umes of water, says study leader Robert Hazen of the Carnegie Institution of Washington's Geophysical Laboratory, they could have churned out enough ammonia to set the stage for life's beginnings—either at the surface, perhaps sparked by lightning, or at the vents themselves. "If these guys have come up with an abundant source of ammonia, that's an important step forward," says Ferris.

The new study isn't the first to propose a source of ammonia in the prebiotic Earth. Other teams previously suggested that ferrous iron dissolved in water or titanium dioxide particles in desert sands could have converted N_2 to ammonia. But these reactions probably would have been too slow to keep pace with the destruction of ammonia by the sun's ultraviolet rays as it wafted into the atmosphere.

Hazen wondered whether the high pressures and temperatures found at deep-sea vents could have sped things along. Such vents line the midocean ridges, where magma wells up to form new ocean crust. Cool water seeps through fissures in the crust, hits the superheated rock near the magma, and roars back upward at temperatures of up to 350 degrees Celsius. Iron and sulfur dissolved in the hot water then rain out as it emerges from the vent and cools, depositing minerals such as pyrite (FeS_2), pyrrhotite ($Fe_{1-x}S$), and magnetite (Fe_3O_4).

These minerals, Hazen thought, might act as catalysts for ammonia production. Testing the idea at present-day vents was impractical, because ammonia from microorganisms would swamp any ammonia made by the minerals. So Hazen, postdoc Jay Brandes, and their Carnegie Institution colleagues devised a laboratory test by combining a vent mineral, a nitrogen source such as N_2, nitrite (NO_2^-), or nitrate (NO_3^-), and water, then cooking the mixture at varying temperatures and pressures. The results were unambiguous. In most ventlike conditions, the minerals turned into little ammonia factories. At 500 degrees Celsius and 500 atmospheres of pressure, for example, pyrrhotite converted up to 90% of the nitrate to ammonia in just 15 minutes. At lower temperatures of about 300° to 350°C, Hazen says, the ammonia conversion was still as high as 70%. Even powdered basalt, the stuff of the sea floor itself, seemed to do the catalytic trick.

"It could be that this is the dominant mechanism" for forming ammonia on the early Earth, says Chris Chyba, an early Earth expert at the Search for Extraterrestrial Intelligence Institute in Mountain View, California, and Stanford University. Still, Chyba says it's hard to say exactly how much would have been produced, as so little is known about conditions in the planet's early days. But Chyba notes that if vents did churn out ammonia, this could help explain another mystery: the faint young sun paradox.

Researchers have long known that early in Earth history, the sun only put out about 70% of the light and heat it does today. The oceans and all other surface water should have frozen, yet life's early appearance on the planet suggests liquid water must have been present. Abundant ammonia resolves this dilemma, says Chyba, because as a powerful greenhouse gas it could have helped trap the sun's warmth. If so, Chyba says, "it suggests that there may have been an important synergy between subsurface and surface environments that helped life get its start."

—ROBERT F. SERVICE

U.S. FOREIGN POLICY

Panel Calls for Science-Savvy Diplomats

Diplomacy is often noted for its slow pace and bland language. But last week an unusually fast-moving National Academy of Sciences (NAS) panel offered the U.S. State Department some plain-spoken suggestions for improving the quality of the scientific advice available to makers of foreign policy. Although government officials say they welcome the input, many observers are skeptical that it will lead to significant changes.

The interim report* is the latest in a long line of well-meaning but often ignored reports aimed at helping the department cope with a growing array of technology-based issues, ranging from bioterrorism to biotechnology (*Science*, 15 May, p. 998). It comes less than 4 months after Secretary of State Madeline Albright asked for outside guidance on shoring up the diplomatic corps' sagging expertise in science and technology. In recent years, scientists have criticized the department for undermining its already slim scientific capabilities by abolishing embassy and headquarters positions once filled by science-savvy foreign service officers.

> "It's not difficult to get good scientific advice. ... The real trick is knowing when to ask for it."
>
> —Robert Frosch

The NAS panel outlines nine "immediate and practical" steps Albright could take to increase the State Department's sensitivity to science and technology issues. The suggestions range from appointing one of her five undersecretaries as a science czar who would integrate science, technology, and health issues into top-level decisions to creating a new external advisory board. A State Department official says senior administrators "are grateful that the committee responded in such a quick and highly focused manner" and are organizing a task force to "digest the report and examine its financial implications" as they assemble their request for the fiscal year 2000 budget.

