

Determination of Carbonate and Organic Matter in Kigoma Bay and Luiche Platform Cores, Lake Tanganyika, East African Rift Valley

Student: James Apolkarpi

Mentor: Curt Stager

Introduction & Previous Research

The introduction for this paper is summarized at the beginning of this chapter “Paleoclimate & Limnogeology”. The main objectives of the research activities I have undertaken are: 1- to establish the distribution and relationship of carbonate and organic matter with depth downcore, and 2- to establish the environmental implications of the trends of carbonate and organic matter.

Methodology

Fieldwork

In order to determine the best location for coring transects, grab samples were collected at each location at 10 meter depth intervals. An echo sounder was used to determine the bathymetry of the lake bottom. GPS points were recorded once an appropriate sampling site had been determined.

Once a site within the area had been selected, gravity cores were used to extract the sediments from the lake bottom. Gravity cores are able to preserve the sediment-water interface, which is vital for accurate dating in a high-resolution study. Eight successful cores and sixteen grab samples were obtained from the two sites, both long and short gravity corers were used to obtain these cores.

Laboratory analysis – Organic Matter and Carbonate

Cores from the two sites were subsampled at 5 cm intervals. Sample weight (A) for each sample was determined by using an analytical balance. Samples were prepared for analysis by drying in an oven for 24 hours at 60°C. Samples were transferred into a Thermolyne 1400 muffle furnace and burned at 550°C for two hours to remove organic matter. After cooling, samples were reweighed (B), and then burned at 925°C for four hours to remove carbonate. The samples were reweighed (C), and organic matter (OM) and carbonate (CO₃) percentages were determined as follows:

$$\% \text{OM} = [(A-B)/A] * 100 * R^{\text{OC}}$$

$$\% \text{CO}_3 = [(B-C)/B] * 100 * R^{\text{IC}}$$

with correction factors R^{OC} of 0.40 and R^{IC} of 0.12 (Zilifi and Eagle, 2000 Nyanza Report)

Results

Organic matter and Carbonates

The percent organic matter and percent carbonate data obtained from the Kigoma Bay area cores show almost the same trend (Figures 3a, 3b and 3c). Each core has a distinct high in percentage carbonate and a corresponding low percentage organic matter at the top. The trend continues downcore with alternating high and low percentages of organic matter and carbonate values. Core LT03-01 (110m) shows a distinct peak in organic matter and corresponding low in percentage carbonate at a core depth of 70 cm (Figure 3a). The same amount of low percentage carbonate occurs at a depth of 85cm. Pronounced high percentage carbonate and low percentage organic matter occur at depths of 0cm, 5cm and 30 cm for core LT03-01. Core LT03-02 (Figure 3b) shows distinct high percentage carbonate at 0 cm and 5 cm and shows a slight but consistent decrease in percent carbonate and an increase in percent organic matter below 70cm downcore. Core LT03-03 (Figure 3c) has a distinct high in percent carbonate and a corresponding low percentage of organic matter at a depth of 5 cm, and also shows a slight but consistent increase in percent organic matter at a depth of 20 cm downcore.

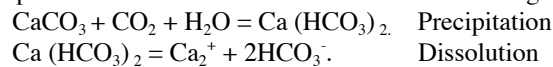
The cores from the Luiche platform also show increased percentages of carbonate values at the tops of cores LT03-06 and LT03-07, shown in Figures 4a and 4b, respectively. Core LT03-06 shows an increasing trend towards the top of the core. Core LT03-07 has a maximum peak of percentage carbonate at 55 cm. Core LT03-06 shows a slight but consistent increase in percent organic matter and core LT03-07 shows a slight but consistent increase in percent organic matter below 60 cm downcore. Generally, the cores show similarly opposing trends of carbonate and organic matter; i.e. when percent carbonate increases, percent organic matter decreases.

