Economic Development Is at the Heart of China's Lunar Program

by Marsha Freeman

July 13—On January 4, 2019, Eastern Standard Time, China became the first nation in the world to land a spacecraft on the far side of the Moon. Contrary to most Western media commentary, this accomplishment was not motivated by an imaginary "Asia space race," or to obtain bragging rights in the international space community. The China Lunar Exploration Program (CLEP), made up of a series of increasingly challenging missions, is considered a key element in the economic advancement of China's population.

The United States has started lunar return programs three times in the past 30 years, but stopped them when they were deemed to be "too expensive." But China's lunar exploration program has been provided with a constancy of goals and support by being situated under the umbrella of long-term economic development plans such as the Belt and Road Initiative and other great infrastructure projects. It is understood that the lunar exploration program is a "science driver" for the economy, not an "expense."

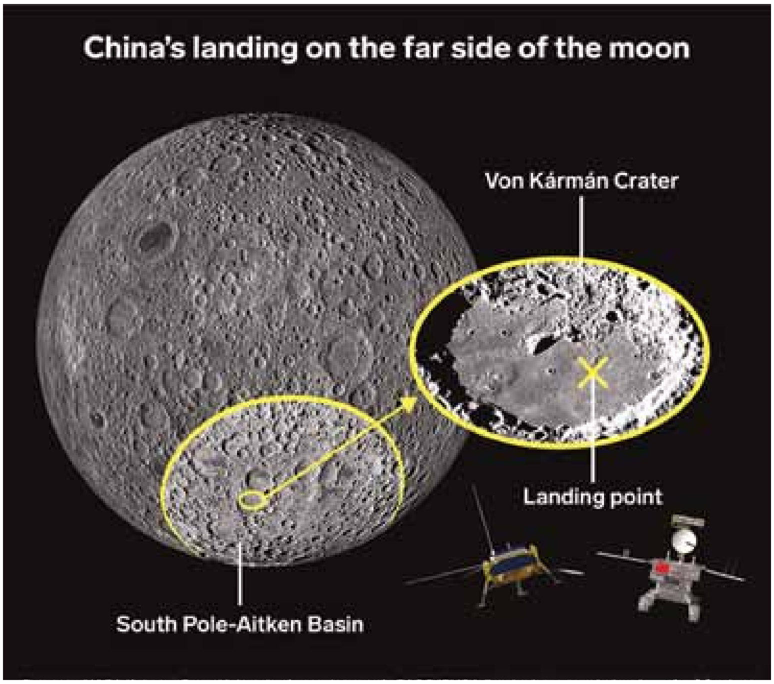
CLEP

China's Yutu-2 rover rolls away from the Chang'e-4 lander, the first spacecraft to land on the far side of the Moon.

The United States has a choice. On the one hand, we can commit to the multi-decade science-driver crash program for space exploration required to fulfill President Trump's call to industrialize the Moon as a stepping-stone to Mars, or continue with what economist Lyndon LaRouche described as a "casino economy," accumulating huge amounts of money in the gyrations of the stock market and its associated speculative arenas. In the minds trapped in the world of British monetarist thinking, this casino accumulation is considered "wealth," and has replaced the production of physical goods, such as high-speed rail and advanced nuclear energy systems. The continuation of such "wealth" accumulation will leave this country without the economic (physical and intellectual) resources to carry out a science-driver space program.

In 1985, when China was deciding which pathway it should take in economic and cultural policy, members of its scientific community consulted Lyndon LaRouche. A group of Chinese scientists visited the United States and met with a staff member of the Fusion Energy Foundation to find out more about the LaRouche-Riemann economic model. They were specifically interested in the impact of military and space science on the entire Chinese economy. Only two years earlier, President Ronald Reagan had announced the Strategic Defense Initiative (SDI), which had earlier been formulated by LaRouche.

In a letter dated November 11, 1985, addressed to Zuwei Huang of the Beijing Institute of Space Systems Engineering, LaRouche answered the question raised, through an extensive discussion of political/economic/scientific/cultural history. In responding to Zuwei



NASA/Arizona State University (map); renderings of lander and rover (lower right), China Aerospace and Technology Corporation/China National Space Administration

Chang'e-4 landed in the small Von Kármán crater within the huge South Pole-Aitkin Basin; it is the first spacecraft to land on the far side of the Moon.