But panel members say money shouldn't be an obstacle. "There are ways to do some of this on the cheap," says panel leader Robert Frosch of Harvard University's Kennedy School of Government in Cambridge, Massachusetts. For instance, Frosch says adopting a new policy on integrating scientific concerns into day-to-day diplomacy doesn't require new spending, nor would building closer ties to knowledgeable staff at other government agencies.

At the same time, the panel concedes that some solutions will cost money. One is to create about a dozen new positions at headquarters for science and health experts, with half assigned to the 130-person Bureau of Oceans and International Environmental and Scientific Affairs. The committee also proposed strengthening scientific posts at a handful of key embassies, as well as spending up to $500,000 per year on a scientific advisory board to help staff with cutting-edge issues, such as the impact of the Internet on foreign relations. The costs of making such moves, the committee concludes, "seem modest given the stakes involved."

Other recommendations are aimed at changing a State Department culture that has discouraged career staff from taking a professional interest in science. Becoming an embassy science attaché is often viewed as a "kiss of death" among foreign service officers hoping for promotion, says Frosch. To combat that trend, the panel wants the department to encourage young diplomats to learn more about the growing role of science in foreign affairs and to provide a career ladder for scientifically literate employees. Details will be included in the committee's final report, due out sometime next year.

In offering its suggestions, the NAS panel acknowledged that it's not the first committee to offer suggestions for injecting more science into foreign policy. "Over the years, the department has gotten a lot of advice on

* "Improving the Use of Science, Technology, and Health Expertise in U.S. Foreign Policy," an interim report of the National Research Council Committee on Science, Technology, and Health Aspects of the Foreign Policy Agenda of the United States (http://www.nap.edu/readingroom/enter2.cgi?NI000955.html)

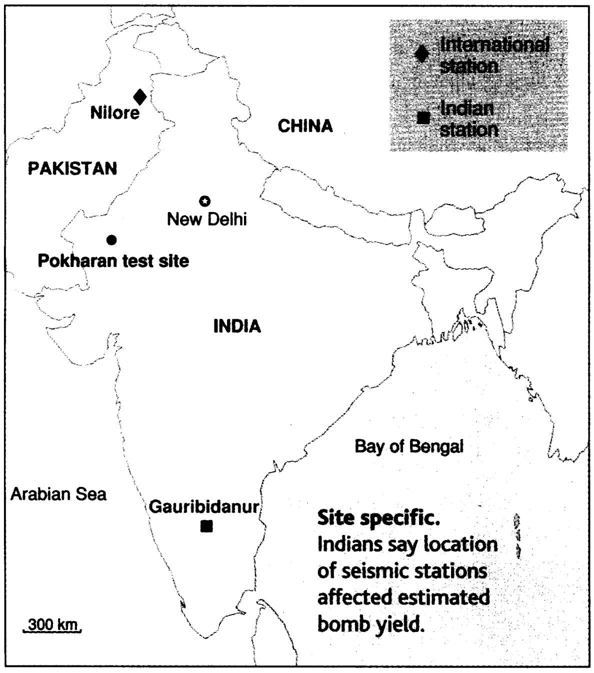
this subject," Frosch says, citing about three dozen reports in the last 50 years. But he thinks the department is more receptive to technical advice now than in the past. "It's not difficult to get good scientific advice in Washington—you have to bob and weave to avoid it," Frosch says. "The real trick is knowing when to ask for it." And State Department officials say that this time they are listening closely: "The Secretary asked for it, so we are taking [the report] very seriously," says one diplomat. —DAVID MALAKOFF

NUCLEAR TESTING

Size of Indian Blasts Still Disputed

Four months after India and Pakistan surprised the world with twin sets of nuclear bomb tests, Indian and U.S. scientists remain sharply divided over the actual size of India's explosions. The debate—which flared up this week in two new papers—could affect the international test ban agreement, as its enforcement depends on the ability to detect even small nuclear tests with confidence.

