interpretation of data. Perhaps it would be useful to use three evaluators: one intending to present objective conclusions, one whose intent is to provide a positive picture of the experimental result, and one whose intent is to provide a critical picture. Ultimate evaluation of the experiment will benefit from exposure to these three diverse viewpoints.

Effect. At a minimum, we need to know whether partisans perceive that "their" case manager did a credible job in making the case. Do they consider the procedures of the Science Court to be fair, even if they feel that their side lost? Do partisans change any of their attitudes or behavior as a result of the Science Court findings? Do regulatory agencies or other relevant governmental bodies take actions that appear to be based on the findings? Do they take contrary actions? Do the mass media provide accurate coverage of the debate and do they accept the findings? Are members of the wider public aware of the experiment? If so, do they understand the procedure, and do they know the Science Court findings? If so, do they express opinions that are consistent with the findings, even when they held contrary views prior to the hearing?

Future Plans

The next proposed step in developing the Science Court is to conduct a meeting (*2*) devoted to two topics. First, it would be useful to have a discussion in depth in which proponents and opponents of the Science Court will have an opportunity to state and debate their positions. Such a debate would bring to light opportunities to improve the concept and its acceptability. Second, it is proposed to have a series of sessions in which people who have been active in scientific controversy surrounding issues such as food additives, nuclear power, and fluorocarbons help to criticize and develop the rules of procedure for the Science Court. It is currently contemplated that partisans from each side of the issues used will be present and that these sessions will afford an opportunity to see whether indeed the active opponents in these vigorously contested issues can agree on rules for an adversary procedure. This would help to visualize the problems which would be encountered when an attempt is made to negotiate agreed procedures between two case managers for the Science Court experiments.

It is our hope that following this meeting enough understanding and procedural development will have been achieved to justify a series of experiments.

Notes

1. We use the expression "scientific fact" to mean a result, or more frequently the anticipated result, of an experiment or an observation of nature.
2. This meeting will be held on 20 and 21 September at the Xerox Center, Leesburg, Va. For further information contact Mrs. Florence Feinberg, U.S. Department of Commerce, Washington, D.C. Telephone: 202-377-5065.

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NEWS AND COMMENT

Chinese Earthquakes: The Maoist Approach to Seismology

With unusual shrewdness for Occidentals, a nine-member delegation of American earthquake specialists visited China last month to learn about Chinese earthquake programs—and then left the country shortly before two highly destructive quakes shook a region northeast of Peking. The demonstrated ability of the Chinese to predict major quakes, as well as to take precautionary measures, has become a subject of fascination in the American seismology community, where earthquake prediction is barely coming into its own (*Science*, 7 May).

Of course the Americans did not leave China because they believed a major quake would occur—in fact, the Chinese failed to predict the quakes of Richter magnitude 8.2 and 7.9 that devastated the industrial city of Tangshan on 28 July. But, while there, the Americans studied several events: a long-term prediction that was in effect for the Tangshan-Tientsin region; the successful prediction of a pair of magnitude 6.9 quakes which struck in Yunan province last 29 May; and the successful prediction of a magnitude 7.4 quake which struck Liaoning province on 4 February 1975. Thus, the Americans have filled out their picture of Chinese earthquake prediction. Frank Press of the Massachusetts Institute of Technology, a geophysicist who was not on the delegation but who has widely publicized the Chinese achievements, says that such an understanding "is the most important thing that can be done for American earthquake programs."

As practiced in China, seismology fits the Maoist ideal of a "people's science." It utilizes thousands of amateurs; yet its leading professionals can compete with their counterparts in the West. The goal of prime importance to the Chinese government is to apply seismology to reduce the horrendous toll of human life and industry due to earthquakes which China has suffered throughout her history. (The most devastating disaster on record, for example, was the great Shensi earthquake of 1556, which killed 820,000 people.) Ideologically, another goal is to fight so-called "reactionary" myths and superstitions which surround earthquakes—one widely held belief, for example, equates the occurrence of great quakes with the passing of dynasties.

C. Barry Raleigh of the U.S. Geological Survey, who led the nongovernment delegation,* explains that the Chinese seem to be working with the same set of hypotheses about the causes of earthquakes that Westerners use. The Chinese were early adherents of plate tectonics; they cite the theory that the India plate is pushing against the Asia plate under the Tibetan Plateau to explain the high seismicity of Yunan, which is on the

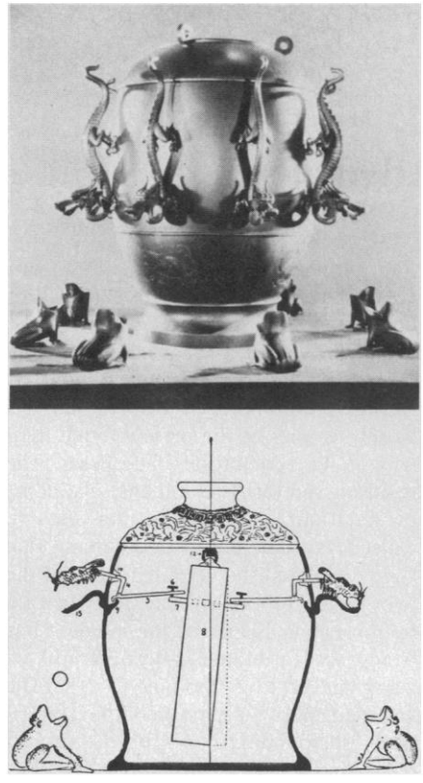
*The delegation was sponsored by the Committee on Scholarly Communication with the People's Republic of China of the National Academy of Sciences.

eastern edge of the plateau, next to the Burmese border. (Chinese enthusiasm for plate tectonic theory may have a political component, however. Soviet geology has been a bastion of resistance to plate tectonic concepts, and Chinese scientists are known to have no wish to emulate their Soviet rivals.) Tectonic explanations have been less useful in explaining why the northeast region of the country (including both the Liaoning and Tangshan regions) are so seismically active.

