Making Tracks: Carrick Eggleston

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In the “Making Tracks” series, RCC fellows and alumni present their experiences in environmental humanities, retracing the paths that led them to the Rachel Carson Center. For more information, please click **here**.

“From Atoms to Energy Transitions”

By **Carrick Eggleston**

Scientists can really only deal with very simple things. They are squeamish about uncontrolled variables. As a scientist and an RCC fellow, I am in unfamiliar territory. Environmental history and humanities? I don’t speak the language! With the help of the stimulating and dynamic intellectual environment at RCC, I am learning. There is a kind of wall that scientists place between their work and “society,” “policy measures,” and “value judgments.” It is difficult and professionally risky to cross that wall—but there is, I think, a growing need to jump back and forth across such walls in order to address climate change and energy transitions.

Climate change and energy transitions are regional and global in scale. My research has mostly been at the opposite end of the size scale, dealing with atomic structures. In college in New England in the early 1980s, acid rain was a major regional environmental concern. I became interested in the effects of acid rain on stream water geochemistry, which led to the study of mineral weathering, which led to the atomic-scale study of the mineral surfaces where the weathering takes place. My journey to the RCC is an outcome of following threads at the atomic scale, only to find them woven into a much larger fabric that can only be studied at a very different scale.

In the late 1980s, as a PhD student at Stanford, I worked with scanning tunneling microscopy (STM), the technique that made possible the imaging of atoms. Figure 1 is an STM image of atoms at the surface of the iron oxide mineral hematite. The regularly repeating pattern of atoms can be seen in the underlying crystal structure along with

nonperiodic “bumps” and apparent depressions scattered around the crystal surface. There is a “step” where several layers of atoms end so that the surface steps down to the right. The macroscopic chemical behavior of such a mineral depends on all of their mutual effects upon each other—an interactive system of atomic identities and structures.

I see more than static bumps and patterns in figure 1. The light and darker spots aren’t just atoms—they’re places where the electric current from the surface is higher or lower, making reactions happen faster or slower. I see a million little processes that add up to a tangible result. I see the ability of the surface to perform environmental jobs, like having contaminants “stick” and be chemically transformed in the process, or to act as an “electron dump” for soil bacteria for the same reason we must breathe oxygen. These were the applications of my work, from aspects of nuclear waste storage to carbon sequestration, to microbial metabolism using minerals.

One of the jobs hematite can do has made it a popular research subject in the solar energy community: it is the least expensive semiconducting material that can absorb the energy of visible light and use it to split water molecules into hydrogen and oxygen. Scientists seek to use this process in a new solar technology to make fuel, chemically stored energy that you can put in a tank, instead of electricity.

My geochemical work became unexpectedly relevant to solar energy research, leading to a sabbatical in 2005–2006 working in a solar energy lab at **EPFL** (Lausanne) headed by Prof. Michael Grätzel. A few years later, I became a cofounder (with my colleague in the Department of Chemistry, Prof. Bruce Parkinson) of the **Center for Photoconversion and Catalysis** in the School of Energy Resources at Wyoming. In only a few years I went from working on atomic-scale environmental chemistry to codirecting a solar energy research center.

Through the changes in research emphasis, I began teaching a course on Earth System Science and climate change. All of the different ideas from both research and teaching became part of an interdisciplinary mix that rattled around my head and emerged as a series of presentations on solar energy and other renewables technology at the global scale. For me, this scale transition (from the atomic to the global) was also a perspective transition—from the chemical to the sociocultural.

With Fulbright-Nehru Fellowships, **Sarah Strauss** (Professor of Anthropology, University of Wyoming) and I taught and conducted research near Pondicherry

(Puducherry) in Tamil Nadu, India, in 2012 and 2013. On days when I was not teaching students about semiconductors at Pondicherry University or doing research, I volunteered with a solar energy enterprise in Auroville (an intentional community outside of Puducherry with a strong set of sustainability ideals and practices), helping people understand and repair their photovoltaic systems. The Auroville area is a unique laboratory for studying all kinds of energy and resource management systems in practical detail, and at a manageable scale.

In Auroville, and elsewhere on our travels in south India, we witnessed energy transition in action, from biogas systems to photovoltaics, from electric scooters to wind power, from solar hot water to electricity policy, from architecture to waste management, from inverters to refrigerator technology. It was impossible to place a wall between the renewable energy science in the laboratory and the people living their lives amid the technology in practice just outside the building.

The nature and scale of changes in energy sources, characteristics, policies, and infrastructures that come with energy transition vary greatly from place to place, country to country, culture to culture. Limiting climate change by means of renewable energy development requires managing complex technology-culture interactions as reflected in individual choices and aspirations, shifting incentives and policies, and changing infrastructures.

So, here we are at the RCC, exploring culturally appropriate approaches to energy and the closely connected problems of water, food, forest, and climate change through dynamic models and engaging narratives—stories that can capture interest in fostering awareness of everyday choices that lead to a lower-carbon future.