Discussion and Conclusions

Changes of the physical, chemical, or biological conditions in the lake may cause precipitation of calcite and other carbonate minerals. Solubility of carbonate decreases with increasing temperature. Salinity increases may also cause loss of CO₂ through lowered solubility and carbonate precipitation, and evaporation in a closed lake basin can increase chemical concentration to the point of precipitation. High algal productivity can also remove carbonic acid from a lake, raising pH and causing carbonate precipitation.

Decomposition of organic matter is a common means of adding CO₂ and causing carbonate dissolution in the lake. Organic matter may be derived from a variety of terrestrial and lake sources, and it has the potential for archiving information about lacustrine and terrestrial ecosystem change.

The precipitation and dissolution of carbonate occur through the following equations:



All of the five analyzed cores in this study have relatively high percentage carbonate values at the top. We can speculate that this trend may be consistent with global warming during the 20th century. High percentage carbonate values may therefore indicate high temperature, low wind, and low mixing because the lake is known to be more stable in recent decades. High percentage organic matter values may indicate high primary productivity, stronger winds and more terrestrial input. The high and low percentage carbonate and organic matter values in the cores may primarily reflect changes in climate and/or algal productivity, but it is difficult to show exactly when they occurred because the ages of the cores are not yet determined.

Future Research

A more extensive study of carbonate and organic matter in the cores should be conducted that includes types of carbonate. Dating the plant material found within the cores would be useful for correlating a specific date with the increases and decreases in percent carbonate observed in the cores. Also, C/N ratios should be determined in cores, because nitrogen is sedimented in lakes from both terrestrial and lake derived organic matter and can tell much about past climates. Organic matter from phytoplankton is much richer in nitrogen and has much lower C/N ratios than terrestrial organic matter. The C/N ratio is a useful tool for distinguishing long-term transitions between terrestrial to algal input dominance in lake sediment organic matter. Such transitions might occur as a result of lake level fluctuations.

Acknowledgements

I would like to thank Dr. Curt Stager, Dr. Kiram Lezzar, Dr. Catherine O'Reilly, Christine Gans, Kamina Chororoka and my fellow colleagues for their ideas, support and encouragement. I would like also to thank the captain and crew of the *M/V Maman Benita*, the Nyanza Project and the Tanzania Fisheries Research Institute (TAFIRI).

References

Alin, S.P. and Cohen, A.S. (2003). Lake-level history of Lake Tanganyika, East Africa, for the past 2500 years based on ostracode-inferred water-depth reconstruction. *Palaeogeog., Palaeoclim., Palaeoecol.*, 199 (1-2), 31-49.

Cohen, A. S. (1997). New paleogeographic and lake level reconstructions of lake Tanganyika; implications for tectonic, climatic and biological evolution in a rift lake, *Basin Research*. 9, 107-132.

Cohen, A.S. (2003). *Paleolimnology: The history and evolution of lake systems*. London: Oxford Press, 252-253, 262-264.

Coulter, G. W. (1991). *Lake Tanganyika and Its Life*. London: Oxford Press. pp. 54.

Gasse, F., Ledee, V., Massault, M. and Fontes, J.-C. (1989). Water-level fluctuations of Lake Tanganyika in phase with oceanic changes during the last glaciation and deglaciation. *Nature*, 342, 57-59.

Haberuan, K.A. and Hecky, R.E. (1987). The late Pleistocene and Holocene stratigraphy and paleolimnology of lakes Kivu and Tanganyika. *Palaeogeog., Palaeoclim., Palaeoecol.*, 61 (3-4) 169-197.

Johnson, T.C. (1996). Sedimentary processes and signals of past climatic change in the large lakes of the East African Rift valley in *The limnology, climatology and paleoclimatology of the East African lakes*,

Johnson, T.C. and Odada, E.O., Eds., Australia: Gordon and Breach Publ. 367-412.

Lewis, C. (2002) Nyanza Project 2002 Annual Report

Nicholson, S.E. (1999). Historical and model fluctuations of lakes Tanganyika and Rukwa and their relationship to rainfall vegetation, *Climatic Change*, 41 (1), 53-71.

