HAWAI'I UNDERSEA RESEARCH LABORATORY
QUICK LOOK REPORT
DIVE: PV-641

MISSION STATUS

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

Latitude: ***Begin*** 24° 34.02'S **Longitude:** ***Begin*** 176° 55.04'W

Mission Date: June 19, 2005 **Duration:** 6 hours 19 min (Bottom Time)

Maximum Depth (m): 1223 m

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

Principal Investigator: Prof. Peter Stoffers, Kiel University

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Observer 1: Tim Worthington **Observer 2:** None
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Pilot 1: Terry Kerby **Pilot 2:** Steve Price

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

Objectives:
Explaore and sample a series of stacked lava flows and chlorite-clay material overlain by the caldera forming pyroclastic flow sequence. These outcrop along a series of 3 ridges at the mid- to upper slopes, inner north caldera wall (WP-1 to WP-10). This is the main aim of the dive. Contour around the inner caldera wall at 910 mbsl to explore for a hydrothermal system known to be present somewhere within the caldera at this depth (WP-10 to WP-12). Explore and sample stacked lava flows on a steep ridge on the inner NE caldera wall (WP-12 to WP-13). If warranted and time permits, continue from here to the summit (WP-14 onwards) to further examine the caldera forming pyroclastic flow sequence.

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

Summary: The dive was launched in good weather conditions, allowing a bottom time of 6.4 hours. The prime objectives were achieved. The pyroclastic flow sequence was found

to be more complex than previously suspected. At least 3 distinct units are present. The lower unit varies from slightly to pervasively altered with local development of sericitic clay veins are rarely chlorite. This alteration is most severe at 920 mbsl but was found over a total range of 843-1020 mbsl. Above this is an unaltered pyroclastic unit with a subwelded middle section, readily distinguished by the presence of basalt clasts within the uppermost 50 m and overlain by basaltic talus. A further thinner pyroclastic flow sequence, with a mixed population of pumice and ~10% basaltic clasts, caps this unit. The same sequence was observed on a parallel ascent of the inner wall later in the day positioned further to the east.

Species List:

Biology Samples:
PV-641-A1 Polychaete (from R9)
PV-641-A2 Caryophiliidae (unusual, from R12)
PV-641-A3 Unusual bivalve (from R12, 12:00, 675m)
PV-641-A4 Unusual bivalves (2, from R12)
PV-641-A5 Porifera (from R5)
PV-641-A6 Caryophiliidae #1 (from R9)
PV-641-A7 Caryophiliidae #2 (from R9)
PV-641-A8 Unusual bivalve (1 valve, from R9)
PV-641-A9 Caryophiliidae (dead, from R9)
PV-641-A10 Caryophiliidae (5, from R14)

Observed in video:

Midwater:
Mysida (Decapoda)
Munnopsidae (isopoda, numerous)
Appendicularia (Larvaceans)
Salpida
Lobata
Aeginura?

Benthic:
Cerianthidae
Crinoidea (white stalked, numerous)
Actiniaria
Gorgonacea (whip)
Paguroidea (hermit crab)
Caryophiliidae (lophelia like)
Anthomastus?
Gorgonacea (green, sampled)
Porifera
Synaptobranchiidae

Ophidiiformes? 10:37, 1008 m
Iridigorgia
Asteroidea
Zoarcidae

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.

Time did not permit more than two ascents of the inner caldera wall, but this was anticipated and the results were more than satisfactory.

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

Dive #641: 19 June 2005 V18s Inner North Wall of Caldera

On bottom 1228 mbsl near WP-1, 09:23. 24°33.974, 176°55.055. A steep (20°) talus field composed of 10-30 cm diameter pumice blocks with no fines. Mostly light grey in color and look fresher than at #640. Attempted to collect pieces as talus and they crumbled to dust when touched by the arm, also very lightweight and nearly float.

Proceeded upslope (~020°) through the talus field. Passed a few very large (~3 m across) blocks with indistinct surface texture- contemplated that these might be the chlorite blocks but on investigation with the arm they proved to be subwelded pyroclastic flow. They are partly buried by the talus, but clearly also talus themselves.

