

EARTHQUAKES



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COVER PHOTO

Rescuers search through rubble for trapped victims at Veteran's Hospital, Los Angeles, California, devastated by 1971 earthquake.

Conn — Plain Truth

*“Killer Quake Strikes —
Thousands Die!” Such
headlines appear regularly as
earthquakes devastate our globe.
Scientists are becoming concerned. Many
feel the next big quake to strike a popu-
lated, highly mechanized area may do BIL-
LIONS of dollars damage; thousands may
be killed. One study discusses the “first
earthquake to kill over one million
people”!*

*This booklet tells the grim facts as they
are. It describes the devastating power of
quakes — where they have wreaked havoc
in the past; where they will likely strike in
the future. The booklet also tells you what
to do in case you suddenly find yourself in
an earthquake.*

Chapter One

WHEN KILLER QUAKE STRIKE!

ONE OF THE MOST DEVASTATING AND CATASTROPHIC series of earthquakes ever recorded on earth suddenly shattered the quiet, gray dawn of Saturday, May 21, 1960.

In major cities and sleepy hamlets along the narrow 2,000-mile-long nation of Chile, an imagination-defying time of terror began.

When the series of disasters was over, Chile counted 1,123 known dead, 588 missing, 258 seriously injured. Approximately 58,700 houses were totally uninhabitable — another 100,000 were partially destroyed; 150 square miles of land was permanently flooded due to sinking.

On a comparative basis, less powerful earthquakes have killed and destroyed much more. But in sheer magnitude and energy, the Chilean quake of 1960 was one of the MOST POWERFUL to hit the earth in modern times!

The quake which hit about six o'clock on the morning of May 21, 1960, was only an ominous forerunner of what was yet to come. Even then, southcentral Chile shook like a rag doll. Damage was serious, but not extreme. Throughout the day and into the next afternoon several smaller shocks followed.

Then came a series of quakes that rocked Chile to its knees. The clock ticked off three minutes after three in the afternoon. The day was May 22, 1960. A serious quake

struck. Damage was moderate. People rushed into the streets and stayed there.

About 3:30 p.m. it seemed the ultimate in earthquakes had hit. It was one of the *most powerful quakes* ever known in modern times. Cars in the streets rolled back and forth. Trees thrashed about. Many were broken like tooth-picks; others were yanked out by the roots.

This swarm of earthquakes included forty-three significant shocks — with thousands of minor tremors. The shock epicenters were spread over an area nearly 100 miles wide, from north of Concepcion southward a thousand miles deep into fjord country. The total area affected was 90,000 square miles — equal to the area of Great Britain, or about as large as New York and Pennsylvania combined. Few known earthquakes in recent history have had a greater range of devastation than this. The sequence of Chilean quakes released more energy than all the notable earthquakes in California in the past 60 years.

Some authorities say that one quarter of Chile's seven million people were homeless — suffering from cold and hunger. Water supplies, sanitary facilities, power — all were gone. Schools were damaged; hospitals were rendered useless. Bridges collapsed. Most transportation and communication were cut off. Hundreds of miles of highways and railways were severely damaged.

The staggering repair bill was one-half billion dollars — a monumental burden for a poor country.

One scientist called it "*the most violent crisis* which the history of man records." If the shock had happened on a weekday, the casualties could very well have been reckoned in the hundreds of thousands.

On a weekday, factories, offices, workshops and schools would have been open and filled with people. With so many buildings suddenly telescoping into a heap of rubble, the slaughter would have been appalling.

On-the-Spot Report

One well-known scientist personally surveyed the damage. He was incredulous at what he saw.

"My mind still could not acknowledge the reality of so

astonishing a fact as the yielding of an enormous piece of the continent, its sinking ten feet in the space of a minute.

"Imagine a strip of land a dozen miles wide, running from Philadelphia to Boston, suddenly giving way and sinking by a man's height.

"...It is very difficult to accept the possibility of something between four and eight thousand square miles of 'the very ground we stand upon,' so proverbially firm, sinking down by the height of a man at one go, and for a long time I REFUSED TO BELIEVE what I was told and what was indeed before my eyes" (*When the Earth Trembles*, Haroun Tazieff, pp. 25, 31).

A man tried to describe to the author what he felt when the terrible quake began:

"First there was quite a violent shock. Then an underground rumbling, like a big storm in the distance: it rumbled like thunder. Then I felt the ground tremble again . . . Suddenly the shocks grew much stronger, and I thought I was going to fall. It went on and on, increasing all the time and getting stronger and stronger.

"I began to be afraid.

"I could not stand upright any more; it threw me from side to side, as if I were in a boat when the sea is rough. Two cars that were going by had to stop. As for me, I went down on my knees so as not to fall, and then on all fours. It went on and on. I was really frightened. Very frightened.

"All the trees were waving — how can I describe it? — as if they were branches that you had got hold of and were shaking with all your strength. The surface of the road was moving like water, like choppy water. Yes, I do assure you it was. And the longer it went on, the more terrible it was: the shocks grew stronger and stronger all the time. It went on forever" (*When the Earth Trembles*, Haroun Tazieff, p. 22).

Newspaper accounts stated that a twenty-five-mile stretch of high ground in the mountainous Lake District dropped ONE THOUSAND FEET! Most geologists felt this could only mean that a twenty-five-mile stretch of high

mountain land slid down a thousand feet. In any case, it must have been an awesome sight.

Our Quaking Earth

The Chilean earthquake was just one of many that strike the earth every year. In fact, earthquakes of varying magnitude — most too small to be felt — rock the earth daily.

There are perhaps one million earth tremors yearly around the world. Some 50,000 of these can be felt without instruments. Of these, between ten and one hundred cause some damage.

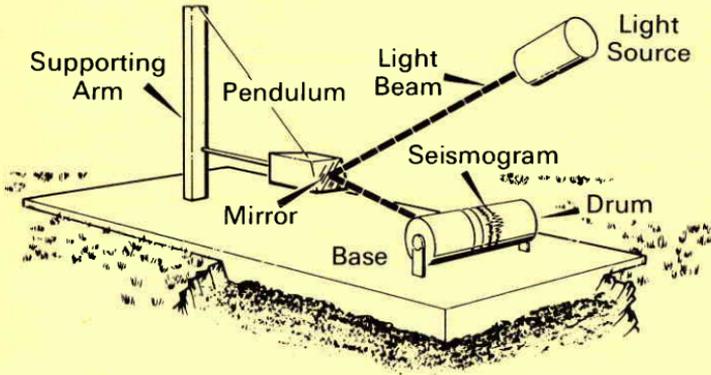
Records kept for about seventy years show there have been sixteen to eighteen major earthquakes every year! (A quake must reach a magnitude of at least 7 on the Richter Scale to be classed as major.)

On an average, approximately twelve quakes strike populated areas, causing serious damage and death every year. According to some estimates, such quakes in the twentieth century killed more than 900,000 people and did more than TEN BILLION dollars' worth of damage in forty nations. A UNESCO report says about 15,000 people a year are killed by quakes on an average over a long period of time. In 1968 some 12,401 people lost their lives in 13 countries due to earthquakes.

Among killer quakes here are six in history that have killed 100,000 or more persons:

1. Shensi, China on January 24, 1556 — 830,000 killed.
2. Calcutta, India on October 11, 1737 — 300,000 killed.
3. Tokyo, Japan on December 30, 1703 — 200,000 killed.
4. Kansu, China on December 16, 1920 — 180,000 killed.
5. Tokyo, Japan on September 1, 1923 — 143,000 killed.
6. Chihli, China on September 27, 1920 — 100,000 killed.

RECORDING THE AWESOME *POWER* OF EARTHQUAKES



In order to measure the movement due to an earthquake, scientists invented the seismograph. This instrument measures the movement of the ground during an earthquake. Any seismograph is hampered by the fact that it moves when the earth moves. But scientists have been able to devise instruments that remain relatively immobile even though the earth moves beneath them.

The drawing above shows a generalized seismograph. Small movements of the instrument are converted into a visible record called a seismogram. The heavy free-swinging pendulum remains immobile. The rest of the instrument, of course, vibrates in relationship to the movement of the ground during a quake.

There are various kinds of seismographs. These measure differing ground movements. Today, most seismographs have pendulums suspended in electric coils. When the instrument moves in relation to the pendulum, there is a change in current flow. As a result, slight motion can be magnified many times and quite precisely measured. Also, seismographs use a light beam instead of a needle to make their records. A small light is shone on a mirror fastened to the end of the instrument's pendulum. The light beam reflects into a chamber where a strip of sensitized photographic paper is turning.

The earthquake at Chillan, Chile on January 24, 1939 was the last quake to claim more than 25,000 lives until the disastrous earthquake of May 1970 in Peru. This quake killed at least 50,000 people. There have been many powerful earthquakes in recent years. Witness the tragic 1960 earthquake in Chile and the Alaskan quake of 1964.

But the year 1906 still holds a dubious distinction. In that year, there was more earthquake energy released than in any other comparable period since.

A Lull in Earthquakes?

Scientists have been studying what seems to be an unusual lull in large-scale earthquakes. To say there has been a "lull" in earthquake activity seems strange when we hear that thousands are killed by quakes.

But the energy expended by an earthquake is not at all synonymous with the number of deaths and amount of destruction it causes.

Where the earthquake strikes, its depth, the type of rock and soil, population density, type and quality of buildings in the area, time of day and people's activities — all these determine to a great degree the number of dead and the amount of destruction.

For example, a number of earthquakes caused death and destruction in 1968 — in Manila, in Sicily, in Mexico City. In August 31, 1968, approximately 11,000 people lost their lives in Northeastern Iran. But the earth was in its *quietest period in at least seventy years!*

In 1967, statistics showed that there were only six or seven earthquakes described as major. The annual average is sixteen. And significantly, the last earthquake classified as "great" (magnitude 8.0 to 8.9 on the Richter Scale) had been the Alaskan shock of March 27, 1964. Not until May 16, 1968, was there another great earthquake. This one occurred off the east coast of Honshu, Japan.

"This," said the U. S. Coastland Geodetic Survey, "was the *longest period* without the occurrence of a great earthquake since seismologists began recording the earth's tremors on their sensitive instruments 70 years ago."

Seismologists hasten to say, "This doesn't mean any-

thing has drastically changed in the stress pattern of the earth." But scientists do wonder, if indeed, there are patterns in the earth's activity. "Could this," some muse, "be the lull before the storm?"

How to Measure an Earthquake's Power

To understand how much of a "lull" in earthquake activity there has really been, you have to grasp the basis of earthquake measurement.

The name "Richter Scale" is a household word today, used by all the newspapers in their accounts of earthquake occurrences. Newspapers, magazines, books invariably have some statement such as, "The magnitude of yesterday's quake was 6.3 on the Richter Scale. . . ."

Unfortunately, most people don't really know the true significance behind this term.

The Richter Scale is simply a standardized scale for measuring earthquakes. It was developed by Dr. Charles Richter and others.

People sometimes ask, "We had a small earthquake — the newspapers said it was rated about magnitude 4.2. Does this mean it was HALF as bad as the 1906 San Francisco earthquake?"

The answer is NO! As a matter of fact, a "million times no!"

The magnitude scale is not a simple arithmetic scale. It does measure energy or power, but on a vast scale. The 8.25 San Francisco earthquake of 1906 released MORE THAN A MILLION TIMES as much energy as a 4.2 earthquake.

The Energy Gap

Dr. Charles Richter devised the scale so that it uses simple numbers. But he adopted a system of measurement commonly employed by engineers and physicists — called a logarithmic scale. Here each whole number represents a quantity 10 times greater than the next whole number below it on the scale.

When the quantities considered in the Richter Scale — the amplitudes of earth vibrations recorded on a stan-

MEASURING THE AWESOME POWER OF EARTHQUAKES

Scientists have various means for making plain the amount of energy released by an earthquake. One simple way is to relate the magnitude of quake to the explosive power of T.N.T.

Here earth scientists caution that the reader must carefully distinguish between the total explosive energy of a bomb and how much of its energy is radiated or propagated outward in the form of elastic waves. There is very low efficiency of conversion from the explosive energy of a bomb into an earthquake's seismic wave energy.

Once the reader grasps this, he can make some interesting comparisons.

For example, a 6.35 magnitude earthquake releases ground wave energy equal to the explosive energy of a Hiroshima-type atomic bomb (20,000 tons of T.N.T.). The Alaska earthquake of 1964 released the ground energy equal to the explosive force of 32,000,000 tons of T.N.T. The most powerful earthquakes known, of 8.9 magnitude, release ground energy equal to an explosion of 125,000,000 tons of T.N.T.

The chart below makes the comparisons clear. The reader is advised that the subject of earthquake magnitudes, and their relationship to released energy, is rather complicated. In fact, it is still not subject to general agreement.

ENERGIES OF EARTHQUAKES

(magnitude 1.0-9.0)

<i>Earthquake magnitude</i>	<i>Approximate earthquake energy</i>
1.0	6 ounces T.N.T.
1.5	2 pounds T.N.T.
2.0	13 pounds T.N.T.
2.5	63 pounds T.N.T.
3.0	397 pounds T.N.T.
3.5	1,990 pounds T.N.T.
4.0	6 tons T.N.T.
4.5	32 tons T.N.T.
5.0	199 tons T.N.T.
5.5	1,000 tons T.N.T.
6.0	6,270 tons T.N.T.
6.5	31,550 tons T.N.T.
7.0	199,000 tons T.N.T.
7.5	1,000,000 tons T.N.T.
8.0	6,270,000 tons T.N.T.
8.5	31,550,000 tons T.N.T.
9.0	199,000,000 tons T.N.T.

