LECTURE-13

Study of Lake Sediments and its Significance

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INTRODUCTION

Lake like any body of standing water, serves as the repository for materials carried into it by water, wind, ice, and the activities of living creatures. These materials include:

- Fine particles of minerals, rock fragments, and organics referred as sediments.
- Sunken boats, bottles, cans, tires, fishing lures, etc. also found on the lake bottom are not considered sediments.

Sediments of lake are studied in their varied aspects i.e. mineralogy, texture, structure and clay content. While minerals, especially heavy minerals, are direct indicators of source of material (Chaudhri and Gill, 1983), the texture and structures bear imprints of environments during and after the deposition.

In this study, the sedimentation pattern of lake sediments worked out with help of textural analyses is described as a case study of lake Agassiz, Canada (Gill & Teller, 1989)

SIGNIFICANCE

Any study on lakes involves varied disciplines varying from microbial and biological characterization to hydrology, geochemistry and sedimentology (Fig.1). Lake sediments are a good source of information about the past terrestrial environment because they are sensitive to environmental change. Although lake sediments can provide a chronological record of environmental change, e.g., induced by industrialization, interpretations must consider that digenetic remobilization can overprint the original depositional record.

Lake sediments respond to climate variations in the following ways:

- Rainfall affects water depth, surface area and salinity
- Temperature affects water stratification and circulation
- Water chemistry affects mineral precipitation
- Water depth, temperature and chemistry affect the composition of plankton.
- Lake sediments respond to changes in their hydrological catchments:
- Catchment vegetation can have an effect on water chemistry
- Soil erosion, agriculture and forest clearance cause an in wash of organic particles into the lake.