Huang, he addresses, thirty years in advance, a major challenge that China faces today: "So, twofoldly, technological progress is indispensable to production of the material preconditions of human life," which China has recognized, by lifting hundreds of millions of people out of extreme poverty. Now the challenge is the scientific and cultural uplifting of the population. ". . . and the principle of technological progress affords to labor a form of existence which is consistent with man's superiority to the beasts."

In conclusion, LaRouche wrote:

> I would recommend to you, your colleagues, and your government that China consider concentrating much of its physical science under institutions integrated by a common mission-assignment respecting the colonization of the Moon and Mars. For reason of the nature of the primary and auxiliary technologies that mission-assignment implies, not only space-related research and BMD [ballistic missile defense], but every frontier of scientific inquiry is implicitly subsumed under that mission-assignment. This would foster the highest ratio of scientific benefit in every field, per average scientist and technician employed.

China's Lunar Vision

How did China advance past the established space powers (the United States, Russia, Europe, and Japan) in its exploration of the far side of the Moon?

Thanks in large part to the tireless, nearly 30-year effort of one scientist, China's long-range lunar development program is a multi-phase exploration program to eventually create a manned base on the Moon. In addition to carrying out leading-edge scientific investigations, the Moon base will provide the infrastructure to exploit lunar mineral resources, most importantly the mining of the isotope helium-3 from the lunar soil. As the advanced fuel for fusion energy on Earth, energy on the Moon, propulsion for deep-space manned exploration, and materials processing, helium-3 fusion would play an important role in the integration of the economy of the Moon with the Earth. In this way, the Moon would become what space visionary Krafft Ehricke called the "Seventh Continent" of the Earth.

In addition to the direct impact on the economy of China's lunar program, that program has been a significant contributor to the leadership's objective to become a world leader in science and technology. Therefore, the civilian space program is not

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Former EIR Economics Editor David Goldman briefs Lyndon LaRouche on progress on the LaRouche-Riemann economic model in 1983.

subject to the vagaries of changing annual budget priorities, or changes in Party leadership, because it is integral to the overall goals that have been set for the country.

The Chinese are well aware of the "Apollo effect," when the optimism created by the Moon landings created a generation of scientists and engineers. China has recently engaged the public in a broad range of activities, through the widely celebrated National Space Day, observed on April 24, on the anniversary of China's first satellite launch in 1970. The highlight of last year's celebration was exhibits with models of the *Chang'e-4* Moon lander and *Yutu-2* rover. And as in the United States, for the most recent lunar missions, Chinese school children have been invited to choose the name for the landers.

The success, so far, of China's lunar missions has put its technical expertise and the dedication of its scientists and engineers on the world stage. But it took 30 years, and extraordinary perseverance, to get there.

Ouyang Ziyuan: Father of Chang'e

It was in the mind of the now 84-year-old scientist, Ouyang Ziyuan, that China's lunar program was born.

Despite an early interest in astronomy, Ouyang decided to study geology and mineral resources after high school. In a 2013 interview with Lu Yishan, a reporter with the *Yangcheng Evening News*, Ouyang explained:

> In 1957, *Sputnik* opened for humanity a new era of exploration. This gave me an extreme shock. I always believed China would have the capability of launching a satellite. I began to conduct a study of a meteorite in 1958, [in the new field of] Cosmo-chemistry. . . ." Gradually, we pulled together a theory and an array of researchers for investigations of meteorites from the Moon and other celestial bodies.

Ouyang's biographer, He Ping, reports in *Ouyang and China's* Chang'e *Project*, that,

> [From the beginning of the 1960s,] Chinese scholars conducted comprehensive and analytical studies of the Moon, its topography and land formations, its origins and the history of its evolution, continuously following the progress of studies of the Moon by the international community, compiling reports, like "Progress in Studying the Moon's Structure," "The Mysteries of the Moon," "The Study of Celestial Bodies," and several monographs.

Ouyang continued, in his 2013 newspaper interview:

> In [May] 1978, President Carter's National Security Advisor, Zbigniew Brzezinski, visited China and left a small Chinese flag that had been taken to the Moon by an astronaut, and second, a piece of the Moon mounted in Plexiglas about the size of a thumb. . . . The State Council asked the Academy of Sciences Guiyang Institute of Geochemistry [where Ouyang was a researcher] to investigate the time and place where the rock was found. With great care, they examined the 0.5 grams. [We] issued a 14-page report and affirmed that the rock was picked up by the Apollo 17 astronauts, and determined where the rock was from, whether there was sunlight there, which they could tell from certain characteristics.

