HAWAI'I UNDERSEA RESEARCH LABORATORY
QUICK LOOK REPORT
DIVE: PV-640

MISSION STATUS

Location: Volcano 18s, South Tonga (Tofua) Arc

Latitude: ***Begin*** 24° 35.86'S **Longitude:** ***Begin*** 176° 52.32'W

Mission Date: June 18, 2005 **Duration:** 7 hours 08 min (Bottom Time)

Maximum Depth (m): 855 m

Project Title: SITKAP
(Submersible Investigations of the Tonga-Kermadec arc using PISCES)

Principal Investigator: Prof. Peter Stoffers, Kiel University

Address: Institute for Geosciences, University of Kiel, Germany

Phone: +49 431 880 2852

Observer 1: Tim Worthington **Observer 2:** None
Address: Institute for Geosciences, University of Kiel, Kiel, Germany

Pilot 1: Terry Kerby **Pilot 2:** Colin Wollerman

Scientific Data Acquired: Video, hand-held still photos, CTD, rock samples, bio samples, scoop samples, geological map

Objectives:
Explore and sample a series of stacked lava flows on a 100-150 m high scarp on the SE flank of V18s (WP-1 to WP-2). This is the main aim of the dive. Traverse and explore the faulted (but little vertical relief) terrain between the top of the steep scarp and the base of the eastern satellite cone, collecting further rock samples if appropriate (WP-2 to WP-8). This includes a small crater 20-30 m deep (WP-4 to WP-5). Explore the western flank of the eastern satellite cone, ascending from its base at 585 m to its summit at 285 m. Further lavas will be collected if appropriate. This traverse is expected to go through a hydrothermal field, which will be mapped (WP-8 to WP-12).

Observations, findings, etc: (Also see Appended Dive Log)

Summary: The dive was launched in good weather conditions, allowing a bottom time of 7 hours. The prime objectives were achieved. Contrary to expectations, the 100-150 m high scarp exposed a cross-section through a pyroclastic flow sequence and not a stacked

series of lavas. The pyroclastic flow sequence ranged from unwelded and clastic at the base of the scaqrp to subwelded with columnar jointing in the middle, and basaltic clasts and beds were common towards the top of the unit. It clearly represents the triggering of a pumice eruption by intrusion of a basaltic magma. Most of the summit plateau was talus, but fresh basaltic scoria was recovered from the small pit crater. The eastern satellite cone is composed of thick fresh basaltic andesite flows which were sampled at the cone base, mid-flanks and summit. The upper western cone flank from 450 to 300 mbsl consists of Fe crust and bacterial mat, but no venting was observed and temperatures were not more than 4°C above ambient. Cloudy water with limited visibility was encountered.

Species List:

PV-640 Biology 6/18/2005 Volcano 18s

Biology Samples:
PV-640-A1 Crinoidea (white, stalked)
PV-640-A2 Gorgonacea (neon green) 14:35, 434 m
PV-640-A3 Caryophiliidae (lophelia like, dead) 12:27, 520 m
PV-640-A4 Serpulidae (most likely dead)
PV-640-A5 Vermetidae (from R8)
PV-640-A6 Porifera (from R8)
PV-640-A7 Bryzoan? (from R8)
PV-640-A8 Ophiuroidea (from R6)

Observed in video

Midwater:
Mysida (Decapoda)
Chaetognatha (Arrow Worms)
Appendicularia (Larvaceans)
Salpida
Cydippida?

Benthic:
Crinoidea (white stalked, numerous)
Actiniaria
Caridea
Galatheidae (long arms, red)
Chyrsogorgiidae 11:16, 637m
Echinoidea
Hydractinia (large)
Cerianthidae
Elasmobranchii
Ophiuroidea

Gorgonacea
Paguroidea (hermit crab)
Narella?
Caryophiliidae (lophelia like)
Anthomastus?
Gorgonacea (green, sampled)
Polychaete (tubes only, all animals were dead)
Porifera

MISSION EVALUATION:

A. Limitations, failures, or operational problems noted:

None.

