Luquillo Critical Zone Observatory
Science meeting 1; May 2010
Meeting Goals

• Project updates
  – Interact and exchange ideas

• Develop work plans and data forms
  – Project descriptions
  – Student & Post-Doc opportunities

• Discuss integration & synthesis
  – Equipment and Technician needs

• Feed back from Advisory Group
Agenda

Thursday May 20, 2010
• 9:00 AM: Introductions and Data Management
• 10:15 AM: The soil zone; A. Johnson, W. Silver
• 11:15 AM: The atmospheric zone; M. Scholl, J. Shanley
• 12:00 PM: Lunch and individual meetings with Data Manager
• 1:30 PM: The Coastal Zone; B. Horton
• 2:00 PM: Short reports by collaborators and visitors,
• 3:00 PM: Break-out groups on field projects and sampling activities
• 5:00 PM Adjourn

Friday May 21, 2010
• 9:00 AM: Water and Sediment; Scatena , Bill McDowell
• 9:30 AM: Deep Weathering and Deep Wells; H. Buss, S. Brantley
• 10:30 AM: Network and synthesis activities: Open discussion
• 11:30 AM: Comments from Advisory Committee
• 12:00: Lunch and close out.
• 1:00-5:00 PM; Optional field trip to Bisley and sites of Deep Wells;
Time Line

- 2010
  - January and May meetings
  - Design & implementation of field studies
- 2011
  - May meeting, field campaign
- 2012
  - Data exchanges and comparisons
  - May meeting or meet with LTER ???,
- 2013
  - Synthesis activities
- 2014
  - Renewal or close-out

CZO annual meeting & symposiums
How to “Critical Zone Processes” Vary with Bedrock Lithology?

How critical zone processes, water balances, and mass fluxes differ in landscapes with contrasting lithology but similar climatic and environmental histories.

7 General Hypothesis

- saprolite
- surface soils
- hillslopes/riparian zones
- fluvial
- coastal
Atmospheric inputs
- Weather stations

Bedrock lithology & Weathering
- Deep Nodes
  - H1, H3

Soils & Vegetation
- Soil Nodes
  - H4, H5

Hillslope Catena’s
- H3, H5

Sediment & solute
- Inputs to channel network

Channel Network & Transport
- Aquatic nodes
  - X-sections
  - H5, H6

Fluvial & Coastal Depositional Environments

Weathering:
- Brantley, White, Buss, Fletcher Porter

Nutrient cycling
- Kurtz, Johnson, McDowell, Scatena, Silver

Streams:
- Jerolomack, McDowell, Scatena, Shanley

Soil & Veg
- Johnson, Silver, Plante, Silver, Scatena

Dating & Isotopes
- Scholl, Willenbring, Hemistath, Kurtz

Atmospheric inputs
- USFS & USGS, Scholl, Shanley, Silver, Scatena, Mayol & UPR
Luquillo CZO Original Hypothesis

**Hypothesis 1:** The rate of *saprolite advance* varies with regolith thickness and landscape position and is fastest in GD valleys and slowest on VC ridges. Over large areas, the rate of saprolite advance will equal the rate of denudation and can be predicted from bedrock chemistry, porefluids, and physical rock properties.

**Hypothesis 2:** In *surface soils*, *chemical transformations* of atmospheric inputs are decoupled from bedrock lithology and influenced by soil carbon, surface redox, and plant nutrient cycling. Biotic influences on soil biogeochemistry decrease with storm intensity and soil depth and are greatest in surface soils of the VC during low intensity rainfalls.

**Hypothesis 3:** The *residence time and routing of water* varies with bedrock lithology and will be longest in areas underlain by the GD and shortest in areas underlain by VC. However these differences will decrease with storm intensity and duration.

**Hypothesis 4:** Over seasonal time scales, *iron reduction* and related *CO2 production* will be greatest in VC surface soils and lowest at depth on stable GD ridge tops. Over large areas and longer time scales deep weathering rates and surface soils properties are closely linked to the frequency of low redox events and the magnitude of iron reduction.

**Hypothesis 5:** The morphology, and soil biogeochemistry of *riparian and colluvial deposits* varies systematically with lithology and in a downstream direction, while their vegetation and soil organic matter chemistry varies systematically with rainfall and temperature.

