IODP Expedition 310
Tahiti Sea-level
Week 3 Report (20th-26th Oct, 2005)

October 27, 2005

Operations

Hole M0009C (TAH-02A-5B): Just before 0000 hrs on the 20th October, the DP Hunter moved to Hole M0009C, approximately 9 m WNW of Hole M0009B in 99.85 m water depth. Coring commenced and continued until 1935 hrs that day, reaching a TD of 25.66 m. Coring at Hole M0009C proved very difficult, with many bit blockages and crushed liners due to pieces of the formation breaking off and entering the core barrel having not been properly cored. The lattice drilled was not strong enough to core, and in many cases had to be crushed for progress to be made. Recovery improved towards the base of the hole, and the total core recovery was 51.86 %. At 1935 hours, the hole was completed and preparations made to move over to Hole M0009D.

Hole M0009D (TAH-02A-5C): The DP Hunter was positioned above Hole M0009D, 5.5 m E of Hole M0009B in 103.18 m water depth, and coring began at 2210 hrs, 20th October. Coring at Hole M0009D continued until 2230 hrs, 21st October, to a TD of 44.59 m. Progress was steady, but core runs were short and bit blocking common. After TD was reached, preparations were made to log the hole.

Logging of Hole M0009D (TAH-02A-5C): Prior to logging the hole, the hole was reamed and flushed for 30 min. The HQ string was pulled and set with a casing shoe at 19 m below sea bed to run the logging tools through the open hole section. Logging commenced at 2230 hrs, 21st October in very wet and windy conditions. This, combined with very poor hole conditions, led to a difficult logging period. Nevertheless, good logs were obtained in sections of open hole where it was possible to log. A hole blockage prevented the resistivity tool from reaching the base of the hole, and the chisel tool was used to clear the blockage. The resistivity, spectral gamma ray and acoustic tools were run. However, large, metre-scale cavities in the formation created sticking points for some of the tools, thus only some of the open bottom-hole interval was logged. The first optical image tool run was affected by power failures on the drill rig, possibly caused by very heavy rainfall. Logging was temporarily interrupted while the cause of the power failures was investigated. After these runs, the casing was pulled to 5 m below sea bed. The top-hole section was logged with the resistivity and optical image tools, with cavities causing problems for the optical tool. While logging up, the optical image tool became stuck many times, and needed to be pulled through obstructions by hand. Logging operations were completed by 1000 hrs, 22nd October, and preparations were made to move to Hole M0010A.

Hole M0010A (TAH-02A-4): The DP Hunter was positioned above Hole M0010A by 1400 hrs, 22nd October, approximately 140 m ESE of Prospectus site TAH-02A-4 in 89.53 m water depth. The DART was drilled into the sea bed, and coring operations

began at 1635 hrs. Coring continued until 1000 hrs, 23rd October, to a TD of 34.6 m below sea bed. During the coring period, an HQ string trip was made to clear a continually blocking bit.

Hole M0011A (TAH-02A-4A): Hole M0011A was located approximately 140 m E of Prospectus site TAH-02A-4 in 101.34 m water depth. After running the API pipe, drilling the DART into the sea bed and running the HQ pipe, coring operations began at 1330 hrs, 23rd October. Coring commenced in very soft silts with poor recovery, but this improved when the river deposits gave way to a carbonate framework. At 0030 hrs, 24th October, coring operations were completed at Hole M0011A at a depth of 17.65 m below sea bed.

Hole M0012A (TAH-02A-4B): Hole M0012A was the first of three holes to be located within the new EPSP-approved zone SE of Prospectus site TAH-02A-4. Before the DART was lowered onto the sea bed, a down-pipe camera survey was run which showed a live coral colony at the first location. The ship was re-positioned 25 m downslope in 77.05 m water depth, and the DART drilled in. Coring operations began at Hole M0012A at 0900 hrs, 24th October. Recovery was generally poor although it did improve in the more competent material at the base of the hole. Coring was completed at 2040 hrs, 24th October, at a TD of 34.1 m.

Hole M0013A (TAH-02A-4C): Hole M0013A was located 30 m downslope from Hole M0012A, in 90.95 m water depth. The DP Hunter was positioned above the hole at 2300 hrs, 24th October. After the API pipe and DART were lowered to the sea bed, a sea bed camera survey was conducted. Coring operations began at 0100 hrs, 25th October. At 0415 hrs, coring was abandoned due to the lack of suitable coral material. TD of the hole was 11.7 m.

