Personal Statement

One of the principle desires I have in life is to understand the world around me and be able to communicate that information to other people, whether the larger scientific community or society as a whole. It is this desire that led me to science, and encourages me to pursue advanced study and a career as a scientist and educator.

I have always based my research goals off of passions that exist in my personal life. As a child growing up on the coast of Maine, the ocean was a major component of my every-day life. I followed this passion into my early research and professional careers, studying oceanography and working on a variety of vessels, ranging from 88-meter research ships and traditionally rigged sailing research vessels on the world's oceans to captaining a 50 foot private sail boat on the Maine coast. Later, as a teen, I discovered the sport of whitewater kayaking- something that has come to be as significant a driving force in my life as the ocean.

It is through the intense experiences I have had paddling whitewater at an elite level around the world, as well as bringing new faces into the sport that I began to shift my interest from the ocean to river environments. The accessibility and ubiquity of rivers, the degree to which human society is directly linked to them, and the enormous impact humans have the ability to impose on rivers became a constant topic of my thought and conversation. My excellent education in geology from Colorado College gave me solid underpinnings from which to begin understanding the control rivers exert on landscapes, the control humans exert on rivers, and how rivers influence humans. This allowed me to turn my emotional connection to rivers I developed as a paddler into a scientific focus, and the research experience I gained as an undergraduate translated directly to the type of research I was hoping to do involving rivers. My immanent research in China is the next phase in my career track; I intend to use the skills and knowledge I gain during my masters research to direct my future plans, which through diligent work has potential to lead to a successful scientific career.

Of the variety of professional experiences I have had, there are two that were instrumental in my decision to pursue a career as a scientist and educator. The first of these was working for the Chewonki Foundation as a Wilderness Trip Leader, and the second as an Assistant Scientist working for Sea Education Association (SEA).

There are a number of responsibilities associated with successfully leading a group of young teens in the wilderness for five weeks. Many are simply skill-based, but for me the most meaningful of these responsibilities is being their role model during a time when most people are transitioning from a child to a young adult. In order to be a successful role model, there are two factors I found that needed to be considered: you must provide a path for the participants to follow, and you need to provide them with the tools to discover that path. When successful, participants are able to recognize their goal and have a self-driven means to their goal. I took pride in training participants, and the skills they needed to become successful paddlers translate well to other aspects of their lives: self-confidence, humility, respect, humor, an eye for detail and technical skill, and clear communication.

As an Assistant Scientist aboard SEA's traditionally rigged sailing research vessels I had the opportunity to combine the educational and leadership skills I acquired working with teenagers at Chewonki with my passion for scientific inquiry cultivated in high-school and at Colorado College. My role was two-faceted: my technical goals were to teach the college students in the program to safely and effectively perform and manage all of the procedures and analyses in the lab, as well as to safely and efficiently deploy sophisticated oceanographic research equipment. My pedagogical goal (explicit in the mission of the program), however, was to teach effective and rigorous research techniques to students and then empower them with leadership of the lab. For example, in the final two weeks of each six-week cruise students were given full responsibility for the operation of the lab, with one student per watch designated as the "Junior Lab Officer." This required the students to step into the leadership role that I served as a model for, and gave them valuable first hand experience in a mode that required them to maintain a "big picture" view, which was often a completely new experience. For myself, this was an opportunity to see how well I had modeled leadership, as well as taught them technical skills. I found this phase of each cruise to be simultaneously nerve-wracking and inspiring; in each new Junior Lab Officer I saw the direct result of my efforts as an educator and a leader. This is perhaps the most poignant expression of my successes and failures I have experienced as an educator, and I found it allowed me to better understand which of my teaching techniques worked, and which failed, better than any evaluation I have ever received. Though at first uncomfortable, this frank self-assessment provided a valuable base upon which to ground educational skills and philosophy.

