■ **Numbers.** Over 100 countries now report cases of AIDS to the World Health Organization (WHO) in Geneva, for a global total of more than 50,000 cases. Based on these admittedly incomplete data, Jonathan Mann of WHO projects that 500,000 to 3 million people will develop AIDS by 1992. In the United States, Curran reports that more than 36,000 people have AIDS and that over 21,000 have died from it. He estimates that about 1.5 million are now infected and that an average of 1 in 30 men between the ages of 20 and 50 carries the virus, a projection that varies widely with geographical location and risk factors.

■ **Assessing the extent of infection.** "The most common question I get is, How many people in the United States are infected with HIV?" said Curran in his address to participants at the AIDS conference. "I don't know. It's extremely difficult to learn the precise number of people infected with the virus . . . and the reason is that studies to do this require sampling of the general population. The general population, as we know consists of homosexual and bisexual men, intraveneous drug abusers, people from other risk transmission categories, as well as heterosexual men and women. Surveys often either undersample or oversample these categories and often do not ascertain accurately which category people belong in."

■ **Protest.** No country has a method for determining the exact number of persons infected with the AIDS virus. Whether such a mechanism should exist is a matter of considerable debate. President Ronald Reagan's announcement on the eve of the AIDS meeting—that immigrants, prisoners, and marriage license applicants should undergo routine screening for antibodies to the AIDS virus—sparked numerous protests.

Dissenters fear discrimation, in jobs opportunities and the ability to obtain health and life insurance, for example. And in the absence of any legislation at a national level that protects the civil rights of people who test positive for the virus, these concerns are well founded. Additionally, a one-time negative test for antibodies against the AIDS virus is not a guarantee that the individual is free of infection, because a recently exposed person may take several months to develop antibodies. If national legislators have considered what should be done after the test results are in their thoughts are not reflected in any part of the public record.

Taken together, these data on the epidemiology of AIDS show how incomplete an understanding yet exists about the disease and therefore how difficult a comprehensive national policy will be to formulate. ■

DEBORAH M. BARNES

Geophysics Smorgasbord Was Spread in Baltimore

Geophysicists specializing in everything from atmospheric science to volcanology converged on Baltimore for the spring meeting of the American Geophysical Union held 18 to 21 May. The range of fare was huge, but here is a sampler: two high-energy phenomena—nuclear testing and the less frequent cratering by large impacts—and an imperceptibly slow process—the motion of the tectonic plates.

Direct Measurements Confirm Plate Tectonics

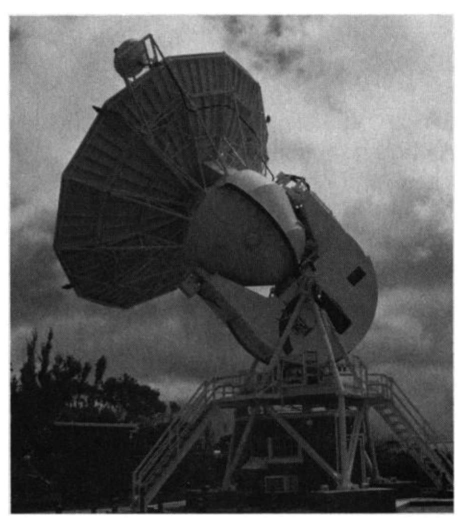
For any doubting Thomases out there, the final word is in—plate tectonics is real, the continents do drift the way the theory predicts. Fixist models of Earth and variations on plate tectonics, such as an expanding Earth, can be put to rest.

The deciding evidence comes from the precise measurement of distances across plate boundaries made by the technique of very long baseline interferometry (VLBI). At the meeting James Ryan of Goddard Space Flight Center in Greenbelt, Maryland, reported the latest VLBI results from the Crustal Dynamics Project operated by the National Aeronautics and Space Administration. In a subprogram of the project called the Great Alaska-Pacific Experiment (GAPE), large radio antennas in western North America, the central Pacific, and Japan were used to record radio noise from immensely distant quasars that act as stationary reference points. The millisecond differences in the arrival times of the same signals at different sites yielded the distance between receivers.

Thanks to the relatively high speed of the Pacific plate, there is no doubt that real plate motion has been detected. After only 3 years of observation, Ryan noted, the calculated shortening of the distance between Hawaii and a site near Fairbanks in central Alaska appears to be 52.3 ± 5.5 millimeters per year. Hawaii is moving toward Japan at a rate of 83 ± 8 millimeters per year.

