R. Bonaccorsi's Key Technical Areas of Expertise

***1. Multi-component analysis of Mars-like* surface materials**

(a) Iron oxydroxides-rich, Sulfates-rich and clay-rich sediments and rocks from modern volcanic terrains (Death Valley Natl. Park, California).

(b) Clay-rich, Carbonates and Sulfate-rich deposits from the Atacama Desert (Chile).

(c) Gravel-supported soil (alluvial) from the Atacama Desert

(d) Intra-dune clay-rich deposits (Namib Desert Sand Sea).

(e) Modern soil from Hawaii (weathering product of basalts).

(f) Soils from the Shetland Islands (Antarctica).

(g) Soils from the Antarctic Dry Valleys and coastal Antarctica.

See examples in Figure 1 and Figure 2.

2. High-resolution stratigraphy of subsurface materials (~300 drill cores)

(a) Miocene-Pliocene marine/lacustrine facies (Eastern Mediterranean Sea).

(b) Clay-supported Ice Rafted Debris (IRD) (Ross Sea, Antarctica).

(c) K/T Boundary North Pacific biogenic deep sediments (siliceous and calcareous microfossils (ODP Leg 197, Emperor Seamounts)

(d) ~ 1km sub-basement lava flows and fossil soils beds (ODP Leg 197, Emperor Seamounts, North Pacific).

(e) ~ 100 m deep Volcanogenic massive sulphide ore deposits and near-surface (6 m) ironstone/clays deposits (Rio Tinto, Spain, MARTE Project).

3. Long-term water cycle monitoring in Death Valley Natl. Park

2009-present: Managing data loggers of soil/air microclimate conditions (moisture, temperature and rainfall). Over 130,000 hrs of instrumental data logged in the last 3 years including ~2500 hrs of direct field observation at study site (Ubehebe Volcanic Field).

- Terrestrial/geological applications: Intra-crater fine-grained sediments store information on decadal cycles of wet and dry years. Individual storm-generated layers inform on intensity, amount and duration of rainfall storms.
- Planetary applications: Miocene to modern Mars-like fluvio-lacustrine deposits in cratered terrains as natural laboratory to understand on how (1) amount of intra-crater liquid and solid transport; (2) deposition of clay-rich fill sediment, and frequency and life cycle of freshwater ephemeral lakes relate to (a) production, (b) concentration, (c) preservation, and (c) detection of biosignatures.

4. MicroRaman Spectroscopy (soil, minerals, sediments, clean surfaces)

- General applications: Non-destructive characterization of terrestrial environments, identification of mineral particles vs. biological organic components (microbes and their cellular constituents) in soil, sediments, and rocks (See example in Figure 1).

- Planetary Protection: Detection of putative microbes in mineral dust-coated spacecraft surfaces to prevent cross contamination of planetary environments.

5. Optical identification of mineral and biological particles in sediments and rocks.

8-year experience in analysis of smear slides (SS) samples. SS enables fast and cheap qualitative/semi quantitative compositional analysis of fine-grained particles via optical microscopy.

- Applications: Marine geochemistry (low T); study of provenance, diagenesis, and transport processes in low vs. high-energy environments; sample characterization and selection; material characterization to resolve ambiguities of microRaman Spectroscopy (Figure 1) and XRD analysis (Figures 1.2).

6. Use of non culture-based biological assays e.g., LAL (Lymulus Amebocite Lysate) and ATP (adenosine triphosphate) Luminometry.

Modifying and implement extraction protocols for rocks and sediments. Assessing total and metabolically active biomass in geological environments.
Terrestrial and Planetary Applications: (a) Detection of viable microbial components (bioburden) on spacecrafts and geological surfaces (Planetary Protection issue); b) Discrimination of living vs. fossil life in geological matrices; (c) testing for habitability potential as planetary analog materials, and (d) use the results to best inform on how and where to search for life on a planetary surfaces with analogue geology.

7. Bulk organic geochemistry. "Flash" combustion CN Elemental Analysis.

17+ experience in quantification of total carbon, organic carbon, and nitrogen in geological and biological materials.

- Terrestrial/geological applications: carbon/nitrogen cycles; soil productivity; soil ecology; palaeoenvironmental/palaeoclimatic assessment; provenance-to-sink studies.
- Industrial applications: Materials & food characterization; evaluation of compost maturity and source components (Quality Control).
- Planetary Applications: Discrimination of organic/inorganic carbon pools in planetary samples; preservation potential in mineral rich environments;. Identification/mitigation of false positive/negative data.