Lunar Probe Development and Launch

By all accounts, that one-gram piece of Moon rock would set Ouyang Ziyuan on his life's course.

Not long after, a group of scientists led by Ouyang proposed to China's political leadership to start to develop and launch a lunar probe. But China, having just come out of the period of the Cultural Revolution, was left unable to tackle such a complex and far-reaching space project.

Due to his background in geology, Ouyang was tapped to find a suitable site for underground nuclear testing, which required that he learn nuclear physics. This would no doubt be useful in his later promotion of the development of fusion energy.

But by the mid-1980s, China's leadership under Deng Xiaoping turned to the policy of "the four great modernizations," to try to catch up to the advanced sector of Europe, the United States, and Japan. One of the great modernizations was the focus on science.

For implementation, Project 863 was promulgated in March 1986. Its purpose was to provide federal support to fulfill the need of China to invest in broad areas of technology development. The funding of R&D projects under Project 863 continued for decades, including in aerospace. Space writer Brian Harvey reports in his comprehensive book, *China's Space Program*, that between 1986 and 2001, about $800 million was invested in 5,200 individual projects under Project 863, including funding for the development of a robotic arm for China's future space station.

Ouyang explains in his interview that by the early 1990s, the scientists believed that China was ready to embark on deep space missions:

> In 1993, we submitted a proposal for a first lunar science mission.... Experts approved it. The Institute of Geochemistry issued a report in 1994, "The Necessity and Feasibility of China's Development of a Lunar Probe." In 1995, the Academy of Sciences proposed to continue the study of a program, which led to a more detailed proposal, "The Development Strategy and Long-Term Plan for China's Lunar Exploration." The Academy approved a plan with three parts:
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> 1. Unmanned probes;
> 2. Manned landings; and
> 3. Creation of a lunar base, with the development of resources and the lunar environment.
>
> The first, unmanned phase was later divided into three parts: orbiting, landing, and sample return.

Chinese Academy of Sciences

Ouyang Ziyuan, known as the "father" of the Chang'e series of lunar missions, speaking at the Xi'an Institute of Optics and Precision Mechanics in November, 2010.

This renewed push by the Chinese scientists for a lunar program coincided by chance with a discovery that would change the view of the Moon as a cold, dry, dead world. In 1994, the U.S. spacecraft, *Clementine*, a joint project between the Strategic Defense Initiative Organization and NASA, discovered the likely existence of water ice inside permanently shadowed craters at the Moon's South Pole. Soon, spacecraft would be under development in Europe, the United States, Japan, and India to investigate further. Water on the Moon could be used to sustain life as well as be one of the ingredients for rocket fuel. It could provide one of the resources necessary for a long-term manned base on the Moon.

In 1998, Ouyang and his team were asked for specific designs for lunar missions. They organized a gathering of experts from various technical domains from around the country; in August 2000, the gathering approved the proposed lunar research plan. They released a report, titled, "Scientific Objectives and Payload of the Lunar Exploration Satellite." On that basis, Ouyang and his colleagues wrote a prospectus for the lunar program.

In a March 3, 2003 interview with *People's Daily*, China National Space Administration Director Luan Enjie provided an overview of the lunar exploration program that was soon to be made public:

> The exploration of the Moon can become the incubator of science and technology, and promote the development of the nation's economy by bringing forth new ideas of a revolutionary nature. [Mankind must] leave the Earth homeland, establish permanent research stations, develop products and industries in space, and set up a self-sufficient extraterrestrial homeland.

