

**LAKE TITICACA, BOLIVIA/PERU  
HIGH RESOLUTION SINGLE CHANNEL SEISMIC SURVEY  
CRUISE ON LAKE TITICACA ON THE R/V NEECHO  
31 MAY - 29 JUNE 1998**

Cruise participant: David A. Mucciarone from Stanford University, Matthew Grove and Co-PI Paul Baker from Duke University, and Karin D'Agostino and Co-PI Geoffrey Seltzer from Syracuse University.

The following is a technical summary for the Lake Titicaca cruise aboard the R/V *Neecho* with the first leg beginning on 6/5/98 ending on 6/12/98 and the second leg beginning 6/16/98 to 6/17/98 which was terminated because of accident with seismic source and the third leg beginning 6/21/98 ending on 6/25/98. The Lake Titicaca single channel high resolution survey was a joint project between the Syracuse, Duke, and Stanford Universities. The cruise involved single channel seismic using a Hunttec boomer source.

Seismic acquisition was digital using the Elics Delph2x acquisition system, Hunttec boomer catamaran, and Benthos streamer. Seismic data was collected in Elics compressed format and translated into SEG-Y format using Elics Delph2x software. All data was stored on 2.3 GB Exabyte tapes. Navigation was GPS acquired manually every 10 minutes. Energy source was the Hunttec boomer at 240J to 375J.

Seismic acquisition:

<u>Parameters</u>	<u>Settings</u>
Shooting Interval =	1000 - 1500 ms
Sampling Frequency =	6000 Hz
Recording Length =	768 - 1024 ms
Source distance from ship =	23 m
Source depth =	1 m
Streamer layback =	24 m
Source energy =	240 - 375 J
High pass cut =	600 Hz
Low pass cut =	1080 Hz

**Leg 1: Seismic File Statistics for single channel lines using Hunttec boomer source:**

<u>Line name</u>	<u>Rec. Len.</u>	<u>Time.</u>	<u>Rep. Rate</u>	<u>Samp Freq.</u>	<u>Energy</u>	<u>SP</u>	<u>Size</u>	<u>Seg.</u>	<u>Date</u>
NE981SL	768	2:00	1000	6000	375	8700	20.10	S/EOL	6/5/98
NE982SL	768	0:22	1000	6000	375	1575	2.73	S/EOL	6/6/98
NE983SL	768	0:31	1500	6000	375	1475	3.49	S/EOL	6/6/98
NE984SL	768	1:53	1500	6000	240	5425	12.82	S/EOL	6/6/98
NE986SL	768	1:46	1500	6000	240	5150	12.17	S/EOL	6/6/98
NE987SL	768	1:02	1500	6000	240	3000	7.09	SOL	6/7/98
NE988SL	768	1:03	1500	6000	240	3000	7.09	-	6/7/98
NE989SL	768	1:12	1500	6000	375	3950	9.34	EOL	6/7/98
NE9810SL	768	0:55	1500	6000	375	2600	6.15	S/EOL	6/7/98
NE9811SL	768	1:03	1500	6000	375	3025	7.15	SOL	6/7/98
NE9812SL	768	1:02	1500	6000	375	3000	7.09	-	6/7/98
NE9813SL	768	0:43	1500	6000	375	2075	4.91	EOL	6/7/98
NE9814SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/8/98
NE9815SL	768	1:34	1500	6000	375	4500	10.64	-	6/8/98
NE9816SL	768	1:05	1500	6000	375	3125	7.39	-	6/8/98
NE9817SL	768	0:18	1500	6000	375	850	2.01	EOL	6/8/98
NE9818SL	768	1:04	1500	6000	375	3025	7.15	SOL	6/8/98
NE9819SL	768	1:04	1500	6000	375	3025	7.15	-	6/8/98
NE9820SL	768	1:09	1500	6000	375	3300	7.80	EOL	6/8/98
NE9821SL	768	0:49	1500	6000	375	2350	5.51	S/EOL	6/9/98
NE9822SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/9/98
NE9823SL	768	1:02	1500	6000	375	3000	7.09	-	6/9/98

