

GEO91-1 LOG

BRANCH OF ATLANTIC MARINE GEOLOGY
Woods Hole, MA 02543

Vessel: RV GEO1 (22' Monarch), Western Michigan University

Cruise no.: GEO91-1

Parent Project: Regional Great Lakes

Dates: 4 August - 8 August, 1991

Area of Operations: Michiana, MI to Benton Harbor, MI

Dates and Ports: August 4-7: St. Joseph, MI
August 8: New Buffalo, MI (demobilize)

Scientific Party: D. Foster (AMG), Co-chief Scientist
D. Folger (AMG), Co-chief Scientist
A. Brill (AMG), Scientist
B. Irwin (AMG), Navigator
D. Wardwell (W. Michigan Univ.), Boat Operator

Purpose of Cruise: Acquisition of surficial sediment samples to verify the NPTN91-1 sidescan sonar interpretations. Reconnaissance of geologic framework and surficial sediment texture.

Navigation: GPS and DGPS, Navigation software provided by B. Irwin. DGPS station set by NOAA on lighthouse on north breakwater of St Joseph Harbor.

Scientific Equipment: Shipek grab sampler, small Vanveen grab, pipe dredge, petit Ponar (borrowed from NOAA), and echosounder.

Notes: Depths are in meters below lake level at the time of sampling, measured from echosounder records and corrected for the 0.59m depth of the in-hull transducer. Geographic coordinates are in NAD83. Samples were collected when the boat was about 30 m or less, an average of 12 m, from the target position as listed in the log. The distance and azimuth of actual sample locations from the proposed target locations are shown in table 1 (see attached) where sample locations were recorded. No sample locations were recorded on Monday, 5 August. Samples were collected using the Shipek grab unless otherwise noted in the log.

Monday, 5 August, 1991

0800 Meet at West Basin Marina, St. Joseph. Begin to mobilize, meet with NOAA field party.

1230 Underway to first sampling station

1245 Station 23-11 (mouth of harbor), Vanveen failed, switch to Shipek,
Shipek failed, move to station north of harbor.

SAMPLE#: GEO91-01a STATION#: 17-6 DEPTH: 10.6 POSITION: 42d07.71457'-86d29.16352'
(from upper part of recovered sample)
Mud dark gray, homogeneous

DGPS
↓

SAMPLE#: GEO91-01b STATION#: 17-6 DEPTH: 10.6 POSITION: 42d07.71457'-86d29.16352'
(from lower part of recovered sample)
Sand coarse, gray-brown, well rounded, slightly muddy

SAMPLE#: GEO91-02 STATION#: 17-5 DEPTH: 12.8 POSITION: 42d07.86138'-86d29.66797'
Sand medium, tan, well sorted, some shell material

SAMPLE#: GEO91-03 STATION#: 17-4 DEPTH: 18.0 POSITION: 42d08.17992'-86d30.90950'
Sand fine, gray-brown, homogeneous

SAMPLE#: GEO91-04 STATION#: 17-3 DEPTH: 21.6 POSITION: 42d08.57465'-86d32.29363'
(3 attempts)
Sand coarse, well sorted, red-brown varicolored, well rounded

SAMPLE#: GEO91-05 STATION#: 17-2 DEPTH: 23.1 POSITION: 42d08.64802'-86d32.56970'
(2 attempts)
Sand fine, gray and brown, silty, gastropod 1 cm long

NO SAMPLE# STATION#: 15-8 DEPTH: 27.0 POSITION: 42d06.21692'-86d35.38912'
No sample recovered- 3 tries, very small amounts of fine sand in grab.

SAMPLE#: GEO91-06 STATION#: 15-7 DEPTH: 23.4 POSITION: 42d05.96375'-86d34.57007'
Sand fine, gray, silty, muddy, some fine shell material

SAMPLE#: GEO91-07 STATION#: 15-6 DEPTH: 21.9 POSITION: 42d05.86228'-86d34.26107'
Sand coarse, gray-brown, some mud and silt

SAMPLE#: GEO91-08 STATION#: 15-5 DEPTH: 17.7 POSITION: 42d05.48127'-86d33.05703'
Sand fine, gray-brown, well sorted, many dark minerals

SAMPLE#: GEO91-09 STATION#: 15-4 DEPTH: 17.0 POSITION: 42d05.23847'-86d32.27725'
Sand v. coarse, varicolor, well rounded, silty and muddy

SAMPLE#: GEO91-10 STATION#: 15-3 DEPTH: 16.7 POSITION: 42d05.13570'-86d31.95060'

Sand coarse, silty, muddy, gray, some gravel (over till)

SAMPLE#: GEO91-11 STATION#: 15-2 DEPTH: 11.3 POSITION: 42d04.88930'-86d31.18267'

Sand v. fine to fine, v. well sorted, dark tan, some shell material

SAMPLE#: GEO91-12 STATION#: 15-1 DEPTH: 8.8 POSITION: 42d04.80422'-86d30.87198'