Energies of some major earthquakes

<i>Location</i>	<i>Date</i>	<i>Magnitude</i>	<i>Energy (tons Magnitude of T.N.T.)</i>
Anchorage, Alaska	1964	8.5	31,550,000
San Francisco, California	1906	8.2	12,550,000
Kern County, California	1952	7.7	1,990,000
El Centro, California	1940	7.1	250,500
Los Angeles, California	1971	6.5	31,550
Long Beach, California	1933	6.3	15,800
San Francisco, California	1957	5.3	500
Hiroshima Atomic Bomb	1945		20,000

ard seismograph — are converted to equivalent energies, we find that one step in the Richter Scale is equivalent to a difference in energy of about 31.5 times.

That means that there is 31.5 times more energy released in an earthquake of magnitude 4 than is released in one of magnitude 3. It's analogous to the old riddle: which would you rather have — a \$1,000,000 NOW, or take a penny and double it for thirty days? If you took the lump sum, you missed out on a lot of money. Double a penny for thirty days. See how much money you end up with.

In the same way, the energy compounds rapidly on the Richter Scale. A tremor of 1.0 magnitude releases energy equivalent to six ounces of T.N.T.; a 4.0 magnitude quake is equal to six TONS of T.N.T.; a 7.0 magnitude quake releases 200,000 tons of T.N.T.; an 8.9 earthquake (the largest known) releases the shocking total of 125,000,000 TONS of T.N.T.

Everyone should realize, however, that only a small fraction of the "chemical energy" in an underground or atmospheric explosion is propagated outward in the form of seismic waves.

Nevertheless, understand what this means in terms of earthquake activity. You would have to have approximately THIRTY-ONE magnitude 7 quakes to release enough energy to equal one 8 magnitude quake.

However, there were less than HALF the normal number of point 7 to 7.9 quakes in 1967!

Actually, more than half the total energy released each year comes in one or two "great" earthquakes. All the hundreds of thousands of other quakes barely equal the energy output of these one or two quakes. One can understand why the idea that small quakes are safety valves against big ones is very dubious at best.

According to some seismologists, for example the late Hugo Benioff of the California Institute of Technology, the average release of energy the world over stays about the same year after year.

For example, "Milne compiled a list of Japanese earthquakes and found that over two thousand years there had been comparatively little *variation* in activity"

(*Earthquakes*, Nicholas Hunter Heck, p. 215). Other Japanese researchers such as Sekiya and Omori calculated that a great earthquake occurs in Japan on the average of every two and three-quarter years. A period of comparatively mild activity will be followed by a time of more violent quakes.

Killer Quakes

Four countries — China, Italy, Japan and Pakistan — suffered more than 500,000 combined fatalities from 1903 to 1935 in just FIVE violent earthquakes. Perhaps the ultimate in killer quakes occurred on January 24, 1556 in Shensi Province, China. In a brief historic reference to it, we are told approximately 830,000 were killed.

Between 50 and 60 million tremors or quakes have occurred in this century. Only about sixty have reached the magnitude of 8 on the Richter Scale. In some years there were none; in others more than one. There were three in the years 1905, 1920, 1938, 1939.

In the exceptional year of 1906 — not equalled to date — there were six earthquakes of magnitude 8 or above. And one almost made the “great” earthquake array.

They were:

Colombia — Ecuador border:	8.9
Chile:	8.4
San Francisco:	8.25
New Guinea:	8.1
Japan:	8.0
Aleutian Islands:	8.0
China:	7.9

The largest earthquakes ever recorded on the Richter Scale were at 8.9 magnitude. However, they were so big that seismologists are not all sure this was the correct rating.

There were two of these quakes. One on January 31, 1906, in the ocean off the northwestern coast of South America and the other on March 2, 1933, in the ocean northeast of Japan. To prove you can't equate number of dead with earthquake power, neither of these quakes killed very many people.

The Awesome Energy of an Earthquake

Just how powerful is an 8.9 earthquake?

The amount of energy represented by an A-Bomb is enough to raise a small mountain a foot off the ground. A small mountain would be about four thousand feet high and twenty miles across the diameter of its base.

Although the energy is distributed differently, the Hiroshima A-bomb blast was equal to about a 6.3 magnitude earthquake. An 8.9 earthquake could move this "small" mountain — not just one foot off the ground — but could blast the mountain about TWO MILES into the air!

Some geologists have likened the *ground force* expended by a great earthquake to the force of ONE HUNDRED THOUSAND atomic bombs.

The San Francisco earthquake released enough energy to run a battleship at full speed for 45,000 years, one scientist has estimated. Another comparison gave the quake enough explosive energy to raise a cubic mile of rock six thousand feet into the air. Of course, as mentioned previously, there is a very low efficiency of conversion of explosive energy into seismic energy. So the comparisons leave something to be desired.

In fact, how do you attach any comparable numerical value to a force that can cause SOLID EARTH to suddenly shift 21 feet?

The Most Powerful Quake

Probably the most violent land-based earthquake was the 8.7 smasher that devastated the Himalayas in 1950. The Alaskan earthquake with 8.5 magnitude — with its thousands of aftershocks, released the equivalent of 500,000 Hiroshima-type atomic bombs. At least, this was the estimate of Frank Press, well-known seismologist. According to Dr. Richter, the largest earthquakes release the energy of "only" TEN THOUSAND atomic bombs.

Some geologists and engineers feel that an 8.9 quake is the most powerful that can occur.

An earthquake specialist tells us:

“The strength of the fault, or in the absence of a fault the strength of the rocks themselves, clearly limits the amount of stress which can accumulate, and, consequently, the maximum energy which can be released in an earthquake” (*Earthquakes and Earth Structure*, John H. Hodgson, pp. 110-111).

With such awesome potential poised to strike, people are concerned that their city may be next! But the most terrifying aspect of an earthquake is its UNPREDICTABLE nature. As a result, people wonder, “Will it ever be possible to know in advance before a ‘killer’ strikes?”

Can Earthquakes Be Predicted?

“Not in the popular sense — although some progress is being made in that direction,” say scientists.

There are many self-styled prophets that claim “California will drop into the Pacific next month” or “A powerful earthquake will rock Turkey next year.” A rash of these quack quake predictors claimed “California will drop into the Pacific!” The favorite date seemed to be April 1969. But April came and went, with no such quake. A best-seller book was even written entitled *The Last Days of the Late Great State of California*. Worried Californians gobbled it up from bookstores.

Most people have no conception of the vast number of earthquakes that shake this earth. Obviously, if you predict an earthquake for an area that is shaken regularly, you can be 90% accurate.

But in spite of earthquake prophets, scientists do make *guarded statements* concerning the future possibility of recognizing an earthquake before it rips up the earth under an unsuspecting populace.

However, it is NOT yet prediction in the popular sense.

Dr. Charles Richter stated some years ago, “At present there is NO POSSIBILITY of earthquake prediction in the popular sense . . . it is uncertain whether any such prediction will be possible in the foreseeable future; the conditions of the problem are highly complex. One may compare it to the situation of a man who is bending a

board across his knee and attempts to determine in advance just where and when the cracks will appear" (*Elementary Seismology*, Charles F. Richter, pp. 385, 386).

That was in 1957. Since then the situation has changed somewhat.

"Recent developments reopen the question of the predictability of earthquakes," began an article in the June 1966 issue of *Science*, the organ of the American Association for the Advancement of Science.

Dr. Frank Press, eminent seismologist and professor of Geophysics at Massachusetts Institute of Technology then stated, "A few years ago the subject of earthquake prediction fell under the purview of astrologers, misguided amateurs, publicity seekers, and religious sects with doomsday philosophies... the situation has changed dramatically in the past three years" ("Earthquake Prediction," Frank Press and W. F. Brace, *Science*, June 17, 1966).

New Clues Being Uncovered

Japanese scientists have been in the forefront of earthquake prediction. In 1964, seismologists in Japan set up shop at the small town of Matsushiro about 110 miles northwest of Tokyo.

Instruments were placed in a number of tunnels in the quaking area. They included tiltmeters to measure the tilt of the earth's crust; magnetometers to reveal alterations in the magnetic field; seismographs to record any tremors, and other instruments.

Several days before major earthquakes in 1965 and 1966, the floors of the tunnels tilted abruptly. Slight alterations in the region's magnetic field were spotted. As much as months prior to the big quakes, swarms of small tremors called microseisms were detected.

Scientists were excited.

Here were *fledgling clues* for possible earthquake prediction.

Of course, it was still impossible to say, "An earthquake of such and such magnitude will occur precisely at such and such a place."

Seismologists in the United States have also found that rocks themselves give warning signs before breaking. Strangely enough, when rocks are about ready to fracture (lacking 10% of the needed pressure), they actually *expand* in volume. They also exhibit other interesting tendencies. Think of breaking a board in half. Just before the board “snaps” the pressure needed to bend it to the point of breaking must be greater. This analogy roughly illustrates what geologists think may happen with rocks. Studies are under way to see whether this line of research will prove fruitful in diagnosing a coming earthquake.

Rocks also exhibit alterations in their electrical resistance. It has been suggested that instruments could monitor the ground to spot such changes.

In fact, with some clues — if they had been understood — the mighty Alaskan earthquake of 1964 might have been predicted. An oil company was monitoring a magnetometer in the area, an instrument that measures the intensity of earth’s magnetic field.

The instrument noted a *mysterious shift* in the field. One hour later the earthquake tore up Alaska. In other earthquake occurrences, sudden shifts in the magnetic field have been recorded from hours to a day or two before.

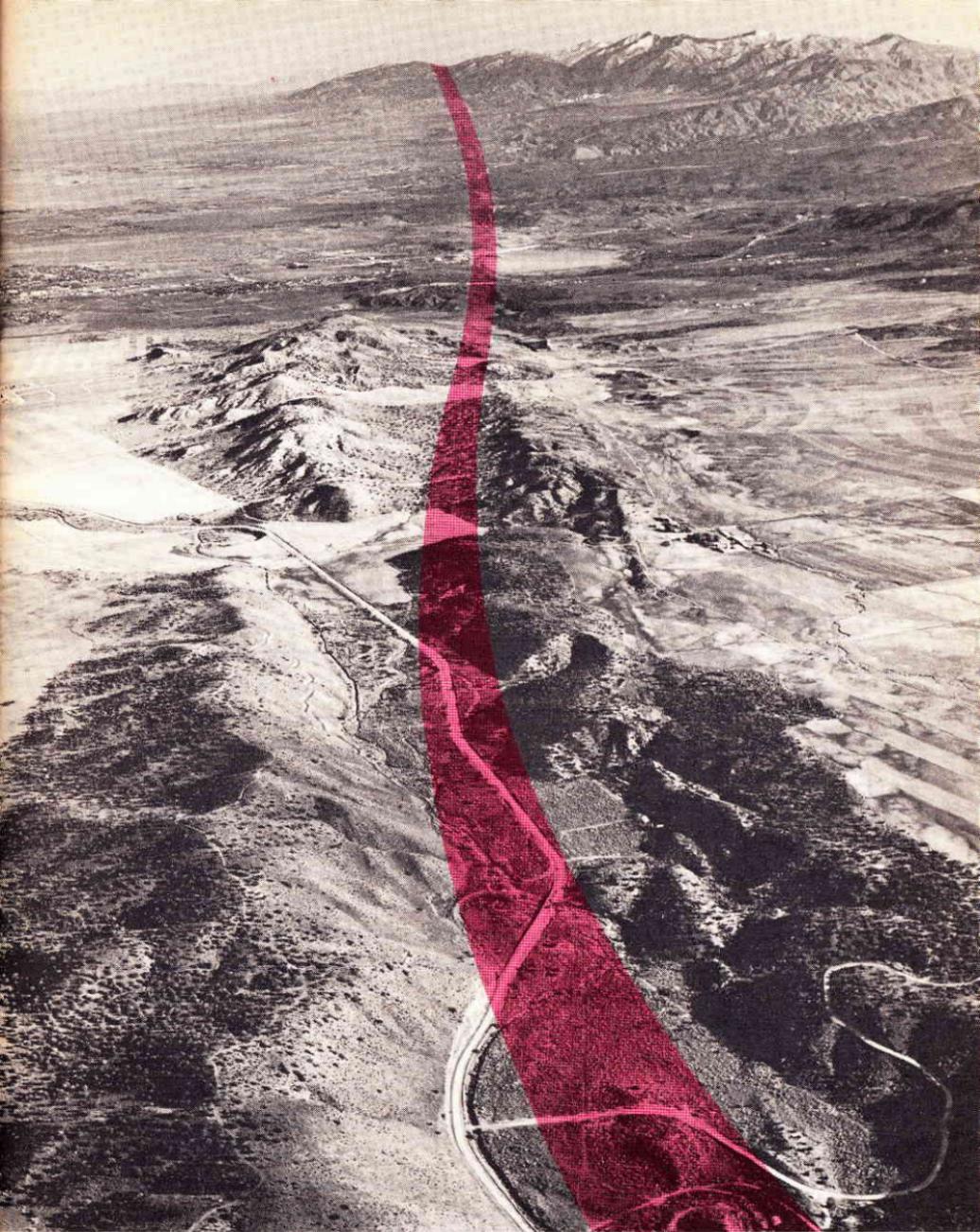
These are some of the various clues scientists are uncovering. Why haven’t scientists then been able to issue predictions that would specify time and place of earthquakes?