**Leg 1: Seismic File Statistics for single channel lines using Hunttec boomer source:**  
(continued)

Line name	Rec. Len.	Time.	Rep. Rate	Samp Freq.	Energy	SP	Size	Seg.	Date
NE9824SL	1024	1:02	1500	6000	375	3000	9.30	-	6/9/98
NE9825SL	1024	1:02	1500	6000	375	3000	9.30	-	6/9/98
NE9826SL	1024	1:03	1500	6000	375	3000	9.30	-	6/9/98
NE9827SL	1024	0:46	1500	6000	375	2225	6.90	EOL	6/9/98
NE9828SL	1024	1:02	1500	6000	375	3000	9.30	SOL	6/10/98
NE9829SL	1024	1:02	1500	6000	375	3000	9.30	-	6/10/98
NE9830SL	1024	1:02	1500	6000	375	3000	9.30	-	6/10/98
NE9831SL	1024	1:03	1500	6000	375	3000	9.30	-	6/10/98
NE9832SL	1024	1:02	1500	6000	375	3000	9.30	-	6/10/98
NE9833SL	768	1:06	1500	6000	375	3175	7.50	-	6/10/98
NE9834SL	768	1:20	1500	6000	375	3875	9.10	-	6/10/98
NE9835SL	768	1:04	1500	6000	375	3100	7.30	EOL	6/11/98
NE9836SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/11/98
NE9837SL	768	1:01	1500	6000	375	2900	6.80	EOL	6/11/98
NE9838SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/11/98
NE9839SL	768	1:02	1500	6000	375	3000	7.09	-	6/11/98
NE9840SL	768	1:08	1500	6000	375	3300	7.80	-	6/11/98
NE9841SL	768	1:02	1500	6000	375	3000	7.09	-	6/11/98
NE9842SL	768	0:19	1500	6000	375	900	2.10	EOL	6/11/98
NE9843SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/12/98
NE9844SL	768	1:20	1500	6000	375	3825	9.00	EOL	6/12/98
NE9845SL	768	1:27	1500	6000	375	4175	9.80	S/EOL	6/12/98

**Leg 1: Seismic Statistics:**

Shots: 138,625  
 Time: 46 hrs. 39 min.  
 Leg 1 duration: 8 days

Elics formatted data collected: 344.6 MB  
 SEGY formatted data translated: 2.01 GB  
 Lines collected: NE981SL - NE9845SL (17 lines in 45 segments)

**Leg 2: Seismic File Statistics for single channel lines using Hunttec boomer source:**

Line name	Rec. Len.	Time.	Rep. Rate	Samp Freq.	Energy	SP	Size	Seg.	Date
NE9846SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/16/98
NE9847SL	768	1:03	1500	6000	375	3050	7.21	-	6/16/98
NE9848SL	768	1:02	1500	6000	375	3000	7.09	-	6/16/98
NE9849SL	768	1:25	1500	6000	375	4100	9.69	EOL	6/16/98
NE9850SL	768	1:36	1500	6000	375	4600	10.89	S/EOL	6/16/98

**Leg 2: Seismic Statistics:**

Shots: 17,700  
 Time: 6 hrs. 8 min.  
 Leg 2 duration: 2 days

Elics formatted data collected: 41.97 MB  
 SEGY formatted data translated: 245 MB  
 Lines collected: NE9846SL - NE9850SL (2 lines in 5 segments)

**Leg 3: Seismic File Statistics for single channel lines using Hunttec boomer source:**

Line name	Rec. Len.	Time.	Rep. Rate	Samp Freq.	Energy	SP	Size	Seg.	Date
NE9851SL	768	1:52	1500	6000	375	5375	12.71	S/EOL	6/21/98
NE9852SL	768	0:33	1500	6000	375	1600	3.78	S/EOL	6/21/98
NE9853SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/22/98
NE9854SL	768	1:02	1500	6000	375	3000	7.09	-	6/22/98

**Leg 3: Seismic File Statistics for single channel lines using Hunttec boomer source:**

(continued)

