How the Armenian Quake Became a Killer

Bad luck and inadequate construction combined to produce the unusually lethal disaster that struck Soviet Armenia last month, according to the first impressions of a group of American experts who visited the area. The team of 18 seismologists and earthquake engineers was under the leadership of the U.S. National Academy of Sciences and the U.S. Geological Survey (USGS).

"What they got hit with was a worst case scenario," says seismologist and co-team leader John Filson of the USGS in Reston, Virginia. The town of Spitak, which was nearly leveled, sat less than 5 kilometers from the fault break. Just 4 minutes after the magnitude 6.8 mainshock struck, a major aftershock of magnitude 5.8 collapsed many buildings that had been weakened by the mainshock. The responsible fault had not been previously identified, but the area is sliced by many known faults.

Bad luck aside, it was buildings, some kinds more than others, that killed people. Structural engineer and co-team leader Loring Wyllie of H. J. Degenkolb Associates in San Francisco cites two types of nine-story buildings whose behavior during the quake displayed some lethal differences. Of the more than 50 frame buildings with precast components attached to column and beam construction, less than a dozen remained standing and even these were heavily damaged. In contrast, the 14 nine-story buildings in which panels and walls were connected in a different way "performed very well."

"There was very little reinforcing to tie some buildings together," says Wyllie. "The buildings basically came apart the way they were put together," notes team member Fred Krimgold of Virginia Polytechnic Institute and State University. Adds Wyllie, "Poor [construction] quality was certainly a factor."

In Leninakan, a large city about 50 kilometers from the epicenter, modern buildings did not fare as well as older ones. "The level of damage was almost inversely related to age," notes Krimgold; the new, high-rise, engineered structures tended to collapse while low-rise, unreinforced buildings were virtually unaffected. Krimgold says that Soviet authorities are planning to rebuild to heights not exceeding five stories using poured-in-place concrete rather than precast. Engineers will also develop new designs under the assumption that earthquakes as strong as this one will strike again; previous designs assumed a maximum shaking well below that experienced last year.

■ RICHARD A. KERR

Reuters/Bettmann Newsphotos

Spitak, Armenia: *Some buildings killed people, others did not.*

Double Exposures Reveal Mini-Comets?

They have not changed anyone's mind yet, but there are new telescopic observations being claimed as additional evidence of small comets pummeling Earth 20 times a minute. These comets are the 100-ton balls of fluffy ice whose physical implausibility and claimed huge abundance have outraged so many Earth and planetary scientists (*Science*, 10 June 1988, p. 1403). Researchers simply cannot imagine how they could have missed them.

When Clayne Yeates of the Jet Propulsion Laboratory announced last spring that he had detected small comets in the numbers proposed by their originator, Louis Frank of the University of Iowa, he hoped the matter was settled. He had slued the Space Watch Telescope on Kitt Peak across the sky in just such a way as to catch Frank's comets as they sped by Earth halfway to the moon's orbit. Any other search strategy and the short streaks recorded on the charge-coupled device (CCD) detector did not appear.

Noise, said CCD experts who saw the images. Everything from cosmic rays to random fluctuations in the CCD, they pointed out, can produce clusters or streaks of brighter-than-average picture elements, or pixels, among the 164,000 pixels making up a CCD image. The only convincing evidence, said these experts, would be the unequivocal detection of the same small comet in two consecutive exposures. That is the traditional requirement for the discovery of a new planetary body.

At the December meeting of the American Geophysical Society, Frank, John Sigwarth and John Craven of the University of Iowa, and Yeates had a poster presentation of their analysis of such multiple exposures. As was the case with all of Yeates's solitary images, they were made under his direction by Tom Gehrels of the University of Arizona, who runs the Space Watch Telescope. Out of 75 pairs of 12-second exposures, the group found 30 pairs of usable images. Out of the first exposures of those 30 pairs, they found five having apparent detections. Experience with the more numerous single exposures predicted that there would be about six detections. Of the five detections in the initial exposures, all five of the expo-

sures made 36 seconds later had a detection, according to the group.

The Iowa/JPL group believes that they have detected the same object in consecutive images because the second streak of each pair looks like the first and is found in its predicted location. Streaks in a pair are of equal length and brightness, a necessity if the same object has the same exposure time in the two images and the telescope is being slued in the same way. The second streak is also where it should be based on the interval between exposures, and its orientation is exactly the same as the first streak's. The chances that random fluctuations in the CCD could generate two streaks so arranged in consecutive exposures ranges from about one in a million to one in 10 million, says Yeates.

