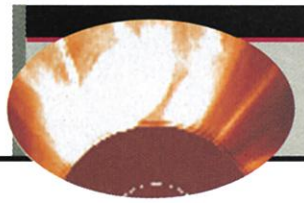
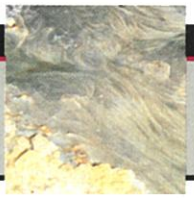


PAGE 1726
Tracking storms on the far side of the sun



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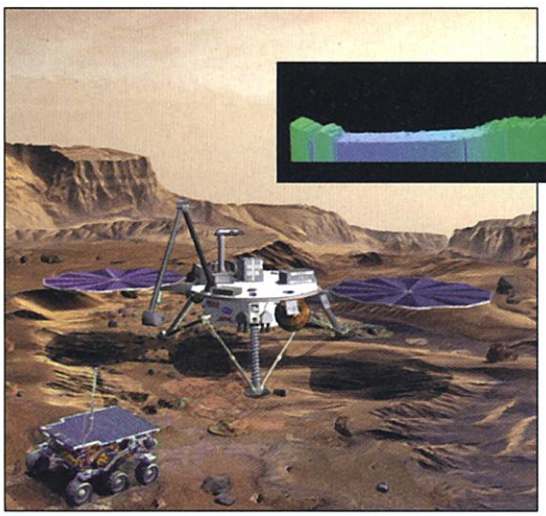
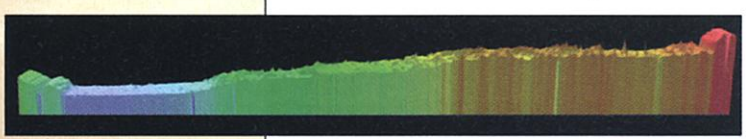
Bacterium with a taste for acid

SPACE SCIENCE

Reports Will Urge Overhaul and Delays to NASA's Mars Missions

In the Hollywood movie *Mission to Mars* released this week, a human trip to the Red Planet goes mysteriously awry, and a team from Earth must quickly attempt a daring rescue effort. A similar real-life drama is under way, with teams of engineers, scientists, and managers working around the clock to save not a stranded astronaut but NASA's troubled Mars research program.





Steep slope. The 2001 Mars lander pictured here likely will be postponed. Meanwhile, Mars Global Surveyor is providing a radical new look at martian topography *(above right)*.

At stake is a $1 billion effort stretching over a decade that aims to understand Mars's climate, examine the planet's resources, and search for signs of life. Following a 1996 report that a martian meteorite contained possible evidence of microscopic fossils (*Science*, 16 August 1996, pp. 864 and 924), NASA planned to launch an ambitious series of orbiting spacecraft and landers every 2 years, culminating in the return of a soil and rock sample to Earth in 2008. The fiery death of the Mars Climate Orbiter in September 1999 and the silence from the Mars Polar Lander 3 months later has shattered that plan. Now NASA is rushing to come up with a less daring but more realistic effort—one that agency officials warn will cost more and take longer to accomplish.

Prompted by the failures, NASA Administrator Daniel Goldin ordered a battery of internal and external reports to reevaluate the agency's direction (see chart). Most are due for public release next week. *Science* has learned that the blueprint to emerge from these still-confidential reports would add smaller spacecraft to the currently planned missions, set up a communications and navigation network around the planet, and provide a longer term vision to take Mars research to 2020. Sources familiar with the deliberations say the revised plan would also delay some science missions—such as the lander being readied for a 2001 launch—and cost $300 million to $500 million more than NASA originally estimated.

The Goldin-ordered reports will urge sweeping revisions in the way the Mars program is planned, managed, and executed. An independent panel chaired by former Lockheed Martin manager Tom Young is expected to criticize the Jet Propulsion Laboratory (JPL) in Pasadena for failing to manage the last two Mars missions adequately. It also will take both NASA headquarters and Lockheed Martin to task for their respective roles in the botched orbiter and lander projects. NASA officials are bracing for the worst. Goldin recently told his managers that the Young report will be the Rogers Commission of space science, referring to the devastating critique delivered by a panel that examined the 1986 Challenger disaster. Several congressional committees are eagerly awaiting the results of the Young panel and plan to hold hearings in the coming weeks to examine NASA's plans to recover from the two losses.

This debate over Mars exploration will likely prove very public and very painful for the space agency in the short term, but space science chief Ed Weiler and outside scientists stoically predict that the attention could pay off in the long haul. "It's a wake-up call. We have an opportunity to correct the mistakes we made," says Weiler, who adds that too little funding and too much complexity made the old Mars plan "an absolute disaster." Michael Drake, a planetary scientist at the University of Arizona in Tucson, agrees: "Everybody was deluding themselves that it would work."

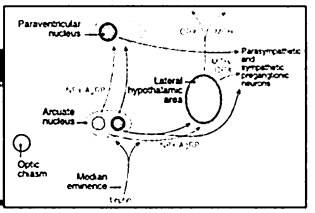
Indeed, until recently, that plan was seen by many NASA officials and academic scientists as ambitious but not unrealistic. The tentative evidence of microfossils in a martian meteorite triggered a wave of enthusiasm for exploring Mars that swept the public, the White House, and Congress. "The rock served us well by igniting public support, which translated into a greater budget and a new focus" on studying Mars, says Drake.

