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Phobos, Key to the Cosmos? Just Ask Russia, China

❮ BRUCE CORDELL ❯

If you haven't gotten excited about Phobos recently, you should. Europe's Mars Express will approach within a mere 3,000 kilometers of the martian moon a few hundred times during the next two years. Mars Express will measure Phobos' mineral composition, probe its subsurface with a radar/altimeter, and study its plasma environment. High-resolution images will provide the first global map of the potato-shaped moon.

Its treasured proximity to Mars and its asteroid-like, milli-g surface (one-thousandth of Earth's surface gravity) combine to make Phobos a unique world. In fact, for those who aspire to exploration beyond the Earth-Moon system, Phobos is the key to the cosmos. This is because every two years a launch window makes Phobos easier to reach — energy-wise — than the surface of the Moon.

In my decade space forecast earlier this year, I suggested that Russia and China might surprise the world sometime after 2015 by jointly establishing a manned outpost on Phobos as a safe, inexpensive and smart first step toward their colonization of Mars.

This idea is supported by the impressive space activities and capabilities of Russia and China and would be a logical outgrowth of their planned joint robotic mission to the martian moon. The Phobos-Grunt mission is to be launched in late 2011 or 2012 and would collect samples from Phobos and return them to Earth for analysis — the first attempt at a sample return from the Mars system.

Russia and China appear to be on a path similar to one sketched by those of us at the first Phobos/Deimos Mission Workshop (chaired by S. Fred Singer) during The Case for Mars III conference in 1987. Our first recommendation was:

"An unmanned sample return mission to Phobos/Deimos should be studied and executed before the end of the 1990s. A sample return is essential to both our scientific understanding of [Phobos/Deimos] and our plans for in-situ propellant production on these moons."

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Space- and ground-based spectra suggest that the surface layer of Phobos is not hydrated. However, this regolith may not be entirely native to Phobos. For example, U.K. planetary scientist John Murray suggests some of it may have originated from major impacts on Mars itself. Thermal data taken by the Mars Global Surveyor have shown that Phobos' surface layer is a fine powder about 1 meter thick that sits on material believed to resemble carbonaceous chondrites (volatile-rich stony meteorites with organics). However, Mars Express has established Phobos' density as 1.887 grams per cubic centimeter (water is 1), which indicates a body with significant porosity, and possibly even large caverns. Thus significant water ice and hydrated silicates could be stored in the martian moon's interior.

University of Hawaii planetary scientist Fraser Fanale's 1990 model of the interior of Phobos — which included orbital and rotational effects, thermal history and diffusion — showed that if water ice was ever present inside Phobos, most of it should still be there. Fanale predicted that ice may be found at high latitudes from 20 to 60 meters depth, and that it should outgas — mainly at low latitudes from less than 1 kilometer depth — at about 3 grams per second. In 1990, the Soviet spacecraft Phobos 2 detected a comet-like interaction of Phobos with the solar wind, and estimates of observed Phobos outgassing were consistent with Fanale's model, although the spacecraft died before they could be confirmed.

Mars Express will help greatly, and Phobos-Grunt, the joint Russia-China sample return mission, will be essential before humans can make Phobos into a space service station.

In the late 1980s at General Dynamics' Space Systems Division, I led an internally funded study of a propellant facility on Phobos. I presented the results to several NASA centers in 1989. Our team used realistic ground rules and assumptions for technologies, vehicles, trajectories and operations, as well as General Dynamics cost models, for several scenarios that we developed. Although the focus was on a Phobos propellant facility, our results provide insights into the challenges associated with a possible near-term manned Phobos/Mars initiative by Russia and China. We estimated that the cost of a Phobos propellant outpost was between $10 billion and $15 billion in 1989 dollars — about $17 billion to $25 billion in 2009 dollars.

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According to "The Space Report 2009," Russia and China spent an estimated $1.54 billion and $1.7 billion, respectively, on space in 2008; as a fraction of GDP that's 0.067 percent and 0.021 percent, respectively. These are relatively modest commitments compared with 0.2 percent GDP for the U.S. averaged over the entire 1960s Apollo Moon program.

Just as an illustration, let's take $20 billion as the cost for a Phobos base. It would take only about six years for Russia and China — using just their current space budgets — to pay for the program. Two effects make it even easier: 1) both economies are capable of significant growth, so the percent of GDP could drop with time, and 2) a major Phobos/Mars initiative would create much ebullience and make increased cost acceptable. So a joint manned Phobos base appears to be financially feasible for Russia and China after 2015.

Keep in mind that Russia has a wealth of historical experience with long-term micro-g effects on humans from its own space station days and currently on the international space station (ISS), and after shuttle retirement, Russia will be launching American astronauts to ISS. Rather interestingly, Russia has started a 520-day Earth-based simulation for human test subjects of a manned mission to Mars. And China not only has its own manned Earth-orbit space program, but also has one of the largest and fastest-growing economies in the world. Plus China will complete its fourth space center, which is also its first low-latitude launch facility, by 2015 — near the likely opening of the new international Space Age.

Bruce Cordell writes and speaks on future trends in space exploration and technology and is co-founder of 21stCenturyWaves.com, which monitors key events and global trends in the economy, technology and geopolitics. Formerly with General Dynamics Space Systems in San Diego, he worked closely with NASA on lunar bases and human missions to Mars, space transportation, and space resources.