Hole M0014A (TAH-02A-4D): Hole M0014A was spud approximately 70 m NNW of Hole M0013A in 99.25 m water depth. Coring operations began at 0610 hrs, 25th October, and completed at 1615 hrs at a TD of 15.43 m. The HQ string, API pipe and DART were lifted onto deck and secured for the transit to previous Site M0007 at the south end of the island, which commenced at 1930 hrs. Poor weather was forecast for the north of the island, and so the decision was made to revisit promising sites in the south.

Hole M0007C (TAH-03A-3B): Site M0007 was reached at 0200 hrs, 26th October. Prior to coring at Hole M0007C, a sea bed camera survey was conducted which revealed a surprisingly barren sloping sea bed in 43.35 m water depth. Coring operations began at 0315 hrs and continued until 2215 hrs. The hole progressed quickly with core recovery generally poor and little formation resistance being evident on the bit. At around 30 m below sea bed, the hole started to become sticky and then collapsed at a wireline trip filling the outer core barrel with cuttings. The string was tripped, the barrel cleaned out (2m of coral cuttings) and the HQ string re-run with an insert bit as the inner core barrel. The base of the hole was reached with difficulty, where rotation also became difficult. The string stuck a few times and the hole was abandoned at a TD of 32.25m.

Hole M0015A (TAH-03A-1): By 2400 hrs, 26th October, the DP Hunter was positioned above Hole M0015A ready for the coring equipment to be deployed.

Summary of holes drilled to date

Hole	Latitude	Longitude	Water depth (m)	Drilled length (m)	Recovery (m)	Recovery (%)	Depth reached (mbsf)
M0005A	17° 45.989733'S	149° 33.052517'W	59.13	16.35	5.37	32.84	16.35
M0005B	17° 45.989733'S	149° 33.052517'W	59.13	12.35	9.24	74.82	21.75
M0005C	17° 45.991467'S	149° 33.047600'W	59.63	27.91	14.81	53.06	27.91
M0005D	17° 45.991467'S	149° 33.047600'W	59.63	79.17	51.35	64.86	102.17
M0005E	17° 45.992117'S	149° 33.045433'W	61.34	2	1.6	80.00	2
M0006A	17° 46.015133'S	149° 33.051483'W	81.58	2	1.55	77.50	2
M0007A	17° 45.955317'S	149° 33.041100'W	44.45	44.4	30.74	69.23	44.4
M0007B	17° 45.946200'S	149° 33.068150'W	41.65	47.93	27.02	56.37	48.23
M0007C	17° 45.955667'S	149° 33.012783'W	43.35	30.75	11.13	36.20	32.25
M0008A	17° 29.620700'S	149° 24.431033'W	62.65	38.7	9.49	24.52	40.2
M0009A	17° 29.317367'S	149° 24.206350'W	99.71	21.54	9.29	43.13	23.04
M0009B	17° 29.315283'S	149° 24.204400'W	100.31	26.29	17.42	66.26	27.12
M0009C	17° 29.312550'S	149° 24.208633'W	99.85	24.41	12.66	51.86	25.66
M0009D	17° 29.315283'S	149° 24.201117'W	103.18	43.31	23.62	54.54	44.59
M0010A	17° 29.397800'S	149° 24.167917'W	89.53	33.25	10.02	30.14	34.6
M0011A	17° 29.369650'S	149° 24.160617'W	101.34	16.08	7.89	49.07	17.65
M0012A	17° 29.429067'S	149° 24.110367'W	77.05	32.3	8.37	25.91	34.1
M0013A	17° 29.411933'S	149° 24.111000'W	90.55	9.55	1.1	11.52	11.7
M0014A	17° 29.369733'S	149° 24.123650'W	99.25	10.93	3.71	33.94	14.41

Science

Holes M0009C and M0009D exhibit two carbonate sequences separated by an irregular unconformity.

The upper carbonate sequence is comprised of coralgal-microbialite reef frameworks in which microbialites (laminated and thrombolitic microbial fabrics) usually represent the major volumetric and structural component. Thrombolites usually represent the last stage of encrustation.

This sequence is characterized by successive coral assemblages including, from top to base:

a) An assemblage dominated by foliaceous *Montipora* associated with submassive colonies of *Porites* and faviids and tabular colonies of *Acropora*. Corals are thinly coated by red algae to form loose frameworks. Primary cavities are partially filled with skeletal sand and gravels.

This coral assemblage characterizes moderate to quiet energy environments in the middle part of the reef slope at depths greater than 20 m.

