On the other hand, the observation is still ambiguous. "We're quite sure we see a ridge of emission," says Morris, "but we're not sure that it's a jet." Not only does it fail to line up exactly with the center, he cautions, but it only appears in an image made at the relatively low frequency of 160 megahertz. Such a ridge might easily be the result of an accidental gap in the intervening galactic material. However, the VLA will soon have the capability to take data at 327 megahertz, where the ridge should also show up clearly. "And then," says Morris, "we'll go at it hammer and tongs."

The threads resemble nothing else in the galaxy

Finally, there are the central region's most mysterious new features, which Morris and Yusef-Zadeh have dubbed "threads" (*4*). The name is apt. The threads—there are at least three of them—are more than 30 parsecs long and less than 0.5 parsec wide. They are dim, gently curved, and quite smooth. And they differ from the filaments of the arc in that they are isolated. Indeed, although they do appear to cross the arc, they are not obviously associated with anything else in the region.

So what are they? Aside from some vague guesses about magnetic fields, says Morris, "We've essentially thrown up our hands." If the threads are shock fronts, why are they so long and uniform? If they are jets, where is the source? If they are the wakes of fast-moving objects of some kind, why do they bend away from the nucleus? One would expect the paths of moving objects to bend *toward* the nucleus because of the concentration of mass there.

Of course, it is always possible that the threads are actually much closer to us than the galactic center, and just happen to lie along the same line of sight. But that implies that a unique set of objects just happens to lie in front of a unique region in the galaxy, says Morris, which seems an outrageous coincidence. And in any case, it still would not explain what the threads are.

—M. MITCHELL WALDROP

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Predictable Quake Damage

The elements that combined to create the Mexico City disaster are all too familiar to earthquake engineers and seismologists. Indeed, the devastation there might have been predicted almost 30 years ago; observers had recognized the vulnerability of the central city after the 1957 earthquake. This time, the shock was stronger and lasted a bit longer than usual, but the sequence of events followed the expected pattern.

If there was anything unusual about the earthquake itself, it was how mildly it shook the ground along the coast where it was centered, 300 kilometers from Mexico City. James Brune and John Anderson of the University of California at San Diego and their Mexican colleagues Jorge Prince and Krishna Singh managed to capture this great earthquake (magnitude 8.1) in a network of seismographs designed to record the strongest shaking without going off-scale. That is a first in strong motion seismology. Surprisingly, the maximum acceleration of the ground as it shook back and forth was only 0.16 that of gravity. Seismographs that had happened to be triggered by other large earthquakes in subduction zones, where ocean crust dives beneath continental crust, had recorded peak accelerations as high as $0.8g$.

Brune suspects that the relatively low acceleration may be typical of a subduction fault rupture buried 25 to 30 kilometers below the surface that fails to touch off other ruptures near the surface. In part because of this relatively mild shaking, there was little damage along the coast. With increasing distance from the earthquake epicenter, the seismic waves became weaker, the peak acceleration dropping to $0.03g$ 100 kilometers outside Mexico City.

Such attenuated shaking could have done little damage without being amplified, but, as observed after the 1957 earthquake, Mexico City is all too effective an amplifier of certain seismic waves. The key to the amplification is the matching of fundamental modes of vibration of the soil beneath the city and of the buildings with certain of the seismic waves. As an example of a fundamental period, an A tuning fork vibrates with a period of 1/440 of a second that is determined by its size, mass, and composition. However it is hit, the fork vibrates with that period. A building behaves much the same way, flexible 5- to 15-story buildings swaying with a period of around 2 seconds when struck by wind or earthquake. By chance, a column of lake-bed sediments in central Mexico City also had a fundamental period of about 2 seconds by dint of its effective depth and composition.

When 2-second seismic waves begin shaking such soil, a resonance exists that amplifies the shaking, just as properly timed, periodic pushes of a swing will drive it into larger and larger arcs. Thus, the waning $0.03g$ acceleration jumped to $0.2g$ on the old lake bed, throwing the ground back and forth 40 centimeters every 2 seconds, a total of 15 to 20 times. That is a lot of shaking for Mexico City, but other great earthquakes have struck the neighboring coast. The only distinctive characteristic of this earthquake may be its complexity, according to Hiroo Kanamori and his colleagues at the California Institute of Technology. This event had two pulses instead of one, which might have lengthened the time of strong shaking.

Once resonance between intermediate-height buildings and the soil further amplified the shaking, the next element in the disaster, inadequate construction, came into play. Edwin Johnson of Atkinson, Johnson, and Spurrier in San Diego, a member of the U.S. team that surveyed the damage, lists at least 20 design and construction practices that contributed to the damage. It is a litany ranging from inadequate foundations—a crucial failing in Mexico City's soft, subsiding ground—to unreinforced masonry that is familiar from reports following the 1957 earthquake and others elsewhere. "What we really had was a recitation of old lessons that we have learned time and time again," he says.

Although staggering when viewed through the camera lens, the Mexico City disaster was a limited one. Only 250 buildings collapsed out of a total of 600,000 or more structures in the city; about 1 percent of the city suffered heavy damage. A great earthquake can be much worse.—RICHARD A. KERR