9/020

CRUISE REPORT, VERE91-1

Vessel:	R/V Vereshchagin
Cruise number:	VERE91-1
Parent project:	Global Change Stratigraphy
Area of operations:	Lake Baikal
Port:	Listvyanka, Siberia, USSR
Cruise dates:	July 13 - Aug. 5, 1991
Chief scientists:	P.P. Hearn, Jr., U.S. Geological Survey
	S.M. Colman, U.S. Geological Survey
	E.B. Karabanov, Limnological Institute, Irkutsk
Cruise participants:	See attached list

Purpose of cruise:

This cruise was part of a long-term cooperative research program supported by the Siberian Branch of the Soviet Academy of Sciences, the U.S. Geological Survey, and the University of South Carolina. The overall objective of this program is to obtain and quantitatively interpret the sedimentary record of changing climate and limnology in Lake Baikal. Our approach is a large, multidisciplinary team effort of both field and laboratory work. Field operations will involve the collection of high-resolution seismic-reflection data to delineate the sedimentary environments beneath the lake, to define how these environments have responded to climate change, and to locate and to correlate the best sites for coring. Seismic-reflection data will also be critical to the selection of target sites for ice-based drilling operations planned to begin in 1992. Sediment cores will provide the raw materials for analyses aimed at detailed reconstructions of paleoenvironmental conditions. Analytical studies include a multitude of micropaleontological, isotopic, geochronologic, sedimentological, and geochemical methods for reconstructing a detailed, quantitative Quaternary climate record.

This cruise follows a reconnaissance field effort in 1990 which resulted in the collection of 520 km of high-resolution (3.5 kHz) seismic reflection profiles and a set of gravity and box cores at seven sites in Lake Baikal. The 1991 field effort was expanded to collect about 2000 km of seismic-reflection data and to acquire a set of box, gravity, and piston cores at about 20 sites. A second seismic-reflection system, using a towed water-gun source and streamer, was added to extend coverage to depths of up to 300 meters below the sediment surface.

Navigation:

Positions were determined from GPS signals using a Magellan GPS receiver. Coordinates were recorded on disk at twelve second intervals using Magellan logging software. Coordinates were logged by hand at 30 minute intervals. Coordinates were also recorded by hand on the seismic-reflection records.

Scientific equipment employed:

- Seismic reflection (3.5 kHz)
  - ORE 4-transducer towed fish
  - ORE 140 transceiver
  - EPC 4800 graphic recorder
- Seismic reflection (water gun)
  - SSI 15 in^3 water gun
  - Hydrophone streamer, 100 element
  - Amplifier/filter system
  - EPC 4800 graphic recorder
- Recording
  - HP 8-track analogue recorder
- Coring
  - Large diameter (10 cm) piston corer
  - Benthos gravity corer
  - Box corer

Equipment performance:

The ORE 3.5 kHz and water-gun seismic systems performed extremely well, with only minor problems, such as failed O-rings on the water gun and a broken connection in the hydrophone streamer. The GPS navigation system also worked well, except for occasional signal losses, generally only for 15-30 minutes duration. The Branch navigation aquisition system was not used because of both software and hardware problems. All of the coring systems worked well, with the exception that the piston corer suffered from several mechanical problems and recovered cores only 5-6 m long rather than the intended 10 m.

Cruise Summary:

Coring Operations:

Several different types of cores were collected at 27 different stations in the lake during the cruise. These included 29 Benthos gravity cores, 19 box cores, and 36 large-diameter piston cores. Water samples were also collected at various depths at about 8 stations, at the mouths of eight rivers flowing into the lake, and at three hot springs. Two piston cores were collected at each site. One was split, described, and sampled onboard ship; these cores will remain in the USSR for further analysis by Soviet scientists. The second core from each station will be returned to the U.S. for analysis by U.S. scientists.

Subcores of box cores and selected piston cores were taken in order to 1) obtain samples of sediment pore waters and 2) obtain undisturbed sediment samples from the sediment-water interface for geochemical and electron- microscope analysis. Pore water samples were extracted from sediments onboard ship by squeezing; several analytical determinations (pH, eH, alkalinity, and PO_4) were made on these samples during cruise.

Selected core samples will be analyzed by both U.S. and Soviet scientists to compare analytical accuracy and precision.

Seismic-Reflection Profiling:
About 2060 km of seismic reflection profiles were collected during the cruise, mostly in 3 principle areas: the Selenga Delta, Academician Ridge, and the North Basin. Two systems were used: (1) a very high resolution 3.5 kHz system, which gave about 0.5 m resolution and commonly gave 30-50 m of penetration into the sediments, and (2) a broad-band water-gun system (100-1060 Hz) that gave 1-2 m of resolution and as much as 300 m of penetration.

The overall quality of the seismic reflection data collected during the cruise was excellent. Seismic profiles were invaluable for selecting core sites during the cruise, because of rapid lateral changes in sediment character and because of common disturbance of the sediments by faulting and erosion.

