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Presentation of the 2017 Roebling Medal of the Mineralogical Society of America to Edward Stolper

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The Roebling Medal recognizes outstanding research in mineral sciences, and this year's medalist—Edward Stolper—conducts experiments that are arguably the most original and innovative of this generation. His interpretations and insights often upend current thinking and, in the process, turn misconceptions and nonsense into solid gold.

Ed's early research, conducted when he was a student, focused on extraterrestrial materials. As an undergraduate, he analyzed the chemistry of lunar green glasses returned by Apollo astronauts. For his Master's thesis at Edinburg, he determined that eucrites—basalts from asteroid Vesta—cluster near the olivine-pyroxene-plagioclase peritectic, suggesting an origin by partial melting rather than fractional crystallization. As a Harvard doctoral student, his insight prompted the first recognition that shergottite meteorites are martian basalts, and his experiments defined the nature of the Mars mantle source region. These seminal papers, now nearly four decades old, are still referenced as state-of-the-art insights into planetary magmatism.

While still a student, Ed recognized that basaltic liquid is more compressible than minerals, implying that melts formed at great depth might not ascend buoyantly. Later, as a professor at Caltech, he helped apply shock wave methods to melts, to extend knowledge of silicate liquid densities to greater depths and to confirm the likelihood of primitive magmas formed at great depth descending rather than ascending. In other work related to the density of magmatic liquids, he recognized that olivine fractionation at low pressure reduces the density of basaltic liquid, whereas plagioclase and pyroxene fractionation does the opposite. His keen insight was that a density minimum occurs during low-pressure fractionation of basaltic melts, allowing some magmas to pass through the crustal filter, and that density minimum corresponds to the composition of mid-ocean ridge basalts.

Ed may be best known for his pioneering experiments defining the behavior of volatiles in silicate melts and glasses. He calibrated and used infrared spectra to determine the speciation and concentration of H_2O and CO_2, and he developed a model for interpreting the behavior of noble gases in magmas. Ed also expanded the interpretive value of the isotopic ratios of hydrogen, oxygen, and carbon in magmas and showed how various degassing scenarios affect these isotopes. Degassing models that allow us to determine initial volatile abundances, to estimate volcanic explosive potential, and to define global degassing budgets are all traceable to this work.

Ed's research also applied thermodynamic models to the melting of peridotite and pyroxenite. His unconventional thinking is illustrated by the recognition that mantle materials undergoing adiabatic decompression can be best modeled using a pressure–entropy diagram, rather than the more conventional temperature–free energy diagram.

Other major contributions that I don't have time to talk about include:

- Conducting experiments to constrain the formation of refractory inclusions, the first-formed solids in the solar system;
- Leading the Hawaii Scientific Deep Drilling Project, which revealed the stratigraphy of a mantle plume;
- Developing a method to measure phosphorus zoning in olivine, which has found wide application in understanding crystal growth kinetics.

From this brief listing of spectacular accomplishments, you can see that much of what we currently understand about melting of the Earth's mantle, the roles of pressure and volatiles in magmas, and the nature of planetary magmatism can be traced to the research in Ed's laboratory. And for the past two decades, this work was done while Ed has shouldered major administrative responsibilities at Caltech, which would have derailed the research programs of mere mortals. His has been a career of extraordinary breadth and depth, in the true spirit of the Roebling Medal.

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