Examples

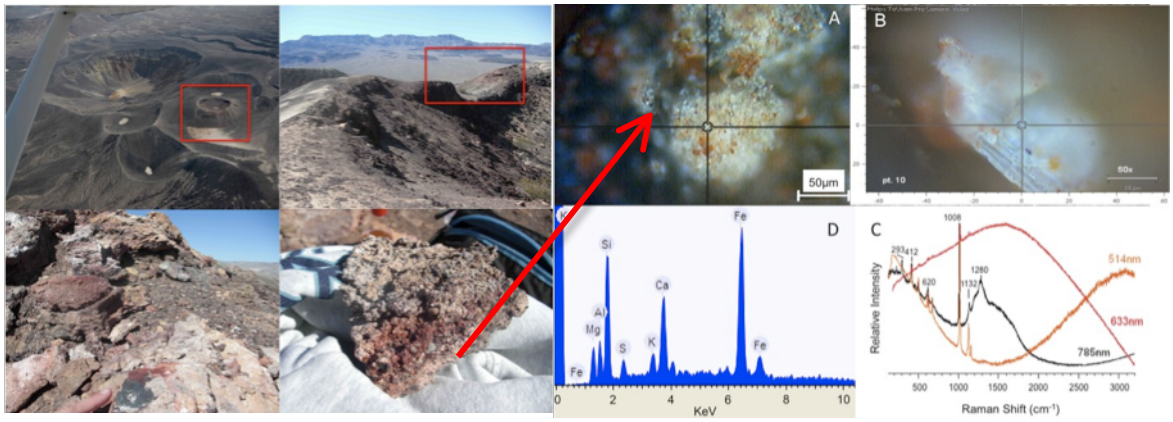

Figure 1. From Macro to Micro: Left-hand side: Aerial view of a cratered volcanic terrain with the Little Hebe Crater framed. Right-hand side: Distinct microRaman spectra signatures of gypsum-cemented rocks from the rim (b) simultaneously showing mineralogical and microbiological spectral signatures of gypsum at 1008, 620, 493 and 211cm–1 (at 785 nm) and hematite at 293, 412, 498 and 660 cm–1. Cyanobacterial colonies band at 1280 cm–1 is assigned to the scytonemin pigment (at 785 nm). The assignments are supported by compositional EDX spectra (d), and optical observations (a, b 20 X microscope objective). Modified from Bonaccorsi et al., 2010.

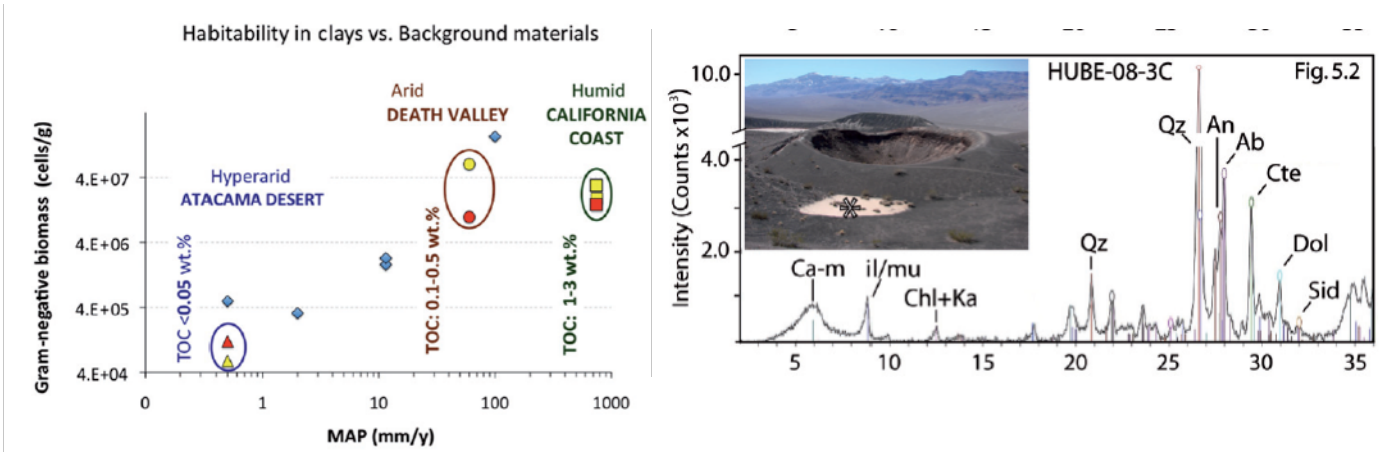

Figure 2A (left). Biomass concentrations of phyllosilicate- (light-toned symbols) versus Fe-oxide-rich samples (dark-toned) along the rainfall gradient. Left to right: samples from (1) the Atacama Desert (triangles), (2) Death Valley, Calif. (dots), and Pescadero Beach, Calif. (squares) sites. Total Organic Carbon content information (TOC, wt%).
Figure 2B (right). X-Ray Diffractogram (background subtracted raw data) for samples from the Little Hebe Crater. Sample analyzed for Lypopolisaccaride (lipid A) biomarker in Fig. 2A. Illite/smectites mixed layer (I-S); illite (ill); chlorite (chl); kaolinite (ka); Ca-montmorillonite (ca-m); muscovite (mu); quartz (Qz); albite (Ab); anortite (An); calcite (ctc); dolomite (Dol); and siderite (Sid).