OKEANOS EXPLORER ROV DIVE SUMMARY

Site Name	Mt Doom		
ROV Lead	Dave Lovalvo		
General Area Descriptor	100 km SSW of Grand Cayman Island		
ROV Dive Name	Cruise Season	Leg	Dive Number
	EX1104	-	DIVE11
Equipment Deployed	ROV:	Little Hercules	
	Camera Platfom:	Seirios	
ROV Measurements	☒ CTD	☒ Depth	☒ Altitude
	☒ Scanning Sonar	☒ USBL Position	☒ Heading
	☒ Pitch	☒ Roll	☒ HD Camera
	☒ Low Res Cam 1	☒ Low Res Cam 2	
Equipment Malfunctions	none		

ROV Dive Summary (From processed ROV data)

Dive Summary: EX1104_DIVE11

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In Water at:	2011-08-14T13:29:34.602000 18°, 22.750' N ; 081°, 47.284' W
Out Water at:	2011-08-14T23:09:34.138000 18°, 22.551' N ; 081°, 47.447' W
Off Bottom at:	2011-08-14T21:36:40.709000 18°, 22.545' N ; 081°, 47.867' W
On Bottom at:	2011-08-14T14:54:57.423000 18°, 22.656' N ; 081°, 47.285' W
Dive duration:	9:39:59
Bottom Time:	6:41:43
Max. depth:	2520.6 m

Special Notes	Click here to enter text.
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Purpose of the Dive

Mt. Doom is similar in shape, but slightly larger than the Von Damm mound and the objective was to explore Mt. Doom to see if it was an abandoned version of Von Damm and then traverse to the west and investigate the slope below Von Damm.

Description of the Dive:

Little Herc was launched at Mount Doom, a conical dome to the east of Von Damm on the top of Mt. Dent. The ROV landed at 2486m (heading due south) at marker MCR124 (waypoint D01) and set down on thick, but smooth, southward dipping, biogenic carbonate. Little Herc traversed NE, around the southern margin of Mount Doom, towards waypoint D02. At MCR125 (2473m), a few, very weathered, gnarly-surfaced boulders were encountered in the biogenic carbonate. The boulders were up to 1m in diameter and apparently had a foliation, but were sediment dusted, Mn-oxide coated and difficult to identify. They were associated with dead coral that was also heavily Mn-oxide coated. Subsequent consideration of the rocks seen throughout the dive suggests that these rocks were most likely extensively hydrothermally altered basalts. Mount Doom exposes many similar patches of altered basaltic boulders that we envisage to represent the top of an irregular surface that underlies and occasionally protrudes through a younger cover of thick carbonate sediment. Approximately 98% of Mt. Doom is covered by biogenic carbonate, but similar occurrences of sediment dusted boulders were found at MCR126, MCR127 and MCR128. Ascending toward the summit of Mt Doom from the South East (MCR129; 2440m) an extensive scattering of extremely weathered (hydrothermally altered) 1-10cm clasts was observed, lying on top of biogenic sediment, and stained bright shades of red, orange and yellow. The clasts had evidently rolled downhill from the south- and east-ward dipping slope of Mt.Doom. While freshly fractured surfaces showed such bright colors, however, individual rocks here were also heavily Mn coated. Nevertheless, on closer inspection, these rocks appeared to be fractured and vuggy and this “outcrop” showed clear evidence for hydrothermal alteration. Proceeding north along the east flank of Mt. Doom, many other boulders in subsequent localities also showed similar yellow coloration on fractured faces consistent with an earlier period of extensive hydrothermal alteration across this steep-sided (~45° slope), ~200m diameter and 70m tall cone. Particularly common across the most heavily sediment areas on the approach to, flanks and summit of Mt Doom was the holothurian ?*Benthodytes*. On hard substrata were small poriferans and the occasional asteroid and galatheid. There were some bamboo corals that were large and healthy (Isididae sp.) but they were few and far between – mostly dead and broken corals strewn on the seafloor. Octocoral colonies or zoanthids were observed growing on some of the dead gorgonian stumps on the rocks. A few anemones, serpulid polychaete tubes and some amphipods/isopods? were also seen on the rocks occasionally. Three wood falls were noted – most had significant evidence of circular burrowing (*Xylophaga* sp.?), tiny crustaceans (isopods or amphipods), one shrimp and serpulid polychaete tubes. One *Bathypterois* sp. fish and a nautilus shell fragment were observed.