Line name	Rec. Len.	Time.	Rep. Rate	Samp Freq.	Energy	SP	Size	Seg.	Date
NE9855SL	768	1:32	1500	6000	375	4425	10.46	EOL	6/22/98
NE9856SL	768	1:32	1500	6000	375	4400	10.40	SOL	6/22/98
NE9857SL	768	1:02	1500	6000	375	3000	7.09	-	6/22/98
NE9858SL	768	1:02	1500	6000	375	3000	7.09	-	6/22/98
NE9859SL	768	0:52	1500	6000	375	2525	5.97	EOL	6/22/98
NE9860SL	768	1:12	1500	6000	375	3500	8.28	S/EOL	6/22/98
NE9861SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/23/98
NE9862SL	768	1:02	1500	6000	375	3000	7.09	-	6/23/98
NE9863SL	768	1:24	1500	6000	375	4025	9.50	EOL	6/23/98
NE9864SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/23/98
NE9865SL	768	1:02	1500	6000	375	3000	7.09	-	6/23/98
NE9866SL	768	1:07	1500	6000	375	3000	7.50	EOL	6/23/98
NE9867SL	768	0:59	1500	6000	375	2825	6.60	S/EOL	6/23/98
NE9868SL	768	1:16	1500	6000	375	3650	8.60	S/EOL	6/23/98
NE9869SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/24/98
NE9870SL	768	1:02	1500	6000	375	3000	7.09	-	6/24/98
NE9871SL	768	1:02	1500	6000	375	3000	7.09	-	6/24/98
NE9872SL	768	0:57	1500	6000	375	2700	6.38	EOL	6/24/98
NE9873SL	768	1:02	1500	6000	375	3000	7.09	SOL	6/24/98
NE9874SL	768	1:02	1500	6000	375	3000	7.09	-	6/24/98
NE9875SL	768	1:37	1500	6000	375	4700	11.12	EOL	6/24/98
NE9876SL	768	0:49	1500	6000	375	2375	5.61	S/EOL	6/24/98
NE9877SL	768	0:17	1500	6000	375	500	1.14	S/EOL	6/25/98

**Leg 3: Seismic Statistics:**

Shots: 84,800

Time: 29 hrs. 21 min.

Leg 3 duration: 5 days

Elics formatted data collected: 200.19 MB

SEGY formatted data translated: 1.17 GB

Lines collected: NE9851SL - NE9877SL (13 lines in 27 segments)

**Total Seismic Statistics (Leg 1 - 3):**

Shots: 241,125

Time: 82 hrs. 8 min.

Leg 3 duration: 15 days

Elics formatted data collected: 586.79 MB

SEGY formatted data translated: 3.42 GB

Lines collected: NE981SL - NE9877SL (32 lines in 77 segments)

**Lake Titicaca Trip Outline 31 May to 29 June 1998**

- 31 May 1998      1) Departed SFO at 1255 on American Airlines Flt. 442 to MIA (Miami) arrived at 2150. Departed MIA at 2305 on AA Flt. 923 arrived in La Paz, Bolivia (LPB) at 0630 on 6/1/98.
- 01 June 1998      1) Met with Harry Rowe at airport in La Paz  
2) Stayed at apartment near downtown La Paz.  
3) Picked up some cruise supplies.
- 02 June 1998      1) Stayed at apartment near downtown La Paz  
2) Harry and Kevin depart for the field.  
3) Pick up some more supplies for cruise

