

**SHORT CRUISE REPORT**  
**RV METEOR: cruises M-66/3a and 3b**

from Caldera, Costa Rica to Caldera, Costa Rica (3a)  
October, 25. to November, 11. 2005

and

from Caldera, Costa Rica to Corinto, Nicaragua (3b)  
November, 12. to November, 19. 2005

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## **Research plan:**

- Sampling of Mound 11, Mound 12, Mound Culebra, Mound Baula, Mound Quetzal using the BGS RockDrill system in rotary drilling mode.
- Sampling the flanks of Mound 11, Mound 12 and Mound Culebra using the BGS RockDrill system in vibrocorer mode.
- Recording core logs of gamma density, compression wave velocity and magnetic susceptibility on RockDrill and gravity cores using a GEOTEK full core logging system.
- Sampling of pore water and immediate determination of pH, alkalinity, SCO<sub>2</sub>, CH<sub>4</sub>, NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup>, SO<sub>4</sub><sup>2-</sup>, SH<sub>2</sub>S, Br<sup>-</sup>, I<sup>-</sup>, Cl<sup>-</sup>, F<sup>-</sup>, Si, Fe<sup>2+</sup> as well as conservation of sub-samples for subsequent analysis of further elements (Si, Ca, Mg, Ba, Sr, K, Na, Fe, Mn, Al, U, Mo, As, Sb, W, Pb, Y-REE, Cr, V, Cu, Co, Ni).
- Conservation of the solid phase for geochemical analyses (POC, S, Ca, Mg, Sr, Ba, Fe, Mn, N, Br, I, F).
- Logging of RockDrill rotary and vibrocorer cores and gravity cores for gamma density, compressional wave velocity and magnetic susceptibility.
- Testing a new device Lander-based system to measure in-situ pore pressure changes on Mound 11
- Collection of continuous echographic records with the shipboard acoustic systems PARASOUND and HYDROSWEEP.

## **Cruise Narrative**

Cruise M66/3a began with a call to the port of Caldera, Costa Rica, which was occupied by numerous logistical tasks. After the University of Bremen QUEST container had gone from board, laboratory containers, reefer containers, a 40-foot container and the winch for the Rockdrill system were placed on the working deck. On 25 October the loading work was finished by transferring the Rockdrill system, which had been pre-assembled on the pier, onto the ship. R/V METEOR left the port of Caldera on 26 October at 10:00 sharp. After a short "wet test" of the Rockdrill system in Nicoya Bay, we headed for our working area off Nicaragua, where we arrived in the morning of 27 October.

The first runs of the British Rockdrill system took place at a water depth of 880m on the summit of Mound Baula, a 200-m-high structure with a diameter of 2.5 km that consists of massive carbonates. While the first trials in "rotary" mode did not produce much core material, the subsequent runs in "vibrocore" mode were very successful. From the saddle region of Mound Baula we were able to retrieve cores with clastic sediment, part of which showed an extensive gas

hydrate cementation. 24-hour-Rockdrill deployments were carried out on 29 and 30 October, sampling Mounds Iguana, Quetzal and Carablanca. The nights were used for the more time-consuming operations in rotary mode and the days for the vibrocore mode. In addition, we took gravity cores and performed PARASOUND mapping on the extended Massaya slide that is located directly beneath the Nicaragua Mounds and consists of several phases. The newly developed PWP lander for long-term measurements of pore pressure variations in active venting areas was deployed for the first time.

One of the highlights of the first days was the discovery that Mound Carablanca, which had hitherto been classified as a carbonate mound due to its acoustic signature, is clearly of a young, diapiric origin, and that areas of high backscatter are characterised by clay clasts that were emplaced through diapiric transport. A further highlight was the recovery of core M66/129 (Fig. 1), the first core with authigenic carbonates, sampled from Mound Iguana using the BGS Rockdrill. Three main zones could be identified during the first examinations: The upper layer is about 16 cm thick and shows primary authigenic carbonates with fractures filled with secondary authigenic carbonate. The second zone (about 24 cm thick) consists of authigenic carbonate containing a lot of shells, with crystalline, layered palisade carbonate in cavities and cemented foraminifera and crystals. The lowermost zone (about 12 cm thick) consists of clay clasts and a matrix of authigenic carbonates.

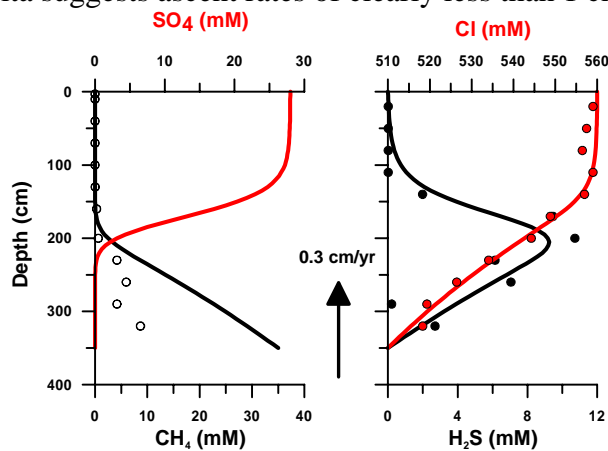


*Figure 1: Deployment of the BGS Rockdrill system on METEOR 66/3a, Core M66-129-Mound Iguana (left), calcitic filling (below)*

The second week was again dedicated to the northern part of the working area off Nicaragua.