B. Recommendations for corrective action or improvement:

None.

C. In your opinion, did the mission essentially achieve its purpose?

Yes.

D. Compare actual work accomplished with the work that was expected to be accomplished.

The ground track was exactly as planned. A major surprise with the scarp exposing a pyroclastic flow sequence rather than stacked lavas, but in hindsight not unexpected.

E. List specimens or samples collected on the mission. (See Sample List Below):

Dive #640: 18 June 2005 V18s Eastern Scarp and Eastern Flank Cone

09:02- on bottom at 806 mbsl at 24°35.771, 176°52.275. The sea floor is sandy with large (up to 5 m diameter) boulders of ropey fresh andesite, possibly in situ, partly buried by deeply weathered yellow-brown pumice talus that nearly floats. No current. Picked up about 20 pieces of loose scoriaceous aa andesite, friable and black, to use as ballast- some appeared glassy. Photo.

Proceeded a little upslope to a ropey aa andesite outcrop. **Sample R1** (basket A), an elongate dark glassy andesite block from the ropey outcrop at 803 mbsl.

09:42- proceeding to WP-1 at 180 m bearing 185°. Went over a 6 m drop at a wall (fault?). By 830 mbsl traversing a talus field of coarse pumice blocks with no fines, a few sponges on stalks seen but little other biology. Given how slowly the sponges grow the slope has to be fairly stable.

10:01- at 24°35.902, 176°52.298 and 855 mbsl. Now 370 m bearing 290° to WP-2 and going upslope. At 820 mbsl see a large block of massive andesite talus, still occasional sponges. Photo.

10:13- now 190 m bearing 280° to WP-2, at 777 mbsl. Have reached the scarp, which outcrops as a vertical wall of bedded ash and breccia with ash beds mostly 1 m thick. Clasts are yellow pumice. Photo.

At 729 mbsl looking at the basal part of a deeply weathered pyroclastic flow sequence, with very yellow friable pumice clasts and rare lithic blocks- no mafic blocks. **Sample R2** (basket A), a solid yellow block from the lower part of the cliff. Photo of poorly developed bedding. Seem to be localised beds and lenses of hydrothermal alteration within the sequence.

10:25- now 100 m bearing 324° to WP-2, at 715 mbsl. See a steep groove in the slope. Continuing through 700 mbsl and passing into a talus field of pumice. Then a small outcrop, 2-3 m high, of bedded massive pyroclastic flow.

At 669 mbsl came across a domain of columnar jointing within the pyroclastic flow sequence, which has a sandy texture when viewed up close together with white vertical fiamme or gas escape structures about a finger length long. Overall the columnar jointing occurs within pillow-like blocks. Interpreted as welding within the pyroclastic flow. **Sample R3** (basket C) is solid yellow pumice from the base of the columnar jointing at 672 mbsl.

Thereafter the pyroclastic flow is poorly outcropping with much talus cover. At 647 mbsl this is a dense subwelded pyroclastic flow, just below its top contact to a black ash bed. **Sample R4** (basket B), a light colored pumice with prominent bedding planes.

Immediately above at 644 mbsl is an abrupt contact to a black ash bed ~10 cm thick and well bedded. **Sediment Scoop 3** sampled this grey ash at 642 mbsl, which came out readily. This is essentially WP-2; 600 m bearing 335° to WP-3.

At 637 mbsl is a black pod of basalt 4-5 m across. The core has columnar jointing and a dyke-like appearance, whereas the outer margins are banded with the surrounding pumiceous pyroclastic flow and locally shades of grey. Locally the basalt is scoriaceous where it lacks columnar jointing. **Sample R5** (basket D) is from the centre of the outcrop and represents the darkest basaltic material. A large crinoid growing on the outcrop was sampled as **Bio Box 1**.

11:20- continuing towards WP-3 across black sands with ripple marks at the top of the scarp, really ranging from fine gravels to silts and with winnowed patches. See a large sea pen, galathaoid crabs, starfish.