Although researchers have been trying for years to determine how much larger than such formal errors the true error is, no one doubts that the observed rapid movement far exceeds any possible error. In addition, the GAPE sites are moving much the way plate tectonics predicted. Hawaii, for example, is moving 83 millimeters per year to the northwest (a course of 322°) if Fairbanks is considered stationary. Previous analyses of the magnetic stripping of the ocean floor and other geologic evidence showed that in the geologic past Hawaii had moved at 90 millimeters per year to the northwest (320°). Around the Pacific, observed rates are tending to be a few millimeters per year less than the geologic rate, but so far GAPE researchers do not consider the differences significant. A few more years of observation will be required before any real differences might be discerned.

In the Atlantic things are much slower moving, but VLBI researchers, despite their conservative nature, are conceding that they have probably detected plate motion there as well. A consortium of Crustal Dynamics Project researchers from one European and six U.S. institutions recently stated in print that they have measured the opening rate between North America and Europe as 17 millimeters per year. The geologic rate is also 17 millimeters per year. After a considerable analysis effort, they placed an upper limit of 10 millimeters per year on the rate's true uncertainty. According to consortium member Thomas Herring of the Harvard-Smithsonian Center for Astrophysics, that is "very strong evidence of plate motion."



Nasa

On the move. *This VLBI antenna on the island of Kauai in Hawaii is moving 8 centimeter per year toward Japan.*

These VLBI results would seem to eliminate once and for all alternatives to the broad scheme of moving plates that was widely accepted almost 20 years ago. Plate tectonics accommodates the measured opening of the Atlantic with sea-floor spreading at the Mid-Atlantic Ridge, and the encounter between the Pacific plate and the largely continental North American and Eurasian plates naturally leads to the predicted subduction of the Pacific plate along the northwest Pacific rim. The alternatives generally preclude sea-floor spreading, subduction, or both. The expanding Earth hypothesis, for example, allows for sea-floor spreading that accommodates the increasing surface area of the globe but predicts that there is no subduction. But then, the dissenters have been nothing if not resourceful. There may yet be new alternatives.

Do Tectonic Plates Drive Themselves?

Now that the drift of continents and the plates that carry them has been measured directly, it would be nice to know what makes it all go. According to recent results from one computer model of plate driving forces, the plates may provide their own motive force.

Donna Jurdy of Northwestern University, Michael Stefanick of Science Systems and Applications, Inc., in Seabrook, Maryland, and John Harper of Victoria University of Wellington, New Zealand, reported that the pull of ocean plate edges sinking into the mantle may provide sufficient force. In their model, the positions, sizes, and velocities of plates in the past are reconstructed from the magnetic record of the sea floor. Jurdy and her colleagues then assumed that only the drag at the base of plates, which can be calculated from the reconstructions, resists plate motion. Recent results from the scientific drill hole at Cajon Pass near the San Andreas fault support the absence of large amounts of drag at plate-plate boundaries.

To balance plate drag, they chose the pull of oceanic plates that have cooled so much since their formation that they are dense enough to sink into the mantle at deep-sea trenches. This slab pull, the magnitude of which depends on the length of the subduction zone and rate of subduction in the reconstruction, plus a proportionally smaller trench suction force induced by subduction were the only forces driving the plates.

When the slab weights of the model were allowed to adjust themselves until the best balance was achieved, plate drag and subduction driving forces achieved an excellent balance in each reconstruction of 10- to 15-million-year periods back to 48 million years ago. During the 20 million years before that, resistive and driving forces could not be brought anywhere near a balance point, probably because the reconstructions became inaccurate.

The surprisingly good balance achieved without including driving forces from sea-floor spreading, mantle convection, or other sources implies that the potential energy of cold ocean plates can drive plate tectonics, says Jurdy. "In the model, the plates are driving themselves," she says. More model runs will be used to explore whether the addition of minor forces would improve the balance.

The Soviet Mantle and Nuclear Test Monitoring

Keith Priestley, David Chavez, and James Brune of the University of Nevada reported at the meeting that their unprecedented seismic monitoring within the Soviet Union should help resolve whether the Soviets have violated the Threshold Test Ban Treaty. The Nevada group found that seismic waves passing beneath the principal Soviet nuclear test site in eastern Kazakhstan east of the Caspian Sea suffer far less diminution than those passing beneath the U.S. Nevada Test Site. Such a small amount of seismic attenuation would imply that official U.S. estimates from seismic data of the size of Soviet tests are likely too large and that the Soviets have probably not exceeded the 150-kiloton limit of the treaty.