- 03 June 1998
- 1) Stayed at apartment near downtown La Paz
  - 2) Measured magnetic susceptibility on core to be shipped to the Duke University.
  - 3) Pick up some more supplies for cruise
  - 4) Packed up gear for cruise
- 04 June 1998
- 1) Departed for Lake Titicaca at 1300.
  - 2) Seismic gear arrived at Crillion dock at 1810.
  - 3) Unpack some seismic gear and stow remainder on fantail.
  - 4) Stay at Inca Utama Hotel in Huatajata (Crillion).
- 05 June 1998
- 1) **Departed for cruise Leg 1 at 1300.**
  - 2) The group will be Geoff, Matt, Karin, and Dave. Harry for 2 days.
  - 3) Load personal gear, supplies, etc in preparation for cruise Leg 1.
  - 4) Store crates and containers in Huatajata.
  - 5) Problems with TSS trigger control, switched to Geopulse 5210A receiver.
  - 6) Problems with Alden thermal plotter.
  - 7) Setup GPS, no input in Elics possible.
  - 8) Deploy and begin seismic acquisition at 1515 with NE981SL.
  - 9) Pulled gear at 1700. End with NE981SL.
  - 10) Stayed on R/V Neecho at Isla de la Luna.
- 06 June 1998
- 1) Departed Isla de la Luna at 1000.
  - 2) Deploy gear and start seismic acquisition with NE982SL
  - 3) Problems with electrical noise in data.
  - 4) Problems with Alden thermal plotter.
  - 5) Lost NE985SL due to power outage on R/V Neecho.
  - 6) Pulled gear and ended with NE986SL.
  - 7) Spend night in Hotel at Copacabana.
- 07 June 1998
- 1) Departed Copacabana at 0850. Harry departs vessel and joins up with Kevin.
  - 2) Deploy gear at 0944 and start seismic acquisition with NE987SL
  - 3) Filter water for POC and PON and collect water for DIC.
  - 4) Pulled gear at 1700 and ended with NE9813SL.
  - 5) Translate Elics data to SEG Y (NE981SL) on Tape 1.
  - 6) Back up Elics formatted data (NE982SL to NE9813SL to Index 1 on Tape 2)
  - 7) Spend night on R/V Neecho at Isla del Sol.
- 08 June 1998
- 1) Departed Isla del Sol at 0939.
  - 2) Deploy gear at 0950 and start seismic acquisition with NE9814SL
  - 3) Filter water for POC and PON and collect water for DIC.
  - 4) Pulled gear at 1700 and ended with NE9820SL.
  - 5) Translate Elics data to SEG Y (NE982SL to NE986SL) on Tape 3.
  - 6) Back up Elics formatted data (NE9814SL to NE9820SL to Index 2 on Tape 1)
  - 7) Spend night on R/V Neecho at Taquile.
- 09 June 1998
- 1) Departed Taquile at 0825.
  - 2) Deploy gear at 0840 and start seismic acquisition with NE9821SL
  - 3) Filter water for POC and PON and collect water for DIC.
  - 4) Pulled gear at 1545 and ended with NE9827SL.
  - 5) Translate Elics data to SEG Y (NE987SL to NE9813SL) on Tape 4.
  - 6) Back up Elics formatted data (NE9820SL to NE9827SL to Index 3 on Tape 1)
  - 7) Spend night on R/V Neecho at Isla Soto.
- 10 June 1998
- 1) Departed Isla Soto at 1215. Strong winds all night delayed start because of rough sea state.
  - 2) Deploy gear at 1250 and start seismic acquisition with NE9828SL

- 3) Filter water for POC and PON and collect water for DIC.
- 4) Pulled gear at 1930 and ended with NE9834SL.
- 5) Translate Elics data to SEG Y (NE9814SL to NE9820SL) on Tape 5.
- 6) Back up Elics formatted data (NE9828SL to NE9834SL to Index 1 on Tape 2).
- 7) Spend night on R/V Neecho at Isla del Sol Crillion dock.

