ments (*12*), and it is one of the most persistent forms in the entire length of the core.

The close conformity of the carbonate sediments on the bottom with the surface current path of the equatorial current system was first indicated by Murray and Renard (*13*). They explained the relationship by assuming a higher production of Foraminifera in the counter currents. Arrhenius (*14*) described a higher rate of accumulation of calcium carbonate (Foraminifera and coccoliths) below parts of the equatorial current system during the Ice Age in the tropical Pacific. He explained the observation as being due to the phenomenon of the high production rate of phytoplankton at the surface of the ocean. This high rate of production is believed to be due to an increased rate of upwelling in the divergence. He further postulated that the high rate of upwelling probably suggests greater intensity of atmospheric circulation in low and intermediate latitude during the Ice Age. From the isotopic measurements on Pleistocene planktonic Foraminifera, Emiliani (*15*) confirmed Arrhenius' interpretation of carbonate maxima as cold-water facies and the minima as warm-water facies. Nyberg (*16*) examined Arrhenius' theory of close association of the high rate of accumulation of calcium carbonate at the bottom of the sea and general atmospheric circulation and concluded that the existing meteorological facts do not contradict the theory. Schott (*17*), in discussing the carbonate deposits, suggested that in the Atlantic the sediments deposited during the glacial stages are low in calcium carbonate while those of interglacial or postglacial stages are high in calcium carbonate. He believed that during glacial stages the surface waters of the tropical Atlantic were cooled, and this resulted in a great reduction in the organic precipitation of calcium carbonate. At the same time the contribution of noncalcareous material from the continent to the sea floor greatly increased. On the other hand, Yalkovasky's study failed to reveal a direct correlation between temperature and carbonate concentration (*18, 19*). Many aspects of this problem and the variety of controls of *Globigerina* accumulation were vigorously discussed by Wiseman, Emiliani, and Yalkovasky (*19*).

I believe that there were no significant changes either in topography or oceanographic conditions in the area of study during the deposition of *Globigerina*-rich sediments from approximately 27,000 to 11,000 (?) years ago. Hence, I conclude it is likely that the greater accumulation of *Globigerina*-rich sediments is due to increased production brought about by intensified atmospheric and oceanic circulation, which brought up nutrient-rich deep water to the surface during Vashon glacial times. Consequently there was a greater production of Foraminifera. The lack of diluting terrigenous material may also have been a contributing factor. The results appear to confirm Arrhenius' hypothesis (*14*).

If we assume that the final withdrawal of the Vashon Ice in the Puget Lowland occurred between 14,000 and 11,600 years ago, then the radiocarbon dates of 12,400 ± 375 years for core 1 (15 to 25 cm) and 15,500 ± 600 years for core 16 (10 to 20 cm), taking into consideration the differences in the sample interval and possible margin of error and location, are in close agreement and can be correlated. These dates suggest that the upper section of variable thickness (7 to 12 cm) low in Foraminifera content, greater amounts of olive-gray silt and clay containing Radiolaria and diatoms (in the northern part of the band), may be due to the gradual return of present-day conditions and can be considered to represent postglacial times. The occurrence of sediments low in *Globigerina* at 115 cm in core 1 (Fig. 3) and from 68 to 104 cm in core 16 (Fig. 4) are correlated because radiocarbon dates of the samples taken above these intervals are nearly the same. These intervals may represent a short time of retreat or fluctuation and wasting of glaciers. It appears from the radiocarbon dates that section 68 to 104 cm in core 16 (Fig. 4) may be related to the "Farmdalian" (*20*).

From the five radiocarbon age determinations for cores 1 and 16 (Figs. 3 and 4) the inferred average rates of sedimentation for the *Globigerina*-rich sediments in this area are (i) less than 2 cm per 1000 years for the upper section in all cores representing postglacial times, and (ii) 10 cm per 1000 years for the section representing Vashon glacial times.

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Strontium Content and Variable Strontium-Chlorinity Relationship of Sargasso Sea Water

Abstract. *Sargasso Sea water has a variable strontium-chlorinity relationship. This observation is contrary to the view that strontium in the ocean is in constant proportion to chlorinity. It is suggested that the increase in strontium concentration at 500 to 800 meters in Sargasso Sea water results from interaction between organic aggregates and the water.*

The purpose of this report is to show that Sargasso Sea water has a variable strontium-chlorinity ratio. Chow and Thompson (*1*) expressed the opposite view: that strontium exists in the ocean in a constant proportion to the chlorinity, which may be expressed by the

Table 1. Strontium content, oxygen concentration, chlorinity, and temperature of Sargasso Sea water at station HS-195, 13 November 1963.