**Hypothesis 6:** *Sediment supply and transport* within the stream channel network is dominated by surface erosion associated with rainfalls of moderate intensity in the VC and landslides associated with high intensity events in the GD.

**Hypothesis 7:** The *depositional environments* of coastal and fluvial sediments draining the GD will have a higher resolution record of climatic disturbances and land use changes than corresponding environments in the VC.
Accomplishments

• Information Management & LCZO web page

• Students
  – Post Docs; USFS, LTER., LCZO funding
  – 5 UPenn PhD plus UCB, UPR, Brown, Boston..
  – 3 EES Masters Students
  – Reu’s; 4+ this summer
  – European exchanges

• Field sampling, campaigns and equipment
  – Lidar; flight in late summer; Wei Wu subcontract
  – Deep wells
  – Soil sampling
  – Bedload monitoring
  – East Peak water sampling
Education

• PhD students &/or post-docs
  – UNH Newsletter
  – LCZO graduate student group; emails to Miguel
  – Class assignments using LCZO data

• Masters
  – Penn Professional Masters
    • Nawl, Rameriz. C. Durban

• REU’s

• Spring Cyber Seminars
Cross-site Activities

• Symposium & special sessions
• Lidar
  – Summer 2010/2011
• Existing collaborations
  – Delaware & Carbon & Streams
  – Sierra Nevada & dating
  – Arizona & energy analysis
• Potential activities
  – Geophysics
Publications

• **Synthesis publications**
  – Geobiology workshop
  – Goldschmidt 2010
  – CZO Network
    • Denver Geochemistry; Summer 10
    • Vadose Zone Journal; Hopmans & Richter; 8/30/10
    • Arizona; Gordon conference
    • Elsevier European CZO network; Philly 2011
  – Other opportunities
    • IITF & LTER Gradient book
    • IITF Coastal Zone workshop
    • Tropical Hydrology Special Issue; Fred Ogden June 10
  – “Tale of 2 watersheds”

• **Acknowledge**
  – Luquillo CZO, USGS-WEBB, USFS-IITF
Individual Projects
Individual Projects &
Big Ideas
(Applications)

• Denudation vs uplift vs sea level changes
  – Atmospheric inputs vs uplift inputs; P inputs, C budgets..
  – Coastal habitat; increasing or decreasing
Old on the inside young on the outside

Graniodiorite
Volcanoclastics
Hornfels
Peaks
Coastal Plain
Alluvium

4 Lithologies X 4 Forest Types
How deep is the CZ?
Uplift & Denudation & Sea Level Rise
mm/yr

- Denudation Studies
- Miocene Uplift
- Holocene Uplift
Individual Projects & Big Ideas

• Denudation vs uplift vs sea level changes

• Long-term denudation vs short-term erosion
  – Cosmogentic dating vs geochemical vs measured
  – Scaling issues
Individual Projects & Big Ideas

- Denudation vs uplift vs sea level changes
- Long-term denudation vs short-term erosion
- Climate links
  - Inputs vs outputs
  - Environmental history; SST vs Precip.
  - Hurricanes as Carbon sinks
Individual Projects & Big Ideas

- Denudation vs uplift vs sea level changes
- Long-term denudation vs short-term erosion
- Climate links
- Temporal links
  - Pluses through systems
600-900 m TWI

Saprolite to bedrock 2-20 m

1 m thick O horizon to 1 m

20-30 m Veg. zone

Hillslope Scale
Critical Zones; Depth and boundaries
Lithology
GD, VC, HF, Mafic
Fluxes & rates
By location, event
Morphology
Boulders…Peaks…
Stream channels…

Landscape Scale

Veg. zone
20-30 m

600-900 m
TWI

1 m thick
O horizon to 1 m

Saprolite
2-20 m
Individual Projects & Big Ideas

- **Denudation vs uplift vs sea level changes**
  - Atmospheric inputs vs uplift inputs; P inputs, C budgets...
  - Coastal habitat; increasing or decreasing

- **Long-term denudation vs short-term erosion**
  - Cosmogentic dating vs geochemical vs measured
  - Scaling issues

- **Climate links**
  - Environmental history; SST vs Precip.
  - Hurricanes as Carbon sinks

