Wandering Seamounts studied by Dr. Vacquier

April 23, 1963

There are four small seamounts on the ocean floor about 100 miles southwest of Honolulu that have scientists here puzzled.

They are in the wrong hemisphere.

They belong south of the equator instead of twenty degrees north of it.

Or so think the men who discovered the fact. They are Victor Vacquier, Professor of Geophysics, University of California, San Diego, and Gerald D. Van Voorhis, U. S. Navy Oceanographic Office, Washington, D. C.

Vacquier's special field of study is the magnetic field of the earth. He has recently developed an ingenious new method of using readily available survey data and the services of a high-speed computer to pinpoint unusual magnetic features.

The first try at using the method on oceanic structures has paid off spectacularly.

Working with data collected by the U. S. Oceanographic Office vessel U. S. S. Rehoboth, Vacquier and Van Voorhis have found evidence that indicates the seamounts southwest of Honolulu either were formed in the Southern Hemisphere and wandered at least 2,100 miles north or else that the direction of the Earth's magnetic field has been displaced by the corresponding amount. The latter interpretation is not supported by other evidence, and is considered less likely to be right, Vacquier says.

These extinct submarine volcanoes are about the same size and height (half a mile) of the 10,000 other seamounts that are known to pimple the floor of the Pacific Ocean.

Vacquier thinks the seamounts probably wandered bodily from the Southern Hemisphere to the Northern. He explained his reasons in a talk here recently.

"Essentially what I'm trying to do is to provide experimental verification for what my friend Professor George Backus calls a 'megathought'-a big idea," he says. "The megathought here is that the rock of the earth's mantle is executing convective motion."

Convective motion arises from the heating of a fluid. Bubbles rise in a warm saucepan. Heated air soars upward to form the billowing cumulus clouds of summer. These are examples of convective motion.

Vacquier and many other scientists think that massive convection currents are flowing in the molten rock of the earth's mantle and that this "hot rock" causes the earth's crust to bulge upward in such features as the Mid-Atlantic Ridge and the great East Pacific Rise.

The rising of the crust in such great earth features must be accompanied by large-scale horizontal motions, Vacquier says. "Many people forget that. But the rising of the crust implies horizontal transfer of matter elsewhere. You have to look for horizontal motion of pieces of land away from where the crust is rising."

Earth movements of this scale-- over hundreds of miles-- had been suggested but never authenticated until two years ago. Then Vacquier brought out evidence that intrigued earth scientists and laymen throughout the world. The floor of the Pacific Ocean moves great distances, he said, and proved it, showing that off California one section of the ocean bottom had moved at least 850 miles in relation to an adjacent section.

Proof came from a series of painstaking surveys conducted by Vacquier and Scripps Institution of Oceanography scientists. These measured the magnetic anomaly (the disturbance in the earth's magnetic field caused by masses of magnetic minerals in the upper 15 miles of the ocean's floor) off the California coast. When large sections of these surveys were completed, it was found that the typical north-south pattern of lineation was interrupted along several lines. There the patterns had been displaced in an east-west direction. It was as if a pattern of stripes had been mismatched. Vacquier could fit them together again by cutting his map into strips and adjusting them.

Vacquier hypothesizes that the four seamounts off Honolulu were shoved aside during the formation of the South Pacific Rise. If they were not, he says, they must have been formed when the magnetic Southern Hemisphere was far from its present location. A study of the age of the rocks collected from the sides of the seamounts might settle the problem, he says. He hopes that the new geophysical institute at the University of Hawaii will attempt to obtain them.

Studies of the earth's magnetism are several centuries old. Magnetism is what makes a compass needle point toward north. The magnetism arises, most scientists believe, from powerful electric currents flowing in the earth's liquid core, and, to a much lesser extent, from electric currents in the upper atmosphere. The earth's magnetism varies slowly in intensity and direction, for reasons as yet only guessed at.

Lines of equal magnetic direction and intensity curve smoothly around the globe except where they are disturbed by the presence of large masses of magnetic minerals close to the surface of the earth.

It is these variations that interest Vacquier, for they tell much about the structure of the earth some 15 miles beneath the sea floor and give some clues to earth history.

The reason they do is that rocks have a property called remanent magnetism. (Rock itself cannot be magnetized, but the minute crystals of iron oxide in it can.) The rocks retain permanently traces of the direction of the earth's magnetic field that prevailed at the time the rocks cooled down from the molten state. The property is as characteristic as a fingerprint. The study of these faint traces of the original magnetism (which are found in ancient brick also, by the way) has expanded rapidly in the past several years.

In the past it has proved impossible to measure this remanent magnetism unless one could go into the field, collect samples of the rock, and subject the samples to exhaustive laboratory analysis.

Recently Vacquier has enlisted the services of a high-speed computer on this problem. He has come up with a method of measuring some aspects of remanent magnetism by a new method that is fast and relatively inexpensive.

He does this by working with data from the magnetic surveys, which map the present pattern of the earth's magnetic field, and from topographic surveys, which define the shape and size of a geologic structure such as a volcano beneath the sea surface.

By combining information from both types of maps, and by using the computer, Vacquier is able to calculate the direction and strength of the magnetization of a structure, if it be assumed that the structure is made of uniform material and that it is on a level plain. The method was first applied to a hill called Round Butte in Montana. The magnetic field above the butte was mapped from an airplane. When the data were put on the computer, the machine found the three magnetization constants and recalculated the magnetic field at 101 points in 15 minutes. "It could not have been done by hand," Vacquier says. "It would have taken too long."

A description of the method will appear soon in Proceedings of the Benedum Symposi on Paleomagnetism, University of Pittsburgh, 1962.

The method is of particular importance to oceanographers. From a ship, it is relatively easy to map the shape and size of a topographic feature on the ocean floor. It is also easy to conduct magnetic surveys from a ship. Obtaining oriented rock samples (which is necessary for determining the direction of the magnetic field in the past by existing methods) has not yet been done in the deep sea.

Vacquier's method cannot be used to measure the component of remanent magnetism parallel to the direction of the present Earth's field because this field adds an induced magnetization of unknown magnitude. Generally, however, in the basaltic rocks which compose submarine volcanoes., the induced contribution is small enough to be neglected. The case of the seamounts southwest of Honolulu is remarkable in that the vertical component of the magnetization is slightly negative whereas the northerly component is not reversed. This situation cannot be explained by either a reversal bf the direction of the Earth's magnetic field,, or by mineralogically reversed magnetism., because these mechanisms would require reversal of both horizontal and vertical components.

The study of the direction of magnetization of geologically dated terrestrial rocks in Australia and India suggest a northerly displacement of these land masses, during the last 100 million years. "If our four seamounts had partaken of this motion they would be at least 60 million years old," Vacquier says.

"This interesting discovery was made as a direct result of a survey conducted by the U. S. S. Rehoboth for purely scientific purposes," Vacquier says. "It is an auspicious beginning for the projected expansion of the scientific investigation of the oceans by the Oceanographic Office of the U. S. Navy."