Occurrence : Hole M0009C, Cores 1R through 10R ; Hole M0009D, Cores 1R through 6R .

b) An assemblage including closely associated massive coral colonies (*Porites*, *Favia*), robust branching *Acropora* and branching *Pocillopora*. Sections of massive *Porites* colonies are up to 35 cm long. The corals are heavily encrusted by red algae and microbialites. Microbialites include both laminated and thrombolitic fabrics and develop into primary and bioerosion cavities. Primary cavities are partially filled with skeletal sand and gravels.

This community characterizes high-energy shallow water environments.

Occurrences : Hole M0009C, Cores 11R through 17R ; Hole M0009D, Cores 7R through 11R.

The lower carbonate sequence recovered in both holes is comprised of successive units, from top to base:

a) Well-lithified gray to brown skeletal limestone (floatstone-packstone) rich in coral fragments (robust branching *Acropora* and *Pocillopora*, tabular *Acropora*, massive *Porites* and encrusting *Pachyseris*) and *Halimeda* segments. Foliaceous *Pachyseris* and *Montipora* form locally loose frameworks. Red algal crusts are abundant and are locally overlain by columnar laminated microbialites. Reworked basalt pebbles occur locally. This limestone is characterized by the abundance of diagenetic overprints, including the recrystallization of coral skeletons and the occurrence of large solution cavities that usually display a brown staining.

Occurrences : Hole M0009C, Cores 18R through 21R; Hole M0009D, Cores 12R through 20R and 23R through 24R .

b) Horizons comprised of coral clasts and basalt pebbles. The coral clasts include shallow- and deep-water corals: robust branching or corymbose *Acropora* (*A. humilis*?), robust branching *Pocillopora*, branching *Acropora* and *Porites*, and submassive *Porites*. Some clasts are encrusted by coralline algae, whereas other clasts are covered partly with *Halimeda* packstone.

Occurrences : Hole M0009D, Cores 20R through 23R and 23R.

c) Sandy packstone/grainstone with coral clasts (branching *Acropora* and *Pocillopora*), overlying a coral boundstone consisting mainly of massive *Porites* and encrusting unidentified corals associated with clasts of robust branching *Acropora*.

Occurrence : Hole M0009D, Core 25R.

The contact between those two sequences occurs at 20.97-21.02 mbsf in Core 18R in Hole M0009C and at 17 m in Core 12R in Hole M0009D. This unconformity is very irregular and is characterized by the abundance of large solution cavities partly filled with unconsolidated skeletal and volcanic sand including coralline algal branches and *Halimeda* segments (Hole M0009C, Core 21-CC; Hole M0009D, Core 11R), and coral gravels (*Pocillopora* branches; fragments of *Montipora* colonies ; Hole M0009D, Core

12R). Some cavities are partly filled with stalagmite crusts. These solution cavities are related to the karstification of the top of the lower carbonate sequence.

Holes M0010A through M0014A recovered complex sequences composed of various lithological units that are locally closely associated and interlayered.

a) Volcaniclastic and skeletal sand and silt usually form the top of the recovered sequences. The skeletal grains include *Halimeda* segments, benthic and planktonic foraminifers, and mollusc fragments.

Occurrences : Hole M0010A, Cores 1R through 4R ; Hole M0012A, Cores 2R, 7R and 8R ; Hole M0014A, Cores 3R-CC and 4R-CC.

b) Beds comprised of reworked coral colonies, coral fragments and basalt pebbles. The coral fragments include robust branching *Pocillopora* and *Acropora*, branching *Porites*, and thin encrusting *Montipora* and *Pachyseris*, some of which are encrusted by coralline algae and/or microbialites (dense and thrombolitic microbial fabrics).

Occurrences : Hole M0010A, Cores 1R, 2R, 5R through 9R, and 14R through 15R-CC. Hole M0011A, Cores 1R through 3R and 4R through 6R. Hole M0012A, Cores 1R through 7R and 9R through 13R. Hole M0013A, Cores 1R through 5R. Hole M0014A, Cores 1R through 9R.

c) *In situ* coral colonies : massive colonies of *Porites*, up to 50 cm long occur in Cores 5R-CC from Hole M0012A, and in Cores 3R and in Cores 5R through 7R and Core 9R in Hole M0014A. Some colonies exhibit traces of bioerosion and cavities are partly filled with skeletal sand and gravels.

d) *In situ* coralgal-microbialite frameworks formed by distinctive coral assemblages : Foliaceous *Montipora*, agaricids and faviids, and thin colonies of *Porites*. Corals are coated by thin red algal crusts and microbialites (especially thrombolites) to form a loose framework. Primary cavities are partially filled with skeletal sand and gravels including abundant volcanic components.

