SYNTHESIS OF BASALTS AS AN ANALOG TO GUSEV CRATER BASALTS, MARS : INTEREST FOR ASTROBIOLOGY. N. Bost[1,2], L. Loiselle[1], F. Foucher[1], C. Ramboz[2], and F. Westall[1]. Centre de Biophysique Moléculaire-CNRS-OSUC, Orléans, France; [2]Institut des Sciences de la Terre-CNRS-OSUC, Orléans, France; (bost.nicolas@orange.fr).

Introduction: Recent observations by the Mars Exploration Rover (MER) Spirit indicate that, Martian and terrestrial basalts are chemically distinct from one another. In situ compositional measurements of basalts at Gusev Crater indicate that Martin basalts are richer in iron and magnesium than their terrestrial counterparts. [1]. Previous studies synthesizing artificial Martian basalts have based their compositions on data collected from the Pathfinder mission geochemical datasets [2,3] which, unlike the MER mission, did not have instrumentation to remove the altered rock surface (demonstrated in Fig. 1).

The goal of this study was to generate artificial basalts that were compositionally analogous to primitive Martian basalts for inclusion in the International Space Analogue Rockstore, a collection of analogue rocks and minerals used test instruments and prepare payloads for in situ space missions including MSL and futrue ExoMars and 2020 mission (ISAR collection [4,5]).

Using the *in situ* geochemical data collected by MER Sprit from basalts at Guvev Crater, three synthesis experiments were conducted, a rapidlyquenched (few seconds) sample (12AR01), a moderately rapidly quenched (< 1 hour) sample (11AR02), and a more slowly cooled sample (1 day; 11AR01). The codes of the samples refer to the sample codes in the ISAR database.

Geochemical composition of martian basalts: The compositions of synthetic Martian basalts were based on the *in situ* geochemical data collected by MER Spirit at Gusev Crater [5]. In order to obtain the best average chemical composition, only data from the least altered, RAT-abraded Gusev basalts were considered (cf. Fig. 1). The martian basalts present a basically tholeitic composition.

Synthesis of artificial basalts: 2g of well mixed oxide powder (SiO_2, TiO_2, P_2O_5, Al_2O_3, Cr_2O_3, MnO, FeO, MgO, CaO, Na2O, K_2O, and NiO) was placed into an open alumina crucible. Samples were heated in an oven at atmospheric pressure (10^5 Pa) to 1350°C for 3 hours under reducing conditions (80%CO_2 – 20%CO gas mixture).

Homogenized melts were cooled at three different rates: one sample was cooled slowly at a rate of ~110 °C h^{-1} (11AR01), the second more rapidly at a cooling rate >> 1400°C h^{-1} (11AR02) and the third very rapidly (few seconds, 12AR01). Longer cooling times were not used in order avoid the generation of gabbro, which was not the target synthetic material of this study. The aim is also to obtain different textures to better simulate the various samples observed on the surface of Mars. Polished sections were prepared for structural, textural, and mineralogical characterization with optical and scanning electron microscopy, Raman and IR spectroscopy, as well as electron microprobe analyses.

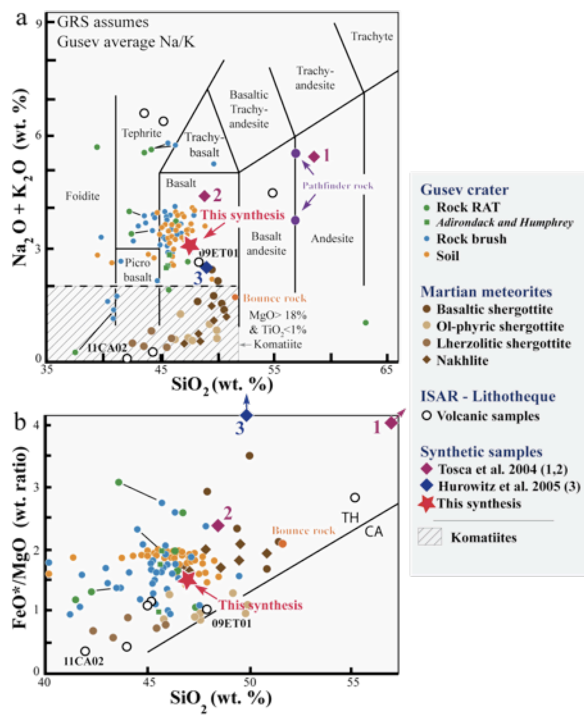

Figure 1. Chemical compositions of martian rocks (*in* situ and meteorites), as well as artificially synthesised basalts from previous studies and this study (red stars).

