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A Cruise Report of the Joint National Geographic Society-U.S. Geological Survey Lake Tanganyika River-Lake Interactions Expedition, July 8 – 27, 1999 in Tanzania

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by

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ABSTRACT-

This report describes details of a joint National Geographic Society-U.S. Geological Survey sponsored research expedition to Lake Tanganyika, Tanzania. The scientific focus of the research was to examine specific biogeochemical links between increased population pressure and biodiversity changes in the lake. Porewater, sediment and water column analyses are being interpreted to examine the effect of anthropogenic signatures, and these results are being prepared for publication in peer-reviewed scientific manuscripts.

1.1 Overall Operations

In July of 1999, a research cruise directed by the US Geological Survey under contract to the National Geographic Society investigated the effects of heightened population pressure on the water quality of select rivers entering Lake Tanganyika, Tanzania (Swarzenski, 1999). The scientific research goal of the cruise was to compare/contrast the delivery of contaminants to Lake Tanganyika from select impacted and non-impacted rivers. Environmental 'impact' was defined for this project as any adverse effect on the natural health of Lake Tanganyika and included both inorganic and organic pollutants as well as physical alterations of the terrain due to agricultural practices. Such impact has an obvious and real effect on the local populations that must rely directly on the lake and the surrounding lakeshore for sustenance.

To achieve the objectives defined in the original proposal, sediment cores were collected from contrasting river deltas and river channels. Pore waters were routinely extracted from the sediments to examine diagenetic signatures indicative of impact. Whole sediment cores were

sectioned to examine historic contaminant inventories. Water column samples at an offshore site were collected to examine contaminant transport processes and scavenging rates.

1.2 Cruise Participants

Dr. Peter Swarzenski, US Geological Survey, St Petersburg, FL; inorganic geochemist

Dr. Bill Orem US Geological Survey, Reston, VA; organic geochemist

Dr. James Krest Uni. of S. Carolina, Columbia, SC; radiochemist

Ms. Greta Klungness Uni. of S. Florida, St. Petersburg, FL; spectrophoto. chemist

Dr. Hudson Nkatago Uni. of Dar es Salaam, Tanzania; isotope geochemist

This project was designed from its inception to be tightly interwoven with Dr. Andrew Cohen's multi-year, NSF-funded Research Experience for Undergraduates (REU) project. Through this collaboration, our own project's resources – both in terms of added personnel and logistics – were greatly extended beyond the project's scope. Andrew Cohen and his entire REU staff (including Catherine O'Reilly, Uni. of Arizona) were all invaluable in assuring the success of this expedition.

1.3 Site Locations

Kigoma, Tanzania is one of the most active and politically stable ports on Lake Tanganyika, and is linked to Dar es Salaam and the Indian Ocean by a vital railway system (see

attached Figure). As such, Kigoma has historically been an important trade city for the lake and has consequently experienced sustained population growth through recent time. Associated with this heightened population density and sustained growth are complex resource and contamination issues that directly effect the well being of villagers who frequently rely on river-lake transition zones for farming and as a source of potable water. While the use of pesticides in agriculture around Kigoma is still largely limited, farming practices per se have caused tremendous accelerated, localized erosion along the lakeshore, and there are serious deleterious industrial/human pollution effects, e.g., cholera, schistosimiasis.

To address these issues, we selected study sites that offer a stark comparison between impacted and non-impacted river systems. The Luichi River and delta are most proximal to Kigoma and reflect a highly impacted, larger watershed. Farming is widespread throughout the catchment of this river system, and as the river flows directly through sections of the city, municipal runoff and associated pollution are likely significant. The Luichi River delta is also extensively farmed and during periods of low discharge, river water is diverted to agricultural fields by a complex network of distributary channels that may also deliver sediment-bound contaminants.

To assess historic (last ~ 100 yrs.) trends in industrial contamination from Kigoma, a gravity core was collected on the distal end of Kigoma harbor and compared to a core collected from a pristine site. In order to sample similar-sized, non-impacted watersheds, we selected comparable catchments in the Mahale Mountains region (SE L. Tanganyika). Here population density effects are still minimal. We chose to sample two adjoining river systems on the northern edge of the Mahale mountains, the Lubuwesi and the Bulimba rivers.

The Malagarasi River is by far the largest river system that drains into Lake Tanganyika, excluding the Ruzizi River of Burundi/Congo. As the Malagarasi River mouth lies directly en

route from the Mahale mountains back to Kigoma, it offered an excellent opportunity to sample such a large drainage basin that is still largely non-impacted.