Sand fine, gray-brown, well sorted, homogeneous

SAMPLE#: GEO91-13 STATION#: 24-3 DEPTH: 6.4 POSITION: 42d04.81115'-86d30.74560'

Sand fine-medium, tan, well sorted, homogeneous

SAMPLE#: GEO91-14 STATION#: 28-5 DEPTH: 6.7 POSITION: 42d04.99650'-86d30.58862'

Sand coarse, reddish brown, well sorted, well rounded, shell material

Tuesday, 6 August, 1991

SAMPLE#: GEO91-15a STATION#: 23-12 DEPTH: 7.6 POSITION: 42d07.28585'-86d29.52520'
(Petit Ponar grab, upper 2cm of sample)

Mud v. dark gray, silty

SAMPLE#: GEO91-15b STATION#: 23-12 DEPTH: 7.6 POSITION: 42d07.28585'-86d29.52520'
(Petit Ponar grab, from beneath 91-15a)

Sand fine, tan, silty

SAMPLE#: GEO91-16 STATION#: 29-1 DEPTH: 10.3 POSITION: 42d05.10365'-86d30.73043'
(Petit Ponar failed 3 times, sample from Shipek)

Sand v. coarse, tan to gray, some rounded pebbles, gravelly and muddy

SAMPLE#: GEO91-17 STATION#: 26-3 DEPTH: 9.7 POSITION: 42d04.95535'-86d30.83358'
(Petit Ponar failed again, switch to Shipek)

Sand medium, tan, well sorted, shell material and black specks

SAMPLE#: GEO91-18 STATION#: 28-4 DEPTH: 13.7 POSITION: 42d05.20693'-86d31.24050'

Sand v. fine to fine, brown, homogeneous, well sorted

SAMPLE#: GEO91-19 STATION#: 26-2 DEPTH: 14.0 POSITION: 42d05.11087'-86d31.31857'

Sand v. fine to fine, v. well sorted, tan, homogeneous

SAMPLE#: GEO91-20 STATION#: 24-2 DEPTH: 14.3 POSITION: 42d05.02743'-86d31.41257'

Sand v. fine to fine, brown, homogeneous, v. well sorted

SAMPLE#: GEO91-21 STATION#: 24-1 DEPTH: 17.3 POSITION: 42d05.29572'-86d32.26738'

Sand v. coarse, some granules, a few small pebbles, well rounded, med sorting, brown-gray

SAMPLE#: GEO91-22 STATION#: 28-3 DEPTH: 17.3 POSITION: 42d05.48813'-86d32.14208'

Sand v. coarse, light brown to gray, poorly sorted, pebbles to 3 cm

SAMPLE#: GEO91-23 STATION#: 27-1 DEPTH: 17.7 POSITION: 42d05.46478'-86d32.24853'

Granules brown to gray, pebbly, some mud, med sorted, well rounded

SAMPLE#: GEO91-24a STATION#: 28-2 DEPTH: 18.0 POSITION: 42d05.62667'-86d32.56205'
(Upper part of recovered sample)

Sand and Gravel muddy, varicolored and poorly sorted

SAMPLE#: GEO91-24b STATION#: 28-2 DEPTH: 18.0 POSITION: 42d05.62667'-86d32.56205'
(Lower part of recovered sample)

Till med. gray, stiff silty sandy clay

SAMPLE#: GEO91-25 STATION#: 26-1 DEPTH: 17.7 POSITION: 42d05.51262'-86d32.56808'

Sand fine to very fine, brown, well sorted with some shell fragments

SAMPLE#: GEO91-26 STATION#: 28-1 DEPTH: 20.7 POSITION: 42d05.90273'-86d33.45565'

Sand very fine silty, dark brown, well sorted

SAMPLE#: GEO91-27a STATION#: 23-10 DEPTH: 10.3 POSITION: 42d04.72820'-86d31.06987'
(Upper part of recovered sample)

Sand fine to very fine, tan, well sorted

SAMPLE#: GEO91-27b STATION#: 23-10 DEPTH: 10.3 POSITION: 42d04.72820'-86d31.06987'
(Lower part of recovered sample)

Till med. gray, stiff silty sandy clay

SAMPLE#: GEO91-28 STATION#: 14-4 DEPTH: 8.8 POSITION: 42d04.41748'-86d30.95863'
(Most sand washed out in retrieval, till and sand bagged together)

Till and Sand (homogenized) silty, some coarse particles, dark brown

SAMPLE#: GEO91-29 STATION#: 23-9 DEPTH: 10.0 POSITION: 42d04.23218'-86d31.40445'

Sand med. to coarse, some pebbles, clay clasts, abundant shell fragments

SAMPLE#: GEO91-30 STATION#: 14-3 DEPTH: 8.2 POSITION: 42d03.99552'-86d31.21717'

Sand and granules, well rounded, varicolored, some pebbles up to 4 cm

SAMPLE#: GEO91-31 STATION#: 14-2 DEPTH: 7.3 POSITION: 42d03.24182'-86d31.69470'