Efforts were undertaken to get BGS Rockdrill cores from massive carbonates, yet only at some of the sites in the Perezoso Mound area and the Baula massive they were successful. Here, cores of up to 100 cm in length could be recovered.

In addition, the sedimentological and geochemical work was continued. Various mound structures were sampled with the BGS vibrocorer and the gravity corer. Pore waters were examined with regard to an ascent of deep fluids which are characterised by negative chloride anomalies, i.e. a depletion in salt in comparison to sea water. So far, such fluids have only been detected in the southern part of our working area off Costa Rica, where they can definitely be attributed to dewatering of clay minerals in the sediments of the subducting oceanic plate. In total, 8 of the 10 structures sampled off Nicaragua showed negative chloride anomalies. However, the anomalies found here are usually less significant, and there are clear differences in the concentrations of nutrients compared to the pore waters of the southern working area off Costa Rica. These differences may indicate shallow circulation systems transporting sea water deeper into the sediments and thus weakening the original fluid signal. Considering all the data, only low ascent rates can be assumed for the whole area. Preliminary modelling of the pore water data from Mound Culebrita suggests ascent rates of clearly less than 1 cm per year.



*Fig. 2: Recorded data and results of modelling of pore water concentrations of chloride, methane, sulfate and hydrosulphide*

The important role the explosive volcanism that is characteristic of subduction zones plays in marine sedimentation is proven by ash layers and ash lenses found in the numerous cores sampled off Nicaragua. Based on their stratigraphic position within the cores and their appearance they were preliminarily matched to eruptions on land. As an example, the photograph in Fig. 3 shows an ash layer of 9 cm in thickness which we assume to be correlated to the Chiltepe eruption of the Apoyeque volcano near the Nicaraguan capital Managua which took place about 2000 years ago.

Another main object of study were the mechanisms triggering submarine landslides. Gravity cores were taken from three submarine landslides located in the deeper part of the continental margin off Nicaragua. We were able to retrieve an exemplary core, core no. M66-3a-151, from Hermosa Slide. It penetrated right through the consolidated,



Fig. 3: Ash layer from the Chiltepe eruption (ca 2000 years ago)

clayey slide plane and the discordant slided mass above it. It is a noteworthy fact that the two sedimentary zones are separated by a thin layer of ash, which presumably was a weak interval and thus an important factor in the destabilisation. Already on previous cruises, ash layers were identified as zones of instability at the base of slides, so that these results fit well into our previous observations.

The first pore analyses performed on board show a marked leap of the gradient of alkalinity and thus support the results of the core classification.