Finally, the water column of Lake Tanganyika adjacent to Kigoma Bay was also sampled for organic/inorganic constituents. These samples were collected to examine aqueous geochemical transformations of river-borne contaminants and nutrients.

Table 1.1 Total sample inventory

	Piston Corers	Gravity Cores	Water samples
Luichi River/delta	4	--	2
Kigoma Bay	--	1	2
Lubuwesi River/delta	2	2	2
Bulimba River/delta	2	2	2
Malagarasi River/delta	1	2	2
mixing zone			5
Lake Tanganyika			8

1.6 Sampling Operations

LUICHI

The Luichi River delta was the first river system sampled due to its proximity to Tafiri (Tanzanian Fisheries Research Institute), our host laboratory while in Kigoma. We hired a small boat to survey the Luichi River mouth/delta from Lake Tanganyika. Coring at this distal end (lakeside) of the delta proved to be too precarious as papyrus reeds made boat travel to shallow

waters impossible. Water depths in the lowest reaches of the Luichi River were never less than 2 m and there was a mat of impenetrable papyrus (floating?) on the water surface. Instead, we traveled by car and an inflatable boat to the Luichi River just outside of town and explored the lower delta plain and upriver reaches for suitable piston coring locations. Two piston cores were collected in the lower Luichi River close to the railroad bridge on 07-14-99. The piston corer used in Lake Tanganyika was specially modified to collect pore waters via whole-core squeezing. Typically, two people would retrieve a 50-cm to 90-cm core. We tried to choose sites on a riverbank where fine-grained sediments tend to accumulate, and in water depths that were shallow enough for us to stand and keep watch for crocodiles. Two piston cores were also collected on the upper Luichi River on 07-15-99. These later two cores were collected at a steep river bank site dominated by fine grained sediment.

R/V MAMAN BONITA

We also hired the 30-m Congolese freighter, R/V Maman Bonita, as a research platform to transport us down to the non-impacted river systems of the Mahale Mountains, and to collect deeper gravity cores in Lake Tanganyika adjacent to the river mouths of interest. Having full use of the R/V Maman Bonita greatly simplified field logistics, as we were also able to utilize the ship as a laboratory while underway. The first river system we sampled was the Bulimba (Ragegi) just NW of the Mahale National Park. We used an inflatable boat to access the river mouth and two piston cores were collected on 07-20-99. Simultaneously, the R/V Maman Bonita steamed off shore from the river mouth to collect a series of four gravity cores (typically 2-3 m long) along a transect perpendicular to the shoreline.

The second river system of interest in this region was the Lubiwesi, which is a few miles NNE of the Bulimba. Again, a subset of our team used the inflatable to collect two long cores from within the river delta plain, while another team went offshore with the R/V Maman Bonita to collect a series of gravity cores (07-20-99). Pore waters were squeezed enroute back to Kigoma harbor, and a gravity core was collected in Kigoma Bay on the near-shore side of a 60–m sill (07-21-99).

Water Column

On 07-21-99 we also steamed out to a deepwater site (1050 m) off Kigoma Bay for water column profiling work. Eight water samples were collected at 1056, 506, 106, 81, 76, 56, and 31 m, as well as at the surface. A Seabird CTD was used to determine hydrographic parameters at this site. Attached to the CTD was a Hydrobios water sampler (courtesy of LTBP-Lake Tanganyika Biodiversity Project), which proved to be ideal in collecting uncontaminated deep samples. The CTD's various probes (e.g., pH, dissolved oxygen) were used for the first time for our water column effort.

Malagarasi River

The Malagarasi River system is by far the greatest river system on the Tanzanian side of Lake Tanganyika and the river enters the lake through a series of channels similar to the Mississippi River. On 07-22-99 we steamed with the R/V Maman Bonita to the northern extent of the Malagarasi River delta. We were not able to get very close (about 10 km) to the river mouth in the large ship as the river discharges a tremendous amount of sediment, which makes

the shelf very shallow and broad. By inflatable boat we explored the bifurcated river mouth and headed upriver for about 8 km. The piston core from the Malagarasi river mouth was taken in the main channel, about 0.5 km from Lake Tanganyika. On the way back to the R/V Maman Bonita, we collected a series of five 20-L samples on a transect from the Malagarasi River mouth out to the ship for radium desorption experiments.

1.5 Overall Cruise Evaluation

Every aspect of this research expedition, from travel arrangements to collecting difficult samples, was accomplished exceptionally well. In all our transportation and lodging needs to and from Lake Tanganyika, we were superbly assisted by Multi-Travel in Dar es Salaam, as well as by Nick Mathieu (field officer for Dr. Cohen's REU) in Kigoma. Field logistics were greatly simplified by Andy Cohen's team of REU support. In particular, Catherine O'Reilly was a tremendous help in the field operations. Finally, we are also greatly indebted to Dr. Cohen for his overall generosity and willingness to share his experience and love for Lake Tanganyika.