Now, as a graduate student at the University of Vermont, I am fortunate to continue my development as a teacher working as a Teaching Assistant (TA) in an introductory Geomorphology class. Working with Paul has been an excellent learning opportunity; he is equally as adept at communicating research as he is underlying principles to the class through lecture, lab activity, and writing. I work with the students on a nearly daily basis, helping them understand concepts covered in class and in the text, providing feedback and grading their assignments and labs. This is my first time taking the role of an educator in a traditional classroom setting, and I have found it to be an exciting way to improve my skills as a communicator, as well as encourage scientific inquiry and development in undergraduates. As I begin my graduate research, I am excited by continuing opportunities to explore my own scientific interests, as well communicate my enthusiasm and knowledge to younger students, better developing communication skills that will be crucial as I move into the larger scientific community.

Previous Research Experience

I am well equipped intellectually to pursue my proposed research plan, having participated in a variety of research projects including extensive field-based research projects, instructing ocean science with Sea Education Association (SEA), and through direct involvement in two large NSF-funded programs. Through these varied research experiences, I have become skilled in data collection, interpretation, research methods, and working as a member of an international research team.

As an undergraduate at Colorado College I was exposed not only to research techniques in my classes, which (within geology) had significant field components, but also detailed data analysis and interpretation. For example, I worked on numerous self-designed research projects for classes such as geophysics, where as a part of a student team of three that I designed, executed, and interpreted a survey of water-table variation at thermal springs in Colorado. Recurring exposure and practice interpreting unique data sets is one of the more valuable academic experiences I had at Colorado College, and prepared me well for independent studies, where I was expected to complete data analysis and interpretation without the framework of a class.

As a junior (2008), I participated in a research cruise through Woods Hole Oceanographic Institution (WHOI) aboard the R/V Atlantis that provided the data for an in-depth project completed back in Colorado. I spent a month aboard ship with Dr. Jeffery Seewald (WHOI) and Dr. Giora Proskurowski (WHOI, now UW) as a member of the hydrothermal vent fluid chemistry team. My role included processing of H_2S samples in the on-board lab, cleaning and maintaining the Isobaric Gas-tight Samplers used for collecting vent fluids, and assisting in gas analysis using gas chromatographs. In addition to my duties in lab, this cruise was my first exposure to large scale, multi-disciplinary international research projects involving career scientists pioneering their field. There were 2-3 lectures a week given by P.I.'s and researchers from each of the five or six research groups on board, which included teams from several U.S. institutions, Austria, and Mexico. This resulted in exposure to a variety of complimentary and different fields, including deep-sea vent microbiology, macro-biology, and geochemistry. I credit the immersive experience I had aboard the Atlantis and exposure to scientific research at the forefront of its respective field with my desire to continue my career as a scientist and educator.

I travelled to WHOI in January 2009 as a Guest Student to complete post-cruise analysis of hydrocarbon samples collected on the cruise. With these data, as well as the other parameters measured, I completed an independent project under the advisement of Dr. Henry Fricke (Colorado College) analyzing vent fluid chemistries and placed them in the context of previous findings at the same vent sites. This project was presented to the geology department at Colorado College, and I visited my high school to give a presentation to the Marine Biology class about the cruise.

As a senior in college (2009), I participated in another research cruise with Dr. Douglas Wiens from Washington University, St. Louis, aboard the R/V Revelle. We deployed 56 Ocean Bottom Seismometers (OBS) in the Lau Basin between Tonga and Fiji, as well as to filled gaps in the existing high-resolution bathymetry dataset for the region. My role was as the leader of a scientific watch, which included monitoring the peripheral scientific equipment in the lab and helping to coordinate and monitor deployments. As a direct result of my role as watch leader, working with government scientists from Fiji, Tonga, and collaborating teams from China and Japan, I learned the importance of building and maintaining strong international relationships based on improving scientific understanding and dissemination of findings

I completed a senior project at Colorado College, advised by Dr. Christine Siddoway (Colorado College), addressing the question of non-transform ridge offset in the Lau Basin. Using modern high-resolution multi-beam sonar bathymetry (to which we contributed aboard the R/V Revelle) and up-to-date earthquake focal solutions from the Harvard database, I re-considered the findings of Wetzel et al. (1993). I had to teach myself to use Generic Mapping Tools (GMT) to manipulate data, build a relationship with Dr. Fernando Martinez (SOEST, UH at Manoa) who maintained the data set, and develop observational skills critical to effectively address the variations in ridge morphology in the Lau basin.. I presented the results of my research to the Colorado College community as a poster as well as a slide-show talk on two occasions. My experience adapting to new data manipulation tools, building relationships with scientists at other universities, and publicly presenting research will be critical as I move into my graduate research and face the challenge of working and presenting internationally and analyzing large and complex data sets.

After graduating from Colorado College, I took a job as Assistant Scientist for Sea Education Association (SEA), a college study abroad program that focuses on oceanography, nautical science, and building leadership skills. My time at SEA was extremely fulfilling and exciting; it allowed me to use my experience gained as an undergraduate to teach college students research methods and model leadership in a dynamic and highly demanding environment. In addition to ship duties, SEA students also attended class daily aboard ship where they would hear lectures on marine science, nautical science, or give presentations. As a part of my role as Assistant Scientist, I gave several lectures on marine geology, a skill I will continue to develop as a scientist.

In addition to working for SEA after graduation, I also took a seasonal job as a wilderness trip leader at the Chewonki Foundation leading whitewater kayaking trips. Whitewater kayaking had been a major recreational activity in my life since high school, however, the transition to being an instructor ultimately resulted in a major shift in my interests and life goals, as well as contributing to my passion for education. I began to think of river environments not just in the context of beautiful places to kayak, but as geomorphically complex and societally crucial. This initial scientific wonder ultimately led me to my current position, working with Dr. Paul Bierman (UVM) and Dr. Amanda Schmidt (Oberlin), poised to begin exciting new research at the graduate level on river systems in southwestern China.

Wetzel, L. R., Wiens, D. A., and Kleinrock, M. C., 1993, Evidence from earthquakes for bookshelf faulting at large non-transform ridge offsets: Nature, v. 362, p. 235-237.

Proposed Research

My research will address the connection between land-use and erosion in Chinese river basins. Specifically, I will use a new combination of isotopic analyses, an unusually long and complete sediment yield record (up to 27 yrs), and remotely sensed land-use data in order to characterize erosion in three watersheds in southwestern China and determine if a relationship exists between land-use and the intensity and spatial distribution of erosion. I am working as apart of a larger NSF funded project, *Deciphering connections among land management, soil erosion, and sediment yield in large river basins*, with Dr. Amanda Schmidt, P.I. (Oberlin), Dr. Paul Bierman (UVM and advisor), and Dr. Dylan Rood, 3rd P.I. (University of Glasgow).

Introduction and Hypothesis

As the world population increases, humans exploit available natural resources. In mountainous southwestern China, this means agriculture expanding into steeper terrain, and rural areas urbanizing. As land-use changes, so do erosion rates and processes, which impacts headwaters as well as the downstream reaches (Citation). This has implications not only for stream behavior, but also for communities that rely on the river for food and water. Determining the erosional processes associated with different types of land-use is important for resource managers and stakeholders to inform assessment and implementation of land management policy. The characterization of the relationship between land-use and erosion is equally as important within the hydrologic sciences, as it will help unravel complex controls on erosion, leading to better models, and more complete understanding of basin dynamics.

The research addresses erosion by employing a new combination of analytical techniques. *Meteoric* ^{10}Be, in situ ^{10}Be, ^{137}Cs, and ^{210}Pb are all established proxies for determining basin-scale erosion properties (Bierman and Steig, 1996; Brown et al., 1995; Brown et al., 1988; Granger et al., 1996; Olley et al., 1993; Whiting et al., 2001). No study, has considered these isotopic systems in conjunction with each other. The power of this approach comes from the established relationship of each isotopic signature and indicative erosional property. I hypothesize that I will be able to synthesize the implications of individual isotopic measurements to pinpoint a specific dominating erosional process and that I will see a quantifiable relationship between spatial distribution and intensity of erosion and land-use within a catchment

Methods

We have selected three moderate sized basins (<10^3 km^2) to analyze: one relatively pristine, one heavily disturbed by human activity, and one experiencing dramatic climate change over the past 25 years (MAT increase of 10°C/100yrs; Haynes (2010)) Each basin will be broken into sub-basins greater than several km^2. This will allow us to collect samples above and below each stream confluence and thus determine erosional characteristics for each sub-basin. The outlet point for each basin is defined by the location of a government sediment gauging station providing daily measurements of sediment yield data. Each sample collected will be analyzed for ways:

- **In situ ^{10}Be**, produced at a known rate within several meters of the earth's surface, its concentration in quartz will be used as a proxy for long-term basin-scale erosion rates (10^3-10^6 yrs) (Bierman and Steig, 1996; Brown et al., 1995; Granger et al., 1996). In situ ^{10}Be will also be used a sediment tracer when concentrations between sub-basins are substantially different.
- ***Meteoric* ^{10}Be** is produced in the atmosphere, and falls to the earth's surface through dry-fall or precipitation, coating sediment and accumulating in soil A- and B-horizons (Valette-Silver et al., 1986). *Meteoric* ^{10}Be concentrations provide basin-scale rates of soil loss, and can be used as a tracer in a similar manner to in situ ^{10}Be (Reusser and Bierman, 2007)
- **^{137}Cs and ^{210}Pb** are short-lived radionuclides that accumulate on the earth's surface through dry-fall and precipitation, concentrating in the top few decimeters of soil (Kaste et al., 2007; Walling and Woodward, 1992). Sediment derived from deeper than the zone of accumulation is devoid of any ^{137}Cs and ^{210}Pb, thereby indicating the depth of erosion.

Each of these isotopic concentrations is individually useful, however, when combined they create a powerful matrix that has the potential to constrain the type of erosion taking place through differing depth and concentration relationships (Table 1).

Table 1: Expected isotopic fingerprint for different catchment sediment sources (from proposal)

	Shallow Surface Erosion	Deep Landsliding	Rills/Shallow Gullies	Bank failure of Holocene river terraces
In situ ^{10}Be	Unchanged (homogenized soil)	Low (parent material)	Unchanged (homogenized soil)	Unchanged (homogenized soil)
Meteoric ^{10}Be	High (A-horizon)	Low (parent material)	High (A-horizon)	Unchanged (homogenized soil)
^{137}Cs *and* ^{210}Pb	High (A-horizon)	Low (parent material)	Low (parent material)	Low (parent material)

When combined with sediment yield and land-use data the isotopic fingerprinting will allow me to relate the type of erosion occurring in a sub-basin to the type of land-use, as well as characterize the sediment budget: is sediment being stored in hill slopes, colluvial wedges, etc., or being transported out of the basin?

Dissemination

I will disseminate the results of my research through presentations at geologic conferences and publications in scientific journals. Preliminary results from previously collected samples in the region will be presented at the Roof of the World joint GSC and GSA meeting June 17-19, 2013 in Chengdu China, and I will present preliminary results from samples collected in May-June 2013 at GSA and AGU meetings the following year. I will publish results from my research in appropriate scientific journals.

Connections to past research and future goals

My proposed research is both new to me and familiar. My extensive previous research experience and training allows me to comfortably undertake a study of this magnitude and complexity. I am excited to begin research in a field that I find fascinating in a region that is completely new to me, using advanced lab techniques and a new method of watershed analysis. I hope to continue my work in the field of fluvial geomorphology as I move on to a PhD, maintaining my focus on disentangling human impact from natural processes.

Broader Impacts

My research will benefit the scientific community in two distinct ways: I am applying a new method of basin-scale analysis that will allow for better understanding of spatial distribution of erosional processes, and I am attempting to shed light on an important question in hydrologic science: how do humans impact erosion?

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