Great quake in Bolivia rings Earth's bell

Seismologists set the snares 2 decades ago, stringing detectors around the world to catch the next great earthquake deep within the planet. But they had to wait until last week before their prey finally tripped the trap. On June 8, a magnitude 8.2 quake emanated from 600 kilometers below Bolivia, punching the planet hard enough to set it ringing like a bell for months on end.

The Bolivian quake packed more power than any other jolt in the last 5 years. But the tremor has an even rarer pedigree; its focus lay especially deep, which reduces the quake's danger and increases its scientific usefulness. The shock caused damage but no known deaths.

"This must be the biggest of the century for deep-focus earthquakes," says seismologist Hiroo Kanamori of the California Institute of Technology in Pasadena.

The quake was felt in much of North America, even as far away as Seattle – a fact that has puzzled geophysicists. "This is the first time we know of that a quake in that part of South America was felt in North America," says Bruce W. Presgrave of the National Earthquake Information Center in Golden, Colo. He suspects that the quake's depth contributed to the widespread shaking.

Geoscientists say the quake will prove most important for studies about the structure of inner Earth. Because the core and mantle remain hidden from view, researchers interested in these regions must wait for large earthquakes to provide indirect information about the planet's interior.

Like a bell, Earth has its own natural frequencies – or normal modes – which start ringing if the globe is hit hard enough. The most persistent of these modes causes the planet to expand and contract every 20 minutes, almost as if it were breathing. Scientists can detect this mode even 3 months after a great quake.

Deep earthquakes have proved especially useful for normal-mode studies because they don't produce many surface seismic waves, which mask important overtones. Overtones provide information about the density of Earth's innards – a factor that ultimately controls how currents of rock inside the planet move the continents around the surface.

"An event like this can allow us to sample modes that haven't been observed since 1970," says T. Guy Masters, a seismologist at the Scripps Institution of Oceanography in La Jolla, Calif.

The last great, deep earthquake struck below Colombia in 1970 and led to unprecedented discoveries about Earth's interior. After that jolt, scientists set up networks of seismometers capable of detecting the long-period vibrations of the normal modes. Then they waited.

"It's depressing that you can spend 20 years of your life dealing with shallow earthquakes or small, deep earthquakes and trying to add [up all these data]. And you still don't get as much of a signal as you do out of one earthquake like this. This is really going to change the level of our information about the deep Earth," says Masters.

Seismologists were especially pleased that no large quakes occurred soon after the Bolivian jolt, because that would have drowned out interesting overtones.

Earthquakes typically do not occur deeper than 20 to 25 km, because the hot rock below that level bends rather than breaks. The Bolivian quake took place in a special region where a piece of former ocean floor – called the Nazca plate – has sunk into the mantle in a process called subduction.

Scientists have yet to unravel exactly what causes these deep jolts. In fact, researchers met this week on California's Catalina Island to discuss the problem. According to one prominent theory, deep tremors occur when increasing pressures cause minerals in the ocean crust to undergo a sudden structural transformation. For answers to this problem and many others, scientists will now start sifting through the bounty provided by the Bolivian quake. – *R. Monastersky*

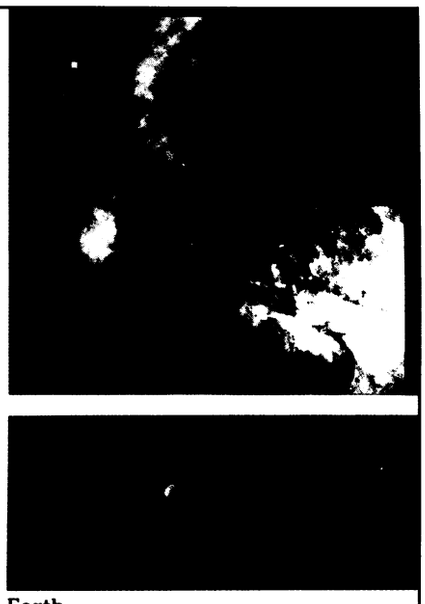
Hubble eyes disks that may form planets

New images suggest that disks of dust and gas – the raw material for making planets – surround at least half the stars in the nearby Orion nebula. If the disks in this crowded stellar nursery survive long enough, the material they contain could condense into planet-size bodies within a few million years, says C. Robert O'Dell of Rice University in Houston.

O'Dell, who worked with Zheng Wen of the University of Kentucky in Lexington, bases his conclusion on images taken with the repaired Hubble Space Telescope's new wide-field and planetary camera. In its survey of 110 Orion stars, most with a mass equal to or less than that of the sun, the instrument revealed that dusty disks surround 56 of them.

The new observations aren't the first evidence of protoplanetary disks. Ground-based and satellite observations of several starbirth regions in the Milky Way have detected excess infrared radiation from young, low-mass stars – an indication that infrared-emitting dust, possibly in the shape of a disk, surrounds these newborns (SN: 10/3/92, p.214). And even before Hubble's repair, the telescope had imaged dusty rings – possible planet-spawning disks – around 15 stars in Orion (SN: 12/19&26/92, p.421).

But the new images constitute "strong proof that protoplanetary disks [exist and] are a common product of star formation," O'Dell asserts. The images reveal that the disks are indeed pancake-shaped, rather than spherical, as some astronomers had maintained. The observations also enabled O'Dell and Wen to measure the variation in brightness across the disks, which are set aglow by the light from hot, background stars. This, in turn, enabled the researchers to estimate the mass in the disks' outer rims. They conclude that the rims contain at least enough material to make three planets the size of Earth.



O'Dell/ Rice University/NASA

Top: Hubble image of part of the Orion nebula, located 1,500 light-years from Earth. Bottom: Dusty disks, some of which may evolve to form planets, surround four of the five stars in this close-up of Orion. Three of the four disks, lit by radiation from a nearby cluster of hot stars, appear as bright objects. The fourth disk appears in silhouette, blocking out the background radiation.

One of the Hubble pictures shows an oval disk, silhouetted against background light, with a width equal to 7.5 times the diameter of the solar system. O'Dell presented the images last week at a press conference in Washington, D.C. The camera recorded the pictures in late December, just weeks after astronauts installed it during Hubble's repair mission. – *R. Cowen*