NEWS IN FOCUS

VICTOR O. LESHYK

SPACE China lays foundations for ambitious expansion in space science **p.276**

ENVIRONMENT Nature loses out in the wake of rampant Gulf development **p.277**

CANCER Targeted therapy as early defence rather than last resort **p.281**

EARTH SCIENCE Did a giant impact trigger the rise of dinosaurs? **p.287**

Engineers inspect the Phobos-Grunt probe in happier times.

PLANETARY SCIENCE

Russia gets the red planet blues

Phobos probe failure puts planetary comeback in doubt.

BY ERIC HAND

It was the largest planetary mission in the history of space exploration, bearing Russia's hopes of recapturing Soviet-era glory in Solar System exploration. But instead of rocketing off on a mission to return soil from the Martian moon Phobos, Phobos-Grunt

is stuck in Earth orbit. Barring a miraculous restarting of its engines, it will make a fiery fall to Earth, probably by the year's end.

The Russian planetary programme could plunge along with it. Roscosmos, the Russian space agency, had hoped that a successful robotic surface-sample return — a feat that NASA has not yet achieved — would, in

one stroke, erase the demons of past failures. Instead, the agency finds itself exactly where it stood 15 years ago after the launch of the ill-fated Mars 96 mission, a previous massive assault on the red planet: unable to leave Earth orbit. "It was over-ambitious," says Roald Sagdeev, former head of the Space Research Institute (IKI) in Moscow, who is now at the University of Maryland in College Park. He sees a suite of future planned missions now in jeopardy, as well as chances for international cooperation. "Opponents will say: why should we waste money on planetary missions?"

Engineers at Roscosmos have been trying daily to communicate with the stalled spacecraft, which at 13,500 kilograms is more than twice as massive as the US-European Cassini mission to Saturn, the largest probe sent beyond lunar orbit so far. As Phobos-Grunt (literally Phobos-soil) seems to be undamaged and its fuel tanks full, Roscosmos hoped to reboot the craft, restart its engines and send it on its way to a rendezvous with Mars' largest moon in early 2013. But all communication attempts have failed, says Alexander Zakharov, the mission's project scientist at the IKI, which manages the 20 instruments on the scientific payload. The window for getting the spacecraft to Mars — determined by the orbital paths of Earth and Mars — will shut on 21 November. "We have a few days more," says Zakharov.

After launching on 8 November from Baikonur Cosmodrome in Kazakhstan, the first stage of the Zenit rocket worked perfectly. But amateur skywatchers in South America, who were enlisted by Russia to supplement its meagre tracking resources, didn't see the expected burn of the second stage, says Ted Molczan, an amateur observer in Toronto, Canada, who runs a satellite-observing group online called SeeSat-L.

A fault in the second-stage control systems seems to be the immediate cause. But journalist Anatoly Zak, the founding editor of *russianspaceweb.com*, says that the deeper problems are institutional. A culture of lax testing meant that some problems lay undetected, whereas known problems were ignored at the higher levels, he says. "The project was doomed from the beginning."

Sagdeev adds that the Russian programme's strength was always in hardware, not control systems and software. "This is the legacy of the Soviet space programme," he says. "The emphasis was on building rockets." ▶

► Friction with the upper atmosphere is steadily dragging on the orbiting spacecraft, now just over 200 kilometres above Earth at its lowest point. Zakharov says it is expected to fall in mid-December. Molczan, who has performed his own analysis of the orbital decay, says it could be as late as January.

Re-entry could make for a massive fireball, as most of the weight of the spacecraft is in its liquid fuel — much of it meant for a return trip from Mars. A statement on the Roscosmos website says that the craft will blow up in the heat of re-entry, which would reduce the risk of anything reaching the ground. But Jonathan McDowell, an astronomer and satellite watcher at the Harvard-Smithsonian Observatory in Cambridge, Massachusetts, says that it's also possible that the fuel, made up of hydrazine and dinitrogen tetroxide, will freeze in space during the spacecraft's initial descent, increasing the chance that some of the craft and its contents might survive the plunge. "Now you have a lump of a couple of tonnes of toxic sludge that's falling out of the sky," he says.