Results: The samples exhibited a homogenous texture in thin section. The more slowly cooled basalt (11AR01) contained some rare vesicles, whereas the rapidly cooled samples (11AR02 and 12AR01) contained many more vesicles as a result of the drop quenching, which prevented out-gassing of carbonate derived CO_2. We present below details of two of the samples [6], the third is still undergoing analysis.

11AR01 – More slowly cooled sample. This material is characterized by spinifex-like textures (Fig. 2) formed by large pyroxene and smaller forsterite crystals exhibiting an arborescent texture. These textures are quite distinct from hopper or swallow-tail-like textures of olivine in MORBs and resemble rather spinifex in komatiites. Associated with these major mineralogical phases are minor phases of well crystallized oxides (e.g., spinels). Despite the relatively slow cooling rate, the material contains small areas of augitic glasses associated with the two types of elongated crystals. Generally, the textures in this sample are more suggestive of rapid magmatic cooling (~58°C/h) than slow cooling.

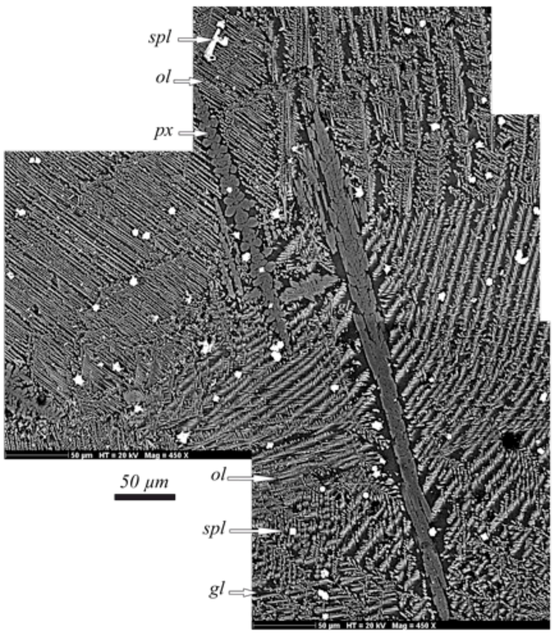

Figure 2: SEM image of the more slowly cooled basalt (11AR01) showing spinifex texture. Px : pyroxenes, ol: olivine, spl: spinels, and gl: glass.

11AR02 – rapidly cooled sample. This material was formed by cooling the homogenized melt material much more rapid rate (>> 1400°C/h). The sample contains large areas of augitic glass and has the same mineralogical composition as 11AR01. It also contains anhedral (globular) olivine phases that are which were formed due to the faster cooling imposed on this material (Fig. 3).

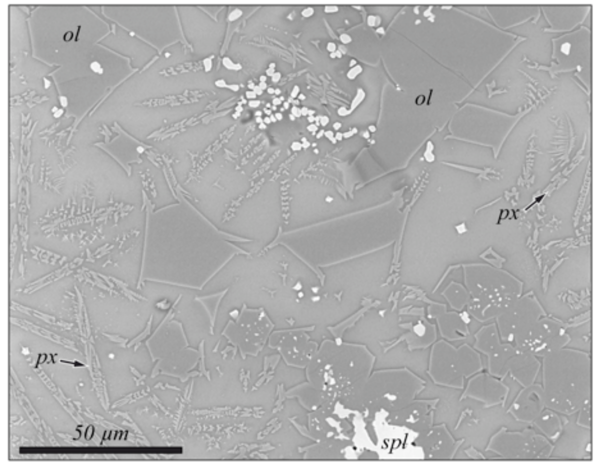

Figure 3: SEM image of the rapidly cooled basalt (11AR02). Px : pyroxenes, ol: olivine, spl: spinels.

Summary and Conclusions: Pyroxene and olivine textures generated in synthetic products from the slowly cooled basalt were very similar to spinifex textures observed in komatiites (volcanic rock type common on the early Earth). Such materials may provide habitats for chemolithotrophic types of microorganisms that obtain their energy from redox reactions at the surfaces of the reactive volcanic material, as well as nutrient. The glass and phyllosilicate derivatives could fix organic compounds, making these samples and interesting target for astrobiological investigations.

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References: [1] Mc Sween H.Y. et al. (2009) *Science, 324*, 736-739. [2] Tosca N.J. et al. (2004) *J.G.R.,109*, E05003. [3] Hurowitz J.A. et al. (2006) *J.G.R., 111*, E02S19. [4] Bost N. PhD thesis, Univ. Orléans, 2012. [5] Westall et al., LPSC XXXXIV, Abstract # 1397. [6] Bost N. (2012) *Meteoritics, 47*, 820-831.