The problem is highly complex and there are far too few instruments scattered in key areas.

Some signs appear before *some* earthquakes and NOT before others. Some are evident years before an event; others only hours before. With too few observations and the lack of an overall pattern — all these attempts are merely unrelated clues in a yet unresolved Sherlock Holmes mystery.

There are several things we can be sure of about earthquakes.

As one scientist has said, “The LONGER it has been since the last quake, the *sooner it will* be to the next.” Another seismologist, Don Leet, put it in these words, “Of



Ambassador College Photo

A GEOLOGIC INCISION. San Andreas Fault slices through Southern California, approximately 35 miles north of Los Angeles area. Line depicts fault running east and south. Palmdale, where large international airport is being built, is just to left of fault area.

one thing we are certain; where large earthquakes have happened in the past, *they will happen* in the future" (*Earthquakes: Discoveries in Seismology*, Don and Florence Leet, p. 50).

Rather elementary!

Also perhaps not too comforting to residents of earthquake belts, but it is nonetheless the only present SURE "prediction" that can be offered against future earthquakes.

Because in spite of recent scientific advances, "the most impressive characteristic [of earthquakes] is their unexpectedness," as one writer phrased it. He continued about the possibility of prediction, "There are sometimes warning signals, but they are of uncertain meaning and provide no basis for specific predictions. Moreover, with few exceptions we don't know where the active faults are. So we may say that earthquakes are *essentially unpredictable*" (*Volcanoes and Earthquakes*, Elliott Roberts, p. 37).

Practicality of Prediction?

Karl V. Steinbrugge in his report entitled, "Earthquake Hazard in the San Francisco Bay Area," warned, "The only best practical approach to earthquake prediction to date is to study the historic seismic activity in a region, to temper this information with geologic knowledge... and then to judge the future earthquake potential."

The answer in a nutshell is that we know where earthquakes generally occur. Scientists are beginning to discover and piece together clues that might in the future yield accurate and precise earthquake warnings and reports.

But the biggest problem in predicting earthquakes is not the technological problem; but rather the *human* one.

There is little doubt that, given enough time, seismologists could learn enough about the interior of the earth to successfully predict when and where earthquakes could occur.

But there are *far greater problems* in earthquake pre-

diction. Have you ever asked yourself: How would knowledge that an earthquake will strike an area affect the people that live, work and own property there?

Steinbrugge was worried about this. His report on earthquake hazard concluded on this somber note. "The social and economic consequences of a successful — or partially successful — earthquake prediction program *are more far-reaching* than most persons realize" (p. 60).

Let's paint the picture.

Consequences of Prediction

Suppose that scientists were now able to predict earthquakes precisely. They issue a warning: "An earthquake of magnitude 8.5 will strike the southern portion of the San Andreas Fault at 9:45 a.m. on Monday, July 10, 1976. Los Angeles County will be heavily damaged."

What series of consequences would such a prediction bring about?

Some would simply not heed. Others would ascribe great religious significance to such an event. New religious sects would sprout up in already sect-ridden Southern California. Perhaps thousands would sell their belongings to follow some earthquake guru.

Landlords would refuse to maintain their properties. Slums would increase. Businesses might leave the area, although their owners might find themselves hard pressed to sell with a 100% earthquake possibility staring potential buyers in the face.

Looters, anarchists — perhaps Communists — might use the event as a signal for area-wide riots.

Major construction — both industrial and commercial — would be curtailed, causing a panic in the economy of Southern California. Certainly it would be most difficult to find the necessary funds and approvals for freeway construction. In fact, Southern California — one of the wealthiest areas in the entire world — could find itself composed of a *series of ghost towns!*

And, perhaps worse, suppose the "prediction" failed — like some weather forecasts?

Why say this? To discourage scientific efforts to

find ways of predicting earthquakes? Certainly not!

The point is this: Earthquake prediction is not a giant panacea that will solve the world's earthquake problem. Any new scientific knowledge about earthquake prediction could do MORE DAMAGE than good — *if not used properly!* At best it is a second-rate “solution” that deals with the *effect* rather than the cause.

Chapter Two

EARTHQUAKES AROUND THE WORLD

MANY EARTHQUAKES are recorded by the ancients. Perhaps the oldest recorded earthquake is discussed in tablets found in ancient Nineveh.

In Japan, earthquakes have been observed and recorded from the earliest days. Between the fifth and nineteenth centuries, an astonishing library was accumulated. Some five hundred manuscripts were assembled in which were described more than two thousand considerable earthquakes — 223 of them catastrophic.

Earthquakes in History

There is a record in Hsien, China, of an earthquake in 7 A.D. that may have killed people by the hundreds of thousands. As mentioned, one in Shensi, China in 1556 A.D. killed 830,000 people.

Plato records the great area of Atlantis sinking beneath the sea in a single night. There can scarcely be any doubt that this was a seismic cataclysm.

According to the traditions that came down to the historians at ancient Greece, an appalling upheaval shook the known world from what is now Turkey to the Straits of Gibraltar. About 1900 B.C., according to accepted dates, a violent earthquake devastated Attica.

Thucydides and Diodorus Siculus both record that in 476 B.C. great earthquakes stopped the Peloponnesian ar-

mies as they were marching on Boeotia. In 373 B.C. a violent earthquake near Corinth, Greece, caused a strip of land several miles long and nearly a mile and a half wide to sink beneath the sea.

Josephus, the Jewish historian, writing in the first century A.D., discusses records of an earthquake hitting Jerusalem about 760 B.C. in the days of King Uzziah of Judah.

“A great earthquake shook the ground, and a rent was made in the temple, and the bright rays of the sun shone through it, and fell upon the king’s face . . . and before the city, at a place called Eroge, *half the mountain broke off* from the rest on the west and rolled itself four furlongs [about half a mile] and stood still at the east mountain, till the roads, as well as the king’s gardens, were spoiled by the obstruction” (Josephus, *Antiquities*, Book LX, Chapter X, part 4).

Earthquakes in the Bible

This same earthquake is also recorded in another historic source, the Bible. It mentions that people “fled from this earthquake in the days of Uzziah, king of Judah” (Zechariah 14:4, 5). As a matter of fact, the Bible has some very scientific statements concerning earthquakes which occurred historically in the area.

In a recent public seminar at the California Institute of Technology, a leading earth scientist referred to a very interesting earthquake found in Psalm 114:3, 4, “The sea saw it, and fled: Jordan was driven back. The mountains skipped like rams, and the little hills like lambs.”

“The reference to the sea fleeing shows a tsunami — a sudden recession of water on the shore line and then a giant wave,” he said. It would take at least a 6.5 magnitude earthquake on the Richter Scale to cause this. Also, the

Ambassador College Photo

WHEN KILLER QUAKES STRIKE. Workers carry body down from 20-foot-high pile of debris in Manila, Philippines. The debris represents what was left of six-story Ruby Tower apartment building.



reference to the "activity" in the mountains showed this quake's epicenter had to be at least within 40 miles — probably much closer.

A number of references to earthquakes are made in connection with future events. They have a curiously scientific ring about them concerning how an earthquake affects the ground.

Zechariah 14:4, says, "And his feet shall stand in that day upon the mount of Olives, which is before Jerusalem on the east, and the mount of Olives shall CLEAVE in the midst thereof toward the east and toward the west, and there shall be a very great valley; and *half of the mountain shall remove toward the north*, and half of it toward the south."

This is exactly what would be expected, if an earthquake ripped through a fault and caused strike slippage north and south. And as a matter of fact, *there have been earthquakes recorded at the mount of Olives.*

It is also important to understand that earthquakes were considered acts of deity by most human families as far back as history records. Sudden upheavals were viewed as disasters brought about by angry gods — as dire punishment for the evil deeds of humans.

In the Bible, modern professing Christians see many references to earthquakes in connection with apocalyptic events of a prophesied "time of the end." While most modern people feel themselves securely emancipated from holding what they might consider "ancient superstitions" to be true, it's interesting to note that even modern insurance companies still list damages from severe winds, hail, flooding, or earthquakes under their "acts of God" clause.

According to Bible prophecy, a dramatic rise in earthquake activity will *accompany* other major world problems. Jesus is quoted as having said, "For nation shall rise against nation, and kingdom against kingdom, and there shall be famines, and pestilences, and *earthquakes*, in divers places" (Matt. 24:7).

Could it be the world actually does stand on the threshold of a combination of such events? We can send you a *free* book called *The United States and British Com-*

monwealth in Prophecy which discusses some of these world problems. Simply write to the address given on page 79 of this booklet. You can receive your *free* copy.

Also, the last chapter in this booklet examines the various places in the Bible where earthquakes are mentioned.

Earthquakes Around the World

Today, most of the world's land earthquakes occur in two distinct belts. The most important is the "Circum-Pacific Zone," which lies around the boundary of the Pacific Ocean. It is dubbed the "Circle of Fire" — because it is along this belt that many volcanoes spew forth death and destruction. In fact, two thirds of all active volcanoes are within the Circle of Fire.

About 90% of large, normal earthquakes occur around this belt. A second earthquake belt is called the "Alpide Zone." It begins off the coast of North Africa in the Atlantic. The belt then passes through the Mediterranean countries of Europe and Africa, cuts up the Near East, skirts the northern border of India, and passes through Sumatra and Indonesia. It joins the Circum-Pacific belt in New Guinea. This earthquake belt is responsible for most of the remaining 10 percent of normal, shallow earthquakes — the ones that cause most of the destruction.

Of course, there are many faults in other parts of the earth. In fact, the earth is riddled with fault lines. But in terms of havoc and destruction, the quakes that occur along the two main land belts are currently the most important.

Earthquakes in the Ocean

Many earthquakes also occur in what is called the Mid-Atlantic Ridge. This phenomenal ridge is really an underwater mountain chain that stretches the full length of the Atlantic. It rears its head above the surface at Iceland, the Azores, Ascension Island and Tristan da Cunha. The Mid-Atlantic Ridge is in fact the *longest mountain chain* in the world — approximated by some to be 47,000 miles long!

Within the center of this ridge there is a remarkable valley that would dwarf the Grand Canyon.

The Mid-Atlantic Ridge is by no means unique. Other ridges are known in the Pacific and Indian Oceans. Russian oceanographers discovered a remarkable one crossing the Arctic Ocean from Canada to Siberia.

Off the California coast is the Mendocino Escarpment, a mile-high wall *cutting nearly two thousand miles* of the sea floor. After years of sleuthing by Coast and Geodetic Survey ships and the Scripps Institute of Oceanography, it was found that matching rock formations on opposite sides of the fault are *seven hundred miles apart!*

It is probably the greatest known movement of the earth's crust. The sea is 5,000 feet deeper south of the fault line than to the north — showing a vertical thrust of vast proportions.

Earthquake Country

California is earthquake country. Since one out of every ten Americans was already living in the Golden State in 1970 — officials are concerned. In fact, the Urban Land Institute estimates that one seventh of the total U. S. population will be living in California by the year 2000. These people will be jammed within an area less than one third of the state. California in many ways is the most wealthy state in the world's wealthiest nation. Destruction here could run into the BILLIONS of dollars. Hundreds of thousands could die.

Numerous articles about the earthquake danger in California are periodically published.

A Popular Mechanics magazine article warned, "Cal-

*Ambassador College Photo (top),
Richard Jahns (bottom).*

OUR "FAULTY" EARTH. Top photo shows the devastated earth along the San Gabriel Fault as it crosses Interstate Highway 5 approximately 50 miles northwest of Los Angeles, California. Bottom photo shows rows of trees in an orange grove (removed in 1964) offset 10 feet by the 1940 Imperial Valley earthquake, less than 100 miles east of San Diego, California.



fornia is digging in today for the major earthquake that scientists say is BOUND TO HAPPEN.

"The seismologists think the shake may center in the vicinity of Los Angeles, the most heavily populated part of the West. They expect it will be more catastrophic than the recent Alaska quake because of the greater density of people and structures!" (July 1964, "They're Bracing for California's Overdue Earthquake," by Thomas Stimson.)

A Date With Disaster?

A *Science Digest* article echoed the same thought with these words, "California, our most populous state, is preparing for a *date with disaster*."

"Within a vast crack in the earth's soil . . . with the potential destructive power of thousands of atomic blasts. It's the San Andreas fault, a sleeping giant that *time will trigger*" ("California's Coming Earthquake," Vincent H. Gaddis, December 1963).

These warnings echo the fears of seismologists, geologists and engineers. Most authorities on the subject know that it's only a MATTER OF TIME before an earthquake strikes the populous centers of California.

For example, William T. Pecora, Director of the U. S. Geological Survey, warned, "We are predicting another massive earthquake within the next thirty years and MOST LIKELY in the next decade or so."