Having headed up slope to waypoint D03 and then contoured around the flanks of Mt Doom to the north (to waypoint D04) and then west as far as waypoint D05, Little Herc was turned south to ascend the northern face of Mt. Doom all the way to the summit at waypoint D06. Altered basalt boulders were encountered at MCR130, MCR131 and MCR132 (all of which showed yellow colouration), MCR133, MCR135, MCR137 (coincident with waypoint D04), MCR138, MCR140, MCR141 (coincident with waypoint D05), MCR142 (which also revealed yellow hydrothermal discoloration), MCR143, MCR144, MCR145, MCR146, MCR147 & MCR148 (the latter at a depth of 2420m, at the summit of Mt Doom and coincident with waypoint D06). In most cases, the exposed rocks had Mn encrusted and dead, broken gorgonians attached to them and were surrounded by dead gorgonian debris in the sediment. The biogenic carbonate covering Mt Doom was for the

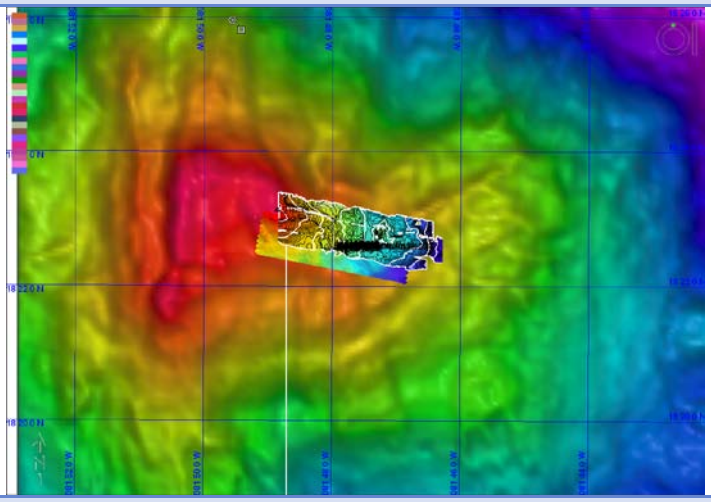
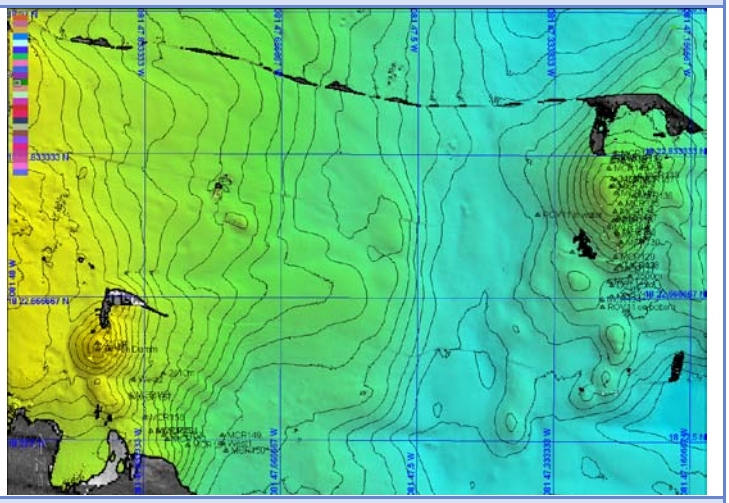
most part relatively smooth (few >1m pockmarks) and consisted of finer particles than on the plain below. Extensive scouring was found on the top of Mt. Doom. More occurrences of the boulders were found going downslope toward waypoint D07, at a depth of 2465m toward the SW corner of the Mt. Doom cone. In summary, we interpret Mt. Doom to be a volcanic mound consisting of hydrothermally altered basalt covered by extensive biogenic carbonate sediment. This sediment cover (estimated ~1m) was too thick for much of the underlying geologic setting to be deduced but it remains a viable hypothesis that Mt Doom may have previously hosted hydrothermal circulation comparable to that currently active at the Von Damm site, 1km distant upslope.