Sand v. fine to fine, homogeneous, brown, well rounded

SAMPLE#: GEO91-32 STATION#: 14-1 DEPTH: 5.8 POSITION: 42d02.85193'-86d31.83437'

Sand med. to coarse, mod. well sorted, red-brown, well rounded

SAMPLE#: GEO91-33 STATION#: 13-6 DEPTH: 8.8 POSITION: 42d02.85220'-86d32.24080'

Sand fine, brown, streaked w/ gray, well sorted and rounded, homogeneous

SAMPLE#: GEO91-34 STATION#: 23-8 DEPTH: 8.8 POSITION: 42d02.52595'-86d32.45867'

Sand fine, brown, well sorted and rounded, homogeneous

SAMPLE#: GEO91-35 STATION#: 23-7 DEPTH: 12.5 POSITION: 42d02.39073'-86d32.56487'
(1st try failed - on scarp 50m NW of station, 2nd try on station)

Sand very fine, with some mud and pebbles, dark gray, well sorted

SAMPLE#: GEO91-36 STATION#: 23-5 DEPTH: 9.1 POSITION: 42d01.54222'-86d33.11565'

Sand med. to coarse, moderately well sorted, red-brown, well rounded

SAMPLE#: GEO91-37 STATION#: 30-4 DEPTH: 6.7 POSITION: 42d01.39138'-86d33.05013'

Sand medium, brown to light gray, well sorted, well rounded, shell fragments

SAMPLE#: GEO91-38 STATION#: 32-5 DEPTH: 6.4 POSITION: 42d01.25262'-86d32.98710'

Sand medium to coarse, light gray, well sorted, abundant shell fragments

SAMPLE#: GEO91-39 STATION#: 34-4 DEPTH: 7.3 POSITION: 42d01.18827'-86d33.12922'

Sand fine, brown, slightly muddy, 1 till fragment

SAMPLE#: GEO91-40 STATION#: 23-4 DEPTH: 8.5 POSITION: 42d00.77468'-86d33.60758'

Sand very fine to fine with some granules, dark brown, well sorted

NO SAMPLE# STATION#: 23-3 DEPTH: 0.0 POSITION: 42d00.58790'-86d33.71592'

No sample recovered- pebbly gray Till on outside of grab bucket

NO SAMPLE# STATION#: 23-2 DEPTH: 0.0 POSITION: 42d00.53740'-86d33.75278'

No sample recovered- hard bottom. Pipe dredge recovered 1 **Shale** pebble

SAMPLE#: GEO91-41 STATION#: 23-1 DEPTH: 9.7 POSITION: 42d00.47005'-86d33.80083'
(No sample with Shipek, pipe dredge used)

Sand, Till, and Shale pebbles; mostly fine to medium brown sand

SAMPLE#: GEO91-42 STATION#: 32-4 DEPTH: 13.4 POSITION: 42d01.52533'-86d33.87052'

Sand fine, tan, v. well sorted

SAMPLE#: GEO91-43 STATION#: 34-3 DEPTH: 13.7 POSITION: 42d01.44258'-86d33.99687'

Sand fine, tan with black specks, some pebbles

SAMPLE#: GEO91-44 STATION#: 30-3 DEPTH: 14.6 POSITION: 42d01.74257'-86d34.19288'

Sand fine, brown, very well sorted

SAMPLE#: GEO91-45 STATION#: 32-3 DEPTH: 16.4 POSITION: 42d01.72710'-86d34.53948'

Sand medium, tan, some pebbles, well sorted and rounded

SAMPLE#: GEO91-46 STATION#: 34-2 DEPTH: 17.0 POSITION: 42d01.66425'-86d34.71697'

Sand v. fine to fine, tan to gray, v. well sorted, some mud. Till on grab bucket

SAMPLE#: GEO91-47 STATION#: 32-2 DEPTH: 16.7 POSITION: 42d01.77150'-86d34.68918'

Sand v. fine to fine, v. well sorted, tan

SAMPLE#: GEO91-48 STATION#: 34-1 DEPTH: 20.7 POSITION: 42d01.86220'-86d35.37893'

Silt sandy, well sorted

SAMPLE#: GEO91-49 STATION#: 32-1 DEPTH: 21.0 POSITION: 42d02.02170'-86d35.51925'

Sand fine, tan to gray, v. well sorted, some shell flakes

SAMPLE#: GEO91-50 STATION#: 30-1 DEPTH: 20.4 POSITION: 42d02.07128'-86d35.30778'
(30m NE of station, most sample washed out on recovery)

Silt coarse, very sandy, gray-brown, homogeneous

SAMPLE#: GEO91-51 STATION#: 30-2 DEPTH: 19.2 POSITION: 42d02.00580'-86d35.07275'

Sand med, well sorted, gray-brown, some mud and clay clasts, black specks

SAMPLE#: GEO91-52 STATION#: 13-1 DEPTH: 26.8 POSITION: 42d04.25777'-86d36.67958'

