GEOPHYSICS

The Earth's Crust

Three phases of the earth's crust will be explored during the IGY: earthquakes, gravity, and latitude and longitude. The U. S. program emphasizes measurements in remote regions.

By ANN EWING

➤ THREE PHASES of the earth's crust will be explored more thoroughly than ever before during the International Geophysical Year, or IGY, beginning officially on July 1.

They are: its earthquakes, or how the planet's surface is continually readjusting; gravity, or how strongly you and every other object is being pulled toward the earth's center; and latitude and longitude, or how far apart are the continents, and are they drifting apart or together.

Most measurements so far made in these fields are concentrated near the world's densely populated regions. During IGY, the United States program will emphasize particularly measurements in usually remote and neglected areas such as Antarctica and the South Pacific.

Although the moon averages about 240,000 miles from the earth, it has more uses than just furnishing light for lovers and creating the ocean's tides. The moon holds a key to learning the distances, within a few feet, between continents.

Measurements by Camera

A new type of camera, developed by Dr. William Markowitz at the U. S. Naval Observatory, can simultaneously photograph the moon and it starry background. It is known as the "dual-rate moon-position" camera, and has a dark, tilting filter that cuts out all but about one-thousandth of the moon's bright light. The movable filter allows photographing at the same time both the stars and the moon clearly.

By taking a series of observations on a single night, the position of the observing station is accurately fixed in relation to star positions and the center of the earth. By using these cameras at some 20 locations around the world, differential shifts between continents can be determined within a few feet, scientists believe.

They call the measurements of "epochal importance" because comparison of results obtained at this time can be made with those taken in the future to determine the directions in which the continents are shifting.

For many problems the general belief that the earth's latitudes and longitudes are precisely known is correct. Mapmakers can draw reasonably accurate maps and navigators can use these maps to pilot ships or aircraft to their destinations with complete confidence. It should be noted, however, that during the last war, some Pacific islands were found to be as much as a mile from their presumed locations.

The IGY moon-measuring program, combined with astronomical determinations of latitude and longitude, will give the pinpoint accuracy needed in the forthcoming era of intercontinental ballistic missiles as well as yield continental shift information.

Two Kinds of Time

Another result of extensive observations with the moon-position camera will be a check on what astronomers call Ephemeris Time, which is time measured from the orbital motion of the moon or other heavenly objects. Another kind of time, that given by the rotation of the earth, is called Universal Time and is known to vary because of changes in the earth's rotation rate.

There is a fairly regular yearly variation, the earth running about 35-thousandths of a second fast on Oct. 1 and about equally slow on June 1, when Universal is compared to Ephemeris Time. The reasons for this variation are not entirely known, although it is partly due to tides, shifts within the earth's core and changes in positions of air masses.

However, the earth also undergoes unexplained and irregular changes in rotation. The amount and time of occurrence for these changes cannot be predicted. They are observed by comparing non-uniform Universal Time with Ephemeris Time, the former being 30 seconds slow at present.

By obtaining Ephemeris Time with great accuracy from the 20 moon camera stations, scientists may be able to show the irregular changes in the earth's rotation speed are related to other geophysical events.

MOON, KEY TO CONTINENTAL POSITIONS—By using 20 special instruments, moon cameras developed at the U. S. Naval Observatory, the positions of all continents will be known within a few feet by the end of the International Geophysical Year.

The moon camera will also be used to determine the size and the shape of the earth, and it will be the only such determination based solely on geometry, independent of the pull of gravity.

The U. S. program for measuring gravity has, in effect, already started. While traveling to Antarctica, a team of scientists made basic reference measurements along the way. These references can now be used during IGY to calibrate future measurements in the same regions.

Although the local topography affects the pull of gravity at any particular location, a composite figure, made from measurements all over the earth, is important for many purposes. Only in heavily populated areas have fairly complete gravity measurements been made. The oceans have remained relatively unexplored gravimetrically.

To remedy this, U. S. scientists plan to put their instruments on submarines, then take the gravity readings while the ship lies at rest below the surface disturbances.

Gravity measurements are also being taken in the Arctic on drifting ice floe stations and in the Antarctic.

Measuring the Earth's Crust

A map of the earth's interior is expected to result from the greatly expanded network of stations recording the ceaseless activity of our planet's crust, its earthquakes.

Some of the seismographic recordings will come from man-made explosions, however, particularly in the Antarctic. Surveys of ice thickness along the route between Little America and Byrd Station have already been made. Dynamite charges were exploded periodically, then the time the sound waves took to travel through the ice to the ground and return was measured.

