Tangshan quake: A Chinese report

With carefully chosen statistics and cautious phrases, Chinese scientists have disclosed in some detail for the first time the true extent of damage from the 1976 earthquake that devastated the industrial city of Tangshan, located some 90 miles southeast of Beijing (Peking). In papers and at a press conference given at the Second U.S. National Conference on Earthquake Engineering at Stanford University last week, the scientists confirmed that the temblor (Richter magnitude 7.8) was the "greatest earthquake that ever occurred in a densely populated industrial-mining city in China."

The delegation, headed by Li Jingzhao, Vice Minister of the State Capital Construction Commission, and Ye Yaoxian, Deputy Director of the commission's Office of Earthquake Resistance, still would not disclose the total number of deaths or value of property damage resulting from the quake. However, when asked about the widely quoted figure of 750,000 deaths, Li replied with a smile, "If that were true, there would be nobody left." He said the present population of Tangshan is about 600,000. Earlier in the decade, Western estimates of the population ranged between 800,000 and 1,200,000. Most of the deaths occurred in the city itself, Li said.

One thing *is* clear, however: Within the 47-square-kilometer area — including most of Tangshan — that suffered a peak shaking intensity of XI on the Mercali scale, building destruction was almost total. In the city, 95 percent of civil buildings, 80 percent of industrial buildings and 60 percent of highway bridges were severely damaged. The basic cause of this extreme degree of destruction, according to the Chinese, was that a major quake had not been expected so near Tangshan and building codes were designed only to allow buildings to withstand shaking of a maximum intensity of VI on the Mercali scale.

Ground cracks, some with offsets as large as 1.5 meters, extended along a complicated fracture line some 10 kilometers long. The delegation characterized the breaks as occurring along an old fault, whose destructive potential had not been realized. Thus, many buildings had been constructed of unreinforced brick or with reinforced concrete columns that did not have adequate bracing. Factory roofs, in particular, proved vulnerable to total collapse. However, "generally no collapse occurred in industrial buildings with strong columns, light-weight roofs and perfect bracing systems," the official report showed.

(Many U.S. scientists have recently expressed concern over the similar lack of preparation for large earthquakes in this country. Even in California, where the location of major fault lines has been well established, building codes have only recently included ductility requirements for reinforced concrete pillars to prevent their total collapse during a strong quake. In the eastern United States, many old fault lines — like the one underlying Tangshan — have not yet even been identified. See SN: 2/10/79, p. 90.)

Land offsets of 1.5 meters (below) and total collapse of buildings marked the near destruction of the city of Tangshan in 1976.

One of the most destructive, yet least understood, aspects of quakes like the one in Tangshan has to do with the phenomenon of "liquefaction" — the violent mixing of sandy soil and subterranean water under pressure that turns what appeared to be solid gound into a kind of quicksand. Two members of the delegation discussed this frightening phenomenon in more detail. Chen Dasheng reported that "damage caused by ground failure . . . is more closely correlated with the surrounding site condition than with intensity rating" — a finding confirmed by some U.S. scientists who are pondering the possible necessity of revamping both magnitude and intensity scales. Xie Junfei reported that placing more compact landfill over areas subject to liquefaction had been effective in minimizing damage, but that the area of necessary fill had proved difficult to estimate.

A related phenomenon, "sand blows," was also described in vivid detail by Chen. "A strange thing happened in a cultivated field about 1 km southwest of Luanxian County," he reported. "A great amount [more than five carts] of gravel fillet spouted out together with sand, water and some concrete lining from underground through an abandoned well and formed a 15-meter radius of gravel cone, with a water pit of 3 meters diameter in the middle." The area subjected to this sort of ground failure extended all the way from Tangshan to the sea, some 40 kilometers south.

According to the Chinese scientists, life is finally returning to normal in Tangshan and virtually all industrial buildings have been reconstructed — according to strict new building codes. (Some Western observers have expressed doubt about such optimistic estimates.) Peasants in the countryside have also received the "suggestion" that they reinforce their adobe houses with bamboo. Meanwhile, the 10-person delegation will spend three weeks visiting various U.S. centers for earthquake engineering research, including the California Institute of Technology and the Massachusetts Institute of Technology. □

U.S.-Japan quake research

Though "earthquake-proof" buildings can be designed (SN: 2/10/79, p. 90), few means — short of an actual quake — exist to test them. But a research agreement signed on Aug. 9 between the National Science Foundation and Japan's Science and Technological Agency and the Ministry of Construction intends to pool the two countries' skills and facilities in order to make the most of those few opportunities.

