Institute in Walnut Creek, California.

Over the past few weeks, Collins and Morgan have tried to mend fences. Most foreign groups are satisfied that they have been included now, according to Rosenthal, and Collins announced at the meeting here that the international teams have given their support. The Europeans and at least one Japanese group—a team led by Yoshiyuki Sakaki of Tokyo University—have signed up for the "working draft" concept and agreed, like other participants, to daily release of the DNA sequence they generate.

Speaking as "operating manager and field marshal" of the U.S. and British sequencers, Collins said that the major centers' performance in 1998 indicated they had enough capacity to produce a fivefold-redundant working draft human genome by next year. He noted that about 10% of the human genome has now been sequenced in final form and 7% more in draft, and boasted that the collaboration has met all of its milestones, "without exception." The project, Collins added, will be "more important than the splitting of the atom or going to the moon."

Collins, Richard Gibbs, director of the genome center at Baylor College of Medicine in Houston, Texas, and Marco Marra of Washington University in St. Louis described the logistics of the new strategy in some detail for an audience of several hundred scientists gathered here. The new plan will require tight coordination to sustain the rapid pace of sequencing, Collins explained. The five largest human genome centers, calling themselves the G-5, have agreed to use as their source material a clone repository at Washington University managed by John McPherson; it will also serve as a method of allocating the work.

Teams have been invited to choose the chromosomes they prefer to analyze, but each choice includes performance goals. Gregory Schuler of the National Center for Biotechnology Information recorded an initial chromosome list last week (see table) and plans to track each center's progress. These assignment could change, though. Members of the G-5 confer by phone every week, and the full consortium will review progress every 3 months. If a member stumbles, assignments (and funding) may be reallocated.

Genome scientists have never attempted a collaboration of this scale or rigor before, and it's not clear how well it will go. As Collins said, he and others are watching with "white knuckles." Several problems still lurk at the edges. One open question is whether the new automated capillary electrophoresis sequencing machines that the centers are now installing will increase the rate of output, as the users are hoping. The MegaBACE capillary machines made by Molecular Dynamics performed reasonably well in tests at the Sanger Centre but did not get praise from others at last week's meeting. Nor did the new Perkin-Elmer 3700 capillary devices, which will form the core of Celera's sequencing operation. Three major labs (Massachusetts Institute of Technology, Washington University, and Sanger) reported that the new 3700 machines—although they demand less human tending—have proved not much more efficient than their predecessor, the 377, which they were meant to outperform dramatically. Even so, MIT has ordered 115 of the Perkin-Elmer machines and Washington University an initial batch of 27.

Two more important issues also remain unresolved: how to measure the quality of a lab's output and how to get from the draft sequence to the fully finished version in 2003. Gibbs said that the G-5 teams have settled on a "provisional" quality index that uses software called "Phred" to count the number of acceptable bases per unit of DNA sequence produced. A final index will be established this summer. But the decision on how to finish the genome is "still in flux," according to Gibbs. He said it may not make sense to try to fill all the gaps in the working draft by reanalyzing previously sequenced clones. It may be more efficient, Gibbs suggested, to start afresh with new clones. At this point, Gibbs said, "we're not really sure" what the best tactic will be.

That's a puzzle the sequencers hope to solve over the next year—in their spare time.

–ELIOT MARSHALL

CREDIT: WILLIAM PHILPOTT/AP

PLANETARY SCIENCE

## A New Look at the Martian Landscape

Mars is 100 million kilometers away, but in at least one respect, we now know it better than our own familiar Earth. On page 1495 of this issue, planetary scientists present a precise map of martian topography, accurate around the planet to within 13 meters of elevation; some parts of Earth are known only to 100 meters or more. "We now have a definitive picture of the shape of the whole planet," says David Smith of the Goddard Space Flight Center in Greenbelt, Maryland, principal investigator of the instrument, called the Mars Orbiter Laser Altimeter (MOLA), that gathered the data from its perch aboard the Mars Global Surveyor spacecraft.

