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Maps Showing the Seabeam Bathymetry and Sedimentologic and Biologic Sample Locations On Horizon Guyot, Mid-Pacific Mountains and A Summary of Existing Data

by

William C. Schwab[1], James R. Hein[2], Kenneth L. Smith, Jr.[3], Christopher de Moustier[3], Lisa A. Levin[4], Amatzia Genin[5], W. Waldo Wakefield[3], and Roberta J. Baldwin[3]

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[1]USGS, Woods Hole, MA } ONLY USGS PARTICIPANTS
[2]USGS, Menlo Park, CA
[3]SCRIPPS Institution of Oceanography, La Jolla, CA
[4]North Carolina State University, Raleigh, NC
[5]H. Steinitz Marine Biology Laboratory, Eilat, ISRAEL

INTRODUCTION

Horizon Guyot (Fig. 1) is a 300-km-long, 75-km-wide volcanic ridge with a relatively flat summit that is diagnostic of guyots (Hess, 1946). The U. S. Geological Survey (USGS) began a study of Horizon Guyot in 1983 as part of a program on the origin, distribution, and composition of ferromanganese-oxide precipitates that encrust the hard substrate of sea floor edifices, such as seamounts and volcanic ridges (Hein and others, 1985a). Mass movement and bedload transport of sediment appears to influence the thickness of these crusts on seamount flanks (Hein and others, 1985b). Because Horizon Guyot has been studied more extensively than any other volcanic edifice in the Mid-Pacific Mountains (Heezen, Fischer, and others, 1971; Lonsdale and others, 1972; Winterer, Ewing, and others, 1973), it was chosen as the principal site for a USGS study of sediment transport processes and the geotechnical behavior of sediment on seamounts (Cacchione and others, 1987; Schwab and others, 1987).

In March, 1987, Horizon Guyot was again investigated using the *R/V ATLANTIS II* and the *D.S.R.V. ALVIN* (cruise 118-12). Although primarily a biologic investigation, observations from 10 submersible dives, bottom samples collected at depth using ALVIN and from the surface using the *ATLANTIS II*, and Seabeam swath-bathymetry add to the overall Horizon Guyot data set. In this report, we summarize the existing data base, present a Seabeam bathymetric map of the study area, *ALVIN* dive tracklines, the sample locations, and a brief description of the samples collected or other station activities on the *ATLANTIS II* cruise 118-12.

The detailed bathymetric map of the study area (Plate 1) was constructed by merging data obtained by a Deep-Tow study (Lonsdale and others, 1972) (Fig. 1) with data obtained from the swath-bathymetry mapping system onboard the *ATLANTIS II*. Detailed information on the Seabeam bathymetric system is given by Renard and Allenou (1979).

PREVIOUS INVESTIGATIONS

DEEP SEA DRILLING PROJECT SITES 44 AND 171

Site 171 reached volcanic basement in a saddle between the two summit platforms of Horizon Guyot (Fig. 1), recovering sediment as old as the Cenomanian-Turonian boundary (Winterer, Ewing, and others, 1973). The recovery of a shallow water limestone, subaerial basalt, and plant remains in the upper Cretaceous sequence of Site 171 indicates that Horizon Guyot was subaerially exposed from at least early Cenomanian (approximately 100 Ma) to late Turonian-early Coniacian time (approximately 90 Ma). Submergence of Horizon Guyot was well underway by Coniacian time and it continued through the remainder of the Cretaceous and Tertiary. The similarities in age and geochemistry between basalts from the Mid-Pacific Mountains and the Line Islands seamount chain suggests that volcanism in both areas is related and occurred over a span of 40 to 50 m.y. (Clague, 1981).

The late Cretaceous submergence of Horizon Guyot caused superficial deposits and volcanic constructional features to be buried by pyroclastics, volcaniclastics, and pelagic sediment. Sedimentation rates interpreted from nearby Deep Sea Drilling Project (DSDP) sites were approximately 3 m/m.y. for the middle Cretaceous, 22 m/m.y. for the late Cretaceous, and 4 m/m.y. for the early Tertiary (Winterer, Ewing, and others, 1973). Other DSDP data indicate slow or even negative rates of sediment accumulation in post-middle Miocene time (Winterer, Ewing, and others, 1973). A slowing of the accumulation of sediment is expected for Horizon Guyot due to its northward movement on the Pacific plate away from the equatorial zone of high biologic productivity. However, an increase in erosion and sediment transport by bottom currents began sometime in the past 10 m.y. as a consequence of late Cenozoic glaciation and the formation of large quantities of cold bottom water in the circum-Antarctic region (Winterer, Ewing, and others, 1973).

Site 44 drilled through the Tertiary nannofossil-foraminiferal ooze that caps Horizon Guyot but was not cored in the upper 40 m. Therefore, no biostratigraphic information exists for that interval (Fischer, Heezen, and others, 1971). Below a subbottom depth of 40 m, the youngest sediment dated is early Oligocene which is underlain by upper and middle Eocene nannofossil ooze (Bukry, 1971). Chert is intercalated in the sedimentary section. Drilling at Site 44 penetrated two thirds of the sedimentary cap of Horizon Guyot before being aborted at a subbottom depth of 76 m in middle Eocene chert because the bottom hole assembly parted.