U.S. facilities for such work — no contracts have yet been signed by the NSF — can simulate earthquake stresses only on scale-model buildings. But a unique facility located at Japan's Tsukuba Science City — a "community" of national, private and university research facilities located 60 kilometers northeast of Tokyo — can test full-scale structures as high as seven stories. Called a strongback, an 8-meter-wide, 20-meter-high, 6-meter-thick vertical wall provides a test-stand, on either side of which is constructed an actual reinforced concrete building. A given design can then be tested for its response to "load" — more familiarly, the shaking of a quake. The first reinforced concrete structure will most likely be tested within a year, said an NSF spokesman. Matched funding for the project may total $6 million to $8 million for a five-year period. □

Pink plankton: Ice Age marker

Hunks of sediments pulled from the ocean bottom by the drill bits of research ships appear, to the naked eye, as just so much ooze. Different layers may appear brown, olive-drab, a little red or crusty-white with diatoms, but not until bits of the muck are subjected to chemical and microscopic scrutiny do they take on meaning. The presence of the skeletons of certain marine organisms may indicate at what depth and how many thousands of years passed since the sediment was formed; a change in the ratio between the isotopes of oxygen or strontium can reveal ancient sea surface temperatures. Such clues, few in number and painstakingly developed, are a researcher's only means of squeezing the earth's history from the mute mudstones of the seafloor.

Now, another marker, and one that signals — at least in the Indian and Pacific Oceans — the last great climatic event on earth, has been honed for use by researchers at Lamont-Doherty Geological Observatory in Palisades, N.Y., Centre des Faibles Radioactivités in France and The Godwin Laboratory in England. The marker is a pink-pigmented variety of the more commonly white planktonic foraminifera *Globigerinoides ruber*, which exists in the present-day tropical and subtropical Atlantic Ocean and Mediterranean Sea but is no longer found in the Indian and Pacific Oceans. And conveniently for researchers, the pink *G. ruber* met its demise in the Indo-Pacific 120,000 years ago, at the beginning of — and probably because of — the last full interglacial age. Researchers had noted the disappearance of the pink species in the Indian and Pacific Ocean sediments, but no one had correlated its extinction so closely to the glacial-interglacial transition — or as Peter R. Thompson of Lamont says, "... no one did it as well."

The beginning of the interglacial period — which is believed to have been quite similar to the present climate and therefore is studied for its predictive value — is usually detected in sediments by a change in the temperature-dependent ratio of ^{18}O to ^{16}O. Thompson, Allan W. H. Bé of Lamont, Jean-Claude Duplessy of France and Nicholas J. Shackleton of England correlated that change in the oxygen isotope ratio to the disappearance of the pink foram in drill cores from the tropical and subtropical Indo-Pacific. The planktonic marker is quite obvious — "you can't help but identify them" — and is complementary to the sometimes mangled oxygen isotope record, says Thompson. The technique is of particular usefulness to Thompson and co-workers, who are part of the project CLIMAP, which has been gradually reconstructing the ancient climate from the information stashed in drill cores.

The disappearance of pink *G. ruber* from the Indo-Pacific region may be another example, the researchers say, of the many foraminifera species that appear to have died or diverged genetically when the Isthmus of Panama — which formed about 2 million years ago — created a migrational barrier between the two great oceans. Curiously enough, the warm-surface-water-dwelling pink *G. ruber* lasted through the Ice Age, only to die at the beginning of a warm period. Possibly, says Thompson, the warmer conditions altered such factors as the salinity of the surface layers and stressed the Indo-Pacific pink *G. ruber* to a genetic limit that did not exist in its Atlantic cousins. In any case, say the researchers in the Aug. 16 NATURE, "stratigraphers now possess a most useful and widespread datum for the identificaion of the [glacial-interglacial transition] throughout the Indo-Pacific area." □

Summer of the gluons: Jets of evidence

It is a basic principle of the physics of atoms and smaller structures that a force is embodied or mediated by a special kind of particle. Such particles are called field quanta, and whether the science itself, quantum mechanics, takes its name from them or they from it, they are central to its operations. Every influence of one subatomic particle on another — attraction, repulsion, change of motion, change of identity, radioactive decay — is mediated by an appropriate field quantum, the one belonging to the class of force that happens to be operating.