Thanks to MOLA, a diverse array of martian features has now snapped into sharper focus, including the polar ice caps and the plateaus and lowlands that hint at the processes that shaped the planet. "MOLA's maps allow you to settle issues once and for all that have been contested in Mars geology for 25 years," says Jeff Moore, a planetary geologist with the

## ScienceScope

**Embryo Taboo Broken?** President Bill Clinton may not be eager to receive it, but his National Bioethics Advisory Commission (NBAC) is ready to give him some provocative advice on human stem cell research. NBAC's draft recommendations—which hit the press last week—advise the government to end rules that now prevent federally funded researchers from deriving versatile stem cells from human embryos.

NBAC's opinion—likely to stir protest from antiabortionists—calls for a limited repeal of the current ban on embryonic stem cell research on grounds that it may be "unjust or unfair" in blocking potential medical benefits. NBAC aims to approve final recommendations in late June.

**Spy Threat** A new report has ratcheted up the pressure on programs that bring thousands of foreign scientists to the United States. This week, a House panel led by Christopher Cox (R–CA) released a long-awaited report concluding that China has used the exchanges to gather intelligence on U.S. nuclear weapons and supercomputers. It recommends that five agencies scrutinize the security risks and report to Congress by 1 July. Meanwhile, the National Academy of Sciences, the National Science Foundation, and the American Physical Society have warned against clamping down too tightly on exchanges, which some lawmakers want banned (*Science*, 7 May, p. 882).

Cox

**Less Ravenous ITER** Europe, Japan, and Russia continue to pursue a cheaper alternative to the moribund $10 billion International Thermonuclear Experimental Reactor (ITER). Last year, a U.S. pullout dashed hopes for the original fusion megaproject (*Science*, 9 October 1998, p. 209). This week, a new working group was to meet in Tokyo to begin mapping out a plan, sometimes called "ITER Light," that would run half the original cost or less.

Japanese officials say the ITER parties have ruled out the idea of scattering experiments among existing facilities. That means the panel will ponder a host of questions, such as a reactor's scale, cost, and location. It is not clear what combination will win out: "We don't know the positions of the other parties," says Hiroshi Kishimoto, director of Japan's Atomic Energy Research Institute and working group co-chair. The panel has until year's end to hammer out recommendations.

NASA Ames Research Center in Moffett Field, California. "We're seeing things that nobody had an inkling existed," adds Bruce Jakosky, a geologist at the University of Colorado, Boulder. "In a sense we're seeing the planet for the first time."

The new map was made by bouncing laser light off the martian surface and using its roundtrip time to determine distance. The map reveals a dramatic landscape of higher highs and lower lows than previously appreciated, with a total range in elevation of 30 kilometers (km), compared to just 20 km for Earth. The data confirm that the southern hemisphere is higher than the northern hemisphere—6 km higher, to be exact. That means that on Mars, "downhill is north," and if the planet had flowing water, the northern lowlands would drain a watershed comprising three-quarters of the planet, says co-author Sean Solomon of the Carnegie Institution of Washington, D.C.

This MOLA-eye view of Mars may also help resolve the genesis of its split geologic personality. Planetary scientists have long realized that Mars is lopsided—thin-crusted, low, and smooth in the north, and thick-crusted, high, and crater-scarred in the south. Conflicting explanations for the mismatched hemispheres include a huge asteroid impact that blew apart and thinned the crust in the north, or internal processes, such as Earth-like plate tectonics or a huge plume of molten rock rising from the interior that melted northern crust.

MOLA's data point in one direction. "We favor internal processes," says Maria Zuber, a co-author of the topographic analysis and a geophysicist at the Massachusetts Institute of Technology in Cambridge. Although MOLA found no direct evidence of plate tectonics such as mountain belts or earthquake faults, several features suggest an unprecedented amount of past volcanic activity, signaling a hot interior. For example, the Tharsis rise, a 4000-km-across bulging plateau that straddles the equator, appears to consist of two volcanic domes rather than one. And Olympus Mons, the biggest volcano in the solar system, is not a part of Tharsis as scientists believed, but rises off its western edge. "This argues for a broader mantle heat source for Tharsis than was previously thought," says Zuber. Added to the magnetic stripes recently spotted on Mars's surface (*Science*, 30 April, pp. 719, 790, and 794)—a possible sign of plate tectonics—the new evidence suggests that an internal, heat-driven process shaped Mars's spectacular topography, says Zuber.