GRAVITY CORES

Sediment gravity cores were collected on USGS cruises L5-83-HW and L9-84-CP using the *R/V S.P. LEE* (Schwab and Quinterno, 1986) (Plate 1). These cores were taken with corers weighing between 2 and 10 kN. All of the cores were contained within a plastic liner. Once onboard ship, the cores were sectioned into 1-m lengths, capped and sealed with cheesecloth and microcrystalline wax and preserved under refrigeration for shore laboratory testing. Cores collected on the sediment cap of Horizon Guyot consist almost entirely of biogenous calcium carbonate. Discoasters, other nannoplankton, and foraminifers comprise the majority of the sediment (Schwab and Quinterno, 1986). Calcium carbonate contents range from 88.4% to 95.6% (Table 1), as determined using a Coulometrics carbonate determinator connected to an acid digestor and an induction furnace (procedure described in Torresan, 1984).

Water Content (w) was determined at many intervals down-core (Table 1) using a drying and weighing technique (American Societey of Testing and Materials (ASTM) standard D2216-80). A correction was made to the weights to account for dried salt assuming a salinity of 35 ppt (Kayen and others, 1986). Horizon Guyot sediment water contents varied between 52.0 and 112.9 %.

Bulk density (ρ) was measured from consolidation and triaxial compression test samples (Kayen and others, 1986). These densities ranged between 1.46 g/cc and 2.07 g/cc (Table 1). Grain densities (G_s), determined with a Beckman air-comparison pycnometer varied between 2.67 and 2.80, averaging 2.73 (Table 1). These values are comparable to pure calcite which has a specific gravity of 2.72.

Grain size analyses were determined using a wet sieve technique and Coulter Counter. Most of the Horizon Guyot sediment is either a sandy clayey silt or a silty clayey sand (Table 1).

Laboratory mini-vane shear testing was performed on split core sections using a technique similar to the ASTM field vane standard D2573-72. A small four-bladed vane, 1.27 cm high by 1.27 cm diameter, was inserted perpendicular to the split core surface then rotated through a motorized torque cell at a rate of 90^0/min. Peak torque was measured and used to calculate the undrained shear strength (Table 1). The results of more sophisticated strength and consolidation testing of Horizon Guyot sediment is presented in Kayen and others (1986) and analysis of these data is presented in Schwab and others (1987).

Relatively short gravity cores collected on Horizon Guyot by Hamilton (1953) and by Lonsdale and others (1972) are not presented in this report but are discussed in Schwab and Quinterno (1986), Cacchione and others (1986, 1987), and Schwab and others (1987). Micropaleontological studies of subsamples from these cores and from the USGS cores are synthesized in Schwab and Quinterno (1986).

DREDGED SAMPLES

Rock samples were collected on the flanks and summit of Horizon Guyot. Most rocks recovered were hyaloclastites, volcanic breccias, and basalt cobbles. The basalt is mostly alkalic. Ferromanganese-oxide crusts coating these rocks average 15-mm thick. Descriptions and chemical analyses of these samples are presented in Hein and others (1985a, 1985b).

CURRENT METER AND TEMPERATURE MEASUREMENTS

An investigation of near-bottom currents over Horizon Guyot by the USGS (Cacchione and others, 1986) was largely motivated by earlier results reported by Lonsdale and others (1972). Based on short duration (less than 5 days) speed data from Savonius rotor-type current meters moored at 3 sites within 12 m of the sea floor in about 1675-m water depth, Lonsdale and others (1972) reported high tidal-current speeds of up to 17 cm/s atop the guyot where sand waves and sand ripples were observed in sidescan-sonar records and bottom photographs.

In order to analyze the tidal and lower frequency motions, the USGS deployed a single current meter mooring atop Horizon Guyot in about 1640 m water depth (Fig. 1) on November 10, 1983 and recovered it on August 11, 1984). Conductivity-Temperature-Depth (CTD) and dissolved-oxygen profiles were obtained in close proximity to the mooring location (Fig. 1). The USGS current meter mooring contained a vector-averaging current meter (VACM) at 213 m above the guyot summit which operated successfully for the entire 9 months. Vector-averaged currents and temperature were obtained every 15 min from 14 November 1983 through 10 August 1984. Hourly averages of the current components and temperature were computed, hourly values were low-pass filtered using a half-power cut-off of 30 hr, and statistical and spectral analyses were performed for each of the three types of data sets (raw, hourly averages, and low-pass filtered hourly values). These data and analyses are presented in Cacchione and others (1986). Results of this study showed that internal tidal currents are the likely cause of erosional features on the sediment cap of Horizon Guyot (Cacchione and others, 1987). It is thought that the anomalously strong tidal currents (speed = 30 cm/s) are the result of topographically induced generation of internal tidal waves (Nobel and others, 1987).

SEISMIC-REFLECTION PROFILES

High-resolution seismic-reflection data show that erosional processes acting on the sediment cap of Horizon Guyot are aerially extensive (Lonsdale and others, 1972; Schwab and Quinterno, 1986). Flat, hard-rock terraces are exposed at the summit perimeter, especially on the north flank (Fig. 1), as a result of this erosion (Lonsdale and others, 1972). An Eocene-age chert outcrop identified by Lonsdale and others (1972) can be recognized and followed upslope for 10 km under the pelagic sediment on USGS seismic-reflection profile 21 (outcrop B on Fig. 2) where it again appears to crop out at a water depth of 1513 m due to erosion of the overlying sediment. Further interpretation of profile 21 suggests that erosion of the sediment cap extends upslope to a water depth of at least 1472 m where, through extrapolation, the same chert layer appears to be exposed. Thus, erosion of the summit platform of Horizon Guyot is more extensive than the 1570 to 2000 m isobath-limit originally recognized by Lonsdale and others (1972) (Schwab and others, 1987).

