

LAVA CAVE MEANDERINGS in the GALAPAGOS ISLANDS

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*The final pitch into Triple Volcan
Photo: John Brush*

The 16th International Symposium of Vulcanospeleology was held on the Galapagos Islands in March 2014 and trips associated with the symposium provided opportunities for visiting a variety of lava caves on several islands. This article briefly describes some of the caves visited and offers some management observations.

The symposium attracted more than 70 participants from around the world and was the largest such gathering since the 13th symposium in Korea in 2008. ACKMA was well-represented with 6 members attending (Greg Middleton, Julia James, Cathie Plowman, David Butler, Marjorie Coggan and John Brush). Formal presentations covered a broad range of topics (see separate article by Cathie Plowman) and while there were a few organisational hiccups and frustrations (see *13 rules for conference organisers*), practically everyone appeared to come away with very positive feelings towards the islands, the local inhabitants and their caves.

The Galapagos Islands sit astride the equator about 1000 km off the west coast of South America. Politically, the islands are a province of Ecuador and in geological terms, they have been formed by effusions of ash and lava above a mantle hot spot over the last three to four million years. The most recent eruption was on Fernandina Island in 2009. Lava caves (or tubes) have been recorded on at least 5 of the 14 or so major islands. A reasonable number of caves on three different islands are accessible to the general public by one means or another. Symposium participants were able to visit more than 20 different caves during their time on the islands.

Some 97% of the land area of the Galapagos Islands falls within the boundaries of the Galapagos National Park (GNP) which, because of its World Heritage status and diverse, delicate and, in places, unique habitats, is highly protected with tightly controlled access arrangements. The remaining 3% of the land area is privately owned and comprises urban areas and cleared

or partly-cleared rural lands (largely cattle ranches and market gardens). Four islands are permanently inhabited and most of the 30,000 residents live in the towns of Puerto Ayora (the largest town), Puerto Baquerizo Moreno (the provincial capital) and Puerto Villamil (a sleepy village) on the islands of Santa Cruz, San Cristobal and Isabela, respectively.

Much of the land area is a virtual desert and it is only in the 'highlands' (approximately 200-700m ASL) of the larger islands where higher precipitation levels support significant growth of 'greenery'. Not surprisingly, it is the relatively lush highland areas of the above-mentioned three islands that have been most developed for agricultural use. This is significant for lava caves because it is much simpler to gain access permission to visit lava caves on private property and it is considerably easier to locate entrances in a grassy field than it is in thick 'jungle'.

Several of the caves we visited were public access caves within the GNP, but the majority of caves visited by symposium participants were on private property on Santa Cruz Island. Several of these privately-owned caves have been developed as low-key show cave operations. Most of the show caves are on cattle ranches where the cave operation has developed as a sideline to providing facilities for tour groups to observe giant tortoises. The tortoises roam freely across the highlands but are attracted by the green pastures of the ranches - local regulations require the bottom wire on fences is high enough for tortoises to push their way under. Thus the ranches are using caves to generate additional cash flow but observations suggest visitation levels are modest. Modifications to the caves generally comprise little more than rudimentary lighting, a few steps, trail markers and occasional handrails.

Gallardos Cave (also known as Bellavista Cave or Tunnels of Love)



*Cave guide and client meet the vulcanospeleologists in Bellavista Cave
Photo: John Brush*



*Lava straws and tree roots, Bellavista Cave
Photo: John Brush*

This arguably the most widely-known and visited show cave. Unique in the Galapagos, it is a stand-alone commercial cave operation and benefits from being the closest cave to Puerto Ayora; just a 15 minute trip by taxi. The cave is approximately 2km long, about a third of which, between an intermediate entrance and one towards the up-flow end, has been developed as a through trip. It appears to operate on either a guided or self-guided basis.

Widely-spaced compact-fluoro lighting has been strung along the show cave section. This would be adequate if all lights were operational but it is quite dark when they are not, such as at the time of our visits. Symposium participants were free to wander through this cave at will and from what we saw of the tour groups, a few torches are provided to guided and self-guided parties alike. Beyond the stone entrance steps, the easy walk-through route is along a passage that is generally 4-5m wide and 3-6m high, mostly on a solid and relatively robust lava floor. A few changes in direction, for example over low breakdown piles, are indicated by small painted arrows. There is a minor mud tracking and a small amount of littering, including the odd condom wrapper! Hmmm.

