Mining the Moon To Power the Earth

by Marsha Freeman

China's ongoing Chang'e-3 lunar mission is the first step toward creating a scientific and economic revolution which will power global economic growth and open the entire Solar System to mankind. The future development of civilization will require vast increases in energy consumption per capita, and fusion power will make that possible. The most advanced fusion technologies will increase mankind's productivity by orders of magnitude, and one pathway toward this end is to use helium-3 as the fuel for fusion. Although mining helium-3 on the Moon to power the Earth has been a goal of scientists since the end of the Apollo program in the early 1970s, today, China alone has embarked on a long-term program to reach that goal.

During his weekly LaRouchePAC webcast on Jan. 17, Lyndon LaRouche addressed the meaning of China's Chang'e-3 lunar mission:

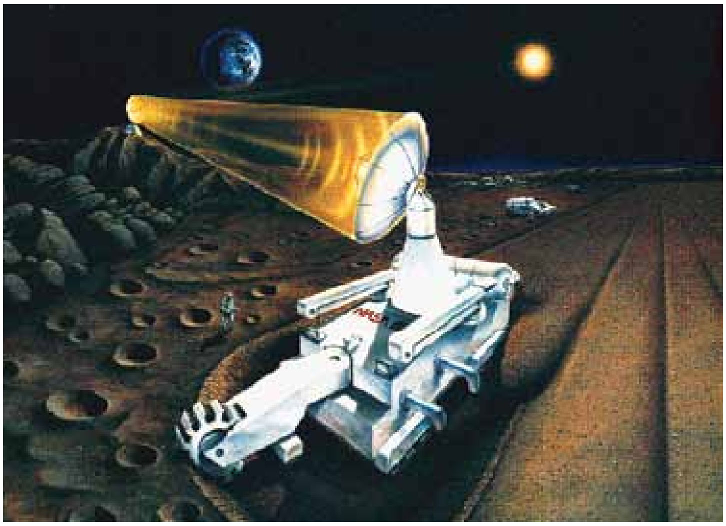
"This Moon landing was a brilliant enterprise, which far exceeded the accomplishments of any attempt at Moon exploration heretofore. But one of the greatest implications of that problem, that challenge, was the fact that on the Moon, there is a raw material which has dropped on the Moon as a part of the radiation of thermonuclear fusion [from the Sun], essentially, that is, of the helium-3. The helium-3 as radiated from the Sun, and accumulated on the surface of the Moon, is now the most promising factor in planning the future of the life of the human species.

"This means that if we do what was implied by what that China team has done, and has reported to mankind, at least to scientific mankind, if that is done, we are no longer Earthlings. Because the effective use of a resource which is not available to us in significant quantity on Earth, helium-3, if included as a raw material, as the core of a raw material, abundant on the Moon, to us, and we develop that, then, if we transmit the benefit of that Moon's accumulation of thermonuclear fusion, *we are no longer Earthlings*; because while we will not live on the Moon, we will not live on Mars, not in any known future; *but,* we can bring into a relationship, a functional relationship between Earth and the Moon, and other places, a new kind of relationship, in which we are no longer Earthlings!

"Because we can, if we succeed in taking advantage of what the Sun delivers to the Moon, as an accumulation, and apply that to the intention of thermonuclear fusion on Earth, the successful application of the use of helium resources stored on the Moon, will create a quality of achievement in the development of thermonuclear fusion *on Earth*, which will *change the history of the Solar System!* And that is my mission-orientation."

'Tons' of Helium-3

Although China's Chang'e-3 rover is not equipped or designed to locate helium-3 on the surface of the Moon, it will be able to determine the titanium content of the bulk lunar soil. Titanium has been found to correlate positively with a concentration of helium-3, so



University of Wisconsin

In this artist's rendition of a concept developed at the University of Wisconsin, a remotely operated mobile unit scoops up lunar soil, extracts the helium and stores it, and then ejects the mined soil.

this mission is taking an indirect measurement of a resource that will be vital for the future.