CCD experts are unimpressed. "The only trouble," says Gehrels, who took the images, "is that the images are not convincing." Other astronomers have had little opportunity to see the image pairs or their analysis. Eugene Shoemaker of the U.S. Geological Survey in Flagstaff has seen one pair. "He [Yeates] is pushing right against the noise limit. When you look for rare things, you can find all kinds of flukes. They don't look convincing to me. I would want three [consecutive] images, and then I would be convinced. If they were strong images, two would suffice." That sort of thinking apparently prevailed in the reviewing of Yeates's paper submitted to *Geophysical Research Letters*, which included one of the five image pairs. The paper has been rejected, but Yeates expects that decision to be reviewed following an appeal by him.

So, the astronomical community has given Yeates and Frank, who are both space physicists, not astronomers, the latest word. Two consecutive detections of the same object, which was the standard of proof, will not do; they need three.

Yeates and Frank are not without support among astronomers, however. Torrence Johnson of JPL, an optical astronomer with both spacecraft and ground-based experience, believes that Yeates may be seeing something real, but the rate at which such objects are going by Earth, which is at the heart of the controversy, remains to be determined. The single detections are too unreliable, Johnson notes, and the multiple exposure detections are too sparse to determine the flux of the objects.

In the end, any attempted confirmation of the claim of small comet detection will have to be made by observers other than Yeates or Frank. Whether the observations to date will prod anyone to that potentially thankless chore remains to be seen.

■ RICHARD A. KERR

"Fragile X" Syndrome and Its Puzzling Genetics

Both males and females can inherit the "fragile X" chromosome and pass it on to their children, but many carriers do not show abnormal cognitive or behavioral symptoms

SINCE IT WAS FIRST IDENTIFIED 20 years ago, the "fragile X" syndrome has been associated with mental retardation and various learning disorders. New reports characterize the nature of the neuropsychiatric syndrome more fully and offer a hypothesis as to its unusual pattern of inheritance. Nevertheless, the data still fall short of explaining what the mutation is and how it causes widely varying symptoms.

"There are many males who carry the fragile X chromosome but do not experience the syndrome. That is very unusual for an X-linked gene."

The fragile X defect is so named because a small portion at the tip of the X chromosome seems susceptible to breakage under certain conditions. "Fragile X is the most common inherited cause of mental deficiency," says W. Ted Brown of North Shore University Hospital in Manhesset, New York. It is second only to Down syndrome as the most common "chromosomal" defect associated with mental retardation. Fragile X probably affects 1 in 1000 to 1 in 1500 in the general population, says Brown. The fragile X site is one of a group of several "rare" fragile sites but it is the only one known to be associated with an observable disorder.

The constriction at the fragile X site apparently results from a failure of the chromatin to condense during mitosis. Researchers can only observe this abnormality in vitro, however. They induce a fraction of a person's lymphocytes to show the fragile site using a cell culture technique described in 1977 by Grant Sutherland of Adelaide Children's Hospital in North Adelaide, Australia. Although not all carriers are fragile X–positive by this test, it still gives researchers the opportunity to study the range of symptoms in people who are known to carry the same genetic defect.

Two of the most active areas of investigation today are clarifying the nature of the neuropsychiatric disorder and unraveling its complicated genetics.

"We see all varieties of problems in males, but only about one-third of females are mentally retarded," says Randi Hagerman of the University of Colorado Health Sciences Center and the Children's Hospital in Denver, who does research in the first area. "The rest of females either have normal IQs or mild learning disabilities." Hagerman characterizes the syndrome as a developmental disorder that can be either subtle or severe.

"In general, these children have growth regulation abnormalities," says Hagerman. "Fragile X babies typically have big heads and higher than normal birth weights." Young children may have large or protruding ears and later on may also have long faces. Some researchers are investigating connective tissue abnormalities in patients who have unusually flexible finger joints, flat feet, or a high arch in the palate. Another characteristic in males is having unusually large testicles.

The key to early diagnosis in young children is often not their physical features, however. "It is more the behavioral phenotype—hand flapping, hand biting, hyperactivity, and poor eye contact—that clue you into fragile X," says Hagerman. These signs are most common in young boys, who may also be diagnosed as autistic. Affected girls tend to show signs of social withdrawal, shyness, and learning disabilities, particularly in math, she says.

To date, no one has shown what, if any, neurobiological abnormalities may cause these behaviors, but researchers are looking. One place to start has been the link between autism and fragile X. Autistic males outnumber autistic females by four to one and about 10 to 15% of autistic males are positive for fragile X in cell culture tests. A recent report by Eric Courchesne of the Children's Hospital Research Center in San Diego, California, indicated that the posterior part of the cerebellum is smaller than normal in some autistic patients (*New England Journal of*