By this technique, ice thickness is measured and a profile of the Antarctic continent obtained. Early measurements indicate that near Byrd Station the ice cover may be 10,000 feet thick. Since the place where these readings were taken is only 5,000 feet above sea level, the underlying land must be 5,000 feet below sea level.

Although most of this is probably due to the particular location, the weight of ice accumulated over many centuries has undoubtedly depressed the continent. This same effect has also been found in Greenland.

Another kind of earth movement, called microseisms and transmitted from the air to earth, will also be studied during IGY.

Of particular interest will be the results of seismic explorations in South America. Scientists want to check a surprising finding made in the United States: the Colorado plateau and Rocky Mountains do not have great roots reaching down some 45 miles, as suggested by their heights. Instead, the continental crust there is hardly different from that of the low lands, being about 18 miles thick.

Thus scientists are faced with the fact that no theory now current can describe a continental structure.

Science News Letter, June 22, 1957

PHYSIOLOGY

Ear Is a Safety Hazard

➤ NORMAL EARS are making it difficult for jet pilots to fly their high performance aircraft safely, Col. James B. Nuttall, U. S. Air Force, Office of the Surgeon General, Washington, reported to the American Medical Association meeting in New York.

In the early days of aviation, a good sense of balance in the normal ear was considered essential but today the ear presents one of the major safety hazards under certain flight conditions.

A recent study of fatal accidents in one of the Air Force's overseas commands showed 14% were caused by "pilot's vertigo," or spatial disorientation. In some cases pilots became so confused by their normal balance system they were actually flying upside down when they thought they were in level flight.

The normal ear was designed to work on a very stable platform, like the earth, and when it is put in three dimensional space and exposed to different acceleration forces, it sends garbled reports of balance to the brain.

Disorientation comes from both visual illusions and illusions of attitude and motion. The visual illusion experienced by a pilot on a very dark night when there is no moon and only scattered lights on the ground has caused him to mistake the ground lights for stars and the sky for the ground. But these visual illusions are minor compared to those of attitude and motion.

Visual perception is almost perfectly reliable, whereas balance and motion perception by the ear is almost completely unreliable. Reduced visibility and poor weather conditions increase the flying hazards.

Even slight head movements by the pilot can have disastrous results and make him think he is climbing when in reality he is diving toward the ground.

Disorientation is not limited to inexperienced flyers. Even the most experienced pilots report it, but usually they are able to recover if they have enough time.

Since it is impossible to eliminate the cause of this vertigo, Col. Nuttall said, attempts must be made to further reduce its effects.

He suggested improved instrument panel design, so the pilot can more readily scan his dials, and more intensive training of pilots to disregard what their ears tell them and rely on instruments.

Science News Letter, June 22, 1957

BIOPHYSICS

Object Reproduces Self

➤ SELF-REPRODUCTION, long thought to be a distinguishing characteristic of living organisms, has been discovered among nonliving objects.

Two scientists report that reproduction can be demonstrated by an "exceedingly simple mechanism."

As they explain it in *Nature* (June 8), a flat material such as plywood or vulcanite, is cut into two special shapes, which they call "A" and "B," although other forms could be chosen.

Several of these objects are placed on a track where they can slide freely but cannot pass each other. The track, formed by a shelf or groove, is blocked at both ends and covered by a roof. When the track is shaken up and down, the pieces move but do not link to each other.

If, however, a linked set of "A" and "B" is introduced into the track, and the shaking resumed, the "A-B" complex is reproduced along the track wherever an A-piece happens to be immediately left of a B-piece.

If the experiment is repeated with a set of pieces linked together as a "B-A" complex, the result is to reproduce the figure "B-A" at all possible places along the track.

Dr. L. S. Penrose of University College and Dr. R. Penrose of Bedford College, London, England, devised the self-reproducing model. The difference between the "A-B" and "B-A" complexes corresponds to mutation in that the changed set is repeated in its changed form.

The simple mechanism for reproduction they discovered has been the starting point for construction of more complicated models with similar basic properties.

Science News Letter, June 22, 1957

AERONAUTICS

Missile System Rings American Cities

See Front Cover

➤ A GUIDED missile system has been designed to fill in the gaps of the air defense missile system ringing the nation's cities.

Called HAWK, the new Army set-up is built to knock out low flying attackers. Its guided missile, shown on the cover of this week's SCIENCE NEWS LETTER, is 16 feet long, 14 inches in diameter and powered by a solid-fuel propellant. Hawk's radars are designed to spot enemy craft in the blind zone of conventional radars.

The system will complement the defense against high-altitude attack provided by the Army's Nike system, the Raytheon Manufacturing Company of Waltham, Mass., prime contractor for the missile system, reported.

Science News Letter, June 22, 1957