- 11 June 1998
- 1) Departed Isla del Sol at 0830.
  - 2) Deploy gear at 0900 and start seismic acquisition with NE9835SL
  - 3) Filter water for POC and PON and collect water for DIC.
  - 4) Pulled gear at 1840 and ended with NE9842SL.
  - 5) Translate Elics data to SEG Y (NE9821SL to NE9827SL) on Tape 4.
  - 6) Back up Elics formatted data (NE9835SL to NE9842SL to Index 2 on Tape 2)
  - 7) Spend night on R/V Neecho at Isla del Sol Crillion dock.
- 12 June 1998
- 1) Departed Isla del Sol at 0900.
  - 2) Deploy gear at 0920 and start seismic acquisition with NE9843SL
  - 3) Filter water for POC and PON and collect water for DIC.
  - 4) Pulled gear at 1500 and ended with NE9843SL.
  - 5) Back up Elics formatted data (NE9843SL to NE9845SL to Index 3 on Tape 2)
  - 6) Stowed and secured gear. Packed up for return trip to La Paz. Arrive in Huatajata at 1530. Depart Huatajata at 1720 for La Paz. **End of Leg 1.**
  - 7) Stayed at apartment near downtown La Paz
- 13 June 1998
- 1) Attempted to purchase a SCSI terminator for Alden thermal plotter, none available.
  - 2) Translate Elics data to SEG Y (NE9828SL to NE9829SL) on Tape 6.
  - 3) Make archive tape of Elics formatted data. NE981SL to NE9827SL to Tape 1A and NE9828SL to NE9845SL to Tape 2A.
- 14 June 1998
- 1) Attempted to purchase a SCSI terminator for Alden thermal plotter, none available.
  - 2) Translate Elics data to SEG Y (NE9830SL to NE9844SL) on Tape 6.
  - 3) Give Geoff all of the SEG Y data tapes. Geoff departs La Paz for Syracuse.
  - 4) Shop for provisions.
  - 5) Pack for trip to lake.
  - 6) Stayed at apartment near downtown La Paz
- 15 June 1998
- 1) Visit Exprinter to set up air cargo shipment to VIMS and pick up in Huatajata at Crillion dock on 6/26/98 at 1300.
  - 2) Clean up computer hard disk, make boot disk, etc.
  - 3) Paul Baker joins us and will replace Geoff on Leg 2. The group in now Karin, Matt, Paul and Dave
  - 4) Load up personal gear, computer, and provisions. Depart for Huatajata at 1300.
  - 5) Load gear on R/V Neecho.
  - 6) Fuel vessel.
  - 7) Stay at Inca Utama Hotel in Huatajata (Crillion).
- 16 June 1998
- 1) Depart Crilion dock at 0830 to Huatajata dock.
  - 2) **Depart Huatajata for cruise Leg 2 at 0945.**
  - 3) Deploy seismic gear at 1120. Begin with NE9846SL.
  - 4) Filter water for POC and PON and collect water for DIC.
  - 5) End with line NE9850SL at 1738.
  - 6) Problem when pulling seismic gear. Captain put vessel into reverse when boomer was almost directly astern. Tow and source cable along with catamaran became tangled into port screw and rudder. I made two attempts to free the port screw, one with help from Matt, but to no avail. All I was able to do was prevent the starboard rigging from getting tangled.

7) Stayed on vessel at Crillion dock on Isla del Sol.

- 17 June 1998
- 1) Morning was spent getting the catamaran and cables out of the port rigging. Matt, Paul and I took many turns to free the rigging. By 1200 we were unable to completely free the rigging of the source cable, close but not complete enough to use the port screw. All battling hypothermia we decided to head back to the Crillion dock in Huatajata on the starboard screw. At least with the catamaran removed from the rigging we had complete control of the rudders.
  - 2) Depart Isla del Sol at 1230 and arrived at Crillion dock at 1700. **End of Leg 2.**
  - 3) Made arrangements to have the stern of the R/V Neecho hauled out of the water so we could remove the remainder of the cable.
  - 4) Gave pontoons from catamaran and source cover to Nico to have them repaired.
  - 5) Stayed at Inca Utama Hotel in Huatajata (Crillion).
- 18 June 1998
- 1) Raised R/V Neecho out of water and removed cable.
  - 2) Depart hotel and dock at 1115 for La Paz arrive at 1445.
  - 3) Gave catamaran frame to Consalo to have it repaired in El Alto.
  - 4) Went into the city to find some adhesive/sealant for the cable termination.
  - 5) Stayed at apartment near downtown La Paz
- 19 June 1998
- 1) Go into city to have cable soldered and purchase tape.
  - 2) Make cable repair at apartment. Wait for other parts of the catamaran to be repaired.
  - 3) Stayed at apartment near downtown La Paz
- 20 June 1998
- 1) Remainder of catamaran repaired. Make arrangements to return to Huatajata and complete survey.
  - 2) Pack once again for the lake. Paul and Karin will not be able to make the remainder of the cruise. Matt and Dave will finish the survey on Leg 3.
  - 3) Stayed at apartment near downtown La Paz
- 21 June 1998
- 1) Depart La Paz for Huatajata at 0610.
  - 2) Make preparations for cruise. Assemble catamaran and test seismic source.
  - 3) **Depart Huatajata at 1100 and begin cruise Leg 3.**
  - 4) Filter water for POC and PON and collect water for DIC.
  - 5) Deploy gear at 1348 and begin with NE9851SL.
  - 6) Pull gear at 1632 and end with NE9852SL.
  - 7) Translate Elics data to SEG Y (NE9846SL to NE9852SL) on Tape 8.
  - 8) Stayed on vessel at north end of Isla del Sol.
- 22 June 1998
- 1) Depart Isla del Sol at 0745.
  - 2) Rain today from 0900 to 1000.
  - 3) Filter water for POC and PON and collect water for DIC.
  - 4) Deploy gear at 0800 and begin with NE9853SL.
  - 5) Pull gear at 1730 and end with NE9860SL. Head for Tiquile. Arrive at 1820.
  - 6) Translate Elics data to SEG Y (NE9853SL to NE9860SL) on Tape 8.
  - 8) Stayed on vessel at Tiquile.
- 23 June 1998
- 1) Depart Taquile at 0730.
  - 2) Filter water for POC and PON and collect water for DIC.
  - 3) Deploy gear at 0832 and begin with NE9861SL.
  - 4) Pull gear at 1736 and end with NE9868SL. Head for Isla Soto.
  - 5) Translate Elics data to SEG Y (NE9853SL to NE9860SL) on Tape 8.
  - 6) Back up Elics formatted data (NE9846SL to NE9868SL to Index 1 on Tape 3)
  - 7) Stayed on vessel at Isla Soto.
  - 8) Rained most of the night.

