ernmost section of the 1906 rupture (SN: 10/28/89, p.277). For decades the section had remained inactive. But in June 1988, a magnitude 5.1 shock broke it at a depth just shy of 14 kilometers. The next moderate temblor hit the area in August 1989, at a depth of almost 17 km. The October quake ruptured the fault at 18 km.

McNally discerned a similar pattern in three smaller shocks occurring in the months before the Livermore-area quake along the Calaveras fault. She calls the earlier quakes "preshocks" to distinguish them from the foreshocks that can appear hours or weeks before a main shock. She also notes that some quakes in Mexico and Costa Rica apparently have followed the deepening preshock pattern.

Geoscientists say the Loma Prieta quake verified the reliability of their techniques for making rough forecasts several decades before a main shock. McNally's observations now suggest a method for intermediate-term predictions: watching for quiescence followed by progressively deeper and larger preshocks. Data from Loma Prieta, however, have not offered hope for making predictions just weeks before a large quake.

William H. Prescott of the U.S. Geological Survey in Menlo Park, Calif., reports that several instruments near the fault detected no precursory signs of the main shock. One such instrument was a dilatometer, which measures strain in the ground and can detect changes one-thousandth the strength of those occurring during the main shock. Located 35 km from Loma Prieta's center, the device may have been too distant to pick up early signals, he suggests. Prescott notes that researchers are now conducting experiments in Parkfield, Calif., to learn what kinds of short-term signals might precede major quakes. Parkfield sits on a San Andreas segment that ruptures at regular intervals, leading scientists to predict a magnitude 6 temblor there within the next three years.

In terms of structural damage, engineers and geologists maintain Loma Prieta held few surprises. As in the 1906 quake, areas on landfills and soft soil shook the hardest. Overall, most buildings fared well, in part because of improved building codes and the relatively isolated location of the quake's epicenter. But peculiar aspects of the shaking also help explain the limited damage, researchers say. The fault broke quickly, producing a shaking that lasted only 6 seconds near the epicenter, says Hiroo Kanamori of the California Institute of Technology in Pasadena. In contrast, last year's magnitude 6.9 earthquake in Armenia shook for 30 to 40 seconds, he says. Usually, the longer the shaking, the more damage wrought. So, although many buildings withstood Loma Prieta, engineers caution that this is no proof they could survive another 7.1 temblor centered just as far away. *— R. Monastersky*

Starry lens puts a twinkle in quasar's eye

The 1985 discovery of four separate spots of light, or images, representing the same distant quasar provided a dramatic illustration of how the gravitational effect of an intervening galaxy can bend the path of light. Now, for the first time, astronomers have observed what they believe is the focusing of light by a single star in that galaxy. The observation, they say, should allow them to estimate the star's mass and the quasar's size.

"This represents the first detection of a microlensing event," M.J. Irwin of the Institute of Astronomy in Cambridge, England, and his colleagues write in the December ASTRONOMICAL JOURNAL.

The quasar, designated QSO 2237+0305, lies almost directly behind the center of a bright nearby galaxy (SN: 1/5/85, p.9). The galaxy's gravity splits and focuses the quasar's light into four images that collectively look like a four-leaf clover.

If the light forming one of these images happened to pass close to a star in that galaxy, the star's gravity would also focus the light. But the magnitude of that effect would change as the star moved within the galaxy, causing the image's brightness to vary over a period of a few months.

In August 1988, Irwin and his colleagues found one of the quasar's images 70 percent brighter than it had been in the previous year. A month later, the image had faded a little. The change was too rapid to result from the motion of the galaxy as a whole and too slow to have been caused by shifts in the quasar's own brightness, they say.

The astronomers calculate that the object responsible for altering the image's brightness has a mass between one-thousandth and one-tenth that of the sun. This suggests the lensing object may even be a brown dwarf — a difficult-to-detect lump of gas larger than a planet but having too little mass to sustain the fusion reactions that occur at the cores of stars.

Additional observations of brightness variations over time should provide detailed information about the quasar's size and structure. "Continued monitoring of the 2237+0305 system to accumulate data on a number of individual events offers the possibility of constraining both the size of the quasar-continuum-emitting region and the mass distribution function for stars and any other population of compact objects within the intervening galaxy," the astronomers say. In other words, it's a system worth watching.

— I. Peterson

Does the moon spark like a Life Saver?

For centuries, amateur and professional astronomers alike have reported observing sudden brightenings or flashes on the surface of the Earth's moon. These events are sometimes described merely as "lunar transient phenomena," for lack of a universally accepted way to explain them. Scientists seeking an energy source for the strange flashes — which observers have seldom if ever found while deliberately looking for them — have speculated on causes, including light emissions stimulated by solar ultraviolet photons, accelerated particles from the tail of Earth's magnetic field, and processes somehow associated with solar flares.

Now, Richard R. Zito of Lockheed Missiles and Space Co. in Sunnyvale, Calif., proposes yet another possible origin — the rocks of the moon itself. Inert gases such as helium would be the likeliest to produce such glows, he writes in the December ICARUS, adding that "surface rocks returned from the moon by Apollo 11 show inert gas concentrations 20 to 10,000 times larger than those of the terrestrial values."

The gases can be released through cracks created by heat stresses, such as those that occur when parts of the lunar surface pass from darkness into sunlight, Zito points out. Many of these surface flashes, he says, have appeared in or near craters associated with fault systems. As for the energy to light up the little puffs of gas, he says, "it has recently been observed that flashes of light are emitted during the laboratory fracturing of rocks."

According to Zito, the flashes appear to take place when energetic electrons are emitted from freshly fractured surfaces. He also notes that "a similar effect is known to occur when Wint-O-Green Life Savers are cracked" (SN: 7/30/88, p.78).

Furthermore, the fracturing of a rock sometimes produces not only the optical pulse but also "a curious radio emission" with frequencies ranging from about 900 to 5,000 hertz, Zito says. This is "believed to be due to the rotational, vibrational and linear motions of charged fresh surfaces created during cracking" — in other words, a rearranging of the rock's crystal structure. The wavelengths of emissions at these frequencies ought to be detectable by an antenna aboard a moon-orbiting satellite, he says. If Zito's hunch is correct, the radiation pattern should resemble that observed in the laboratory studies. *— J. Eberhart*