B41C MCC: Level 2 Thursday 0830h

Ecosystem Interactions With Land-Use Change III Posters *(joint with H)*

Presiding: **M R McHale,** U.S. Geological Survey**; N Ohte,** Kyoto University**; G P Asner,** Carnegie Institution**; R DeFries,** University of Maryland

B41C-0884 0830h POSTER

Data Mining Relationships Among Urban Socioeconomic, Land Cover, and Remotely Sensed Ecological Data

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This research investigates the relationships among socioeconomic character, land cover, and ecological function in a rapidly urbanizing region, the Front Range of Colorado. We use novel spatial geographic information systems- (GIS-) based data integration and data mining techniques to integrate and analyze diverse spatial data sets. These data include elevation data, transportation data, land cover data derived from aerial photography, block group-level U.S. Census data, and vegetation greenness (NDVI) data derived from Landsat imagery. These data are used to derive a variety of U.S. block group-level variables indicating demographic, geographic, ecological, and land cover characteristics. We employ spatial association rule mining, decision tree induction, and spatial on-line analytical processing (OLAP), in addition to more conventional multivariate statistical techniques, to investigate relationships among these variables.

B41C-0885 0830h POSTER

Towards Understanding The Spatial Relationship Of Land Cover Thermal Anomalies And Anthropogenic Features On The Siberian Landscape.

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Fires are a common occurrence in the Siberian boreal forest. The Thermal anomalies product of the Terra MODIS product suite is designed to detect thermal anomalies (i.e. hot spots) on the Earth's surface. In most cases hot spots detected by MODIS in Siberia are wild fires, but many are related to agricultural burning or industrial activities. Along with the MODIS products, Geographic Information Systems (GIS) are being used to locate and identify thermal anomalies. The results show that the frequency of fires (hot spot anomaly pixels) decreases with distance from human settlements and transportation lines. This alone does not imply causality but might be an indicator of natural and anthropogenic factors acting together to shape where and when fires are burning. These findings have important implications for carbon and climate modeling to quantify and predict carbon storage and climate change and to provide an insight into anthropogenic impacts on land use and land cover change.

B41C-0886 0830h POSTER

Carbon and Nitrogen Trace Gas Fluxes from Urban Grasslands in California

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Human management of urban ecosystems affects their biogeochemical cycling by altering environmental conditions such as water and resource availability. Urban grasslands under human-modified regimes comprise approximately 10 million hectares in the United States and represent a poorly quantified biogenic source of radiatively active trace gases from soil. We described the annual pattern of net CO_2, N_2O, and CH_4 soil effluxes and associated soil C and N pools and fluxes for urban grasslands in Berkeley, California, USA. Using a static chamber approach, we undertook a 12-month field study of 6 irrigated and fertilized lawns dominated by grasses of either C3 or C4 photosynthetic systems. The urban grasslands emitted 36($\pm$4) Mg C ha^{-1} yr^{-1} as CO_2, more than 7 times the rate observed from natural grasslands globally. Lawns dominated by C4 species emitted significantly greater amounts of CO_2 on average relative to C3-dominated lawns. Rates of CO_2 efflux from the urban grasslands showed a strong response to ambient temperature, and urban grasslands emitted higher CO_2 fluxes during warm summer months when unmanaged grassland ecosystems in this Mediterranean climate would exhibit low to no activity due to drought. Fluxes of N_2O and CH_4 were generally negligible. The exception was a large and significant release of N_2O associated with the construction of a new lawn. In this site we measured a maximum rate of N_2O emissions of 877 ($\pm$244) ng N cm^{-2} h^{-1} and an average rate of 290 ($\pm$41) ng N cm^{-2} h^{-1} over a 6.5-week period. The observation of higher trace gas losses from urban grasslands relative to natural systems encourages further examination to determine their role as sources of greenhouse gases.

B41C-0887 0830h POSTER

NATIONAL FIRE FUELS AND RISKS ASSESSMENT USING REMOTE SENSING AND ECOLOGICAL MODELING: PROTOTYPE RESULTS

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Hazardous fuel reduction, ecosystem rehabilitation and restoration, and firefighting safety, are land management priorities emphasized by recent national fire policies such as the National Fire Plan. Implementation of these policies requires geospatial data of vegetation conditions, fire fuels, risks, and ecosystem status developed consistently nationwide that can be used at multiple scales (i.e., local, regional, and national). A new research and development project called LANDFIRE has been conducted to develop an integrated methodology to produce geospatial fire data and predictive models for the land management community and a broad range of other applications. Main deliverables include mapped potential and existing vegetation types and structure variables, various biophysical data layers, fire fuels models, fire risk layers, as well as state-of-the-art computer models for assessing fire risk, behavior and effects. In this presentation, we will review research results and findings of the LANDFIRE project using results from a prototype study covering central Utah Uinta and Wasatch ecosystems. Particularly we will describe how a consistent and operational vegetation mapping component may be achieved by integrating machine-learning algorithms, field reference data, satellite imagery, and ecologically significant biophysical variables. We will discuss how remotely sensed vegetation cover types and structure can be successfully converted to fire fuel classes and risk layers which are necessary input into fire behavior and fire effect models. Finally we will discuss challenges and opportunities for national implementation of the methodology.

B41C-0888 0830h POSTER

Reconstruction of Overbank Sedimentation Rates with Chromite Mining Waste in Small, Urbanizing Eastern Piedmont Watersheds (Baltimore, MD, USA)

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Basin scale sediment dynamics continue to elude generalization, especially in areas where the agricultural transition preceded the advent of conventional data sources such as the decennial census and aerial photography. Studies of sediment accumulation in overbank areas are similarly impeded by the short temporal coverage of radio-isotopes (e.g., ^{137}Cs $\sim$40 years and ^{210}Pb $\sim$100 years) and the tendency of biomarkers to degrade in unsaturated overbank sediments. European settlement and associated land use transitions began $\sim$1730 in the Red Run basin, a small (2000 ha) drainage in western Baltimore County. Early chromite mining activity (1820-1880) introduced Cr contaminated sediments to the fluvial system during a rapid transition to agricultural land use (the peak of local agricultural activity is commonly estimated to be $\sim$1900). Sedimentation rates were reconstructed for a series of overbank cores using ^{137}Cs techniques and Cr concentration stratigraphy dated with corresponding changes in mining activity. Sedimentation rates during 1820-1880 are 4-8x pre-1820 rates, 1-4x 1880-1963 rates and 2-8x post 1963 rates. These rates are compared with regional land use change/basin sediment dynamics models. Sediment accumulation in Red Run began earlier than regional models suggest and periods of peak sedimentation occurred before peak regional agricultural activity. These results indicate that floodplain sedimentation in Eastern Piedmont basins may have occurred much earlier than expected, leaving a legacy of buried sediments that continues to influence fluvial systems, especially as these areas undergo urbanization.