USGS seimic-reflection profile 20 (Fig. 3) shows that large linear hummocks on the northern perimeter of the sediment cap of Horizon Guyot are caused by sediment slumping. This mass movement has occurred on an average sea floor declivity of 1.6^0 and extends from an exhumed hard-rock terrace at a water depth of 1845 m to a water depth of 1458 m. The slumping appears to have affected the sediment to a maximum subbottom depth of approximately 40 m. Slope stability analysis suggests that these slumps were most likely caused by infrequent earthquake loading (Kayen and others, 1986; Schwab and others, 1987).

ATLANTIS II CRUISE 118-12

The data collected on cruise 118-12 of the *R/V ATLANTIS II* and *D.S.R.V. ALVIN* are presented as station logs (Tables 2 and 3); station locations and *ALVIN* tracklines are shown on Plate 1 along with a detailed bathymetry map of the study area that was constructed using

Seabeam. In comparison to the preexisting bathymetry presented by Lonsdale and others (1972) (Fig. 1), the Seabeam map shows finer detail of the northern flank of Horizon Guyot, including submarine canyons and small volcanic pinnacles.

Mixed macrozooplankton were collected at 1, 5, 10, 20, and 50 m above the sea floor at stations S101, S111, and S122 with a 4-chambered slurp gun respirometer (SGR) mounted on *ALVIN*. This instrument is described by Smith and Baldwin (1983). Each chamber on the SGR is equipped with a polarographic oxygen sensor and stirring motor. Oxygen consumption by the zooplankton in each chamber is monitored for an incubation period of 1 to 2 days while tethered at depth to a mooring line.

Oxygen consumption by sediment biota and overlying water-column biota was monitored for incubation periods of 1 to 2 days using a grab respirometer at stations S105, S114, and S125. The grab respirometer consists of a stainless steel Ekman grab sampler that encloses 413 cm^2 of sediment surface and penetrates to a subbotom depth of 30 cm (Smith and others, 1978).

A bacterial sampling array (Smith and others, 1986) was used on *ALVIN* dives 1805, 1808, 1811, and 1813 to measure the metabolism and growth of bacterioplankton at 1, 5, 10, 20, and 50 m above the bottom. This array consisted of four 50 ml syringes mounted in two parallel banks in an aluminum rack. Upon initial release of a spring-loaded trigger by *ALVIN*, the syringe barrels were driven down, filling each syringe with ambient water and exposing it to radiolabelled compounds. After incubation, a second trigger was released to allow the syringes to take up formalin in order to poison the samples prior to returning to the surface.

Current meter arrays were successfully deployed and recovered at stations S102, S104, and S106. Each array consisted of two Savonius current meters tethered at elevations above the sea floor of 10 and 100 m. The arrays collected current data for approximately 8 days.

A sediment trap array was deployed for about 8 days at station S103. The array was composed of two sediment traps (one inverted) moored at an 100 m off-bottom.

A CTD/rossette was deployed at stations S109, S112, S121, and S128 producing conductivity - temperature profiles and collecting 12 water samples representative of the water column in close proximity to the current meter stations.

Two trawl samplers were towed with the *ATLANTIS II*. The multiple opening and closing net, MOCHNESS (Wiebe and others, 1976), was used at station S115 in order to sample zooplankton at water depths between 400 and 1200 m. A midwater trawl was towed at station S110 in order to sample micronekton at a similar water-depth range.

A series of amphipod trap arrays were deployed for 3 days at stations S117, S118, S119, and S120. These arrays were composed of a series of 4 to 8 traps. The arrangement of these traps and sampling techniques are described in Smith and Baldwin (1984).

Box cores were collected at stations S123 and S127 from the *ATLANTIS II*. Capable of subbottom penetration depths of 50 cm over a surface area of 900 cm^2, the recovered sediment was subsampled on deck with sub-cores for studies of infauna, bacterial counts, granulometry, CHN, and Pb-210 analysis.

A series of push cores and small box cores were collected using *ALVIN* for infaunal, radiochemical, and sedimentologic/geotechnical studies (Table 3). The push cores were 6.5 cm in diameter and had a maximum subbottom penetration of 30 cm. The box cores were 15 cm on a side and were capable of a maximum subbottom penetration of 20 cm.

DISCUSSION

Seismic-reflection profiles, sediment cores, and current velocities help assess the impact of erosion and sediment redistribution on Horizon Guyot (Cacchione and others, 1987; Schwab and others, 1987). Sediment transport processes are concentrated around the rim of the northwest perimeter of the guyot's sediment cap. Slope stability analysis (Schwab and others,

1987) suggests that if the measured overconsolidation of Horizon Guyot sediment is the result of this sediment transport (current reworking of the topmost sediment) or if local undercutting by bottom currents steepens the sea floor declivity, then portions of the sediment cap may be unstable during infrequent earthquakes, transporting sediment from the guyot summit to the abyssal sea floor.