The longer down-flow section of passage contains some of the most impressive, varied and delicate lava speleothems ever seen by the author. The entrance to this part of the cave is in the same elongated collapse pit as the show cave entrance. Fortunately it is at the opposite end and is not visible from the show cave trail. This section of cave has a couple of breakdown piles and the passage dimensions are generally more modest - roof height rarely exceeds 3m and trends lower towards the lower end, meaning that speleothem development on the roof is within easy reach and so is quite vulnerable.

The inner end of the passage contains a profusion of lava straw clusters up to 20cm long, lava stalactites and shawls and forests of slender conical stalagmites up to

50cm high. At present, this decorated section is protected only by its distance from the entrance, the rock piles and the crawls. This cave deserves better protection such as restricted access, track marking and ideally, a locked gate. This was stressed to the owner when we took her into the cave, but how effective these representations will be remains to be seen. The cave is still in remarkably good condition, but has suffered from some irreparable damage to lava straws, stalactites and stalagmites and to secondary calcite encrustations and superficial tracking of mud onto the solid lava floor and around some of the tall stalagmites.

Soyla Cave

The sole entrance to Soyla Cave is in a field only a hundred metres from the 'visitor centre' at Gallardos Cave. From the entrance, the passage heads down-flow for about a kilometre (parallel to the nearby Gallardos Cave) and it does not take long to conclude this is a gem of a cave. It has a bit of almost everything one hopes to see in a lava cave: a variety of nice passage cross sections, very little breakdown, lava falls and cascades,



*Lava falls, Soyla Cave
Photo: John Brush*



*Lava straws with secondary calcite encrustations,
Soyla Cave
Photo: John Brush*

lava incisions, rolls, benches and levees, pahoehoe (ropy lava) floor, red, grey and yellow lavas, tube-in-tube structures, glazed wall lining, driplets and other delicate lava speleothems, secondary calcite encrustations and rafted blocks to name but a few.

Despite being so close to a road, the cave appears to have had little visitation and it is in excellent condition.

Primicias Cave

On the several occasions that we visited the Rancho Primicias, it was common to see taxis and buses disgorging or picking up loads of visitors. The ranch appears to generate a considerable amount business from its large restaurant and bar, the gifts shops and tortoise viewing operations. However, a few visitors pay an extra fee to visit Primicias Cave, located several hundred metres away along the ranch access road. The down-flow end of the cave is spacious but unlit, unspectacular and a tad muddy and so attracts little attention. The lit section is far more interesting and in



*Rudimentary lighting along the show cave route in
Primicias Cave
Photo: John Brush*



*Healthy lampenflora in Primicias Cave
Photo: John Brush*



*The leafy upper entrance to Royal Palm Cave
Photo: John Brush*

theory operates as a through trip. However, a short but low and muddy crawl a short distance from the exit means that most visitors, including many hardened cavers, retrace their steps to the lower entrance. Most visitors appear to be self-guided and the cave is well lit. In fact, too well lit. Unfortunately, the lights appear to be left on all day, every day, thus creating so serious a lampenflora (or as the Editor put it, lampenforest) problem that it is sufficient to make a pteridophile's heart flutter. The cave is showing a few signs of superficial wear and tear (eg mud tracking and minor littering) but is quite robust and, apart from installation of the lights and stone steps at both ends, the cave has been little modified to accommodate visitors.



*Unlit down-flow section of Primicias Cave
Photo: John Brush*

Royal Palm Cave

Hidden away in the misty highlands of Santa Cruz and protected by a security guard at the entrance gate, the exclusive Royal Palm Resort seemed to be an unlikely place for a caving trip. It sounded even more unlikely that a cave on the property had been equipped with pathways, ladders, bridges and lighting for the exclusive use of the few guests who can afford to stay at the resort.

It also seemed highly unlikely that a bunch of 60 or so scruffy cavers would be granted permission to visit the cave. However, for a mere \$1 per head, we not only gained access but were accompanied by the recently-appointed resort manager who was keen to receive our comments on the cave.