One possible gauge of how successful an expedition can be might be the quality and total number of samples taken. If this is our 'measuring stick', we were highly successful in that we brought back many more samples than we had initially set out to collect, and all samples made it back to our laboratories in good order.

As in almost every scientific endeavor, after our 1999 field effort to Lake Tanganyika there are now many more questions and hypotheses that would be rewarding to pursue. As we progress in data analyses and interpretation, we will reevaluate the potential possibility of revisiting this unique and challenging environment.

Table 1.2 Piston core sampling locations,

	Latitude	Longitude	Time	Date	Length
Lower Luichi River I,II	04 53.984 S	29 42.922 E	13:12	07-14-99	50cm
Upper Luichi River I,II	04 54.025 S	29 42.654 E	11:45	07-15-99	46.5cm
Lubuwesi River/delta I,II	05 53.622 S	29 57.154 E	15:25	07-20-99	76 cm
Bulimba River/delta I,II	05 55.155 S	29 55.435 E	09:25	07-20-99	72 cm
Malagarasi River I	05 14.598 S	29 48.745 E	17:30	07-22-99	80 cm

Table 1.3 Gravity core sampling locations

	Latitude	Longitude	Time	Date
Kigoma Bay	04 52.657 S	29 36.123 E	08:30	07-21-99
Bulimba delta I	05 53.353 S	29 51.331 E	10:00	07-20-99
Bulimba delta 2	05 55.155 S	29 54.435 E	11:00	07-20-99
Bulimba delta 3	05 54.059 S	29 52.832 E	11:30	07-20-99
Bulimba delta 4	05 52.991 S	29 51.955 E	12:00	07-20-99
Lubuwesi delta 1	05 53.353 S	29 51.331 E	10:00	07-20-99
Lubuwesi delta 2	05 55.155 S	29 54.435 E	11:00	07-20-99
Lubuwesi delta 3	05 54.059 S	29 52.832 E	11:30	07-20-99
Lubuwesi delta 4	05 52.991 S	29 51.955 E	12:00	07-20-99
Malagarasi delta 1	05 14.598 S	29 48.745 E	17:30	07-22-99
Malagarasi delta 2	05 14.598 S	29 48.745 E	17:30	07-22-99
Malagarasi delta 3	05 14.598 S	29 48.745 E	17:30	07-22-99
Malagarasi delta 4	05 14.598 S	29 48.745 E	17:30	07-22-99

Table 1.4 Radium desorption experiment sampling locations

	Latitude	Longitude	Time	Date	Volume
Malagarasi delta 1	05 11.986 S	29 48.745 E	15:00	07-22-99	20-L
Malagarasi delta 2	05 13.695 S	29 49.495 E	17:00	07-22-99	20-L
Malagarasi delta 3	05 14.580 S	29 48.757 E	17:15	07-22-99	20-L
Malagarasi delta 4	05 15.095 S	29 48.230 E	18:00	07-22-99	20-L
Malagarasi delta 5	05 15.105 S	29 47.105 E	18:15	07-22-99	20-L

Table 1.5 Lake Tanganyika water column sampling locations (lat/long variations are due simply to the ship's drift).

Number	Latitude	Longitude	Time	Date	Depth (m)
SURF	04 53.351 S	29 28.755 E	14:30	07-21-99	Surface
1	04 53.606 S	29 28.160 E	11:30	07-21-99	1056
2	04 54.039 S	29 29.161 E	13:08	07-21-99	506
3	04 53.351 S	29 28.755 E	14:15	07-21-99	106
4	04 53.092 S	29 28.822 E	14:36	07-21-99	81
5	04 52.852 S	29 28.909 E	14:55	07-21-99	76
6	04 52.680 S	29 29.103 E	15:10	07-21-99	56
7	04 52.532 S	29 29.081 E	15:22	07-21-99	31

1.6 Conclusion

The water and sediment samples obtained from Lake Tanganyika and adjoining rivers are now in various stages of laboratory preparation, analyses and interpretation. We are interested in various geochemical constituents, including: dry bulk density, total and organic C, total N, total P, and total S, sediment accumulation rates, metal and nutrient analysis of the sediments and porewater, and organic contaminants. Results from this field expedition will be written up as peer-reviewed scientific manuscripts.

1.7 Bibliography

Swarzenski, P.W. (1999) USGS Heads to Lake Tanganyika to Study Delivery of River-Borne Contaminants, SoundWaves, November, 1999.