Photographic copies (high-resolution flow camera) of all the original seismic data will be provided to the Limnological Institute as soon as possible (by late 1991). After these copies are examined by Soviet specialists, we suggest that a Soviet scientist come to Woods Hole in Spring 1992 to process and replay desired parts of the data.

Preliminary Conclusions

Based on the results of onboard core examination and seismic-reflection profiles, the areas of the Selenga Delta and the Academician Ridge appear to have the greatest potential as sites for paleoclimate study. This conclusion is based on the following criteria: 1) relatively continuous, as opposed to episodic sedimentation; 2) flat-lying sediments; and 3) the absence of faults or other structural disturbances. The North Basin of Baikal is a somewhat less desirable site for paleoclimate research, but also merits attention. Cores from the following stations were selected for priority analysis by U.S. and Soviet scientists: 316 (Selenga Delta), 331 & 333 (Academician Ridge), and 321 (North Basin).

The seismic data outlined areas with different depositional environments, such as delta-front and pro-delta areas, of hemipelagic sedimentation, and turbidite-fan areas. These different environments served as large- scale targets for coring.

The seismic data also showed important relationships for larger-scale features of the lake. For example, even the youngest sediments in the lake are cut by faults, and most of the faulting appears to be continuous and progressive, rather than episodic. Another example is the fact that the thickness of the Selenga Delta is much less than it appears, because it is built on top of a structurally high bedrock block.

Attachment: 1. List of participants
2. Track chart and core locations

cc: B. Butman
H. Knebel
M. Bothner
N. Soderberg
D. Nichols
T. Aldrich
T. O'Brien
K. Klitgord
D. Hutchinson
P. Hearn

