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layer, is responsible for the turbulent zones referred to as the mobile belts.

Conflicting evidence points to a difference of temperatures between the basaltic layer beneath the ocean floor and the subsurface of the continent. It is argued, convincingly, that sub-continent basalts are cooler than those beneath the oceans. It is just as convincingly argued that sub-continent basalts are warmer than those beneath the oceans.

Inadequacy of measuring devices and difficulty in obtaining sufficient coverage of data is the present barrier to proof in either direction. It appears, to the writer, more logical to assume warmer sub-continent temperatures for several reasons. The material of the continents is less dense and less apt to lose its heat. Also, the oceanic cover of water would appear to act as a reflecting shield to prevent the degree of heating of the submarine surface by solar radiation as that being absorbed by the continents. In any case conclusive evidence is still lacking, and it fits the general hypothesis to follow the latter view.

Attention is called to the fact that oceanic waters, subjected to flow by various factors, the principal of which is the earth's rotation, seek levels based upon their temperature and density differentials. Although there is some mixing, the major feature observable is the fact that bodies of water of even slightly different temperatures and densities collide with the result that the warmer or lighter current overrides the cooler or denser. At their zone of collision a surface of discontinuity is set up much like that of an overthrust fault zone, and the ensuing upwelling creates a pronounced zone of turbulence.

A generalized diagram of a cold front in the atmosphere is illustrative of the same principle. As in the case of ocean currents, the triggering mechanism is, in the main, a great and extensive force—the earth's rotation. The warmer and lighter air overrides the cooler and denser along a surface of discontinuity between two air masses of only slightly different temperature and composition. It is along, and in proximity to, that surface of collision that a zone of turbulence with its ensuing thunderstorms is created.

It is therefore postulated that an analogous situation occurs between the warmer, lighter continental mass and that of the cooler, denser sub-oceanic mantle, thus creating a zone of turbulence in the form of volcanoes and mobile belts. Although the specific differences between air, earth, and water are great, there exists a much lesser difference in the principles involving two masses of the same media. It is considered less than reasonable to deny the existence of the subjacent and superjacent relationships between contrasting masses in all three media. In each case there is a major cause which is not immediately apparent upon specific or particular examination. In all cases temperatures and densities are involved, and the major intermediate cause of overriding in air and water is the earth's rotation. A major, intermediate cause for overriding in the earth's crust is held to be the crustal shrinkage as diagrammed. The only apparent, great difference between the three cases of turbulence is one of time and the time required is apparently proportional to the density and friction of the medium involved.

That an overthrusting relationship exists between continent and ocean, is indicated by the depth of earthquake foci which are most shallow at the island arcs and progressively deeper toward, and beneath the continents. Diagrams are constructed to illustrate this concept of how the continents have grown by accretion due to encroachment of auxiliary welts and subsequent marginal mountain building. The bordering geosynclines are thus formed, primarily by compressional forces oriented horizontally, and are filled with sediments the character of which mainly depends upon source—cratonal or extra-cratonal.

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May 4, 1964

MERRILL J. REYNOLDS, Oliphant Co.
Tulsa

"Geothermal Energy Exploration"

The search and utilization of geothermal energy as a new source of power commenced in Italy in the early 1900's. The first light bulb to be lit by power produced from the natural heat of the earth occurred in 1903. Today, Italy produces sufficient power from geothermal energy to operate its entire network of electric railroads which amounts to approximately 300,000 kw.

Iceland followed Italy in its search for geothermal energy after World War I. Today, domestic and industrial heating is quite common; there is a prospect of a 25,000 kw plant soon to go into operation.

New Zealand produced their first power from geothermal energy in 1958. Their present capacity is approximately 102,000 kw.

In the U. S., between 1921-1925, eight steam wells had been drilled at the Geysers, 75 miles north of San Francisco, California. The project was unsuccessful because abundant, relatively low cost water and fossil fuel generated electric power was available. Between 1956-1958, several of the original wells were reworked and several new wells were drilled. In 1958 the first power plant, with a capacity of 12,500 kw, was installed.

A second unit is being installed to boost the capacity to 28,000 kw.

From 1956 to the present time, approximately 97 wells have been drilled in the United States: 73 in California, 19 in Nevada, 3 in Oregon, and 2 in New Mexico.

The deepest geothermal well in the world was completed February, 1962 in the Salton Sea area of California. The temperature gradient averaged about 13° F. per 100', having a maximum temperature of 720° F. at the total depth of 5230'. This well has tapped a very saline brine which has a high concentration of heavy metals and other rare elements. Gold, copper and silver are precipitated during brine production. It has a mass flow rate of 36,000 barrels per day at a well head temperature of approximately 400° F. This one well is capable of producing 10,000 kw of electrical power for an indefinite period of time.

Exploring and drilling for geothermal energy is extremely expensive and hazardous. The cost of drilling and completing a steam well is approximately $50.00/foot.

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May 25, 1964

JAMES M. FORGOTSON, Pan-American Tulsa

"Current Applications of Computers by Exploration Geologists"

Many geologists are beginning to use the computer to aid in solving some exploration problems. Examples of five types of computer applications in use by explorationists are presented.

Key micropaleontological data from several thousand wells penetrating portions of the Tertiary in the Louisiana-Texas Gulf Coast area are stored on magnetic tape for computer usage. Data retrieval programs select wells encountering specified paleo markers and process associated environmental data for preparation of maps showing paleogeography, shorelines, and attitude of ancient sea floors. Too much time is required to justify such map preparation manually.

Correlative tops from electric logs and sample logs are recorded on punched cards or magnetic tape to allow rapid map preparation using the computer in combination with automatic plotting equipment. Current programs include ability to accept normal fault data and restore section on isopachous maps. Fault patterns, combinations of isopach and structure data, and isoliths of sands and combinations of sands can be mapped. Truncation, onlap, shale-out, etc., are indicated on printed results and plotted maps to aid interpretation and contouring.

Computers prepare facies maps from quantified descriptive lithologic information. Many maps can be plotted automatically to show interrelationships of lithologic and faunal variables for quick appraisal and selection of key maps for further refinement.

Trend analysis is used to remove regional gradient to enhance local anomalies. The technique is being applied to various types of contoured data where identification of local anomalies is important.

Computer programs designed to calculate theoretical gravity due to known or postulated structures are useful for interpretation of deep salt mass configurations. Models of assumed structures can be constructed from seismic or subsurface data and modified until computed gravity agrees closely with observed gravity thus indicating the best structural interpretation.

Computers will become more important in exploration as our ability for efficient use improves and as geologists realize their potentialities.