Since the 1970s, when scientists examined the lunar rock samples that were returned to the Earth by the Apollo astronauts, and by the unmanned Soviet Luna probes, they have known that there is helium-3 on the Moon. It was estimated that the Apollo 11 landing site at the Sea of Tranquility, alone, contains 8,000 tons of helium-3, to a depth of about two meters.

Having been deposited there over eons by the solar wind, on a body where there is no interfering atmosphere or magnetic field, the helium-3 has lain undisturbed, bound up in the rocks and soil. Scientists have long recognized that this Earth-rare isotope of helium, used as a fusion fuel, could provide a source of energy available that is a qualitative advancement over the energy sources available today, or even those on the horizon. But the short supply of helium-3 available on Earth had discouraged scientists from seriously considering this more advanced fuel for fusion, until it became clear that there are bounteous reserves available on the Moon.

Recognizing this intimate relationship between the Moon and fusion, China is pursuing a multi-decade lunar exploration program, with the long-term goal of detecting, mining, and using helium-3 as a fuel for fusion power plants. To make this a reality, China is carrying out a determined experimental program to develop commercial fusion energy, by the middle of this century. It plans to build the infrastructure to develop the Moon, and using the helium-3 that is there for fusion could be the first step in deploying the power that lunar development will require. Industrial-scale mining and processing of the lunar regolith, or soil, could produce helium-3 for transport to power the Earth.

Although small-scale fusion experiments with helium-3 have been carried out, most notably by a very determined group of scientists at the University of Wisconsin, the overall contraction of the U.S. fusion program over the past 30 years virtually eliminated the support that would have allowed the breakthroughs in the science and engineering to make fusion energy a reality in the United States. China has picked up where the U.S. left off, decades ago.

The question now posed is, who will join China along this pathway to the future?

Why Fusion?

Each scientific breakthrough, translated into new technologies, creates new resources and entirely new interventions into nature by man. In the last century, through the new science of the atom, the applications of nuclear fission created the possibilities for food irradiation, disease diagnosis and treatments, extended capabilities in space exploration, and peaceful nuclear explosions for construction, none of which could be done with coal, oil, or natural gas, much less solar collectors or windmills.

The fusion of light ions releases orders of magnitude of energy greater even than the most advanced nuclear fission processes. But it is the *quality* of the energy produced, more than the quantity, that makes fusion a wholly new energy platform. The fusion reaction can be engaged to produce energetic particles, and also can be be tuned to release its energy in an array of wavelengths along the electromagnetic spectrum. This allows processing of materials, not only by heat, but, for example, by microwaves or X-rays. A highly-energetic fusion-plasma system will revolutionize space propulsion, whether to send probes to the outer reaches of the Solar System, or to direct energy to disable, destruct, or deflect asteroids and comets that threaten the Earth.

With fusion enabling the industrial development of the Moon and the technologies to explore beyond the Moon, mankind will expand dominion over nature to the entire Solar System.

Why Helium-3?

The fusion experiments being carried out and planned around the world use primarily deuterium and tritium—both isotopes of hydrogen—to create the controlled fusion reaction. This is the easiest fusion reaction to attain, in terms of the temperature of the plasma and the strength of the magnetic field needed to confine it. But there are drawbacks to this approach.

One, is that about 80% of the energy from the deuterium-tritium (D-T) fusion reaction is in the forms of neutrons (**Figure 1**). These cannot be controlled or directed away from the walls of the inside of the fusion machine through the use of magnetic fields. The energy from fusion is extracted from the neutral particles in the form of heat, by slowing them down. These collisions present serious challenges to the materials placed between the neutrons and the lining of the wall of the reactor, which will come into contact with the neutrons. It also means that the only way to use the energy is to degrade it to a temperature low enough to boil water, to turn steam turbines, to produce electricity. Much of the energy-dense fusion reaction is wasted in this process.

In the D-He-3 reaction, upwards of 90% of the energy produced in the fusion reaction is in the form of charged particles, rather than neutrons. This has a number of advantages. From the materials standpoint, the high-temperature fusion products can be directed away from the walls of the reactor by magnetic fields, simplifying the engineering. From the standpoint of efficiency, it is not necessary to use heat to boil water, because the plasma products from fusion can be separated by charge, using magnetohydrodynamic or electrostatic direct conversion, and produce electricity directly. The efficiency of conversion from fusion energy to electricity would be more than double what is possible with the 19th-Century technology of steam turbines.

