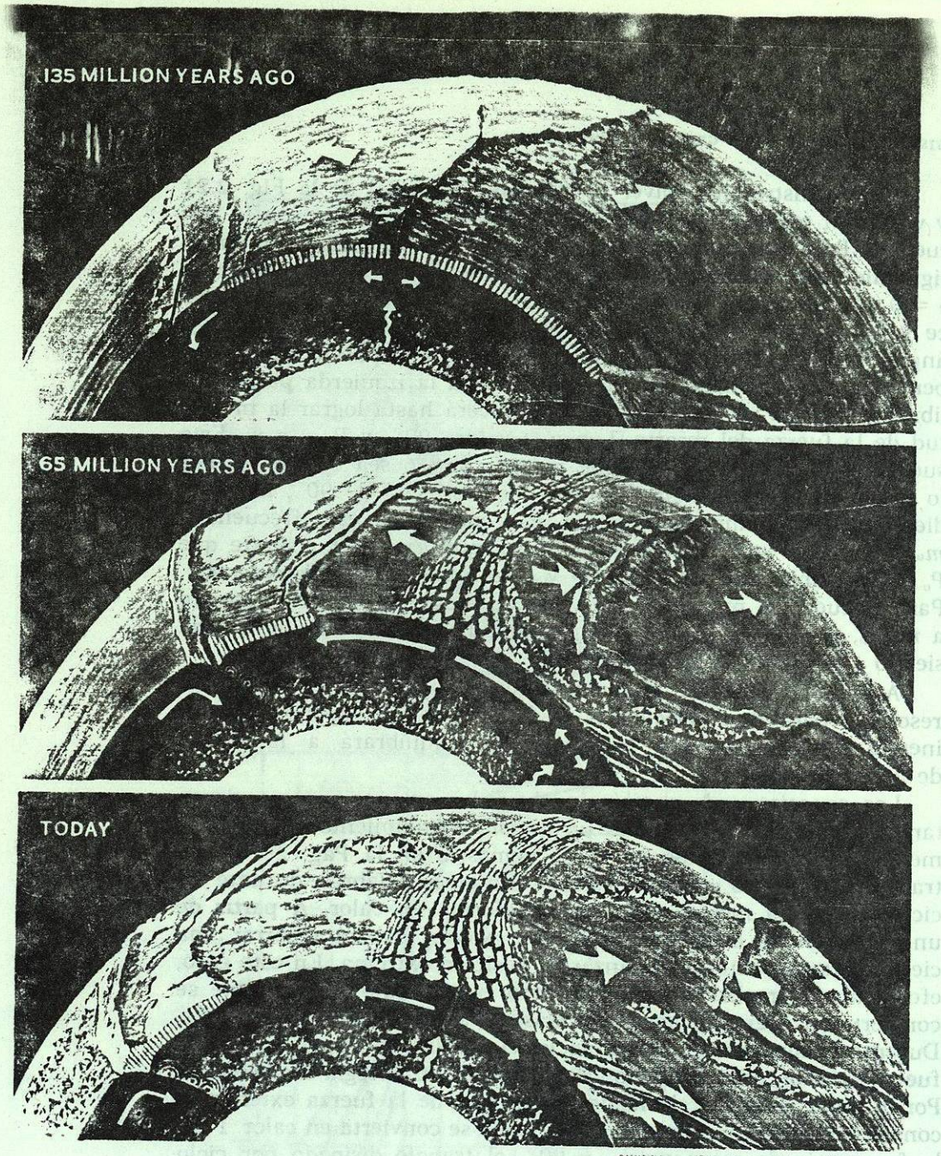
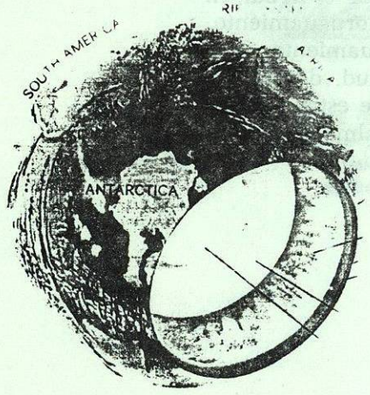