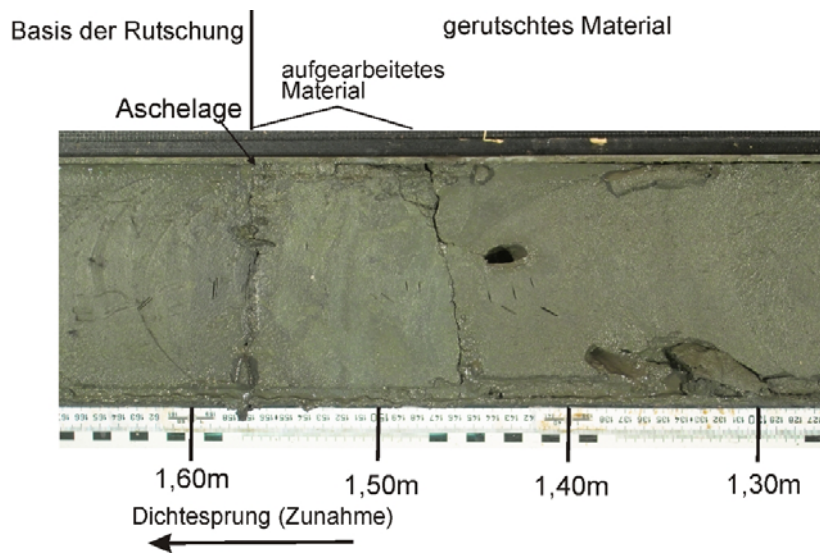


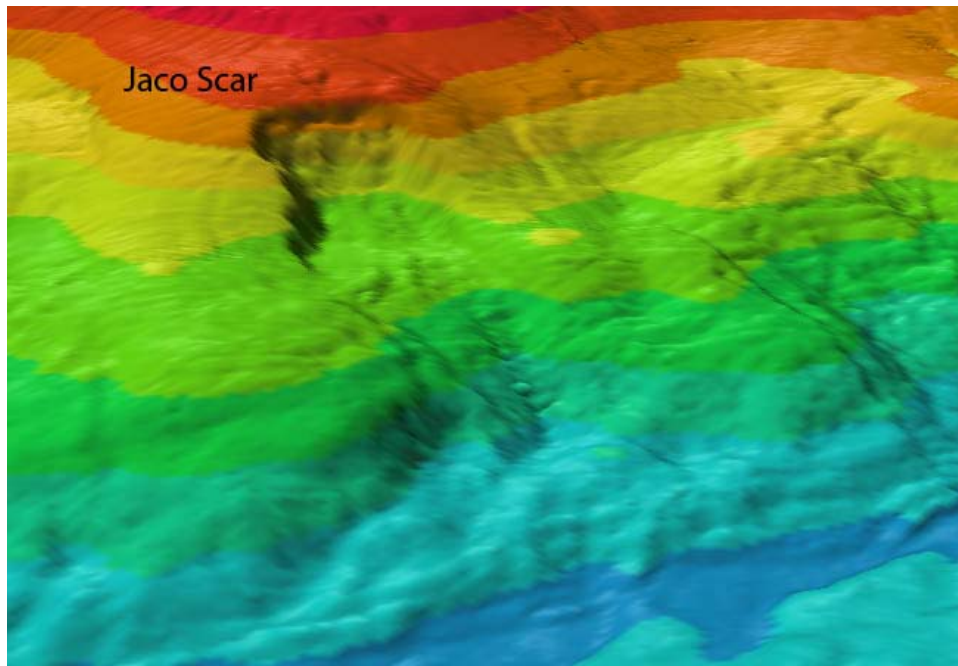
Fig 4:  
Detailed  
of

*insight into the basis  
Hermosa Slide*

Our work off Nicaragua was concluded by recovering the PWP lander, a new in situ tool developed by the SFB 574. The second deployment was very successful. Over a period of three days high-resolution pore pressure profiles have been recorded from depths of up to 2 m.

A further deployment of the PWPL is planned in the area of Mound 12 off Costa Rica, where there are already several flow meters belonging to an US group that were deployed by ALVIN as well as IFM-GEOMAR ocean bottom seismometers (OBS).

On Saturday, 5 November, R/V METEOR left the northern working area off Nicaragua. In the morning of 6 November we arrived off Costa Rica and started Rockdrill sampling at the base of the Jaco Scar slide.



*Fig. 5: Perspective view of the bathymetry of Jaco Scar at the Costa Rican continental margin. The whole structure is about 8 km wide and 20 km long. It was formed by the subduction of a seamount.*

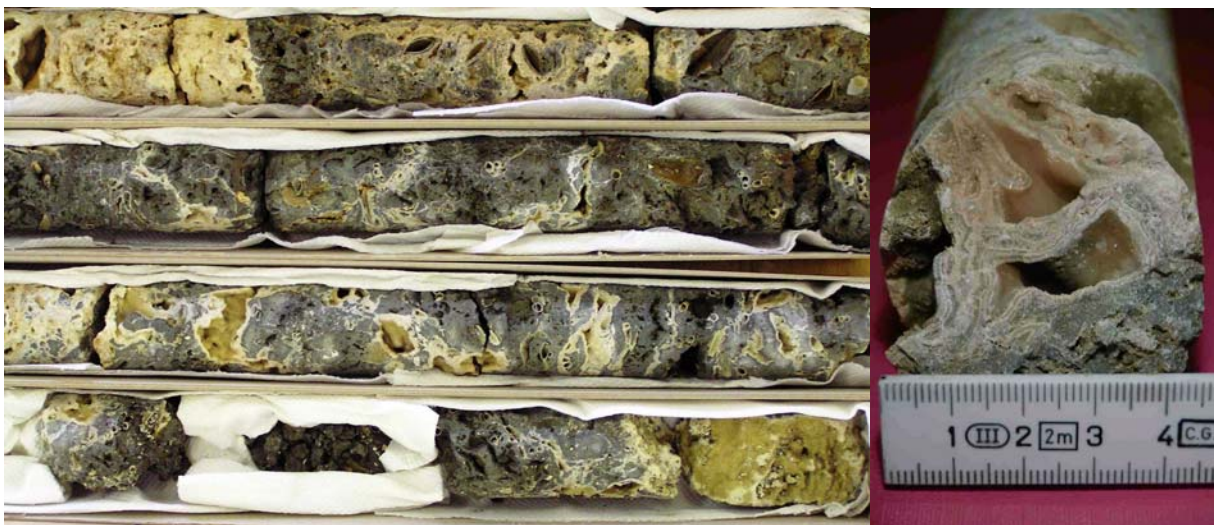
In the third week of leg M66/3a we concentrated our work on the southern working area off Costa Rica. Corresponding to the northern working area off Nicaragua, we mainly focussed on drilling carbonate mounds, which are an important element in the process of volatile and fluid recycling at this erosive continental margin off Central America. It was our aim to sample authigenic carbonates from the summits of the mounds studied during our previous cruises. They were to serve as the basis for a high-resolution reconstruction of the history of devolatilisation and defluidisation. Unfortunately, our attempts to drill carbonates from the best-examined mounds in this area, mounds 11 and 12, were unsuccessful as we did not find carbonates that were sufficiently massive to be cored by the BGS rockdrill.