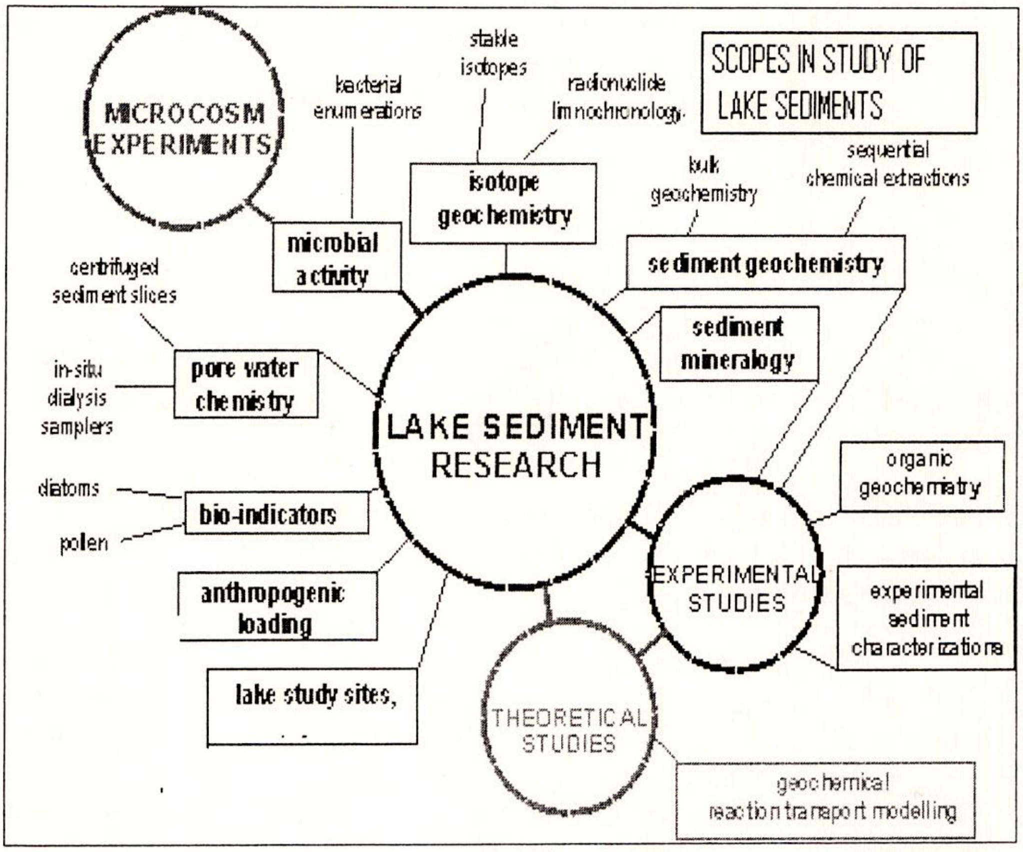

Fig. 1: Scopes in study of lakes

These responses to the environment are recorded in the texture and composition of the sediments laid down at the lake bed. Lake sediments are continuous records, with a high time resolution. They contain organic and inorganic particles, microfossils such as pollen and algae, and macrofossils such as leaves and seeds. All these elements can be used to date lake sediments and to provide information about past climatic conditions.

The record of the material carried into the lake over time is contained in the lake sediments and in addition to the constituents referred to above are plant materials indicative of climate through time. Also, the character and distribution of the sediments says a great deal about the processes which formed them. In short, from study of lake sediments, we can get both a history of the lake and its surroundings, including climate, and knowledge of the processes now shaping that part of the earth's surface.

SEDIMENT SAMPLING

Lake sediments can be sampled in many ways.

- **Dredge or box corer:** It collects blocks of surface and near-surface sediment.
- **Coring device:** It yields small diameter cylindrical sediment samples extending 5 meters or more below the lake floor.

- **Geophysical instruments:** These are used for those sediments which are beyond the reach of the corer (and most are, of course). These instruments work on the same principle as sonar and reveal on a strip-chart recorder, sediment thickness, the arrangement of sediment and indications of the character of sediment as far down as the rock surface below the lake.

PARTICLE SIZE ANALYSIS

The size of the particles (grains) in sediment mass indicates the processes which formed the mass. For example, we know that coarse-grained sediments are deposited by swift-flowing currents (streams, tide) or by the motion of fluids the density of which is greater than that of water (mudflows, glaciers). Fine-grained sediments are the result of deposition by very slow-moving currents or deposition in standing bodies of water. To consider particle size, we need a particle-size scale and the one used in geology is the Wentworth Scale (Wentworth, 1922). Its subdivisions are:

Gravel		>2 mm (can be measured with a ruler)
Pebbles		2-64 mm
Cobbles		64-256 mm
Boulders		>256 mm
Sand		2.0-0.62 mm
	Fine	0.062-0.250 mm
	Medium	0.250-1.0 mm
	Coarse	1.0-2.0 mm
Silt		0.062-0.004 mm
Clay		<0.004 mm

Most lake sediments are layered, the layers (strata) being defined by color variations and change in grain size. Sediment type varies with water depth. Deeper-water sediments are fine-grained while those in shallow water are coarse: silty clay (mud) vs. fine sand and gravel. Shallow-water sediments: may contain shells, bits of wood and plant, and cinders.

The Figs. 2 to 4 show sedimentation in a lake in four fluxes, each corresponding to greater supply of sediments with stronger transporting force behind them after a lean period. The extent to which the sediments of different grain size are spread varies with each episode (Gill and Teller, 1989). The different episodes of deposition overlap the sediments of previous ones thus concealing their nature and extent. This gives rise to prograding deltaic deposition.

SORTING

In addition to particle size, the range of particle sizes (sorting) in a sediment mass is of importance in understanding how that mass came into being. As an example, if you have been to a beach, you know that the sand or gravel found there is made up of particles of only a few sizes. Beach sands are said to be well sorted

(Chaudhri, 1987). In contrast, if you have seen concrete being poured, you know it is made up of particles of several sizes: gravel, sand, and cement. Concrete might be thought of as being poorly sorted. One measure of sorting is a histogram (or bar-chart) where the volume-percent of sand is plotted against particle diameter.

The procedure for measuring particle size and sorting is a simple one. Compute the volume-percent of the sample retained on each sieve, the volume-percent of the gravel, and the volume-percent of the sample which passed the finest sieve.10. Prepare a histogram comparing volume-percent and grain-size.