- **Temporal links**
  - Pluses through systems
HOW
Individual Projects & Big Ideas

• **Project Descriptions**
  – LCZO web page
  – Graduate student & PI’s

• **Activities**
  – Luquillo AGU symposium: 2012 or 2013

• **Joint Publications**
  – 2013-14
Data Management

• **Miguel Leon; Information Manager**
  – LCZO Online data forms

• **CZO Data Management Committee**
  • Standard keywords / ontology
  • SDSC host

• **Geochemistry Data;**
  – S. Brantley
Data Management
Searchable & Expandable

• Project Descriptions
  – Abstract, location…

• Data sets
  – Variables, methods,
  – Meta data, format…
Data Sets

Description
Project Description:
Climate data from the Bisley Lower Climate Station
Research Location:
Bisley Tower I
Core Area(s) and/or Keywords:
Tabonuco Forest
Climate

Publication
Relevant Publication Downloads:
Schellekens Interception.pdf

Data Sets:
Bisley Tower daily meteorological data 1993 to 2006
Bisley Tower daily meteorological 2007
Bisley Tower daily meteorological 2008
Bisley Tower daily meteorological 2009 to 5-03-10
Bisley Tower hourly meteorological data 2002 to 2008
Bisley Tower hourly meteorological data 2007 to 2010-5-03
Bisley Tower 10 min meteorological Feb to March 2008
Bisley Ozone 2008-2010
Bisley Weekly Rainfall and Throughfall
Geological controls on the physical and chemical properties of the regolith and on key aspects of the LEF forest communities

Project Description:
The classic paradigm that has guided our understanding of why particular soils have the properties they do, includes the influences of climate, organisms, parent material, time, and topography. Across natural landscapes, one or more soil properties can change substantially along gradients in any of the environmental factors noted above. In this segment of LCZO research we are focusing on trying to understand the effects of lithology on a variety of soil properties. Parent material has the potential to directly affect soil texture, moisture holding capacity, pH, base saturation and nutrient content, and may therefore produce edaphic conditions that could influence the spatial distribution of forest types, nutrient pools and nutrient cycling. Question 1 is designed to determine which soil properties change as a function of lithology when the other four factors are constant. We are considering the following properties: clay mineralogy, organic matter content and quality, pH, exchangeable nutrient cations, and N and P content and availability. We believe that there will be differences in soil properties linked to parent material, and the next step focuses on the relationships, if any, between lithology and the properties of plant communities. Question 2, then, is for the same climate, elevation and landscape position, are there detectable relationships between lithology and the properties of the forest communities including species composition, biomass, productivity and the cycling of N and P?

Research Location:
Luquillo Elevational Gradient

Source of Funding:
NSF CZO Program

Relevant Publications:

Relevant Publication Downloads:
Gould et al 2006.pdf

Dissemination:
unrestricted

Contact Information
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INFORMATION MANAGEMENT
Atmospheric Studies

Legacy Data
Coordinate East Peak Collections
Isotope Sampling
Sampling Campaigns
All ready have problems with Infrastructure!

11-23 inches/day

~ 1 in/15 min
Tasks for Working Groups
Weathering-soils-atmospheric-H20

• Define Data sets
  – When will data be collected
  – When will they be ready for publication

• Plan participation in symposium/work shops
  – Existing and self-organized
  – What year should we have a Luquillo AGU session

• How to promote interactions
  – Graduate Students
  – Collaborators

• Review original hypothesis
Stream Studies

• Bedload transport and flux; D. Jerlomack
  – Tagged rocks; Bisley 3, Mameyes, Rio Blanco
  – Boulder composition

• Total export
  – Dissolved + suspended + bedload
Administrative

• Annual NSF Report
• Contracts
• Annual Network Meeting; Sept 13-14-15
  – Bill McDowell
1 m thick O horizon to 1 m

20-30 m Veg. zone

600-900 m TWI

Saprolite to bedrock 2-20 m
Linkages & Integration

• Critical Zones;
  – Depth and boundaries
• Lithology
  – GD, VC, HF, Mafic dikes
• Fluxes & rates
  – By lithology, elevation, event magnitude
• Boulders
  – Hillslopes, stream channels…
• Temporal & spatial variation
  – GIS analysis