MOLA's data also tend to refute the idea of a northern impact. The maps show no sign of a giant northern crater, and the north-south boundary is too irregular to be a circular crater wall. Instead, MOLA's team concludes that the boundary is a mosaic of regional effects, shaped by such factors as erosion, volcanism, and debris flung up from a southern impact.

Indeed, when it comes to impacts, "we've been looking in the wrong hemisphere," says Zuber. MOLA has discovered that the south's Hellas basin, 9 km deep and 2300 km wide, is surrounded by a giant ring of topography 2 km high that stretches 4000 km from the basin's center (see image). These highlands were likely raised by rock blasted out by the impact.

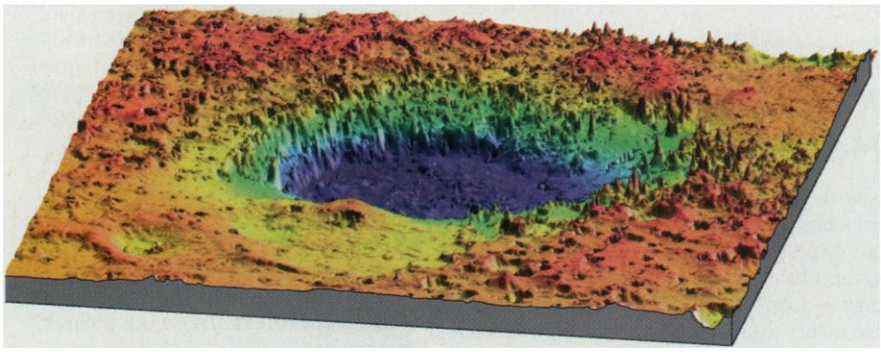
Other researchers aren't ready to discard the idea that an impact gouged out the north. "It's too soon to jump on a bandwagon," because either an internal mechanism or a megaimpact could produce planetary-scale changes in topograpy, says planetary geologist George McGill of the University of Massachusetts, Amherst. He adds that traces of even a massive impact could have been obliterated over billions of years.

But McGill and others say they are impressed with the data, which reveal a host of other details, including the size of the polar ice caps. The northern ice cap turned out to be smaller than expected, but MOLA found that the southern polar cap is surprisingly large, because although the visible cap is small, the topography suggests vast layered deposits of ice and dust. Assuming both caps are chiefly water ice, the MOLA team estimated a maximum ice volume of 4.7 million $km^3$—about one-third less than the previous best estimate—suggesting that much of Mars's water has either escaped to space or been sequestered underground.

MOLA will continue to collect 900,000 elevation measurements daily for the next 2 years, and researchers are now signing up to use the data for questions ranging from the location of ancient water reservoirs to the best places to land spacecraft. "I just can't wait until people have the opportunity to use this map," Zuber says.

–BERNICE WUETHRICH

Bernice Wuethrich is an exhibit writer at the Smithsonian's National Museum of Natural History.



CREDIT: MOLA SCIENCE TEAM

**High and lows.** An impact punched out Mars's giant Hellas basin, but the ejected material raised the surrounding highlands, as shown in this MOLA image (verticle scale exaggerated).

GENETICALLY MODIFIED FOOD

## Britain Struggles to Turn Anti-GM Tide

For the past year, debate has raged in the British media, on an almost daily basis, about whether genetically modified (GM) crops will harm the environment or if food made from them will harm the people who eat it. Clouding the issue were fears that U.K. regulations weren't adequate to protect the public, should those hazards be real. Now, in a move intended to restore public confidence in Britain's ability to regulate GM foods and crop planting, the government last week announced the creation of two new commissions to advise politicians on the long-term impact of genetic technologies on human health, agriculture, and the environment. To back up the pro-GM position it has maintained throughout the debate, the government at the same time released a report from its chief scientific adviser and chief medical officer, which examined the theoretical risks to public health from first principles and concluded that there was no "current evidence to suggest that the GM technologies used to produce food are inherently harmful." They did call, however, for a public health surveillance network that will quickly flag any problems that may arise among people eating GM foods, such as allergic reactions.

The tactics seem not to have worked, however. Newspapers reacted with headlines such as "GM measures scorned." Environmental groups were similarly scathing. While welcoming the greater openness the new commissions would produce, Friends of the Earth called the report "miserably inadequate." According to spokesperson Adrian Bebb, "We don't need another layer of committees. That will not solve anything."