

# U. S. Submarine on Scientific Cruise

*Geophysics*

Using a submarine to weigh the earth's crust instead of to sink ships is the task about to be undertaken by the U. S. Navy Department, in cooperation with the Carnegie Institution of Washington. On Tuesday afternoon, October 2, there sailed from the Washington Navy Yard the submarine S-21, accompanied by two eagle boats, on one of the most novel cruises ever undertaken—a cruise reminiscent of Jules Verne or Conan Doyle.

The submarine is a floating gravity observatory. By means of an instrument invented by a Dutch scientist, Dr. F. A. Venning Meinesz, of the Geodetic Commission of Holland, measurements of the force of gravity can be made at sea for the first time. So important are these observations that Dr. Meinesz was invited to the United States by the Carnegie Institution. The Navy Department has now given him the use of the eagle boats and submarine for a period of several months. During this time they will cruise around the region of the Gulf of Mexico and the Caribbean Sea. Assisting Dr. Meinesz are Dr. Fred E. Wright, of the Carnegie Institution's Geophysical Laboratory, and Elmer Collins, of the Hydrographic Office of the Navy.

In order to know the exact shape of the earth, scientists must know the force of gravity, and the only way of measuring this is by accurately timing the swings of a pendulum. Such measurements have been made on land for many years, but since the largest part of the earth's surface is covered with ocean, it left a large unknown area. The motion of the ship made pendulum observations impossible at sea.

Dr. Meinesz decided to make use of a submerged submarine, which is much more steady than a ship on the surface. But his improved apparatus is so successful that he now believes it possible to use it on a ship on the surface in still water and with the engines stopped to prevent vibration. Instead of using a single pendulum, he uses three, arranged as two pairs. They all have the same period, but are swung somewhat out of step. Tiny mirrors attached to them reflect a beam of light back and forth as the pendulum moves. Unlike an ordinary gravity pendulum, however, the light goes from one pendulum to the one next to it and then back to a moving strip of photographic paper,

on which a record is made as a wavy line. Though the motion of the ship affects each pendulum, and each would give a very irregular record if recorded separately, the combination of the two results in a record like that of a single, steady pendulum. The apparatus was tried on a Dutch submarine, in which two trips were made from Holland to Java, one by way of the Suez Canal, the other by way of Panama.

The importance of these observations is that they afford an indirect method of weighing blocks of the earth's crust, said Dr. William Bowie, of the U. S. Coast and Geodetic Survey. Then, if it is found that the weight under water is the same as that of the crust under the land, it means that the density of the block of the crust under the ocean is greater, and that this part of the earth is in what the geophysicist calls "isostatic equilibrium." This gives a better and more accurate idea of the exact figure of the earth, and so provides data of fundamental importance to

students of the earth. The region in which the coming cruise will be made is one of several important ocean deeps, great submarine rifts in the earth's crust. As an ocean deep is a favorite place for the occurrence of earthquakes, more exact knowledge of their characteristics may prove of especial value.

Though this is the first time that this work has been done except on the Dutch submarine, Dr. Bowie hopes that it will eventually be performed by all the navies of the world. "There is plenty of room in the oceans," he said, "for everybody." He also advocates that the U. S. Navy continue the work in the future, even after the present project is completed, by permanently equipping a submarine with the apparatus. As the accuracy of the charts used by the Navy depends upon exact knowledge of the earth's figure, the work is of considerable practical value.

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