B41C-0889 0830h POSTER

Analyzing Land Cover Change in Kazakhstan: Land Surface Phenology, Climatic Variation, and Sensor Artifacts

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The collapse of the economic and political institutions of the Soviet Union in the early 1990s led to widespread agricultural de-intensification, land abandonment, loss of livestock, and decreased grazing pressure. In semi-arid to arid regions dominated by dryland agriculture and grazing, the quantification of land cover change must distinguish anthropogenic forcings from interannual climatic variation and the peculiarities associated with specific sensor systems. Were the land cover changes that occurred in Kazakhstan following independence in 1991 of sufficient magnitude to alter the land surface phenology at resolutions relevant to climate models? To explore this question it is necessary first to partition the sources of variation in the image archive. We used the standard Pathfinder AVHRR Land (PAL) dataset, which consists of global 10 d maximum NDVI composites from 7/1981 to 9/2001 at 8 km resolution. To what extent are the PAL data affected by sensor artifacts that may mask other kinds of change? We evaluated 19 subsets of 1600 sq km, one for each ecoregion of Kazakhstan as delineated by the World Wildlife Fund. To minimize residual cloud contamination in the PAL data, a modified version of the best index slope extraction algorithm was applied. The method filters distortions without altering the seasonal NDVI pattern. We pursued two complementary aspects of change analysis: (1) detection of trends within each sensor's tenure and (2) detection of trends and discontinuities across the entire observational period. Seasonal polynomial models of NDVI phenology were developed to relate accumulated growing degree-day with NDVI. To test for trends within periods, both the residuals and the filtered data were submitted to seasonal Mann-Kendall tests that were modified to correct for serial correlation. To identify discontinuities, the entire series was tested using the standard normal homogeneity test (SNHT) without trend. The Kruskal-Wallis test with Bonferroni correction was applied to compare both the original NDVI data and the residual data among the periods. All ecoregions displayed distinct land surface phenologies. There were no significant trends in the NDVI data within a single sensor period. SNHT detected specific discontinuities that were attributable to sensor changes in certain ecoregions. These results imply that PAL NDVI data are a credible source for land cover change research and that straightforward nonparametric statistical methods are able to distinguish between climatic variation, sensor artifacts, and institutional changes.

URL: http://www.calmit.unl.edu/kz/

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B41C-0890 0830h POSTER

Land-Cover Transitions as Predictors of Fire Activity in Amazonia

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Fires are of special interest in environmental studies. Because of their short time scale and strong links to biogeochemical cycles, fires can significantly affect many environmental characteristics, such as carbon stocks and fluxes, air composition, and land productivity. Fires happen both naturally and as a result of anthropogenic activities. In Amazonia, previous studies have identified climate, land-use and land-cover as major factors for explaining large-scale fire patterns throughout the basin. In this study, high-resolution land-cover transitions rates are analyzed together with information from satellite fire products for a study region in Rondonia. Land-cover transition rates were based on an analysis of sequential Landsat images, and included spatially resolved estimates for transitions between three main vegetation classes: forest, secondary, and clear. Satellite fire data were based on NOAA12/14, and GOES-8 as daily fire pixel maps. The results for 1995-96 show that the various transitions types differed in their utility as predictors for fire activity. In particular, correlations between fire activity and land-cover dynamics were highest for transitions from secondary to clear, forest to clear, and clear to clear. Transitions from forest to clear were related to more intense fire activity. While data from GOES-8 reported more fires and correlated better with changes in land-cover, fire products reported similar trends in fire activity. These results suggest that spatial/temporal data on land-cover transition rates may provide valuable information for improving fire models in the region.

B41C-0891 0830h POSTER

Iroquoian and Canadian Disturbance to the Ecosystem of Crawford Lake, Canada

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A suite of geochemical and ecological proxy show perturbations to the Crawford Lake, Ontario, ecosystem by both Iroquoian horticulturalists during the 13th century and Canadian farmers during the mid-1800s. Carbonate and Total Organic Carbon (TOC) accumulation rates change markedly following initial human disturbance, increasing from 1 to 13 mg/cm^2/year and from 1 to 5 mg/cm^2/year, respectively. Carbon isotopes of inorganic carbonate increase from -6 to -1.8 per mil. The sudden preservation of varves and changes in carbon cycling show that the Iroquoian People initiated permanent water anoxia through increased algal organic matter production, related to elevated nutrient inputs caused by changing land use. An age model combining varve counts and 23 AMS ^{14}C dates allows unparalleled temporal resolution in investigating ecological response to changing nutrient levels. Iroquoian nutrient input, synchronous with the first appearance of *Zea* (maize) pollen in the sediment record, produces rapid changes in diatom species assemblages, where pre-disturbance meso-oligotrophic communities largely comprised of *Cyclotella bodanica* and *Cyclotella michiganiana* are replaced by species adapted for higher nutrient concentrations. The changes in species assemblage occur prior to alterations to the carbon cycle, and suggest that algal community structure may be a more sensitive indicator of ecological change than some geochemical pathways. As Iroquoian activity within the region declines, geochemical parameters drift towards pre-disturbance levels. However, diatoms remain in post-disturbance assemblages. Land clearance by Canadian farmers with plow-style agriculture begins in the 1800s, as shown by increasing *Ambrosia* (ragweed) pollen in the sediment. Diatom productivity, carbonate, and TOC accumulations subsequently reach their highest levels following Canadian land-clearance, yet produce no carbon isotopic shift. Lack of a carbon isotopic signal is due to increased oxidation of biologically produced methane, and is a direct result of permanent water anoxia caused by the Iroquoians. While diatom communities may fluctuate following Canadian land clearance, overall species composition remains similar to post-Iroquoian assemblages, suggesting that initial perturbations may be most important in altering ecologic communities from their baseline conditions.

B41C-0892 0830h POSTER

Increasing the accuracy of information from coarse-resolution satellite imagery

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With the deployment of Earth Observing System (EOS) satellites that provide daily, global imagery, there is increasing interest in defining the limitations of the data and derived products due to its coarse spatial resolution, compared with higher spatial resolution but less frequently available data such as that provided by Landsat and airborne remote sensing, and the potential problems with combining EOS data with data from other sources. These issues are particularly relevant to studies of vegetation disturbance that require information on the amount and spatial pattern of fragmented types of land cover. For fragmented land cover, much of the detail, i.e. small fragments and notches in boundaries, is lost with coarse resolution imagery. As a result, not only do EOS image products look different than those generated with high spatial resolution imagery, but statistics such as land cover area and perimeter length are altered. Emerging methodologies based on fractal analysis and geostatistics can be used to adjust the information from satellite imagery to make them more consistent with finer resolution imagery and photography. These techniques make use of relationships between landscape measures at different spatial resolutions due to the self-critical processes that created them, and thus do not require a higher spatial resolution data set. Our adjusted estimates of wetland and burn scar area and forest perimeter from NOAA AVHRR imagery are much closer to values derived from Landsat than the usual products of pixel counts and pixel area. We also present adjusted estimates of burn scar area based on experimental EOS burn scar products and compare them with Landsat-based estimates.

