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SEDIMENT SAMPLING IN SIX WESTERN LAKES

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ABSTRACT

Eleven 21 cm diameter sediment cores and 15 water samples were taken from six western lakes. The collected sediment samples will be dated by their ^{137}Cs fallout patterns. The samples will be analyzed for trace elements and carcinogenic organic compounds associated with the combustion of fossil fuels.

Introduction

Atmospheric discharge during the combustion of fossil fuels is a significant source of many toxic and potentially toxic trace metals and organics in the environment(1, 2). In order to properly evaluate the extent of accumulation and movement of these toxic trace substances in the environment and food webs leading to man, there must be a reliable estimate of their background levels. Sediment cores taken from large inland, generally undisturbed lakes with fairly high rates of sedimentation (greater than 1 cm/year), may provide an historical record of events that have occurred within a lake's watershed(3, 4). For example, this procedure may be used to obtain a reasonable estimate of the ambient levels and changes in input of anthropogenic substances over an extended period of time.

Accurate dating of recent sediments may be accomplished by measuring the concentration of selected artificial and natural radionuclides occurring in the sediment(4, 5, 6, 7).

Yearly fallout records for one of these nuclides, ^{137}Cs, produced from global atmospheric nuclear testing, shows a maximum fallout peak in 1963 with another distinct peak in 1959(8). Atmospheric deposited ^{137}Cs may also be adsorbed onto fine soil particles which, through erosion, may be transported into aquatic systems(5). Sediment core profiles taken from fast depositing bodies of water would be expected to reflect these two fallout peaks. In turn these peaks would serve as historical "guideposts" by which recently deposited sediments may be accurately dated. The natural occurring radionuclide ^{210}Pb may also be used in the dating of sediments(6, 9).

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DISCLAIMER

During August 1976, personnel from the Health and Safety Laboratory (HASL) and Woods Hole Oceanographic Institution (WHOI) began field work in which a series of sediment cores were taken from six lakes and reservoirs in the Southwestern United States. These included: Hansen Reservoir, Los Angeles, California; Lake Mead, Overton, Nevada; The Great Salt Lake, Salt Lake City, Utah; Utah Lake, Provo, Utah; Navajo Reservoir, Arboles, Colorado; and Standley Lake, Jefferson County, Colorado.

The sediment cores will be used to evaluate the recent historical deposition record of a series of trace elements and organic compounds which are associated with the combustion of fossil fuels. In particular, two of the lakes, the Overton Arm of Lake Mead in Nevada, and Navajo Reservoir in Northern New Mexico are situated near coal fired electric power plants, Moapa and Four Corners respectively, and are within range of the airborne transport and deposition of trace substances from these plants. In addition, effluents discharged from the Moapa Power Plant are transported into the Overton Arm of Lake Mead by the Muddy River. It is hoped that the sediment cores taken from these two lakes will be useful in establishing the recent depositional history of a few toxic stable trace substances which have been released into the environment since operation began at these coal fired power plants. In addition, analysis of a few radioactive nuclides such as plutonium and americium will be carried out at Woods Hole.

A preliminary listing of those substances that are now under consideration for evaluation are presented in Table 1.

The stable trace elements in groups I and III are known to be toxic or potentially toxic to man. Those in group I are primarily incorporated in man via ingestion while those in group III are taken up primarily by inhalation. Group II elements remain questionable as to whether they pose health or environmental hazards. Group IV elements have been shown to be harmful to various ecosystems.

The organic compounds in group I are proven human carcinogens. Compounds in group II have produced cancer in animals while those in group III have shown some evidence of being carcinogenic to some animals. The organic compounds in group IV are suspected of being carcinogens based upon their structure.

Table 1

TRACE ELEMENTS AND ORGANICS UNDER CONSIDERATION FOR ANALYSIS IN SEDIMENT, BIOTA, AND WATER

1.: Trace Elements -

Group I	Group II	Group III	Group IV
Arsenic	Antimony	Beryllium	Flourine
Cadmium	Gallium	Vanadium	Copper
Chromium	Tellurium	Nickel	Zinc
Lead			Silver
Mercury			Manganese
Selenium			
Thallium			
Tin			

2.: Organics -

Group I	Group II	Group III	Group IV
Dibenzoanthracene	Benzoanthracenes	Chrysene	Biphenyl
Dibenzoflourene	Benzo(a) anthrone	Methylchrysenes	Acenapthalene
3,4 benzo(a) pyrene	Dimethylbenzanthracene	Benzocarbazoles	Acenapthalyne
	Dibenzopyrenes	Indenopyrenes	Flourene
	Benzoacridine	Carbazoles	Alkylanthracenes
		Pyrenes	Alkylphenthracenes
		Cresols	Anthracenes
		Phenols	Perylene
			Benzoperylene
			Coronene

Methodology

(a) Sediments

1. Sampling - Sediment cores were obtained with a 21 cm diameter coring device equipped with a sphincter core retainer(10). The sampling depth, corer weight, core length and description of the sediment are given later.

