SEARCHING FOR ORGANICS DURING THE ROBOTIC MARS ANALOG RIO TINTO DRILLING EXPERIMENT : GROUND TRUTH AND CONTAMINATION ISSUES. R. Bonaccorsi[1], C. R. Stoker[1], and the MARTE Project Science Team. Space Science Division NASA Ames Research Center M.S. 245-3 Moffett Field, CA 94035 USA. rbonaccorsi@mail.arc.nasa.gov; cstoker@mail.arc.nasa.gov

Introduction: The subsurface is the key environment for searching for life on planets lacking surface life. This includes the search for past/present life on Mars where possible subsurface life could exist [1]. Searching for bulk organics of biological origin in a subsurface sample from a planet is a key step to assess possible life within it. We report here on the distribution of bulk organics and their CN isotopic composition in Hematite and Gohetite-rich gossanized rocks and clay layers within 0-6m-depth

Background & Study Site: The Mars Analog Rio Tinto Experiment (MARTE), a NASA-ASTEP 2003-2005 funded project (PI, Carol Stoker), performed a simulation of a Mars drilling experiment at the Rio Tinto site (Peña de Hierro, Spain) [2,4]. In 2005 Borheole 7 was drilled on the oxidized cap, or Gossans (Figure 1) of a massive-pyrite deposit from the Iberian Pyritic Belt (IBP). The Rio Tinto is considered an important analog of the Sinus Meridiani Site on Mars and of Astrobiological interest as an ideal model analog for a deep subsurface Martian setting [2-4]. Former results from conventional MARTE drilling suggested that a subsurface community including aerobic and anaerobic chemoautotrophs and strict anaerobic methanogens sustained by Fe and S minerals exists [2,4-5].

Approach and Methods: 28 mini-cores i.e., ~22-cm from Borehole-7 were robotically handled and subsampled for life detection experiments under anti-contamination protocols [6].

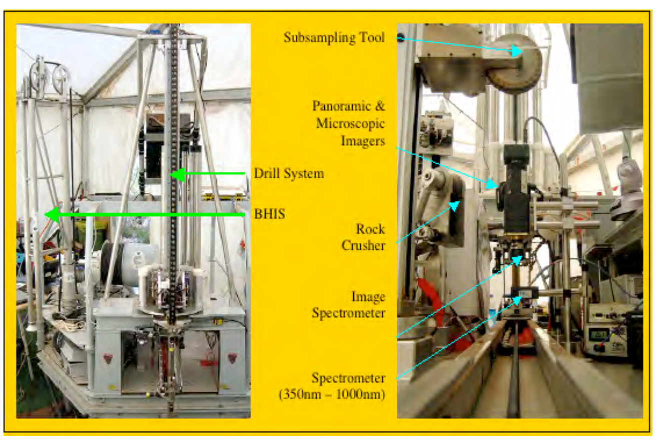

Figure 2: Robotic drilling platform and subsystems. BHIS is the Borehole Inspection System.

The robotic drilling system (Figure 2) included subsystems for hands-off drilling, adjustment to variable downhole conditions and core acquisition, sample handling physical data acquisition, and sample transfer to in-situ life detection instruments (Figure 2) [2,4,6-7].

Figure 1: Borehole 7 Site at Pena de Hierro. The water table is at 90-95 m-depth. A Pine tree vegetation covers the ground. It represents a widespread source of biomass-rich soil and dust that were analyzed as control in this study.

We applied a clean sterile protocol developed for minimizing contamination tha can occur between cores and samples, and the surrounding environment, or during drilling operations [6,8]. We performed a suite of test to check different types of contamination (man-made, environmental and cross-contamination [6]. Cross-contamination was tested by analyzing a set of pristine samples (those stratigraphically known) vs. cuttings (loose clays) or artifacts from the robotic drilling (indurated clay layers). Environmental contamination was tested by comparing the organics and biomass content in cored samples vs. windblown dust loads/ soil surface samples of know origin (litter layer). Man made, or drilling-derived contamination was tested in whole (unfaced) vs. faced cores.