Two cores with a clear signal of deep fluids were taken from the central area of mound 12. They indicated a direct connection to the fault running NW-SW and thus to Mound 11 which is located further to the south-east. The site work on mound 11 and 12 was completed by retrieving the PWP lander developed by the SFB. Again, it was successful in collecting high-resolution in situ pore pressure profiles which are to be correlated with the data of several flow meters (Scripps,

San Diego) and ocean bottom seismometers (IFM-GEOMAR, Kiel) that are currently deployed at the same site.

Our examinations of Jaco Scar (Fig. 5), a large erosive structure created by seamount subduction, turned out a great success. Several cores were sampled from the basis of Jaco Scar using the BGS vibrocorer. They were taken in the immediate vicinity of extensive fields of tube worms. Pore water chemistry showed clear signs of deep fluids.

Above Jaco Scar, the continental slope is bulged upward by the subducting seamount. Here, we were able to observe and core thick layers of carbonate. Core M66-215 (Fig. 6), which is 317 cm long, is the greatest highlight of the BGS Rockdrill drilling programme.



*Fig. 6: Overview photograph and detail of M66-215.*

We would like to stress the unusually good quality of the cored material: few fractures, complete core segments of up to 42 cm. The core is composed of two sequences recurring throughout the whole thickness of the material sampled: Medium grey to dark grey primary carbonates with a high content of sediments and cemented tube worms and shells alternate with light beige to white secondary carbonates (Fig. 6). It should be noted that this is a fossil analogue to the faunal community found recently at the basis of Jaco Scar. Thus, the core serves as a document of a dewatering process caused by seamount subduction that has not been included in quantitative assessments so far.

Leg METEOR M66/3a ended in the morning of 11 November when R/V METEOR berthed in the port of Caldera, Costa Rica. 11 members of the scientist crew left the ship. The BGS rockdrill was demobilised and taken from board, three containers left the ship. Four containers had arrived with the equipment for leg M66/4a and were unloaded. A new, 8000-m-long coaxial cable was spooled onto winch W12. Our two-day, busy port call was accompanied by an event for presentation and representation that had been organised in collaboration with the German embassy in San José. Apart from the ambassador, among the participants there were representatives of university institutes, authorities and the media. The scientist group was completed by 10 newly arrived members, and R/V METEOR left the port of Caldera in the

morning of 13 November, heading north in order to start the working programme of leg M66/3b off Nicoya peninsula.

### **Cruise M66/3b**

The programme for the last week of M66/3 mainly comprised sampling ash layers and performing heat flux measurements in the northern working area off Nicaragua, El Salvador and Guatemala. The first task of the final, short leg M66/3b was the deployment of a Canadian ADCP mooring which is to record flow velocities and flow directions in the vicinity of ODP site 1255 (Leg 205) off Nicoya Peninsula, Costa Rica, over a period of several years. The resulting information will be important for interpretation of the data collected by the CORK drill hole observatory, which has been installed at site 1255. It is visited at regular intervals by American colleagues using the ALVIN submersible.

A series of gravity cores was taken during the first days of leg M66/3b from a total of six positions parallel to the deep sea trench off El Salvador and Guatemala. All cores showed several layers of mafic and felsic ashes. Mafic ashes in the cores taken from the sites further towards the north showed an enrichment in biotite indicating an increasing alkalinity of the erupted material corresponding to the observations on land. In addition, many graded layers show characteristics that are interpreted as an indication of eruptions that were stronger than those observed off Nicaragua. The tephrastatigraphy covers more than 70ka, which is the age of the Arce ashes of Coatepeque Caldera in northern El Salvador. This layer was found in all cores at approximately the same depth, which will facilitate stratigraphic correlation. All ash layers were sampled for further chemical and petrographic examinations, especially for thermoluminescence dating.



*Fig. 7: A typical graded ash layer*

Surprisingly, in spite of the great distance of the sampling sites to the Central American deep sea trench, all cores showed indications of numerous slides that were presumably caused by tectonic events on the flexural bulge of the Pacific plate before subduction.

