

estimated to be in the annual river discharge of the globe. Joly took for these the results of Murray,* who, basing his calculations on the discharge of nineteen of the principal rivers of the world, estimated the total amount of the sodium and other salts annually put into the sea by river water. Joly finds from Murray's tables that the sodium annually discharged is 157,270,000 tons, and the quantity in the sea is 14,151,000,000,000,000 tons. Dividing the latter by the former he gets as quotient, approximately, 90,000,000, which, expressed as years, would be the age of the earth, or, rather, the period of time which has elapsed since the first condensation of water vapour took place on the globe. Joly admits that the ocean at first contained a considerable quantity of sodium as sodium chloride, and this he puts at about 14 per cent. of the present amount in the sea. This would make the amount discharged into the sea by river water less than that stated above, but, on the other hand, the volume of the ocean may, as a result of more recent estimations, be given a higher value, and in consequence the mass of sodium in it would be 15,627,000,000,000,000 tons. Further, of the sodium annually put into the ocean, Joly allows as much as 10 per cent. for that which is taken from the ocean by the rain and returned again in river water, and this estimate would make the amount of river sodium, which is annually leached out of the rocks and strata, as 97,800,000 tons. With these values Joly finds that the corrected figures for the age of the earth is 89,300,000 years.

In support of his contention Joly shows that as compared with the igneous rocks there is in the sedimentary rocks, which are derived from them, a deficiency of sodium, and that the sodium now in the sea would approximately account for the difference. The bearing of this fact is that all the sodium now in the ocean was derived from the original rock crust by processes which to-day are in operation in decomposing rock material and removing the sodium therefrom. In other words, the discharge of sodium into the sea has been in the past a uniform one, or at least subject to no great variations that would constitute a factor against determining the age of the earth by this method.

This estimate has been ably criticized by the eminent geologist, the Rev. Osmond Fisher,† who points out that the sodium which is derived from the decomposition of crystalline or igneous rocks is in the form of carbonate rather than chloride; and he asks whether it is not possible that the chloride of river water is derived, not from crystalline,

* On the Total Annual Rainfall on the Land of the Globe, and the Relation of Rainfall to the Annual Discharge of Rivers. *The Scottish Geogr. Mag.*, Vol. 3, 1857, p. 65.

† *Geol. Mag.*, New Ser., Vol. 7, p. 124, 1900.