Silt dark gray, homogeneous, some sand grains

SAMPLE#: GEO91-53 STATION#: 13-2 DEPTH: 22.8 POSITION: 42d03.91267'-86d35.59923'

Sand some mud, very fine, brown

SAMPLE#: GEO91-54 STATION#: 13-3 DEPTH: 18.3 POSITION: 42d03.66700'-86d34.76375'

Sand fine, well to very well sorted, dark specks, homogeneous, brown

SAMPLE#: GEO91-55 STATION#: 13-4 DEPTH: 16.7 POSITION: 42d03.47123'-86d34.19740'

Sand fine, brown with many dark specks, homogeneous

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SAMPLE#: GEO91-56 STATION#: 13-5 DEPTH: 15.2 POSITION: 42d03.25147'-86d33.49938'

Sand fine to medium, well sorted, brown-gray, some mud

SAMPLE#: GEO91-57 STATION#: 11-1 DEPTH: 27.1 POSITION: 42d02.79487'-86d37.55058'

Mud slightly sandy, gray-brown, smooth and well sorted

SAMPLE#: GEO91-58 STATION#: 10-1 DEPTH: 28.0 POSITION: 42d00.49118'-86d39.12133'

Mud very little sand, dark gray

SAMPLE#: GEO91-59 STATION#: 10-2 DEPTH: 22.5 POSITION: 41d59.98973'-86d37.27248'

Sand fine, gray-brown, well sorted with some shell material

SAMPLE#: GEO91-60 STATION#: 10-3 DEPTH: 18.3 POSITION: 41d59.45993'-86d35.32215'

Sand fine, gray mottled with brown, well sorted with some mud

SAMPLE#: GEO91-61 STATION#: 35-13 DEPTH: 7.9 POSITION: 41d59.82902'-86d34.07985'

Sand very fine, tan, well sorted

SAMPLE#: GEO91-62 STATION#: 10-4 DEPTH: 8.2 POSITION: 41d59.19915'-86d34.36942'
(Suspect nav - high PDOP)

Sand fine to very fine, tan and gray mottled, well sorted

SAMPLE#: GEO91-63 STATION#: 35-12 DEPTH: 10.3 POSITION: 41d58.28293'-86d34.72200'

Sand fine to very fine, gray-brown, well sorted

SAMPLE#: GEO91-64 STATION#: 8-1 DEPTH: 10.6 POSITION: 41d56.82027'-86d35.59855'

Sand very fine, tan, well sorted, with some shell material

SAMPLE#: GEO91-65 STATION#: 8-2 DEPTH: 14.3 POSITION: 41d56.91947'-86d35.92770'

Sand fine to medium, gray-brown, well sorted

SAMPLE#: GEO91-66 STATION#: 8-3 DEPTH: 14.3 POSITION: 41d56.97388'-86d36.08762'
(Pipe dredge used after Shipek; no recovery, but till on mouth of dredge)

Till with **shale** pebble. Sample too small for size analysis.

SAMPLE#: GEO91-67 STATION#: 8-4 DEPTH: 17.0 POSITION: 41d57.11308'-86d36.45543'

Sand very fine, gray-brown, well sorted, with some mud and shell material

SAMPLE#: GEO91-68 STATION#: 8-5 DEPTH: 21.0 POSITION: 41d57.70405'-86d38.16358'

Silt moderately sandy, dark gray, pelicy pods common

GPS
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SAMPLE#: GEO91-69 STATION#: 8-6 DEPTH: 25.9 POSITION: 41d58.30735'-86d39.89920'

Silt moderately sandy, dark gray, pelicy pods common

SAMPLE#: GEO91-70 STATION#: 6-1 DEPTH: 30.2 POSITION: 41d57.53912'-86d42.26710'

Silt, very dark gray, sorted

SAMPLE#: GEO91-71a STATION#: 6-2 DEPTH: 21.9 POSITION: 41d56.37350'-86d39.76738'
(Upper part of recovered sample)

Silt clayey, dark gray, with plentiful worm burrows

SAMPLE#: GEO91-71b STATION#: 6-2 DEPTH: 21.9 POSITION: 41d56.37350'-86d39.76738'
(Lower part of recovered sample)

Sand fine to medium, gray-brown, well sorted

SAMPLE#: GEO91-72 STATION#: 6-3 DEPTH: 17.0 POSITION: 41d55.36038'-86d37.60105'

Sand fine, tan, well sorted, some shells present

SAMPLE#: GEO91-73 STATION#: 6-4 DEPTH: 16.4 POSITION: 41d55.27977'-86d37.42658'

Granules, pea gravel, and 10cm rock, poorly sorted, varicolored and rounded

SAMPLE#: GEO91-74 STATION#: 6-5 DEPTH: 8.8 POSITION: 41d54.95227'-86d36.71813'

Sand fine to very fine, tan, homogeneous, very well sorted

SAMPLE#: GEO91-75 STATION#: 5-1 DEPTH: 8.2 POSITION: 41d52.59907'-86d39.10087'

Sand fine, tan mottled with gray, v. well sorted, shell particles common

SAMPLE#: GEO91-76 STATION#: 35-11 DEPTH: 10.6 POSITION: 41d52.05245'-86d40.16140'

Sand very fine to fine, tan, well sorted

SAMPLE#: GEO91-77 STATION#: 35-10 DEPTH: 10.6 POSITION: 41d51.98377'-86d40.29045'

Granules and Gravel up to 1cm, some sand and silt, varicolored and rounded

SAMPLE#: GEO91-78 STATION#: 38-1 DEPTH: 15.2 POSITION: 41d51.76002'-86d40.97078'
(2 attempts)

Sand medium, muddy and gravelly, gray with some shells, unsorted.

