GEOLOGY

Our Trembling Earth

Every year, more than a million earthquakes shake the earth, some so gently that only the most sensitive instrument can detect them, some so violently that thousands are killed

By Barbara Tufty

➤ THE SERIES of earthquake shocks, that recently rolled across eastern Turkey and killed thousands of people, hit in one part of an enormous earthquake-prone belt that stretches from the Pacific Ocean through the Himalaya Mountains, the Caucasian Mountains and the Alps of Europe.

In this vast belt, together with the other great earthquake belt that encircles the Pacific Ocean, are generated about 95% of the world's earthquakes. These areas are the most restless regions of the world—zones of weakness where mountains are being pushed upward, where the earth's crust is being folded and wrinkled, and where rocks miles beneath the surface are under tremendous pressures and high temperatures.

These stresses slowly build up until the strain becomes enormous. When a stick is bent too much, a breaking point is reached and the stick snaps. So also do rocks beneath the earth. They reach a point where they suddenly slip or break and snap back to a position where they have relieved the strain and are in a temporary condition of equilibrium again. Such breakage results in an earthquake.

The sudden adjustment displaces immense masses of earth and sends shock waves radiating outward from the source in all directions, traveling at different speeds through the earth's interior. A similar thing happens, on a much more minor scale, when a rock is tossed into a pool of water, sending out ripples that radiate outward in all directions.

ESSA

EARTHQUAKE RUBBLE—The Alaskan earthquake of 1964 is just an example of the stresses slowly built up by the earth's crust until the strain becomes enormous and the rocks snap. The resulting shock waves cause violent disruptions and destroy whole towns and villages.

Fractures Occur Everywhere

The underground fracture where an earthquake originates is called a focus. This fracture can occur anywhere in the earth's crust from a mile or two beneath the surface, or it can start below the crust, as deep as or deeper than 400 miles. The location on the surface crust above the focus is called the epicenter.

When shock waves of an earthquake break out on the earth's surface, they cause violent disruptions, toppling buildings, creating landslides, damming rivers, and destroying whole towns and villages. The damage done depends on the size of the earthquake and on how close the area is to the point of origin. Shocks and tremors can sometimes be felt over enormous distances, covering thousands of square miles.

The main shock strikes suddenly and lasts only a short while—only a few seconds. A few have lasted more than a minute. But during that brief time, it can inflict much damage to the earth's surface. This shock is generally preceded by a series of foreshocks—smaller tremors that sometimes are so gentle and short-lived that they pass unnoticed by most people.

Some say that birds and animals can feel these minor vibrations and become extremely agitated, flying up in the air, pacing restlessly or uttering strange cries.

After the main shock has struck, a series of aftershocks may follow, diminishing in intensity until the earth is once again at rest. Even though they are smaller, aftershocks can cause surprising damage, for they give an extra jolt to buildings and structures already weakened by the major quake.

Earthquakes may roll over the earth in a series of large shocks, such as those that, starting on Aug. 19, shook the Erzurum region of Turkey, where 29 villages were reported wiped out and over 2,000 dwellings destroyed. In the area around Varto, near the quake's epicenter, more than a thousand persons were reported dead. Total toll of lives is expected to reach 3,000, although the final count may not be known until late September, when the full extent of the damage should also have been assessed.

The Turkish earthquake started on the eastern end of North Anatolia fault zone, a rift in the earth that is geologically very similar to the San Andreas fault in California, cause of the great San Francisco earthquake of 1906. Both faults are more than 600 miles long. Blocks of the earth's crust slip horizontally on opposite sides of the fractures, creating great strains and resulting in sudden breakage and earthquakes. In recent years, no major earthquake has occurred along the San Andreas fault, but the North Anatolia fault has instigated earthquakes in 1939, 1942, 1943, 1944, 1946, 1953 and 1964, reported Dr. Robert Wallace of the U.S. Geological Survey's National Center for Earthquake Research.

Other disasters have struck within the past five years on the same earthquake belt as the Turkish disaster. On Sept. 1, 1962, an earthquake killed 10,000 persons in northwest Iran; and a series of earthquakes shook Skopje, Yugoslavia, on July 26, 1963, killing more than a thousand persons.

The worst earthquake catastrophe in world history occurred in Shensi Province of northern China in January 1556, when a tremor killed 830,000 people. China was inflicted with another great tragedy in December 1920, when 180,000 persons were reported killed in the earthquake near Kansu.

Throughout the centuries, appalling death tolls have made earthquakes and their resultant fires and floods the greatest natural destroyer of life and property—killing on an average some 15,000 persons each year.

More than a million earthquakes occur annually, with an average of two every minute. Most of these are very slight tremors and produce little damage. There are about 20 earthquakes yearly large enough to cause serious damage. Fortunately, most of these occur in sparsely populated areas of the world.

Tremendous Energy Released

A tremendous amount of energy is released by an earthquake. For instance, the energy of a very large quake may be equal to that of a 100-megaton fusion bomb—hundreds of times greater than the nuclear explosion over Bikini.