As previously described by Volchok and Burke(11), where possible the water above the sediment in the core barrel was removed and retained for water quality analysis. After removal of the bottom water by siphoning, a piston was placed in the barrel, on top of the sediment column and the entire device was inverted. The core was then extruded bottom side first.

The sediment from each core was divided into increments of between 1.5 and 2 cm in thickness and placed in acid washed polystyrene jars. During the extrusion of the sediment material found in the nose cone and for at least 1 cm around the edge of the core was discarded.

2. Core Notes - A total of 11 cores were obtained. Table 2 lists the location, water depth, and other pertinent information about each core. Following are specific notes about the consistency of the sediment at each site.

Hansen Lake - Cores 1 and 2

The cores were primarily oxidized mud, with some cloudy mud on the surface. The top water was drained upon retrieval. The cores were soft to a depth of 6 cm, becoming progressively stiffer to the bottom which was quite dry.

Lake Mead - Core 1

The top sediment was soft light grey oxidized mud. Following were alternating layers of brown mud. There were also some areas of mottled brown and black mud. The core bottom sediment was quite dry and stiff.

Great Salt Lake - Cores 1 and 2

These cores consisted of fine light grey silt or sand. Water was siphoned off the top.

Utah Lake - Cores 1 and 2

These cores were uniform in consistency except for the top 6 cm which had a higher water content. The sediment was light grey clay. The top water was siphoned off.

Navajo Lake - Cores 1 and 2

The first core was dark grey brown clay. The second core was clay and had a similar color to Core 1 but was stickier in composition. In addition, there was coarse sand and clay on the core cutter. Some leaves and twigs were present in this core.

Standley Lake - Cores 1 and 2

Both cores were soft and fluffy throughout their entire lengths. Twigs and other biological debris were also present throughout. The cores were composed of black oxidized mud.

Table 2

CORE SUMMARY

Lake	Date	Core No.	Water Depth ft.	Corer Weight lbs.	Core Length cm	Position
Hansen, California	8/11/76	C-1	10	125	60	Center of Lake
" "	"	C-2	10	100	50	" " "
Mead, Nevada	8/15/76	C-1	70	125	56	Mouth of Muddy River on a line between the fork of the virgin and Muddy rivers and Overton Beach mid point
Great Salt, Utah	8/19/76	C-1	30	125	15	Southern End 40°40' N 112° 18.5'W
" " "	"	C-2	30	125	15	Southern End 40° 40.3'N 112° 18'W
Utah Lake, Utah	8/20/76	C-1	9	75	61	1/4 mile west of State Park breakwater
" " "	"	C-2	9	125	49	" " " "
Navajo, Colorado	8/23/76	C-1	60	125	18	Convergence of San Piedro and San Juan Rivers
" "	"	C-2	55	125	12	Mid channel of San Juan River at the mouth where it enters Navajo Lake
Standley, Colorado	8/25/76	C-1	65	125	50	Center of lake
" "	"	C-2	65	125	36	" " "

(b) Water

1. Sampling - Water samples were collected with a battery operated plastic pump or manually via a plastic bucket. All samples were stored in 55 liter heavy duty plastic carbuoys. Two of the samples from Lake Mead and Navajo were preserved with 200 ml each of Baker Ultrex Grade Nitric Acid.

2. Water Notes - A total of 15 water samples were obtained. Pertinent information is summarized in Table 3.

Table 3

SURFACE WATER SAMPLING SUMMARY

State, Lake	Date	55 Liter Drums Filled	Remarks
California Hansen Lake	8/11/76	2	
Nevada Lake Mead	8/15/76	3	Same position as core samples (mouth of the Muddy River)
Utah Salt Lake	8/19/76	2	40°40'N 112° 18.5'W
Utah Utah Lake	8/20/76	3	Water from pump, same position as core samples (1/4 mile west of State Park breakwater), one drum treated with acid
Colorado Navajo Lake	8/23/76	3	Pump and bucket, one drum treated with acid, taken from same position as Core 1 (convergence of San Piedro and San Juan Rivers)
Colorado Standley Lake	8/25/76	2	Bucket, same position as cores (center of lake)

3. Water Quality Analysis - In situ water quality tests were performed on both surface and bottom water samples taken from all of the lakes except Hansen and Standley. Samples of lake bottom water were taken from the water trapped above the sediment in the corer.