SAMPLE#: GEO91-79 STATION#: 38-2 DEPTH: 7.0 POSITION: 41d51.49055'-86d40.59137'

Sand fine to very fine, tan, well sorted, homogeneous

SAMPLE#: GEO91-80 STATION#: 4-5 DEPTH: 6.1 POSITION: 41d51.26513'-86d40.77327'

Sand fine to medium, tan, moderately sorted, some shell material

SAMPLE#: GEO91-81 STATION#: 35-9 DEPTH: 13.7 POSITION: 41d51.03180'-86d41.61863'
(2 attempts)

Shale pebble, one only, unrounded. Not submitted for size analysis.

SAMPLE#: GEO91-82a STATION#: 35-8 DEPTH: 11.9 POSITION: 41d50.48952'-86d42.23113'

Sand fine, tan, with till and shale pebbles

SAMPLE#: GEO91-82b STATION#: 35-8 DEPTH: 11.9 POSITION: 41d50.48952'-86d42.23113'

Till, gray, sandy and silty

SAMPLE#: GEO91-83 STATION#: 35-7 DEPTH: 12.2 POSITION: 41d49.71515'-86d43.06910'
(14m off station; bathy shows 3 meter depression)

Sand fine, gray-brown, well sorted

SAMPLE#: GEO91-84 STATION#: 35-6 DEPTH: 10.0 POSITION: 41d49.34087'-86d43.47723'

Sand fine to very fine, tan, well sorted, homogeneous

SAMPLE#: GEO91-85 STATION#: 3-1 DEPTH: 9.1 POSITION: 41d49.28828'-86d43.63753'

Sand fine to very fine, gray, very well sorted

SAMPLE#: GEO91-86 STATION#: 35-2 DEPTH: 10.7 POSITION: 41d46.56173'-86d48.65632'

Sand fine to very fine, gray-brown, well sorted, some till clasts

SAMPLE#: GEO91-87 STATION#: 1-8 DEPTH: 9.1 POSITION: 41d45.97958'-86d49.78062'

Sand fine to very fine, tan, well sorted

SAMPLE#: GEO91-88 STATION#: 35-1 DEPTH: 9.8 POSITION: 41d45.89713'-86d50.01928'

Sand fine to very fine, with some pebbles; gray and tan, well sorted

SAMPLE#: GEO91-89 STATION#: 1-7 DEPTH: 15.5 POSITION: 41d46.19430'-86d49.97120'

Sand medium with some granules and pebbles, tan mottled with gray

SAMPLE#: GEO91-90 STATION#: 1-6 DEPTH: 14.9 POSITION: 41d46.47965'-86d50.24745'

Sand fine to very fine, gray mottled with tan, very well sorted

SAMPLE#: GEO91-91 STATION#: 1-5 DEPTH: 16.8 POSITION: 41d46.79703'-86d50.59348'
(Sample consolidated from two very small grabs)

Till silty, sandy, brown

SAMPLE#: GEO91-92 STATION#: 1-4 DEPTH: 16.1 POSITION: 41d47.58948'-86d51.26638'

Sand medium, gray-brown with dark granules, poorly sorted

SAMPLE#: GEO91-93 STATION#: 1-3 DEPTH: 15.2 POSITION: 41d47.63875'-86d51.31037'

Sand fine to very fine, tan, very well sorted homogeneous

SAMPLE#: GEO91-94 STATION#: 1-2 DEPTH: 21.2 POSITION: 41d48.98982'-86d52.60535'

Sand fine silty, gray; well sorted and homogeneous

SAMPLE#: GEO91-95 STATION#: 1-1 DEPTH: 26.5 POSITION: 41d50.07397'-86d53.61350'

Silt very dark gray, sorted

SAMPLE#: GEO91-96 STATION#: 2-1 DEPTH: 29.9 POSITION: 41d51.57812'-86d51.60207'

Silt some fine sand, very dark gray

SAMPLE#: GEO91-97 STATION#: 2-2 DEPTH: 23.3 POSITION: 41d50.29188'-86d50.24643'

Sand fine, slightly muddy, dark brown; well sorted

SAMPLE#: GEO91-98 STATION#: 2-3 DEPTH: 16.2 POSITION: 41d48.73873'-86d48.61737'