The Nevada group probed the mantle beneath the Soviet test site with seismic waves generated by distant earthquakes and recorded at three monitoring sites installed in Soviet territory. These installations were built within about 150 kilometers of the Kazakh site under a cooperative agreement between a U.S. environmental group, the Natural Resources Defense Council, and the Soviet Academy of Sciences. Most of the moderate earthquakes in the study were located along the Pacific rim from the Aleutian Islands to Indonesia.

When the Nevada researchers compared the apparent magnitudes of the earthquakes as recorded at the the Kazakh sites with those determined from seismographs around the world by the National Earthquake Information Service, they found the Kazakh magnitudes to be 0.2 magnitude unit higher. That would mean that the mantle beneath the site is cold enough that it absorbs less seismic wave energy than does the mantle beneath the typical global network site. The Nevada test site, on the other hand, sits over warmer than normal mantle and has a negative bias with respect to the global network—apparent magnitudes from a site there are 0.2 magnitude unit smaller, according to the group.

The total bias determined by the Nevada group of about 0.4 magnitude unit is twice the 0.2 unit bias assumed in official test yield estimates used by the Reagan Administration. The Administration claims that as many as ten Soviet tests have exceeded the 150-kiloton limit, but the low bias estimate could inflate yield estimates of 150-kiloton explosions by about 100 kilotons, notes Priestley. Such low bias estimates, he says, are based on limited data of far lower quality than used by the Nevada group.

There are questions about remote test site monitoring other than the transmission qualities of the mantle. The primary one is how efficiently the earth converts the energy of a nuclear blast into seismic waves. The efficiency of coupling undoubtedly differs between the two sites, the Nevada shots being in soft volcanic tuff and the Soviet shots being in hard granite. Priestley thus suspects that any bias in assumed coupling efficiencies would probably favor an overestimation of Soviet yields. The question would be settled if the Soviets released the yield of one of their tests, but *glasnost* has not yet progressed quite that far.

Impact Cratering Looks Clustered, Not Periodic

Once the claim was made from evidence in the fossil record that biological evolution has been punctuated by mass extinctions every 26 million years, the search was on for periodicities in other records that would provide clues to the cause of such regular mass killings. Virgil Sharpton of the Lunar and Planetary Institute in Houston and Richard Grieve and Alan Goodacre of the Geological Survey of Canada in Ottawa reported that despite claims to the contrary, the record of large impacts on Earth shows no reliable signs of periodicity.

The geological record may appear nonperiodic, but that could still be the fault of the record itself; it is a poor record indeed, Sharpton noted. To illustrate his point, he discussed their search for periodicity in two different sets of craters, one selected by Grieve, Sharpton, Goodacre, and James Rupert of the Geological Survey of Canada, and the other by Eugene Shoemaker and Ruth Wolfe of the U.S. Geological Survey in Flagstaff. Both groups set the same general criteria for crater size, age, and age uncertainty, criteria intended to weed out unrepresentative or poorly documented craters.

The independent culling of the cratering record of the past 250 million years yielded two rather different data sets. One contained 25 and the other 27 craters, with 20 craters common to both lists. But only 10 of those 20 craters have the same ages in both lists. The problem is in the selection of the best age for a crater from all the possibilities in the literature. The mean age uncertainty of the lists is about 5 million years, but that includes analytical error only. There is obviously additional error. For example, Gosses Bluff crater in Australia had an age uncertainty of 0.5 million years in one list and 3 million years in the other, but its ages differed by 9.5 million years.

The apparent periodicities extracted from the two records differed as well. Sharpton's list yielded a periodicity with a period of 18.5 million years having confidence limits greater than 95%. No period had a significance exceeding the 99% confidence limits, as periods from earlier data sets had, and no period appeared near 30 million years. The Shoemaker and Wolfe list did yield a period of 30 million years with a confidence limit of greater than 95%. But when Sharpton searched for shorter periods, he also found a period of 16 million years that was even more significant.