In a Policy Forum published this week in *Science* (p. 1967), a group of 19 academic and U.S. government seismologists calculate that the yield from the 11 May Indian event—the larger of India's two sets of tests—was 9 to 16 kilotons with 50% uncertainty. (The Indian government reported that three devices were exploded simultaneously that day, the largest a fusion device.) However, a group of physicists at India's Bhabha Atomic Research Centre (BARC) in Mumbai claims this estimate is too low by a factor of 4. In a paper appearing in the 10 September issue of the Indian journal *Current Science*, Satinder Kumar Sikka and his colleagues in BARC's high pressure physics division report that the international monitoring system grossly understated the blast sizes by failing to account for the seismic patterns created by the overlapping explosions. Based on a computer analysis of the seismic recordings, they say the actual yield was 58 kilotons, even larger than the initial report of 55 kilotons.



Site specific. Indians say location of seismic stations affected estimated bomb yield.

SOURCE: INDIAN GOVERNMENT/IRIS

Neither the Indian nor U.S. paper casts any new light, however, on the most controversial test in last spring's series. That is the two low-yield explosions India says it detonated 2 days later, on 13 May. Indian officials said at the time that these small tests released nuclear energy equivalent to about 800 tons of TNT. But they produced no signals on remote seismic sensors, and some U.S. researchers concluded that no nuclear blast had occurred (*Science*, 26 June, p. 2038). The authors of this week's *Science* Policy Forum estimate that a blast larger than 30 tons would have been detected but that one 10 times larger could have escaped detection if detonated in sand, as reported. The BARC scientists do not mention this test in their analysis.

The U.S. seismologists base their estimate of India's 11 May test on earthquake data, an analysis of local geology, and a compilation of seismic recordings from dozens of stations around the globe. The BARC researchers argue, however, that seismic waves from the blasts may have interacted to produce misleading, attenuated signals at remote sites. Sikka, Falguni Roy, and G. J. Nair note that the major explosions on 11 May took place in two shafts separated in an east-west direction by 1 km. (A much smaller device was exploded in a third shaft 2.2 km away.) Delays between surface waves from these sites, Sikka told *Science*, could create "destructive interference of the waves in the east-west direction" as well as "constructive interference in the north-south direction." This could explain, he says, why some seismic stations—particularly those on an east-west line from the test site—actually recorded smaller signals. The BARC scientists say this phenomenon also explains a 30-fold variation, roughly three times larger than expected, in the size of the compression waves from the blasts.

In an effort to calculate the "true magnitude" of the signal created by the 11 May test, the BARC research team analyzed data from 51 stations of the International Data Center in Arlington, Virginia, and concluded that seismic stations east and west of the Indian test site at Pokharan (which recorded smaller signals) were not as reliable as those to the north or south. The BARC researchers combined information from the Indian seismic array at Gauribidanur (see map) with data from a select group of 11 other stations, excluding many stations that their paper says "could have underestimated the true [seismic wave]," to peg the magnitude at 5.4 on the Richter scale, not 5.0, as claimed by the U.S. group. Sikka says averaging the data is misleading but that it serves the interests of some seismologists: "They want to belittle our tests; at the same time they want to defend [the credibility of the seismic monitoring system]."

Terry Wallace of the University of Arizona, a senior author of the *Science* paper, says the BARC scientists "are choosing arguments clearly designed to make the yield as large as possible." He added that "half a dozen" teams of sesimologists participating in a Defense Department conference this week had reached roughly the same conclusion as his group: The upper bound on India's 11 May tests is 25 kilotons. A colleague, seismologist Jeffrey Park of Yale University, adds that most of the arguments presented in the BARC paper have been considered "very carefully" in the past. "There are some novel elements in the BARC paper," he notes, but "I don't find them persuasive." Sikka says his team is still analyzing cores from the test site for a more accurate measure of the yield.

—PALLAVA BAGLA,
WITH REPORTING BY ELIOT MARSHALL

Pallava Bagla is a correspondent in New Delhi.

SCIENTIFIC COMMUNITY

Two More Scientists Died in Swissair Crash

The crash of Swissair flight 111 on 2 September claimed the lives of two prominent scientists who were not included in our initial coverage of the tragedy (*Science*, 11 September, p. 1587). Also aboard the flight were Eugenia Spanopoulou, an immunologist at Mount Sinai Medical School in New York City, and Thomas Kreis, chair of the Department of Cell Biology at the University of Geneva. Spanopoulou's research focused on the role of the immune system's recombination activating genes, *RAG-1* and *RAG-2*, in generating antibody and T cell receptor diversity. Spanopoulou, who was traveling with her husband and 16-month-old son, was selected as a Howard Hughes Medical Institute investigator and joined the institute last year. Kreis was an internationally known authority on proteins that regulate membrane traffic in cells.