State Council Approves Lunar Mission

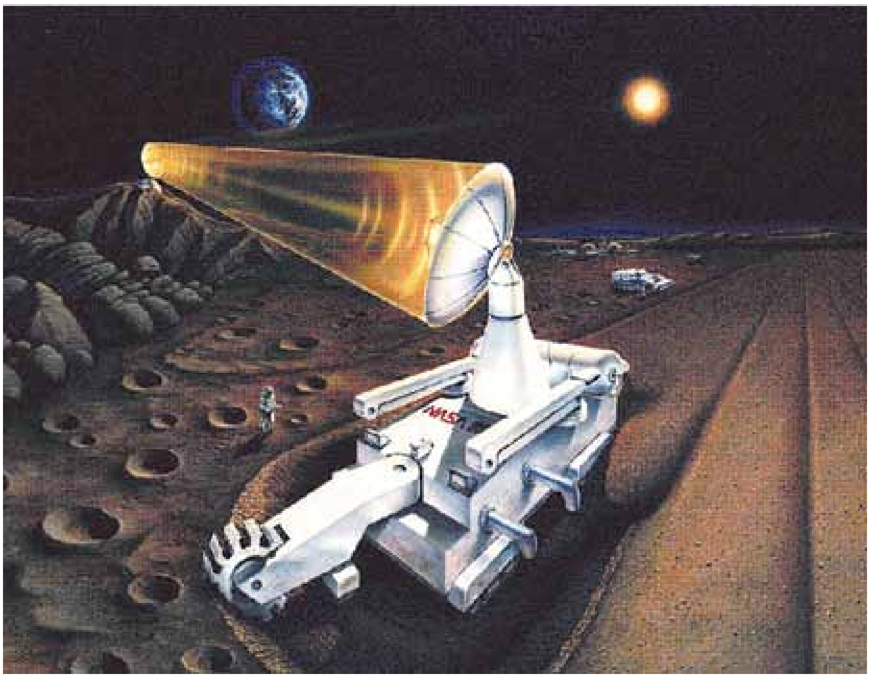
On January 24, 2004, the State Council approved the report laying out the lunar exploration program, as did Premier Wen Jiabao. This ratified the development of the lunar probes, inaugurating the multi-phase China Lunar Exploration Program (CLEP). The lunar missions were officially named Chang'e, drawing on the legend of the goddess who flew to the Moon with her Jade Rabbit (Yutu), having been banished from Earth, for having angered the gods by drinking the elixir of immortality.

The secret Chinese space program was about to undergo major changes. In November 1999, China carried out an unmanned test of its man-rated Shenzhou capsule. For the first time, Chinese space officials spoke publicly about the test while it was underway. Previously, the world had only learned about a Chinese space mission after the fact, and if it had been a success.

In 2000, the Information Office of the State Council took a major step toward "opening up" its space program. In November of that year, the State Council published, in English, a 24-page white paper titled simply, "China's Space Activities." The white paper laid out a 20-year perspective for China's space plans, with an emphasis on Earth-orbital applications, such as remote sensing, just then being developed in China. It also revealed the plan for the near-term launch of a manned orbital mission, *Shenzhou-5*, which in fact took place three years later.

China well recognized that it would take years for it to "catch up" to, or even compete with, the world's space-faring powers. That was not the motivation for the programs. As outlined in the white paper:

> As a developing nation, China's fundamental tasks are developing its economy and continuously pushing forward its modernization drive. [The space program is] an integral part of the state's comprehensive development strategy.


Courtesy of Gerald Kulcinski

An artist's conception of the Mark II Lunar Helium-3 Miner.

No specific years, only general outlines, are given for each program category. The space program is not a "race," the report makes clear. And it has proceeded from the beginning at a pace that is determined, not by political exigencies, but by technical readiness.

In 2006, the State Council released a ten-page update report titled, "China's Space Activities in 2006." The purpose, the report states, is "to give people around the world a better understanding of the development of China's space industry over the past five years, and its plans for the near future."

The report explains, again, that China places its space program within the context of its "overall development strategy," with a focus over the following five years on technology transfer from the space industry to "upgrade traditional industries."

The first flight of the lunar exploration program, *Chang'e-1*, was only one year away.

Helium-3: Lunar Fuel for Fusion

From the beginning of China's lunar program, Ouyang lobbied for the development of the resources on the Moon. As quoted by Ouyang's biographer, He Ping:

> . . . "[T]he mineral resources of the Moon, its energy resources and its specific environment, will open up a new source of development for mankind in the future. If China would continue to look at this opportunity without lifting a finger, then it will be difficult to safeguard the interests of our people, and we will forfeit our ability to have a say in matters of space exploration," states the 1994 report, "The Necessity and Feasibility of China's Development of a Lunar Probe."

For years, discussions about resources on the Moon referred mainly to the presence of water ice. But in the 1970s, scientists, closely examining the rocks brought back by the *Apollo* astronauts, and the unmanned Soviet *Luna* probes, also found helium-3. It has been estimated that just at the Sea of Tranquility, where the *Apollo* 11 astronauts landed, there are 8,000 tons of helium-3.

