The Caves of Christmas Island (Indian Ocean)

by Ken Grimes

Christmas Island is a tropical island (Latitude 10°30'S), in the Indian Ocean, northwest of Australia. In March - April of 1998 a group of six caver-scientists spent two and a half weeks on the island, doing a study of the island's caves and karst. The team involved Bill Humphreys and Stefan Eberhard, who studied the cave biology, Ken Grimes and Dan O'Toole, who looked at the geological hazards, and Andy Spate and Rauleigh Webb who looked at other hazards and cave and karst management in general (Grimes, 1998). This was done for Parks Australia North, so as to assist them in preparing a management plan for the National Park which now covers a large part of the island. Our job was made much easier by a set of unpublished cave maps and reports prepared in the 1960s by local cavers, such as David Powell and Roy Bishop; and also by maps and reports from a later cave expedition from West Australia in 1987 (Brooks, 1990).

The island is an old basaltic volcano with a limestone capping that is rising out of the Indian Ocean at a rate of 0.14mm per year and drifting north towards Indonesia at 8 cm per year. The interaction of uplift and a sequence of old sea-levels is a series of old shore-terraces cut into the steep and cliffy limestone sides of the island. The central plateau (about 200-250m ASL, with hills up to 360m ASL) is phosphate over a pinnacled epi-karst limestone surface, with the crest of the volcanic surface about 30-40m down. Phosphate mining has exposed the pinnacled sub-soil surface. I had expected a relatively soft porous limestone, similar to the Nullarbor (which is the same age) but the limestone is tight and hard. It is mostly a massive marine micritic calcarenite with scattered corals and partly recrystallised.

Most of the big caves are at sea level and entered from the base of the coastal cliffs. Higher up one finds uplifted systems that formed at past sea levels, and on the plateau there are some horizontal stream passages (see figure). The coastal cliffs which circle most of the island have strong notches cut at sea-level, and well-developed hackly phytokarst sculpturing of the rocks. In one place spring-fed streams running across the Shore Terrace have cut narrow canyons, known locally as The Dales.

Coastal Caves

The coastal caves are horizontal and lie at present sea level. They are typically entered by jumping off a boat and swimming into a low entrance in the sea cliff at low tide, and you continue wading or swimming in tidal water for much of their length (which is why most of the local cavers are also divers). The longest has 2.5 km of mapped passage, and many unexplored leads. Most of these caves have strong outflows of fresh water and submarine springs have been reported from depths as great as 200m.

These caves are horizontal joint-controlled passages with irregular, sharp, spongework walls. At intervals they are punctuated by massive rockpile chambers, and some entrances are via collapse dolines on the "Shore Terrace" (20-40m ASL). Some caves are dominantly collapse with little of the original passage visible. The caves have some very well decorated parts, but these are mostly difficult to reach. In places within the coastal caves one can feel cool fresh water floating on warm salt water, so I suspect salt/fresh-water mixing-corrosion is active and responsible for the extensive spongework sculpturing. Tidal mixing & flushing may also assist in the solution of the limestone.

The tight nature of the rock restricted the original passages to the joints, but spongework cavities are actively expanding from these.

The presence of drowned speleothems down to at least -6m in the main flooded passages suggests that the original cave development predates the present Holocene high-stand of the sea, and might date back to an earlier sea-level; most likely the 101-104 ka high-stand if we superimpose measured uplift rates on sea-level curves.

Several caves had irregular pockets of paleokarst breccias exposed in the walls; these are strongly cemented and very hard. Possibly they could date back to prior karstic events during the periods of low sea-level of the Pliocene, or even the late Miocene.

