6.29 Teece, B. Hydrocarbons and hot springs; looking at analogues in the quest for life on Mars

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The landing site for the Mars 2020 Rover will be determined after presentations at the fourth and final landing site workshop in October, 2018. One of the potential landing sites is Colombia Hills, which includes what has been interpreted as a fossilised hot spring deposit that was previously visited by the rover Spirit (Squyres et al., 2008; Ruff et al., 2011). Spirit observed a large amount of geological diversity in the Columbia Hills, including possible lake deposits, tephra deposits, and opaline silica deposits interpreted to have formed in a hot spring setting. The hot spring deposits on Mars have Earth analogues, such as hot springs within the Taupo Volcanic Zone (TPV) in New Zealand, and the more arid hydrothermal field of El Tatio in Chile (Ruff & Farmer, 2016). Additionally, 3.5 billion-year-old hot spring deposits on Earth contain fossilised evidence of ancient life (Djokic et al., 2018). One of the primary goals of the Mars 2020 Rover is to search for evidence of past life on Mars, and prepare a cache of samples for return to Earth.

Hot spring environments are composed of silica sinters that form because of the rapid cooling of hyper-silica-saturated fluids, and because of the activity of microbial communities (Kaur et al., 2008). However, our understanding of how sinter preserves traces of life is not well understood. Most of the preservation studies have focussed on physical preservation, whereas only a small proportion of studies have considered chemical preservation of microbial biosignatures (Siljeström et al., 2017) or fossilised microbes (Campbell et al., 2015; Gibson et al., 2014; Kaur et al., 2008; Kaur et al., 2011; Ruff & Farmer, 2016). The existing fossilised biomarker studies are limited to those with the best preservation, and are all of samples <900years old, and are primarily only on samples from the TPV (Hays et al., 2017).

In this study, we investigate the organic geochemistry of hot spring samples from El Tatio and the TPV, with ages varying from modern to ~9.4ka. The aim of the study is to examine both polar and apolar fractions to assess whether biomolecules are preserved in these samples. This information will provide additional support to the Columbia Hills site selection for the Mars 2020 Rover mission. All samples from both El Tatio and the TPV contain very high amounts of *n*-C_{17} relative to C_{16}–C_{18} *n*-alkanes (e.g. Figure 1), and several contain mid-chain monomethyl alkanes, including methylheptadecanes that are indicative of cyanobacterial input (e.g. Hoshino & George, 2015). Several samples also contain polyaromatic hydrocarbons, including phenanthrene, fluorene, biphenyl and naphthalene, and the methyl-isomers of each. Additionally, Fourier Transform Infrared Analysis (FTIR) results on whole crushed rock powder indicate the presence of thiols in the TPV samples, which can occur when sulphate is reduced by microrganisms (Stoner, 1993).

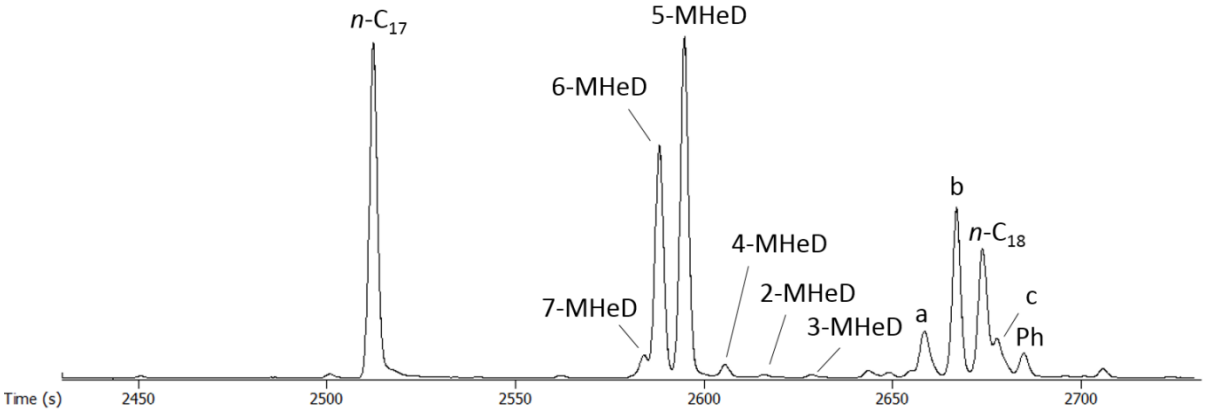

Figure 1: *Partial m/z 57 mass chromatogram of n-alkanes and methylheptadecanes (MHeD) in a sample from El Tatio. The letters a, b, and c denote so-far unidentified branched alkanes.*

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