In addition, leg M66/3b gave us the opportunity to prolong some heat flow profile sections across the deep sea trench towards the oceanic crust in the west. Heat flux measurements performed during METEOR M54 to assess the seismic hazard potential were extended for the areas off



Costa Rica (CR1) and Nicaragua (NIC1). Hardly any measurements have been performed in the area north of Nicaragua so far. So we took the chance and mapped a profile, albeit short, off Guatemala (GUA1) as an extension of earlier DSDP 84 drilling. The comparison of the thermal structure of different segments of the Pacific plate will contribute to understanding variations of seismicity along the Central American continental margin, as it is already known that the rigidity of the subducting plate to a certain degree is determined by its temperature. Unfortunately, the work on profile GUA1 had to be finished early on 18 November because the new coaxial wire was damaged so that further measurement became impossible.

Leg M66/3b ended on 19 November when FS METEOR entered the port of Corinto, Nicaragua.

## **Technical details**

### **Rockdrill Coring**

The coring programme used the BGS rockdrill with the option of vibrocoring by interchange of barrels and selection of different computer functions. Deployment was over the stern of RV Meteor via a combined signal/power/hoist umbilical cable on a dedicated winch system. All functions were PC controlled and two TFT monitor displays allowed the operators to observe progress and vary the coring parameters. The data on seabed operation were recorded for each coring site.

In rockdrilling mode, the tool collects a core of 49 mm diameter and a maximum length of about 5 m in a double-walled core barrel. The speed of rotation can be varied from 0-600 rpm, the bit weight control can be adjusted and either one or two flush pumps can be used. A real time video color camera gives the advantage to observe and evaluate the seafloor and search for desired drilling targets. Penetration, oil pressure and rpm are normally monitored, as being the most useful for interpretation of the drilling process. Additional sensors fitted include pitch and roll to check the stability of the frame on the seabed. The maximum possible drilling angle of the BGS rockdrill device is 25 degrees. Two different bits were used on this cruise: a stepped profile, surface set bit and a soft matrix impregnated diamond bit. Upon full penetration or refusal to drill further, the drill function is switched off and the barrel is retracted into the frame. Within the inner core barrel, the core is retained by a core spring during recovery. The core is extracted by removing the bit and reaming shell from the bottom end of the outer barrel, withdrawing the top water swivel and disconnecting the inner core barrel. The core is then removed from the inner barrel into labelled plastic guttering (A (BASE), B, C, D, E, F (TOP) -each individually sub-labelled with BASE and TOP) using controlled water pressure.

### **Gravity Coring**

Sediment cores of 2 to 8 m total length were taken with a standard gravity coring system during M66 cruises in the Costa Rica, Nicaragua, El Salvador and Guatemala for-arc area. The gravity coring device was equipped with a 1.5 ton weight attached to the top of a 3 to 9 m steel tube barrel surrounding an inner 3-9 m PVC-tube acting as the core liner. A valve situated at the top end of the coring barrel allows water to escape during sediment penetration. Standard outer liner diameters are 12.5 cm and average liner thickness is around 2.5 mm. During some stations of M66-3b the core barrel was equipped with attached Miniature Temperature Loggers (MTL), measuring the in situ temperature of sediment during penetration (minimum recording/equilibration time in the sediment of 7 minutes).

### **Multi Sensor Core Logging (MSCL)**

Following proper labeling the core segments were carried from the cold lab to the logging container. Geotechnical logging with the GEOTEK Ltd. (UK) multi sensor whole core logger included 4 directly measured parameters taken at a 2 cm sampling interval.

The core diameter is determined by two differentially operating resistivity distance transducers attached to the pressure wave (PW) transducers. The analog output signal is converted to a deviation in mm from the standard core liner Thickness. During M66-3a two different core liner Diameters and core liner thickness from vibro coring with rockdrill and gravity coring were handled. Sediment thickness determination is crucial for calculating Gamma densities and PW travel time.

PW- attenuation and PW travel time are determined by stimulating the Piezo-elements inside the active transmitter rolling transducer (sender) with a short 500-kHz pulse (2- $\mu$ s wave period; 120 V) and a repetition of 1kHz. The pulse generates an ultrasonic compressional pulse at about 500 kHz. Pulse timing (PW-travel time) is measured with a resolution of 50 ns. The P-wave propagates through the core, is received by the passive receiver transducer and is displayed in real time on an oscilloscope screen (Blum, 1997). Attenuation is expressed as a percentile of signal amplitude in Water (set equal to 100) and signal amplitude received through the air (set equal to 0). Since PW-Attenuation is very sensitive to free gas in the pore space it proved to be a useful indicator for the sulfate / methane transition zone where free Methane may be present in the pore space. Calibration of the data and reduction of liner effects is performed on a water-filled liner with a known water temperature. All given PW velocities correspond to the transient core temperatures during logging. Using the temperature log and in situ temperature information the given values can easily be converted to in situ PW velocities.