The slope stability analysis of Schwab and others (1987) is based on laboratory generated sediment strength profiles obtained from triaxial compression testing of gravity cores collected by the USGS (Plate 1). Although the techniques described in Kayen and others (1986) were used to minimize the effects of sampling disturbance, some error remains. High quality push cores and box cores collected by ALVIN in the area of slumping (dives 1807, 1810, and 1814) will be analyzed to test the reliability of the slope stability analysis; i.e., to determine if the gravity cores collected by the USGS are representative of the slumped material.

Internal tidal currents are the likely cause of the erosional features, such as current ripples, sand waves, and truncated bedding horizons, on the sediment cap of Horizon Guyot (Cacchione and others, 1987). An analysis of the initiation of motion of the foraminiferal sand by the internal tidal currents indicates that these currents are likely to transport the surficial sediment and generate the observed bedforms (Cacchione and others, 1987). These findings were based on a single current meter mooring. Measurements from the current meter moorings at stations S102, S104, and S106 will be analyzed for correlation with the findings of the longer-term measurements in order to build a more accurate model of the sediment transport processes.

REFERENCES

American Society for Testing and Materials (ASTM), 1983, Annual book of ASTM standards, part 19, Natural Building Stones; Soil and Rock, ASTM, Philadelphia, 710 p.

Bukry, David, 1971, Cenozoic calcareous nannofossils from the Pacific Ocean: Transactions, San Diego Society of Natural History, v. 16, n. 14, 327 p.

Cacchione, D. A., Schwab, W. C., Tate, G. B., and Noble, Marlene, 1986, Current meter and temperature measurements and implications for sediment transport, in, Schwab, W. C., ed., Sedimentologic study of Horizon Guyot, Mid-Pacific Mountains: U. S. Geological Survey Open File Report 86-433, p. 104-132.

Cacchione, D. A., Schwab, W. C., Noble, Marlene, and Tate, G. B., 1987, Currents, temperature, and sediment movement on Horizon Guyot, Mid-Pacific Mountains: Geo-Marine Letters (IN PRESS).

Clague, D. A., 1981, Linear island and seamount chains, aseismic ridges, and intraplate volcanism: Results from DSDP, in, Warme, J. E. Douglas, R. G., and Winterer E. L., eds., The Deep Sea Drilling Project: a decade of progress: Society of Economic Paleontologists and Mineralogists, Special Publication No. 32, p. 7-22.

Fischer, A. G., Heezen, B. C., and others, 1971, Initial reports of the Deep Sea Drilling Project, v. VI, Washington, D. C., U. S. Government Printing Office, 1329 p.

Heezen, B. C., Fischer, A. G., and others, 1971, Site 44, in, Fischer, A. G., Heezen, B. C., and others, Initial reports of the Deep Sea Drilling Project, v. 6, Washington, D. C., U. S. Government Printing Office, p. 17-19.

Hamilton, E. L., 1953, Upper Cretaceous, Tertiary, and recent planktonic foraminifera from mid-Pacific flat-topped seamounts: Journal of Paleontology, v. 27, no. 2, p. 204-237.

Hein, J. R., Manheim, F. T., Schwab, W. C., and Davis, A. S., 1985b, Ferromanganese crusts from Necker Ridge, Horizon Guyot, and S. P. LEE Guyot: Geological considerations: Marine Geology, v. 69, p. 25-54.

Hein, J. R., Manheim, F. T., Schwab, W. C., Davis, A. S., Daniel, C. L., Bouse, R. M., Morgenson, L. A., Sliney, R. E., Clague, D. A., Tate, G. B., and Cacchione, D. A., 1985a, Geological and geochemical data for seamounts and associated ferromanganese crusts in and near the Hawaiian, Johnston Island, and Palmyra Island Exclusive Economic Zones: U. S. Geological Survey Open File Report 85-292, 129 p.

Hess, H. H., 1946, Drowned ancient islands of the Pacific basin: American Journal of Science, v. 244, p. 772-791.

Kayen, R. E., Lee, H. J., and Schwab, W. C., 1986, Geotechnical analysis and physical properties of sediment from Horizon Guyot, in, Schwab, W. C., ed., Sedimentologic study of Horizon Guyot, Mid-Pacific Mountains: U. S. Geological Survey Open File Report 86-433, p. 29-103.

Lonsdale, P. F., Normark, W. R., and Newman, W. A., 1972, Sedimentation and erosion on Horizon Guyot: Geological Society of America Bulletin, v. 83, p. 289-316.

Noble, Marlene, Cacchione, D. A., and Schwab, W. C., 1987, Observations of strong mid-Pacific internal tides above Horizon Guyot: Journal of Physical Oceanography (IN PRESS).

Renard, V., and Allenou, J. P., 1979, Seabeam, multi-beam echo-sounding on *JEAN CHARCOT*: description, evaluation, and first results: International Hydrographic Review, v. 56., p. 35-67.

Schwab, W. C., Lee, H. J., Kayen, R. E., Quinterno, P. J., and Tate, G. B., 1987, Erosion and slope instability on Horizon Guyot, Mid-Pacific Mountains: Geo-Marine Letters (IN PRESS).