Sand fine to very fine, some silt, gray; well sorted

SAMPLE#: GEO91-99 STATION#: 2-4 DEPTH: 16.0 POSITION: 41d48.61257'-86d48.48278'

Sand fine to very fine, tan, very well sorted

SAMPLE#: GEO91-100 STATION#: 2-5 DEPTH: 15.2 POSITION: 41d47.85463'-86d47.68785'

Sand fine to medium, gray, moderately sorted

SAMPLE#: GEO91-101 STATION#: 2-6 DEPTH: 8.1 POSITION: 41d47.26588'-86d47.07672'

Sand very fine to fine, tan, well sorted

SAMPLE#: GEO91-102 STATION#: 35-3 DEPTH: 8.5 POSITION: 41d47.69627'-86d46.31890'

Sand fine to very fine with shale pebbles, laminated dark and light tan

SAMPLE#: GEO91-103 STATION#: 35-4 DEPTH: 8.5 POSITION: 41d47.86415'-86d46.02200'
(suspect nav - high PDOP)

Sand fine with some pebbles, tan to gray

SAMPLE#: GEO91-104 STATION#: 35-5 DEPTH: 7.8 POSITION: 41d48.57225'-86d44.80538'

Sand fine, tan, clean and well sorted

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NO SAMPLE# STATION#: 3-2 DEPTH: 13.0 POSITION: 41d49.43452'-86d43.82527'

No sample recovered– high wire angle. Possibly hard bottom.

NO SAMPLE# STATION#: 3-3 DEPTH: 16.3 POSITION: 41d49.88092'-86d44.33542'

No sample recovered– some fine sand in grab.

End cruise GEO91-1 due to high wind and waves.

