Princeton University

Honors Faculty Members
Receiving Emeritus Status

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Lincoln Steffens Hollister

Throughout his career, Lincoln Hollister studied the largest metamorphic complex in the world, the Coast Mountains of western British Columbia, Canada, and of southeast Alaska. His work laid the foundation of his search for a unified theory for the formation of continental crust. For 45 years, Lincoln and his students shared the tremendous ice-carved rock exposure of mid- to lower-crustal rocks in the Coast Mountains with wolves, wolverines, bears, eagles, ravens, mountain goats, and with very few other geologists. He and his colleagues and students determined thermal and structural implications of accretion of crustal fragments to the North American continent.

At the beginning of his career, the overwhelming consensus amongst petrologists was that most metamorphic minerals were homogeneous, a necessary condition for thermodynamic equilibrium. However, using one of the first electron microprobes available to geologists, Lincoln showed that many metamorphic minerals are compositionally zoned, due to processes occurring during mineral formation. His work showing that two or more compositions of the same mineral can grow at the same pressure-temperature conditions similarly challenged the then conventional application of chemical equilibrium principles to geology. Lincoln applied these findings from Earth minerals to understanding lunar processes, using some of the first rocks retrieved from the moon. He showed that the pyroxene phenocrysts in the mare basalts had grown rapidly after the lavas had poured out onto the surface of the moon, rather than growing at high pressures in the lunar interior.

Field work always has been essential to Lincoln's research, and he was among the first to use lightweight jet-powered helicopters to access study sites on remote mountain ridges, where he and colleagues worked from base camps for two to six weeks at a time. These expeditions allowed the direct exploration of Earth forms and processes for both research and teaching purposes. They also provided innumerable adventures, that are probably best related in person, but which proved life changing for Lincoln, his students, and his colleagues.

Another major focus of Lincoln's research was the origin and geological implications of fluid inclusions in rocks. After several years of study of fluid inclusions, he and colleagues concluded that carbon dioxide fluid inclusions were the result of metamorphic processes hitherto unrecognized, but which led toward an understanding of processes of continental crust formation. By correlating fluid inclusion properties with rock texture, Lincoln and colleagues showed that metamorphic rocks, while they were still hot, were commonly brought close to the surface. The story read from the fluid inclusions, combined with the story preserved in the metamorphic mineral assemblages, led to the general observation that most crystalline belts are brought to the surface sufficiently fast that temperatures as high as 400° C can occur at depths of only five to 10 kilometers.

In the 1980's Hollister participated in two major seismic survey projects in Alaska and Italy, and applied what he learned there to development of the ACCRETE project in 1993, arguably the biggest scientific accomplishment of Hollister's career. He reasoned that improved seismic images of western North America would be accomplished in British Columbia by using airguns towed behind a ship that could fire thousands of pulses at a known location and time, with the pulses being recorded by hundreds of closely spaced portable seismometers placed along the shores of the fjords and into the continental interior. The flagship experiment of ACCRETE was a combined offshore/onshore seismic study that provided an unprecedented image of the top 50 kilometers of the Earth's crust and mantle for a 500-by-300-km area straddling the Alaska-British Columbia border. By 2006, Lincoln, working with his former student Chris Andronicos, brought the final results together in a paper that proposes a unified theory for the formation of continental crust.

In starting ACCRETE, Lincoln gained the support of local residents who had at first worried that the project might be environmentally threatening through the use of airguns in inland waterways where fishing is the basis of the local economy. He found, however, that the local residents were very receptive to learning what was to be done and how and why. Understanding led to reduced fear, and ACCRETE gained the permissions to proceed from government agencies, community groups, and native tribes. The lengthy negotiations with leaders of several tribal councils to carry on research on their lands led to subsequent cooperative educational outreach projects with the tribes and with other community groups and schools in the region. Later, at a tribal council meeting, Lincoln presented the Nisga'a Nation a Princeton University NCAA trophy basketball, signed by the coaches of back-to-back Ivy League championship teams.

In 1987 Lincoln and his wife, Sarah, joined a six-week expedition organized by his now-late brother, Charlie, which traversed on foot along and across the Himalayas of Bhutan. This exhibition marked the beginning of a research program based in Bhutan that continues to the present. These expeditions led to the discovery of the process by which hot rock is rapidly expelled from between rigid, converging plates, and marked a major step toward his goal of formulating a unified theory of how continents form.

Lincoln thoroughly enjoyed teaching about rocks and minerals. He built his courses around natural occurrences, and he expanded the range of field experiences for his students to include many areas of the West; he also took classes to British Columbia and to Brittany, France. His favorite area for field trips was northern New Mexico, which is rich in occurrences of spectacular metamorphic and igneous rocks. The students collected samples to bring back to Princeton to use as a basis for class projects, and they learned mineralogy and petrology as they worked on the samples they had collected. One of his most important legacies, beyond his contributions to our understanding of the Earth, is his impact on both graduate and undergraduate students, exciting their interest in the subject and inspiring their own careers and accomplishments.

Innovation in methods marked Lincoln's career, as his tools of research continuously evolved—he was one of the first to apply the electron microprobe to the study of chemical zoning in rock-forming minerals, was one of the first to use jet-powered helicopters to reach previously inaccessible regions of mountain belts, introduced the study of fluid inclusions in metamorphic rocks to petrologists in North America, and was the first to use a seismic ship for studying metamorphic geology. He also greatly benefited from the Apollo rockets that carried his “field assistants” to the moon to bring back rocks formed during the first quarter of the history of the solar system.