Schwab, W. C., and Quinterno, P. J., 1986, Geologic Setting and sedimentologic environment of Horizon Guyot, in, Schwab, W. C., Sedimentologic Study of Horizon Guyot, Mid-Pacific Mountains: U. S. Geological Survey Open File Report 86-433. p. 3-28.

Smith, K. L. Jr., and Baldwin, R. J., 1983, Deep-sea respirometry: In-situ techniques, in, Gnaiger, E., and Forstner, H., eds., Polarographic oxygen sensors: Springer-Verlag, Berlin, 17 p.

Smith, K. J., Jr., and Baldwin, R. J., 1984, Vertical distribution of the necrophagous amphipod, *Eurythenes gryllus*, in the north Pacific; spatial and temporal variations: Deep-Sea Research, v. 31, p. 1179-1196.

Smith, K. L., Jr., Carlucci, A. F., Williams, P. M., Henrichs, S. M., Baldwin, R. J., and Craven, D. B., 1986, Zooplankton and bacterioplankton of an abyssal benthic boundary layer: in situ rates of metabolism: Oceanologica Acta, v. 9, p. 47-55.

Smith, K. L., Jr., White, G. A., Laver, M. B., and Haugsness, J. A., 1978, Nutrient exchange and oxygen consumption by deep-sea benthic communities: preliminary in-situ measurements: Limnological Oceanography, v. 23, p. 997-1005.

Torresan, M. E., 1984, Fabric and its relation to sedimentological and geotechnical properties of near-surface sediment in Shelikof Strait, Alaska: [master's thesis]: San Jose State University, California, 220 p.

Wiebe, P. H., Burt, K. H., Boyd, S. H., and Morton, A. W., 1976, A multiple opening/closing net and environmental sensing for sampling zooplankton: Journal of Marine Research, v. 34, p. 313-326.

Winterer, E. L., Ewing, J. I., and others, 1973, Initial reports of the Deep Sea Drilling Project, v. 17, Washington, D. C., U. S. Government Printing Office, 1283 p.

Table 1. Sediment Index Properties and Shear Strength[1]

Cruise	Core	Depth (cm)	w (%)	ρ (g/cc)	Grain Size (%) sand	silt	clay	$CaCO_3$ (%)	Vane Shear Strength(kPa)	G_s
L5-83-HW	GC2	72	88.0						3.3	
L5-83-HW	GC2	174	89.0						3.3	
L5-83-HW	GC2	274	93.8						1.6	
L5-83-HW	GC2	303	84.3	1.54						
L5-83-HW	GC3	103	82.5	1.55						
L5-83-HW	GC3	119	64.0						0.4	
L5-83-HW	GC4	36	104.0						1.8	
L5-83-HW	GC4	133	87.0						4.8	
L9-84-CP	GC2	30						94.3		
L9-84-CP	GC2	70	81.5	1.53	46.63	40.71	12.66		12.2	2.72
L9-84-CP	GC2	80	75.0		52.19	37.10	10.71			
L9-84-CP	GC2	90	86.6		52.46	39.01	8.53			
L9-84-CP	GC2	105	104.4		42.63	44.36	13.01		23.9	
L9-84-CP	GC2	125	96.0		41.70	40.83	17.48	88.4	16.1	
L9-84-CP	GC2	140	71.4		39.52	46.84	13.64	92.4	18.1	
L9-84-CP	GC2	160	98.8		35.33	49.85	14.83		20.2	
L9-84-CP	GC2	175	79.3					95.6		
L9-84-CP	GC2	195	86.9		35.12	49.05	15.83		22.2	
L9-84-CP	GC2	205						92.5		
L9-84-CP	GC2	215	81.5		6.37	70.18	23.46		21.4	
L9-84-CP	GC2	240	57.6		5.46	63.44	31.15	95.2	12.4	
L9-84-CP	GC2	250	65.2		5.77	80.48	13.75		14.8	
L9-84-CP	GC3	26	103.1							
L9-84-CP	GC3	111	91.0							
L9-84-CP	GC3	196			35.97	54.79	9.24			
L9-84-CP	GC4	16	90.1							
L9-84-CP	GC4	101	77.0							
L9-84-CP	GC4	115	75.3	1.61	38.03	57.03	4.94			
L9-84-CP	GC4	123	87.1	1.57	39.46	46.08	14.46			
L9-84-CP	GC5	13	79.1	1.55	41.61	40.74	17.65		7.4	2.77
L9-84-CP	GC5	38	91.9		23.49	52.39	24.12		6.6	
L9-84-CP	GC5	55	76.0	1.56	7.92	40.51	51.58		9.5	2.73
L9-84-CP	GC5	72	75.7		6.77	34.99	58.25		7.4	
L9-84-CP	GC5	98	87.5		10.98	30.99	58.03		2.1	
L9-84-CP	GC5	121	90.6		9.00	33.38	57.62		4.9	
L9-84-CP	GC5	150	71.6		18.83	46.78	40.38		2.9	
L9-84-CP	GC5	165	94.4	1.49	63.79	23.43	12.78			2.75
L9-84-CP	GC5	180	93.4		45.19	26.74	28.07		7.4	
L9-84-CP	GC6	0	102.7							
L9-84-CP	GC6	12	91.4	1.5	81.48	7.89	10.62			2.77
L9-84-CP	GC6	20	93.8		42.01	32.77	25.22		4.9	
L9-84-CP	GC6	34	62.4							
L9-84-CP	GC6	60	70.8		40.85	50.93	8.22		17.7	
L9-84-CP	GC6	80	81.1		35.32	29.47	35.20		23.1	
L9-84-CP	GC6	100	87.9		36.55	51.54	11.91		18.9	
L9-84-CP	GC6	118	77.1							
L9-84-CP	GC6	138	112.9		35.28	41.94	22.78		20.6	