Gamma attenuation is used to determine the wet bulk density of sediments and rocks (Tittman and Wahl, 1965; Evans, 1965). The principle is based on the fact that medium-energy gamma rays (0.1–1 MeV) interact with the formation material mainly by Compton scattering, that the elements of most rock-forming minerals have similar Compton mass attenuation coefficients, and that the electron density measured can easily be related to the material bulk density. The  $^{137}\text{Ce}$  source used transmits gamma rays at 660 KeV. A scintillation detector measures the gamma-ray beam transmitted through the core during a 5s sampling interval (Blum, 1997).

Magnetic susceptibility is the degree to which a material can be magnetized in an external magnetic field. It is expressed as the ratio of the magnetization and the external field and measured with a Barington Loop Sensor with a 16 cm internal diameter. Following the logging the raw magnetic susceptibility values are converted to volume based susceptibilities. The magnetic susceptibility value of a natural sample is proportionally related to the volume fraction of magnetic minerals and therefore the most sensitive logging parameter in identifying basaltic ashes since they contain abundant magnetic minerals like magnetite and titanomagnetite and that far exceeds the concentration of magnetic minerals of the surrounding sediment. Core log signatures of mafic to intermediate ashes show therefore high magnetic susceptibility- and density values. Felsic ashes however are rich in feldspar, SiO<sub>2</sub> rich glass and related weathering products all characterized by exceptionally low even negative magnetic susceptibility values (Hunt et al., 1995). As a consequence core log signatures of felsic ashes show low or lower than background magnetic susceptibility values combined with distinct highs in gamma density (Kutterolf et al. 2006).

### **Geotechnical index measurements**

Moisture content and mineral density are basic sediment and rock properties that are determined most accurately through mass and volume determinations (Blum, 1997, DIN). For this purpose core specimens of exactly 10 cm<sup>3</sup> are extruded from the working-half of the cores with an open-ended stainless steel cylinder or approximately by sampling with a spatula. Moisture content is determined by measuring the specimen's mass before and after removal of interstitial pore fluid through oven drying for 24 hours at temperatures varying from 90° to 110°C. Moisture content, porosity, and void ratio are defined by the mass or volume of extracted water (assumed to be interstitial pore fluid), corrected for the mass and volume of salt evaporated during the drying process (see also ASTM, 1990). The mass and volume of the evaporated pore-water salts are calculated for a standard seawater salinity (35), seawater density at laboratory conditions (1.024 g/cm<sup>3</sup>), and an average seawater salt density of 2.20 g/cm<sup>3</sup> following ODP procedures described in Blume 1997.

During M66-3 we used two different ways to determine index properties:

- 1) Wet-bulk volume measured with the 10 ccm volume sampler and consequent determination of the grain density using the Penta Gas pycnometer from Quantachrom and Helium 4.6 as a measuring gas. Following this procedure we were able to recalculate bulk densities from grain densities and porosity and therefore obtaining 2 independent wet bulk densities used for calibration of the MSC logs. Method 1) is most appropriate in homogenous sediment section with and overall low sediment rigidity.
- 2) Volumetrically undefined sampling with a spatula and recalculation of bulk densities from grain densities and porosity. Method 2) delivers only one recalculated bulk density value and is reserved for inhomogeneous sediment intervals or indurated sediment section where equal volume sampling is not possible.

### **Shear strength measurements**

In order to assess the geotechnical properties of sediments from Mound and Slide locations off Costa Rica and Nicaragua and ash cores from the incoming plate off Nicaragua El Salvador and Guatemala, the undrained shear strength "cu" was determined using a fall-cone method. The undrained shear strength is critical in evaluating sediment compaction and processes like sliding, slope failure and erosion.

The fall-cone testing was conducted with a "Strassentest Kegelfallpenetrometer" (fall cone tester). The cone has an angle of 60° and a mass of 85 g. The cone was lowered carefully to the surface of the sediment and than fell free for five seconds until no further movement could be expected. Finally the depth of penetration was measured with a dial gauge. The undrained shear strength was determined with the equation of Hansbo (1957) with the coefficients from Houlsby (1982):

$$c_u = \frac{k \times M}{h^2}$$

where k is an empirical Factor determined by the cone angle, M is the mass of the cone and h is the penetration of the cone.

## **Porewater Geochemistry**

Surface sediments were taken using a TV-guided vibrocorer (RDV) from BGS (Edinburgh) and a gravity corer (GC).