In spite of the warnings, those in the know can only look on with horrified eyes as land developers build rows of houses directly over known active faults. Many of the engineering lessons which should have been learned from previous quakes have never been put into practice.

For example, the 1906 earthquake in San Francisco ruptured the earth for miles. Fortunately, most of the area was virtually uninhabited. But today, the engineer who surveys the area is horrified to find thousands of homes actually straddling the fault break.

Why are seismologists so fearful that another destructive quake will occur? In fact, how can they be so

DOGMATIC, when they admit earthquake prediction is not yet possible?

Why Quakes Are Sure to Happen

Based on what earth scientists know about earthquakes, they see no sign that such earth-jarring occurrences will not happen in the future as they have in the past.

Therefore, it's quite obvious the *further* we are from the last quake the *closer* we are to the NEXT one.

Dr. Charles Richter, eminent seismologist and deviser of the Richter Magnitude Scale, believes we may expect large earthquakes on a more or less regular schedule. He personally feels that great earthquakes (over 8.0 magnitude) occur about once every 100 years along specific fault areas in California. On the average, over California as a whole, destructive earthquakes have occurred about once every fifty years.

The last great earthquake in Southern California was in 1857. The conclusion is obvious. The next big quake is not far off. In fact, it may be over a decade overdue. No one, of course, can make any *specific* prediction about it as to day, month or even year.

The Awesome Power of the San Andreas

"The Fault," as the San Andreas is normally called (although the whole state is criss-crossed by the San Andreas Fault "System" which includes other faults such as the Garlock, Hayward, San Jacinto), is some 600 miles long. This geological incision runs from approximately north of San Francisco, through the mountains which form the western hem of the San Joaquin Valley, comes down about 30 miles east of Los Angeles, skirts the population centers of the San Bernardino-Indio area and bisects the agricultural Imperial Valley.

Several devastating earthquakes in historic times have occurred along the main San Andreas fault during the past 150 years.

Of course, other devastating quakes have occurred on subsidiary faults. These can be equally destructive. A de-

structive earthquake on the Newport-Inglewood fault hit the Long Beach area in 1933. Another destructive quake along the White Wolf Fault struck the Bakersfield-Arvin-Tehachapi area in 1952; a third quake possibly along the Mesa Fault ravaged Santa Barbara in 1925; a fourth earthquake along the Owens Valley Fault struck the Owens Valley on the east side of the Sierra Nevada in 1872; a fifth quake along the Imperial Fault devastated the Imperial Valley in 1940. The 1971 quake which caused extensive damage in the San Fernando Valley of Los Angeles, occurred on a fault line previously unrecognized and not even listed on geologists' maps.

Our Shifting Earth

But the 600-mile, ribbon-like San Andreas Fault is the most celebrated of all. The land on the western side of the Fault is moving northward at a rate of *two inches* a year, overall. At some places it is moving faster; at others slower.

Upon this known movement, a type of "prediction" has been set up. "These measured accumulating strains in the earth's crust in the San Francisco Bay area have allowed earthquake prediction calculations to be made. These calculations are based on the *average* of the largest fault displacements in the 1906 earthquake divided by the average rate of measured accumulating strain. This number comes to a reasonable figure of 60 to 75 or more years between major or great earthquakes, depending upon the interpretations given to the data" (*Earthquake Hazard in the San Francisco Bay Area*, Karl V. Steinbrugge, 1968, pp. 8, 9).

Of course, not all geologists agree. Some think the interval is one hundred years. Some claim there is *no regular interval* between San Andreas Fault quakes.

But what NO ONE disputes is that we can expect a quake at some time. And if indeed, we cannot know even approximately when a quake might strike — it makes the danger even more awesome.

The strain between the two sides of the fault is building up. There is no question here. Obviously something's

got to give soon. And two thirds of the nation's leading geophysicists in a survey in 1957 believed that a major earthquake was due in California. "It could come tomorrow," said Dr. Hugo Benioff, the late professor of seismology at Caltech, "or it might not come for years!"

Where a Quake May Strike

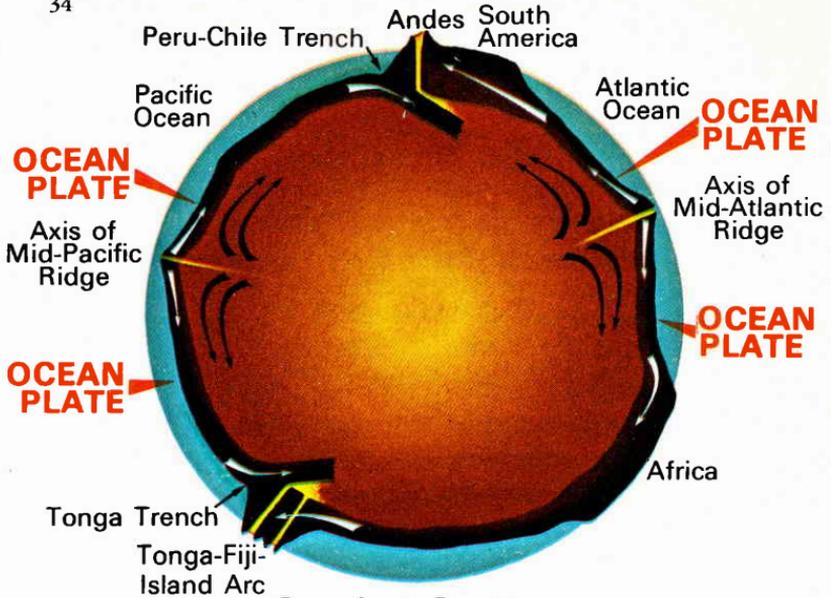
Dr. Charles Richter has set up an order of probability as to where the next quake will come. Of course, this is merely his personal "guess" based on years of experience.

1. Repetition of the 1857 earthquake in Southern California. Based on the idea of a 100-year time cycle.
2. Repetition of the 1906 earthquake in Northern California, near San Francisco. Based on accumulating strain.
3. An earthquake along the San Andreas Fault in the Central Coast ranges. Here earthquakes of significant magnitude struck in 1857.
4. An earthquake in the Owens Valley, on the eastern slopes in the Sierra Nevadas. Indians reported a major quake about 1790 and another occurred in 1872. This would be the *least disastrous* in terms of people killed and property destroyed.
5. An earthquake on some other large fault.

Although scientists may disagree on this exact order, "very few would be astonished if a major earthquake occurred along the San Andreas Fault during the next 20 or 30 years" (*Earthquake Country*, Robert Iacopi, p. 188).

Dr. Richter himself has cautioned that this is not to be taken as a "prediction" when he said, "Opinion on the most likely place for the next great earthquake in California is *little better than guessing*" ("Our Earthquake Risk," *California Institute of Technology Quarterly*, vol. 5, number 2).

Nonetheless, scientists are concerned as they see the strain build up along the San Andreas Fault. As close as 33 miles from the heart of Los Angeles the fault is now distorted about 19 feet — *and still moving!*



Coming Soon —

A WAY TO EXPLAIN EARTHQUAKES?

The New Global Tectonics is a theory which may clarify many features about our earth not fully understood before. It may be possible to simultaneously explain such geological puzzles as the enigmatic deep sea trenches that nearly circumscribe the Pacific Ocean; the earthquake phenomena associated with these trenches; the mid-Atlantic ridge, often called the world's longest mountain chain; the great land mountain systems such as the Himalayas, the Rockies, the Alps and the Andes; why some areas of the earth rarely are subjected to earthquakes; and why earthquakes occur at different depths beneath the earth's surface.

The New Global Tectonics pictures principal earthquake activity as the result of interactions at or near the edges of large mobile plates of ocean floor, called the oceanic crust. Sets of these plates spread apart at the ocean ridges where new igneous material rises to the surface from the underlying mantle. Individual plates slide past one another along large transform faults as they move at different rates away from the ocean ridges. Where they reach the adjacent continents, as along the island arcs, the oceanic material descends beneath the marginal parts of the continental crust.

Although the New Global Tectonics is not accepted by all scientists and fails to explain all known problems, most scientists feel they are definitely on the right track with this approach.

But Los Angeles citizens are not the only ones who need fear. In fact, any who come to the supposed pot of California gold must brace themselves for a possible quake.

No Place to Hide

“The shaky Californian who has just been through a heavy jolt and looks for some way to escape future danger will be acutely disappointed. There is **NO WAY TO ESCAPE** earthquakes and still live in California” (*Earthquake Country*, Robert Iacopi, p. 13).

Dr. Richter receives many letters asking about the earthquake danger.

In his own words, “Many letters I receive, say, more or less plainly, ‘I understand that this locality where I am living is far from the San Andreas Fault; am I then not right in concluding that there is no earthquake danger here?’

“The answer is that there simply is no locality in California which is exempt from earthquake risk.”

Since faults incise most of the California landscape, and since severe shaking reaches a long way from the moving fault, every population center runs the risk of earthquake damage. Weak ground may shake more violently fifty miles from the fault than firm ground at the fault slip.

In fact, Donald E. Hudson, professor of mechanical engineering and applied mechanics at the California Institute of Technology plainly warned, “A common opinion now is that perhaps the **WHOLE OF CALIFORNIA** should be considered to have approximately the same earthquake risk.”

Another Quake at Any Time

For example, experts warn that the San Francisco Bay area should brace itself for another earthquake at any time. Two major earthquake faults — the San Andreas and Hayward — run through or skirt most of the populated area there. Much of the area is built on ground that is *especially susceptible* to an earthquake rumble.

As a matter of fact, "all portions of the nine counties can anticipate severe or violent shaking in future great earthquakes, which the experts tell us are inevitable . . . year by year, stresses continue to build up . . . sooner or later something will give, producing a major earthquake. Although its date and epicenter cannot now be predicted, the authorities emphasize that the Bay Area's next jolt **COULD OCCUR ANY DAY**" (*Earthquake Hazard in the San Francisco Bay Area*, Karl V. Steinbrugge, foreword, 1968).

Shocking Damage Potential

In December, 1968, a group of scientists proposed a ten-year national earthquake hazards program. Some of their damage estimates were shocking.

Total losses, they said, in the San Francisco Bay area, for an earthquake like that which occurred in 1906 would be **NINE BILLION** dollars today; fourteen billion dollars in twenty years. If such an earthquake struck Los Angeles, the damage would be a staggering **FOURTEEN BILLION DOLLARS** today!

The report issued a stern warning:

"Many moderate, a few severe, and probably one great earthquake can be expected within the United States between now and the year 2000.

"The probable potential loss due to one great earthquake in a metropolitan area approaches **TWENTY BILLION DOLLARS . . .**

"Each year, new construction in earthquake-prone areas totals about 10 billion dollars and in 10 years this may increase to 20 billion dollars per year. The potential dollar losses will thus accelerate rapidly over the next 30 years" (*Proposal for a Ten Year National Earthquake Hazards Program*, Ad Hoc Interagency Working Group for Earthquake Research, p. 12, 1968).

Will Anyone Heed?

The agency is finding it rather difficult to make itself heard. That's human nature of course. Most people buy umbrellas **AFTER** it starts to rain; not before. It seems that few people get stirred up about earthquakes until one

strikes their area. In a recent poll, people were asked, "Do you fear earthquakes?" Almost every answer was "No, I'm not concerned!"

This committee also discussed the more somber aspects of earthquake loss — death and injury of civilians.

They frankly stated that the United States has been fortunate in the low loss of lives due to earthquake destruction.

For example, during the 1933 earthquake in Long Beach, most of the school buildings collapsed. The same occurred during the Alaskan earthquake in 1964. In both cases school buildings were *unoccupied*.

Had they been occupied, thousands may have perished!

All three earthquakes which killed over a hundred people in the United States occurred at times when most people were home — incidentally, one of the safest places to be. Had city streets been jammed with people, the death toll from falling objects and collapsing buildings would have been appalling; because it is in fact *our own man-made technological society* with heavy buildings, sometimes of poor construction, that has become the greatest threat.

The Shock of Disaster

As industrial, commercial and residential developers rush to cover the landscape with structures and as more people flock to the economic meccas in California, the significance of inevitable earthquakes increases for the entire nation.

If one in seven Americans will be living in California by the year 2000, the tragedy that strikes them will strike the rest of the nation. If billions of dollars worth of damage occur in California, the rest of the nation will suffer.

If an earthquake of only 6.3 magnitude caused sixty million dollars damage to a relatively sparsely populated Long Beach area in 1933, imagine the havoc a great earthquake could wreak on a heavily populated metropolitan area!

Many areas, practically uninhabited when the great

quakes struck the state in the first part of the century, are now crisscrossed by subdivisions and monolithic structures of various kinds.

The Ultimate Disaster?

In fact, if a quake strikes northern or southern California, it could be one of the biggest disasters in world history, potentially destroying either San Francisco or Los Angeles on the scale of Hiroshima or Nagasaki. In fact, scientists who work in civil defense admit that nuclear war and earthquakes are their biggest concerns. A United Nations report said history's FIRST MILLION-VICTIM earthquake could strike before the end of the 20th century!

If a great earthquake — over 8.0 on the Richter Scale — hit either of these two cities, it would be the first time that a complex major population center with skyscrapers, freeways, suspension bridges, closely packed subdivisions, crowded stores and shopping centers and other engineering trappings of a technological 20th century civilization was jolted by an earthquake of major significance.

