The systematic under-estimation of depth by non-directional sonic-sounding gear is considered in another more recent report of the *Meteor* expedition,⁵ and the matter is of sufficient interest to be discussed briefly. In an ideal echo-sounding apparatus, the receiving instruments would be arranged so as to detect an infinitesimally small amount of energy, and if such an instrument could be made, the time interval recorded would be the time which elapses between the emission of an infinitely short impulse and the return of the echo from the *nearest point* of the bottom. If the bottom is not horizontal, the echo would in general come from a point not vertically beneath the ship, but from some point on a tangent plane to a sphere the centre of which is at the transmitter, and the true contour of the bottom would be a series of such intersecting tangent planes. The depth recorded would be the distance of the nearest tangent plane and would generally be less than the vertical depth of water beneath a ship.

In actual practice it is not possible to build a receiver which would be sensitive to excessively small quantities of energy, nor would it be possible, on account of parasitic noises which cannot be eliminated, to use it at sea if it could be made. The impulses emitted by practical sonic transmitters are of finite duration and the receivers operate on a finite amount of echo energy. It is therefore obvious that the received echo comes from an area of the bottom and not from a point on it, and that the observed time will in general be less than the time corresponding to the depth of water vertically beneath the vessel, since the area from which the echo is received is not in general directly beneath the ship. In water of gradually decreasing depth the echo comes from an area in advance of the vessel and vice versa, but the error made in estimating the depth will not be great except when the slope of the bottom is large. A warning of an imminent decrease in depth is given to a vessel using sonic gear before the vessel is actually over the obstruction, and this is an advantage in navigation.

A series of echo soundings was made in the autumn

⁵ *Ibid.*, Nr. 41, 1926.

of 1925 by four submarines and the depot-ship *Pelikaan* of the Dutch Navy in the Indian Ocean to the south of Java and Bali.⁶ The submarines were submerged to a depth of 12-30 metres during the observations and the ordinary sound-signalling gear for inter-ship communication was used with stop-watches, for ascertaining the depths. The results are generally in good agreement with the charts and are of particular interest owing to the peculiar configuration of the bottom, which includes a row of submarine elevations in about 11° south longitude, to the north of which is a long deep depression having a maximum depth of about 7400 metres. These soundings have a particular interest to seismologists, because the deep valley in and near Wijnkoops Bay coincides with the origin of a great many earthquakes. The use of the echo method in Dr. Meinesz's gravity survey in a Dutch submarine has already been reported in *NATURE* in an article dealing with the new pendulum apparatus for gravity observations.⁷

In the German publication⁴ to which reference has been made above, it is stated that 548 soundings were taken in rather less than four days at intervals of about one sea mile. This works out at one sounding every 10½ minutes approximately. While there is nothing remarkable in this, and the number could easily have been increased if desired, the figures given permit a comparison to be made between the rapidity of sonic sounding and wire sounding. Since, when the wire is used, the whole series of operations of slowing down and getting up speed, paying out and winding in the wire, must be repeated for each observation, the time expended in making an equal number of soundings would have been enormous. Even in depths of about 200 fathoms, about a quarter of an hour is lost per sounding, while in about 3000 fathoms, 2½-3 hours is required to do with the wire what is done practically instantaneously with the echo gear.

J. B.

⁶ Koninklijk Mag. en Met. Observatorium te Batavia. *Verhandelingen* No. 17, 1925.

⁷ *NATURE*, April 10, 1926, pp. 531-33.

Tectonic Features of New Guinea.

DUTCH New Guinea is still geologically one of the least known parts of a region which, from Malacca to New Zealand, presents a bewildering tangle of structural problems. A pioneer account of the north coast and its hinterland by J. Zwierzycki, one of the geologists attached to the Dutch East Indies Department of Mines, is therefore unusually welcome.¹

The Cyclops Mountains along the north coast of the Dutch territory are made up of ancient crystalline rocks, including typical members of the greenschist and amphibolite facies associated with marble and gneisses, and intruded by gabbro and serpentine. Across the Australian boundary to the south-east, the old rocks, though interrupted and hidden by bays and deltas, can be traced through the Bougainville and other coastal mountains to the lofty peaks of the Finisterre group. E. R. Stanley, the Government geologist of Papua, describes the latter as composed

of schists, and recognises the terrane as part of a marginal geanticline related to Halmahera and New Britain. West of the Cyclops the crystalline rocks are hidden beneath a low-lying swampy coastal plain. Off the coast, however, there are coral islands with others of serpentine, leading to the mountainous ridge of Jappen Island, which again is built of schists and serpentine. At this point Zwierzycki suggests that the trend line turns north through Geelvinck Strait to the open Pacific, but it seems far more probable that the marginal rocks continue beneath Geelvinck Bay to reappear in the Arfak Mountains. These have been briefly referred to by Suess as an ancient massif flanked by unfolded Mesozoic strata. Moreover, the island of Waigeo, at the north-west corner of New Guinea, carries on the belt of serpentine and peridotite intrusions, and so links up the coastal ranges with Halmahera, where these very significant rocks are widely distributed east of the volcanic line. Actinolite schists are recorded from the south of Halmahera, and gneisses from Bachian.