09:47- came across the 96DR dredge track! A groove through the talus about 1 m across with 50 cm high raised ridges, continues like a road upslope. Followed this for several hundred metres through the talus- it remained straight and on bottom.

09:56- came to a steep wall at 1133 mbsl. A breccia of varied lithologies in ash? - probably the welded pyroclastic flow as unable to extract any clasts due to their smoothness. Partly buried by talus pumice.

Reverting to a talus field of pumice at 1110 mbsl, which continued to 1085 mbsl (10:03).

10:15- came to a wall of fine grained material with no surface texture, light tan color, at 1055 mbsl. Interpreted as subwelded pyroclastic flow. Dropped ballast (draw-down on batteries proving too great). Wall continued to 1040 mbsl, then re-entered talus field.

Came across another 2-3 m high wall. Scraped this with the basket and it proved to be yellow pumice coated in darker weathering rind. Took photos. Interpreted as proof that these walls are massive pyroclastic flow and not the anticipated chlorite unit.

At 1013 mbsl came to a very big wall, which includes a vein-like seam of white clay. Followed this and the wall took on an olive green hue suggesting chlorite. Clearly discolored material resembling chlorite on an Fe crust, but developed within the massive pyroclastic flow. The alteration looks to be pervasive with rare veins.

10:38- **Sample R1** (basket A), a dense grey lava with white clay specks occurring as a clast in the chlorite-altered wall. Depth 1007 mbsl, location 24°33.822, 176°54.945. Other pumice clasts in the wall are a chalky brittle white, suggesting alteration to kaolinite. Continued up the wall towards WP-2, with the wall remaining altered pyroclastic flow.

At 997 mbsl saw a crusted vein outcropping in the wall, about 20 mm across with margins of Fe-crust that protrude 10 cm above the surface. Talus buries the field to port (west).

At 977 mbsl see a horizontal white clay vein in the wall (photo). Above this is a distinct bed of darker clasts in the otherwise smooth textured wall. Scraped these with the basket and they revealed white altered pumice clasts (brittle). Then left the wall, which is capped by talus pumice.

11:11- found a white vein in another wall of massive pyroclastic flow at 925 mbsl. **Sediment Scoop 5** was an attempt to dig out the white vein. This proved to be quite hard and more like bedded brittle altered white pumice. Not helped by the buoyant condition of the sub. Considerable relict bedding was visible in the wall of the pyroclastic flow, which has the appearance of fine fallout beds separating massive pyroclastic flow units. Location 24°33.798, 176°54.836. Continued up through a talus field of pumice overlying the altered white pyroclastic flow.

At 844 mbsl came to a series of walls composed of massive pyroclastic flow, but this time unaltered (hidden contact between basal and central flows?). The flow here has a granular clastic structure with poorly developed horizontal bedding and vertical flutes, also erosional channels with "sandflows". By 825 mbsl the low is becoming more massive and weakly subwelded. This looks like the caldera-forming pyroclastic flow eruption of #840.

At 783 mbsl darker greyish lenses and rocks start to appear in the flow, suggesting the start of the basalt component. At 768 mbsl are some fine grained dark grey ash beds.

11:39- at 735 mbsl had steep walls on both sides of sub, composed of the massive pyroclastic flow with dark lenses. Given the large apparent thickness of the basalt-bearing unit here, is this a last gasp of the ignimbrite that is restricted to the northern wall area? Poorly welded but standing sub-vertically.

At 715 mbsl see more bedding, including a yellow bed with apparent big black basalt boulders. Tried to sample but these proved grey and crumbly (not basalt).

11:47- at 689 mbsl saw a pumice block with a nice sponge. **Sample in Bio Box**.

At 679 mbsl reached basalt talus overlying the inferred top of the pyroclastic flow. **Sample R2** (basket C) with a coral at one end and brown-grey rind. Took on **many ballast boulders of basalt talus** from here. Location 24°33.689, 176°54.723. Another basalt with talus had a cup coral on it; **sample put in the Bio Box**. Continued upslope.

At 655 mbsl came to a wall of massive pyroclastic flow, which had black basalt lenses around 640 mbsl. This flow has poorly defined clasts and is subwelded.