Ground truth analysis (GT) included field visual observation of returned faced cores and lab based analysis of organics [8]. Samples were analyzed with a Carlo Erba NA-1500 Elemental Analyzer-coupled with a Finnigan Mat Delta Plus XL Isotope Ratio Mass Spectrometer (EA-IRMS). We used an ATP (Adenosine 5´-triphosphate) Luminometry hand-held assay (Lightning-MVP, Biocontrol BioControl Systems, Inc., WA) to measure the in situ level of contamination (as Relative Luminosity Units, or RLUs) in faced vs. unfaced cores and the total biomass in soil/ dust samples.

Results: A total depth of 605.7cm was penetrated with a total core recovery of 215.1cm (~35.8%). Cores included consolidated and unconsolidated materials i.e., gossanized rocks, silty-clayey sized loose material and clay levels with colors indicative of their mineralogical composition (Hematite, Gohetite, and Illite/Muscovite) [8-10].

Ground Truth: C-org and N-tot vary up to four orders of magnitude among the surface litter layer (~11 Wt% at 0-1 cm), the mineralized layer (~3 %wt at 1-3 cm), and the first 6-m-depth (C-org = 0.02 - 0.38Wt%; N-tot = 0.008-0.4Wt%) [3]. The distribution/ preservation of plant/ soil-derived organics (C/N ratio = 50; δ^{13}C-org = -26‰ to -24‰) is ten times higher (C-org = 0.3 Wt%) in hematite-poor clays, or where rootlets are present (~1500 - 8,850 RLUs), than in hematite-rich samples (C-org = <0.01 Wt%).

The ATP assay provided insights for potential contamination from core-handling and environmental dust loadings (e.g., 6,782 - 36,243 RLUs) on cleaned/ sterilized standard surfaces ($64cm^2$) as control. ATP data indicate that cleanliness/sterility can be maintained by applying a simple sterile protocol under field conditions as the majority of cores were within the background (100-150 RLUs). Total biomass in wind blow dust is similar to that measured from surface soil, which corresponds to ~10^{-14} to 10^{-13} moles ATP [6,8].

GT vs. remote visual observation: C-org data match well ATP data for total biomass in nearsurface (~6.07m, ~avg. 153RLU) vs. surface soil samples (~1,500 - 81,449 RLU). However, the in-situ ATP assay failed in detecting any presence of mm-to sub-cm sized roots (in faced Core 7-25: ~180 RLU), which were overlooked during the simulated life detection experiment under remote observation [8-9].

Conclusions: MARTE ground truth drilling, in parallel with the automated tests, provided control information on the discontinuity/continuity of the stratigraphic record i.e., texture, color and structure of loose and consolidated materials.

Science results from this experiment will support future Astrobiology–driven drilling mission planned on Mars or other planets. Specifically, ground truth offers relevant insights to assess strengths and limits of in-situ/remote observations vs. laboratory measurements. Particularly, it will aid the debate on advantage/ disadvantages of manned vs. robotic drilling missions.

Furthermore, data on nearsurface organics in the RT system will help understanding the degree of separation between the surface and the deep subsurface environment microbial community including aerobic and anaerobic chemoautotrophs [4-5].

References: [1] Boston P. et al. (1997); [2] *http://marte.arc.nasa.gov*; [3] Bonaccorsi C. and Stoker al. (2006) *AGU Fall Meeting*, Abstract #P51D-1231; [4] Stoker C., et al., *LPS XXXVI,* Abstract #2025 (2005)*;* [5] Stoker C. et al. (submitted); [6] Miller D. et al, submitted; [7] Parro V. et al. (submitted); [8] Bonaccorsi R. et al. (submitted); [9] Prieto O.et al. (submitted); [10] Sutter B. (in prep).