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Presentation of the Mineralogical Society of America Award for 2008 to James Badro

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President Heaney, MSA Members, and guests:

It is with great pleasure that I introduce you to the recipient of the Mineralogical Society of America Award for 2008, Jimi Badro.

James Badro started with a physics background (B.S., M.S., Ph.D.) at École Normale Supérieure de Lyon. At that time, Professors Philippe Gillet and Francis Albarède ran a very successful outreach program called "Geophysics and Geochemistry for Physicists," that converted Jimi to a mineral physicist. James wrote a series of papers establishing the theoretical basis for the new expanding field of pressure-induced mineral amorphization, including the prediction of fivefold-coordinated silica intermediate phase and the interpretation of memory glass. He also reported strong-to-fragile transition in silica melts and solubility of argon in silicate melts. He collaborated with our group on a high-pressure, XRD, and X-ray imaging experiment that became a cornerstone in advancing ultrahigh-pressure diamond-anvil technique over three megabars. James was one of the very few scientists who had made outstanding contributions in both theoretical and experimental mineral physics, and he had done these before his Ph.D. degree.

After receiving Ph.D. degree, Jimi was facing the draft to French military service with an option. In the French system, he could go abroad for post-doc study for a couple of years, which could substitute for the National Service. He took that option and came to Geophysical Laboratory, where I guess he had more fun than in the military.

It is not too far fetched to call the search for pressure-induced high-spin to low-spin (magnetic collapse) transition an elusive "holy grail" in mineral physics. Bill Fyfe (MSA Awardee 1964) postulated its existence and advocated for its importance. Roger Burns (MSA Awardee 1975) further amplified the topics of magnetic collapse in his 1970 classic book *Mineralogical Applications of Crystal Field Theory* and provided the sole example of pressure-induced magnetic collapse, i.e., Fe^{2+} in gillespite. This example, however, was later shot down by Bob Hazen (MSA Awardee 1982) in his Ph.D. thesis work on high-pressure X-ray crystallography of gillespite. I actually went to the Geophysical Lab working with Peter Bell mainly to search for the magnetic collapse transition at high pressures. Working later with Yingwei Fei (MSA Awardee 1999), we found many new phases in FeS and FeO systems, but still no magnetic collapse transition in sight. Meanwhile, Ron Cohen (MSA Awardee 1994) predicted magnetic collapse in transition-metal oxides with ab-initio theories.

Focusing on this problem, James Badro worked with Chichang Kao and Jean-Pascal Reuff to develop novel high-pressure applications of high-resolution X-ray emission spectroscopy. With the clinching technique, he published several seminal papers on discoveries of pressure-induced, magnetic collapse transitions in iron sulfide and oxides, on minerals that many others, including myself, had looked unsuccessfully before. He further surprised the world by discovering the magnetic spin collapse of Fe^{2+} in ferropericlase and silicate perovskite that make up more than 50% of the solid Earth. The significance of the discovery goes far beyond the *Science* publications, because iron, the most abundant element in Earth, plays a key role in processes from the crust to the core. The new low-spin Fe^{2+} that he discovered has entirely different properties from the ordinary high-spin Fe^{2+}. As a result, the transition introduces wholesale changes of geochemical (element partitioning, oxidation-reduction, thermochemistry, reactivity, etc.) and geophysical (density, seismic velocity, thermal conductivity, electrical conductivity, magnetism, etc.) paradigms that the rest of the research world has been rushing to comprehend ever since. European Association for Geochemistry awarded James Badro with the 2006 Houtermans Medal. His discovery is considered by many as one of the most fundamental advancement in deep Earth research of this decade, and profoundly affects the current thinking in high-pressure mineralogy.

Mineral physics and experimental geophysics

An ultimate goal of high-pressure experimental geophysics, as defined by Francis Birch in 1952, was to simulate in laboratory the seismic velocities as we detected all way down to the core. Such experiments, however, were very challenging technically, and geophysicists in the past were limited to measurements of densities at high pressures and indirect estimations of velocities. With Guillaume Fiquet (MSA Awardee 2003), James Badro went to the basic physics to study the phonon dispersion that contains the complete information of the seismic velocities. They developed the novel high-resolution, high-pressure, synchrotron, inelastic, X-ray scattering technique to directly measure phonon wave velocities of iron at pressures of the Earth's core and finally fulfilled the half-century long quest. This study has enabled a new field of research and followed by a flurry of theoretical, geophysical and experimental activities around the world, including the phonon studies of Fe and Co with their student Daniele Antonangeli and the single-crystal phonon dispersion study of Mo with collaborator Dan Farber at Lawrence Livermore National Laboratory in the U.S. Recently, James extended the velocity studies of Fe to include the effects of light elements.

The development of geophysics usually started from advancement in physics and later applied to geoscience, but James' high-

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pressure research flows bi-laterally and benefits basic physics and materials chemistry as well. His pioneering development in synchrotron X-ray emission spectroscopy has triggered many follow-up discoveries of pressure-induced high-spin low-spin transition in other 3*d* transition metal oxides. Physicists have extended his high-pressure phonon study to other materials. His development in high-pressure synchrotron technology has led to the discovery of electronic transition in osmium and new high-pressure chemistry of noble metal nitrides.

Considering his major impacts to the multidisciplinary mineralogical science, James Badro richly deserves the recognition by the honor of the Mineralogical Society of America Award. The timely award will enable him to further advance his research to an even higher level and to reach out training other young talents at this most productive and crucial stage of his career. This will be beneficial to our field of mineralogy overall.

Mr. President, ladies and gentleman, I present to you the 2008 MSA Award winner, Jimi Badro. Congratulations.