The cave is about 800m long, with the show cave route between two entrances accounting for about two-thirds of the length. Both entrances are set in thick regrowth scrub and neatly mown tracks make for easy access and exit. A combination of stone and timber-edged steps lead into the cave and further in, the route is generally defined by a scoria path edged with stones and, where necessary, with wooden handrails.

In places there are two levels in the cave. These formed when a flow that half-filled a pre-existing tube solidified on top and the remaining fluid lava drained away, leaving a secondary roof in parts of the cave. Subsequent partial collapse of the secondary roof has left a series of bridges which the tourist path meanders its way over and under. In areas where the later flow did not crust over, there is a deep floor channel. At one point, the trail crosses the channel on a large wooden bridge. Elsewhere, steep wooden ladders or steps lead from one level to the other.



*Colourful lavas in Royal Palm Cave
Photo: John Brush*

Apart from the lava bridges, arguably the most striking feature of the cave is the variety of colours seen - black, red and orange lavas sometimes topped with white, yellow and orange secondary encrustations. In one stunning area, the lower walls are bright red, but above that the upper walls and roof are black basalt.

Participants were eager to check out one section of the lower level which, we had been told, was used as a wine cellar. Sadly, all the bottles had been removed, perhaps in anticipation of our visit.

Beyond the end of the tourist route and the exit ladder, the passage continues for a couple of hundred metres. In this section, there is more breakdown but sections of roof lining remain intact and in places there are clusters of colourful lava straws. The passage terminates at a boulder pile where there are signs of digging and blasting, presumably in an attempt to extend the cave. We could not figure out why somebody had gone to so much trouble.

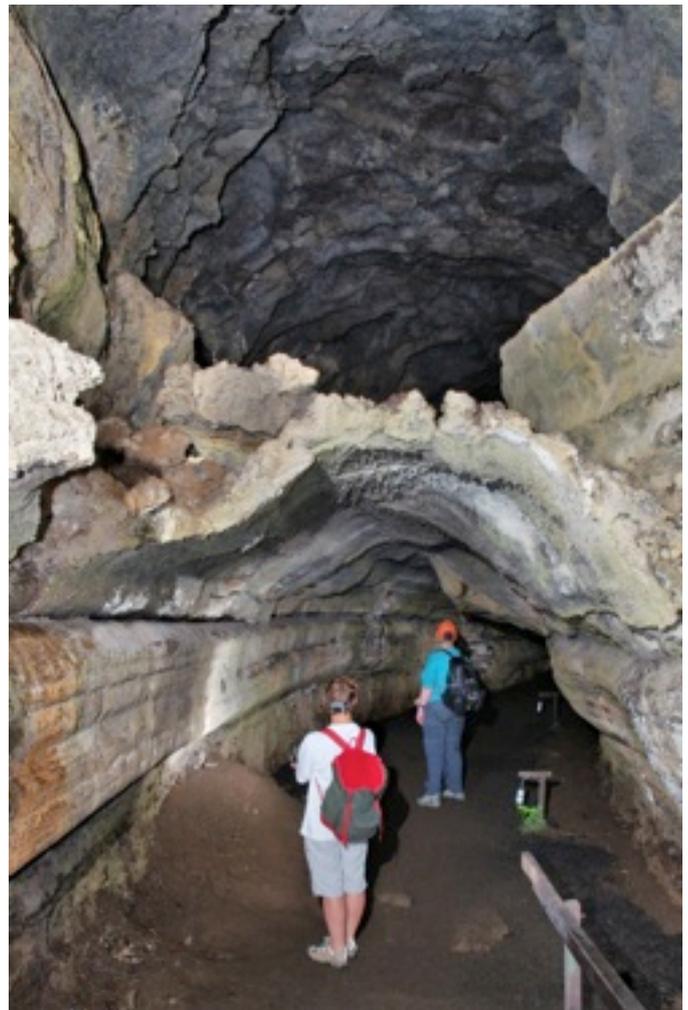
Although this is an impressive cave, it was probably the most highly modified of the show caves that we visited. The constructed path, extensive use of wood (for steps, ladders, handrails and bridges) and two generations of cave lighting have all had an impact. There is also lampenflora around some of the lights as well as a scattering of rubbish. As with other local show caves, there is minor littering beside pathways, but in addition, discarded wooden handrails and bridge planks appear to have been thrown into the nearest convenient pit. Off-trail, there is detonation wire leading into the terminal rockpile, and at one point, there, curiously, a 200 litre oil drum. Several of us had a good discussion on these issues with the new Manager, who was receptive to addressing them within the constraints of his limited budget.