Sharpton believes that a single cluster of four craters slightly younger than 40 million years plus the tendency of recent craters to have an unduly large representation on the lists accounted for the observed periods. He finds no merit in the recent suggestions that the record may appear so poor because the periodic component is only 50 to 30% of the total, the rest being random impacts. If that were the case, Sharpton said, the assignment of reasonable errors would eliminate the significance of any period. "You can play with statistics forever, but to resolve whether there is any geological significance to it, we need to go to the field."

In the next talk, Peter Schultz of Brown University and Seth Posin of Arizona State University carried the discussion to quite a far distant field. They searched the cratering record of the moon for any signs of periodicity, on the assumption that on an airless, waterless world the cratering record could be more complete. Combining Apollo dating of three craters with counts of craters 20 to 100 meters in diameter in Apollo and Lunar Orbiter images, Schultz and Posin found times when craters larger than 1 kilometer were particularly abundant. The clusters have ages of about 2, 7, 10 to 30, and 60 to 80 million years. Schultz sees this as evidence for clustering, not periodicity. ■

RICHARD A. KERR

Soviet Space Science Opens to the West

Even as prospects are looking up for Soviet-American cooperation in space, the Soviet Union is becoming remarkably more open about its space program; a visit to the Space Research Institute suggests that something more than glasnost *is at work*

IN the spring of 1987, the prospects for Soviet-American cooperation in space appear brighter than they have for years. First, a formal framework is now in place: on 15 April, U.S. Secretary of State George P. Shultz and Soviet Foreign Minister Eduard Schevardnadze signed a new space cooperation agreement during Shultz' visit to Moscow (page 1430).

Second, American space scientists generally seem eager for increased cooperation—especially now, when the Challenger accident has left so many U.S. spacecraft stranded on the ground. The Reagan Administration allowed a previous space cooperation agreement to lapse in 1982 as a protest against the imposition of martial law in Poland; since then, U.S. and Soviet researchers have had to make do with informal, scientist-to-scientist contacts. But with a renewed agreement, say researchers contacted by *Science*, the way has been opened for more substantive collaboration, perhaps culminating in a joint Mars Sample Return mission to bring martian rocks back to terrestrial laboratories—and perhaps even in a joint manned expedition to Mars after the turn of the century.

Finally, the Soviets themselves seem willing. Roald Z. Sagdeev, director of the Space Research Institute in Moscow (abbreviated IKI in Russian), a member of the Soviet Academy of Sciences, and by all accounts the dominant figure in Soviet space science, has repeatedly stressed that a multibillion-dollar Mars Sample Return mission almost demands international cooperation. "It would be very difficult to afford such missions," he said during a recent visit to Stanford University. "Maybe only our two countries could do it—America and Russia. But even in this case, I think there is a great deal of necessity to join efforts."

However, the very fact that the prospects for cooperation look bright makes it all the more important for American space scientists to understand what their Soviet counterparts are up to. Not so long ago, for example, the Soviets would not even announce their missions until they had been successfully launched. But just within the past few years—and in fact, beginning well before the ascendancy of Soviet General Secretary Mikhail Gorbachev in March 1985—their space science programs have begun to operate in an atmosphere of remarkable openness. Western journalists are freely being invited to visit IKI, which manages most of the Soviet space science missions. And Western scientists are freely being invited to place instruments aboard the spacecraft and to help plan the missions.

At the same time, the Soviets have committed themselves to an exceptionally vigorous space science program, especially when it comes to their flagship planetary missions. Western observers agree that the Soviets' recent VEGA mission to Halley's comet was scientifically and technically impressive by any standard. Moreover, the Soviets' Phobos mission (page 1428), due for launch in the summer of 1988, is only the first in a series of increasingly ambitious missions to Mars, a series that may well culminate in a Mars Sample Return mission by the late 1990s. "You can sense a buoyancy there [among Soviet space scientists]," says one recent visitor from the United States. "They act as if they are on a fast track, as if they have a green light through the year 2000. The contrast with the mood at NASA [the National Aeronautics and Space Administration] is black and white."

That contrast has only been underscored by the successful test launch of the Soviets' Energia booster on 15 May. The Energia, which can place as much as 100,000 kilograms of payload into orbit with a single launch—three times the payload of the space shuttle—rivals the Americans' now-defunct Saturn 5 in lift capacity and is currently the most powerful rocket in the world. Among its possible payloads are new and larger manned space station modules, as well as advanced planetary missions.