In fact, *no one can be sure* exactly how much damage would be done. Some scientists see it as an ominous problem. Others are less pessimistic. But all concur, the damage could run into the billions of dollars. Loss of life could be staggering.

Earthquakes: Dam Busters?

Destruction in cities is not the only earthquake headache seismologists and engineers have. The San Andreas fault system is "of tremendous engineering significance, for no engineering structure can cross it *without jeopardy*" (*Geology of Northern California*, G. B. Oakeshott, California Division of Mines and Geology Bulletin 190, p. 35, 1966).

For example, a great nuclear power plant was abandoned after its construction had begun, due to heated public outcries about the dangers of earthquakes on a nearby fault.

The two-billion dollar Feather River water project in

California is a case in point. The water carried by the Feather River System will be worth between \$400,000 to \$900,000 *per day*. It has been estimated that the down time in repairing a water tunnel damaged by a fault would range from three to six months. The lost water alone would cost between 50 to 100 million dollars.

The cost of destroyed agricultural products was not estimated. It could, in fact, be a national catastrophe!

Of course, engineers have built the aqueduct so as to hopefully withstand any such earthquakes. However, the California Department of Water Resources has abandoned the idea of trying to design a completely earthquake-resistant aqueduct. The cost would be too great! The system is geared to withstand most quakes and is to be constructed in such a way that the rupture could quickly be repaired. Automatic gates will be installed at strategic points to cut off the water flow. Also, large reservoirs south of the fault at two key points are designed to hold enough water to provide an emergency supply until normal flow is restored.

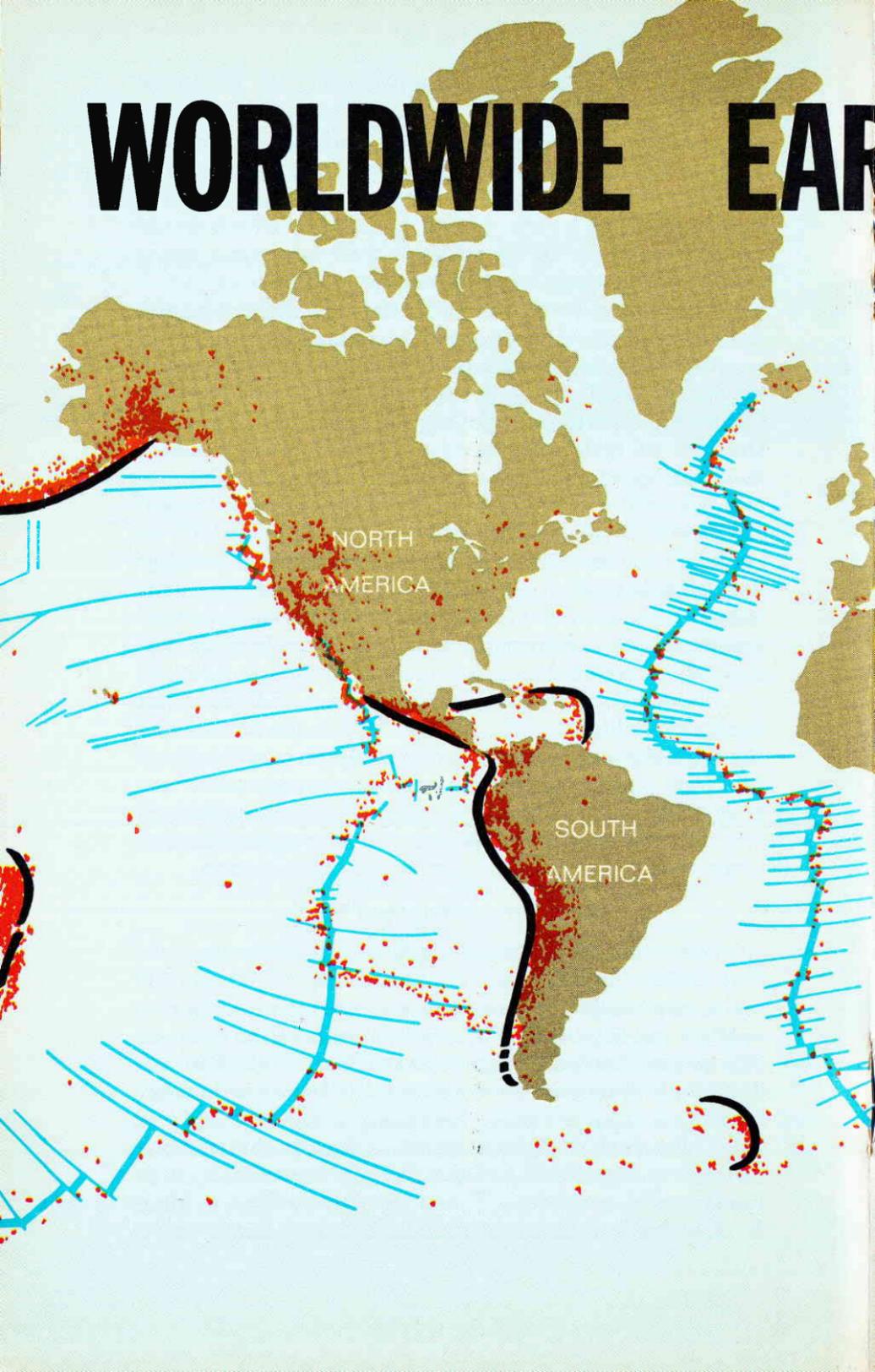
There are also two other major sources of water for Southern California. The Owens River aqueduct crosses the fault through underground tunnels. Here at least several feet of offset occurred in an 1872 earthquake. If the next quake were to shear those tunnels, there could be a serious water shortage for several million people. The Colorado River Aqueduct also crosses the fault system.

The Little-Understood Fault

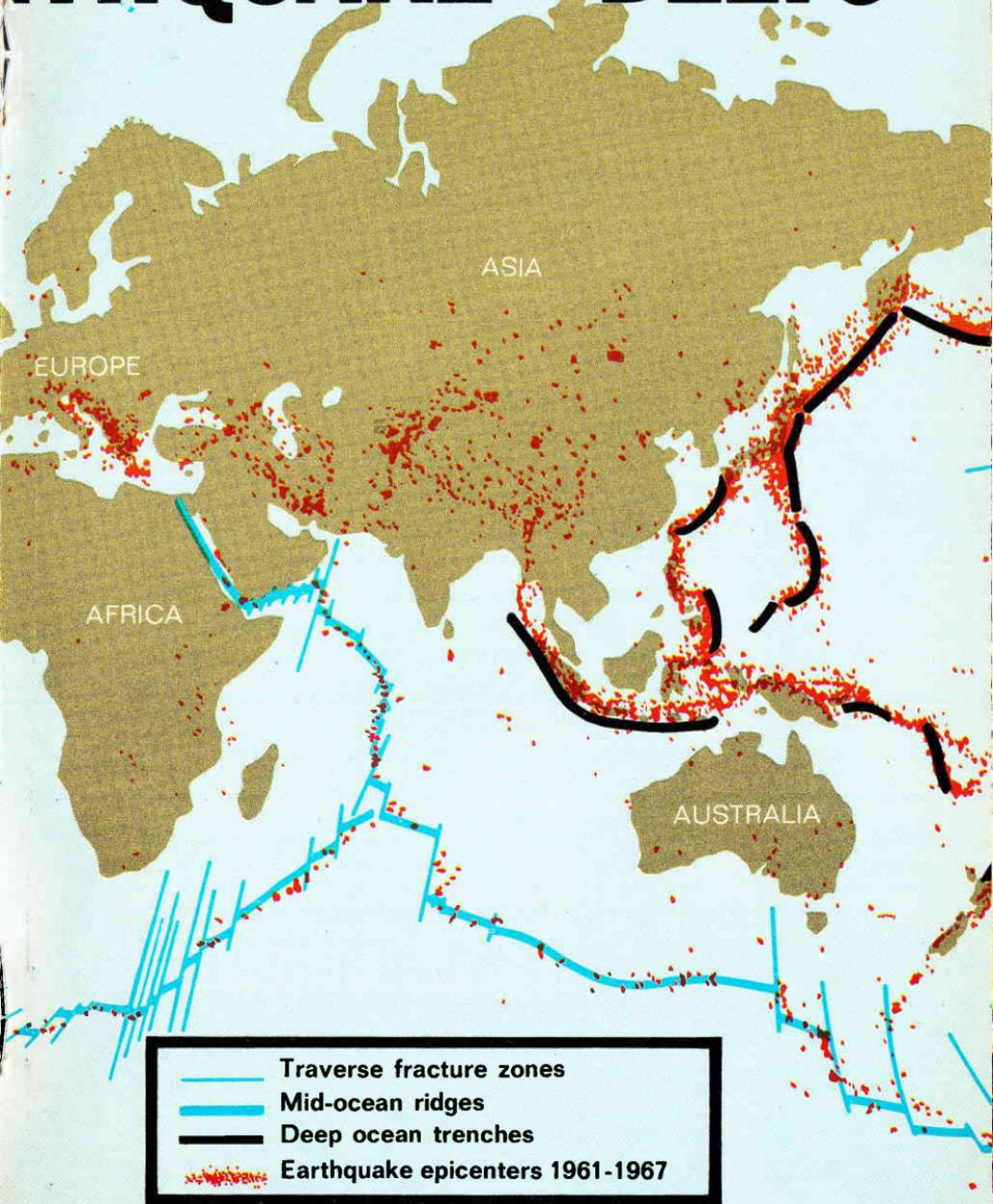
The most famous of all earth faults is the ominous San Andreas in California. It has been traced for over 600 miles from above San Francisco to the Mexican border south of the Imperial Valley. Yet, "in spite of the interests of geologists and seismologists to the study of the San Andreas fault, it remains *very incompletely known* and understood.

"After review of the evidence, it is clear that there is NO GENERAL AGREEMENT on satisfactory answers to such fundamental questions . . ." and then the author, Gordon B. Oakeshott, in the California Division of Mines Special

WORLDWIDE EAR



EARTHQUAKE BELTS



Report 57, *San Francisco Earthquakes of March 1957*, goes on to list a number of controversies which rage.

One of the most crucial questions is: How far has the horizontal displacement been on the San Andreas fault? This is important because it shows what *can happen* in the earth's crust.

Some geologists think the displacement has "only" been several thousand feet. Others claim it has been on the order of several HUNDRED MILES!

Can you imagine the forces in the earth that would move billions upon billions of cubic yards of material thousands of feet — or hundreds of miles? And, of course, geologists cannot really be sure that this movement has been gradual. That is, in fact, one of the key questions: Has the present displacement of two inches a year been the same throughout time?

Geologists don't know!

Are Small Quakes "Safety Valves"?

The basic facts of the San Andreas Fault are as incompletely understood as earthquakes are unpredictable.

Even an answer to the crucial question, "Are small tremors relieving the pressure on the fault or do they portend a *great quake* is coming?" is not agreed upon. Gordon Oakeshott of the California Division of Mines and Geology asks us, "Are earthquakes, which center in the San Andreas fault zone, relieving stresses and thus lessening the chances of future earthquakes, or do the continuing earthquakes merely indicate a high level of seismic activity portending many future earthquakes?" (*Geology of Northern California*, p. 367.)

Thomas Dibblee of the U. S. Geological survey indicated the general uncertainty and conflict among geologists on this score when he admitted, "*Their interpretations* vary according to the parts of the fault they

Ambassador College Photo

FAULTLINE REVEALED. Antelope Valley Freeway crosses and cuts through escarpment along most recent trace of the San Andreas Fault. Rock crushing and folding effects of fault action are very visible.



have investigated, and with the way in which they have mapped and interpreted the related geology" (*Geology of Northern California*, p. 375).

Part of the problem is the complexity of the geologic evidence and the scant amount of historic evidence. The greatest single earthquake displacement in historic times is generally considered to be the 21-foot surface offset at the south end of Tomales Bay near San Francisco during the tragic 1906 earthquake.

Let's take a brief look at some of the geologic evidence. It is shocking in what it reveals about the awesome potential of the San Andreas fault system.

Hundreds of Miles of Shift

According to some geologists, what is called Pleistocene gravel in the Carrizo Plain area of California has been offset some **TWELVE MILES!** Strata called Pliocene may be offset anywhere from 20 to 50 miles!

Some rocks called Miocene are apparently offset even further along the San Andreas fault system. In central California is an area of granitic rock, schist and marble detritus. However, on the other side of the fault this type of rock *simply is NOT there!*

The nearest possible source of the above-mentioned rock is in the Gabilan Range — some **EIGHTY MILES** to the northwest. Some geologists think this shows a right lateral displacement of this distance.

In rocks called lower Miocene and Oligocene there is a strand of marine and non-marine beds which may have once been continuous across the fault. If it was, the rocks have been displaced by **ONE HUNDRED AND SEVENTY-FIVE MILES!**

Similarities in rock and fossils of the Eocene, Paleocene and Late Cretaceous rocks of the Santa Cruz Mountains and the San Emiglio-Temblor Range — some 225 miles to the south — suggest that the fault has been displaced by this distance.