Tortuga Crossing Caves

Tortuga is Spanish for tortoise or turtle and Tortuga Crossing appears to be a relatively new tourist operation in the Santa Cruz highlands near Rancho Primicias. In fact, much to the chagrin of field trip participants, the Conference Convener directed some people to walk there by road from Primicias, only for them to discover that after a hot 4km walk under an unrelenting equatorial sun, they ended up less than 200m from where they had started out. Needless to say, the return trip was considerably quicker – with not even a fence to cross.

As with Primicias, the giant tortoises are the main attraction. However, there is also a lava tube. This has been divided into sections by roof collapse and one section has been developed for visitors with entrance steps, lights and a pathway. It appears to run as a self-guided operation.

The stone entrance steps and timber handrail lead down to a flat earth floor that has been partly covered with a layer of basalt aggregate to provide a mud-free surface. Lighting is by means of compact fluoros fixed to low wooden posts. Although the lights were turned off



*Inner roof in Tortuga Crossing Cave;
note ferns growing under the light
Photo: John Brush*

during one of our visits into the cave, the luxuriant growth of mosses and ferns around the lights suggests they are not always turned off so promptly. The cave also supports some healthy fungus displays around the timber lamp posts. There is a whole new ecosystem down there, it seems.

It would be interesting to know what the longevity of the lighting system is. American cavers who were mapping the cave a year or two back had to retreat in haste when water started pouring into the cave after a heavy downpour and covered some of the lights. That can't be good.

The lit section of cave is quite short but is well worth a visit if only to observe the spectacular lava bridge which divides the passage in two for some distance. The bridge is as thin as 30cm in places and provides an aesthetic inner roof over the pathway. Keen visitors may also be able to find remnants of a second false roof high up near the inner end of the show cave trail.

A few hundred metres further down-flow, a tricky descent over slippery breakdown leads into a long section of passage that is generally 2-4m wide and 2-5m

high. Through much of the cave there are lateral shelves on either side of the passage indicating former levels of lava that once flowed along the passage. In places the original lava floor has been covered with a layer of mud – most likely transported in by running water. A few hundred metres into the cave, the trampled bones of a giant tortoise can be seen sitting in the mud. How did it manage to get so far into the cave?



*Lateral lava benches and shelves in Tortuga Crossing Cave
Photo: John Brush*

El Chato Caves

El Chato is yet another tourist-oriented ranch in the Santa Cruz highlands. The operation appears to be more low key than some of the others, but is worthy of mention. The comfortable open air restaurant is a pleasant spot to take in the views down to the coast while enjoying a cold beer after an afternoon of hard caving. And what could be more convenient than having the show cave exit right beside the restaurant?

The entrance to the show cave is about a 300m walk from the restaurant. From the entrance collapse, passage extends in both directions. Access to the shorter (300m) unlit section, known as Chato II, involves a 3-4m climb and features some undamaged lava straws and untrampled bones of an extinct giant rat (*Megaoryzomys curioi*). The show cave section is about 800m long and consists of two parallel passages joined at either end. Only the smaller of these two passages is lit. This is arguably the less interesting part, but it does have a smoother floor with less breakdown and so makes for an easier trip for visitors. We did not see any other visitors in the cave during our two visits to the ranch and so it is not known whether the commercial trips are guided or self-guided.

As with other local show caves, the lights are compact fluoro tubes fixed to wooden posts. That the system does not have great longevity in the moist cave environment is suggested by plastic bags wrapped around some light fittings and a succession of disused fittings and electric wires along the show cave trail. The cave has also been equipped, where necessary, with rope and timber handrails on wooden posts and at the end of the cave

trail, a long flight of stone steps leads out of the cave and back to the restaurant.