Plateau Caves

The few known plateau caves are different. Smaller, muddy, horizontal stream passages running at or not far above the limestone-volcanic contact, and entered via vertical shafts or collapse dolines. They show some joint-control, but it is partly obscured by a tendency to meander. These presumably feed water to the coastal caves (several kilometres away, and 200m down) as some of those have impressive water-spouts coming out of small holes in their ceilings (or out of a hole in a basalt wall in one case), but no connections have been found so-far. We found foul air (3% carbon dioxide with 17% oxygen) in all the plateau caves. This had not been reported before so perhaps it is just a seasonal thing - we were there at the end of the "wet" season, but it had been an unusually dry one.

Other Caves

There are also a couple of fissure caves, behind and parallel to cliff faces, that I suspect are at least partly the result of mass-movement. Most intriguing was a report by David Powell, held in the phosphate company records, that describes a sizeable cave near the edge of the plateau that had a stream and was formed mainly in basalt beneath the limestone. Unfortunately, the entrance was filled in some years ago, and is currently lost.

FURTHER READING:

BROOKS, S., 1990: Caving in Paradise. *Australian Caver,* **124**: 11-13.
GRIMES, K.G., 1998: The Christmas Island Study. *ACKMA Journal,* **31**: 33-34.

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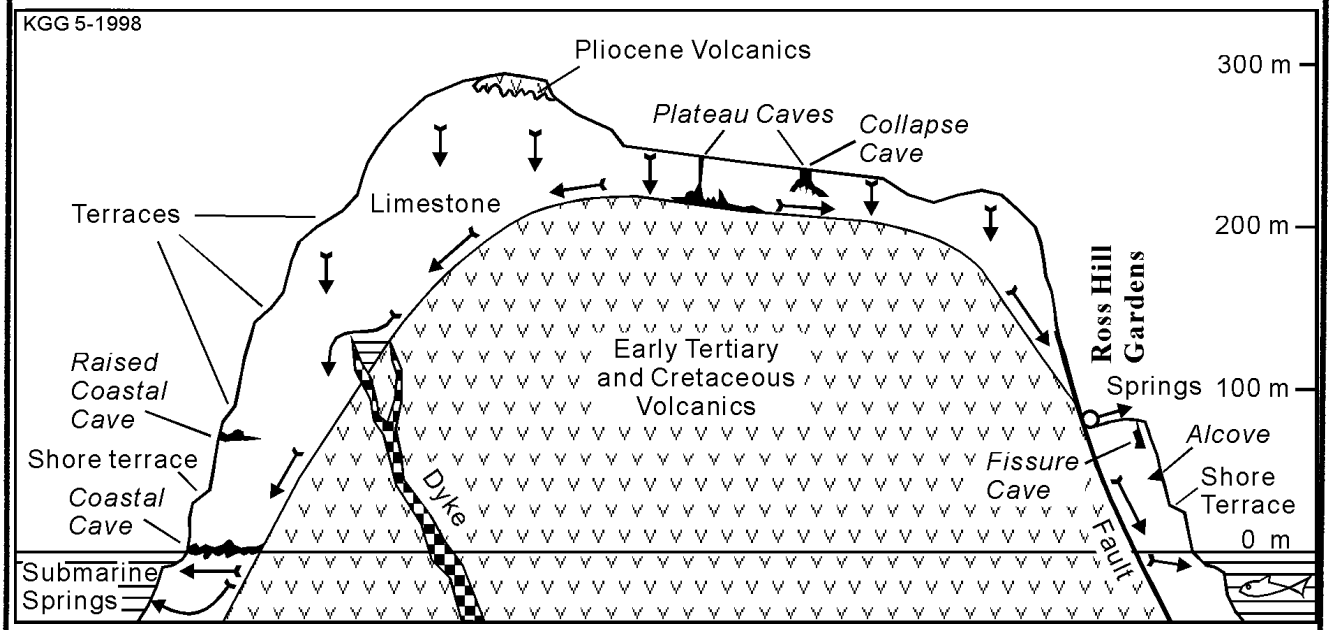
Figure Caption:

Cross-section of Christmas Island (vertical scale exaggerated x10) showing water movement and location of typical cave types.



Christmas Island – Aerial View

Rockpool - Dolly Beach