Planetary Exploration and the Role of In Situ Mass Spectrometry

ABSTRACT

Top-priority science questions drive the course of NASA (and ESA) mission selection, and are defined openly by groups of scientists, engineers and advocates of exploration. As the ambitions of the community evolve, so do the technologies required to address them. For decades, mass spectrometers have served as low-risk, cost-efficient means to explore the inner and outer reaches of the solar system. Legacy analyzers have characterized a range of planetary environments, including the lunar exosphere, the surface of Mars, and the atmospheres of Venus, Mars and outer planets. However, the collection of complicated mass spectra and detection of organic compounds on Mars and Titan, coupled with ground-based measurements of organics observed in meteorites and cometary materials, has underlined the importance of molecular disambiguation in next generation instruments. In response to these demands, next generation mass spectrometers promise: compatibility with chemical separation techniques, such as two-step ionization methods and liquid or gas chromatography; isolation/enrichment of targeted ion signals and intentional fragmentation of precursor (or "parent") molecules; and, intrinsically higher mass resolving powers to distinguish compounds with nearly identical mass-to-charge ratios.

Here, a review is provided on the process by which missions concepts are formulated, and the evolution of mass spectrometry as a versatile analytical tool for probing the chemical compositions of high-priority planetary environments.

BRIEF BIO.

Dr. Arevalo Jr. is a Research Space Scientist at NASA/GSFC with expertise in in situ methods of chemical analysis, particularly: high-resolution magnetic sector, time-of-flight and ion trap mass spectrometry; laser ablation and desorption sample processing; and, electron probe microanalysis (EPMA) of terrestrial and extraterrestrial materials. His scientific research is focused on analyzing geological samples from the Earth and other differentiated objects, and establishing comprehensive models of the chemical compositions of planetary interiors.

He graduated with a BS in Geological Sciences from the University of Florida in 2005, and earned a Ph.D. from the University of Maryland (College Park) in Geology in 2010.