Mass spectrometer for geochemical, geological and mineralogical investigation onboard a Mars lander

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Geochemical, Geological and Mineralogical studies on Mars (hereafter $[GM]^2$) provide us knowledge for understanding formation and evolution of Mars and other planets. Comparison of surface environments, atmospheric compositions, volcanic eruption styles and so on between Mars and the Earth is particularly interesting, and differences between them would explain reason for diversity of planets. However, we have not yet enough information to discuss them. As an advantageous approach for those researches, we propose $[GM]^2$ using a mass spectrometer likely onboard a surface lander of MELOS, a plan of the next Mars mission of Japan. Examination for scientific concepts and instruments has been started recently. The main objectives by the $[GM]^2$ we suggest are (1) to clarify atmospheric evolution, including escape mechanism of planetary atmosphere, based on the isotope measurements of Martian atmospheric noble gases (particularly Ne), (2) to constrain thermal histories of Mars by determining K-Ar ages for some volcanic rocks at geologically key locations, and (3) to characterize surface environment stabilities and changes based on isotope measurements of light elements such as hydrogen and sulfur. Scientific discussion is also presented by Tachibana et al. in this meeting, and current status for instrumentation is reported here.

In order to address the research objectives ((1) - (3) given above), the instrument consisting of a mass spectrometer, a robotics for collecting rock samples and a sample preparation system (an oven and chemical processing lines for separating target gases) is required. For determining the compositions of atmosphere (objective (1)), only the mass spectrometer and a simple chemical processing line are needed. In the case where the payload allowed for $[GM]^2$ instrument is absolutely limited, only objective (1) will be performed without the robotics and the complex chemical processing line. Neon isotope determination is very important in Martian atmospheric sciences. However, since spectrum of $^{20}Ne^{+}$ is interfered by that of $^{40}Ar^{++}$, Ar should be removed from Ne during mass spectrometry. We are examining the way of Ar separation applicable to the system on the Mars mission. On the other hand, if the whole of the instrument can be loaded on the spacecraft, investigation involving analyses for rock samples will be applied and then environmental and chronological studies will be carried out (objectives (2) and (3)). For the case of K-Ar dating, analytical sequences currently we plan are as follows; (i) selecting suitable samples (fresh and high K content) by using a camera and an instrument like LIBS, (ii) collecting rock samples by the robotics, crushing into small grains and separating into two fractions for K and Ar analyses, (iii) determining K for one fraction (possibly with XRF), and (iv) for the other fraction, weighing and determining Ar isotope abundances with the mass spectrometer. Further discussion is necessary to success this project.