Even without the public-relations disaster of a crash to Earth, the damage to Russia's future planetary plans will be considerable. Zakharov says it will be difficult for Roscosmos to consider repeating the US\$163-million Phobos mission. The agency and its primary contractor, Lavochkin, had also wanted to pursue missions to the Moon, Mars, Venus, Mercury and even Europa, the icy moon of Jupiter. But the plans, never firm, are now more uncertain. A 2014 launch of the Luna-Resource mission, a Moon lander paired with an Indian-built orbiter and rover, is still on track, Zakharov says. But after the loss of Phobos-Grunt, which carried a small Chinese satellite, India will be rightly concerned, says Sagdeev. "If something similar happens to the Indian payload, it would be a real disaster."

In the old days, failures could be tolerated, because the Soviet Union would launch mission after mission until each problem was fixed, says Louis Friedman, former director of the Planetary Society in Pasadena, California, and principal investigator of a small astrobiology experiment on Phobos-Grunt. But with no money for frequent launches, Roscosmos and Lavochkin — which has designed and built all Russia's interplanetary missions since the dawn of the space age — will have to change their cultures, Friedman says. "The hope is that there will be a real shake-up," he says. "Do I think that will happen? History says it won't." ■

"The project was doomed from the beginning."

The Shenzhou-8 spacecraft (above, before launch) has docked successfully with the Tiangong-1 module.

SPACE EXPLORATION

China forges ahead in space

Mars-probe problems are a minor blip in a bold strategy.

BY DAVID CYRANOSKI

The likely demise of Russia's Phobos-Grunt mission has dashed China's hopes for its first Mars orbiter, Yinghuo-1, which was piggybacking on the larger craft (see page 275). But it is a relatively small setback for a nation that has notched up a string of high-profile space successes in recent years, including this month's 'heavenly kiss' of two unmanned orbiters, Shenzhou-8 and Tiangong-1 — a milestone in the country's effort to build a manned space station, the Tiangong ('Heavenly Palace'), by the end of the decade.

And ambitious moves on the ground suggest that China will increasingly be able to develop and launch its probes without partnering with other nations. In July, the Chinese Academy of Sciences (CAS) in Beijing opened its National Space Science Center (NSSC), which will take charge of overall planning for the country's space science. "China was a space country without a space science programme," says Ji Wu, the centre's director. Now that the CAS "has got government support to manage space science missions as a series," he says, "it will lead to a new era for space science in China."

For years, the lack of a clear national strategic plan that prioritized missions has hampered researchers' efforts to launch space telescopes or planetary probes. The convoluted relationships between the various Chinese agencies involved in funding, building and launching

satellites impeded many mission proposals, and decisions about their fate were at best "opaque," according to one European researcher who has collaborated with Chinese space scientists.

Centralized planning under the NSSC could change that. The centre already has about 450 staff, including 50 scientists, inherited from its predecessor, the Center for Space Science and Applied Research, which last year had a budget of 300 million renminbi (US\$47 million). (Individual missions have separate funding.) That will grow to 700 million renminbi as the centre develops space science missions over the next few years.

First in the queue is an orbiting X-ray observatory, HXMT, with a budget of about 900 million renminbi and due for launch in 2014. Then there is the KuaFu mission, which aims to reach space the following year, to study the Sun's effects on space weather.

Later missions could fly on China's Long March 5 rocket, expected to enter service in 2014. Its ability to loft payloads of 14 tonnes into a highly elliptical orbit should allow China to launch interplanetary missions as large as Phobos-Grunt.

The NSSC's mission selection and planning procedure is "more or less the way we prepare missions at ESA," says Philippe Escoubet, a mission manager at the European Space Agency's (ESA's) Science and Robotic

"In twenty years, China will be dominating the United States."