B41C-0893 0830h POSTER

Methane Emissions from Tropical Coastal Lagoons, Yucatan, Mexico

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Tropical and sub-tropical wetlands are thought to be the dominant natural source of methane to the atmosphere, and the majority of tropical methane flux research has been carried out in freshwater environments. In order to obtain better estimates of methane emissions from tropical coastal environments, we are currently conducting a multi-year study of methane cycling and flux in three tropical coastal lagoons and associated mangrove ecosystems located on the Yucatan Peninsula in Mexico. Previous studies have shown that methane emissions from tropical coastal ecosystems are widely variable, and that these emissions can be quite high despite the presence of moderate to marine salinities. We measured surface water methane concentrations in two lagoons (Celestun and Chelem) during different seasons, as well as in a third, heavily polluted lagoon (Terminos), during the rainy season. Celestun lagoon has a distinct year-round salinity gradient (7-35 ppt) due to groundwater input, Terminos lagoon ranges from fresh water at the river entrances to marine in most of the lagoon area, and Chelem has a salinity range from marine to slightly hyper-saline (30-40 ppt). Diffusive methane flux to the atmosphere was calculated from surface water methane concentrations, using both sample-specific and average area wind speed measurements. Additionally, flux chambers were used to measure methane emissions from each of the lagoons during the rainy season. Calculated diffusive fluxes ranged from less than 1 mg CH4/m2/day up to 100 mg CH4/m2/day in all three lagoons, with the highest fluxes occurring in both areas of lower salinity and areas with known waste water discharge. However, measurements of bubble flux made using flux chambers were between 20 and 150 times greater than the diffusive flux calculated for the same locations. During the course of this study, it appears that the most significant bubble flux occurs in these lagoons during the rainy season. Observations and flux chamber measurements indicate that bubble flux even over a relatively short portion of the year could account for a significant amount of the total methane emissions from these systems. Therefore, additional research is needed to better quantify bubble flux emissions from tropical coastal lagoons and mangrove ecosystems, and estimates based on diffusive methane flux represent only the minimum average methane flux from the lagoons.

B41C-0894 0830h POSTER

Modeling Land Use Change in the Chesapeake Bay Watershed

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Low density, decentralized residential and commercial development is increasingly the dominant pattern of exurban land use in many developed countries, particularly the United States. The term "sprawl" is now commonly used to describe this form of development, the environmental and quality-of-life impacts of which are becoming central to debates over land use in urban and suburban areas. Continued poor health of the Chesapeake Bay, located in the Mid-Atlantic region of the United States, is due in part to disruptions in the hydrological system caused by urban and suburban development throughout the 167,000 square kilometer watershed. We present results of a spatial predictive model of land use change based on cellular automata (SLEUTH), which was calibrated using high resolution (30m cell size) maps of the built environment derived from Landsat ETM+ imagery for the period 1986-2000. The model was applied to a 23,740 square kilometer area centered on Washington DC - Baltimore MD, and predictions were made out to 2030 assuming three different policy scenarios (current trends, managed growth, and "sustainable"). Accuracy of the model was assessed at three scales (pixel, watershed and county) and overall strengths and weaknesses of the model are presented, particularly in comparison to other econometric modeling approaches.

B41C-0895 0830h POSTER

Carbon and Nutrient Transfer due to Selective Logging in the Amazon Using Remote Sensing Data.

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Until recently it was thought that remotely sensed data was not sensitive enough to detect and quantify selective logging damage in tropical forests. Spectral mixture analysis of multispectral remote sensing data resolves fractions of surface covered by photosynthetic

vegetation (PV), non-photosynthetic vegetation (NPV = litter and woody debris), and bare soil. We have successfully applied this method to detect selective logging in the Amazon and have developed an equation to estimate canopy gap fraction in selectively logged areas using a combination of field and satellite data. The Tapajos National Forest in Para is the site of a controlled logging experiment where reduced impact logging (RIL) has been measured and monitored. In RIL, vines and lianas are cut before trees are felled. This practice should reduce damage to surrounding areas and thus may result in logging damage that correlates to the size and number of trees removed. We tested how well an estimate of gap fraction from EO-1 Advanced Land Imager data correlated with harvested wood volume in logging blocks. Percent gap ranged from 9-22%, while volume harvested ranged from 26-54 m3/ha. Remote sensing derived canopy gap fraction data can also be used to quantify green canopy biomass and nutrients transferred to the ground during logging. Canopy biomass transferred averaged 25.07 kg/ha for 5 logging blocks immediately following timber harvests in 2001. Canopy carbon and nitrogen transfers were estimated at 12.56 kg C/ha and 0.44 kg N/ha for the same year. Our results suggest that remotely sensed data can provide valuable information about the spatial characteristics and quantity of C and nutrients altered by selective logging.

B41C-0896 0830h POSTER

Agricultural Practice and Regional Climate Interactions in a Coupled Land Surface Mesoscale Model

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Regional climate affects the timing of harvest for rain-fed crops. In response to dry conditions, for example, farmers may harvest crops earlier than they do under wet conditions. This removal of vegetation alters the land surface characteristics and may, in turn, affect regional climate conditions. We studied the dynamic relationship between land use practice, i.e. winter wheat harvest, and regional climate by applying a coupled climate (MM5) and land-surface (LSM1) model to the ARM-CART region of the Southern Great Plains. We compared early and late harvest scenarios, with winter wheat harvested on June 5 and July 5, respectively. Winter wheat is grown in a fairly uniform belt that accounts for 20% of the total land area over the domain of the ARM-CART. Results showed that harvest dramatically affects energy, momentum, and water fluxes. Regionally-averaged, 2 m air temperatures were 0.5-1°C warmer in the early- compared to late-harvest case, with peak warming of 5°C centered over the harvested area. Soils in the harvested area were drier and warmer in the top 10 cm. Near-surface soil water-filled pore space was reduced by 7% across the region, with a peak drying of 22% centered over the harvested area. Soils were up to 10°C warmer, with area-averaged warming of 0.6°C at mid-day two weeks after harvest. Differences between scenarios were greatest during an initial two-week dry period. A subsequent wet period greatly reduced these differences.

