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Presentation of the Dana Medal of the Mineralogical Society of America for 2022 to Cin-Ty Lee

Roberta L. Rudnick[1,*] and Fang-Zhen Teng[2,*]

[1]Department of Earth Science and Earth Research Institute, University of California at Santa Barbara, Santa Barbara, California 93106-9630, U.S.A.
[2]Department of Earth and Space Sciences, University of Washington, Seattle, Washington 98195-1310, U.S.A.

If there is a Renaissance "human" in geology, it is Cin-Ty Lee. We are continually awed by his curiosity, breadth, knowledge, and ability to synthesize information in order to provide novel insights into Earth's workings. I (Roberta) had the privilege to mentor Cin-Ty when he was a graduate student at Harvard, and it was abundantly clear from the outset that he was a force to be reckoned with.

From the beginning, Cin-Ty demonstrated two traits that have become hallmarks of his approach to doing science. The first is a nearly insatiable thirst for understanding, which propels him to read intensively, think hard about problems, and interact with a much broader scientific community than is typical for most scientists, young or old. The second is an innate creativity that allows him to "think outside the box" and approach solutions to problems in innovative ways, often combining field geology, petrology, geochemistry, geophysics, and modeling to gain a holistic view of how Earth works.

We must state by way of disclaimer, though, that summarizing the major contributions of Cin-Ty Lee is a daunting task and would take much more than the time allotted here. So, we've chosen to highlight just a few of his contributions that are our personal favorites.

During his Ph.D. he investigated the composition, structure, and age of lithospheric mantle in several regions (Tanzania, SW U.S., Sierra Nevada). Using a combination of petrology, geochemistry, and Os isotopes, which he helped co-develop at Harvard with Qingzhu Yin, he demonstrated that mantle lithosphere was lost beneath the Sierra Nevada following the Mesozoic arc magmatism. By contrast, very ancient lithosphere is preserved below the Colorado Plateau and Death Valley, despite the fact that the mantle in these two regions is compositionally very different. He hypothesized that these compositional differences led to the relative stability of the Colorado Plateau and the instability of the Death Valley lithosphere. These studies resulted in first-authored papers in *Science* and *Nature*; pretty good for a Ph.D. student! Subsequently, he went on to unravel the effects of composition from those of temperature on the seismic wave velocity of mantle peridotite in a sole-authored paper in *Journal of Geophysical Research*. This was a major step forward in understanding the peridotitic portion of continents and has been widely used within both the geophysical and geochemical communities. Cin-Ty is now widely regarded as a world authority on lithospheric mantle formation, as reflected in his well-cited paper in *Annual Review of Earth and Planetary Science*.

But Cin-Ty's reach goes far beyond mantle lithosphere. He has spent a good portion of his career delving into the idiosyncrasies of igneous processes writ large. He developed a widely used thermobarometer based on Si and Mg concentrations in basalts to determine the pressures and temperature of their formation on Earth and other planets. This paper produced an incredibly useful tool for studying planetary magmatism and evolution and is his most highly cited.

Much of Cin-Ty's work on igneous systems has centered on subduction zone magmatism, particularly continental arcs, which are one of the important building sites of continental crust. He has used the Mesozoic North American margin (Sierra Nevada and Peninsular Ranges batholiths) as a natural laboratory to deduce crust formation processes and has published many influential papers on these areas. More generally, Lee and Bachmann (2009, EPSL) used the behavior of Zr and P in igneous rocks, both elements whose concentrations are controlled by common accessory phases (zircon and apatite), to determine the origin of andesites. They showed that andesites are mainly produced by crystal fractionation, with hydrous mantle melting and mixing between basalt and rhyolite being much less important. It's a simple yet powerful observation. Finally, another major contribution within this realm is his insight regarding the oxidation state of convergent margin magmas and the consequences for the distribution of economically important metals such as copper. This is an area of very active debate, but Cin-Ty and his collaborators have shown that the copper concentrations in primary arc basalts and mid-ocean ridge basalts are identical, yet the copper concentrations of more evolved magmas in arcs are very low—reflecting copper removal by sulfide fractionation and sequestration within the deep crust of arcs. This is important on several fronts: it suggests that arc magmas are reduced enough to saturate sulfide and, because the continental crust is also Cu-depleted, that sulfide-rich cumulates must have formed during continental differentiation. Later, with post-doc Ming Tang, he suggested these cumulates are a crucial step in the formation of porphyry copper deposits, providing the Cu as the sulfides are oxidized to sulfates due to magmatic garnet fractionation in thick regions of continental arcs, thereby explaining the correlation between the thickest crust and the presence of porphyry coppers in places like the Andes.

OK, that's just a brief summary of some of Cin-Ty's contributions. Left out are his studies of continental weathering and its influence on continental crust composition, his work linking continental evolution with the rise of atmospheric oxygen, the application of lattice strain theory to understanding element partitioning, and his work on how continents and arcs influence the carbon cycle. All major, thought-provoking, and science-stimulating contributions. To summarize Cin-Ty's influence—he makes us think!

But this citation would not be complete if we didn't mention Cin-Ty's broader contributions to science. This involves his effective mentoring of younger scientists—undergraduates and graduate students—one of whom, Mark Little, is now the President of GSA!—and post-docs; his large positive impact on the Department at Rice University, where he has spent most of his professional career helping to build a top-ranked program that celebrates diversity in all its forms; and his contributions to the art and science of birds!

Mineralogists: I give you the 2022 Dana Medalist, Cin-Ty Lee.

* E-mail: rudnick@geol.ucsb.edu and fteng@u.washington.edu

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