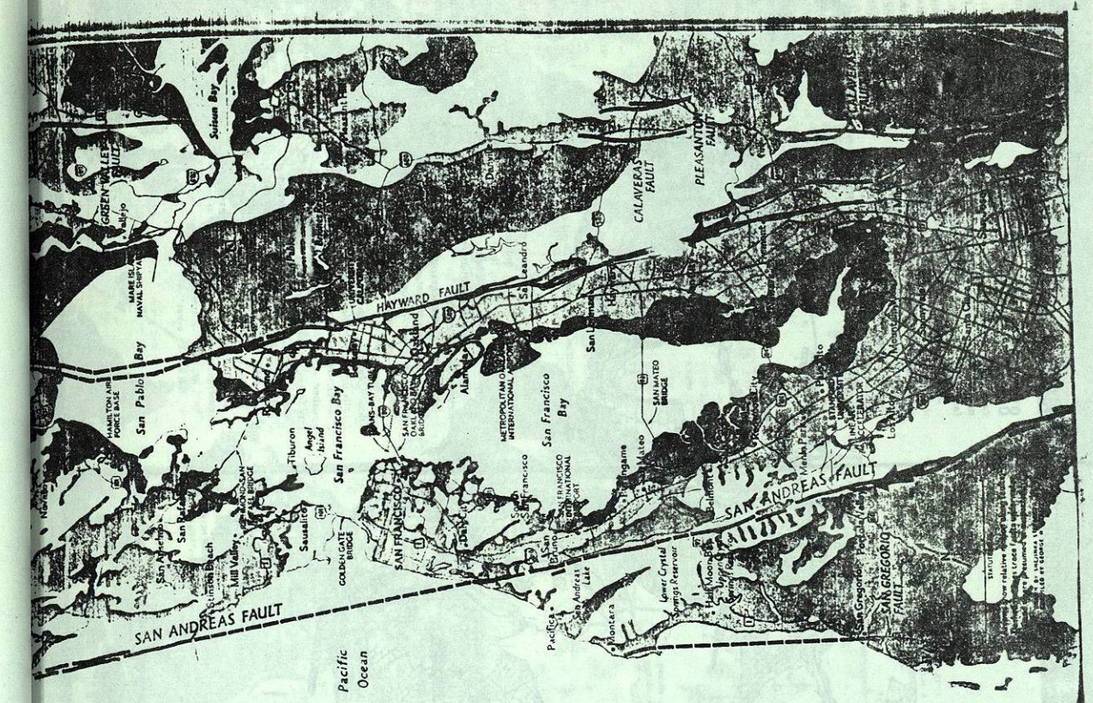


Unzipping the South Atlantic

top

diagram at left

middle



Faults lace the Golden State...

THRUSTING ASHORE from the Gulf of California, the San Andreas Fault system reaches northward to Oregon before vanishing beneath the Pacific. In addition to the main fracture, there are hundreds of branch fractures. Major ones are shown here; all can cause quakes. Between Cholame and San Juan Bautista, the side of the fault to lock completely. Instead, they ease gradually past each other in a movement known as "creep."

SOURCE OF QUAKES lies deep in bedrock; most tremors along the San Andreas begin about five miles down. Seismometer networks locate the focus, the point of fracture. From it seismologists plot the epicenter, the surface point directly above. Violent quakes rupture the surface, offsetting streams and splitting hills to form scarps.