B41C-0897 0830h POSTER

The Relationship Between Carbon Input, Aggregation, and Soil Organic Carbon Stabilization in Sustainable Cropping Systems

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Approximately 10% of the earth's soil C is stored within agricultural soil ecosystems. Because farming systems hold promise for sequestering C, their sustainability, environmental impact, and potential role in mitigating rising atmospheric CO_2 concentrations must be addressed. Our current challenges are to provide credible evidence that agricultural practices can sequester significant amounts of C and to quantify the mechanisms, capacity, and longevity of agricultural lands as C sinks. Agronomic practices that influence yield and, therefore, affect the proportion of crop residues returned to the soil (e.g. cover cropping, irrigation, fertilizer addition, and compost application) are likely to influence soil organic carbon (SOC). The objectives of this study were (1) to determine the influence of C input on C sequestration in SOC fractions and (2) to evaluate how aggregation (MWD) relates to SOC and cumulative C input, across 10 different cropping systems. Using SOM fractionation techniques, soil samples from 10 cropping systems at LTRAS (Long-term Research on Agricultural Systems, Davis, CA) were separated into four aggregate size classes (LM: >2000μm, sM: 250-2000μm, m: 53-250μm, and silt&clay: <53μm) and into three SOM fractions within LM and sM (cPOM:250-2000μm, mM: 53-250μm, and silt&clay: <53μm). All fractions were analyzed for their C content. Empirically derived relationships between yield and aboveground biomass-C plus yield and belowground biomass-C were used to quantify C input from corn, wheat, and tomato residues as well as for legume cover crops and compost for the different cropping systems. We found a positive correlation between cumulative C input and SOC (R^2=0.45, P<0.0001). After 9 years, MWD increased linearly with greater C input (R^2=0.64, P<0.0001) and SOC (R^2=0.61, P<0.0001), respectively. We observed that aggregate-C shifts from the microaggregate fraction (53-250μm) in low C input systems to macroaggregate fractions (>2000μm and 250-2000μm) in high C input systems. Our findings indicate that management practices directed towards improving annual production, thereby, increasing residue C input would result in greater aggregate stability and aggregate associated SOC levels and have the capability of long-term C stabilization.

B41C-0898 0830h POSTER

Global Agricultural Land use Data

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The conversion of natural ecosystems to agriculture has been the dominant mode of land conversion over the last three centuries. To understand the ecosystem consequences of global agriculture, we need global data sets of the spatial extent of agricultural land cover, as well as the management practices occurring on those landscapes. We are developing contemporary and historical datasets of global agricultural land use and land cover using a combination of remotely-sensed land cover data sets and agricultural land use census data. In particular, we are mapping the extent of croplands and pastures, the distribution of major crop types, the yield and production of various crops around the world, the fertilizer application rates, etc. The methodology as well as maps of several of these data sets will be presented.

B41C-0899 0830h POSTER

Lifting the Green Veil: A Fresh Look at Synoptic Vegetation Dynamics

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Observing the dynamics of the vegetated land surface synoptically from spaceborne sensors plays a key role in understanding the global water, carbon, and nitrogen cycles, land cover and land use change, and biodiversity mapping. For the past three decades the study of global and regional vegetation dynamics has relied on satellite observations of the distinctive spectral contrast between red and near infrared reflectance exhibited by photosynthetically active green vegetation. It has long been recognized, however, that the spectral vegetation index with the widest currencythe Normalized Difference Vegetation Index (NDVI)suffers a rapid decrease of sensitivity even at moderate Leaf Area Index (LAI) values of 2 to 4, as are commonly encountered in croplands and woodlands. This decrease in NDVI sensitivity casts a green veil over the land surface that obscures vegetation dynamics across vast areas during much of the growing season. This veil has important consequences for monitoring vegetation dynamics, developing land surface climatologies, and detecting significant changes. A straightforward modification of the NDVI, developed to increase its sensitivity under higher green biomass conditions, was applied to a standard, widely available AVHRR NDVI dataset for the conterminous US. The new Wide Dynamic Range Vegetation Index (WDRVI) exhibited increases in sensitivity between 30%-50% for Omernik Level III ecoregions dominated by woodlands, croplands, and grasslands. Ecoregions with lower aboveground net primary production, such as aridlands and semi-arid grasslands, showed no increase in sensitivity of the WDRVI over the NDVI. This powerful, new but simple approach creates an opportunity for a fresh look at the satellite data record. Further, it offers the possibility for significant improvements in the retrievals of canopy variables for carbon and nitrogen models, more accurate land surface characterizations for numerical weather prediction models, more sensitive analyses of land cover / land use change, and improvements in habitat mapping for biodiversity management.

B41C-0900 0830h POSTER

Environmental Controls on Multi-Scale Soil Nutrient Variability in the Tropics: the Importance of Land-Cover Change

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The natural controls on soil variability and the spatial scales at which correlation exists among soil and environmental variables are critical information for evaluating the effects of deforestation. We detect different spatial scales of variability in soil nutrient levels over a large region (hundreds of thousands of km2) in the Amazon, analyze correlations among soil properties at these different scales, and evaluate scale-specific relationships among soil properties and the factors potentially driving soil development. Statistical relationships among physical drivers of soil formation, namely geology, precipitation, terrain attributes, classified soil types, and land cover derived from remote sensing, were included to determine which factors are related to soil biogeochemistry at each spatial scale. Surface and subsurface soil profile data from a 3000 sample database collected in Rondônia, Brazil, were used to investigate patterns in pH, phosphorus, nitrogen, organic carbon, effective cation exchange capacity, calcium, magnesium, potassium, aluminum, sand, and clay in this environment grading from closed canopy tropical forest to savanna. We focus on pH in this presentation for simplicity, because pH is the single most important soil characteristic for determining the chemical environment of higher plants and soil microbial activity. We determined four spatial scales which characterize integrated patterns of soil chemistry: less than 3 km; 3 to 10 km; 10 to 68 km; and from 68 to 550 km (extent of study area). Although the finest observable scale was fixed by the field sampling density, the coarser scales were determined from relationships in the data through coregionalization modeling, rather than being imposed by the researcher. Processes which affect soils over short distances, such as land cover and terrain attributes, were good predictors of fine scale spatial components of nutrients; processes which affect soils over very large distances, such as precipitation and geology, were better predictors at coarse spatial scales. However, this result may be affected by the resolution of the available predictor maps. Land-cover change exerted a strong influence on soil chemistry at fine spatial scales, and had progressively less of an effect at coarser scales. It is important to note that land cover, and interactions among land cover and the other predictors, continued to be a significant predictor of soil chemistry at every spatial scale up to hundreds of thousands of kilometers.

B41C-0901 0830h POSTER

Characterizing regional land cover change by synthesis of information at multiple spatial scales

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In order to evaluate the implication of land use change on ecosystems, biogeochemistry, and the atmosphere, those changes and their uncertainties must first be quantified. This task is especially challenging at regional to global scales, where tradeoffs exist between spatial resolution and temporal coverage. Several existing approaches involve the use of both high-resolution and moderate-resolution imagery, and their combination, to identify dominant land cover types within a pixel or grid cell. Other approches are based on the notion of mixing of functional or structural types within landscape elements. The Amazon region of Brazil provides an important testing ground for these methods. In this presentation we review current approaches for characterizing land cover and change, and present the results of an analysis that combines MODIS nadir-adjusted reflectances, landsat ETM reflectance data, and extensive field validation. We provide a statistical estimate of upper and lower bounds of basin-wide coverage of cleared land for pastures or agriculture and secondary vegetation. We define limits to precision in our ability to detect changes in these total areas over this region.