Another unlit cave on the ranch is located a few hundred metres down-flow from the show cave entrance. This has a thickly vegetated collapse entrance pit where we found a thick rope handline affixed to trees leading down into it – and then out again the other side without revealing where the cave entrance was. Whether this is a conservation measure, or just reflects rapid regrowth of vegetation we could only guess. Further investigations revealed a 3m by 5m entrance hidden behind a blackberry and vine thicket and after forcing our way through, we discovered a rope handrail affixed to wooden posts leading down a steep slope into the cave. At the bottom, broken giant tortoise shells suggested this was not a good place for a tortoise to find itself. Not far into the cave, the only feasible route was along an exposed traverse high on a narrow ledge with few handholds. This weeded out the party and made us wonder why so much trouble had gone into the entrance handlines. The cave passage continues for about 300m, mostly over breakdown.

Sucre Cave

Sucre Cave is an unlit public access cave within the GNP in the forested highlands of Isabela Island. It takes its name from a former local resident, Señor Sucre Gil, who apparently found the cave, hidden deep in the forest, was a good place to track down wild boars; thus ensuring his family a regular supply of fresh meat. Today, there are no signs of boars and there is a well-marked forest walk to the entrance and stone steps leading down into the cave, which is in excellent condition.



*Marjorie Coggan examining lava dribbles and yellow bacteria in Sucre Cave
Photo: John Brush*

Sucre is like no other cave that we visited on the islands. It is a relatively short (~400 metres) but branched system on several 'levels', suggesting a complex formation history. At a glance, the higher levels appear superficially similar to a phreatic cave in a limestone

area. At the lowest level, there is a floor of rough (a'a) lava bounded on one side by a lava levee bank up to 50cm high. Also in the lower levels, the roof and walls were festooned with lava drips and stalactites and thin yellow and gold microbial (mostly bacterial?) coatings were common. These often sparkled in our light beams because of a surface layer of condensation drops.

Triple Volcán

Triple Volcán is another feature in the highlands of Isabela Island. The cave lies beneath a rugged volcanic landscape and despite the number of nearby vents and cones, it does not take its name from these features, but rather from a set of triplets born into the family of the owners.

The cave is a partially drained lava chamber that is entered through a steeply-inclined closed depression - more correctly called a volcanic vent or an extinct (hopefully) volcano. A local landowner has established an adventure caving operation into the cave and as a result, the steep entrance slopes and lower vertical drop are festooned with a profusion of fixed ropes and wooden-runged ladders, most of which seem to be tied back to a couple of small trees on the surface. This infrastructure appears to be of varying vintages and condition and makes for easy but nerve-racking access.

In the limited time available, most people had an opportunity to descend 20m or so on the upper steeply inclined sections but only a few were able to descend all the way to the bottom of a large breakdown floored chamber that bells out beneath the narrow entrance throat.



Greg Middleton trying to decide which ropes are safest for a descent into Triple Volcan

Photo: John Brush



Entrance to Post Office Cave on Floreana Island

Photo: John Brush

Caves on Floreana Island

Although there were no formal symposium field trips to Floreana, a number of participants organised a day trip by boat prior to the start of the symposium and were able to visit the Caves of the Pirates on private property towards the centre of the island. The caves are a series of short overhang caves developed in volcanic ash. They have been substantially modified by digging over the years and their interest is largely cultural rather than speleological.

In addition, Marjorie and I visited Post Office Cave on the north side of the island during a boat trip around the Galapagos a week or so before the symposium. The cave lies within the GNP and is a site approved for public access. All that is required is (a) for the tour boat to have its itinerary approved by the GNP, (b) for the boat to have booked a time slot for that part of the island, (c) for shore parties to keep to marked tracks and (d) be accompanied at all times by an accredited naturalist. The tour boat we were on does not usually do trips into the cave, but when staff became aware of our cave interests, they arranged to extend the normal walk on the island to include a visit to the cave. About a dozen people chose to join us for a trip into the 300m long cave.