Table 1 (cont.). Sediment Index Properties and Shear Strength[1]

Cruise	Core	Depth (cm)	w (%)	ρ (g/cc)	Grain Size (%) sand	silt	clay	$CaCO_3$ (%)	Vane Shear Strength(kPa)	G_s
L9-84-CP	GC6	164	82.0		30.61	30.92	38.47		23.9	
L9-84-CP	GC6	191	52.0		32.91	53.91	13.08		19.4	
L9-84-CP	GC6	202	75.2							
L9-84-CP	GC6	218	72.7	1.59	33.48	50.80	15.72		18.1	2.80
L9-84-CP	GC6	250	78.7	1.55	35.00	46.23	18.77		25.5	2.75
L9-84-CP	GC6	270	90.0	1.49	43.01	27.81	29.18		19.4	2.69
L9-84-CP	GC7	0	74.7		52.40	29.63	17.97			
L9-84-CP	GC7	38	90.1							
L9-84-CP	GC7	95	93.8	1.49	44.72	24.88	30.4			
L9-84-CP	GC7	119	80.6							
L9-84-CP	GC7	170	93.3	1.49	45.50	33.50	21.00			
L9-84-CP	GC7	203	80.5							
L9-84-CP	GC7	260	70.0	1.58	33.92	31.94	34.14			
L9-84-CP	GC7	265	75.9	1.64	39.73	31.61	28.66			
L9-84-CP	GC7	275	65.8	1.76						
L9-84-CP	GC8	0	95.4							
L9-84-CP	GC8	70	78.9	1.52	39.87	46.31	14.00			
L9-84-CP	GC8	80	81.4	1.64	41.03	50.75	8.21			
L9-84-CP	GC8	90	81.2	1.87	33.05	46.84	20.09			
L9-84-CP	GC8	100	83.9	1.60	33.70	51.84	10.46			
L9-84-CP	GC8	110	83.6	1.46						
L9-84-CP	GC8	120	76.8	1.56						
L9-84-CP	GC8	125	88.9	1.63	37.94	51.14	10.92			
L9-84-CP	GC8	133	85.5	2.07	38.55	50.31	10.94			
L9-84-CP	GC8	156	78.2	1.56	27.58	52.51	19.90			
L9-84-CP	GC8	195	77.2	1.77	28.08	44.31	27.61			
L9-84-CP	GC8	200	78.7	1.56						
L9-84-CP	GC9	20	72.1		33.23	45.50	21.25		17.3	
L9-84-CP	GC9	37	78.1		54.45	40.21	5.34		28.0	
L9-84-CP	GC9	65	103.7		41.13	24.97	33.90		10.7	
L9-84-CP	GC9	85	91.0		37.05	48.80	14.16		13.2	
L9-84-CP	GC9	108	78.9	1.54	36.45	21.41	42.14		15.6	2.67
L9-84-CP	GC9	118	69.4							
L9-84-CP	GC9	140	84.0		24.23	61.68	14.09		10.3	
L9-84-CP	GC9	165	92.1		22.67	26.05	51.28		15.6	
L9-84-CP	GC9	190	80.3		24.62	26.47	48.91		8.2	
L9-84-CP	GC9	201	81.3							
L9-84-CP	GC9	215	86.3		22.25	52.96	24.79		15.6	
L9-84-CP	GC9	235	78.9		26.16	35.48	38.36		27.2	
L9-84-CP	GC9	255	73.6	1.58	24.87	45.70	29.43		32.1	2.69
L9-84-CP	GC9	278	81.4		30.76	45.60	23.64		13.2	

[1] from Kayen and others (1986)

Table 2. Cruise 118-12 Station Log (Biologic)

Station	Activity*	Station	Activity
S101	SGR	S115	MO
S102	CM	S117	AT
S103	ST	S118	AT
S104	CM	S119	AT
S105	GR	S120	AT
S106	CM	S121	CTD
S109	CTD	S122	SGR
S110	IKMT	S123	UBC
S111	SGR	S124	IKMT
S112	CTD	S125	GR
S113	IKMT	S126	CTD
S114	GR	S127	UBC
		S128	CTD

*SGR = slurp gun respirometer
CM = current meter array
ST = sediment trap array
GR = grab respirometer
CTD = conductivity-temperature-depth/water sample rossette
IKMT = midwater trawl
MO = MOCHNESS
AT = amphipod trap array
UBC = box core

