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Recent microbiological surveys of terrestrial and oceanic subsurface biosphere have revealed that sizable microbial populations are present in the global subsurface environments. However, little is known about the community structure, the genetic diversity and the distribution pattern of the subsurface bacteria and archaea since these surveys are mainly dependent on microscopic observations and conventional cultivation techniques. Culture-independent, molecular phylogenetic techniques are now applied to explore microbial communities in various subsurface environments such as underground mines, subterrestrial rocks, continental and ocean oil reservoirs, subseafloor pelagic sediments and methane hydrates, and subvent microbial ecosystems. It becomes apparent that unique archaeal components are commonly present in these subsurface microbial habitats whereas archaea are always less abundant than bacteria. Most frequently recovered genetic signatures are of hyperthermophiles Thermococcus and extreme halophiles Haloarcula members. Unexpected ubiquity of them even in non-extreme, subsurface environments may represent the great mass potential of probably dormant extremophilic archaea in the global subsurface biosphere. Archaeal populations in deep-sea hydrothermal vents and the subvent environments might serve as sources of the dormant extremophiles, the silent majority of archaea. It seems likely therefore that the global and local ocean hydrothermal activities persistently have a great impact on the formation of subsurface microbial communities and the distribution of subsurface microorganisms. In the KR01-09 cruise which was named ?geomicrobiological investigation of subseafloor biosphere associated with deep-sea hydrothermal activity in the Okinawa Trough?, active populations of hyperthermophilic archaea Thermococcus were detected from non-hydrothermal subseafloor sediments. Their viability was likely correlated with the distance and the duration from the deep-sea hydrothermal vent activities. It will be discussed how the extremophilic archaea are propagated in the global subsurface biosphere.

B32C-06 1445h

Biological Origin of Micro-laminated Calcium Carbonate Deposits on Antarctic Rock Surfaces

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We have observed and sampled patchy encrustations of calcium carbonate on rock surfaces in East and West Antarctica. Individual disk-like deposits are up to 1 cm across and a few mm thick, but in places coalesce to form more extensive, colloform coatings. We have observed these deposits on substrates of granite, sandstone, and schist. Their distribution appears similar to that of Antarctic lichens and endolithic algae, extending up to ca. 1000m elevation, but has no consistent relationship to snow drifts, solar radiation, or prevailing winds. The morphology and position of the deposits are distinct from sub-glacial carbonate precipitates. In Marie Byrd Land, the encrustations occur on the surfaces exposed by deglaciation within the past 5000 yrs, and the sample from East Antarctica contains live C-14 (M. Mabin, pers. comm.), suggesting a possible biological origin

Electron microprobe and SEM examination of cross-sectioned specimens reveals micron-scale layering of predominantly calcium carbonate, but with a number of bright laminae in SEM images, believed to be calcium fluoride. Sections closely resemble desert varnish in micro-morphology, though not in mineralogy. Isotopic analysis of an organic carbon extract (as opposed to C from the CaCO3 itself) gave a delta C-13 PDB value of -23.3 per mil, similar to values expected in carbon of biological origin. However, we have no proof yet that the carbon analyzed was produced by organisms within the encrustation, rather than being entrapped during an inorganic precipitation process. To investigate the possible biological origin of this material, we attempted to sequence the 16S segment of rRNA in the organic extract, but have not yet completed successful PCR replication. We are continuing attempts to isolate and analyze the pertinent genetic material.

The micro-morphology, strongly negative delta C-13 and presence of live C-14 suggest a biological process for precipitation of these calcium carbonate deposits. We hope to be able to test this in future by comparing extracted genetic material with that from known psychrophilic bacteria. If this Antarctic material proves to be biological in origin, it may yield insights into the adaptation of organisms to conditions of extreme cold, aridity and UV exposure on Earth, or elsewhere in the Solar System.

B32C-07 1500h

Biologically-Induced Mineralization by the Endolithic Lichen *Verrucaria rubrocincta* Breuss in the Sonoran Desert

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Verrucaria rubrocincta is an endolithic lichen that inhabits exposed caliche in southwestern Arizona. It has developed a survival strategy against the high photon fluxes, aridity, and temperature extremes of the Sonoran Desert. The lichen occurs within the surface of caliche plates. *Verrucaria rubrocincta* -inhabited caliche can be distinguished from uninhabited substrate by the abundance of reddish-black fruiting bodies protruding through the rock surface. The lichen invades the rock from the edges. It grows beneath a 50 to 150 μmsurface precipitate of fine-grained calcite (micrite). Below the micrite is the upper medulla, ca. 120 μmthick, characterized by an abundance of algal cells. Fungal hyphae penetrate up to 1 cm into the caliche. The micrite layer is dominated by calcite with minor quantities of weddellite ($CaC_2O_4.H_2O$), and detrital quartz. Ca-oxalates are absent in the unaltered caliche. The micrite is enriched in ^{13}C ($\delta^{13}C = 8.1$) relative to the underlying caliche ($\delta^{13}C = 0.0$). It is therefore ca. 5 per mil enriched in ^{13}C relative to calcite in isotopic equilibrium with atmospheric CO_2, indicating that the light carbon is fractionated into organic material hence leaving heavy CO_2 to form carbonate. The heavy ^{13}C enrichment suggests that the micrite layer is not strictly a biological precipitate but a biologically-induced fractionation with light CO_2 extracted by the organism leaving a residual heavy CO_2 to form the micrite. Our observations suggest that the endolithic growth of the lichen results from two different processes: 1) Dissolution and mechanical weathering of the caliche by the fungal hyphae, and 2) precipitation of a protective surface layer of micrite. The lichen thus simultaneously dissolves the caliche substrate and biomineralizes a micrite surface. Our field observations suggest the *Verrucaria*-inhabited substrate weathers at a similar rate as uninhabited caliche.