R/V VERESCHAGIN CRUISE
JULY 13 - AUGUST 5, 1991

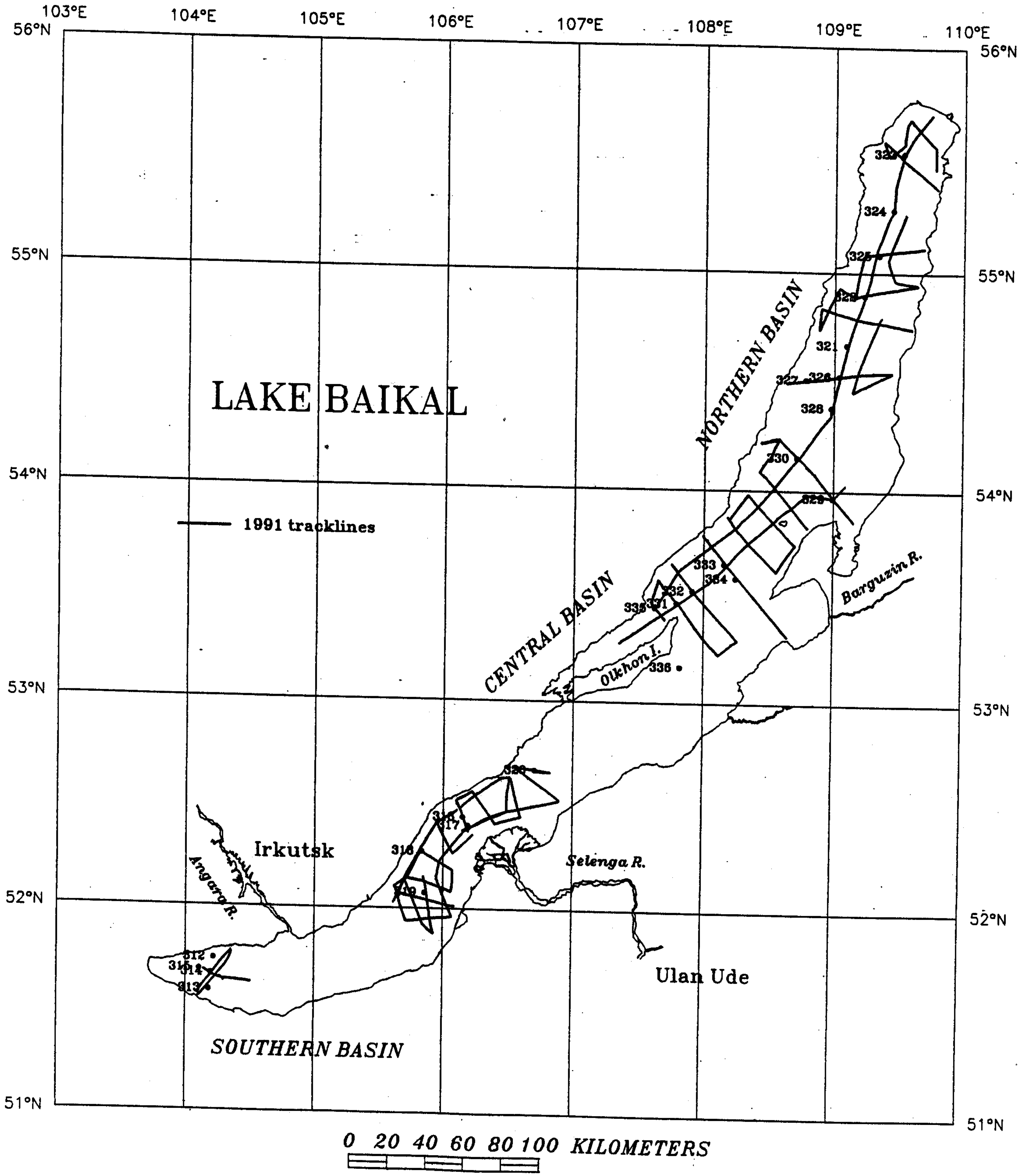
CRUISE PARTICIPANTS

Scientist	Affiliation	Cruise Responsibilities
Paul P. Hearn, Jr.	Deputy Chief Office of International Geology U.S. Geological Survey Reston, Virginia	Co-Chief Scientist Navigation Seismic line and sample sample site selection
Steven M. Colman	Geologist Branch of Atlantic Marine Geology Woods Hole, Mass.	Co-Chief Scientist Seismic operations Seismic line and sample site selection
Edward Callender	Geochemist Water Resources Division U.S. Geological Survey Reston, Virginia	Pore-water geochemistry
Susan W. Carter	Geologist Branch of Atlantic Marine Geology U.S. Geological Survey Woods Hole, Ma.	Navigation Core Description Magnetic Measurements Coring Operations
Hans Nelson	Geologist Branch of Pacific Marine Geology U.S. Geological Survey Menlo Park, Ca.	Turbidite systematics Core description
David R. Nichols	Marine Seismic Specialist Branch of Atlantic Marine Geology U.S. Geological Survey Woods Hole, Ma.	Seismic operations
Kevin O'Toole	Marine Technician Branch of Pacific Marine Geology U.S. Geological Survey Menlo Park, Ca.	Coring operations Water-gun system operations
Rick R. Rendigs	Geologist Branch of Atlantic Marine Geology U.S. Geological Survey Woods Hole, Ma.	Coring operations

Scientist	Affiliation	Cruise Responsibilities
James Broda	Research Associate Woods Hole Oceanographic Inst. Woods Hole, Mass.	Coring Operations
Anne Felton	Senior Petroleum Geologist Bureau of Mineral Resources Canberra, Austrailia	Core description Smear slide description
John King	Associate Professor Graduate School of Oceanography University of Rhode Island Narragansett, R,I.	Paleomagnetics
Cynthia Pilskaln	Geochemist/ Sedimentologist Monterey Bay Aquarium Research Institute Pacific Grove, Ca.	Geochemistry of surface sediment layer

SOVIET CRUISE PARTICIPANTS

E. B. Karabanov	Chief of Laboratory Limnological Institute Siberian Branch USSR Academy of Sciences Irkutsk	Co-Chief Scientist Core site and seismic line selection Core description
A. Bardardinov	Limnological Institute Siberian Branch USSR Academy of Sciences Irkutsk	Seismic operations Navigation
L. Granina	Limnological Institute Siberian Branch USSR Academy of Sciences Irkutsk	Pore-water geochemistry
A. Gvozdkov	Institute of Geochemistry Siberian Branch USSR Academy of Sciences Irkutsk	Core sampling operations Pb-210; surface layer anal.
E. Seleznova	Engineer Paleomagnetics Lab USSR Ministry of Geology Irkutsk	Paleomagnetics


LAKE BAIKAL
1991 tracklines
NORTHERN BASIN
CENTRAL BASIN
SOUTHERN BASIN
Irkutsk
Ulan Ude
Angara R.
Selenga R.
Barguzin R.
Olkhon I.
103°E
104°E
105°E
106°E
107°E
108°E
109°E
110°E
56°N
55°N
54°N
53°N
52°N
51°N
0 20 40 60 80 100 KILOMETERS

Lake Baikal R/V Vereshchagin 1991 Core stations

Stat.	Lat	Long	Depth (m)
312	51.74450	104.21767	1390
313	51.59017	104.18117	
314	51.67150	104.19683	1310
315	51.69183	104.10717	1360
316	52.43983	106.15050	300
317	52.39950	106.19067	250
318	52.27333	105.83433	970
319	52.07500	105.85683	125
320	52.66983	106.70467	1100
321	54.66917	109.08900	960
322	54.89433	109.22333	950
323	55.53450	109.52183	710
324	55.28333	109.44367	870
325	55.07950	109.33400	880
326	54.52800	109.03217	950
327	54.51083	108.78067	950
328	54.38350	108.97733	930
329	53.96733	108.99217	490
330	54.15300	108.71583	950
331	53.46883	107.78967	360
332	53.52700	107.91000	330
333	53.65300	108.15583	390
334	53.58700	108.24717	350
335	53.44683	107.61850	270
336	53.16850	107.81917	1710