B41C-0902 0830h POSTER

Land atmosphere interactions in a rapidly urbanizing environment

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The majority of greenhouse gases and other atmospheric pollutants originate in cities, yet the interactions between human activities, vegetation, and the atmosphere are poorly understood in urbanizing environments. The Urban Trace-gas Emissions Study (UTES) in the Salt Lake Valley is a multidisciplinary study of the interactions between land cover types and atmospheric processes in a rapidly urbanizing, semi-arid ecosystem. Our goal is to: 1) determine the major local sources of trace gases and quantify their temporal and spatial variability in a variety of land cover types; 2) study the underlying and interacting social-environmental processes controlling emissions and concentrations of pollutants, and 3) use a collaborative process with decision-makers to evaluate scenarios for managing air quality and greenhouse gas emissions as the population of the valley rapidly increases. Our major emphasis is on carbon dioxide, water vapor, and volatile organic compounds (VOC's), all of which influence climate and air quality, and have both anthropogenic and biogenic components. Here we report preliminary results from a pilot study combining measurements of eddy covariance, CO2 concentrations and isotopes, aerosols, VOC's, meteorology, traffic flow, and natural gas combustion in a residential neighborhood. Natural gas usage was fairly constant during the study, which was conducted in the winter, while traffic flow had the characteristic rush hour diurnal pattern. Source identification of CO2 concentrations with stable isotopes showed that only 60% of CO2 sources were attributable to traffic emissions, with the remainder attributed to residential natural gas combustion. Diurnal pollutant concentrations were strongly influenced by local scale near-slope flow patterns, while on a longer scale daily patterns were determined by meso-scale climatic conditions such as the build-up and mix-out of atmospheric inversions. These results showed that an understanding of patterns and influences on human activities, aspects of urban form, and natural processes all contribute to our ability to quantify urban land-atmosphere interactions. The results are being applied to an urban systems model in order to improve our understanding of interactions and feedbacks between social and natural parameters, scale the results to other land cover types, and develop an urban airshed management tool for decision-makers. The model is currently being validated with additional data collection in other land cover types including a pre-urban area and two residential neighborhoods of varying ages, urban structure, and urban forest cover.

URL: http://slvairshed.utah.edu

B41C-0903 0830h POSTER

Variation in Gross Nitrogen Mineralization and Microbial Communities Along a Chronosequence of Lodgepole Pine (*Pinus contorta*) Stands, Yellowstone National Park

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Soils and vegetation were analyzed in 20 forest stands in Yellowstone National Park, Wyoming, USA that varied in age from 50 to 350 years and had initiated following stand-replacing fire. Our goal was to determine how nitrogen (N) availability (NH_4^+) varied among post-fire, mature lodgepole pine (*Pinus contorta*) stands and to determine whether that variability was related to stand age, stand tree density, microbial community composition and aboveground net primary productivity (ANPP). Gross N mineralization was measured using a laboratory isotopic dilution technique, and microbial community composition was measured using a hybrid Fatty-Acid-Methyl-Esther/ Phospho-Lipid Fatty Acid procedure. Gross nitrogen mineralization rates ranged from 0.3 to 4.2 μgN g soil^{-1} d^{-1} (average=1.44±0.24 μgN g soil^{-1} d^{-1}). Gross N mineralization rates declined with increasing stand age: 2.11 ± 0.41 (50-100 yr), 1.83 ± 0.75 (125-175 yr), 0.99 ± 0.24 (200-250 yr), 0.82 ± 0.21 (300-350 yr). Gross mineralization rates in the 50-100 age class were significantly higher than in the 200-250 and 300-350 age classes. Gross mineralization was positively related to stand ANPP (p=0.0186, R^2=0.96), negatively related to stand foliar N averaged by age-class (p=0.0219, R^2=0.96), and was not significantly related to tree density. The first principal component (PC1), which explained 53% of the variation in microbial community composition, was correlated with age class. PC1 was strongly controlled by a fungal lipid (18:2 ω6c). The proportion of microbial lipids in specified functional guilds differed among age classes but did not differ with stand density. These results are consistent with other studies reporting declines in N availability with increasing time-since-fire, which we attribute to changes in ANPP and changes in microbial community composition.

B41C-0904 0830h POSTER

Changes of Stream Water Chemistry After Clear Cutting Using Forest Rotation

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It is well known that clear-cutting has a large impact on stream water chemistry. There are many studies about the influences of the clear-cutting. These results have showed that nitrate concentration increases, pH decreases and increases of peak drainage etc. These qualitative influences are common, but it is still unclear the quantitatively. Our watershed including more than 50 small watersheds, they are managed using forest rotation in a unit of watershed. It results that the watershed is useful for the chronosequence study. We introduce the preliminary results of stream water chemistry after clear-cutting until 87 years and discuss the qualitative repeatability of the influences.

B41C-0905 0830h POSTER

Prolonged Effect of Severe Wildfires on Mercury and Other Volatiles in Forest Soils of the Lake Superior Region, USA

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Soils in Isle Royale National Park, Michigan and Voyageurs National Park, Minnesota show spatial patterns of depletion of total Hg, organic C, Se, total S, P, and Pb within areas of severe, stand-replacing wildfires that burned in 1936, approximately 65 years prior to our current study. The fires burned during a regional drought, were of high severity, and likely consumed a high percentage of organic forest-floor material (O-horizon). A "fire factor" is defined by positive correlations among Hg, C, Se, S, P, and Pb. A factor score for this six-element grouping derived from factor analysis was assigned to each sample. The scores show a high spatial correlation with the footprint of the 1936 fires in both parks, particularly for A-horizon soils. Because many of these elements are volatile, and are highly correlated with soil organic matter, observed depletions likely represent instantaneous atmospheric release during combustion of O-horizon soils coupled with decades-long reduction of organic matter on the forest floor and near-surface soils. Nearly complete combustion of the modern O-horizon would release roughly 1 mg Hg/m2 from the forest floor. Decades-long disturbance resulting from destruction of mature forests and gradual regrowth following fire also play an important role in Hg cycling. Destruction of a mature forest results in decreased deposition of Hg from litterfall as well as throughfall, which contributes Hg by wash-off of dry deposited Hg from foliar surfaces. Hg in forest soils may follow a fire-dependent cycle in which sudden Hg loss during fire is followed by a period of continued Hg loss as evasion exceeds sequestration in the early stand-replacement stage, finally to resume gradual buildup in later stages of forest regrowth. In the Lake Superior region this cycle exceeds 65 years in duration and is of the same magnitude as the fire return interval for this region. Forests that are controlled by fire-induced cycles of stand replacement may also be in continuous cycles of Hg sequestration and emission. Fire history appears to be a major determinant in the amount of Hg stored in forest soils. Fire almost certainly releases Hg to the atmosphere as forest floor material is burned and thus contributes to atmospheric Hg loads. Fire also appears to cleanse burned areas of Hg both by the atmospheric release during combustion and longer-term release during post-fire forest reorganization. Fire cleansing appears to persist for decades after severe fires and may ameliorate Hg contamination of aquatic food webs by decreasing the soil Hg load of burned watersheds.