Temperature and dissolved oxygen were measured with a Yellow Springs Instrument, YSI 54 RC oxygen meter. Dissolved oxygen was also measured with HACH Model AL-36B Water Quality Test Kit. The pH was measured with Corning 610A portable pH meter and the above HACH Test Kit. Salinity and conductivity were measured with a Yellow Springs Instrument, YSI-33 Salinity-Conductivity-Temperature probe. Free acidity, free CO_2, total alkalinity, total hardness, and total acidity were all measured with the HACH Model AL-36B Water Quality Test Kit.

The results of analysis are summarized in Table 4.

Table 4

WATER QUALITY ANALYSIS SUMMARY

Depth		Dissolved Oxygen (mg/ℓ)	pH	Water Temp. C°	Salinity %	Conductivity (μ MHOS)	Free Acidity mg/ℓ	Free CO_2 mg/ℓ	Total Alkalinity mg/ℓ	Total Hardness mg/ℓ	Total Acidity mg/ℓ
Surface	Lake Mead	7.7	8.5	27	0.4	1010	0	10	154	240	4.56
Bottom	" "	6.4	8.5	23	0.4	1010	0	17.5	154	240	5.71
Surface	Salt Lake	8.1	9.2	23	Could not be measured accurately	Could not be measured	0	-	548	>1700	0
Bottom	" "	-	-	-	-	-	-	-	-	-	-
Surface	Utah Lake	7.8	8.8	21	0.5	1180	0	20	427.9	377	0
Bottom	" "	7.8	8.8	21	0.5	1180	0	20	427.9	377	0
Surface	Navajo Lake	8.8	8.1	19	~0	170	0	5	252.0	94	2.28
Bottom	" "	7.5	7.0	15.3	~0	130	0	10	-	94	4.56

Related Areas of Research

As a supplement to measurements of the levels of trace substances in sediments, lake water trace substances analysis will also be performed.

Once an indication of the ambient level of these toxic trace substances is made in the sediment, an evaluation of the potential for bioaccumulation of these substances in various trophic levels of aquatic food chains leading to man will be initiated. Such information will also be useful in assessing the effects of trace substance deposition due to the combustion of fossil fuels on aquatic ecosystems.

References

1. Bolton, N. E., et al, 1973
Trace Element Measurements at the Coal-Fired Allen Steam Plant
ORNL-NSF-EP-43, pp. 1083, Oak Ridge National Laboratories

2. Gehrs, C. W., 1976
Coal Conversion Description of Technologies and Necessary Biomedical and Environmental Research
ORNL Special Report 5192, pp. 1-288

3. Iskandar, K. I. and D. R. Keeney, 1974
Concentration of Heavy Metals in Sediment Cores from Selected Wisconsin Lakes
Environmental Science & Technology, 8, No. 2, pp. 165-170

4. Syers, J. K., K. K. Iskandar and D. R. Keeney, 1973
Distribution and Background Levels of Mercury in Sediment Cores from Selected Wisconsin Lakes
Water, Air, and Soil Pollut., 2, pp. 105-118

5. Ritchie, J. C., J. R. McHenry and A. C. Gil, 1973
Dating Recent Reservoir Sediments
Limnology and Oceanography, 18, No. 2, pp. 254-263

6. Edington, D. N. and J. A. Robbins, 1976
Records of Lead Deposition in Lake Michigan Sediments Since 1800
Environmental Science & Technology, 10, No. 3, pp. 266-274

7. Watts, W. A., 1971
Postglacial and Interglacial Vegetation History of Southern Georgia and Central Florida
Ecology, 52, pp. 676-690

8. Appendix, pp. A-1 to A-390
USERDA Report HASL-308, October, 1976

9. Chow, T. J., et al
Lead Pollution: Records in Southern California Coastal Sediments
Science, 181, pp. 551-552

10. Burke, J. C., 1968
A Sediment Coring Device of 21 cm Diameter with Sphincter Core Retainer
Limnology and Oceanography, 13, pp. 714-718

11. Volchok, H. L. and J. C. Burke
Sediment Sampling near Mound Laboratory - July 1974
USAEC Report HASL-286, October, 1974, pp. 71-81