To prevent a warming of the sediments after retrieval all cores were immediately placed in a cooling room and maintained at a temperature of about 5°C. Each core was cut lengthwise after recovery. Sample intervals between 10-50 cm were taken for pressure filtration. At sampling locations where methane was expected to be present, syringe samples were taken on deck from every cut segment surface. Occasionally, higher resolution sampling for methane analysis was carried out in the cooling laboratory. Syringe samples of 3 ml sediment were injected into 24 ml septum vials containing 9 ml of a concentrated NaCl-solution. Porewater was separated from the sediments using PE-squeezers. The squeezers were operated with argon at a pressure gradually increasing up to 5 bar. Depending on the porosity and compressibility of the sediments, up to 30 ml of pore water were received from each sample. The pore water was retrieved through 0.2 µm cellulose acetate membrane filters.

Dissolved phosphate, silica, ammonia, and sulphide were determined in pore water samples using standard photometric procedures (i.e. Grasshoff, 1997). Sub-samples for nutrient analysis were taken, acidified with HCl and purged with N<sub>2</sub>-gas for 90 minutes to remove dissolved sulphide prior to analysis. Total alkalinity (TA) was determined by titration with 0.02 N HCl. Most samples were also analysed for dissolved chloride using argentometric titration in order to control the IC results. Methane concentrations were measured using standard GC methods. Acidified sub-samples (35 µl suprapure HCl + 3 ml sample) were prepared for ICP analyses of major ions (K, Li, B, Mg, Ca, Sr, Mn, Br, and I) and trace elements. Sulfate, DIC, δ<sup>18</sup>O and δ<sup>13</sup>C of CO<sub>2</sub> will be determined on selected sub-samples in the shore-based laboratories.

## Stationlist Meteor M66 – cruises M66-3a and M66-3b

Date	Station No.	Instrument	Latitude N°	Longitude	Water depth (m)
<b>M66-3a</b>					
27.10.2005	113	RDR	11:15.34	87:09.83	876
27.10.2005	114	RDV	11:15.33	87:09.83	882
27.10.2005	115	GC	11:15.58	87:09.64	973
27.10.2005	116	RDV	11:15.30	87:09.86	876
27.10.2005	117	RDV	11:15.29	87:09.90	880
28.10.2005	118	RDV	11:15.29	87:09.89	874
28.10.2005	119	RDR	11:15.22	87:09.91	874
28.10.2005	120	RDR	11:15.33	87:09.77	874
28.10.2005	121	RDR	11:15.34	87:09.75	872
28.10.2005	122	RDR	11:15.22	87:09.01	864
28.10.2005	123	RDV	11:12.22	87:09.27	1240
28.10.2005	124	RDV	11:12.21	87:09.29	1230
28.10.2005	125	RDV	11:12.28	87:09.21	1210
28.10.2005	126	RDV	11:12.59	87:09.33	1236
28.10.2005	127	RDV	11:12.18	87:09.22	1226
29.10.2005	128	RDR	11:12.21	87:09.27	1226
29.10.2005	129	RDR	11:12.22	87:09.28	1225
29.10.2005	130	RDR	11:12.23	87:09.28	1225
29.10.2005	131	GC	11:09.07	87:13.22	2017
29.10.2005	132	GC	11:08.77	87:13.18	2147
29.10.2005	133	GC	11:08.71	87:13.20	2184
29.10.2005	134	RDV	11:15.30	87:09.88	894
29.10.2005	135	RDV	11:15.28	87:09.87	902
30.10.2005	136	PWPL	11:15.58	87:09.61	989
30.10.2005	137	RDR	11:12.25	87:10.78	1353
30.10.2005	138	RDR	11:12.36	87:10.85	1323
30.10.2005	139	RDV	11:16.42	87:15.25	1448
30.10.2005	140	RDV	11:16.35	87:15.16	1465
30.10.2005	141	RDR	11:16.35	87:15.16	1445
30.10.2005	142	GC	11:16.51	87:15.32	1442
30.10.2005	143	GC	11:16.49	87:15.31	1443
31.10.2005	144	GC	11:15.29	87:09.86	893
31.10.2005	145	Parasound	11:08.18	87:13.43	2366
31.10.2005	146	RDV	10:17.88	86:18.37	1528
31.10.2005	147	RDV	10:17.86	86:18.37	1526
01.11.2005	148	RDR	10:17.90	86:18.42	1523
01.11.2005	149	RDR	10:17.92	86:18.26	1527
01.11.2005	150	Parasound	10:12.04	86:18.57	1812
01.11.2005	151	GC	10:12.35	86:18.07	2006
01.11.2005	152	GC	10:12.41	86:18.34	1939
01.11.2005	153	GC	10:12.35	86:18.37	2012
01.11.2005	154	GC	10:17.92	86:15.84	1290
01.11.2005	155	RDR	10:17.97	86:18.30	1520
02.11.2005	156	RDR	10:17.94	86:18.31	1520
02.11.2005	157	RDR	11:02.21	86:54.73	783
02.11.2005	158	RDR	11:02.22	86:54.70	784
02.11.2005	159	RDV	11:00.86	86:54.33	1009
02.11.2005	160	PWPL	11:15.45	87:09.26	990
02.11.2005	161	RDV	11:16.40	87:15.22	1000
03.11.2005	162	GC	11:38.74	87:49.48	2262
03.11.2005	163	GC	11:39.34	87:49.55	2490
03.11.2005	164	GC	11:39.19	87:49.49	2528