From waypoint D07, it was decided to transit as expediently as possible over the seafloor to waypoint D08 and to achieve this the vehicle was transitted primarily through the water column over biogenic carbonate with fewer holothurians than had been observed at/on Mt Doom. A few rock clasts up to 1m across were sighted in biogenic carbonate at MCR149 near to waypoint W1 (2467m MCR150) at the foot of an approximately eastward dipping, N-S trending slope, downhill to the southeast from the most SE corner of the central Von Damn cone. Proceeding NW upslope from waypoint W1 toward W2, the outer limit of the influence of the Von Damn hydrothermal field was reached at MCR151. Here, as Little Herc traversed up slope towards the W2 waypoint, 100% sediment cover gave way to a rock density that increased from sporadic clasts to 100% exposure consisting of rounded, gnarly, cobbles of basalt rubble. Occasional pillows up to 2m were visible (MCR153, 2400m, MCR156, 2386m) as were hints of ropey flows and possible lava tubes. Yellow discoloration of fractured surfaces was visible, pervasively among these rocks – comparable to that observed across much of Mt Doom earlier in the dive, indicative of extensive hydrothermal alteration. Indeed, it was upon seeing these rocks that it became apparent that we were in a lithology near-identical in appearance to that observed throughout our entire exploration of Mt. Doom. By contrast, however, there was only a very light sediment dusting here, indicating that the basalts at the approach to the Von Damm are relatively much more recent. Initially, this area appeared to be lacking in fauna, however quite soon after making the first observations of hydrothermally altered rocks, continuing upslope, we came across large aggregations of dead and lightly-sedimented *Bathymodiolus* shells (MCR152-MCR154). There were huge variations in mussel shell size suggesting the entire population died at once – some shells were over 30cm in length. Some galatheids were noted and then tens of live tubeworms were sighted (MCR155) at a range extending out to ~170m from the central spire of the Von Damm hydrothermal field. There were also variations in tubeworm sizes - some much smaller than others. No diffuse flow was observed throughout these marked areas (MCR152-MCR155) and more dead mussel shells were encountered uphill from the MCR155 tubeworms.

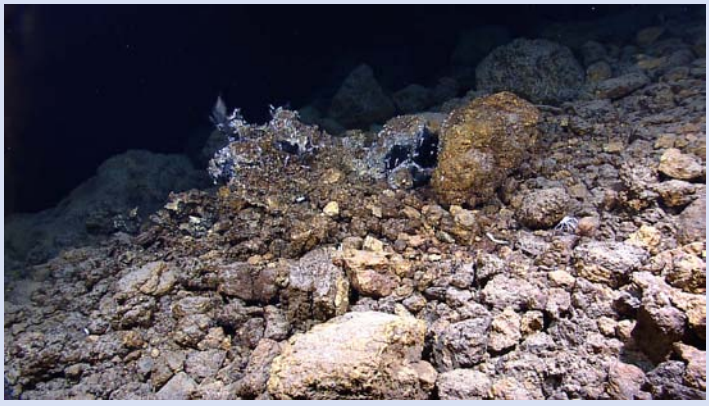
Little Herc encountered a second site of >5 individual living tubeworms, anchored in heavily altered, yellowed basalt pillow clasts at MCR 156. Soon after, ~30 tubeworms were found anchored in crevices in hydrothermally altered basalts at MCR157. There, variations in the sizes of the tubeworms present were noted. We also located a previously unknown chimney structure emitting focused fluid flow immediately downslope from these tubeworms (MCR158; HDG = 282; Depth = 2380m, approx. 10-20m from the W2 waypoint (our final intended target for this dive) that coincided with the SE corner of our original square-spiral survaey around and out to the base of the central Von Damn cone. Several shrimp were also located at this site, along with the tube worms, and a second area of lower T diffuse flow was also visible to the right under a large boulder with white staining and microbial mat. Vigorous focused clear fluids were pouring out of a 10cm orifice atop the 'chimney' composed of a very altered raised basalt outcrop heavily coated with Fe-oxide and white microbial material. More fresh, black basalt surfaces were poking through the altered coating. A 10cm long piece of feathery dark gray colored tissue was fluttering at the vent orifice, possibly microbial mat right in the most robust upflow. Due to the absence of visible anhydrite and the robust shimmer and flow velocity, vent T was

estimated to potentially fall the range: 100-150ºC. Locally, the ROV temperature sensor was recorded to reach 4.7°C, representing at elevation of 0.5°C over the ambient 4.2°C at these depths on the Mid-Cayman Rise. To conclude this dive (we found this site 15 minutes from planned ascent time) we repositioned *Little Herc* to image the other side of the vent (HDG = 081; Depth 2379m) for more video recording, during which little mini-chimneys were just visible to the left within the frame. Little Herc left the seafloor after filming this vent. On the chimney itself, many *Rimicaris* were seen. Most were quite small and had red colorations suggesting recent colonization or recruitment. There were also many white gastropods, some white small crustaceans (either amphipods or isopods) and one zoarcid eelpout as also seen at the central Von Damm cone. On the periphery, there were a few tubeworms and galatheids.

Summary: We suggest that Mt. Doom is an older, extinct hydrothermal mound, possibly formed in a similar way to Von Damm. We established that the Von Damn hydrothermal system sits on a relatively recently erupted mass of pillow basalts and the whole site is more extensive than originally thought.

Overall Map of ROV Dive Area	**Close-up Map of Main Dive Site**
	
	Bathymetry courtesy of D.P.Connelly et al.

Representative Photos of the Dive

	
A tripod fish in distinctive feeding posture	Hydrothermal rubble with a small chimney in the background

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