some experiments stimuli which produced no effect in the control period now evoked a potential equal to the greatest response produced by supramaximal stimuli. In the rabbit, transmission of impulses across the superior cervical sympathetic ganglion was also facilitated by doses of reserpine that depleted ganglionic norepinephrine.

Experiments with cats given adrenergic blocking agents provided additional evidence of a role for norepinephrine in ganglionic transmission. Within 20 minutes after the intravenous injection of 1 mg of ergotamine per kilogram, the potential evoked by supramaximal stimuli was facilitated by 200 percent or more for a period of at least 1 hour. Similar effects were produced with 20 mg of dibenamine per kilogram. Preliminary results have shown that ganglion transmission is also facilitated by bretylium, a hypotensive drug that prevents the physiologic release of norepinephrine from sympathetic nerve endings (6).

Since transmission was enhanced in ganglia devoid of norepinephrine, the question could now be raised whether transmission would be inhibited in ganglia containing an accumulation of the free amine at the sites of release. A high level of free norepinephrine in ganglia was produced by treatment of cats with MO 911 (7), a potent monoamine oxidase inhibitor (8), and then by releasing the amine from storage by means of reserpine (1.25 mg/kg). As a result of blocking monoamine oxidase, the disappearance of the norepinephrine released in ganglia by reserpine was much slower than in animals given reserpine alone. Thus 1 hour after reserpine administration, the level of norepinephrine in the ganglia of cats given both the monoamine oxidase inhibitor and reserpine was 2.7 $\mu g/g$ (mean of four ganglia) compared with traces of amine in ganglia of animals given reserpine alone. Within 15 minutes after administration of the alkaloid, the potential evoked by submaximal stimuli was almost completely blocked; even the potential evoked by supramaximal stimuli was markedly reduced. In 2 to 3 hours, when the free norepinephrine had finally diffused away, facilitation of the evoked potential was again observed.

The data presented here support the concept that norepinephrine as well as acetylcholine is implicated in transmission phenomena in sympathetic synapses. Cholinergic ganglionic transmission may be considered to effect the release of norepinephrine which in some unknown manner counteracts the effect of acetylcholine in the postsynaptic membrane. The reciprocal relationship between acetylcholine and

norepinephrine in sympathetic ganglia might be important in buffering large fluctuations in central sympathetic output. These results bring up the possibility that in the brain there is also a reciprocal relationship between the chemical transmitter and norepinephrine or serotonin, the monoamines serving as modulators of synaptic transmission rather than as transmitting agents.

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Ionium-Thorium Chronology of Deep-Sea Sediments of the Western North Pacific Ocean

Abstract. The rate of deposition of deep-sea deposits collected at the depths of 6215 to 8450 m in the western part of the North Pacific Ocean was estimated by means of the ionium/thorium ratio. The ratio was determined by an alpha-ray spectrometer. Results showed the rate of 0.5 to 0.8 mm/10^3 yr for the upper 10-cm layer below the sea bottom.

Pelagic sediments provide important records of geological processes in the ocean in the past. To estimate the rate of sedimentation, distribution of chemical elements with radioactivity has been extensively studied. The ionium-thorium geochronology (1–3) is one of the processes which is based on the assumption of simultaneous removal and deposition of two isotopes of thorium, ionium (Th^{230}, a member of the U^{238} series; $T_{\frac{1}{2}}$, 80,000 yr) and thorium (Th^{232}; $T_{\frac{1}{2}}$, 1.4 × 10^{10} yr), from sea water. Another assumption of this method is that the Io/Th ratio remains constant in a given water mass over the period under consideration. The contribution of thorium and uranium from detrital minerals of continental

or volcanic origin must be negligible or can be accounted for.

Recently, Goldberg and Koide (2) developed the alpha-ray spectrometric method for determination of ionium and thorium in deep-sea deposits. They have found an exponential decrease in the Io/Th ratio with the depth of burial which indicates that the ionium may not be redistributed after deposition. Rona, Akers, and Parker (3) also applied the same method to the age determination of North Atlantic deposits. In our laboratory, attempts have been made to obtain ages, by means of the Io/Th ratio, of deep-sea sediments of the western North Pacific collected at various depths from aboard the research vessel, M.S. *Ryofu-maru*.

One to two grams of dried sediments were subjected to leaching with a hot solution of a mixture of hydrochloric and perchloric acid. The residue was separated by centrifuge, and leaching was repeated. The solution was nearly dried up on a sand bath and dissolved again in dilute hydrochloric acid from which silica was removed by filtration. The acidity of the filtrate was adjusted to a 3f solution of hydrochloric acid.

Thorium isotopes were isolated from the filtrate with a cation-exchanging resin. The thorium isotopes have a strong tendency to adsorb selectively on the cation exchanger, while there is little adsorption of aluminum, iron, and other cations in the hydrochloric acid media of high concentration. The cation exchanger of HR form, Amberlite IR-120 of 100 to 200 mesh, was used in a column 4 mm in diameter and 5 cm long. A solution was passed through the column at a flow rate of approximately 1 ml/min. The column of the resin in which thorium isotopes were adsorbed was rinsed with the hydrochloric acid solution (4f) and water. Thorium isotopes were subsequently eluted with 0.5M oxalic acid. The thorium contained in the effluent was plated on a platinum disk 4 cm in diameter; this was followed by ignition to remove oxalic acid. Another thorium isotope, Th^{234} (UX$_1$), which was prepared by the method of Cowan (4), was used as a radioactive tracer to determine the chemical yield. The recovery of the thorium isotopes was checked each time with the activity of beta rays of Th^{234}. The results of tracer experiments gave a yield ranging from 70 to 97 percent.