Occurrence : Hole M0010A, Cores 10R-1. Hole M0011A, Cores 7R through 9R.

Massive faviids associated with massive *Porites* and branching *Pocillopora*. Microbialites usually form dense compact layers in those frameworks.

Occurrence : Hole M0010A, Cores 11R-1.

Robust branching *Acropora*. Interlayered horizons of gravels and rubble include branches of *Pocillopora* and basalt pebbles. This unit seemingly fills large cavities occurring in the underlying well-lithified limestone described below.

Occurrence : Hole M0010A, Cores 16R-CC and 17R-CC.

e) Microbialite-sandy bioclastic grainstone unit rich in coral clasts. *In-situ* algal-coated corals are encrusted by microbialite. Inter- and intraskeletal space and cavities are filled with sandy bioclastic grainstone. The bioclasts include *Halimeda* segments, shell fragments, and much less common bryozoan skeletons. Fine to medium sand-sized volcaniclastic grains are contained. Coral clasts mostly have microbialite encrustations. The coral fauna comprises branching *Pocillopora* and *Porites*, robust branching *Pocillopora* and encrusting *Porites*.

This unit grades downwards into poorly bedded volcaniclastic sandstone rich in bioclasts. The bioclasts include *Halimeda* and corals associated with benthic foraminifers, bryozoans, and gastropods.

Occurrence : Hole M0014A, Cores 10R through 14R.

The sequence described above overlie well lithified gray to light brown coralgal and skeletal sandy limestone, and horizons of gravels and rubbles made of that material. The coral assemblage is dominated by foliaceous colonies of *Pachyseris*, tabular and branching colonies of *Acropora*, robust branching *Pocillopora*. The matrix of the limestone is rich in *Halimed*a segments; volcanic grains are locally abundant. Subaerial diagenetic processes are indicated by the alteration of coral skeletons and the occurrence of large solution cavities that are filled with volcaniclastic and skeletal sandstone.

Occurrence : Hole M0010A, Cores 15R-1, and 18R through 20R. Hole M0011A, Cores 9R and 10R. Hole M0012A, Cores 14R through 19R.

Holes M0007C recovered a reef sequence including two successive units displaying distinctive coral assemblages and internal structure.

a) Loose coralgal-microbialite frameworks dominated by encrusting *Montipora*, *Pavona* and agaricids; other corals include *in situ* massive colonies of faviid and *Porites*, and branching colonies of *Porites*. Branching *Montipora* and robust branching *Acropora* occur as fragments. Coral colonies are coated by thin red algal veneer overlain by thick and massive microbialite crusts. Large primary cavities are partly filled with skeletal sand and gravels. These frameworks are usually broken by drilling.

Occurrence : Hole M0007C, Cores 4R through 14R.

b) coralgal-microbialite frameworks dominated by robust branching *Pocillopora, Pavona* and *Acropora*, tabular *Acropora* and massive *Porites*. The coral colonies are heavily encrusted by red algae overlain by very thick and massive microbialite crusts. Large primary cavities are partly filled with skeletal sand and gravels. Corals exhibit traces of possible diagenetic alteration in Cores 20R through 22R.

Occurrence : Hole M0007C, Cores 4R through 22R.

Logging of Holes M0009B and M0009D

Hole M0009B was logged on the 19th of October in a water depth of 100.31 m. The maximum depth of penetration was 21 m below sea floor, while the total drilling depth was 27.15 m. A variety of geophysical probes were used. The imaging probes (OBI-40 and ABI-40 of Advanced Logging Technologies Ltd.) provided superb mm-resolution images of the borehole wall. A specific coral species could even be determined from these. More striking even, was the amount of pore space observed and quantified from borehole geophysical imagery. Adding up the pore space and core recovery, it is fair to state that core recovery is in the order of 90 to 100 percent for Hole M0009B. Large cavities (up to 0.5 m in size) are present in the lower part of the penetrated section. From about 10 m below sea floor, the borehole fluid properties change in composition. Borehole fluid temperature and electrical conductivity decrease, which may indicate ingress of brackish or fresh water in the formation. Unfortunately, extremely hostile borehole conditions did not allow logging the Pleistocene to Holocene transition.