B41C-0906 0830h POSTER

Rainfall, Plant Communities and Methane Fluxes in the Ka'au Crater Wetland, Oahu, Hawaii

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Tropical wetlands constitute a major source of methane, an atmospheric greenhouse gas. Net methane emission in freshwater settings is the result of organic matter decomposition under anaerobic conditions modulated by aerobic methane oxidation and is thus also an indicator of wetland ecosystem processes. This study is monitoring the methane flux from the Ka'au crater wetland on the island of Oahu (Hawaii) and correlating it with environmental parameters such as precipitation and sunlight. We are obtaining precipitation, Photosynthetic Active Radiation (PAR), and water table level data with data loggers and are correlating these data with static chamber methane flux measurements and measurements of soil methane production potential. Additionally, our research is studying the effects of changes in vegetation type, i.e., of the invasive strawberry guava tree (Psidium Cattleianum) on the wetland methane emissions. Changes in soil chemistry and in the transport of gases by roots that accompany such vegetation change are a potential driver of methane flux modifications that have not been previously examined. Strawberry guava forms dense mats of surface roots that may change soil gas exchange and prolific fruiting may raise the soil organic content. We collected soil samples along a 30 meter transect that extends through two vegetation patterns; the strawberry guava canopy and the sedge meadow (Cladium

B

Leptostachyum). Samples were incubated for 24 hours to estimate their methane generation potential. Our preliminary results show that methane generation potential is greater under the strawberry guava canopy. However, 2 of the 15 samples collected in the sedge meadow section of the transect did not match this pattern. Soil organic carbon content is slightly higher in the strawberry guava than in the sedge. We recorded a 90% decrease in methane generation potential in sedge meadow soils during a dry period relative to a wet period 2 months earlier. We propose that this change reflects a difference in the relative activity of microorganisms in the oxic and anoxic parts of the soil column. We will use environmental molecular technique to compare the microbial community component responsible for the production of methane in the different wetland soils.

B41C-0907 0830h POSTER

Simulation of Stream Water Alkalinity Under Scenarios of Changing Acidic Deposition and Changing Climate.

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Models of soil and stream water and catchment acidification have typically been applied without consideration of climate change. Soil air CO_2 concentrations have potential to increase as climate warms and becomes wetter. We simulate this increase by applying a coupled series of models which simulate soil temperature, soil tension, catchment hydrology, soil air CO_2 concentrations, and soil and stream water chemistry to predict daily stream water alkalinity values for a small catchment in the Blue Ridge of Virginia for 60 years into the future given stochastically generated daily climate values. This is done for four different scenarios of climate change and atmospheric deposition change. We find that stream water alkalinity continues to decline for all scenarios except when climate is gradually warming and becoming more moist, indicating the influence of increasing soil air CO_2 concentrations on stream water chemistry. In all other scenarios, base cation removal from catchment soils is responsible for limited alkalinity change resulting from climate change. This has strong implications given the extent that models such as MAGIC are used to establish policy and legislation concerning deposition and emissions.

B41C-0908 0830h POSTER

Post-Fire Overland Flow Frequency, Volume and Quality

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We present results that assess the importance of post-fire hydrophobicity on runoff generation and the evolution of water quality following a stand-replacing chaparral fire. In September of 2002 85% of Southern California's San Dimas Experimental Forest (SDEF) was burned during the Williams' fire. Following this event, 58 overland flow collectors were installed at discrete locations within a chaparral catchment at SDEF in order to quantify the spatial and temporal frequency as well as the water quality of overland flow during and immediately following precipitation events. Results show that precipitation events that occurred one right after the other, with little drying time in between, led to more frequent and higher volumes of overland flow than those events with dry spells preceding them. This suggests that soil antecedent conditions had an impact on soil infiltration capacity and thus on overland flow generation. These results indicate that soil hydrophobicity was not the most important post-fire hydrologic process as we would have expected more runoff in the first storm of the year and in those following drying periods if it were an important mechanism. The reestablishment of vegetation also influenced runoff processes. As the rainy season proceeded and vegetation recovered, collected overland flow volumes decreased. Interception of precipitation by these plants may have shielded the ground from immediate impact, and lowered the overall intensity of the storm in relation to the soil surface, thus increasing the amount of water that could infiltrate into the ground. Increased evapotranspiration may also be significant, although it was not specifically studied. Spatially, the frequency and quantity of runoff accumulated at each site was a function of the specific contributing slope and the characteristics of that slope. These characteristics include the composition of the soil within the samplers' contributing area, i.e. areas of bedrock yielded more water than areas of sand. The water captured in these collectors has also been analyzed for several chemical constituents. Testing yielded high concentrations of nitrate, ammonium and phosphate immediately following the fire, with declining concentrations as the rainy season continued and vegetation was reestablished. The same was found of mineral nutrients, suggesting that the system was being flushed of post-fire by-products as the season progressed.

B41C-0909 0830h POSTER

Use of stable isotope tracers as a diagnostic tool for determining connectedness of road runoff to stream peak flows in disturbed forest environments.

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Forest disturbance, and in particular forest road construction can cause changes in hydrological processes emergent at the catchment scale. The magnitude of the impacts of forest roads on stream peak flows and chronic sedimentation is perceived to be directly proportional to the degree that roads are connected to the stream system. Scientific studies to date that have examined the degree to which the roadside ditch acts as an extension of the stream system have been highly equivocal. The engineering prescription to "fix" the perceived impacts of roads is to isolate the road system from the stream system. This is generally carried out by upgrading the drainage system for the forest road by either installing more drainage structures, cross drain culverts, or simply isolating live stream crossing culverts using water bars or rolling dips. At this time there is no simple, universally applicable method to determine the degree of connectivity of a road system to the stream. This paper presents some preliminary research using stable isotope tracer approaches as a diagnostic tool for quantifying connectedness of road runoff to stream peak flows. We argue that time source hydrograph separation may be a tool for determining whether or not engineering improvements have "worked" and how much current road systems in any given watershed influence stream peak flow. We present data for a rainstorm in the Winter of 2003 from nested subcatchments and road ditches at the Oak Creek Watershed in the McDonald/Dunn Research Forest, Western Oregon.

B41C-0910 0830h POSTER

Carbon and Nitrogen Pools in Oregon Cascades Forests Over a Successional Gradient

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In a study to examine impacts of successional and disturbance history on N export from 20 headwater stream systems in the west central Cascades of Oregon, a region of low anthropogenic N inputs, watersheds of differing ages showed a number of significant difference in nutrient export. In order to determine the mechanistic factors driving these differences, we measured soil solution and mineral soil C and N, forest floor and coarse woody detritus biomass, C and N in 12 plots categorized into 4 different classes of successional development. In streamwater, DON ranged from 24% to 51% of TDN in the youngest and oldest watersheds, respectively. In soil solution, %DON did not vary with succession, and was 40-75% of TDN. Although ammonium concentrations were very low in streamwater, ammonium was 25-59% of TDN in lysimeter samples and also did not vary with time since disturbance. The C content and C:N ratio of the forest floor was significantly higher in the youngest plots, most likely due to post-harvest residue and slash. Although there were 2-fold differences in the C content of the mineral soil, these differences were not related to disturbance history. Even with these sharp differences in both forest floor and mineral soil C contents as well as C:N ratios among plots, no measure of N export – not soil solution, not stream flow – was significantly related to forest floor, down wood, or mineral soil characteristics. This is most likely because forest floor C:N ratios (54-126:1) all greatly exceed the C:N ratios reported to allow significant leakage.