The Chinese make general predictions about the seismicity of an area much the way Americans do. They plot the amount of energy recently released by ground motion against long-term averages. But, in contrast to American practice, the labor of making field observations is divided between professionals and "barefoot scientists," or amateurs. Professionals survey minute changes in ground elevation with laser-ranging devices which may be better than American ones. Professionals measure relative changes in the local magnetic field and sample radon levels in water. Amateurs, who may number in the tens of thousands, measure changes in the electrical resistivity of the ground, observe wells for level changes and bubbling, and note animal behavior which could signal tremors in the earth. Animal observations are not made in the United States.

When signs point to an area as prone to have future earthquakes, such as the Yunan and Liaoning provinces, the Chinese authorities order construction of local seismic observatories, manned by professionals, to gather and correlate more information. Public education campaigns are launched. American experts were favorably impressed by the movies the Chinese show to the public explaining what earthquakes are and how to prepare for them. With all their general information, the regional networks make long-term predictions. In the cases of Yunan and Liaoning earthquakes, the official public warnings were sounded only when foreshocks began occurring—in one case only 25 minutes before the quake. No single set of indicators seems to be used as the criterion for issuing evacuation warnings, however; and the Chinese told the Americans of case histories of 4 other, small quakes which had no foreshocks but were successfully predicted and evacuated. There were no foreshocks before the first Tangshan quake and, as far as is known, no mass evacuation order preceded it.

The emphasis on human observation has paid off in providing genuinely new information. A trained seismologist, for example, gave the Americans a convincing account of an "earthquake light" which illuminated the night sky during one quake. Americans say that reports of such lights have been made elsewhere—but never have been so well documented. Raleigh explains that the electrical discharge represented by an earthquake light may build up before the quake; measurements of such a buildup could possibly serve as a predictor of a coming shock.



A Chinese "earthquake weathercock" from A.D. 130. When a quake struck, the inner pendulum moved to let a bronze ball fall from the mouth of one of the eight dragons. Which ball dropped indicated direction of quake. [Drawing from Joseph Needham, Science and Civilisation in China *(Formosa edition), vol. 3 (also published by Cambridge University Press)]*

Nevertheless, Raleigh and other experts find aspects of Chinese seismology something of a mystery. It is not clear to them exactly what the Chinese define as a "prediction," since predictions of different kinds can be made by regional observatories, street or factory committees, and higher political councils. These different councils have considerable autonomy in making predictions. The track record for successful predictions is blurred still further by the frequent statement that many predictions have proved false—but on this sensitive point the Chinese are inscrutable, refusing to give details.

Western observers have been impressed with the willingness of Chinese leaders to order evacuations in advance of earthquakes and the seriousness with which people react to such warnings. Some of this behavior, says Ralph H. Turner, of the University of California at Los Angeles, a sociologist on the delegation, is attributable to the Chinese leaders' freedom from lawsuits and insurance claims—issues that trouble disaster warning policies in capitalist countries. The Peoples' Liberation Army, which has been highly efficient in offering relief after earthquakes, is in general more involved in civilian life than are Western armies—it helps with harvests, for example.

Turner notes other reasons for the achievements of the Chinese, however. In China, the job of evaluating precursor information and making a warning is delegated to many groups: street committees, factory committees, brigade committees, provincial governments, and councils in Peking. Sociologists have established that, regardless of culture, people in groups tend to make riskier decisions than people acting as individuals. This "risk shift" could be occurring in China when these groups gather to decide what to do.

By contrast, he says, "the American experience is that it is very hard to get public officials to issue warnings and take fairly radical decisions." President Ford's decision that a swine flu epidemic might occur this fall and must be guarded against with an expensive vaccination program is the exception, not the rule. As with Ford's swine flu decision, when a warning is issued, the burden of proof lies entirely with the individual leader. "One guy makes a decision, and there is a whole cage of hungry lions out there waiting to get him if he's wrong," Turner says of the United States.

Moreover, the Chinese take such warnings of earthquakes more seriously because in the "people's science" so many individuals are already involved. Thousands of amateurs are watching for signs of an imminent quake and discussing it with others. Thus, says Turner, when the prediction is finally issued there is less tendency to put the blame on someone else if it is wrong. "So it's not like a guy from Caltech suddenly making a prediction based on something he's found in his laboratory."

By contrast, "Western scientists tend to be rather aloof and regard the amateur as a nuisance instead of an extension of his capability. That aloofness has bred a certain amount of understandable mistrust of scientists on the part of amateurs and the public."—DEBORAH SHAPLEY