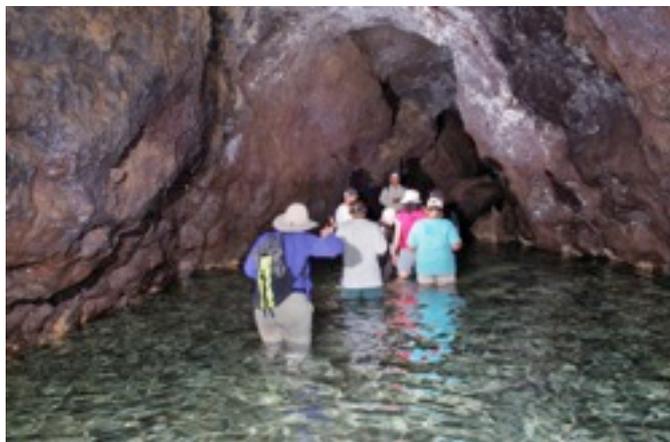
There is a marked track to the cave and wooden steps and a handrail leading down into it. Further in, a handline has been fixed for assistance down a steep lava cascade. At the bottom, the passage bells out to a lofty chamber some 8-12m high and 10-15m wide. Beyond the chamber, the passage pinches down to 3-6m wide and 4-5m high and in the final 50m of passage, a shallow lake extends across the full passage width. The lake is apparently tidal and gets progressively deeper before sumping. In some parts of the cave, such as near the base of the entrance steps and in the lake area, the original glazed lining of the tube remains intact, along with some small lava drips, but the chamber area has been substantially modified by breakdown.

Conclusions

Symposium participants were able to experience a wide range of public access, commercial and wild volcanic caves across several islands of the Galapagos. Most of the caves are in good condition and some that are both spectacular and delicate are worthy of more protection through more stringent access controls, track delineation and improved local understanding of the values of the caves and their contents.

According to official government figures, the Galapagos attracts about 170,000 visitors a year and it would be fair to assume that only a very small percentage of visitors go there primarily for the caves. Nevertheless, many tour group itineraries include a highland ranch visit to see tortoises and some groups appear to include a quick cave trip. Some independent visitors, especially younger ones looking for more adventurous activities, also find their way to a cave operation or two. But overall, visitor levels to the commercial caves appear to be relatively low, perhaps in the order of 20-60 visitors per cave per day, at most. This helps to limit direct impacts on the caves but it also means the revenue

generated is unlikely to be sufficient for cave owners to consider using lower impact materials (eg plastic and stainless steel rather than timber), making substantial improvements to lighting systems or to providing interpretive information.



*Wading along the terminal lake in Post Office Cave
Photo: John Brush*

13 RULES for CONFERENCE ORGANISERS

John Brush

This list was drawn up after experiences at recent cave-related symposium and may be helpful as a checklist for convenors of future ACKMA conferences.

1. Do not be afraid to seek help while planning and organising a conference; people will not think poorly of you if you don't do everything by yourself.
2. Never advise a cave/karst speaker to "talk as long as you like, we have plenty of time".
3. Ensure there is scope in the program to devote another day to presentations in the event that Rule 2 is ignored.
4. Compile and distribute a list of speakers, preferably before presentations start but, as a fall-back, before the conference ends.
5. Before presentations start, confirm the data projector /DLP is actually projecting all three colours; and make prior arrangements to ensure a backup data projector is available somewhere in town.
6. Avoid the temptation to provide continuous tea, coffee and snacks at the back of the meeting room and use this as justification for cutting out morning and afternoon tea breaks.
7. If lunch is to be provided at a location distant from the meeting room, ensure someone has a key to get back in again.
8. Designate someone (anyone?) to chair presentation sessions and to co-ordinate the order of speakers and the timely loading of their PowerPoint files.
9. Ensure hotel room bookings made for participants are confirmed for the full duration of their stay.
10. Express (at least some) concern when participants are told by hotel staff to vacate their rooms at short notice "but only for a night" because the hotel had lined up someone else for the room.
11. Ensure that any cavers designated as guides to run field trips actually know where the caves are located and how to get to them.
12. Never allow all of the guides to go home before the field trips end.
13. When all else fails, provide free beer.