The Geology and Geochemistry of the Gunung Mulu and Gunung Buda Caves

Preliminary Report

Prepared by Jud Partin
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Research Objective:
The goal of the research is to analyze the spatial and temporal variations of cave hydrology and geochemistry in response to changes in precipitation. This knowledge will be applied to reconstruct past precipitation records using cave stalagmites previously collected at Gunung Buda National Park (see preliminary report by Cobb, K 2003). The chemical evolution of the cave waters will be monitored from the time when rain falls to the point at which the dripwaters hit the surface of the cave formations. The goals of the field trips are to: i) determine which parameters affect water chemistry in addition to those caused by climate change, and ii) observe how these signals are recorded by the cave. Ultimately, we hope to work closely with Sarawak Forestry officials and scientists in hopes of applying our research results towards cave conservation and biodiversity objectives.

Expedition Summary:
Dr. Kim Cobb, assistant professor at the Georgia Institute of Technology, and Mr. Jud Partin, PhD candidate also from Georgia Tech, conducted field research in Gunung Mulu and Gunung Buda National Parks in Sarawak, Malaysia from 2 March 2005-16 March 2005. The campaign was carried out in close cooperation with Mr. Brian Clark, Park Manager of Gunung Mulu National Park, official guides from Mulu Park, as well as representatives from the Department of Forestry, Sarawak. Dripwaters from 66 locations were collected for analysis. Bedrock samples were collected from all caves explored. Temperature, relative humidity, and drip-rate monitors were installed in several caves at Mulu to record changes in the cave environment over the next year. Such information will be coupled to bi-weekly samples of cave dripwater geochemistry in order to address the scientific questions outlined in the ‘Research Objective’ section.
Preliminary Results:

I. Gunung Mulu National Park

Research was concentrated on the Mulu Park area for the period from 02/03/05 to 11/03/05. Park guides led the research team to Deer, Lang’s, Clearwater, Clearwater Connection, Wind, and Racer Caves. Dripwaters were analyzed from over 40 locations, including a 24 hour monitoring of a location in Lang’s Cave. A range of sites were chosen for study: fast and slow drips, forming stalagmites, eroding stalagmites, flowstones, flat surfaces, pools, streams, and other cave formations. We wanted to sample the full range of environments in the Mulu cave system to determine the chemical range of the dripwaters. We hope to determine the role that dripwater geochemistry plays in the diverse morphology of the Mulu caves. Bedrock samples were also collected from the different caves to assess the relationship between host rock geochemistry and dripwater geochemistry.

For each dripwater, we measured drip rate and pH, and collected three 5-mL samples to measure the oxygen isotopic, carbon isotopic, and trace metal concentrations upon return to the US. These measurements include:

1) Oxygen isotopic composition ($\delta^{18}$O) – (Dual Inlet Mass Spectrometer)
2) Carbon isotopic composition ($\delta^{13}$C) – (Dual Inlet Mass Spectrometer)
3) Trace Metals concentrations (Sr, Mg, Ca) – (Inductively Coupled Plasma Atomic Emission Spectrometer)

We also collected waters from three different locations to estimate the residence time of the groundwater before entry into the cave. These determinations require much larger volumes of water than the C, O and metal analyses, so only select locations were chosen. Three different methods will be used to determine the residence time. These methods cover a range of timescales and allow for agreement between methods to verify the age of the dripwater. Age-related geochemical measurements will include:

1) Uranium-Thorium concentrations (Using Multi-Collector Inductively Coupled Mass Spectrometer)
2) Radiocarbon ($^{14}$C) (Accelerator Mass Spectrometry)
3) Tritium ($^{3}$H) (Mass Spectrometry)

Temperature, relative humidity, and drip-rate monitoring devices were installed in Wind Cave and Lang’s Cave. Mulu Park guide Jenny Malang has been trained in retrieving the data from the monitors and will do so over the next year. She will keep a record of the cave environmental data for park use and also will send a copy to Georgia Tech.

Rainwater and dripwater collection programs that began during the October 2003 field mission were re-supplied and will be continued by trained park personnel (including Jenny Malang). The bi-weekly rainfall collection program has yielded a history of rainwater isotopic composition for the last one and a half years, and will continue over the next several years. The bi-weekly dripwater collection program at two sites in Wind
Cave has revealed the temporal variability of dripwater geochemistry. These two drips (one fast, one slow) will be monitored in coming years, along with an additional drip in Lang’s cave.

Ceramic plates (N=22) were placed on top of actively growing stalagmites as part of a controlled growth carbonate sampling experiment. In 2-3 years, the plates will be collected and returned to the US for subsequent lab analysis. The isotopic composition of the carbonate which has been deposited on top of the plates over the next several years will be measured and compared with instrumental data, both ground-based and satellite measurements. No ambiguity will exist in dating the carbonate because the exact date is known of when deposition began (March 2005).

As done during the 2003 Buda expedition, previously broken stalagmites were collected to be used as records of past precipitation. Eight samples were collected in the Clearwater Cave Connection passage and brought back to Georgia Tech. These samples will be compared to the dripwaters collected during this field mission as well as to records generated by the Buda samples. Spatial coverage of different caves is an important tool for verification of the climate change signal.

II. Gunung Buda National Park

The expedition was based at Gunung Buda National Park from 11/03/05 to 15/03/05, guided by Johnny Baei Hassan and Joseph (of Mentawai Ranger Station), both Sarawak Department of Forestry employees. Dripwaters were collected from 25 locations in Snail Shell and Mojo Caves. Ceramic plates which will be collected for future analysis were also deployed. The Buda dripwater procedures were identical to the Mulu dripwater procedures. However, owning the short amount of time spent at Buda, only two samples were collected for dripwater age determinations. The other difference between Mulu and Buda sampling is that no long term monitoring of temperature, relative humidity or drip-rate will take place due to logistical constraints.

Future Work:

We plan on measuring the chemical composition of the dripwaters collected at Gunung Mulu and Gunung Buda National Parks using instruments located in Kim Cobb’s lab at Georgia Tech. These results will be compared to the dripwater geochemical analyses that were measured on samples collected in October 2003. A key difference between the two missions is that the 2003 mission was conducted during the wet season of a neutral year, while the March 2005 mission took place during the dry season of a weak El Niño year, which should make the area even drier. Thus the two collections of reflect two very different rainfall regimes – one relatively wet and one anomalously dry. We are hopeful that differences in dripwater geochemistry that we observe between October 2003 and March 2005 will help us to constrain the response of the cave environment to large changes in precipitation. We intend to publish these results over the next several years in international peer-reviewed journals. We will return to Malaysia
next year to investigate how the cave environment has evolved over the several-year-long research period.