EARLY ARCHAEAN SHALLOW WATER SEDIMENTS AS ANALOGUES FOR NOACHIAN SEDIMENTS ON MARS. N. Bost[1], F. Westall[1], C. Ramboz[2], and M. Viso[3], [1]Centre de Biophysique Moléculaire-CNRS-OSUC, Rue Charles Sadron, 45071 Orléans, France nbost@cnrs-orleans.fr), [2]Institut des Sciences de la Terre-CNRS-OSUC, 1a rue de la Férollerie, 45071 Orléans, France, [3] Centre Nationale d'Etudes Spatial, 2 place Maurice-Quentin, 75039 PARIS CEDEX 01, France.

Introduction: The geological and environmental conditions of Mars and Earth during their youth were, in some respects, similar in that Mars had considerable quantities of water during the Noachian and possibly the Hesperian, including large, water-filled basins/impact/volcanic craters [1]. Associated sedimentary deposits derived from the volcanic materials that covered the planet would include volcaniclastics and products of aqueous and hydrothermal alteration. These kinds of igneous and sedimentary materials were common in Early-Mid Archaean (3.5-3.3 Ga) rocks in South Africa (Barberton) and Australia (Pilbara), making them good analogues for the martian Noachian period (3.8 to 3.5 Gy). Study of the mineralogy, texture, structure, and traces of life in these materials provides an extremely useful indication of what could possibly be expected in martian rocks, especially in view of the planned ESA-NASA two rover mission 2018. The mission objective for the European ExoMars rover is the search for traces of life, past or present, on Mars, whereas the NASA Max-C rover objectives are to cache suitable samples for return to Earth by a subsequent mission.

The 3.45 Ga-old Kitty's Gap Chert: The 3.45 Gy-old Kitty's Gap Chert (fig.1) consists of silicified volcanic sediments deposited in a coastal mudflat environment [2-4]. The black and grey banded rock consists of millimetre to centimetre-thick layers of volcaniclastic sediments exhibiting structures such as parallel, wavy, ripple, flaser, and channel bedding, intraformational breccia etc, that document an infilling tidal channel. These structures are highlighted on the exposed rock surface by weathering. The sediments were silicified during early diagenesis, the silica coming largely from silica-saturated seawater as well as a minor local hydrothermal source. Prior to silicification, the volcanic particles were altered to phyllosilicates by aqueous activity and then partially replaced by silica during silicification. The Kitty's Gap Chert contains a variety of cryptic carbonaceous biosignatures. Small colonies of 0.5-0.8 µm-sized coccoidal microfossils coat the volcanic particles and occur in the fine dust layers. Hiatus surfaces are coated with a biofilm consisting of coccoids, chains of coccoids, filaments (~0.3 µm diameter), rods (<1 µm long), polymer and resedimented portions of torn-up microbial mats. These structures are not defintively identifiable by optical microscopy – high resolution SEM and in situ analyses are necessary to determine their biogenicity. Bulk C contents and isotope compositions of individual layers are 0.01-0.05 % and ~-26 to – 28 ‰ respectively.

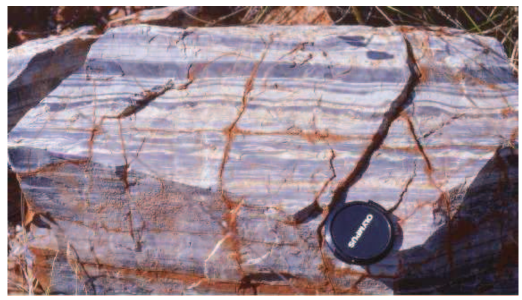

Fig.1 : Outcrop of Kitty's Gap chert in Pilbara.

The 3.3 Ga-old Josefsdal Chert consists of silicified volcaniclastic sediments deposited in a similar shallow water environmental setting to the Kitty's Gap Chert. The sediment exhibits a variety of structures including, importantly, macroscopic biolamination. Carbonaceous layers represent the remains of anaerobic photosynthetic microbial mats, as well as sedimented bio-detritus [5]. The microbial mats were constructed by small 0.25 µm thick microbial filaments that are individually not visible optically. Bulk carbon contents of this rock range up to 0.01-0.07% and C isotopes from – 23 to -27‰.

Conclusions: Early Archaean terrestrial sediments are useful analogues for Noachian sediments. The methods necessary for studying the traces of the primitive anaerobic life that they contain demonstrate the limitations and constraints of *in situ* missions such as the 2018 Max-C and ExoMars mission and emphasise the necessity of returning samples to Earth.

Acknowledgements: CNES, OSUC for funding.

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