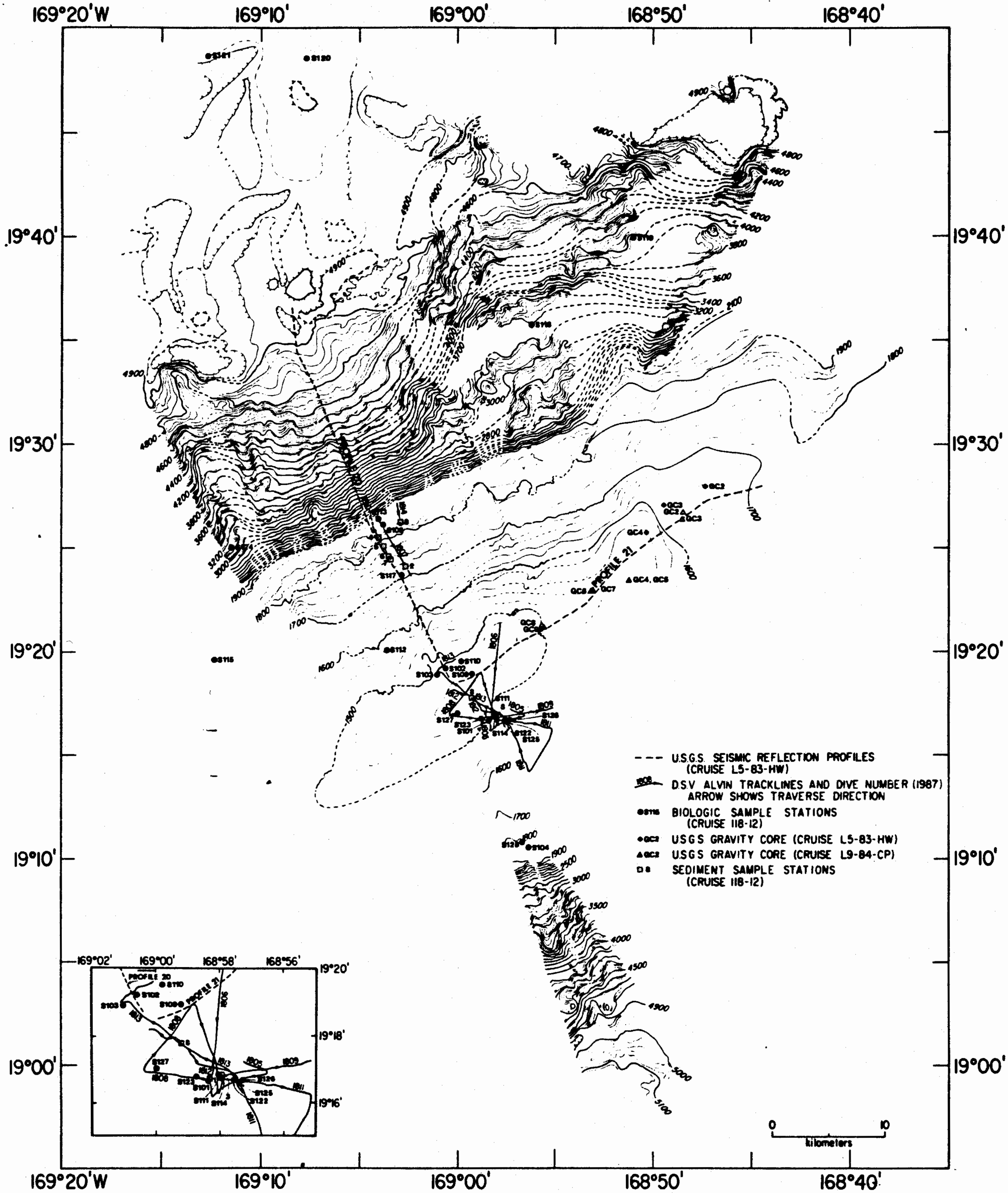
Table 3. DSV ALVIN Sample Stations (Sedimentologic)

Dive No.	Station	Sample*
1806	1	PC1, PC2
1807	2	PC2, PC3, BC1
1809	3	BC1
1810	4	PC5, PC6, PC7, PC8, BC1, BC2, BC3, RS1
1810	5	PC3, PC4
1810	6	RS2
1810	7	PC1, PC2
1812	8	PC1, BC1
1814	9	PC1, PC2, PC3, PC4, PC5, PC6, BC1, BC2, BC3, BC4

*PC = push core
BC = box core
RS = rock sample

(THIS WILL BE A FOLDOUT)

PLATE 1



(IN PREPARATION)

Figure 1. Base map of Horizon Guyot modified from Lonsdale and others (1972) showing the locations of exhumed hard rock (volcanic) terraces, Deep-Tow study area, DSDP drill sites, USGS CTD stations, and the USGS current-meter mooring. Bathymetric contours are in meters.