- 24 June 1998
- 1) Depart Isla Soto at 0740.
  - 2) Filter water for POC and PON and collect water for DIC.
  - 3) Deploy gear at 0817 and begin with NE9869SL.
  - 4) Pull gear at 1700 and end with NE9876SL. Head for Isla Soto.
  - 5) Rained off and on all day.
  - 7) Stayed on vessel at Isla Soto.
- 25 June 1998
- 1) Depart Isla Soto at 0725.
  - 2) Filter water for POC and PON and collect water for DIC.
  - 3) Deploy gear at 0747 and begin with NE9877SL.
  - 4) Pull gear at 0805 and end with NE9877SL. Lake too rough to shoot seismic. Secure gear on deck and head for Huatajata.
  - 5) Translate Elics data to SEG Y (NE9869SL to NE9872SL) on Tape 8.
  - 6) Back up Elics formatted data (NE9853SL to NE9877SL to Index 2 on Tape 3)
  - 7) Disassemble boomer catamaran. Have Nico repair some cracks in the pontoons. 6)
  - 8) Dock at Nico's. **End of cruise Leg 3.**
  - 9) Stayed at Inca Utama Hotel in Huatajata (Crillion).
- 26 June 1998
- 1) Arrange for van to pick up crates at Nico's and for trip to La Paz.
  - 2) Clean up the R/V Neecho for storage.
  - 3) Translate Elics data to SEG Y (NE9873SL to NE9877SL) on Tape 8.
  - 4) Make Archive back up Elics formatted data (NE9846SL to NE9877SL to Index 1 on Tape 4).
  - 5) Pick up crates at Nico's and bring to Crillion dock. Pack up seismic gear for shipment to VIMS via Exprinter, pick up at 1300.
  - 6) Depart Huatajata for La Paz at 1400
  - 7) Stayed at apartment near downtown La Paz
- 27 June 1998
- 1) Confirm American airlines flights to SFO..
  - 2) Pack personal gear.
  - 3) Pack, inventory, and store gear at apartment for next season.
  - 4) Clean up apartment.
  - 5) Reserve cab for airport.
  - 6) Help Harry and Kevin ship gear back to Stanford University via FedEx
  - 7) Stayed at apartment near downtown La Paz
- 28 June 1998
- 1) Depart for airport at 0415 with Harry. Arrive at 0445 and check in at 0500 at American airlines. Pay for excess baggage (4 pieces at \$332.00). Pay departure tax. Flight delayed over 5 hours. Unable to make connections in MIA for SFO. AA put me up in hotel for the evening.
- 29 June 1998
- 1) Depart MIA at 0710 on Flt 431 and arrive SFO at 0954.
  - 2) Drop off core and excess bags at Stanford University.
  - 3) End of trip.