Scientists classify earthquakes on a magnitude scale according to the total amount of energy released. The magnitude scale most often used was devised by Dr. Charles F. Richter of the California Institute of Technology in Pasadena, Calif. The scale starts at 0 and goes up to 8.9, the highest magnitude recorded.

Each increase of a whole number on the scale represents a tenfold increase in the energy of the earthquake. Thus, an earthquake of magnitude 2 is 10 times greater than that of magnitude 1. One of the greatest earthquakes ever recorded, the Assam earthquake of Aug. 15, 1950, had a magnitude of 8.6. The Good Friday earthquake in Alaska, March 27, 1964, was recorded as 8.5 on the Richter scale.

Earthquakes are also described by their intensity, which is the amount of shaking and destruction observed above ground at a particular place and time. Intensity varies with distance from the epicenter. The two types of scales are often confused by the layman, but they are quite different.

There is only one magnitude of an earthquake, but there can be many differing reports of the damage inflicted on towns and cities above ground.

Scientists "listen in" on the earth with instruments so delicate that they can "hear" a mouse walk across the basement floor—or an earthquake hundreds of miles away. These are seismographs, working on the principle of inertia in the following manner:

A heavy weight is suspended from a frame anchored in bedrock. A "pen" or beam of light from the weight draws a line on a continuously running band of sensitized paper. When an earthquake or tremor shakes the rock, it also shakes the frame and the recording device—but the free-hanging pendulum remains inert. The movement of the earth is thus recorded as a series of agitated lines on the sensitized paper.

Constant Earthquake Check

Hundreds of seismograph stations throughout the world constantly are recording shocks and vibrations that crisscross through planet earth. By checking with other stations, seismologists keep track of earthquakes and also accumulate knowledge about the interior of the earth.

Earthquake waves travel at different speeds through different kinds of materials. Some do not pass through liquid or molten rock; others speed up in denser material such as granite and slow down in sand. By clocking the various times of arrival and the directions from which the waves arrive, then analyzing their behavior, scientists have been able to draw a detailed chart of the earth's structure.

Earthquake research is underway in many parts of the world. A National Center for Earthquake Research, part of the U.S. Geological Survey, is set up at Menlo Park, Calif., to be an open exchange research laboratory. The President's Office of Science and Technology, after an in-depth study of earthquake research, recommended extensive field surveys of earthquake areas, more research in earthquake-resistant buildings and installation of batteries of sophisticated instruments to monitor restless faults, such as the San Andreas Fault in California.

A newly established National Earthquake Information Center, part of the Environmental Science Services Administration, will inform the public of sizable earthquakes, magnitude 6.5 or larger, occurring anywhere in the world.

As the world population continues to increase, and men continue to build more cities and towns across the changing face of earth, the disasters from these natural forces cannot help but become more catastrophic unless great caution is taken.

Scientists may not be able to control or prevent the suddenly released energies of nature. However, catastrophies to human and animal life can be reduced by better understanding of the causes and behavior of the forces that shake the earth and by recognizing the warning signals predicting their arrival.

Nature Note

Coriolis Force

➤ A COMPLEX force, set up by the rotation of the earth, has been blamed for helping generate the great twisting windstorms—hurricanes, cyclones and tornadoes. Because of this force, rivers in the Northern Hemisphere scour their right banks more severely than the left. This force is partly responsible for the major wind systems of the earth—the trade winds, westerlies and easterlies.

Known as the Coriolis force, this deflecting influence of the earth's rotation gives the winds their spin.

Essentially it can be explained this way: as the earth rotates on its axis from west to east, all trees, mountains and other things attached to it move with it. But the air, unattached and free moving, continues in a certain direction while the earth slips under it.

For instance, suppose a mass of cold air starts to move southward from the North Pole toward a point on a meridian. In the time necessary for it to reach that point, the point will have moved to the east with the rotating earth, and the air body will reach another point that has moved in from the west. Hence, to an observer on earth, the air seemed to have blown from the north toward the west in a curved path. To an observer in space, the air body actually followed a straight line; it was only the earth that slipped beneath it to give an appearance of a path curved to the right.

Masses of air from the South Pole are affected the same way, and they undergo deflection to the left. The earth's spin does not affect the moving air at the equator, however. The deflecting force starts to take effect from about six to 15 degrees north and south from the equator.

CONSERVATION

Bubble Wall to Reduce Silt Deposits

➤ A BUBBLE barrier may be created across the entrance to Newcastle Harbor, New South Wales, to stop the build-up of silt.

The State Government is investigating a novel scheme that, if successful, would save about one million dollars yearly. At present the Public Works Department dredges up to four million tons of silt each year from the bed of the harbor to keep the channels open for free movement of shipping.

At the department's hydraulic laboratory, a full scale model of the Lower Hunter Valley has been constructed. Silt flows into the harbor from the upper sections of the Hunter. The model also simulates actual flood conditions to test the effectiveness of a major flood mitigation program.