Depth (m)	O_2 (ml/liter)	Temp. (°C)	Cl (per mill)	Sr (mg-atom/liter)	Strontium-chlorinity ratio
25	4.96	22.80	20.175	0.097	0.00481
75	5.06	21.14	20.265	.096	.00474
100	4.79	19.96	20.242	.098	.00484
250	5.00	18.21	20.237	.098	.00484
500	4.63	—	20.106	.104	.00517
600	4.18	15.33	19.930	.118	.00592
800	3.45	11.08	19.586	.106	.00541
1000	4.40	6.69	19.405	.098	.00505
1400	5.93	4.32	19.359	.100	.00517
2595	6.05	3.12	19.339	.102	.00527

ratio 0.0048 if strontium is measured in milligram-atoms per liter and chlorine is measured in per millage.

In order to investigate seasonal and annual variations in physical, chemical, and biological properties of the Sargasso Sea, a standard oceanographic station (Station S), located 23 km southeast of Bermuda at 32°10′N, 64°30′ W, has been occupied by the Bermuda Biological Station research vessel *Panulirus* at intervals of approximately 2 weeks since 1954. The ocean depth is 3400 m. Water samples for strontium analyses were collected there from various depths (Table 1) during November 1963 with Nansen reversing bottles; temperatures were recorded with reversing thermometers mounted on the bottles. Soon after collection, the samples were analyzed for oxygen by the Winkler method and for salinity with an inductive salinometer (*2*). Polyethylene bottles were used to store the samples for strontium determinations—also made soon after collection. Immediately after collection and before analysis for strontium, the samples were filtered through a 0.45-μ Millipore filter to remove plankton and particulate matter. Strontium concentrations were determined by the flame photometric internal standards technique of Chow and Thompson (*1, 3*); the determinations are accurate within 0.002 mg-atom/liter. Resultant data are presented in Table 1 and Fig. 1.

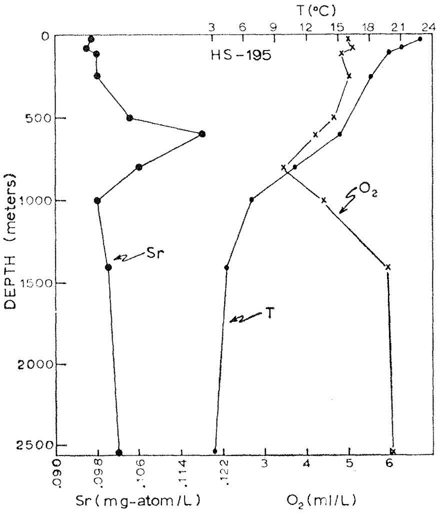

Fig. 1. Vertical distribution of strontium, oxygen, and temperature in Sargasso Sea water on 13 November 1963. Of special interest is the strontium concentration at 500 to 800 m.

The vertical distribution of strontium in waters below this station shows that the strontium-chlorinity ratio is variable (Table 1) and that there is a significant increase in strontium at 500 to 800 m (Fig. 1). Strontium-chlorinity ratios are correspondingly high at these depths (Table 1). The high strontium content is found at the permanent thermocline and lies near the top of the oxygen minimum zone. Chow and Thompson (*1*) reported a low strontium-chlorinity ratio for the oxygen minimum zone at 1000 m in the Pacific. They did not compute strontium-chlorinity ratios, but the data of Sugawara and Kawasaki (*4*) from the Western Pacific, Indian, and Antarctic oceans, recalculated by me, also indicate that the strontium-chlorinity ratios of those waters are variable.

Maxima at intermediate ocean depths have been reported for other trace elements. Recently cesium was found to be concentrated at 500 to 1500 m (*5*). It was suggested that the downward transport of cesium by particulate matter accounted for high concentrations at these depths.

The reasons for these relatively high strontium concentrations in Sargasso Sea water are still unknown, and only further investigation will show whether there are seasonal or other variations which can be correlated with oceanic processes. Solution of calcareous skeletons of organisms may occur at 500 to 800 m, releasing strontium; this could account for the relatively high strontium concentrations at these depths. However, it may be significant that the greatest concentration of organic aggregates is frequently found at 500 to 800 m (*6*); this is thought to arise through physico-chemical processes whereby dissolved organic materials in the water column are converted to particulate form on the surfaces of rising and bursting bubbles (*7*). Chemical bonding occurs during the conversion process, and some of the products may be insoluble organic compounds containing strontium. Reaction of these organic aggregates with the water may account for the higher strontium content and strontium-chlorinity ratio of these waters.

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Crystal Structure of Weddellite

Abstract. *On the basis of x-ray analysis of its crystal structure, weddellite (the tetragonal crystal of calcium oxalate polyhydrate) has been determined to be a zeolitic dihydrate salt. The oxalate ion has at least the symmetry* 2mm *and possibly the symmetry* mmm. *The calcium ion is coordinated with eight oxygen atoms arranged in the form of a distorted cubic antiprism.*

The tetragonal form of crystals of hydrated calcium oxalate in certain plants and animals has been given the common name, weddellite (*1*). The