12:18- still going up through the pyroclastic flow. Came to a bed of darker material and sampled. **Sample R3 (1)** (basket C) is white pumice immediately below an apparent black basalt bed at 624 mbsl. When we sampled the basalt bed it turned out to be pumice clasts with a dark coating- a fallout bed. **Sample R3 (2)** (basket C) is an elongate piece from this bed, complete with its "black" FeMn coat.

12:25-12:35 was the lunch stop. Then proceeding through the standard talus pumice and basalt.

At 583 mbsl were well-bedded fallout pumice beds, very well sorted, composed of pumice with various colors. This 3-5 m high sequence (see photos) was interpreted as erosional debris flows, possibly generated by the onset of quake activity prior to the next eruption. It is conformably overlain by a massive pyroclastic flow with poorly defined pumice clasts and numerous dark basaltic lenses.

From 560 mbsl to 534 mbsl is the standard talus pumice and basalt. The ascent was terminated at 534 mbsl and we returned to sample the pyroclastic flow at 565 mbsl.

13:25- **Sample R4** (basket B) was pumice from 3 m below the top of the pyroclastic flow at 572 mbsl, in situ. Location 24°33.622, 176°54.660. Unable to find any good examples of the basalt lenses to sample.

At this point the decision was made to go deep to WP-8 and try the more eastern ridge for a parallel ascent. At departure it was 700 m bearing 205° to WP-8, and the downslope transit took 80 minutes.

14:44- on bottom 50 m west of WP-8, 1135 mbsl, at the base of a steep wall composed of altered pyroclastic flow covered by dark greyish brown sediment. Photos. Several circular burrows into sediment at the base of the wall expose bluish material, suggesting alteration. **Sediment Scoop 3** sampled this bluish silty clay, which proved very fluffy. Hard white clay was exposed beneath the blue veneer. **Sample R5** (Bio Box) was from the base of the cliff in the pyroclastic flow and proved to be white crumbly pumice with a dark surface coating of FeMn.

At 1120 mbsl are some thin yellow veins cross-cutting the altered pyroclastic flow- these appear to be following bedding planes and were photographed.

At 1110 mbsl the outcrop is a subwelded pyroclastic flow the horizontal bedding planes and a dark surface coating. When scraped the angular jointed blocks reveal white-yellow pumice with no alteration. So the alteration stopped between 1110-1120 mbsl or there is a hidden contact between 2 pyroclastic flows here.

At 1070 mbsl is a vertical white vein. Otherwise still ascending through the massive pyroclastic flow with horizontal bedding, exposed on the vertical wall. The wall stops at 1065 mbsl.

At 1062 mbsl reverts to the massive pyroclastic flow exposed in another wall, locally leaking white pumiceous sand from cracks.

At 1043 mbsl is a black horizontal band in the massive pyroclastic flow. Photo. Again on scraping this proves to be a reddish brown coating on yellow pumice. Another clast layer outcrops in the pyroclastic flow above this. The wall is really a big exfoliating cliff- now moving to the next cliff about 30 m away.

At 1030 mbsl is a change to talus.

At 1015 mbsl is another wall of altered pyroclastic flow with white veins. This is poorly exposed and has much silt covering it.

At 960 mbsl the outcrop is back to an unaltered massive pyroclastic flow.

15:26- talus composed of small pumice blocks at 935 mbsl, coarsening to large pumice blocks at 927 mbsl.

At 911 mbsl took **Sample R6** (basket D), being a large white pumice clast from the massive pyroclastic flow. This took a long time to collect as samples kept breaking when touched.

At 902 mbsl back into talus of pumice.

At 876 mbsl a big cliff of massive pyroclastic flow with horizontal bedding, with indistinct clasts.

At 849 mbsl is an altered lens of locally blue and yellow material in the pyroclastic flow.

At 830 mbsl passing into a talus field of pumice.

At 825 mbsl another wall of massive pyroclastic flow.

At 784 mbsl is the top contact of the pyroclastic flow, overlain by pumice talus. Immediately below the top is a stained yellow weathered zone representing a paleosol.

Dive was aborted at this point (15:45) and we surfaced at 15:55. First, ballast blocks were placed into baskets A, B, C, D, and 2 into E (including a basalt with coral and and altered lava with clay from site of R1). Most were from the basalt talus bed at the site of sample R2.