The result was a strategy for a series of missions ultimately aimed at returning a martian sample to laboratories on Earth as early as 2005, although the target date was later revised to 2008. A panel of the National Research Council concluded in 1998 that the Mars exploration plan was "a well-thought-out and rational approach to achieving NASA's programmatic goals." Although

PAPER MARS: NASA-COMMISSIONED REPORTS ON THE RED PLANET

Panel	Chair	Job
Mars Independent Assessment Team	Former Lockheed Martin manager Tom Young	Evaluate recent failures and new exploration strategy
Mars Missions Failure Board	Retired JPL manager John Casani	Investigate root causes of Mars orbiter and lander failures
Mars Architecture Team	JPL's Charles Elachi	Define new exploration strategy
NASA Faster, Better, Cheaper Task Force	JPL's Anthony Spear	Recommend ways to implement the faster, better, cheaper approach

CREDITS: (LEFT TO RIGHT) C. J. WASTE (JPL/NASA); MOLA SCIENCE TEAM



some researchers expressed concern about the pace and complexity of the missions, others were delighted with the program's newfound popularity.

But orbiting Mars is tricky; numerous Russian spacecraft have missed their target, and NASA's massive Mars Observer apparently exploded in 1993 as it reached its destination. Landing is even tougher, given the distance from Earth and the uncertainties about the martian terrain. And collecting samples, ferrying them to orbit, and rocketing them to Earth, as proposed in the sample return, has never been done.

Despite the odds, the 1997 success of Mars Pathfinder, with its innovative balloon landing and its tiny but indefatigable rover, raised hopes that NASA was up to the technical challenge. And the overall success of Mars Global Surveyor, despite some notable glitches, raised expectations that the 1999 missions would succeed. The subsequent losses of the lander and the climate orbiter stunned NASA managers and alarmed the scientific community.

The climate orbiter's demise was quickly pegged to a miscalculation in units made by contractor Lockheed Martin. The lander's fate, however, remains a mystery. "We still don't have a 100% smoking gun," says Weiler. A panel led by retired JPL manager John Casani came up with several theories, including the premature shutdown of the descent rocket, but none is certain.

In the aftermath, the finger-pointing has begun in earnest. Some scientists blame Goldin and the White House for pushing the program too hard and too fast with too little money. Others cite JPL's poor management of the projects and Lockheed Martin's underbidding of the Mars contract and problems on the factory floor. Weiler, however, says "everyone is to blame"—including the scientific community—for overconfidence.

A JPL-led panel chaired by Charles Elachi last week briefed NASA officials and the Young panel on their proposed new exploration blueprint. The most pressing issue is whether to launch the 2001 lander, which is roughly identical to the one that failed, or to scrap the launch and use the hardware for a later mission. Weiler said after the briefing that JPL suggests the latter and strongly hinted that he sees no other option. Flying the mission next year, he added, would require adding a hefty package of communications hardware to avoid the unknown fate that befell the December landing; this modification would reduce by half the amount of science the lander could perform and boost costs by another $30 million to $40 million. On the other hand, the 2001 orbiter will likely get a green light, because the failure last year of a similar spacecraft was easily explained and easily corrected.

The Elachi plan includes launch of a communications system and navigational beacons in the next few years to aid later orbiters and landers, while a series of "micro" missions would complement the larger landers by examining the planet more broadly, according to sources familiar with the details. A sample would likely not be returned to Earth before 2010. So far, however, Weiler is not satisfied with what he's seen of the Elachi plan, although he declines to be specific. "It's not even close," he grumbles, adding quickly that "it's a work in progress" and that "the people at JPL have made a good start." Weiler says that whatever the details, he will insist that the new plan include a contingency fund of at least 25%—far more than the current 10%—as well as funding for handling and studying the Mars samples. And he says that although "the sample return will be a major part of the new architecture, it will not drive it like the old one did." Hashing out the details may take until summer, he says. "Let's slow down and do this right. Taking it slow sometimes is better than speeding up—and screwing up."

Going slow is fine with many scientists who say they were nervous about the earlier plan. "If you delay a cycle or so, it's not a disaster," says David Black, an astrophysicist at Houston's Lunar and Planetary Institute. Michael Malin, a geologist who heads San Diego's Malin Space Science Systems, agrees. "Mars just isn't the place we thought it was," he says. "A slower, more deliberate and diversified scientific investigation program would be a better long-term investment than an Apollo-like race to return samples." So unlike the Hollywood version, NASA's Mars rescue mission likely will include more patience than daring.

–ANDREW LAWLER

CREDITS: (RIGHT TO LEFT) PE CORP.; SAM KITTNER

GENOME SEQUENCING

Talks of Public-Private Deal End in Acrimony

Any hope of getting publicly and privately funded scientists to work together on the human genome dissolved this week in a bitter dispute over who would control the raw data. The dispute went public on 5 March, when the Wellcome Trust, a British charity that funds genome research, released a letter spelling out the details of a controversy that has been simmering for months. As word spread that the trust had released the letter, tempers flared, triggering a flurry of finger-pointing as each side accused the other of sabotaging a potential collaboration.

The principals in the dispute seem to think the chances of mending the break are slim. "I'm pretty angry," says Tony White, CEO of PE Corp., chief backer of the private effort to sequence the genome. White even goes so far as to call the attitude of Francis Collins, director of the U.S. National Human Genome Research Institute (NHGRI), the chief U.S. funder of the public venture, "hypocritical." Collins was more restrained, calling the experience "disheartening." In retrospect, neither side was very eager to have the negotiations succeed.

Sparring partners. PE head Tony White *(left)* and NHGRI chief Francis Collins.

This is the latest and sharpest upset in a long-running dispute between scientists involved in determining the precise sequence of the 3 billion units of DNA in the human genome. PE Corp. of Norwalk, Connecticut, and its subsidiary, Celera Genomics of