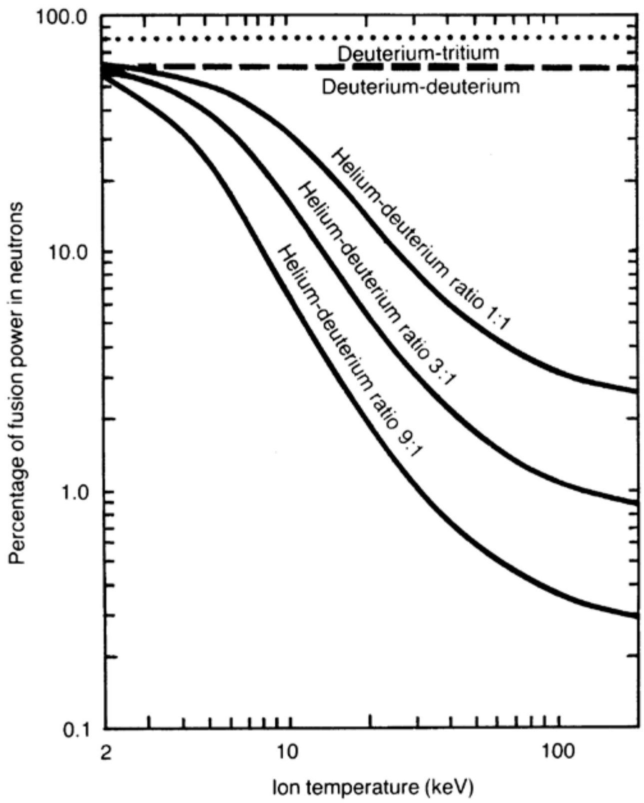
In space, the stream of highly energetic charged particles from a D-He-3 reactor can be directed with magnetic fields to exit the back of the rocket for propulsion, and can provide efficient on-board power for the spacecraft. The higher efficiency of plasma propulsion translates into trips to the planets, such as Mars, in a matter of days, rather than months or years.

Eliminating the use of slightly radioactive tritium in the fusion process, by using deuterium and helium-3 for fuel, also has the benefit of simplifying the engineering to meet radiation standards. Moreover, tritium is not an abundant, naturally occurring isotope of hydrogen on Earth, because of its short half-life of 12.3 years. For D-T fusion, the tritium would have to be bred from lithium, in a blanket surrounding the inside of the fusion reactor, which is a complication that would be eliminated with D-He-3 fusion.

Various approaches have been proposed to meet the challenges of the more demanding temperature and magnetic-field requirements for the D-helium-3 fusion reaction, as compared to D-T fusion. It has been suggested that the fuel be polarized, to increase the reactivity of the plasma, and lessen the constraints on the helium-3 fusion process. Other approaches to fusion, and different geometrical configurations and designs for experiments, have also been proposed.

FIGURE 1

Neutron Output Using Helium-3 and Deuterium Fusion Fuel



Source: NASA Lunar Helium-3 Fusion Power workshop, April 1988

A major advantage of burning deuterium and helium-3 as fusion fuel is the reduction of the percentage of fusion energy in the form of neutrons. Three helium-3 and deuterium fuel mixtures are compared to deuterium-tritium and deuterium-deuterium (at 50% tritium burnup). Using a fuel with a 9:1 ratio of helium-3 to deuterium results in a small neutron flux, thus allowing for simple plant design and the direct conversion of the fusion energy to electricity and coherent energy.

For initial experiments that should be done in both existing and new fusion devices, the small cache of He-3 on Earth can suffice. There is some helium-3 created as a natural decay product of tritium, which is used in the production of thermonuclear weapons. There is a small amount of helium-3 that can be extracted as a by-product of natural gas production. This could supply the near-term research, in order to move the research forward.

But to supply the Earth with fusion power for centuries, we have to return to the Moon.

Why the Moon?

