28th Annual Five College Geology Faculty Symposium

McConnell Hall 103, Smith College
21 September 2006, 5 pm

Whitey Hagadorn, Amherst College
"Surfing Late Cambrian Shorelines"

Qian Yu, University of Massachusetts
"Integration of Geospatial Sciences into Environment Complexity Study"

Amy Rhodes, Smith College
"Using Stable isotopes to Distinguish Orographic from Convective Rainfall in a Cloud Forest, Monteverde, Costa Rica"

Mark McMenamin, Mt. Holyoke College
"*Lifeworld* and Perturbation of the Biosphere over Geologic Time"

Steve Roof, Hampshire College
"Iceland - What you Missed if you Missed the Five College Geology Trip this Summer"

Surfing Late Cambrian Shorelines

Whitey Hagadorn
Department of Geology
Amherst College
jwhagadorn@amherst.edu.

Pre-Ordovician epicratonic coastlines differ radically from their younger counterparts because they are mud- and metazoan-poor, vegetation-free, and dominated by microbial binding. They are important because they may record the first advance of animals onto land – as invertebrates crawled onto tidal flats. Yet little is known about the ecology of such settings because most early land-going animals were soft-bodied, and most sandy environments are not conducive to soft-tissue preservation. Similarly, the facies architecture of such settings is difficult to constrain because environmentally diagnostic fossils are absent and many indicators of tidal influence require the presence of mud.

Late Cambrian quartz arenites of New York-Quebec-Ontario (Potsdam Gp.), Missouri (Gunter and Lamotte Ss.), and Wisconsin (Elk Mound Gp.) may help address this knowledge gap. Tidal flat facies within these Potsdam-type deposits contain a suite of exceptionally well-preserved trace fossils made by soft-bodied arthropods and mollusks. Many of these trackways were produced subaerially, as evidenced by their cross-cutting relationships with raindrop imprints, adhesion structures, and polygonal cracks. Emergent facies in these units are also characterized by a suite of microbial structures such as domal sand buildups, sand shadows, sand chips, “old elephant skin”, patchy ripples, broached ripples, sand rollups, and sand balls. Three-dimensionally preserved soft-bodied fossils also occur, and include scyphomedusae and euthycarcinoid-like arthropods. Fossils are often mantled by microbial structures, suggesting that their preservation may be linked to microbial binding.

Although the presence of soft-bodied and delicate trace fossils in these upper flow-regime lithofacies seems paradoxical, it is consistent with the style of preservation known from Ediacaran konservat-lagerstätten - where microbial binding, sessile animal lifestyles, and lack of burrowing predominate. Together, these observations suggest that animals began crawling out of the sea by the Late Cambrian, and that re-examination of tidal flat facies in older Potsdam-type deposits should provide further insights into the colonization of the subaerial realm.

Integration of Geospatial Sciences into Environment Complexity Study

Qian Yu
Department of Geosciences
University of Massachusetts
qyu@geo.umass.edu

Geospatial science, mining remote sensing images or other spatial data for information with geographic information systems' support, is one of the most important emerging and evolving field. Its applications significantly increase amounts of scientific data and analysis techniques to research in geosciences and environmental sciences. This talk will briefly review the current issues and problems in vegetation information extraction from remote sensed imagery. And then I will explain how the science advancement in this area would improve our research in environmental sciences and ecosystem study. Finally, two newly started projects involving geospatial sciences will be presented: Aquatic Plant Biomass Assessment, and Dynamics of Carbon Cycle at the Land-sea Interface.

Using Stable Isotopes to Distinguish Orographic from Convective Rainfall in a Cloud Forest, Monteverde, Costa Rica

Amy L. Rhodes
Department of Geology
Smith College
Arhodes@email.smith.edu

Climate and land-use change may diminish orographic clouds over tropical montane forests, stressing biota and water resources during dry seasons. From 2003-2005, we measured the stable isotopic composition of precipitation and throughfall in Monteverde, Costa Rica to distinguish convective, wet-season rainfall associated with the Intertropical Convergence Zone (ITCZ) from dry-season, orographic rain produced by northeasterly trade winds. While event-to-event fluctuations of $\delta^{18}O$ and $\delta^{2}H$ are high, monthly samples reveal a seasonal signal that may be used to trace water through the hydrologic cycle. Deuterium excess indicates that water evaporated from land is an important flux to the region during the transitional and dry seasons when winds from the Caribbean slope dominate. Following the shift to convective rainfall at the start of the wet season—when the western equatorial winds influence the Pacific slope of Costa Rica—d -excess values become depressed. Yet as the wet season progresses, d-excess begins to climb. These data suggest that several months of rain are needed following an acute dry season on the northern Pacific slope before a terrestrial evaporative signal is detected in wet-season precipitation. The evaporative flux may result from a wet-season expansion of surface water bodies and flooding of seasonal wetlands.