Stager, J.C., Cumming, B.F. and Meeker, L.D. (2003). A 10,000-year high-resolution diatom record from Pilkington Bay, Lake Victoria, East Africa, *Quat. Res.*, 59 (2), 172-181.

Zilifi, D. and Eagle, M. (2000). Nyanza Project 2000 Annual Report

NOTE: For Figures 1 & 2 please refer to the Section Introductory report.

Figure 3a:

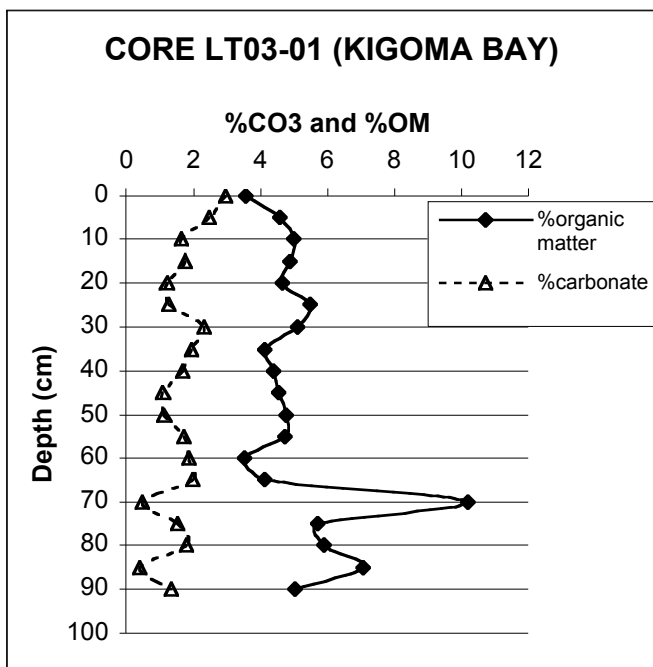
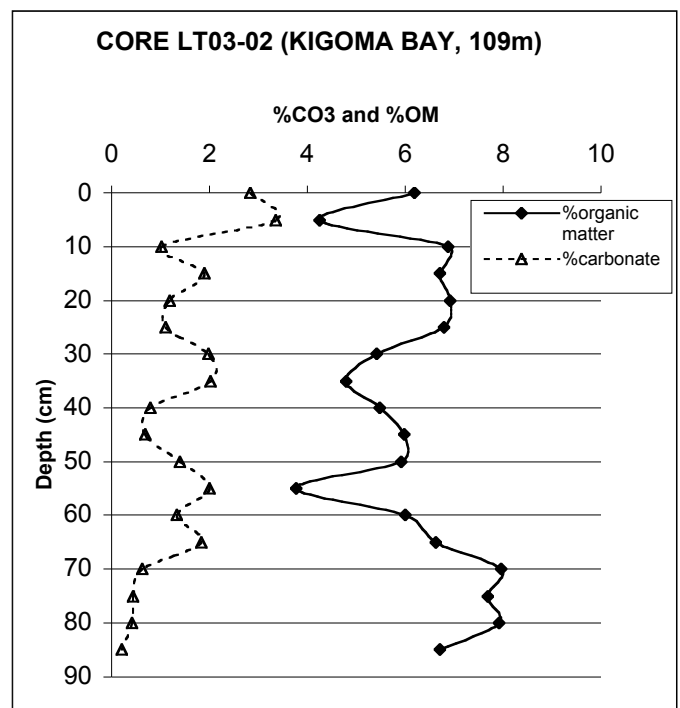


Figure 3b:



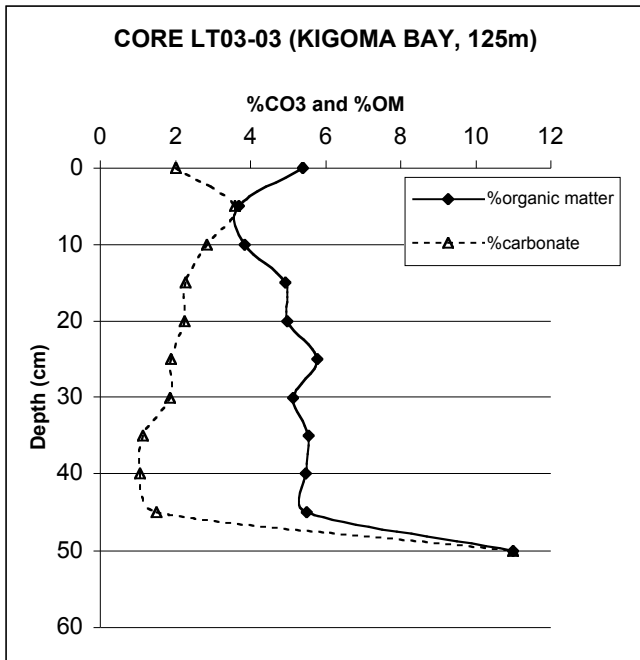


Figure3c:

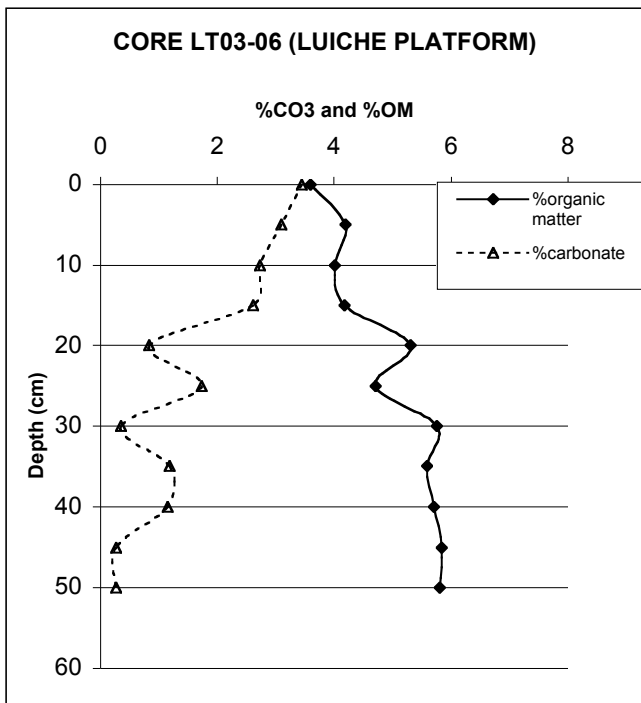


Figure4a:

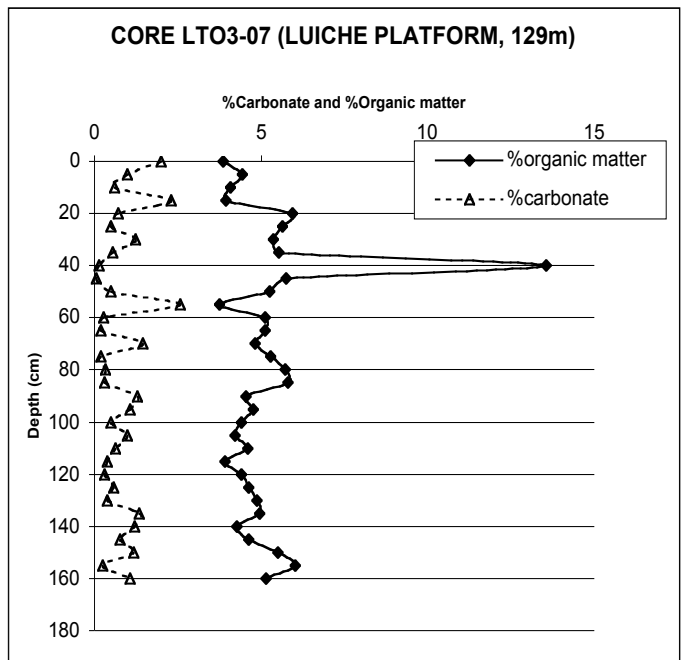


Figure4b: