Personal Statement

Motivation

I am interested in studying processes that shape the Earth on a global scale in order to understand how modern or ancient features evolved to their present state. These processes can rarely be studied in isolation; rather, it is crucial to understand the complex interactions that couple all Earth processes into a single system. I hope to use sea-level change, which can be examined globally, as a lens for studying smaller-scale, local processes such as river delta formation or continental shelf exposure. Sea-level plays a key role in shaping these types of geological features, which in turn, through weathering and biological processes, exert a control on ocean and atmospheric chemistry cycles. As a graduate student in the Applied Physics program at Harvard, I will be capable of approaching this research project with unique strengths and a process-based interdisciplinary approach that will enable me to connect fields within Earth Sciences. By working with advisors with expertise in geophysical modeling of sea-level change (Prof. Jerry Mitrovica), geomorphology (Prof. Taylor Perron (MIT)) and geochemistry (Prof. David Johnston), I will be able to move between these research areas to make quantitative predictions on how river delta morphology, shallow ocean chemistry, and local changes in sea level are connected. Through this interdisciplinary project I will hone my communication skills across these fields and gain preparation as a scientific leader.

Background and Research Experience

I became interested in Earth Science problems just before graduating from Princeton with a degree in Chemistry. As president of the materials science society I organized an event that brought together geology and material science engineering students with a trip led by geology faculty. Through this event I met Prof. Adam Maloof, with whom I worked as a field assistant. I participated in a fieldwork project in Nevada for 10 days on a collaborative project with Prof. Susannah Porter, (UCSB) and Prof. Mark Webster (UChicago). Following my return to campus, I was offered a paid position with Prof. Maloof to complete necessary fieldwork over the summer in northeastern England.

These field experiences were my first exposures to geology. Although I had never taken a formal geology course, my background in chemistry and material science prepared me to understand rock formation chemistry and mechanical transformations with facility. The focus of my field project was to use stratigraphy and stable isotopes of carbon and oxygen to reconstruct the paleoenvironment of the tropics during the mid-Carboniferous ($\sim$330 million years ago) in order to examine far-field response to ice age cycles. The goal of the project was to use information based on stratigraphy and isotope curves to improve our understanding of the timing of ice ages and ocean chemistry cycles during this geological period. Our stratigraphic observations relied on our ability to discern small-scale structures in order to deduce possible depositional environments. Considering rock formation environments, such as oxic or anoxic waters or specific conditions of stress, greatly appealed to my material science background. Prof. Maloof trained me and one other student for 5 days in the field, after which the two of us spent five additional weeks working as a team on the project, developing research goals and conducting literature surveys while measuring and recording stratigraphy and taking samples in the field.

My background in chemistry and material science granted me unique insight into this project. On the field, I found an exciting natural experiment where I could physically see the consequences of the many analytical tools I learned during my undergraduate degree. In the field I could see diffusion-limited crystallization processes occur in Liesegang iron rings, or localized stress-induced dissolution in stylolites. Every topic covered in material science had its own hands-on analogue out in the field. My chemistry background also facilitated my understanding of seawater chemistry cycles and pH environmental control on precipitates and reactions.

My research experiences as an undergraduate prepared me to set research goals and achieve them. The summer following my first year I received an NSF-REU fellowship to work on a project in Prof. Holger Schmidt's Applied Optics group, selecting and optimizing a coating for a lab-on-a-chip device that detects virus DNA using ARROW (anti-resonant reflective optical waveguide) technology. In addition I was trained on using the SEM and performing electon-beam lithography. The following summer I returned to Prof. Schmidts group to continue the development of the ARROW chip by adding a functional layer to achieve sample processing prior to entering ARROW channels. Simultaneously I worked on an independent programming bioinformatics project, which served to advance the ARROW chip by automating selection of the molecular probes used in virus DNA detection.

I also spent a semester abroad in Paris where I joined Prof. Yong Chen's microfluidics laboratory at L'Ecole Normale Superieure. In this time, I jump-started a collaborative project involving both academia and industry to design a biomimetic collagen scaffold using electrospinning techniques for stem-cell therapy to treat myocardiac infarction. With no designated mentor, I outlined my own project and prioritized and executed experimental goals. Independently, I mastered the machines and tools necessary for my research. My progress led to secondary stages of development involving collaborators to perform in-vivo tests.

My international experience in research demonstrated the role of language and culture both as a conduit and barrier to science. Besides having to learn a new vocabulary within French to express scientific principles, I witnessed the challenges that non-native English speakers face navigating an English-dominated scientific community. My activities have shown me that, besides research habits, an essential component of science is communication, through publication and presentation. Growing up bilingual in Spanish and studying French since the age of 10, I was accustomed to dealing with limitations of language structure. Scientific culture, however, transcends linguistic barriers while simultaneously being strictly confined by its lexicon and social codes. Ultimately my international experience in research taught me to interact in a collaborative environment and overcome cultural boundaries in order to achieve project goals.

At Princeton I completed a yearlong senior thesis in Prof. Howard Stone's Complex Fluids group, where I developed a novel structure system of microfiber encapsulated double-emulsion droplets. The lab work, data processing, and writing process gave me invaluable experience in developing a longer-term research project, executing experimental goals, and consolidating my findings into written form. Through close mentorship with two post-doctoral fellows, I learned how an ambitious research project with multiple experimental stages could be divided into smaller achievable parts. One of my mentors and I presented our research in the microfluidics symposium at the Materials Research Society Spring 2014 conference. We filed our innovation with the U.S. patent office, and our patent protection is currently pending. Moreover, our paper on the novel droplet-in-microfiber system was recently published in Materials Chemistry B.

Future Goals: Academic and Outreach

Through close collaboration between professors within different disciplines of Earth Science, I hope to bring a fully interdisciplinary approach to a number of open scientific questions at the interface between geology, geomorphology and geophysics. Specifically I aim to understand delta morphology development and geochemical cycle shifts using state-of-the-art sea-level models in order to quantify how local changes feedback into a global system. In addition to forming connections between research fields to answer pressing questions, I also hope to connect people inside and outside the academic realm.

As an undergraduate at Princeton, I was heavily involved as a leader in mentoring and outreach. I was elected president of the national Materials Research Society student chapter and was in charge of directing all chapter activity. I served as a peer tutor in organic chemistry and multi-variable calculus, and was chosen as a Peer Academic Advisor, in charge of mentoring a group of freshmen in academic decisions. Outside of my academic involvement at Princeton, I volunteered for the Petey Greene Prisoner Assistance Program, where I tutored inmates every week to prepare for the GED. Back home, my Hispanic background and subsequent knowledge of Spanish inspired me to tutor ESL students in high school. Throughout the school year and summers in high school, I worked at the local Immigration Center in the agricultural town of Watsonville, assisting clients in filling out paperwork and translating documents.

During my first semester at Harvard I have continued my commitment to mentoring and outreach as a non-residential tutor in the undergraduate houses and a mentor for undergraduate women in science. I have planned events with invited guest speakers for the Harvard Graduate Women in Science and Engineering Society. I continue to volunteer weekly at the women's prison in Framingham, tutoring inmates in math for high school equivalency exams. The community work I've undertaken has helped underrepresented and disadvantaged groups gain opportunity and encouragement. I believe research's impact is strongest when felt by the larger community, and my dedication to outreach is deeply rooted in my commitment as a scientific researcher.