If an electron is bound to the nucleus of an atom, the theorist views the binding as equivalent to a continuing exchange between nucleus and electron of the field quantum belonging to electromagnetic forces, the photon, otherwise known as the particle of light. There is abundant evidence for the existence of photons, but up to now they were the only sort of field quantum of which that could be said. Now some physicists are claiming that several experiments done at the PETRA colliding beam facility in Hamburg and reported at the International Symposium on Lepton and Photon Interactions at High Energy held at Fermilab this week give indirect evidence for a second field quantum, the so-called gluon, the motivating particle of the color force or chromodynamic force, proposed by the relatively new theory called quantum chromodynamics. Not only is the gluon only the second of all the field quanta of physics for which evidence is claimed, it happens also to play a particularly important role in the structure of matter and in the structure of physicists' attempts to unify all of physics into a single grand theory of forces and particles.

It is the electrodynamic class of force that holds together atoms (and molecules), and the science of quantum electrodynamics is largely the explanation of the structure of atoms and molecules. The color force is believed by theorists to hold together the structures inside the atomic nucleus, the internal composition of the neutron and proton as well as the large class of particles related to them, the hadrons.

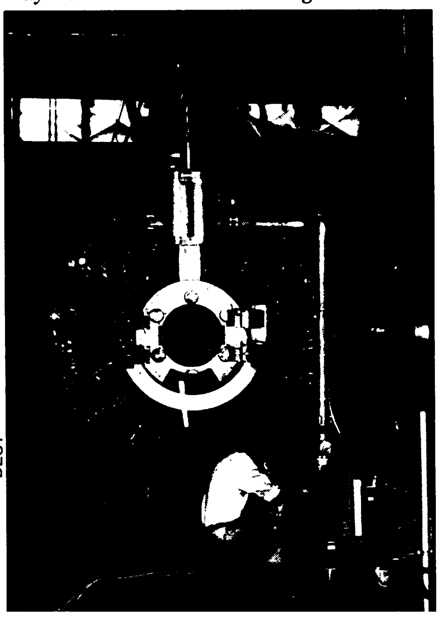
For more than a decade now it has seemed that the best way to explain the properties and behavior of the hadrons is to view them as built of subparticles called quarks, some hadrons being made of three quarks, some of two. It had seemed that with a hundred or more different kinds of hadrons on record some way of classifying and simplifying was necessary. It turns out that a small number of quarks, six in most current versions of the theory, in continually permuted combinations can account for all the hadrons (see p. 148).

Some physicists would argue that it isn't really necessary to worry about what might hold quarks together, but those who do have elaborated a theory of a force, the color force, that binds them. (The name has about as much to do with the common meaning of the word as electricity has with the Greek word for amber, from which it is derived.) The theory of the color force, or chromodynamics, attempts to do for internal structure of hadrons what quantum electrodynamics does for atomic structure, but it does so in a much more complicated way. There is just one kind of photon (although in modern theory it has a number of yet undiscovered close relatives); there are eight kinds of gluons. An experiment to find direct evidence of photons is trivial; an experiment to find gluons must be difficult, indirect and more than a little controversial.

The experiments in question are four arrays of detectors set up at the places where high-energy electrons collide with high-energy positrons in the PETRA colliding beam facility. The detectors are called MARK J, TASSO, PLUTO and JADE, and their function is to record whatever happens after the collision of electrons and positrons. The four experiments involve more than 250 physicists, undoubtedly the largest crew of physicists yet assembled for essentially the same investigation.

One of the things that can happen in an electron-positron collision at PETRA energies is the production of a quark, an antiquark and a gluon. These come away from the interaction in three different directions and each of them immediately produces a bunch of particles that the detectors can record. These "jets" of particles, three of them coming off at definite angles to each other, are the signal that a gluon has manifested itself. Their presentation in the reports of the PETRA experiments, led Haim Harari, a theorist from the Weizmann Institute in Israel, who reviewed recent developments, to conclude that 1979 would be the summer on which physicists would look back as the time when gluons began to appear real. And he

PLUTO: *One of the detectors at* PETRA *that may have found evidence of gluons.*



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