...and threaten San Francisco

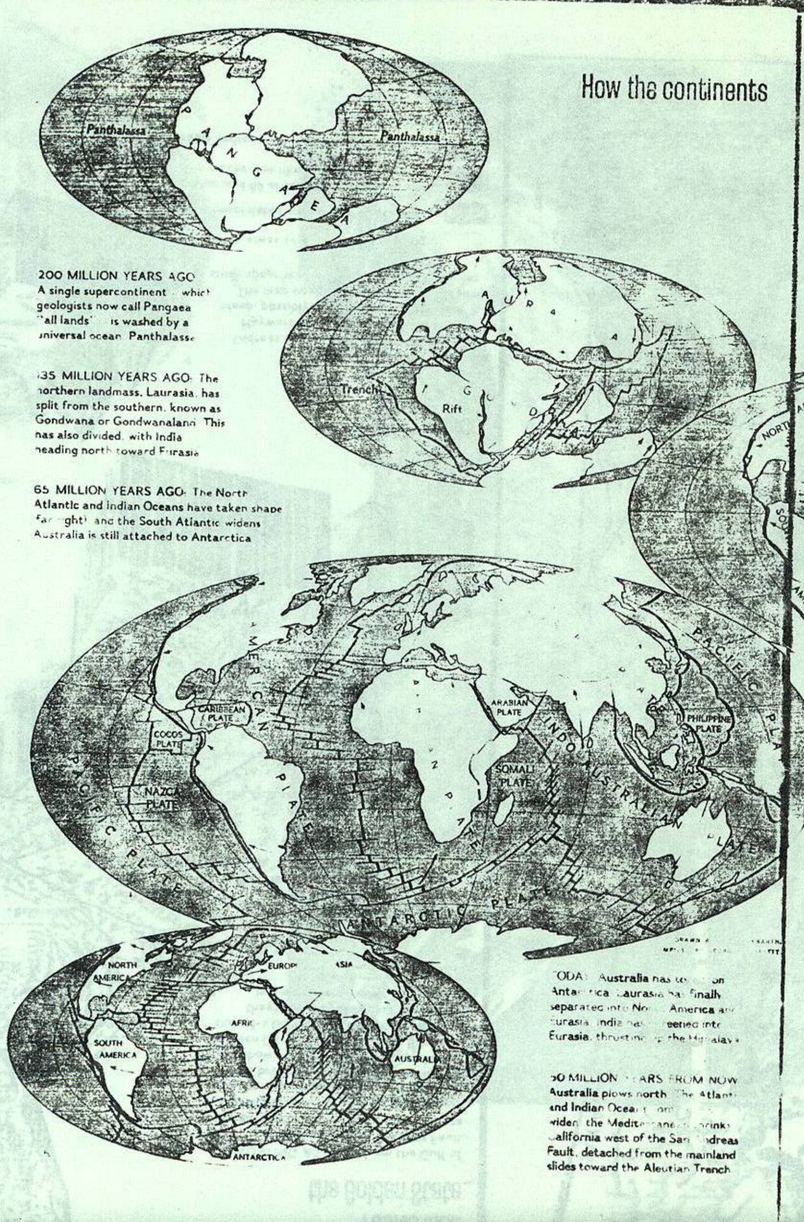
Three major faults slice the San Francisco Bay region, home of 4,700,000 Californians. The San Andreas shifted 20 feet in 1906. Both the Hayward and Calaveras Faults undergo creep, possibly relieving crustal stresses. The map opposite follows a new detailed study spearheaded by the Geological Survey.

Bedrock areas best withstand shaking

Unconsolidated soils show fair stability

Mud and fill areas amplify shaking and in places flow like liquid when vibrated

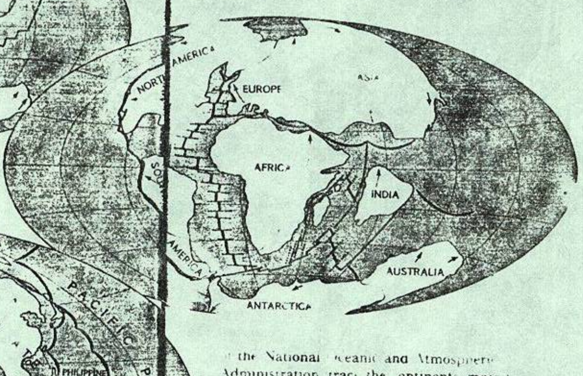
Unstable bedrock could produce earth slides



200 MILLION YEARS AGO A single supercontinent which geologists now call Pangaea "all lands" is washed by a universal ocean Panthalassa

135 MILLION YEARS AGO The northern landmass, Laurasia, has split from the southern, known as Gondwana or Gondwanaland. This has also divided, with India heading north toward Eurasia