Abstract from: Seasonal variation in the stable isotopic composition of precipitation in the tropical montane forests of Monteverde, Costa Rica (in press at *Water Resources Research*; Authors: Rhodes, A.L., Guswa, A.J., and Newell, S.E.)

Lifeworld and Perturbation of the Biosphere over Geologic Time

Mark McMenamin
Department of Earth and Environment
Mount Holyoke College
mmcmenam@mtholyoke.edu

The biosphere has suffered a series of setbacks over the past half billion years, but after each crisis it emerges stronger than before. Evolutionary trends, such as the increase in the amounts organic matter preserved in sediments, the drop in background extinction rate, and the increase in encephalization quotient in animals, have proceeded virtually unhindered over this time.

What gives the biosphere its resilience? To study this question, students and I are using the *Lifeworld* modeling system to quantify resistance to perturbation. Developed for my first year seminar, *Lifeworld* uses John Conway's *Game of Life* as a computational substrate to generate statistical data for a variety of evolving systems. One of these paleoecological simulations, named Square One, evolves into a distinctive blinking pattern called Traffic Lights. In order to study the effects of perturbation on Square One's progress to Traffic Lights, cells are numbered in a counterclockwise spiral fashion as follows:

28	29	30	31	32	33	34
27	11	12	13	14	15	35
26	10	2	3	4	16	36
49	25	9	1	5	17	37
48	24	8	7	6	18	38
47	23	22	21	20	19	39
46	45	44	43	42	41	40

To simulate a paleoecological perturbation, one of the 49 evolutionarily active cells is arbitrarily changed (from live to dead or dead to live, respectively), and the *Lifeworld* simulation is run. Each experiment has a defined evolutionary trajectory, with outcomes ranging from extinction of the entire biota to the production of a stable pattern with a combination of oscillators (blinkers) and still lifes (blocks, ships, ponds, beehives and even a loaf; these are formal *Game of Life* terms). Assessment of these outcomes allows us to calculate Perturbation Index P.

If the probability of a random cell switch causing a high perturbation outcome is between zero and 0.5, then such a system is defined here as a high resistance to outcome perturbation system or HRTOP system. If the probability is greater than 0.5, then the system is defined as a low resistance to outcome perturbation system or LRTOP system. Square One has P=0.81, and is thus a LRTOP system. The lowest P yet observed is P=0.733 (Five Bar *Lifeworld*). We are currently searching for *Lifeworld* systems with P<0.5 because these would be likely to share critical systems characteristics with the real biosphere.

Fire and Ice: What you missed if you missed the Five College Geology Fieldtrip to Iceland, August 2006

Steve Roof
Department of Natural Sciences
Hampshire College
srNS@hampshire.edu

For a week in August, 33 students and 6 faculty from the Five Colleges traveled around Iceland to view the geological features of this "spreading center above the sea" island. Prior to the trip, students prepared by meeting weekly during the spring semester to hear presentations about Iceland geology, and to work in teams to research different geological features and processes present on Iceland. A one-day symposium with invited experts highlighted the current thinking on Iceland's formation (a hot spot or not?) and glacial events of the Pleistocene.

The trip to Iceland in August was awesome. Everybody had a great time as we toured around the island by 4x4 bus. We visited lush vegetated areas along the coast and barren dry deserts in the interior. We saw recent lava flows that were still steaming hot, geothermal power plants tapping the immense steam geysers, rhyolites interbedded with basalt flows, geothermally-warmed lakes perfect for skinny dipping. We saw glacier tongues, caps, and crevasses, and massive outwash plains formed by jokulhlaups. Finally we visited the place called Þingvalla (say "thingvallir") where Iceland is cracking open as the island continues to expand (this is also a site of great historical significance in the history of Iceland).

If you missed this trip, stay tuned, the Five College Geology program will be sponsoring future trips to places like the Grand Canyon, perhaps Greece, maybe Hawaii ...