This isotope of helium has been deposited in the top layers of lunar soil by the solar wind over billions of years. It is rare on the Earth, due to the interference by the Earth's atmosphere and magnetic field. But not much value was attributed to this find at the time. That changed a decade later, when scientists carrying out research on fusion energy, began looking for helium-3 for fuel.

Fusion is the process by which the Sun and the other stars create their energy. It is often described as the opposite of fission, which is the splitting of atomic nuclei. Fusing light ions releases orders of magnitude more energy than fission, without fission's radioactive by-products. Helium-3 is an "advanced" fusion fuel, because it is more difficult to produce fusion energy with it than with the more common isotopes of hydrogen. But its products allow a more efficient use of the energy produced.

Although the helium-3 on the Moon was not considered a resource in the 1970s, in the 1980s, when fusion experiments using helium-3 were making progress, the scientists soon realized they would need more helium-3 than is available on Earth. Now helium-3 on the Moon became a resource, and mining it became a major objective of China's long-range lunar plan. From the time it was discovered that a potentially large quantity of helium-3 existed on the Moon, Ouyang became a strong and vocal promoter of developing this new resource for fusion fuel.

Energy for Ten Thousand Years

At the 36th Scientific Assembly of the UN Committee on Space Research, held in Beijing in July 2006, Ouyang presented a special lecture, in which he said:

> One hundred tons of helium-3 will be needed each year if nuclear fusion technology is applied to meet global energy demand. The Moon has reserves estimated to be between 1 and 5 million tons. Each year three Space Shuttle missions could bring back enough fuel for all human beings across the world. [These millions of tons of helium-3 on the Moon could provide] at least 10,000 years of energy for all mankind.

He explained in the lecture that China's first lunar missions would enable the analysis of minerals covering only five elements. "We will try to improve that to fourteen" minerals, he said, which was, in fact, done in later missions. The target, he explained, is to "improve our understanding of helium-3 reserves" and refine the estimate of the amount of it on the Moon.

Helium-3 is thinly dispersed in the lunar soil, and soil samples must therefore be brought back to laboratories on Earth to determine the contents. *Chang'e-5*, to be launched by the end of this year, will bring back lunar samples from the Earth-facing near side of the Moon. It has also been proposed that the far side of the Moon could contain a higher concentration of helium-3 than the near side, since it is more exposed to the solar wind, and lacks any protection from Earth.

China is not the only country that has expressed an intention to exploit the helium-3 reserves on the Moon. Scientists in Russia have noted the importance of those reserves for many years and have included mining the Moon in their long-term plans. India, too, has recognized the importance of the enterprise.

China's Plans for the Future

On January 14, 2019, following the successful landing of *Chang'e-4* on the far side of the Moon, the leadership of the China National Space Administration (CNSA) held a press conference to discuss the ongoing *Chang'e-4* mission and the future of China's lunar exploration. During the briefing, Wu Weiren, chief designer of the lunar program, said that CNSA is organizing Chinese experts to work on the follow-on lunar missions. Next will be the *Chang'e-5* near-side, equatorial sample return mission. Following that, three future missions are being planned:

- *Chang'e-6* will conduct a very challenging South Pole sample return. Whether it will be conducted on the near or far side depends upon the results of the sampling mission of *Chang'e-5*.
- *Chang'e-7* will conduct comprehensive exploration of the South Pole, including its land formations, material composition and environment.
- *Chang'e-8* will test key advanced technologies on the far side. Companies will be invited to industrialize the technologies developed for the mission.

China's *Science and Technology Daily* reports that Wu Yunhua from CNSA added: "On *Chang'e-8*, we are planning even more crucial experiments for our lunar exploration, including to determine the possibility of establishing a lunar base for scientific research, if we can do 3D printing on the Moon, and whether it is possible to use the lunar soil for the construction of buildings, in order to jointly construct a lunar base for further exploration of the Moon."

For the scientists carrying out China's lunar exploration missions, the Moon is not the limit, but a necessary stepping stone to the rest of deep space.

Ouyang Ziyuan, now 84 years of age, attends the Chang'e launches, and is looking beyond the Moon. He told Xinhua on November 23, 2012: "I hope Chinese people can set their 'footprints' all over the Solar System."