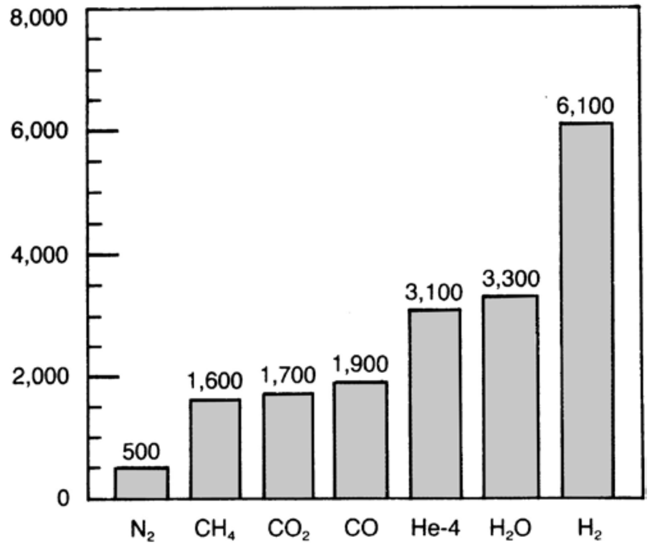
The Earth's magnetic field and atmosphere have destroyed the helium-3 that would have been deposited here from the solar wind, whereas estimates are that there are more than 1 million tons on the Moon.

These are not in concentrations, such as bodies of ore that are found on our planet, but embedded in the upper layers of the lunar regolith. Concentrations are estimated to vary from zero to 300 parts per million. Dr. Gerald Kulcinski and the team of scientists at the Fusion Technology Institute at the University of Wisconsin, have done extensive research on D-helium-3 fusion since the mid-1980s. At that time, dramatic progress had been made in fusion experiments at laboratories in the U.S. and abroad.[1] This success indicated that meeting the more demanding challenges of moving to advanced fusion fuels was a possibility.

To mine the Moon, they suggest that the top 30 centimeters of lunar soil would be scooped up by an automated rover, and heated to 6,000°C. This would vaporize the material, so the helium-3 could be extracted. To produce 1 kilogram of helium-3, they estimated that about 100,000 tons of soil would have to be processed. Having done their calculations when the United States was still flying the Space Shuttle, and using what is still a valuable heuristic device, the University of Wisconsin group estimated that one Shuttle payload bay full of helium-3, could produce as much electricity through fusion as the entire amount consumed in the United States in 1985 (**Figure 2**). This would require mining an areas the size of Washington, D.C. A cornucopia of other valuable materials—such as oxygen, nitrogen, and carbon monoxide and dioxide—will be produced in the course of recovering the helium-3.

1. For more on this, see Marsha Freeman, "Mining helium-3 on the Moon for unlimited energy," *EIR*, July 31, 1987.

FIGURE 2
By-Products of Lunar Helium-3 Mining



Source: NASA Lunar Energy Enterprise Case Study Task Force Report, July 1989

The tons of gases released from the mining and processing of lunar soil for helium-3 can be exported to be used by spacecraft and other facilities in space. The amounts given are metric tons per metric ton of helium-3 recovered.

The Wisconsin team calculated that if the entire surface of the Moon were mined, and all of the helium-3 were used for fusion fuel on Earth, it could meet world energy demand for over 1,000 years. Of course, it will not be necessary to mine the entire Moon, because there are supplies of helium-3 throughout the Solar System. The giant gas planets in the outer Solar System are estimated to be composed mainly of hydrogen, but with estimates that as much as 25% of the weight of Jupiter and Saturn is helium. There is helium-3 deposited by the solar wind, not only on the Moon, but the other inner, solid planets, and on asteroids and other space travelers.

And before there could be any possibility of running out of helium-3, more advanced technologies, such as matter/anti-matter reactions, will have already been developed.

The most important thing that the Chinese space and fusion programs are providing to world civilization now is optimism. The late space visionary Krafft Ehricke advised that the Moon should become the seventh continent of the Earth, to supply the materials and manufacturing capabilities of an open world. This is the path the Chinese have chosen.