Moon Mines: Visionary or Senseless?
Al Globus, December 2011

Do lunar mines make sense? The answer depends on what you want to do in space. If what you want is something close to what we have now: a booming commercial communication satellite business and government programs for science and exploration, then no. Lunar mines built entirely with tax dollars are expensive and unnecessary. On the other hand, if you see further than a few years ahead, if you see civilization, humanity, and Life itself expanding into space, if you see large scale industrialization, commercialization and settlement of space, then lunar mines are of enormous importance. The interesting thing is, the second vision will probably cost the taxpayer a lot less and deliver much greater value to the people of Earth.

First, let us consider what lunar mines can supply a growing civilization in space:

1) Shielding mass. Our atmosphere protects us from the intense radiation in space. For those who seek to spend long periods in space, particularly beyond Earth's protective magnetic field, radiation shielding is a must. To mimic the atmosphere, roughly 10 tons/m^2 is necessary. The Moon is ideally situated to supply these bulk materials.
2) Rocket propellant. Today's rockets are propelled by chemical reactions. The highest performance propellant is hydrogen and oxygen, which combine to produce water and the energy and thrust necessary to travel in space. Most of the weight, roughly 90%, of this propellant is oxygen. The Moon has very large quantities of oxygen tied up in surface materials.
3) Water. A great deal of money is spent today bringing water to the International Space Station (ISS). The same oxygen that supplies most of the mass for rocket propellant can be used to make water. There are also large quantities of water in the craters at the lunar poles where the Sun never shines.
4) Metals. Lunar materials returned by the Apollo astronauts contain large quantities of titanium, aluminum, iron and other metals. These metals can supply materials for large space structures, including habitats.
5) Silicon. Silicon and metals from the Moon could be used to build the space segment of Space Solar Power (SSP) systems. These satellites would gather energy in space and transmit it wirelessly to the ground. If successfully developed, SSP could supply massive quantities of clean energy to Earth for literally billions of years. A recent paper published in the *NSS Space Settlement Journal*[1] suggests that using lunar materials for the SSP satellites requires more up-front capital than ground launch but begins generating profits much sooner.

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[1] A Contemporary Analysis of the O'Neill – Glaser Model for Space-based Solar Power and Habitat Construction. Peter A. Curreri and Michael K. Detweiler. December 2011. http://www.nss.org/settlement/journal/NSSJOURNAL_AnalysisOfONeill-GlaserModel_2011.pdf

6) He-3. Over billions of years the solar wind has implanted He-3, an isotope that is particularly well suited to fusion power, into lunar surface materials. This could be mined, brought to Earth, and used in future fusion power plants.

Thus, a vigorous lunar mining system could be part of a system to deliver energy to Earth, build large structures in space, and even provide radiation protection, water and oxygen to those who want to spend significant time in orbit. Developing lunar mines will be an enormous effort and would cost huge amounts of taxpayer money if it were done the same way Apollo, the Space Shuttle, and the International Space Station (ISS) were developed. Fortunately, there is another way.

In the 1960s the U.S. government provided modest subsidies to start up the communication satellite business. Today, communication satellites are a $250 billion/year global business producing yearly tax revenue far greater than the subsidies.

The U.S. government is currently providing subsidies to help develop private, commercial launch vehicles. The cargo versions are almost complete. Two launchers, one of which has flown, were developed at a small fraction of the usual cost for government launcher programs. The human launch versions are being developed by the commercial crew program, which was budgeted for $6 billion and scheduled to develop two or three vehicles that could deliver astronauts to the ISS by 2015[2]. By contrast, the all-government Space Launch System (SLS) is not scheduled to fly astronauts until 2021 and is estimated cost $40 billion to develop. Although the SLS is much larger, variants of the commercial vehicles may approach or even exceed SLS performance sooner and at much less cost[3].

Thus, the evidence suggests that reorienting our space program to support commercialization and industrialization of space, as opposed to 100% government missions, may produce far greater results at much less cost. Lunar mining could be a major component of such space industrialization. There is already at least one commercial company that intends to mine the Moon. Perhaps we should support it.

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[2] The budget for the first year was cut from $850 million to $406 million. This is expected to delay the first flight by a year or two.

[3] The first SLS version is expected to place up to 70 tons into Low Earth Orbit (LEO); a later version may lift up to 130 tons. The Falcon Heavy, due to launch in late 2012, is expected to place up to 50 tons in LEO. SpaceX has also proposed a larger version of the Falcon that could lift 150 tons to LEO; it is projected to take five years to develop at a total cost of $2.5 billion.