Hole M0009D (4.5 m E of M0009B) was logged on the 22nd of October in a water depth of 103.20 m. The maximum depth of penetration was 32 m below sea floor, while the total drilling depth was 44.53 m. A variety of geophysical probes were used. For the first time, a continuous log from 32 to 5 m below sea floor could be made. Again, optical and acoustic imaging was successful. High-resolution images from the lower part of the borehole show a dense coral framework, intersected by dissolution-enhanced primary cavities from 25 cm to nearly 80 cm in size. Fluid properties change at these levels, indicating relatively fast refreshment of the drilling fluid (normal sea water only).

Having nearly complete optical coverage of the post-glacial section in two boreholes, better insights in the distribution of coral species was obtained. More importantly, the borehole images show that the recovered core pieces are extracted from their in situ growing position. Furthermore, these images will allow for the placement of the recovered core at their exact depth below sea floor.

Technical Activities

Detailed in ‘Operations’.

HSE Activities

By Law, and on instruction from the owners, a yearly emergency response drill to an 'incident' was initiated. It had to take place on 20th October and be in the form of a Bomb Alert Incident. Heads of groups were informed in advance of the procedures and while due regard was made for shift patterns and 24hr working the ship was brought to muster and searches made of all accommodation, engine room spaces, stowage spaces, scientific containers etc. A dummy bomb was duly found and reported and further exercises in disposal were then conducted with the crew of the vessel.

Accident to David Baxter, 21st October

David was working on the drillfloor with two Seacore personnel, Danny Bennets and Lee Pope. They were attempting to clear pieces of crushed coreliner from an inner barrel. The barrel had been laid down horizontally on a set of trestles, approximately 0.50 m above deck level. The first attempt to clear the barrel was by pumping water into the "top" end of the barrel, in an attempt to push the material out at the other end. In order for the water to build up pressure, the inner barrel has a brass plug with an 'O' ring seal, which fits inside the barrel at the "pumping" end. Danny operated the pump while David and Lee fitted the brass plug and screw on valve assembly at the top end of the barrel. The attempts to pump the material from the top end of the barrel did not succeed, and so an attempt was made to push the material out from the opposite direction. David and Lee removed the pumping assembly from the top end and fitted it to the bottom end. The brass plug remained in the top end of the barrel.

David was crouched down so that his head was just above level with the top end of the barrel. He was pointing a torch into the barrel, and looking into the barrel with his head next to the torch, approximately 1.00 m back from the end of the barrel. Whilst crouched in this position, the brass plug was forced out from the top end of the barrel under pressure. It flew into the torch that David was holding, and ricocheted off the lense of the torch, hitting him on the forehead, beneath the brim of his hardhat, immediately above his left eye.

David received a deep cut on the forehead above the left eye and a minor one on the left side of the bridge of the nose. First aid was given by A. Skinner and D. Smith (both ESO) in the ship's hospital with the Captain also in attendance. The bleeding quickly stopped and no dizziness or nausea was felt throughout by David Baxter. After the wound was cleaned, steri-stripped and covered, David Baxter was rested under supervision (head wound). This monitoring will continue beyond the period of this report.

Immediate preventative measures (see Daily Report, 21st October) were put in place to avoid a recurrence despite it possibly being a 'freak' occurrence. Additionally, the requirement for scientists to remain clear of the drillfloor when core barrel operations are being carried out was re-iterated in the light of this occurrence.

Recovery of David Baxter

Concerns over the well being of David Baxter after his accident, particularly with the possibility that the humid conditions may encourage infection, led to the decision to have him taken ashore for further medical attention. At 1600 hrs, 22nd October, David was transported ashore by the pilot boat and escorted to a local clinic operating under Europe Assist, with whom Seacore had previously made medivac arrangements on behalf of the project. All this was done through the ship's agent. After receiving medical attention it was diagnosed that David had sustained a broken nose, and was seen by a specialist on 24th October.

David Baxter returned to the vessel on the 24th October, but could only assume light duties. This was inappropriate to the work scope on board is scheduled to be replaced on 28th October. Work schedules have been re-arranged and do not infringe any working time directives.

At 1800 hrs, 23rd October, the 2nd (back-up) dynamic positioning workstation crashed. The positioning of the ship was not affected as the primary DP system continued to operate as normal. The 2nd system was re-started and continues to operate normally, in tandem with the primary system.

Adverse weather conditions with high wind gusts and very heavy rain squalls does not, to date, have an effect on the station keeping or the navigation and positioning signals.