B41C-0911 0830h POSTER

The impact of the degree of forest fragmentation on dry-season Amazonian precipitation

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Numerical experiments have suggested that wholesale destruction of tropical forests on continental scales can lead to a large-scale decrease in precipitation. Other work, focusing on smaller scales (e.g., similar to those of local watersheds), has shown that mesoscale landscape heterogeneity, e.g., due to partial deforestation, can induce atmospheric circulations that can alter the intensity and spatial distribution of the preexisting pattern of precipitation. One consequence of this might be a local enhancement of precipitation in a given region, which in turn could strongly impact watershed-scale hydrological and ecological processes. Therefore, the net impact on total rainfall for a given amount and pattern of deforestation (i.e., the degree of fragmentation) remains an open question. We have carried out a suite of high-resolution, month-long simulations with the Regional Atmospheric Modeling System (RAMS) to investigate the sensitivity to different imposed forest fragmentation patterns, based on satellite-observations of human-caused deforestation. These fragmentation patterns range from highly fragmented to highly clumped (though all with the same mean amount of deforestation). From these experiments we find that the degree of forest fragmentation significantly affects the monthly total rainfall in the simulation domain. This variability in total rainfall can be linked to the intensity and organization of landscape-forced mesoscale circulations and the associated vertical motion and atmospheric stability field. The key point is that forest areas interspersed with many small-scale patches of grassland or pasture can experience different total rainfall, on monthly timescales, than forest areas with fewer, larger deforested patches, even given the same total deforested area. This implies that ecological processes that are both (i) sensitive to rainfall and (ii) help control vegetation patchiness may lead to significant hydrologic feedbacks. Such feedbacks could have important consequences for the subsequent evolution of forest systems under a combination of human and natural pressures.

B41C-0912 0830h POSTER

The Rate of Weathering-Derived Calcium Input to a Base-Poor Forest Ecosystem in the Northeastern USA

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Over the past 50 years,acid deposition in the northeastern USA has leached calcium and other base cations (K, Na, and Mg) from the soil exchange complex, creating a nutrient-poor environment for trees. In order to quantify losses from the soil exchange pool and estimate ecosystem recovery from acid deposition, inputs from atmospheric deposition and mineral weathering must be known. Atmospheric deposition can be measured directly, but weathering inputs are difficult to distinguish from cation exchange pool depletion in stream fluxes. The objectives of this study were to determine the variability of long-term weathering rates across a small watershed at Hubbard Brook Experimental Forest (HBEF), NH, and to compare these rates to the current flux of cations from the watershed. The HBEF is a northern hardwood forest last logged in the

early 1900s; at higher elevations, conifers are dominant. Soils have developed on relatively homogeneous, glacial till deposited about 14,000 years ago and derived predominantly from granodiorite and pelitic schist. Soils were sampled by horizon from 45 soil pits within a 12-hectare watershed. Long-term weathering rates were calculated as the loss of elements from soils relative to the parent material using Ti as an immobile element. The average long-term chemical weathering rate in the watershed (40 meq m^{-2} yr^{-1}) is similar to rates in other 10 to 15 ka old soils developed on granitic till in temperate climates. The soil parent material is chemically homogeneous, yet the weathering rates range from 21 to 65 meq m^{-2} yr^{-1} across the watershed, generally increasing with elevation due to changes in vegetation, soil water flow paths, and depth to impermeable bedrock. Feldspar weathering rates are greater at higher elevations at HBEF. Plagioclase weathering accounts for a significant amount (56-84%) of the calcium lost from the soils over the last 14,000 years, while the dissolution of apatite accounts for 15 to 32%. The present-day loss of base cations from the watershed greatly exceeds the long-term weathering rate providing additional support that the pool of exchangeable base cations in the soil continues to be diminished.

B41D MCC: Level 2 Thursday 0830h

Aqueous Microbial Geochemistry I Posters *(joint with H, OS, V)*

Presiding: **E Shock ,** Arizona State University**; L A Warren,** School of Geography and Geology, McMaster University

B41D-0913 0830h POSTER

Characterization of novel archaeal lineages associated with acid mine drainage in Iron Mountain, CA using anaerobic cultivation and cultivation-independent genomic analysis

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Iron Mountain in northern California, contains a pyritic orebody undergoing dissolution from mining creating extremely acidic (generally pH 0.8), warm (>40°C), and highly concentrated metal solutions, referred to as acid mine drainage (AMD). AMD communities are limited in the number of lineages that have been associated with them. The archaeal members of the mine community, in the past, have been restricted to the Thermoplasmatales order. The various clades within the Thermoplasmatales have been named the "alphabet plasma" (ie. Aplasma through Gplasma). The majority of them remain uncultured. Anaerobic media containing ferric sulfate and glucose has been successful in enriching and maintaining members of the "alphabet plasmas". Analysis of aqueous chemistry of these cultures shows a reduction of ferric iron, suggesting a subset of these archaea are capable of iron reduction. This may be a relevant part of iron cycling in the mine previously overlooked. Recently, another deeply branched archaeal group, named WTF1102, has been identified. Completely independent of all previously identified AMD lineages, its closest relative available in present databases is to that of the euryarchaeota group referred to as VAL1, which consists entirely of uncultured and poorly represented in sequences. Screening of the community genomic library constructed from the site revealed a contiguous fragment from two shotgun clones, totaling 4.4kb in length. These clones have been fully sequenced and contain two genes, a phosphatase and 16S rRNA. The 16S rRNA gene has a 515 bp long intron at 1102 (E. coli numbering) that contains an open reading frame which encodes for a ubitiquitin-like protein modifier. Phylogenetic analysis of the phosphotase amino acid sequence revealed it branches with that of other acidophiles, Thermoplasma and Ferroplasma. We are developing FISH probes to target the individual "alphabet plasma" and WTF1102. This work extends what we know about the diversity and metabolic capabilities of archaea in AMD.