Sample #	Station	Target	Position	Sample Position	*Azimuth	*Distance
GEO91-01	17-6	42d07.71457'	-86d29.16352'			
GEO91-02	17-5	42d07.86138'	-86d29.66797'			
GEO91-03	17-4	42d08.17992'	-86d30.90950'			
GEO91-04	17-3	42d08.57465'	-86d32.29363'			
GEO91-05	17-2	42d08.64802'	-86d32.56970'			
GEO91-06	15-7	42d05.96375'	-86d34.57007'			
GEO91-07	15-6	42d05.86228'	-86d34.26107'			
GEO91-08	15-5	42d05.48127'	-86d33.05703'			
GEO91-09	15-4	42d05.23847'	-86d32.27725'			
GEO91-10	15-3	42d05.13570'	-86d31.95060'			
GEO91-11	15-2	42d04.88930'	-86d31.18267'			
GEO91-12	15-1	42d04.80422'	-86d30.87198'			
GEO91-13	24-3	42d04.81115'	-86d30.74560'			
GEO91-14	28-5	42d04.99650'	-86d30.58862'			
GEO91-15	23-12	42d07.28585'	-86d29.52520'			
GEO91-16	29-1	42d05.10365'	-86d30.73043'	42d05.1190'	-86d30.7434'	327.8 33.6
GEO91-17	26-3	42d04.95535'	-86d30.83358'	42d04.9598'	-86d30.8378'	324.8 10.1
GEO91-18	28-4	42d05.20693'	-86d31.24050'	42d05.2244'	-86d31.2449'	349.4 32.9
GEO91-19	26-2	42d05.11087'	-86d31.31857'	42d05.1080'	-86d31.3251'	239.5 10.5
GEO91-20	24-2	42d05.02743'	-86d31.41257'	42d05.0311'	-86d31.4210'	300.3 13.5
GEO91-21	24-1	42d05.29572'	-86d32.26738'			
GEO91-22	28-3	42d05.48813'	-86d32.14208'	42d05.4943'	-86d32.1531'	306.9 19.0
GEO91-23	27-1	42d05.46478'	-86d32.24853'	42d05.4825'	-86d32.2580'	338.3 35.3
GEO91-24	28-2	42d05.62667'	-86d32.56205'	42d05.6243'	-86d32.5850'	262.1 31.9
GEO91-25	26-1	42d05.51262'	-86d32.56808'	42d05.5225'	-86d32.5732'	338.9 19.6
GEO91-26	28-1	42d05.90273'	-86d33.45565'	42d05.9032'	-86d33.4605'	277.4 6.7
GEO91-27	23-10	42d04.72820'	-86d31.06987'	42d04.7338'	-86d31.0710'	351.5 10.5
GEO91-28	14-4	42d04.41748'	-86d30.95863'	42d04.4200'	-86d30.9488'	71.0 14.3
GEO91-29	23-9	42d04.23218'	-86d31.40445'			
GEO91-30	14-3	42d03.99552'	-86d31.21717'	42d04.0003'	-86d31.2216'	325.4 10.8
GEO91-31	14-2	42d03.24182'	-86d31.69470'	42d03.2447'	-86d31.7090'	285.1 20.4
GEO91-32	14-1	42d02.85193'	-86d31.83437'	42d02.8520'	-86d31.8394'	271.1 6.9
GEO91-33	13-6	42d02.85220'	-86d32.24080'	42d02.8548'	-86d32.2525'	286.6 16.8
GEO91-34	23-8	42d02.52595'	-86d32.45867'	42d02.5298'	-86d32.4680'	299.0 14.7
GEO91-35	23-7	42d02.39073'	-86d32.56487'	42d02.3982'	-86d32.5657'	355.3 13.9
GEO91-36	23-5	42d01.54222'	-86d33.11565'	42d01.5464'	-86d33.1156'	0.5 7.7
GEO91-37	30-4	42d01.39138'	-86d33.05013'	42d01.3941'	-86d33.0529'	322.8 6.3
GEO91-38	32-5	42d01.25262'	-86d32.98710'	42d01.2657'	-86d32.9986'	326.8 29.0
GEO91-39	34-4	42d01.18827'	-86d33.12922'	42d01.1990'	-86d33.1275'	6.8 20.0
GEO91-40	23-4	42d00.77468'	-86d33.60758'	42d00.7772'	-86d33.6156'	292.8 12.0
GEO91-41	23-1	42d00.47005'	-86d33.80083'	42d00.4721'	-86d33.8059'	298.5 8.0
GEO91-42	32-4	42d01.52533'	-86d33.87052'	42d01.5336'	-86d33.8788'	323.3 19.1
GEO91-43	34-3	42d01.44258'	-86d33.99687'	42d01.4420'	-86d33.9924'	99.9 6.3
GEO91-44	30-3	42d01.74257'	-86d34.19288'			
GEO91-45	32-3	42d01.72710'	-86d34.53948'	42d01.7293'	-86d34.5514'	283.9 16.9
GEO91-46	34-2	42d01.66425'	-86d34.71697'	42d01.6713'	-86d34.7278'	311.1 19.8
GEO91-47	32-2	42d01.77150'	-86d34.68918'	42d01.7711'	-86d34.6891'	171.5 0.7
GEO91-48	34-1	42d01.86220'	-86d35.37893'	42d01.8680'	-86d35.3893'	306.9 17.9
GEO91-49	32-1	42d02.02170'	-86d35.51925'	42d02.0294'	-86d35.5306'	312.3 21.2
GEO91-50	30-1	42d02.07128'	-86d35.30778'	42d02.0741'	-86d35.2986'	67.6 13.7
GEO91-51	30-2	42d02.00580'	-86d35.07275'	42d02.0075'	-86d35.0769'	298.8 6.5
GEO91-52	13-1	42d04.25777'	-86d36.67958'			
GEO91-53	13-2	42d03.91267'	-86d35.59923'	42d03.9161'	-86d35.5995'	356.6 6.4
GEO91-54	13-3	42d03.66700'	-86d34.76375'	42d03.6722'	-86d34.7627'	8.6 9.7
GEO91-55	13-4	42d03.47123'	-86d34.19740'			
GEO91-56	13-5	42d03.25147'	-86d33.49938'	42d03.2619'	-86d33.5050'	338.1 20.8
GEO91-57	11-1	42d02.79487'	-86d37.55058'	42d02.7988'	-86d37.5664'	288.4 23.0
GEO91-58	10-1	42d00.49118'	-86d39.12133'	42d00.4985'	-86d39.1340'	307.8 22.1
GEO91-59	10-2	41d59.98973'	-86d37.27248'	41d59.9878'	-86d37.2851'	258.4 17.8
GEO91-60	10-3	41d59.45993'	-86d35.32215'	41d59.4685'	-86d35.3235'	353.3 16.0
GEO91-61	35-13	41d59.82902'	-86d34.07985'	41d59.8301'	-86d34.0798'	2.0 2.0
GEO91-62	10-4	41d59.19915'	-86d34.36942'	41d59.1990'	-86d34.3747'	267.8 7.3
GEO91-63	35-12	41d58.28293'	-86d34.72200'	41d58.2878'	-86d34.7203'	14.6 9.3
GEO91-64	8-1	41d56.82027'	-86d35.59855'	41d56.8188'	-86d35.6028'	245.1 6.5
GEO91-65	8-2	41d56.91947'	-86d35.92770'	41d56.9165'	-86d35.9331'	233.6 9.3
GEO91-66	8-3	41d56.97388'	-86d36.08762'	41d56.9713'	-86d36.0936'	240.0 9.5

