

Los Angeles Is on a Voyage Northwest

'The Big One' Is a Tiny Part of the Violent Story of California

By RAYMOND V. INGERSOLL

I am more than 99.99% sure that a major earthquake will shake the Los Angeles area within the next 1,000 years. I am equally sure that anyone who has bought potential beachfront property in Nevada because California will fall into the ocean" will be disappointed. On the other hand, within a mere 10 million years, San Francisco may become a suburb of Los Angeles. To find out how these things might occur, read on.

All of man's recorded history is a mere instant when compared to the immensity of geologic time, which is measured in millions and billions of years. The Earth came into being 4.5 billion years ago. Simplest life forms (microorganisms) evolved soon thereafter, thus beginning the long evolutionary process. Physical and chemical changes have occurred within the Earth along with these biological changes. Before 4 billion years ago, the Earth's surface was ocean. There were no continents.

During the next 2 billion years most of the dense material within the Earth rose to the surface and gradually created the continents. Only 250 million years ago all modern continental masses were assembled in a super continent (Pangea), surrounded by a super ocean; there was no Atlantic. Eventually Pangea broke up into several continental "plates" and new oceanic plates (sea floors) were formed between these fragments. As the Atlantic Ocean grew by sea-floor spreading, North America moved westward and overrode the Pacific ocean floor. By 100 million years ago, this motion had resulted in a chain of volcanoes along the California continental margin; the

granites of the Sierra Nevada formed beneath those volcanoes.

The San Andreas fault system came into existence about 30 million years ago, and the Gulf of California began to open only about 5 million years ago. The Los Angeles Basin, which earlier had been a deep marine depression similar to those off the coast today, was in the process of being filled in by sediment eroded from the uplifting surrounding mountain ranges. Thus arose, over an enormous span of time, the locale that many of us call home.

Throughout this history, the motion of continents has been dominantly horizontal, with little evidence for drastic vertical motions, such as "falling into the ocean." Coastal California today is one of the most geologically dynamic areas of the Earth, due primarily to movements along the San Andreas and related faults. This activity is the result of California's position astride a major plate boundary, where the Pacific plate is moving northwestward relative to the North American plate. In contrast, Hawaii and Kansas sit within the stable interiors of their respective plates, and ride along passively without much deformation (Hawaiian volcanoes are unrelated to plate-boundary effects).

The above historical facts are agreed upon by the majority of earth scientists, who have been trained to think within a time framework that is foreign to our daily experiences. It is important to remember this when listening to geological discussions concerning the inevitability of the next big quake or other predictions of doom and destruction.

We can say, with more than 99.99% certainty, that a major earthquake will affect the Los Angeles area within the next 1,000 years, because the Pacific plate has been moving northwestward past the North American plate for the last 30 million years, and there is no reason to suspect that it will stop. Each time movement occurs, there is an earthquake; seismic activity is continuous, though usually on a scale detected only by instruments.

But I am not nearly so confident in predicting the likelihood of a major earthquake before the turn of the century. I leave that to earth scientists specializing in the relatively new field of earthquake prediction. Meanwhile I am taking common-sense measures to prepare for the inevitable next "big one" as if it will happen tomorrow, because this is the prudent thing to do.

Los Angeles, and all of Southern California on the ocean side of the San Andreas Fault, is moving northwest at about two-and-a-half inches a year relative to most of North America. At this rate and direction, the San Francisco Bay area will be directly east of San Bernardino in about 10 million years—much to the consternation of our friends in the north. On the other hand, the boundary between the Pacific and North American plates has had a complex history. The modern San Andreas fault has been this boundary only for the last 5 million years or so, and there has been a general tendency for the boundary to move inland relative to North America. This is the process that has caused most of coastal California, from the vicinity of San Francisco to the tip of Baja

California, to become attached to the Pacific plate and to start moving northwestward. If this inland movement of the plate boundary continues, there is a good chance that the San Andreas will become less active and the plate boundary will jump to the east side of the Sierra Nevada in a few million years, thus reuniting most of California on a single plate, the Pacific plate. Of course, parts of Oregon and Washington also might be transferred to the Pacific plate and participate in this northward voyage.

So Nevadans might have beachfront property after all, but not for several million years. Ultimately, in the sense of this "brief" 100-million-year history, California and attached baggage will follow the oceanic part of the Pacific plate into the Aleutian trench, where a massive collision will occur (somewhat analogous to the collision of India with Asia that began 40 million years ago and resulted in the formation of the Himalayas). Thus, California will become attached to Alaska.

These somewhat frivolous, although reasonable, predictions are easy for me to make. I certainly don't need to concern myself about whether any people will be around to judge whether or not I was correct. Of far greater difficulty and of more seriousness to society are attempts to predict impending potential disasters (for example, the "big one"). However, both types of studies and predictions—long-term and short-term, geologically speaking—support and test each other. The long-term studies (my type of research) provide a framework within which to understand the overall processes affecting California; the short-term studies (earthquake prediction) provide both input to societal concerns and tests of long-term hypotheses.

Everyone should respect the tremendous difficulties involved in short-term predictions, as well as share a sense of wonder about the nature of the earth on which we live. The immensity of geologic time is overwhelming and the only certainty is change—slow, sporadic, often gradual, sometimes violent, but always change.

Raymond V. Ingersoll is ~~an~~ professor in the Department of Earth and Space Sciences at UCLA.