B41D-0914 0830h POSTER

Rare Arsenic-Antimony-Sulphide Bio-immobilization and Bacterial S-layer Preservation in Siliceous Sediments from Champagne Pool Hot-Spring, Waiotapu, New Zealand

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Champagne Pool is a large (65 m diameter, 150 m deep) hot spring in the Waiotapu geothermal area of North Island, New Zealand. The spring discharges water of a mildly acid chloride type, with a pH of 5.2, a constant temperature of 75 °C and a silica concentration of 460 ppm. Siliceous sinter, loose sediments, and flocs suspended in the spring water are composed of opaline silica and metal-rich sulfides that contain many well-preserved, mineralized microbes. Detailed analysis by transmission electron microscopy and energy dispersive spectrometry has shown that bacterial cell wall and capsular material is preserved by the immobilization of high levels of As (up to 33 wt%), Sb (up to 60 wt%), and S (up to 20 wt%) in the organic matrix. Significant precipitate formation is absent (and when present only small microcrysts form), suggesting much of the As-Sb-S has accumulated through adsorption processes. When extensive biomineral precipitates are present upon the cell wall, they are composed of Al rich amorphous silicates. This suggests a 2-step biomineralization process whereby As and Sb sulfur complexes are adsorbed onto the cell surface polymers first, followed by inorganically driven precipitation of the supersaturated amorphous silica phase. Despite the lack of detailed preservation, biomineralization commonly preserves S-layers, an ordered mosaic of proteins on the outer surface of the cell wall. These are the finest ultrastructural details thus far found preserved by hot-spring biomineralization. Preserved S-layers exhibited either a hexagonal (p6) or square (p4) lattice structure with unit-unit spacing of 9.7 ± 1.6 nm. Because S-layer morphology varies considerably between species it can be used as a fingerprint to aid identification of microfossils. By considering both S-layer morphology and the hot-spring habitat (pH, Eh, temp etc) it is suggested the S-layers preserved here belong to *Clostridium thermohydrosulfuricum* or *Desulfotomaculum nigrifacans*. To determine possible mechanisms behind S-layer preservation, geochemical speciation calculations were undertaken to determine the probable inorganic species present in the hot spring water, using the REACT component of the Geochemists Workbench software package (GWB version 3.2.1). Mineral saturation indices were also calculated using this code. Results suggest that arsenic and antimony are present in the spring water as negative and neutrally charged thio or hydroxide complexes such as $HAs_2S_4{}^-$, H_3AsO_3 and $HSb_2S_4{}^-$. Furthermore, all As, Sb and S mineral phases were undersaturated. This explains the lack of notable As-Sb-S precipitate upon the cells and adds credence to the idea that the As-Sb-S phases may have been adsorbed onto the organic polymers. The observation that S-layers are preserved whilst other ultrastuctures are not may indicate a novel mechanism is involved in S-layer preservation at this hot-spring site. S-layers are dominated by amine groups which would be positively charged at the pH of the spring water. Although tentative, it is speculated the early adsorption of negative As-S and Sb-S complexes onto reactive amine groups on S-layers is paramount in the excellent preservation of these delicate ultrastructures.

B41D-0915 0830h POSTER

Sulfide as a Chemoautotrophic Electron Donor for Dissimilatory Arsenate Reduction in Mono Lake, California

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In aqueous systems, arsenic occurs as arsenate [As(V)] or as arsenite [As(III)], with the latter form being more toxic and mobile. Mono Lake, California is a meromictic soda lake (pH = 9.8; salinity = 70-90 g/L) with exceptionally high arsenic content (∼200 μM), a consequence of hydrothermal inputs combined with evaporative concentration. Previous work has shown that arsenic speciation changes from As(V) to the more reduced As(III) with vertical transition from the lake's surface oxic waters to its unmixed, anoxic bottom waters and that dissimilatory reduction is responsible for the observed change in arsenic speciation. Rates of *in situ* dissimilatory As(V) reduction measured by radiotracer (∼1- 6 μmol/L/d) were estimated to be significant enough to mineralize up to 14% of annual primary productivity. Subsequent lab-based investigations with As(V)-amended (∼1-2 mM) bottom water displayed significantly higher rates (150-260 μmol/L/d) of As(V) reduction and were not limited by the availability of organic electron donors such as acetate, lactate, malate and glucose. The focus of this study was to identify a natural source of electrons for As(V) reduction in Mono Lake. While Mono Lake contains plentiful dissolved organic carbon (∼7 mM) this material is usually refractory and resistant to bacterial oxidation. Alternatively, the anoxic bottom waters contain high concentrations of sulfide ions (∼1-2 mM) that could potentially serve as an electron donor for dissimilatory As(V) reduction. In a time course experiment with As(V)-amended Mono Lake bottom water, we observed oxidation of sulfide linked to the reduction of As(V) to As(III). This reaction did not occur in filter sterilized controls and sulfide loss did not occur in samples lacking As(V). In bottom water amended with additional sulfide (total = 6 mM) and As(V), we observed a linear relationship between rates of dissimilatory As(V) reduction and As(V) concentration. The highest rate observed under these conditions was ∼3 mmol/L/d, over 1000-fold higher than Mono Lake *in situ* rates. We isolated an anaerobic bacterium from Mono Lake bottom water, strain MLMS-1, that grows in mineral salts media by oxidizing sulfide to sulfate and reducing As(V) to As(III). MLMS-1 grew with a 4:1 stoichiometry of As(V) reduced to sulfide oxidized, indicating an 8 electron transfer. MLMS-1 aligned by 16S rDNA amplification and sequencing in the δ-Proteobacteria, being closely related to the sulfate-reducing bacteria of the genus *Desulfobulbus*. However, strain MLMS-1 does not grow with sulfate as an electron acceptor.

B41D-0916 0830h POSTER

Importance of Fe(II)-Hydroxide Complexes For the In-Situ Bioremediation of ARD Sites

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Enhancing the growth of heterotrophic bacteria such as Acidiphilium cryptum that are indigenous to acid rock drainage (ARD) sources is a potential strategy for in-situ inhibition of pyrite oxidation and acid formation. When biodegradable organic carbon was supplied to A. cryptum, oxygen was consumed by rapidly growing heterotrophs, and bacterial iron reduction observed, accompanied by increasing solution pH. A. cryptum (ATCC 33463) cells were incubated in well-aerated liquid media containing Fe2(SO4)3 and glucose at varying initial pH values from 1.5 to 3.5. No more than 1% of the added ferric iron was detected as soluble Fe3+ for any of the media, indicating that the A. cryptum cells were able to reduce precipitated ferric iron. No organic carbon consumption or iron reduction was observed in flasks incubated at pH 1.5 indicating that A. cryptum may not be able to grow at this low pH. In reactors where the initial pH was 3.5, the pH increased to approximately 5.5 during the experiment accompanied by a 0.4 gl-1 decrease in Fe(III) species after aeration stopped. In reactors where the initial pH was 2.5, final pH values were inconsistent between replicate experiments: pH decreased to 2.3 in one experiment and increased to 2.8 in the second. Dissociation of Fe(OH)2+ complexes at pH values near 2.5 could have acted as a buffer, minimizing pH change during iron respiration. The existence of Fe(OH)2+ complexes was investigated using O-square wave voltametry, a pulse polarography technique which allows for identification of metal complexes and estimation of complex stability constants. The presence of ferric hydroxide complexes at pH near 2.5 was confirmed by pulse polarography. When the initial pH was 3.5, the base neutralizing capacity of the solution decreased due to the replacement of Fe(OH)2+ by Fe(OH)3 resulting in the pH increase of over 2 units.

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