What are termed Jurassic and Triassic rocks may be offset perhaps to about *three hundred and fifty miles!*

Fearful Energy Potential

The 1906 earthquake — one of California's worst — had a MAXIMUM displacement of "only" 21 feet.

A geologist computed the energy that caused the 1906 surface rupture of the San Andreas. His answer was 130,000,000,000,000,000 foot-pounds of energy. That is enough energy to raise that many pounds one foot. That equals a total amount lifted of 65 trillion short tons!

Here's another way to look at it.

Think of the mass of rock shifted by the fault. A block of earth some 275 miles long was moved. Its average thrust was 13 feet; the greatest thrust was about twenty-one feet.

The fault probably moved to a depth of twelve miles. If you assume a shearing force of about 1,850 pounds per square inch is needed to break granite, then the work accomplished was fifty billion kilowatt hours. In terms of electricity, that would be enough to supply one fourth of all residences in the United States with power for a FULL YEAR.

When Quakes Strike a City

A chilling quake occurred in Long Beach, California on March 10, 1933 — chilling because had the earthquake occurred two hours earlier some twenty-six thousand pupils and teachers might have perished or been severely injured.

Why so?

Because most of the school buildings in the area collapsed. When engineers tried to determine the cause of the failure of the buildings, they found the schools had unique defects in design.

There were 85 schools in Long Beach, valued at fifty million dollars. Estimates were that 75% of all buildings were damaged or collapsed.

The Long Beach earthquake of 1933 was not a large one. It was destructive out of all proportion to its magnitude. But it did show *how vulnerable* a modern city is to even a moderate earthquake. The small shock had struck a very densely built-up area, much of it on gravel

and alluvium from an old flood plain. Also, as the earthquake dramatically proved, the building codes were inadequate.

The Alaskan Disaster

On Good Friday, March 27, 1964, shortly after 5:36 p.m., Alaska was shaken by one of the *greatest earthquakes* of this century.

This magnitude was computed as 8.5 by the U. S. Coast and Geodetic Survey. It may have had twice the violence of the 1906 shock in California and equalled the Chile shock of 1960.

Estimates of the death toll range from 100 to 200. Property damage estimates ran from 300 to 750 million dollars — depending on who was doing the calculating.

This shock permanently distorted more of the earth's surface than any *previously documented earthquake*. Approximately 150,000 people living in the area were affected by strong shaking. Damage amounted to about \$2,000 per person.

After three years of study, ESSA (Environmental Sciences Services Administration) compiled the shocking evidence of how potent the Alaska quake really had been.

Mountains in various areas dropped seven feet. The Kenai mountains moved laterally as much as five feet. In a 480 by 127-mile area, the ocean floor rose about 50 feet. Near Valdez — a strip of land 4000 by 600 feet tumbled into the sea.

Waves generated by the quake reached as high as 220 feet above sea level. At Hilo, Hawaii — some 2800 miles away — the sea waves were 12½ feet high. Along the U. S. Gulf Coast from Texas to Florida, sea oscillations were noted. At New Orleans, a span of bridge shook and the Mississippi suddenly rose from 1 ½ to 5 feet. Docked vessels broke loose from their moorings.

Quakes Across America

Although most earthquakes occur in definite belts, quakes definitely DO OCCUR in other areas.

Who could have guessed that in 1811 the quiet lands

of the Mississippi River would be torn up by earthquakes?

The latter quakes are known as the New Madrid quakes. Three of the shocks, judging from the effects, exceeded magnitude 8. One of them may have been the *largest known earthquake* in the United States outside of Alaska.

The December 16, 1811 shock was felt over an area of at least *one million square miles* — from Canada to New Orleans and from the upper Missouri River to Boston. Chimneys cracked, plaster fell and bells rang in far away South Carolina.

Fortunately, these quakes occurred at a time when there were few man-made structures. Yet, they produced such dramatic changes in the surface of the earth “that they have come to be regarded as the **MOST SERIOUS SERIES** of earthquakes in United States history” (*Earthquakes and Earth Structure*, John Hodgson, p. 7).

Aftershocks occurred several a day — for more than a year. Two of them, on January 23 and February 7, 1812, were fully as severe as the first one. An area from 3000 to 5000 square miles was beaten up by the quakes.

The quakes were so powerful that the mighty Mississippi REVERSED a part of HER COURSE! Trees were uprooted and submerged. Farmland was ruined. In all, some 150,000 acres of prime timber were destroyed.

There have been frequent small tremors in the area periodically since that time. One occurred in November 1968. But no great earthquake has struck the area. One geologist mentioned that if you draw a straight line from New Madrid along the Great Lakes and the St. Lawrence River, you find many earthquakes have occurred along it — some quite serious.

The Colonial Quake

For example, a quake struck Three Rivers, Quebec, in the St. Lawrence Valley during 1663. It may have been as large as the New Madrid earthquake.

A contemporary account gave details that bore a curious similarity to the effects of the 1812 New Madrid quake.

“New lakes are seen where none were before. Some mountains were engulfed and disappeared. Many a waterfall is levelled and many a river is no more . . . and there has resulted such a disorder of fallen and splintered trees that one sees today fields of more than a thousand aspens all levelled as if they had been recently tilled, in many places where there was nothing but forests” (*Earthquakes and Earth Structure*, John Hodgson, p. 10).

And all this in an area OUTSIDE the seismic belts.

From careful examinations, there is sufficient evidence to state that an area of 30,000 square miles sank from 5 to 15 feet — in varying amounts.

An Indian tradition stated that there was a great earthquake in this region about one hundred years earlier. Is Southeastern Canada also OVERDUE for another great quake?

Today the large cities of Memphis and St. Louis are located in the New Madrid region. Yet, this area is TOTALLY unprepared for a devastating earthquake. A relatively small earthquake could cause serious damage. When one understands the terrifying potential, earthquake hazard is a national problem.,

Quakes Ring Mediterranean Sea

Earthquakes periodically occur around the Mediterranean area. Many recent ones have struck in Morocco, Greece, Italy, Turkey, and Yugoslavia.

Portugal holds the melancholy record for the world's most violent earthquake known in historic times. The place was Lisbon. The time was 1755 — twenty-one years before the American War of Independence and about the time British rule was being laid down in India.

Since there were no seismographs then, one can only attempt an estimated magnitude for the quake. Gutenberg and Richter, the highest seismological authorities, estimated the magnitude between 8.5 and 8.75. Other authorities say the magnitude of the quake did not exceed 8.6. In any case, it was one of the most powerful quakes to rock the earth in historic times.

The quake was felt over a MILLION SQUARE MILES.



Keystone Photo

ANOTHER MEDITERRANEAN QUAKE. Survivor looks over small town in Sicily devastated by earthquake in 1967.

Chandeliers swung crazily 1400 miles from Lisbon, Portugal. Spain, North Africa and Southern France were violently shaken. Water in lakes and bays as far away as Scotland and Scandinavia was set in motion. Sloshing was reported at the River Dal near Stockholm, Sweden — 1,820 miles away. No other known earthquake has caused rhythmic disturbance of water at such great distance.

Interestingly, Lisbon has had major earthquakes about two hundred years apart. It has now been OVER two centuries since the most recent violent quake. Is Portugal overdue for a devastating earthquake?

Loss of life in Lisbon alone is commonly stated as at least 60,000. The estimates vary from 30,000 to 70,000. There were three shocks in all, over a period of nine minutes. At the end of this short span, the city lay in ruins. Not long afterwards, one of the greatest seismic seawaves of history rolled over the low-lying portions of the city to complete the disaster.

Japan, the Quaking Island

The most progressive nation in the Orient is Japan. It also is hard hit by more destructive quakes than any other oriental nation.

On September 1, 1923, one of the most disastrous earthquakes known hit the packed Japanese island of Honshu. The two cities of Tokyo and Yokohama were wrecked. Urban slums in both cities burned up like paper boxes.

Around one hundred and fifty thousand people perished or were reported missing in the holocaust. Half a million homes were destroyed. The tally of economic loss mounted to THREE BILLION DOLLARS! In Yokohama eleven thousand buildings collapsed; more than a third of a million went up in flames.

Raging waves at Sagami Bay inundated the shores with 35-foot crests. Another one hundred thousand were injured; over one hundred and twenty-five thousand homes were partially destroyed.

The Kwanto earthquake — as Japanese writers refer to it — was a chilling terror.

Eyewitness accounts in Yokohama remember the earthquake announcing itself with an underground roar. Then came a frantic shaking. The quake struck just at the midday meal. Almost immediately fires broke out in many points.

All the firefighting equipment had been lost and the water mains were broken. There was no way to control the blazes. Communications were completely disrupted. Authorities thought only their city had been hit. But when they finally got through to Tokyo, the stark reality of the raging destruction in the capital city gave pause to the most hearty.

Fire was sweeping through the city. Ultimately, 40% of it would be completely destroyed.

Tragedy Strikes Quickly

One of the great tragedies of the quake took the lives of about 38,000 people in minutes. Milling, panic-stricken

people had fought their way to a 250-acre clearing, a military clothing depot on the banks of the Sumida river. By late afternoon, the area was jammed with over 40,000 people — fellow fugitives from the fire.

But suddenly, a howling tornado born in the fierce updrafts of the many fires, swept down on the throng. The breathable air was suddenly replaced by searing gales. About 38,000 persons were left standing dead. They were so closely packed, they could not fall over. Only those right next to the river survived.

There were also astounding earth movements. Visible faulting occurred to the north and east of Sagami Bay. Measurements showed that points in this area had moved to the east by as much as *fifteen feet!*

But even more dramatic changes took place in the bay floor. In the center, the level of the bottom of the bay sunk between 300 and 600 feet. In the north the bay floor was ELEVATED by as much as 750 feet.

One scientist aghast at such changes said, "It calls for all the confidence that one has in the trustworthiness of the Japanese scientists not to attribute these extraordinary figures to technical error" (*When the Earth Trembles*, Haroun Tazieff, p. 113).

The Dread Tsunami

Associated with many quakes are giant sea waves — called tsunamis. They sometimes cause more destruction than the earthquake itself.

For example, a submarine earthquake near Kamchatka Peninsula was detected on November 4, 1952. Its tsunami washed across the Pacific and struck Hawaii. The damage was \$800,000. But due to the Seismic Sea Wave Warning System that links various Pacific nations, no lives were lost.

One of the most destructive seismic sea waves or tsunamis to ever hit, struck the northern Japanese coast on June 15, 1896. Unsuspecting crowds were celebrating a festival. At seven in the evening they felt the ground roll from a distant earthquake. The people continued with

their festival. Twenty minutes later the sea began to quietly withdraw from the shore.

Then shortly after eight o'clock tragedy struck!

The water returned in a surging sweep; it piled higher and higher as it reached the shore. In places the wave was a wall of water *one hundred feet high!* It engulfed whole villages. There was no trace of survivors or buildings. Twenty-seven thousand persons died and ten thousand houses were swept away in the brief cataclysm.

On August 8, 1868, a tsunami hit the coast along the Peruvian-Chilean border. The biggest wave rose to a height of 47 feet and carried the U. S. gunboat *Wateree* three miles up the coast and two miles inland. It was plunked down like a toy only 200 feet from the walls of a sheer cliff.

The Circle of Fire, where almost all of the world's tsunamis occur, has an average of one seismic sea wave a year. More than 275 destructive tsunamis have been recorded in world history. The greatest is thought to be the one that struck Japan in 1703 — more than 100,000 people perished. Certainly one of the deadliest struck the coast of India in 1737, where a reported 300,000 were killed. The most destructive one to hit the United States smashed Galveston on September 8, 1900. Approximately 6000 people were killed.

These are a few of the earthquake disasters that continually rock this earth. There are some immediate precautions you can take to prevent damage, injury or death. These are clearly explained in the next chapter.

Chapter Three

HOW TO SURVIVE AN EARTHQUAKE

ON DECEMBER 11, 1967, the Indian village of Koy-nanagar was hit by an earthquake. The series of tremors took 200 lives. Approximately 20,000 homes lay in huge piles of mortar and dust.

But ironically, up to 1967 there had *never been* a recorded earthquake in this part of India. In fact, there would have probably been no earthquake to this day in Koynanagar if it weren't for man's technology.

Scientists are now certain that the earthquake was caused by a large reservoir of water that was built near the city. The water was held back by a huge concrete dam 310 feet high. Behind the dam were two billion cubic yards of water.

Man-Made Earthquakes

In 1962, when engineers first started filling the dam, feeble earth tremors were detected with sensitive measuring instruments. Periodically, rumbling sounds came from the vicinity of the dam. No one, it seems, paid any attention to the tremors.

In mid June of 1965, a tremor strong enough to shake the ground was felt. Two years later the big quake came. Geologists now think the immense pressure of the dam and impounded water on underlying rock caused them to shift.

. . . Around the Earth

On the other side of the globe, Denver, Colorado is having its problems. Since April 1962, no less than 700 mild earthquakes have been recorded in the area around Denver. Since this part of the country had no quakes for 80 years before the recent quiverings, Denver's citizens became concerned.

What was causing the trouble?

In November 1965 a geologist suggested that the quakes could be traced to a deep well at the nearby Rocky Mountain Arsenal.

