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OCEANOGRAPHY.—*The circulation of the abyssal water of the oceans.* AUSTIN H. CLARK, National Museum.

The geographical and bathymetrical distribution of the recent crinoids, animals which, occurring at all depths, are thruout life, with very few exceptions, strictly sessile, and of which the young are developed entirely in the water immediately surrounding the adults, furnishes data of the greatest importance for the solution of the problems connected with the abyssal circulation of the oceanic waters. This circulation, as would be expected, differs radically from the circulation of the surface waters, and is altogether of a much simpler type. As indicated by the distribution of the recent crinoids, the general scheme of the abyssal circulation of the oceanic water is as follows:

The surface water of the antarctic regions, bathing the shores of the antarctic continent and forming the circumpolar antarctic stream, is in reality abyssal water, derived entirely from the abysses of the Pacific, Atlantic and Indian oceans. It has nothing whatever to do with the surface water of the rest of the globe, from which it is separated by a broad neutral zone, the so-called west wind drift. Antarctic water enters the basins of the Pacific, Atlantic and Indian oceans in the form of great peripheral currents (the Humboldt, Benguela and Australian currents) flowing along their southern, southeastern and eastern borders, which, in the Pacific and Atlantic, plunge beneath the surface at about the latitude of the equator, but are continued as deep currents northward, westward, and finally for a greater or lesser distance

southward, along the eastern, northern and northwestern margins of these basins. At every point in their course these currents give off water from their seaward (left) side which falls into the abysses and forms the strictly abyssal water; on account of the effect of the rotation of the earth this process is carried on far more actively in the southern than in the northern hemisphere. In the northern hemisphere the rotation of the earth; instead of inducing the flow of water from the borders of these currents into the abysses, tends to cause the currents to hug the coast and, by rendering them more compact, to prevent the diffusion of their water and hence to maintain their motion and to preserve them as currents. Also it operates to bring their upper levels near the surface so that, wherever a powerful surface current flowing diagonally away from the shore causes the formation of a vacuum, as it were, between itself and the coast, the water of these peripheral currents, composed of water of the strictly abyssal type, and ultimately of antarctic origin, immediately rises to the surface. This occurs off northwestern Africa and off southern California, and again off the Kurile Islands and off the New England coast from Cape Cod northward; on the New England coast, however, the identity of the antarctic water is more or less concealed by mixture with water of low salinity coming from the north.

In the pocket-like Gulf of Alaska the rotation of the earth causes the water of the antarctic current to pile up, and to rise nearly, in the winter possibly in some places quite, to the surface. Over the surface of this cold antarctic water flows the wind-impelled drift from the Kuro-Siwo, which divides, part of it skirting the northern part of the Gulf of Alaska, and part flowing southward down the coast. The water of the Kuro-Siwo drift and the antarctic water are of the same salinity, and therefore they mix readily. Hence the southern derivative from the Kuro-Siwo drift, the so-called California current, as it flows southward dissolves into itself the cold water of the antarctic stream immediately beneath it, presenting the curious phenomenon of a current flowing southward, yet at the same time becoming colder and colder.

In the southwestern portion of the basins of the Pacific, Atlantic and Indian oceans the abyssal water slowly rises and, flowing southward, takes the place in the circumpolar antarctic circulation of the water lost thru the Humboldt, Benguela and Australian currents.

In the central portion of the oceanic basins the general motion of the water is from east to west, the water lost from the currents flowing northward across the basins and being picked up by the southerly currents on the other side. This circulation is rapid in the high southern latitudes, diminishing in intensity northward.

The water of the circumpolar west wind drift of low southern latitudes, north of the true antarctic current, is mainly surface water from the north caught up and driven forward by the strong wind. This west wind drift forms a band dividing the abyssal antarctic circulation from the superficial circulation further north.

By this drift many organisms, pelagic at some stage of their existence, or capable of transportation by floating objects, are distributed thruout the southern latitudes, tho they are unable to withstand truly antarctic conditions; and to this is largely due the similarity of the faunas of southern Africa, southern South America, southern Australia and New Zealand, a similarity which is in no way indicated by the crinoids of these localities.

GEOCHEMISTRY.—*Note on the chlorine content of rain water at Tortugas, Fla.* R. B. DOLE, Geological Survey. Communicated by F. W. Clarke.

The appreciable quantity of salt carried by normal rainfall off the seacoast is well shown by test of a sample collected by the writer on Loggerhead Key, Tortugas, Fla. After heavy all-night rains and morning showers had thoroly washed the roof of the Marine Biological Laboratory a large sample of rain was collected during the afternoon of June 13, 1913, in a galvanized bucket under one of the gutters. This sample was immediately bottled and later tested at Washington, D. C., by E. C. Bain. A 250 cc. portion concentrated to 25 cc. and titrated with a solution of silver nitrate, 1 cc. of which was equivalent to 0.5 mgm.