The intensities of the alpha rays of Th^{230} and Th^{232} plated on the platinum disk were measured with an alpha-ray spectrometer, which consists of a Frisch grid-ionization chamber (Tracerlab), combined with a high-gain amplifier and a pulse-height analyzer. Since alpha-particles of Io and Th have dominant

Table 1. Ionium-thorium ratio and rate of deposition of cores from the western North Pacific Ocean.

Depth interval (cm)	Io/Th	Rate of sedimentation (mm/10³ yr)
Sample JEDS-1-R; 30°24.6′N, 124°18.7′E; 8450 m (Ramapo Deep)		
0– 3	3.4 ± 0.2	
3– 7	2.0 ± 0.1	0.5 ± 0.04
12–15	0.2 ± 0.1	.3 ± .04
Sample JEDS-2-C₂; 42°48.0′N, 147°59.0′E; 8005 m		
0– 4	4.0 ± 0.2	
4– 8	2.6 ± 0.1	.8 ± .05
Sample JEDS-3-D₁; 29°50.0′N, 147°28.3′E; 6215 m		
0– 5	6.2 ± 0.5	
5–10	2.8 ± 0.2	.5 ± .04
10–15	0.4 ± 0.1	.3 ± .04

energies of 4.6 to 4.7 and 3.98 Mev, respectively, they can be measured separately with a pulse-height analyzer. Thus the abundance ratio of Th^{230} to Th^{232} was obtained as the ratio of alpha-counts at each energy level.

The results of analyses of Io and Th in three cores of deep-sea sediments collected from the depth of 6215 to 8450 m in the western North Pacific are given in Table 1. Exponential decrease in the Io/Th ratio with the depth of burial is observed in each sample. Thus, it may be said that, during the time period of the last 100,000 yr, the sedimentation environment in this region has not differed largely from that of the present.

From these analytical results the rate of sedimentation of approximately 0.5 to 0.8 mm/10^3 yr was obtained in the upper 10-cm layer below the sea bottom. These values are of the same order of magnitude that Goldberg and Koide (2) gave to the deposits of the Eastern Pacific and that Pettersson (5) gave to the sediments from near Tahiti Island in the South Pacific.

Baranov and Kuzmina (6) gave a much more rapid rate of deposition of 10 to 30 mm/10^3 yr in the western region of the North Pacific. However, there are some doubts about their analytical results and the estimation of the rate of sedimentation.

According to Goldberg and Koide, the Io/Th surface ratios in the Eastern Pacific clays can be classified into two groups. One is found in the region between the Aleutian Islands and Hawaii with the value of the Io/Th ratio of about 15; the other group has the value of about 35, and is found from the region between 120°W and 140°W longitude and between 40°N and 40°S latitude. However, our results regarding the western North Pacific cores show that the Io/Th surface ratio ranges from 3 to 6, which is considerably smaller than that in other areas of the

Eastern Pacific (7). This difference is difficult to explain at present, but it may be noted that Goldberg, Patterson, and Chow (8) suggested the similarity between the distribution patterns of isotopes of lead (Pb^{206}) in manganese nodules and the Io/Th ratio in the deposits in the Pacific. In this respect, they gave the extraordinarily smaller value of the lead isotope for the sea area near the Japanese islands (9, 10).

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Compositional Categories of Ancient Glass

Abstract. From chemical analyses of ancient glasses found in Europe, Western Asia, and Africa from roughly the 15th century B.C. until the 12th century A.D., five main compositional categories have become apparent. With the possible exception of lead glasses which are only occasionally encountered in finds from this period, each of the main categories was prevalent over a wide geographic area for a period of at least several centuries. The categories are described in terms of the expected ranges of concentrations of the five elements, magnesium, potassium, manganese, antimony, and lead, which most clearly differentiate the groups.

A series of approximately 200 fragments and powdered samples of ancient glass has been collected through the agency of the International Committee on Ancient Glass and analyzed chemically at Brookhaven National Laboratory. The specimens were selected to represent a cross section of glass produced in the Middle East, Africa, and Europe after the inception of hollow glass manufacture during the second millennium B.C. Our terminal date in Europe coincides with the introduction of postassium-rich compositions in about the 10th century A.D. We follow Islamic glass to the development of its splendid enameled bottles and lamps about two centuries later. The specimens were generously provided from the collections of 20 museums, universities, and related institutions, 12 active sites of archeological excavations, and several individuals. Most of these specimens were excavated under scientific supervision; others were of known provenance to the degree, at least, that the locations of their discovery were recorded. Occasionally the data on certain groups of specimens were supplemented by analysis of objects of unknown origin but showing a high degree of conformity in style. Otherwise, specimens of unknown origins have been investigated only where equally valid justification was present.

The purpose of this research has been to reveal any systematic compositional differentiations in ancient glass, whether based on regional or chronological classifications. The work represents an initial approach to a systematic technological study of ancient glass (1). We have placed the principal emphasis on the common types of clear glass, to avoid undue bias of color chemistry or the distractions of highly atypical specialties in ancient glass. Only occasionally have deliberately colored specimens been examined.

The glasses were analyzed for 26 elements by a combination of three techniques: arc spectrography, flame photometry, and colorimetry, the spectrographic plates being read quantitatively by means of a photoelectric densitometer. The resulting analyses were found to be reproducible with standard deviations within 20 percent of the reported values.

On the basis of these analyses, five main categories of ancient glass have become apparent, not considering ancient production in the Far East. Each is characterized by a chemical composition distinctly different from that of the others. A preliminary report of these groupings is presented here (2).

The most significant chemical differences between these five groups of ancient glass are presented in Table 1 and Fig. 1. No finality is claimed for these groups. Further research, for example, will surely reveal transitional and marginal groups. Within a group, a plot of the occurrence of specimens against the logarithm of concentration closely approximates a chance (Gaussian) distribution. The significance of