The Army had sunk a 12,045 foot shaft and pumped down the first 4,000,000 gallons of waste water in March 1962. The contaminated water contained the waste products of a deadly nerve gas and other products manufactured at the arsenal. Between April and September 1965, for example, when the Army pumped 5,800,000 gallons per month into the earth, an average of 44 quakes per month was recorded. In the months when NO WATER was pumped into the well, the quakes fell off to five per month.

Authorities feared that unless remedial action was taken — an earthquake of man-made origin could inflict serious damage. On the other hand, some experts feared that the REMEDY ITSELF might set off the more severe earthquake.

In a city not prepared for such an occurrence, the result could be catastrophic.

The Problem with Dams

Hoover Dam holds back Lake Mead. The Colorado River pours fifty billion tons of its water into the lake — enough to fill a good-sized swimming pool for every *person* in America. When engineers built Hoover Dam, near Las Vegas, Nevada, they produced a small-scale crustal bending.

Understandably, the crust began to sink under the weight. Small earthquakes began. Engineers spent years studying the problem and pronounced the dam safe. To date all seems well; one hopes it continues to be so.

Other problems have occurred when oilmen withdraw petroleum from the ground. Enough has been sucked out through wells to cause dangerous settlement of land near Los Angeles. So has pumping the ground water for the insatiable thirst of the agricultural San Joaquin Valley — two hundred miles north. No one really knows if this might result in earthquakes for the vast California farm belt.

One seismologist said, "As long as we keep making these mistakes, we're going to run into these unexpected problems." As man increases his technology and desires to manipulate his environment, he becomes his own most dangerous enemy when it comes to earthquakes.

Man is also his own enemy in another way.

Man-Made Death Traps

It is *man's own structures* that trap him when the earth shakes. In fact, few persons have been killed or injured by earthquakes as such.

Hundreds of thousands HAVE lost their lives in weak, structurally unsound buildings which have collapsed. Dr. Charles Richter has said, "Over ninety percent of this loss of life, and more than half the property loss in earthquakes, is unnecessary and preventable." He was, of course, talking about California. But the principles apply the world over.

But sound engineering principles too often are discarded for low cost or other "reasons." For example, Russian cities are poor earthquake risks. They have put up the *most housing* with the *least cost* in work, materials and time.

In fact, nothing but gravity holds together the parts of large buildings that house hundreds of people. If an earthquake struck Moscow, appalling loss of life would occur.

In fact, earthquake magnitude and death are seldom synonymous. The great Chilean earthquake of 1960 killed 6000 people; two minor tremors at Agadir, Morocco and Lar, Persia killed men by tens of thousands.

But people seldom stop to think that poor and

faulty construction is the problem in so many cases.

For example, the current annual construction volume in the United States exceeds seventy billion dollars. About TEN BILLION DOLLARS of this is placed in areas which historically have had a high level of seismic activity.

As Nicholas Hunter Heck in his book, *Earthquakes* (p. 191), has stated, "One lesson that is stressed over and over in every important earthquake is that if the buildings survive there will be little loss of life . . . at the present time neither human life nor property are as safe as they could be made if *present knowledge* was generally applied."

But the sad facts of life are that such warnings are usually not heeded.

Doomed to Repeat History

After a particularly destructive earthquake in Italy in 1857, then current building practices were strongly condemned. But engineers found the same problems *still extant* when a 1930 earthquake devastated the same area.

In Israel, for example, "There is no extensive experience concerning the seismic resistance of buildings . . . as a blunt statement: earthquake engineering, as nowadays understood, is not practiced in Israel. This does not, of course, imply that our engineers are unaware of earthquake problems, but these are not considered to be of an urgent nature" (This from a UNESCO report on earthquake engineering).

But, of course, there are several historical accounts of devastating earthquakes in the area! A minor earthquake hit Israel in early 1969.

Take the example of Romania. The last earthquake mentioned as being destructive occurred on October 26, 1802. It was known as the "great earthquake." "Therefore, when at 4:39 a.m. on November 10, 1940, a very strong earthquake ravaged an important area of our country and

BEFORE AND AFTER A QUAKE. Top photo shows the Saada Hotel in Agadir, Morocco. Bottom photo shows what happened to it after the earthquake struck the city.



especially Bucharest, there was generally great surprise," said a commentator.

Remember the Agadir, Morocco, earthquake of February 29, 1960?

It was a minor earthquake in strength. Perhaps a tiny kitten in comparison to a large work horse — if we liken it to the San Francisco quake of 1906. But the quake happened in a crucial place — only two miles deep and directly under a VERY VULNERABLE CITY.

The result?

Some 12,000 were killed; another 12,000 were injured. The population of the city? It was only 33,000!

Same Story Worldwide

But it is this type of destruction that also happens in modern cities. Take the Alaskan earthquake of 1964 as an example.

"The fact that all problems have not been solved is clearly evident from the extensive damage to many buildings in Anchorage during the 1964 Alaskan earthquake. Most of the damaged buildings were designed to be earthquake resistive in some degree; most buildings were designed by recognized professional engineers; and most damaged buildings were built under construction standards common to many parts of the United States" (*Earthquake Hazard in the San Francisco Bay Area*, Karl V. Steinbrugge, p. 37).

The author then pointed out that similar circumstances are found in other large cities where a large earthquake can cause similar damage.

Another case in point is the Iranian earthquake of September 1, 1962.

The area had no significant history of earthquake activity. Actually, "earlier studies on the seismicity of Iran had tended to indicate that the area about this epicenter was the LEAST SEISMIC area of Iran" (*Earthquakes*, William Mansfield Adams, p. 83).

But on September 1, 1962, such ideas were violently tossed aside. Nature simply didn't co-operate!

The toll from the earthquake on that day was 12,000

people killed and 2,500 injured. More than 21,000 homes were ruined and 35% of the livestock in the area was destroyed.

Why so much damage?

“The damage caused by the earthquake was due MAINLY to the *extremely poor quality* of the building materials and the unstable walls and heavy roofs employed in the construction of rural houses in Iran” (*ibid.*, p. 93).

What Causes Damage

Several factors determine the extent of earthquake damage.

Obviously, the first is the strength of earthquake waves reaching the surface. The shallower a quake is — the more potentially destructive it can be.

A most overlooked point is the *duration* of the earthquake motion. Usually a quake will be felt as a fluctuating series of tremors. They may last from ten seconds to one minute. The combined effect of all this motion can be very destructive.

Aftershocks can also be deadly. This may polish off weakened buildings left standing by the large shock. In the Kern County, California earthquake, the aftershock that came a month later of only 5.8 magnitude did *most of the damage* at the city of Bakersfield, California.

Proximity to the fault will also be an important factor.

But what is more important is the construction of your home and the geologic foundation under it. In fact, many engineers feel that the most important reason for building damage is due to the type of ground it sits on.

Earthquake shaking is almost *directly related* to the type of ground supporting the building. Buildings on solid ground near earthquake epicenters fare much better than more distant buildings on soft ground.

How to Avoid Earthquakes

Building design is the other crucial factor. Architects and engineers maintain that a building CAN BE DESIGNED to be earthquake resistant — providing the site is right!



Ambassador College Photo

BUILDING AGAINST QUAKE HAZARD. Building in San Francisco, California, is built with steel cross girders in hopes of withstanding future earthquake.

The principle is simple; the building must move with the earth as a unit — instead of helter-skelter as an unrelated assembly of parts going their own way.

Many people in California and other earthquake-prone areas often ask, "Where can I build to avoid the fault areas?" Dr. Richter usually tells them, "In a region like California the differences between two locations depend less on their distances from faults than on the *character of the ground*" (*Elementary Seismology*, Charles Richter, p. 384).

For example, there was an earthquake on July 28, 1957, near Taxco and Acapulco, Mexico. Moderate damage was done at those places, solidly built on rocky hills.

However, at Mexico City, several times as far away, the damage was severe. Sixty-eight were dead and the city had a repair bill of about twenty-five million dollars. Reason? Mexico City is built on deep beds of soft mud where an ancient lake once existed. This soft mass quivers violently whenever an earthquake strikes.

Tall Buildings — Can They Survive?

"And what about tall buildings," many people ask, "won't they tumble in a heap when a quake hits?" Not necessarily so, say engineers. It all depends on their construction — and the **TYPE OF GROUND** they are built on.

For example, in Los Angeles and San Francisco, California, increasingly large and complex structures are being constructed — some as high as 70 stories!

Some scientists are predicting the worst if an earthquake should strike near a technologically complex city such as Los Angeles or San Francisco. Others are more cautious, such as Dr. George W. Housner, Caltech professor of civil engineering.

"There is no reason," he says, "for a fifty-story building to be less safe than a five-story building if it is **CONSTRUCTED PROPERLY**." This, of course, is the key. He and others expect some damage to tall structures, but not general collapse.

Usually buildings of this type have the best designs and materials. Plans and specifications have been rigor-

ously enforced. With even a great earthquake such buildings would probably not collapse into a heap of rubble. But they could be left in such a weakened state that to repair them would cost too much — or the only proper safety precaution would be to tear the structure down.

This, of course, doesn't take into account the facts of life. Not everything is constructed according to the ideal standard. The evidence is around us; the reasons why are obvious.

Not all the experts, of course, are in agreement on this.

Dr. Charles Richter warns, "The crowding of metropolitan centers brings a demand for tall structures of the 'skyscraper' class, twenty stories or more in height. In the writer's personal opinion, such structures *simply should not be built* in a region subject to severe earthquakes, unless they can be founded directly on the soundest type of rock, granitic preferably; certainly not on sand or sediments" (*Elementary Seismology*, Charles F. Richter, Appendix, part 3).

"In California," cautions Dr. Richter, "buildings for occupancy above thirty stories should not be constructed."

What to Do in a Quake

What should you do if caught in an earthquake? If you live in earthquake country, quakes are something you will have to put up with. At present there is little hope of prediction and none of running away.

But there is much you CAN do to insure protection for yourself.

The maximum violence in a destructive shock is generally reached within ten seconds of the first tremor.

Since most injuries and loss of life in earthquakes are caused by man-made structures — here is the key which will insure your immediate safety. First of all, if you live anywhere within an earthquake zone, be certain the home you are living in is *generally earthquake resistant*. You can find this out by writing to various governmental or engineering organizations.

What do you do when the quake strikes?

Remember, the actual shaking will probably be over in less than a minute. Therefore, you must quickly compose your thoughts. You can't afford to make mistakes in judgment. It could mean your life — and the life of your loved ones.

Before the earthquake, in the advice of Dr. Charles Richter, "In your home, shop, or office, you can try to eliminate fire risks, which are worse after an earthquake. See that heavy and breakable objects are safely placed or supported."

How to Avoid Injury

Here are some pointers to help in avoiding injury or death during an earthquake.

1. Never try to out-guess a quake. Assume it will be the world's worst — and act accordingly. Be alert but don't panic.

2. Stand immediately in the nearest doorway. If inside a building stand against a wall or get under a table. Stay away from windows. The idea is to be near a support in case of collapse and also to be protected against flying debris.

3. If outdoors, move away from buildings — should this be possible. Or get inside a building just under the arch or doorway. But again, stay away from windows.

4. Don't run, especially down stairs. Outside, you could just get into a general stampede and either hurt or get hurt by other human beings.

5. If light tremors precede the major shock, turn off gas appliances and the main electrical switch. Do what is possible to prevent a fire. In some cases, fires following earthquakes have *killed far more* than the collapsing buildings during the quake.

6. If you live adjacent to the ocean, get away from the area as quickly as possible. The quake may have set a tsunami in motion. The resultant seismic sea wave could potentially be **MORE DESTRUCTIVE** than the quake that set it in motion.

7. **NEVER** be stampeded into leaving an upright building merely because it groans horribly, cracks open and



Ambassador College Photos

SUDDEN DESTRUCTION caused by the February 9, 1971 Los Angeles earthquake, which took the lives of 64 persons.

plaster falls. However, if collapse seems imminent you may need to do something else. Collapse of a building is generally indicated by walls falling as a unit or tumbling straight down in disintegrating rubble. Run for whatever load-bearing walls are still standing. And, *in this case*, watch for another chance to dash to relative safety outside.

8. In any commercial building of many stories, sprint to the INNER load-bearing walls, doorways, elevator shafts or stairwell walls. It is the outside walls that will collapse first. If engineered for earthquake resistance, there is no more need to fear a high-rise building, according to most engineers, than short stocky masonry ones.

9. If you're caught in city congestion, stop your car. Do not leave the car. Dive for the floor, and curl up. Protect face and hands, also body, in whatever way possible from flying glass. Average cars can withstand debris very well below the seat cushion level. You're encased in steel and protected as well as possible. Live wires are an intermittent danger. Their current and recoil action keeps

them moving. Rarely will they stay in prolonged contact with your car. If they do, sit still, don't touch interior metal. Stay where you are until someone such as a policeman or power lineman assists you.

When the Quake Is Over

After the quake is over, check for gas leakage. If there is any, turn off main gas valve and leave it off until you are advised by the utility company or some other competent source.

You may want to store some water in case supply lines are disrupted. Fill several containers, but don't draw out excessive supply. Thousands of homes may be doing the same — and water is needed to fight fires.

Don't start making telephone calls, except for emergencies.

Avoid wandering around the neighborhood, especially in a car. Although, it would be a good idea to check the immediate area in which you live for any injured people or other potential problems.