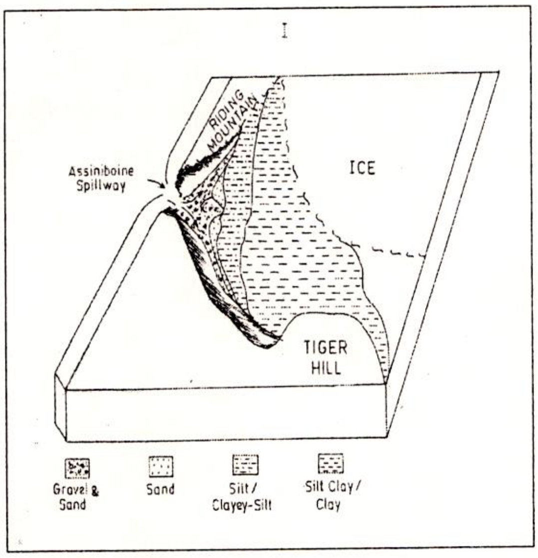

Fig. 2: Sedimentation in first phase

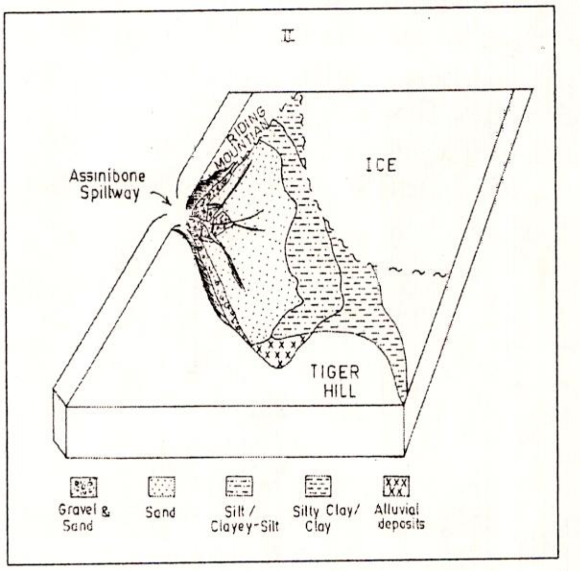

Fig. 3: Sedimentation in second phase

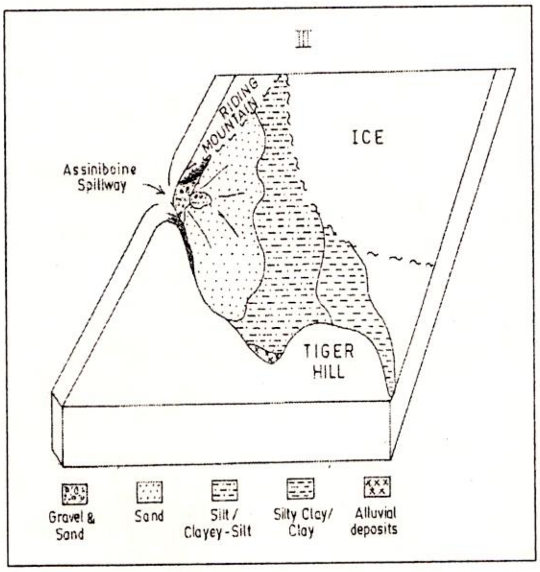

Fig. 4: Sedimentation in third phase

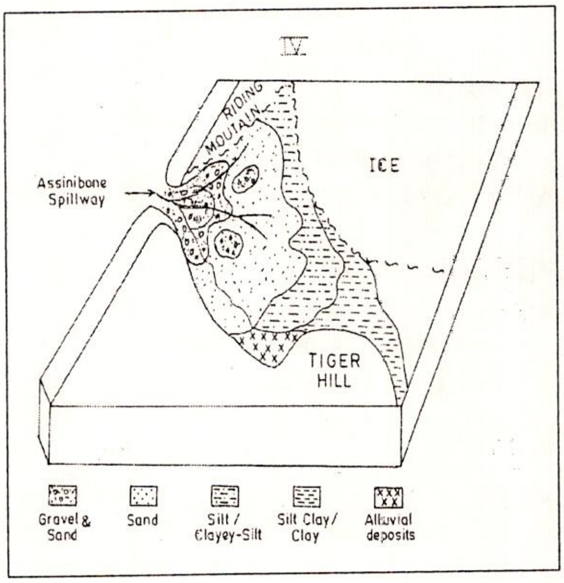

Fig. 5: Sedimentation in fourth phase

A few questions about sorting:

Do the sediments you have sieved exhibit good-, fair- or poor-sorting?
Why is this level of sorting developed here?
How might these sediments have arrived here?

Most of what looks to be clay in this and other lakes is really silt. It is too fine to study with sieves but you can get an idea of what these finer materials are by taking about a teaspoonful of sample, putting it onto the 0.088 sieve and washing the sediment through with water. Using the hand lens, identify what you see on the sieve and estimate the % of the sample made up by each of the particle types you see.

Since the shallow-water sediments are coarser and are made up of a wider variety of constituents, it is probably true that they accumulate differently than do the deeper water sediments. Fig. 6 shows the log probability curves prepared from sediments transported by different mechanisms The textural parameters of lake sediments are used to identify the domains of different modes of transportation hence the palaeoclimatic conditions (Gill,1988).

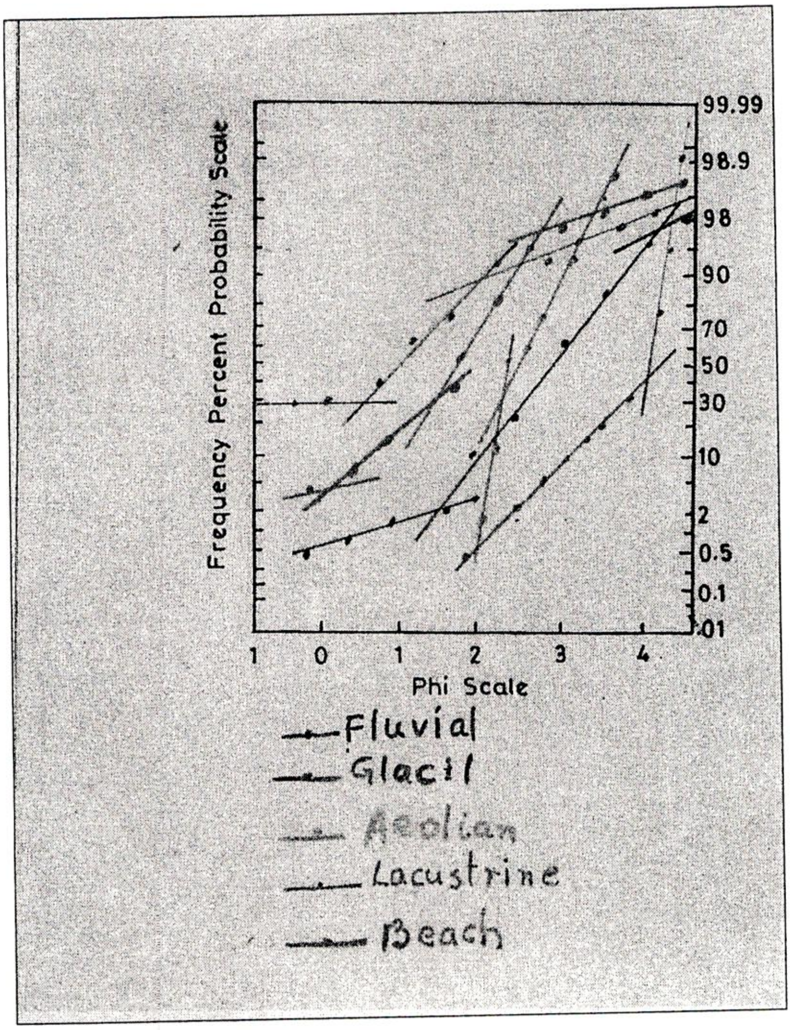

Fig. 6: Modes of Sedimentation in different environments

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