B32C-08 1515h

Organic Sulfur Gas Production in Sulfidic Caves

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Lower Kane Cave, Big Horn Basin, WY, permits access to an environment where anaerobic sulfide-rich groundwater meets the aerobic vadose zone. At this interface microorganisms thrive on diverse metabolic pathways including autotrophic sulfur oxidation, sulfate reduction, and aerobic heterotrophy. Springs introduce groundwater rich in H_2S to the cave where it both degasses into the cave atmosphere and is used by chemautotrophic sulfur oxidizing bacteria in the cave spring and stream habitat. The cave atmosphere in the immediate vicinity of the springs has elevated levels of CO_2, H_2S and methane, mirroring the higher concentration of H_2S and methane in the spring water. The high CO_2 concentrations are attenuated toward the two main sources of fresh air, the cave entrance and breathing holes at the rear of the cave.

Conventional toxic gas monitors permit estimations of H_2S concentrations, but they have severe cross sensitivity with other reduced sulfur gases, and thus are inadequate for characterization of sulfur cave gases. However employment of a field-based GC revealed elevated concentrations of carbonyl sulfide in cave atmosphere. Cultures of microorganisms collected from the cave optimized for enriching fermenters and autotrophic and heterophic sulfate reducing bacteria each produced carbonyl sulfide suggesting a biogenic in origin of the COS in addition to H_2S. Enrichment cultures also produced methanethiol (methyl mercaptan) and an additional as yet undetermined volatile organic sulfur compound. In culture, the organo-sulfur compounds were less abundant than H_2S, whereas in the cave atmosphere the organo-sulfur compounds were the dominant sulfur gases. Thus, these organo-sulfur gases may prove to be important sources of both reduced sulfur and organic carbon to microorganisms living on the cave wall in a subaerial habitat. Moreover groundwater has not yet been recognized as a source of sulfur gases to the atmosphere, but with the abundance of sulfidic groundwater, this environment may prove to be important to the global sulfur cycle and its influence of the global radiation budget.

B32D MC: 135 Wednesday 1600h

Carl Sagan Lecture

Presiding: **D M McKnight,** INSTAAR, Univ of Colorado

B32D-01 1600h

Mars, Panspermia, and the Origin of Life: Did it begin on Earth, Mars, or Somewhere Else?

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There is no abstract available for this presentation.

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B41A MC: 122 Thursday 0830h

Water, Energy, and Carbon Cycles in Terrestrial Systems: Local-Scale Observations Through Fluxnet and Other Micrometeorological Tower Sites I *(joint with H)*

Presiding: **L Gu,** University of California at Berkeley**; D Baldocchi,** University of California, Berkeley**; S W Running,** University of Montana**; R Leuning,** CSIRO Land and Water**; R Valentini,** University of Tuscia

B41A-01 0830h

FLUXNET: Distribution of a Global Network of Eddy-Covariance Flux Towers and their Role in Validating Models and Remote Sensing Products

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Currently the global network called FLUXNET consists of over 150 eddy-covariance flux-tower systems, with most flux towers operating continuously for 4 years or longer. FLUXNET (see http://daac.ornl.gov/fluxnet/) provides scientific coordination and access to consistent flux data to support global carbon cycle science. The FLUXNET database contains carbon, water vapor, sensible heat, momentum, and radiation flux measurements with associated ancillary and value-added data products. Towers are located in temperate conifer and broadleaf forests, tropical and boreal forests, crops, grasslands, chaparral, wetlands, and tundra on five continents. An analysis of the distribution of towers in the conterminous United States shows that most environmental conditions are well represented by the set of 35 towers. The combined climate, soils, and topography for each tower was compared to clusters representing groupings of similar climate, soils, and topography across the United States. The comparison identified a few combinations that were not well represented. Flux data are being used to validate ecosystem model outputs and to provide information for validating remote sensing based products, including surface temperature, reflectance, vegetation indices, LAI, FPAR, and PSN (photosynthesis) derived from the MODIS sensor on the Terra satellite. Estimates of the selected products for 8-day periods for 1-km pixels in the immediate vicinity of the flux tower are being posted on the FLUXNET Web site