Check your home or apartment for damage, even if you think your house withstood damage. Cracked plaster, loosened chimney or shattered glass could cause injury or death later — in even a small shock or other accident. Also, check areas such as closets where large heavy objects on upper shelves might be tipped just far enough to topple.

Follow these common-sense rules! If you do, your chances or your loved ones' chances of being victims in the next big quake that strikes will be greatly reduced.

Chapter Four

EARTHQUAKES AND THE BIBLE

ANCIENT peoples once believed that the earth was supported upon the back of a huge legendary beast. Whenever the earth convulsed they believed it to be the movements of this great beast.

As man's knowledge increased, he learned more about the earth beneath his feet. Scientists now know that deep within the earth tremendous forces are at work. These forces are part of the primary system of physical law which keeps this earth in balance.

Seismologists, experts who study earthquakes, realize there is much they do not yet know or understand about these great forces constantly in motion beneath the surface of the earth. Yet, their awesome potential is evident when one examines the breathtaking flaws and distortions on the earth's surface.

Earthquake Faults

In recent years seismologists have come to astounding new knowledge concerning the *origin* of earthquakes and earthquake potential on this earth. In their studies they have encountered new potentials that *stagger the imagination*.

Over sixty years ago, at the time of the San Francisco earthquake of 1906, scientists were aware that certain "earthquake cracks" were associated with the movements of the earth's crust. At that time scientists believed that these cracks in the earth were the *by-product* of earth tremors — but had nothing to do with their *cause*.

San Franciscans, back in 1906, knew of the "earthquake crack" and referred to it as the "great fissure." Other earthquake cracks had been observed in different places along the Pacific Coast, but had never been associated in any way *with* each other.

Soon after 1906 and the San Francisco disaster, serious investigations began into these isolated earthquake cracks. It was at this time that a startling truth was learned. These "isolated" faults were all part of the one *tremendous gargantuan fault system!* It was to this particular vast fault — running visibly on the surface of the land for over 600 miles and stretching from the Gulf of California to a point well above San Francisco — that scientists gave the name "San Andreas Fault Line."

Intensive studies of similar fault systems have revealed to scientists and seismologists that the *entire surface* of our earth is cracked and creased by these tremendous cracks and deformities.

Startling new facts came to light as a result of exhaustive and intensive scientific research made during the International Geophysical Year of 1957. Charting and scrutinizing the hidden depths of previously unknown ocean floors, scientists discovered additional breathtaking flaws in the earth's crust.

Beneath the waters of the Mid-Atlantic lies the *Mid-Atlantic Ridge*, a spectacular mountain range tracing its serpentine course from Antarctica in the south, through the Atlantic, all the way to the North Pole. This breathtaking ridge continues, in fact, beyond the North Pole on into the Pacific and AROUND THE WORLD.

Probing the mysteries of this phenomenon, scientists have discovered a huge *crack* or fault running along the crest of this ridge — in places MILES wide.

In similar studies in the Pacific, giant fractures trace

their way — unseen — beneath the sea, mute evidence of the tremendous forces lying below.

Terrible Potential

In studying these fault systems, scientists have had to come to an entirely new concept in earthquake potential. With the startling new knowledge of the immensity and magnitude of the tremendous fault systems that trace themselves through this earth, seismologists and geologists came face to face with the destructive potential in the earth's crust.

Just as scientists 60 years ago did not associate the isolated fissures near San Francisco, California, with one tremendous fault system over 600 miles long, scientists of just a decade ago did not realize how intricately this earth is cracked into a maze or network of *related* fault systems. With the investigations of the I.G.Y. the staggering truth became known.

Seismologists and earthquake researchers have had to revise their concepts of earthquake potential in light of the recent discoveries. No longer can a single earthquake be considered as an *isolated* incident, but, rather a *symptom in a complex interrelated system of earthquake faults which is worldwide in scope!*

Today, a theory called the New Global Tectonics visualizes earthquakes, volcanoes, mountain building and other physical phenomena as part of the same series of interrelated activities of our earth.

Magnitude of Earthquake Energy

As we discussed in chapter two, all about us in this earth is mute testimony of the awesome displacement potential of earthquakes. We see great mountains with twisted, uplifted strata. We can visit giant valleys and chasms which have been created by super-upheavals of the earth.

In many places on the surface of the earth the very fault lines themselves with tortured rock and distorted strata are visible. One such area is in California, not over 50 miles from Pasadena, in the Coastal Range mountains

near Gorman, California. Here the San Gabriel fault (a tributary of the great San Andreas fault line which is often called the "Mother of Earthquakes") is exposed plainly to view.

There is no more dramatic display of wildly distorted strata anywhere. As many times as one goes through this area he is still spellbound by the fantastic potential of earthquake force shown so graphically there. Can you imagine what would happen to a mighty city like Los Angeles should such displacement occur *beneath the city*?

Havoc in the Himalayas

Such catastrophic evidence of past violence is seen the world over. One example involves the destruction of mammal life, as is clearly seen in the Siwalik Hills. These are the foothills of the mighty Himalayas.

In the nineteenth century, workers found the remains of living and extinct animals here in great abundance.

The mammal life of the area today cannot compare with the plethora of creatures' remains found in the Siwalik Hills. Musing on this catastrophic extinction, geologist D. N. Wadia said, "The sudden and widespread reduction, by extinction, of the Siwalik mammals is a most startling event for the geologist as well as the biologist.

"The great carnivores, the varied races of elephants belonging to no less than 25 to 30 species . . . the numerous tribes of large and highly specialized ungulates [hoofed animals] . . . are to be seen no more in an immediately succeeding age" (D. N. Wadia, *Geology of India*, 2nd edition, p. 279).

When Burma Broke Up

This was NO local disaster. Thirteen hundred miles away the same spectacle of sudden and wholesale slaughter and distortion of land surface is seen. The place is central Burma. Here two fossiliferous horizons occur, interrupted by approximately 4000 feet of sand.

The signs of two destructions are quite obvious in deposits sometimes 10,000 feet thick.

In the upper horizon, we find typical Pleistocene

mammals, similar to those in the Siwalik Hills.

“The sediments are remarkable for the large quantities of fossil-wood associated with them. . . . Hundreds and thousands of entire trunks of silicified trees and huge logs lying in the sandstones suggest the denudation of thickly forested” area (*ibid.*, p. 275).

The proof is unmistakable. Cataclysmic occurrences wiped out mammal life and denuded the landscape. The effects of violent water action and tectonic activity are everywhere obvious.

Obvious, too, is the fact that great mountain uplifts occurred simultaneously with these incursions of the sea. That such uplifts occurred in the history of man — as did the violent flooding — is also unmistakable.

“In Kashmir, de Terra and Sahne have found sedimentary deposits of an ancient sea bottom which in places has been elevated to an altitude of FIVE THOUSAND FEET and up-ended to an angle of as much as 40 degrees.

“These deposits contain Paleolithic fossils and other organismal fragments belonging to the Quaternary period.

“Who in the face of such facts can venture to repudiate the bold hypothesis that *since the appearance of man* on the earth the passes leading into Tibet have become more difficult owing to the rise of THREE THOUSAND FEET or more in the height of the mountains — however fantastic changes so extensive may seem to a modern geologist?” (Arnold Heim and August Gansser, *The Throne of the Gods, An Account of the First Swiss Expedition to the Himalayas*, 1939, p. 218.)

Not Natural Disasters

Biblical reports tell us that these disasters were not natural — but induced by God! The earthquakes of today are merely *natural outgrowths* of a “faulty” earth which groans and strains. However, the destructive *potential* evidenced in a worldwide fault system is plain to see.

Biblical prophecy indicates there is a time coming when God is once more going to take a direct hand in the affairs of men — perhaps using this already existent world-

wide rift system to bring on earthquakes of an UNPARALLELED magnitude.

These will not be the ordinary, isolated earthquakes we experience today — however destructive they may be.

Christ's News Conference

Nearly two thousand years ago, Jesus Christ held His own "news" conference. Present were His disciples — scribes who *wrote* His Words which have been preserved down to this day.

Christ was asked about the close of an age! He was asked about the SIGNS preceding the "end of the world" (From the Greek word *aion* meaning "age" — not the destruction of the physical world or earth. Jesus was referring to the conclusion of this *age* or *period* in the human chronicle).

But, what does all this have to do with EARTHQUAKES? Just this:

One of the signs He was asked about was *earthquakes*. Notice the historical record in Matt. 24:3. "Tell us, when shall these things be? and what shall be the *sign* of thy coming, and the end of the age?" Jesus Christ answered that among many terrible and destructive circumstances EARTHQUAKES would occur in many places (Matt. 24:7).

He promised that together with famines and pestilences, *earthquakes* would be one of the *signs* immediately preceding His imminent return. Later in that same chapter of Matthew, Christ told His disciples, "Now learn a parable of the fig tree; When his branch is yet tender, and putteth forth leaves, *ye know* that summer is nigh: So likewise ye, when ye shall see all these things, know that it is *near*, even at the doors" (Matt. 24:32, 33).

Those same days are described in a parallel historical account — Luke 21:25-26: "And there shall be signs in the sun, and in the moon, and in the stars; and upon the earth *distress* of nations, with perplexity; the sea and the waves roaring; Men's hearts FAILING THEM FOR FEAR, and for looking after those things which are *coming* on the earth: for the powers of heaven shall be shaken."

The Return of Jesus Christ

Bible prophecy tells us that all these events will culminate in the *return of Jesus Christ to this earth!* Let's understand what is to occur.

Notice an Old Testament prophecy in Zechariah 14. "Behold, the *day of the Lord* cometh, and thy spoil shall be divided in the midst of thee" (verse 1). Now continuing in verse 4. "And his feet shall stand *in that day* upon the mount of Olives, which is before Jerusalem on the east, and the mount of Olives shall CLEAVE in the midst thereof toward the east and toward the west, and there shall be a very great valley; and half of the mountain shall remove toward the north, and half of it toward the south. And ye shall flee to the valley of the mountains . . . yea, ye shall flee, like as ye fled before the EARTHQUAKE in the days of Uzziah king of Judah . . ." (verse 5).

When Jesus Christ returns to this earth to plant His feet upon the Mount of Olives, there will be a TREMENDOUS earthquake in which the whole face of the land will be changed. Mountains will be moved out of their places! New valleys and rivers will be created.

That same occurrence is mentioned in Revelation 16. The time setting is the return of Jesus Christ to this earth. "And the seventh angel poured out his vial into the air; and there came a great voice out of the temple of heaven, from the throne, saying, It is done. And there were voices, and thunders, and lightnings; AND THERE WAS A GREAT EARTHQUAKE, such as *was not since men were upon the earth, so mighty an earthquake and so great*" (verses 17-18).

The whole face of the earth is to be changed by this cataclysmic earthquake. "And every island fled away, and the mountains were not found" (verse 20).

According to Bible prophecy — advanced news reports — the return of Jesus Christ is going to be highlighted by the most cataclysmic earthquake that has ever struck this earth in the time of man. It will defy the imagination! Every fault system and earthquake crack on the face of the earth may come into full play when Jesus Christ descends to the earth.

Tremendous Tidal Waves

Not only will the earth itself writhe under the cataclysmic convulsions of this tremendous earthquake, but also the very oceans and seas will erupt in tremendous seismic waves to devastate huge portions of this earth.

Notice Luke chapter 21. "For these be the days of *vengeance*, that all things which are written may be fulfilled. But woe unto them that are with child, and to them that give suck, in *those days!* for there shall be GREAT DISTRESS in the land, and wrath upon this people. . . .

"And there shall be signs in the sun, and in the moon, and in the stars; and upon the earth distress of nations, with perplexity; THE SEA AND THE WAVES ROARING; men's hearts failing them for fear, and for looking after those things which are coming on the earth: for the powers of heaven shall be shaken" (Luke 21:22, 23, 25, 26).

Notice the Biblical prophecy recorded in Isaiah 2:17-21: "And the loftiness of man shall be bowed down, and the haughtiness of men shall be made low: and the Lord alone shall be exalted in that day. And the idols he shall utterly abolish [the possessions men value above God's way]. And they shall go into the holes of the rocks, and into the caves of the earth, for FEAR of the Lord, and for the glory of His majesty, when He ariseth to SHAKE TERRIBLY THE EARTH.

"In that day a man shall cast his idols of silver, and his idols of gold, which they made each one for himself to worship, to the moles and to the bats; To go into the clefts of the rocks, and into the tops of the ragged rocks, for FEAR of the Lord, and for the glory of his majesty, WHEN HE ARISETH TO SHAKE TERRIBLY THE EARTH."

Promised Protection

God promises protection. God will protect those who obey Him. Notice Psalm 91:

"He that dwelleth in the secret place of the most High shall abide under the shadow of the Almighty. . . . Surely he shall deliver thee from the snare of the fowler, and from the noisome pestilence. . . .

“Thou shalt not be afraid for the terror by night; nor for the arrow that flieth by day; nor for the pestilence that walketh in darkness; nor for the destruction that wasteth at noonday. A thousand shall fall at thy side, and ten thousand at thy right hand; but it shall not come nigh thee. . . .

“Because thou hast made the LORD, which is my refuge, even the most High, thy habitation; There shall no evil befall thee, neither shall any plague come nigh thy dwelling. . . .”

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