11:30- entering a dark sand area at 586 mbsl. Now 345 m bearing 340° from WP-3 and progressively close in, reaching it at 11:40 and 532 mbsl. All this area is talus composed of 10% pumice gravels in 90% black sands with winnows and ripples.

11:43- 260 m bearing 330° to WP-4. Proceed down a fault with 2 m throw. Passing over a 40-50 m wide valley with floor at 533 mbsl and composed of talus pumice.

Floor reverts to black sands when 160 m bearing 325° from WP-4. There seems to be a crust under the black sands with numerous thin cracks and small (cm across) pits at 75 m bearing 320° from WP-4.

Reach WP-4 at 522 mbsl and have lunch.

12:10- resuming after lunch at 160 m bearing 225° from WP-5. Seafloor drops steeply into the pit crater, but remains black sands. Contouring around the SW side of the crater through talus of black sand. This seems to be a thin layer over weathered greyish andesite(?), but no real outcrop. Shutes on the crater walls include much pumice talus.

At 80 m bearing 280° from WP-5 come to an area of large (20 cm diameter) black basalt boulders occurring as scree together with altered brown pumice.

At 35 m bearing 280° from WP-5 still in the basalt and pumice boulder field. Many of the basalt boulders are spherical with thick brown altered glass rinds over black cores, suggesting these are bombs from the crater forming eruptions. **Sample R6** (basket E) is one of the larger basalt bombs from here, and had hard corals and other biology on it. Hard corals are common in this area, but most are dead. A crust with hard coral on it was sampled as **Bio Box 2**.

Continuing to contour around the crater to WP-6 over black sands with patches of talus pumice, basalt boulders are now rare. Saw one lens of basalt in a small outcrop of pyroclastic flow overlain by talus, confirming that the basalt-bearing pyroclastic flow top is immediately below the talus surface.

12:43- now 300 m bearing 040° from WP-6. Going downslope over a grey talus field with black sands and pumice. Pass a 2 m wide ledge at 543 mbsl, suggesting a possible fault.

12:47- now 250 m bearing 030° from WP-6. Steep drop off in the floor making it difficult to observe the bottom. Going downslope.

12:57- reach the base of the saddle at 587 mbsl, 100 m bearing 005° from WP-6. Still in the talus field, but the pumice abruptly stops and some large blocks of ropey andesite appear, still in the black sand.

At 50 m bearing 330° from WP-6, now change course to head 080° at an end point near WP-9. Proceeding over andesitic sands and fine gravels on a gentle talus slope with rare ropey andesite blocks.

13:10- reach a massive aa flow with a 5-10 m high flow front at 24°35.351, 176°52.398 and 558 mbsl. Change video tape 2-->3. **Sample R7** (basket C) is a large tabular piece of basaltic andesite about 5 m up from the base of the flow front at 555 mbsl and was in situ. Had a single coral growing on it.

13:24- proceeding to WP-8 at 180 m bearing 170°. Followed the flow front most of the way, and saw no sign of alteration in the flow or of breaks to other flows.

13:45- reached WP-8, again at the basal contact of a thick aa flow to the talus slope at 585 mbsl. Much biology (hydrozoans and fish) in this area. **Sample R8** (basket E) was a fairly tabular black basaltic andesite from the aa flow front 1-2 m upslope of the flow base at 582 mbsl and was in situ.

Now proceeding up and over the massive flow towards WP-9. Passed a barnacle cluster about 10 m up from the flow front. Rare local sediment patches on the strongly undulating flow surface are fresh black and grey andesitic sands with no sign of alteration. These sediment patches become more common above 550 mbsl (possible change to an older flow?). Also now some deep valleys (5 m) between lava outcrops.

At 180 m bearing 304° from WP-9. Continuing around slope to avoid diving. Water depth 505 mbsl and going in and around 3-5 m deep valleys. Outcrop is large lava blocks separated by fine grained talus, no sign of alteration. In this terrain there is no chance of distinguishing individual flow units.

14:07- 63 m bearing 280° to WP-9. Much biology including a green hydrozoan with shrimps. Changing course to WP-10 at 525 m bearing 060°.