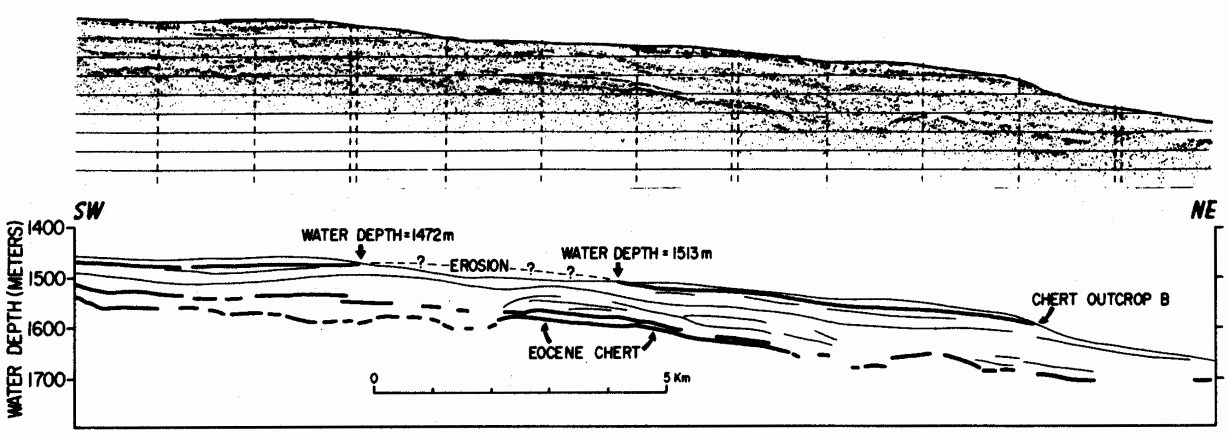


Figure 2. 3.5 kHz seismic-reflection profile 21 and interpretive sketch (from Schwab and Quinterno, 1986). The reflector labeled Eocene Chert was identified at DSDP Site 44 (Fischer, Heezen and others, 1971). The location of this profile is shown on Plate 1.

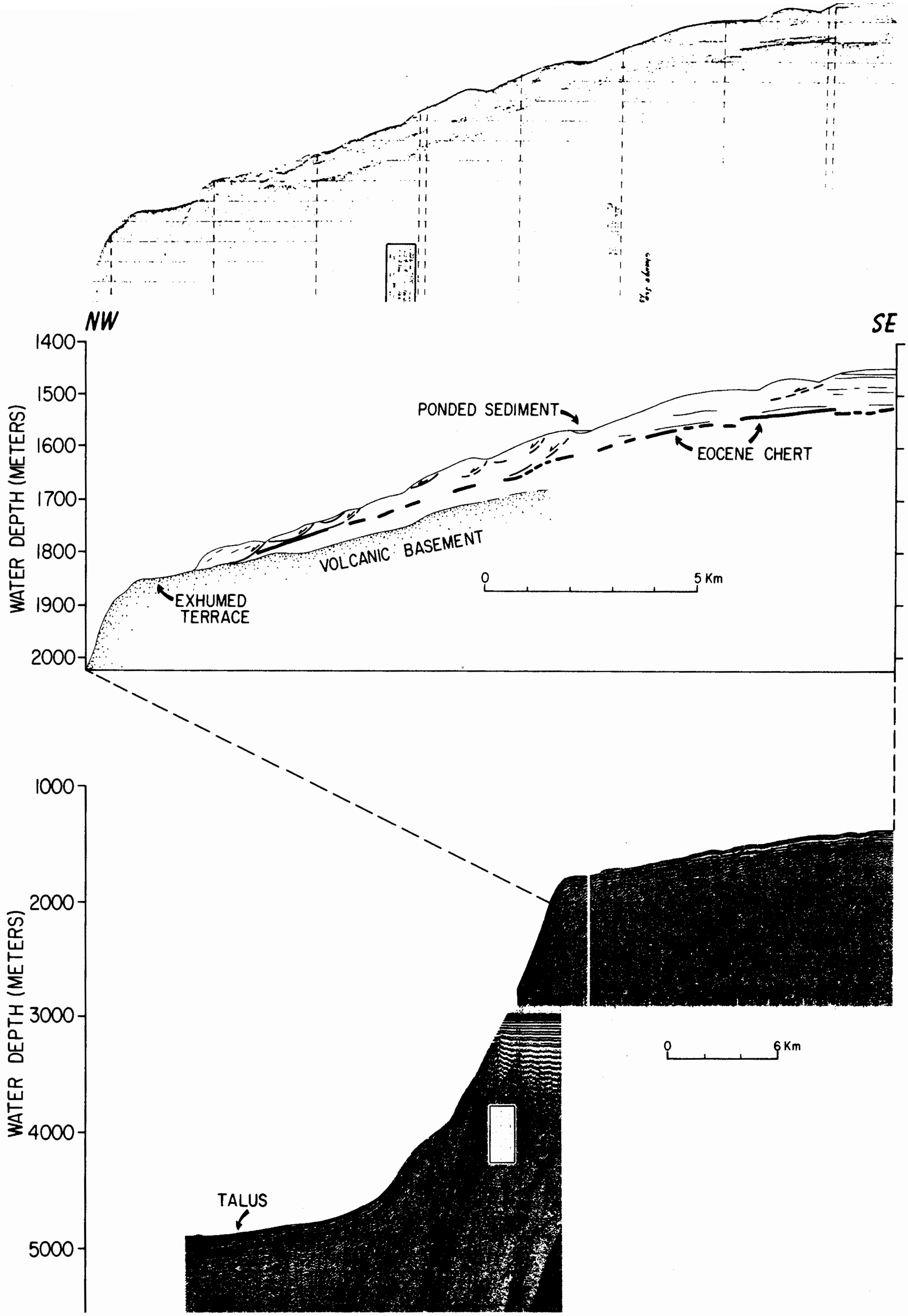


Figure 3. 80 in^3 airgun seismic-reflection profile 20 with a segment of the 3.5 kHz profile collected over an area of slumping and interpretive sketch (from Schwab and others, 1987). For location see Plate 1.