65 MILLION YEARS AGO The North Atlantic and Indian Oceans have taken shape ... and the South Atlantic widens. Australia is still attached to Antarctica



TODAY Australia has ... from Antarctica. Laurasia has finally separated into North America and Eurasia. India has ... into Eurasia, thrusting up the Himalayas

50 MILLION YEARS FROM NOW Australia plows north. The Atlantic and Indian Oceans ... widen, the Mediterranean shrinks. California west of the San Andreas Fault, detached from the mainland, slides toward the Aleutian Trench

How the continents have drifted apart

SLOWLY AND PONDEROUSLY, the continents are traveling across the face of the planet carrying us as passengers. In the lifetime of a man, North America and Europe will move farther apart by about his own height.

Some 200 million years ago, only yesterday in earth's time span of $4\frac{1}{2}$ billion years, the land areas formed a single supercontinent. Then it broke into fragments that largely define today's continents, and they began incredible voyages across the planet. These diagrams, based on maps by Robert S. Dietz and John C. Holden of the National Oceanic and Atmospheric Administration, trace the continents' majestic progression and even plot their predicted positions 50 million years hence (bottom).

How can colossal landmasses cross the seemingly solid earth?

In the 1950's oceanographers discovered that a continuous mountain range 40,000 miles long winds through all the ocean basins. Along its crest runs a narrow rift valley ... with hot rock. In a process known as sea-floor spreading, material from earth's interior wells upward in these valleys. The ocean floor moves steadily outward from the rift, pulled or pushed across a less rigid layer beneath by forces still not understood. Offsetting the steady creation of new surface, other regions of the ocean floor plunge down, or subduct, into earth's mantle along deep-sea trenches.

Earth's shifting crust, scientists postulate, is actually a mosaic of perhaps 20 great segments known as plates (page ...). They carry the continents and ocean basins on their backs like great rafts.

... geologic time I was seeking to cross. I was making a journey across inconceivable distances of time and earth-change. I was going back two hundred million years and more, back to an age when there was only one great continent, Pangaea, meaning "all lands" —and only one ocean, Panthalassa, "all seas."

My guides were to be dozens, even scores, of scientists who study the earth. Within just the past few years these men and women have come to a startling new understanding of the shifting, shuddering, hot-hearted planet on which we ride.

