earth sciences

GEOPHYSICS

Tracing continental drift

Two Government geophysicists have pieced together a geographically precise reconstruction of the giant landmass thought to be the forerunner of all the continents and have traced the path its pieces followed in their 200-million-year journey to their present positions.

Drs. Robert S. Dietz and John C. Holden of the Environmental Science Services Administration used continental margins, oceanic ridges and ancient geomagnetic-pole positions as reference points to place continents and sea-floor features on an absolute geographic grid.

In a series of five maps published in the Sept. 10 JOURNAL OF GEOPHYSICAL RESEARCH, the two scientists show the positions of the continents in each of the five geological periods during which the breakup and drift took place.

The first split, according to their calculations, began midway through the Triassic period when Pangaea, the mother continent, broke into two supercontinents, Gondwana and Laurasia. Laurasia drifted northward, eventually breaking into North America and Eurasia. Gondwana, whose former shape has only recently been precisely mapped (SN: 2/28, p. 229), split into Africa, South America, Antarctica, India and Australia. In the present Cenozoic period India moved rapidly northward and collided with southern Asia, uplifting the Himalayan Mountains, and Africa nudged Eurasia, splitting to create the Arabian Peninsula and the Red Sea.

GEOLOGY

Birth of the Canary Islands

For many years the origin of the Canary Islands has been the subject of speculation and controversy. Their peculiar location, on a line with the Atlas Mountains in Africa led some geologists to believe they were once part of the continent.

Recent seismic and gravity surveys of the western Canaries by Drs. E. Bosshard and D. J. Macfarlane of the Imperial College of Science and Technology in London and reported in the Sept. 10 JOURNAL OF GEOPHYSICAL RESEARCH indicate that the islands are an independent volcanic chain.

THERMODYNAMICS

Phase-change instability in the mantle

Most explanations of continental drift involve some kind of thermal convection in the mantle (SN: 7/25, p. 74). But seismological and geochemical evidence points to the occurrence of a phase change in the mantle which may be stable and therefore act as a barrier to thermal convection. Thus, if the mantle fluid moves upward, a change from a dense to a light phase causes heat to be absorbed, cooling the fluid and creating a stabilizing downward force.

Drs. Gerald Schubert of the University of California at Los Angeles, D. L. Turcotte of Cornell, and E. R. Oxburgh of Oxford, in the Sept. 11 SCIENCE, apply a recent analysis of the influence of phase transformations on fluid stability to the mantle. Their research leads them to conclude that under certain conditions the phase change could be unstable and thus allow convection to occur.

Their model may also account for migration of oceanic ridges, a phenomenon which previous theories of mantle convection were unable to explain.

GEOPHYSICS

Gravity field and global tectonics

An improved resolution of the earth's gravity field made by Drs. E. M. Gaposhkin and Kurt Lambeck of the Smithsonian Astrophysical Observatory enables scientists to draw a clearer picture of its relationship to the earth's topography.

It now appears, reports Dr. William Kaula of the University of California at Los Angeles in the Sept. 4 SCIENCE, that ocean rises and island arcs are associated with positive gravity zones while ocean basins and areas of recent glaciation are negative.

Dr. Kaula translated Gaposhkin's and Lambeck's gravity field values for a number of terrestrial features into terms of mass excess and deficiency, so that ocean rises and island arcs appear as regions of mass excess and ocean basins as areas of mass deficiency.

These excesses and deficiencies, according to Dr. Kaula, can often be attributed to flow in the asthenosphere, the relatively soft region of the earth's upper mantle. For instance, Antarctica, which corresponds to a large negative area, is about five-sixths surrounded by ocean rises—lines of spreading in the global tectonic system. An absence of the seismic activity that would result if the movement were toward the continent indicates that the rises must be moving away. The Antarctic negative, says Dr. Kaula, could therefore be caused by an insufficient supply of asthenospheric material in the flow to match the lithospheric loss.

PALEONTOLOGY

New view of the Tethys Sea

For most of this century, scientists have known that the southernmost part of Eurasia was once covered by a shallow body of water. But new biological evidence, uncovered by Dr. Richard H. Benson of the Smithsonian Institution's National Museum of Natural History and Dr. Peter C. Sylvester-Bradley of the University of Leicester in England, indicates that this Tethys Sea (SN: 7/4, p. 20) was not just a shallow waterway but was in fact a major extension of the world oceans.

Examining fossilized skeletons of prehistoric ostracodes—microscopic marine animals related to lobsters—found in rocks from the mountains of eastern and southern Italy and from Sicily, Drs. Benson and Sylvester-Bradley discovered many details identical to those of specimens taken from the depths of modern oceans.

This evidence supports the theory that the floor of the Atlantic and Indian Oceans extended between Eurasia and Africa for a period of some 200 million years. About 2 million years ago Africa converged on southern Europe and the Iberian "gate" pivoted southeastwardly into its present position, blocking the Tethys off from the Atlantic. Today's Mediterranean is a relic of this ancient ocean, according to the theory.