Geophysical Research Abstracts, Vol. 8, 05499, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05499
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Architecture options for lander-based science at Europa

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The potential for a global liquid water ocean, and the astrobiological ramifications of such an ocean, make Jupiter's satellite Europa a high priority science destination. The United States' National Research Council document, commonly called the Solar System Exploration Decadal Survey [1], names Europa as the single highest near-term priority destination for its largest class of mission. NASA's pre-project organization for the Jupiter Icy Moons Orbiter (JIMO; now essentially abandoned) convened a Science Definition Team (SDT) that described in detail the science objectives to be treated by a very capable Europa mission. These include a number of objectives that are best addressed, and some that can only be addressed, by a landed platform. Seismometry and detailed astrobiological analyses are examples of such objectives. The SDT considered the landed science objectives of sufficient priority that they allocated one quarter of JIMO's anticipated 1500-kg payload mass to a lander.

An ideal lander would address all of the identified surface science objectives, and could land anywhere on Europa. But such a lander would far outstrip the available resources of a near-term flagship orbiter mission, not wholly due to the large instrument package. Images from the Galileo mission indicate that landing on Europa is more difficult than landing on the relatively smooth and flat regions common on Mars and our Moon. There are multiple lander architecture options for delivering surface science packages to Europa's surface, categorized by their maximum deceleration loads: soft landers, maximum decelerations less than 40 g; rough landers (e.g., airbag-assisted), less than 600 g; and impactors, greater than 600 g and likely thousands of g's. In general the more gently a package must be delivered, the more complex and expensive is the landing strategy required to accomplish it. Decisions must be made concerning the relative priorities of various objectives and the cost and risk of the implementation options.

NASA-sponsored studies within and outside of the JIMO project have addressed various Europa lander designs. These studies were not part of a single coordinated effort; they were based on different science objectives, technology assumptions, etc., so in the aggregate cannot be viewed as a definitive trade study. Still, there are some general conclusions that can be drawn. This information will be useful for groups such as the joint ESA-NASA International Europa/Jupiter Working Group that is currently exploring near-term collaborative Europa mission options.

This work was performed at the Jet Propulsion Laboratory / California Institute of Technology, under contract to NASA's Office of Space Science.

References: [1] National Research Council Space Studies Board (2003), New Frontiers in the Solar System: An Integrated Exploration Strategy, Michael J.S. Belton Ed. (National Academies Press, Washington, D.C.); Also available at http://www.nap.edu/catalog/10432.html.