

Presentation of the Mineralogical Society of America Award for 2016 to Anat Shahar

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I am privileged and honored to introduce the 2016 MSA award recipient, Dr. Anat Shahar. This award recognizes outstanding published contributions to the science of mineralogy by relatively young individual or individuals near the beginning of their professional careers. In Anat's case, she is being recognized at an early age for helping to establish a new field. The field I shall refer to as planetary stable isotope geochemistry. At its essence, stable isotope geochemistry of high-temperature materials is about crystal chemistry of the materials of interest, and so it is appropriate that the advances in this area should be recognized by the MSA.

Anat's first foray into this new field came in the beginning of her graduate career in which she found herself recruited to join our effort to characterize the iron isotope effects of an applied voltage. This first work on iron isotopes and unconventional driving forces for isotope fractionation kindled something in Anat's thinking.

Anat has since focused her research on the use of high-pressure/high-temperature experiments to explore the fractionation of stable isotopes between phases relevant to the differentiation of rocky planets and high-temperature geochemistry in general. She has been a leader in the development of this new field and, by her example, has helped establish a new application for stable isotope fractionation. The titles of papers authored or coauthored by Anat defining this field include: "Non-chondritic iron isotope ratios in planetary mantles," "Equilibrium fractionation of non-traditional stable isotopes: an experimental approach," "Pressure-dependent isotopic composition of iron alloys," "Stable isotope evidence for the differentiation of planetesimals," "Experimentally determined sulfur isotope fractionation between metal and silicate and implications for planetary differentiation," "The accretion and differentiation of Earth under oxidizing conditions," "An experimental geochemistry perspective on Earth's core formation," and "Sulfur-controlled iron isotope fractionation experiments of core formation in planetary bodies." These titles represent just the last two years (2015–2016)!

The titles of these most recent papers evidence Anat's stubborn insistence dating back to her graduate student days that she wanted to combine stable isotopes with high-pressure research, as she was certain that this was an underdeveloped area. The first step was her set of experiments on iron isotope fractionation performed at modest pressures in our labs at UCLA. One has to recall the context to truly appreciate the importance of this contribution. Multiple collector inductively coupled plasma-source mass spectrometry ushered in the era of measuring Mg isotope ratios, Fe isotope ratios, Si isotope ratios, Cu isotope ratios, Zn isotope ratios, etc., in all manner of geological materials, but there were almost no experimentally determined fractionation factors applicable to high-temperature minerals. What is more,

the magnitudes of fractionations at high temperatures in these new systems were debated. Her first Ph.D. product at UCLA, the paper by Shahar et al. in *EPSL* in 2008, on equilibrium Fe isotope exchange between magnetite and fayalite, was the first to extend the three-isotope exchange method developed earlier at the University of Chicago to inter-mineral fractionation experiments. It sets a standard for subsequent studies in the field.

But it was the prospect of using stable isotopes as monitors of planetary scale events that really caught Anat's imagination. With all due respect to my theory-based colleagues, the resulting papers on silicon isotope fractionation between silicate and metal placed what was largely speculation about isotope fractionation between metal and silicate during core formation on a solid experimental footing. These papers include Shahar et al. 2009, in *EPSL* and Shahar et al. 2011 in *GCA*.

Most recently, Anat has investigated the effects of metal chemistry on Fe isotope partitioning, with potentially profound implications for our understanding of planetary cores. Her paper published in *Science* this year describes experimentally determined effects of light alloying elements on iron isotope fractionation between silicate and iron metal. She and her coauthors use this compositional dependency to constrain the identity of the light elements in Earth's core.

Anat is a gifted experimentalist. She is able to execute difficult experiments deftly. Add to this her keen eye for attacking important problems and one arrives at the formula for her success. Her work using nuclear-resonant inelastic X-ray scattering, NRIXS, to estimate Fe isotope fractionation factors is a signpost for her future work and emblematic of her fearlessness in acquiring new skills. She has embraced a quantitative predictive approach that she can employ at high pressures. Here again, she brings her own particular brand to the endeavor by pairing up with colleagues to do the work at high pressures. She is well on the way to establishing stable isotopes as a viable tool in planet formation and evolution.

The impact that these studies have had in the field is evident at international meetings where others are now presenting results parroting the methods used in the studies cited above.

I wish to add that Anat is an extraordinary colleague. She is smart, affable, positive, and insightful. I am pleased to say that she is not only a colleague but also a good friend, and I know many others who have worked with her feel the same way. It is no fluke that her colleagues at the Geophysical Laboratory quickly recognized her value as a scientist and as a human being and moved rapidly to elevate her from postdoctoral fellow to staff member.

Such respect for the work of someone so early in a career is deserving of extraordinary recognition, and so I am delighted to present to you the 2016 MSA awardee, Dr. Anat Shahar.