14:20- **Sample R9** (basket D), rather scoriaceous grey andesite from a large in situ block at 497 mbsl. Has distinctive biology with a puff ball on one end. Still no sign of alteration in surrounding talus. Continuing to a sheer wall 10-15 m high at 475 mbsl, interpreted as the western wall of the main rift. Then through a smooth talus slope at 465 mbsl with some big boulders, mussel shell fragments with no alteration or sediment at 461 mbsl, and dead corals at 451-446 mbsl.

14:38- Finally altered talus sediments, looking like old and cold Fe crust underneath. At 440 mbsl and 340 m bearing 063° to WP-10. Temperature probe gave 11.5°C on tan sediment overlying blue sediment, with ambient sea water at 11.2°C. This alteration continues for about 20 m. Lots of bright green coral-sponges, sampled as **Bio Box 3** from 434 mbsl.

Water increasingly cloudy at 416 mbsl and above a brown ledge, 24°35.180, 176°52.186. Lots of dead corals, but the bacterial mat looks partly alive. Temperature probe returns 13.8°C on the mat versus ambient at 12.5°C. Clearly in a cloudy plume here. Substrate is a cobble pavement consisting of bacterial mat on stained tan Fe crust, probably in turn on talus. Many finger-sized small chimneys when the ground is viewed close up.

Proceeding through the bacterial mat-Fe crust field. Found some bright orange crusts which are very soft when probed. Temperature of 14.4°C, 399 mbsl. Sampled as **Sediment Scoop 4**.

Continuing the ascent through the bacterial mat and Fe crusts. Lots of eels at 375 mbsl. Change to mostly cobbles at 348 mbsl, reverting to platy crust at 330 mbsl.

15:13- Patch of relatively fresh lava in talus. **Sample R10** (basket B), a greyish brown andesite with orange clays on surface but a solid and jointed block. Looks like a piece from a massive flow. The surrounding talus slope is still brown-yellow bacterial mat and Fe crust. 318 mbsl.

At 305 mbsl come to a lava flow 2 m high, clearly the source of the R10 talus. This continues to 290 mbsl and has a grey-brown "steamed" appearance. Numerous cracks and dead vents occur in the flow at 285 mbsl, but it remains essentially unaltered.

15:24- on the summit at 273 mbsl at WP-10 in the "steamed" lava. No venting here- dead. However visibility is no better than 5-6 m. Proceeding to the eastern summit at WP-11 and go over a near vertical 11 m drop.

At WP-11 on the eastern summit at 273 mbsl. This is a ridge with sheer drops on all sides (faulted). Again the substrate is the "steamed" lava flow. Deployed the temperature probe into a crack in the flow with yellow bacterial mat around it. No sign of any significant fluid flow, but the probe recorded 18.5°C versus an ambient 16.4°C. Location is 24°35.092, 176°51.979. Deployed HURL marker 39.

15:34- at 100 m bearing 015° from WP-12. Going down a vertical wall in the "steamed" lava. See big overhanging blocks in the wall with steps following jointing, make extensive use of sonar and spinning the sub during descent. Several white "seams" representing former vents, but no sign of present activity. Visibility remains low at ~7 m.

15:53- on a ledge at 322 mbsl, still in the "steamed" lava with talus patches. **Sample R11** (basket E), a triangular shaped piece of brownish grey andesite with some bacterial mat encrustations from the talus but represents the eastern summit lava. Particulate flow coming up over this ledge, implying possible plume source below.

Continuing descent. At 335 mbsl find a 2-3 m wide patch of dead mussel shells, probably more in this area have been buried by the talus.

16:10- find a field of dead tube worms that grew on Fe crust in a talus field of weakly altered "steamed" lava at 340 mbsl. Somewhat of a puzzle- the lavas are too fresh for the degree of

venting implied by the worms, yet the worms couldn't have survived transportation from anywhere else as they and the crust disaggregate readily. Are the worms simply filter feeders and not a vent fauna? **Bio Box 4** sample of many worms. Location is 24°35.046, 176°51.960. Preparing to leave the surface and then ascend.