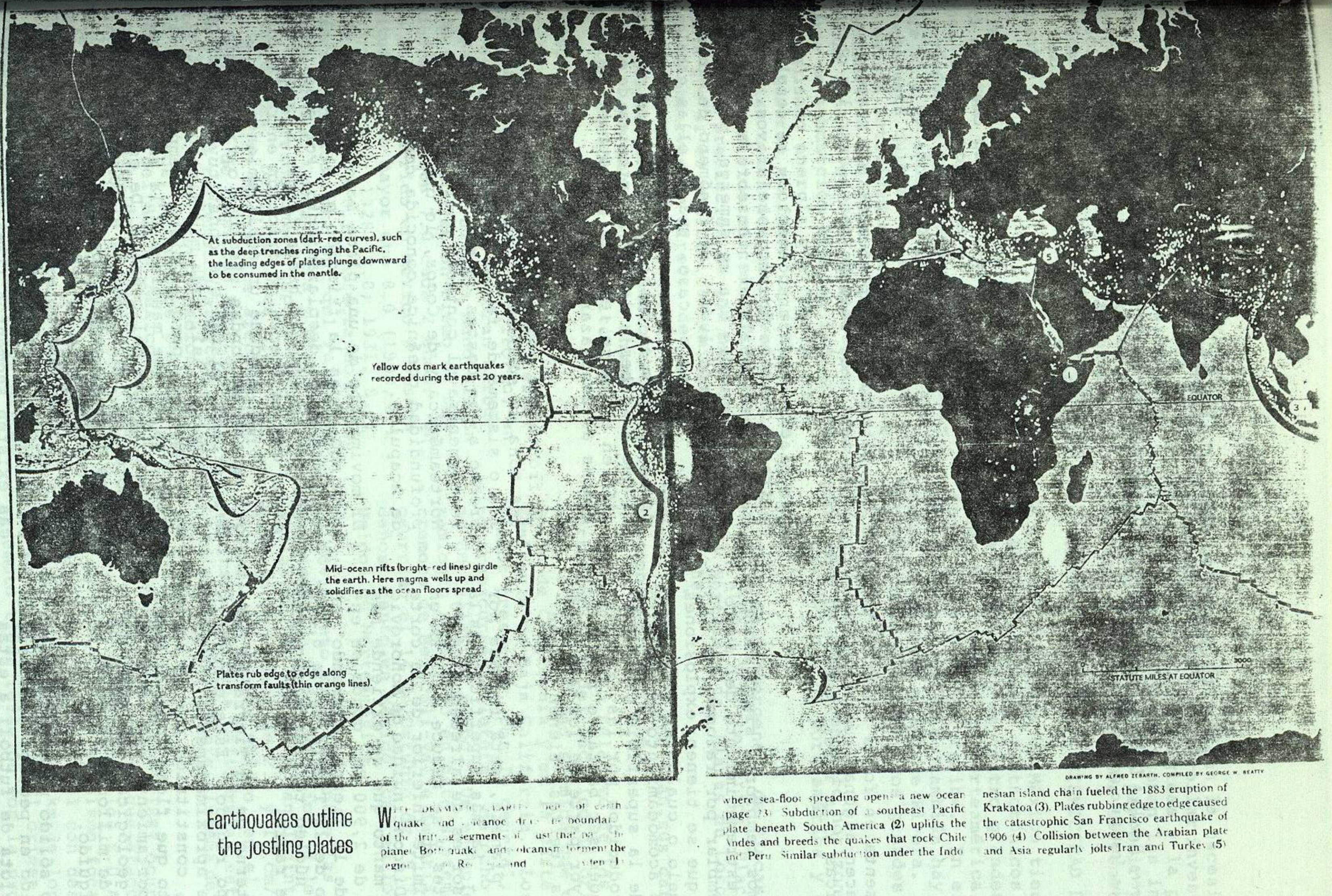
Their new view of the earth is of continents drifting majestically from place to place, of mountains and island chains forming like rumples in rugs pushed together, of oceans opening and closing.

The earth's seemingly rigid crust, geologists say, actually consists of a crazy quilt of great rafts or "plates" that are much like huge ice floes jostling about in a frozen sea. From 30 to 100 miles thick, the plates slowly move, carrying the continents and ocean basins with them, sliding over a hot semiplastic layer below. The rigid plates grind and crush together, causing earthquakes and volcanic eruptions. The cracks usually ... the ocean basins where they are thinnest, and the pieces move apart. In the cracks molten rock wells up and solidifies like new ... forming. Along other edges the plate ... is steadily destroyed. The ... bends downward, forming the deep oceanic trenches, and slide beneath an opposing plate or edge of a continent to be consumed within earth's interior.

ALL THIS sounds like utter fantasy. It would have seemed to many ... geologists and geophysicists only ... years ago ... still seems to some. But the past decade has brought a sweeping revolution in understanding of the earth, a new basic grasp of the forces that shape it. The change of thought has been compared to the scientific upheavals that occurred when Copernicus showed ... our planet ... the center of the universe, Darwin postulated the slow evolution of living things, ... Bohr described the atom.

... walking ...

Continued on page ...



DRAWING BY ALFRED ZEBARTH. COMPILED BY GEORGE W. BEATTY

Earthquakes outline the jostling plates

WITH DRAMATIC CLARITY ... of earthquakes and volcanoes ... the boundaries of the drifting segments of crust that ... the planet. Both quakes and volcanism torment the regions ... Red ... and ... where sea-floor spreading opens a new ocean (page ...). Subduction of a southeast Pacific plate beneath South America (2) uplifts the Andes and breeds the quakes that rock Chile and Peru. Similar subduction under the Indonesian island chain fueled the 1883 eruption of Krakatoa (3). Plates rubbing edge to edge caused the catastrophic San Francisco earthquake of 1906 (4). Collision between the Arabian plate and Asia regularly jolts Iran and Turkey (5).