¹ "Notes on the Morphology and Tectonics of the North Coast of New Guinea," *Philippine Journal of Science*, April 1926, p. 505.

Thus from Halmahera to New Britain there are numerous relics of a crystalline foreland heavily injected with peridotite and serpentine—probably towards the end of the Cretaceous—which served as the buttress against which the Neocene formations to the south were folded and overthrust in the late Tertiary. That this foreland was formerly more extensive is indicated by the presence of pebbles containing Jurassic fossils in the basal Miocene conglomerate, and by the interesting observation that the pebbles diminish in size as they are traced southwards from the coastal region.

A broad belt of Neocene beds has been traversed as far south as the Idenberg River. For the most part this terrane consists of low undulating hills with slow-flowing rivers. There are Miocene andesites and basalts, as in Papua and most of the circum-Pacific lands. But although the landscape is quiet and in a far advanced stage of erosion, the rocks have been strongly compressed and overfolded to the north. Fortunately the low relief is conspicuously interrupted, half-way between the swampy plains of the Idenberg valley and the coast, by a series of ridges having a north-west trend that becomes westerly in the west. These are the Karamoor and Van Rees Mountains, and they constitute a resistant anticlinal core with windows through the Neocene conglomerates revealing the crystalline schists beneath. Folded Miocene beds are known both north and south of McCluer Gulf, while the anticline exposing the older rocks appears to be continued to the west through Misool, Obi, and the Sula and Peling Islands. The observations of Zwierzycki east of Geelvinck Bay thus give a meaning to this east-west line of islands, and make it no longer necessary to assume, as some geologists have done, that the Central Range of New Guinea is continued through the Arfak Mountains or through Misool.

The great Central Range stretches from the south-east of the island through the Owen Stanley Range of Papua to the Charles Louis Mountains of Dutch New Guinea. In the British territory, it has a core of Archæan rocks and is flanked to the north and south by Palæozoic formations.² The existence of a similar core in the Dutch part of the Range is known only from pebbles brought down by the rivers, for the mountains themselves have not yet been explored. Nevertheless, it is now clear that the core continues to the west through Ceram and Buru, both of which are Archæan terranes composed mainly of schists.

South of the Owen Stanley Range there is another belt of Tertiary sediments and volcanic rocks. E. R. Stanley states that the trend lines can be traced into Dutch New Guinea, and thence into Ceram, Celebes, and Southern Borneo. Structural and palæontological work in the oil-fields probably justifies this conclusion, but I am aware of no published evidence that helps one to trace any of the trend lines here elucidated into the little-known complex of Celebes. Stanley suggests that the Central Range has an Indo-Malayan structure, and the association of tin with some of the granites, especially in the east, makes this a tempting speculation. Zwierzycki, on the other hand, correlates the Central Range with the Himalayas, and suggests that the depression of South New Guinea is similar to the Indo-Gangetic Plain. It is, however, equally probable that it corresponds to the depression that runs from the Irrawadi valley to the Straits of Malacca. Until the direction of overthrusting or overfolding, if any, is determined in the southern Tertiary belt of New Guinea, and until the puzzling structures of Celebes and Borneo are linked up with those of the neighbouring islands, it will not be possible to deduce the position of New Guinea in the Alpine-Himalayan system.

ARTHUR HOLMES.

² E. R. Stanley, "The Geology of Papua," 1924, p. 51.

Obituary.

MANY readers of NATURE will learn with regret of the death of Mr. Joseph Goold, of Nottingham, who passed away in his sleep in the early morning of November 15 at the age of ninety years. He had retained all his faculties until the end. Mr. Goold was well known to many through his invention of a novel method of causing steel bars and plates to vibrate. His method was to fix a short length of cane in a suitable handle, and having arranged the cane to vibrate at a particular frequency, he gently stroked the plate or bar with the end of the cane. The friction set the cane into a state of vibration, and its small motions were imposed upon the plate or bar, which was set into a very active state of similar vibration. Mr. Goold gave many demonstrations of his experiments at conversaciones of the Royal Society, and at meetings of the British Association. He used to relate that this method of vibration suggested itself to him while he was thinking of the difference between the sound of a creaking door and that of a musical instrument. For many years Mr. Goold had worked at new ideas in connexion with the musical scale. A paper on this subject by Mr. Goold was communicated

to the Royal Society of Edinburgh and published in the *Proceedings*, vol. 40, part 2, No. 18, June 21, 1920. He says in this paper: "The scale is primarily a system of intervals rather than a series of notes; for though its divisions are marked by notes (just as the divisions of a ruler are marked by lines) the divisions themselves are not notes but intervals." Since then Mr. Goold has extended this investigation, and was working at it practically until the time of his death.

WE regret to announce the following deaths:

Mr. Carl Akeley, author of "In Brightest Africa" (1924), who was collecting for the American Museum of Natural History in Central Africa, on November 29, aged sixty-two years.

Prof. Ettore Molinari, of Milan, one of the best known of Italian technologists, and the author of "Trattato di Chimica generale ed applicata all'Industria" which has been translated into several languages, died on November 9, aged fifty-nine years.

Prof. R. W. Phillips, formerly professor of botany at University College of North Wales, Bangor, on December 2, aged seventy-two years.