Sample #	Station	Target Position		Sample Position		*Azimuth	*Distance
GEO91-67	8-4	41d57.11308'	-86d36.45543'	41d57.1158'	-86d36.4529'	34.8	6.1
GEO91-68	8-5	41d57.70405'	-86d38.16358'	41d57.7073'	-86d38.1697'	305.4	10.4
GEO91-69	8-6	41d58.30735'	-86d39.89920'	41d58.3110'	-86d39.8958'	34.8	8.2
GEO91-70	6-1	41d57.53912'	-86d42.26710'	41d57.5466'	-86d42.2635'	19.8	14.7
GEO91-71	6-2	41d56.37350'	-86d39.76738'	41d56.3756'	-86d39.7666'	15.5	4.0
GEO91-72	6-3	41d55.36038'	-86d37.60105'	41d55.3617'	-86d37.5990'	49.2	3.7
GEO91-73	6-4	41d55.27977'	-86d37.42658'	41d55.2821'	-86d37.4216'	57.9	8.1
GEO91-74	6-5	41d54.95227'	-86d36.71813'	41d54.9575'	-86d36.7140'	30.5	11.2
GEO91-75	5-1	41d52.59907'	-86d39.10087'	41d52.6005'	-86d39.0982'	54.4	4.5
GEO91-76	35-11	41d52.05245'	-86d40.16140'	41d52.0530'	-86d40.1621'	316.4	1.4
GEO91-77	35-10	41d51.98377'	-86d40.29045'	41d51.9811'	-86d40.2950'	231.9	8.0
GEO91-78	38-1	41d51.76002'	-86d40.97078'	41d51.7600'	-86d40.9694'	91.1	1.9
GEO91-79	38-2	41d51.49055'	-86d40.59137'	41d51.4885'	-86d40.5898'	150.2	4.4
GEO91-80	4-5	41d51.26513'	-86d40.77327'	41d51.2677'	-86d40.7730'	4.5	4.8
GEO91-81	35-9	41d51.03180'	-86d41.61863'	41d51.0342'	-86d41.6276'	289.7	13.2
GEO91-82	35-8	41d50.48952'	-86d42.23113'	41d50.4899'	-86d42.2329'	286.0	2.5
GEO91-83	35-7	41d49.71515'	-86d43.06910'	41d49.7118'	-86d43.0819'	250.7	18.8
GEO91-84	35-6	41d49.34087'	-86d43.47723'	41d49.3393'	-86d43.4851'	255.1	11.3
GEO91-85	3-1	41d49.28828'	-86d43.63753'	41d49.2935'	-86d43.6408'	334.9	10.7
GEO91-86	35-2	41d46.56173'	-86d48.65632'	41d46.5627'	-86d48.6640'	279.6	10.8
GEO91-87	1-8	41d45.97958'	-86d49.78062'	41d45.9819'	-86d49.7878'	293.3	10.8
GEO91-88	35-1	41d45.89713'	-86d50.01928'	41d45.8976'	-86d50.0189'	31.2	1.0
GEO91-89	1-7	41d46.19430'	-86d49.97120'	41d46.2004'	-86d49.9754'	332.7	12.7
GEO91-90	1-6	41d46.47965'	-86d50.24745'	41d46.4843'	-86d50.2539'	313.9	12.4
GEO91-91	1-5	41d46.79703'	-86d50.59348'	41d46.7996'	-86d50.6013'	293.7	11.8
GEO91-92	1-4	41d47.58948'	-86d51.26638'	41d47.5914'	-86d51.2656'	16.9	3.7
GEO91-93	1-3	41d47.63875'	-86d51.31037'	41d47.6419'	-86d51.3184'	297.7	12.6
GEO91-94	1-2	41d48.98982'	-86d52.60535'	41d48.9978'	-86d52.5831'	64.4	34.2
GEO91-95	1-1	41d50.07397'	-86d53.61350'	41d50.0768'	-86d53.6150'	338.4	5.6
GEO91-96	2-1	41d51.57812'	-86d51.60207'	41d51.5765'	-86d51.6006'	145.8	3.6
GEO91-97	2-2	41d50.29188'	-86d50.24643'	41d50.2908'	-86d50.2404'	103.5	8.6
GEO91-98	2-3	41d48.73873'	-86d48.61737'	41d48.7374'	-86d48.6136'	115.2	5.8
GEO91-99	2-4	41d48.61257'	-86d48.48278'	41d48.6112'	-86d48.4819'	154.3	2.8
GEO91-100	2-5	41d47.85463'	-86d47.68785'	41d47.8557'	-86d47.6899'	304.9	3.5
GEO91-101	2-6	41d47.26588'	-86d47.07672'	41d47.2637'	-86d47.0778'	200.3	4.3
GEO91-102	35-3	41d47.69627'	-86d46.31890'	41d47.6999'	-86d46.3196'	351.8	6.8
GEO91-103	35-4	41d47.86415'	-86d46.02200'	41d47.8670'	-86d46.0182'	44.9	7.5
GEO91-104	35-5	41d48.57225'	-86d44.80538'	41d48.5726'	-86d44.8048'	51.1	1.0
NOSAMPLE	3-2	41d49.43452'	-86d43.82527'				
NOSAMPLE	3-3	41d49.88092'	-86d44.33542'				
NOSAMPLE	15-8	42d06.21692'	-86d35.38912'				
NOSAMPLE	23-2	42d00.53740'	-86d33.75278'				
NOSAMPLE	23-3	42d00.58790'	-86d33.71592'				

$\Sigma = 993.6$

$n = 34$

* Azimuth in degrees from target to sample position. Distance in meters from target to sample position

$\bar{x} = 11.83m$ from target