS-Institut des Sciences de la Terre d'Orléans, 1A Rue Férollérie, 45071 Orléans, France cedex. [4]School of Physics and Astronomy, University of Edinburgh, Peter Guthrie Tait Road, Edinburgh EH9 3FD, UK.

Introduction: The geological context for the search for life on Mars is basically volcanic and old, as documented by Gale Crater [1]. This includes the alteration products of the volcanic protoliths, including clays, evaporate salts and the deposits of hydrothermal fluids coursing through the volcanic sediments. These are the kinds of sediments that characterise the early Earth, where the conditions for habitability – on the microbial scale – were identical to those of early Mars [2,3]. However, in contrast to the Noachian-Early Hesperian sediments on Mars, the early terrestrial sediments were preserved by heavy silicification, largely hydrothermal in origin. Although hydrothermal lithologies have been hypothesized for Mars [4,5], the majority of the volcanic sediments observed have not been silicified. Nevertheless, the primitive life forms that inhabited the terrestrial sediments are very relevant for Mars [2,6,7] and their well-preserved organic traces allow *in situ* examination of their distribution with respect to the microbial-scale (and macroscopic) context. ***Understanding of the distribution of the organic traces of primitive life in this volcanic/ hydrothermal/ evaporitic context will aid the search for, and identification of, organic traces of life on Mars, if it existed and if it was preserved***.

Materials and Methods: Samples of volcanic sediments from shallow water environments of the 3.45 Ga-old Kitty's Gap Chert (Pilbara) [2,9] and the 3.33 Ga Josefsdal Chert (Barberton) [6-8] were carefully chosen for study based on field context. They were examined by optical and SEM microscopy, Raman spectroscopy, and analysed using *in situ* geochemical (PIXE, NanoSIMS) and isotopic methods.

Results and Discussion: Of prime importance in documenting the distribution of the organic biosignatures was the combination of optical microscopy and Raman spectral mapping. We were thus able to trace the presence of organic carbon at the surfaces of bedding planes (Fig. 1c,d) and around individual volcanic particles (Fig 1a,b). The carbon on bedding planes was either detrital in origin and/or produced *in situ* by anaerobic phototrophic biofilms [2,7,8]. More subtle were the traces of organic carbon around individual volcanic grains that were generally not visible in optical microscopy (although sometimes occurring as a thick carbon coat) (Fig 1a,b). The origin of these carbon coatings is intriguing. They could be simple, mono-molecular organic conditioning coats or they could represent microbial colonies. Note that [2,9] documented the presence of monolayer microbial biofilms on volcanic grains from 3.45 Ga-old volcanic clasts from the Pilbara and thickly colonised grains in nutrient-rich environments are described by [7].

Conclusion: The co-location of organic carbon with respect to specific, primary sedimentary structures is of great importance in aiding interpretation of the nature of organic biosignatures. However, other *in situ* organo-geochemical techniques are necessary to verify the biogenicity of the organic matter.

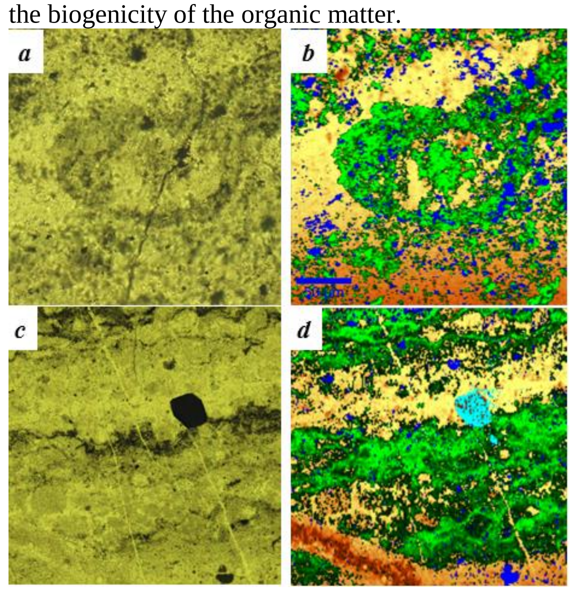

Figure 1. Optical micrographs and Raman maps of organic carbon concentrations around volcaniclastic particles (a,b; green-carbon, yellow-quartz; blue-anatase); and on sediment bedding surfaces (c,d; same mineral colour scheme as in (b); light blue-pyrite). Josefsdal Chert, Barberton.

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