Date	Station No.	Instrument	Latitude N°	Longitude	Water depth (m)
03.11.2005	165	Parasound	11:38.68	87:49.58	2400
03.11.2005	166	RDR	11:16.74	87:15.89	1414
03.11.2005	167	RDV	11:16.75	87:15.89	1422
03.11.2005	168	RDV	11:12.28	87:10.82	1326
03.11.2005	169	RDR	11:12.38	87:10.83	1327
04.11.2005	171	RDR	11:12.37	87:10.87	1324
04.11.2005	172	RDR	11:12.36	87:10.82	1319
04.11.2005	173	RDR	11:12.36	87:10.84	1354
04.11.2005	174	RDV	11:02.25	86:54.71	805
04.11.2005	175	RDV	11:02.25	86:54.71	780
04.11.2005	176	RDR	11:02.25	86:54.71	791
04.11.2005	177	RDR	11:02.29	86:54.65	802
04.11.2005	178	RDV	11:01.12	86:54.39	958
05.11.2005	179	RDV	11:01.30	86:54.17	920
05.11.2005	180	RDV	11:02.45	87:02.12	1707
05.11.2005	181	RDR	11:13.58	87:07.46	858
05.11.2005	182	RDV	11:13.37	87:06.52	811
05.11.2005	183	RDR	11:13.37	87:06.53	800
05.11.2005	184	RDR	11:13.36	87:06.53	799
05.11.2005	185	RDR	11:13.36	87:06.53	796
05.11.2005	186	RDR	11:13.38	87:06.52	797
05.11.2005	187	PWPL	11:15.07	87:05.00	703
05.11.2005	188	RDR	11:13.39	87:06.55	803
06.11.2005	189	RDV	09:07.18	84:50.54	1766
06.11.2005	190	RDV	09:06.99	84:50.49	1857
07.11.2005	191	GC	08:59.56	84:43.77	1927
07.11.2005	192	PWPL	08:56.05	84:18.88	1007
07.11.2005	193	RDR	08:55.87	84:18.60	979
07.11.2005	194	RDR	08:55.32	84:18.24	1023
07.11.2005	195	RDR	08:55.19	84:18.18	1038
07.11.2005	196	RDV	08:55.84	84:18.62	1013
07.11.2005	197	RDV	08:55.86	84:18.62	1013
07.11.2005	198	DOS	08:55.82	84:18.53	1014
07.11.2005	199	RDV	08:59.57	84:43.65	1937
08.11.2005	200	RD-Test	08:59.38	84:43.63	1953
08.11.2005	201	RDR	09:07.08	84:50.57	1832
08.11.2005	202	RDV	09:07.07	84:50.45	1795
08.11.2005	203	RDV	09:07.10	84:50.51	1849
08.11.2005	204	GC	09:12.18	84:44.03	576
08.11.2005	205	GC	09:12.08	84:43.87	592
09.11.2005	206	GC	09:12.02	84:43.98	623
09.11.2005	208	RDR	09:09.00	84:49.21	817
09.11.2005	209	RDR	09:09.05	84:49.14	833
09.11.2005	210	RDR	09:09.02	84:43.17	815
09.11.2005	211	RDV	09:06.99	84:50.42	1845
09.11.2005	212	PWPL	09:06.99	84:50.42	1025
09.11.2005	213	RDV	08:55.84	84:18.60	980
10.11.2005	214	RDR	09:09.04	84:49.19	828

Date	Station No.	Instrument	Latitude N°	Longitude	Water depth (m)
<b>M66-3b</b>					
14.11.2005	218	GC	11:02.36	87:02.20	1719
14.11.2005	219	GC	11:02.45	87:02.16	1710
15.11.2005	220	GC	11:08.75	87:13.23	2158
15.11.2005	222	GC	11:37.35	89:07.37	3630
16.11.2005	223	GC	11:54.78	89:46.61	3882
16.11.2005	224	GC	12:10.66	90:23.61	4003
16.11.2005	225	GC	12:22.62	91:04.45	3707
16.11.2005	226	GC	12:22.40	91:05.91	3732
16.11.2005	227	GC	12:42.77	91:48.13	3965
17.11.2005	228	GC	12:33.96	92:02.01	3838
17.11.2005	229	GC	12:15.06	91:30.65	3703
17.11.2005	230	GC	11:44.92	90:31.23	3593

**RDV** = **Rockdrill Rotary Mode**  
**RDR** = **Rockdrill Vibrocorer Mode**  
**GC** = **Gravity Core**  
**PWPL** = **Pore Water Pressure Lander**  
**Parasound** = **Parametric Echosounder**