WELLINGTON CAVES – NATURAL HISTORY NOTES AND SPECULATIONS FROM THE 5th KARST STUDIES SEMINAR FIELD TRIPS

- Henry Shannon

SURFACE DEVELOPMENT

The turnoff to the caves is marked by a junk sculpture on the Molong-Wellington road. Once you get to the right area you look for a full size fibreglass replica Diprotodon optatum in the carpark. Next to the carpark there are service buildings for the cave tours and the adjoining caravan park, and further away a golf course – all green and inviting and unpretentious. This is on the land that slopes away to the Bell River and its alluvial flats still a fair way off. Up hill from the caravan park the ground steepens slightly and is mostly outcrop in the form of tombstoney clints with good rillenkarren, and occasional outcrop-free patches attributed to outcrop of cave fill at the surface. Up to this point the development is all good stuff, making you feel welcome rather than intimidated. The new concrete paths going to the tourist caves are not so good being overly wide and straight. I was told they turned out this way partly from desire to accommodate wheelchair people, partly in response to litigation panic. More serious is the general weed infestation, with saffron thistle being really bothersome.

CAVE ORIGIN SPECULATIONS

By local NSW standards there are lot of substantial caves in a restricted area, and up on a low ridge that is not a promising kind of situation for caves to develop in at present. But since the caves are old they belong to a vanished and presumably more believable landscape than what is there at present. Cave floor sediments associated with Macroderma type bats outcrop at the surface in unroofed cave deposits; so there must have been open caves higher than this to house the bats. Furthermore the phosphate beds show signs of having been deposited underwater. Being familiar with the Mt Etna karst I considered what a similar karst might look like after its distinctive high outcrop had been eroded away, and applied it to what I saw at Wellington. There are some things that fit, for example the concentration of caves around a high point on the limestone, and the concentration of caves in massive and very pure limestone. A distinctive style of elongated shaft cave seen at Mt Etna does seem to be present (Grand Canyon in the Phosphate Mine and a blocked shaft with boulder and clay fill next to the Alter in Cathedral Cave).

The type of limestone found in the Mt Etna type of karst is always very massive and pure. At Wellington there are two types, a very massive light variety with barely detectable bedding, and a strongly bedded dark grey type. The caves are mostly in the massive variety. Lots of cave in very massive limestone is a feature of the Mt Etna karst; the water is all supplied by runoff from bare limestone, as from an enormous tin roof. But since the acid concentration is unusually high and there is ample time, cave development occurs. Acid to dissolve the limestone comes from in-situ decay of organic matter in earth sumps which provide soil-air, or foul air concentrations of carbon dioxide for the water to work with rather than the much lower concentrations found in stream water equilibriating with ordinary air. The standard Mt Etna style cave bottoms in an earth sump which has the form of an elongated shaft with sediments that are locally derived; organics, boulders of limestone and fines (the organics break down quickly).

The Cathedral cave shows wall sculpture that is essentially big scooped out hollows more of less parts of a sphere in terms of geometry. This style of wall sculpture indicates a cave that is water-filled, with the water moving slowly and not putting in any serious sediment load – nothephreatic conditions in the Jennings terminology. Only right at the entrance is there a horizontal incut feature that might indicate the water table. The cave seems to have been a rising outlet for substantial underground river. The problem is where did the water come from in such quantity as to hollow out the cave? The bulk of the cave seems to post-date the shaft with boulder and clay fill.

Near the caves turnoff I noticed there is a swelling-clay soil with siliceous boulders and the odd rounded quartz pebble mantling the limestone. Later I found that this covering material is widespread in the district. Beneath this cover there is a tropical-looking pinnacle karst that is exhumed at several places, including a pair of pinnacles viewed from the road near Borenore and a freshly exposed face in the quarry we went to in Molong. The kind of situation in which it is normally seen is where limestone is found on relatively high ground as isolated outcrop poking through clay soil, not where there is continuous outcrop. At Molong the cave fill seen in the council's quarry was also a swelling clay, not what you would expect as residue from dissolving limestone. In other exposures marginal to the quarry there were some old alluvial sand and gravel beds. I think all the swelling clay is alluvial, derived from basalt and later than most of the cave development. I can envisage it as building up and burying hills that were once more than just bumps in the landscape, as a response to a rising base level. On this model the pinnacle forms could be subaerial forms only slightly modified by subsoil solution.

If this model seems strange consider "McCavity," the divers' underwater extension where there are all the usual travertine formations which have to form in airspace but now convincingly underwater, owing to a buildup of alluvium on the Bell River flats. In this case climate change is the main factor (the alluviation of streams generally in Eastern Australia is connected to a change from big meander streams to wriggly ones).

To go on with the idea of drowning the landscape under clay deposits there is a subdued dip off the caves ridge where sediments were drilled to 47m without bottoming them (Osborne 2000). I think the clays here relate to the widespread gilgaied clays in Queensland (gilgai are little hollows produced by the soil heaving when it is wetted). I know this sort of country best from the Durong Plain just North of the Bunya Mountains in Queensland, where the Great Dividing Range becomes impossible to find. This country more or lest connects over to Chichilla and becomes the clayey part of the Chinchilla Sand, which has a classic fossil mammal fauna considered to be of Pliocene age. I suspect that a sea level rise preceding the Parilla Sand strandline set was involved in a biggish base level rise, with a consequent buildup of alluvium propagating up the rivers upstream from the now-vanished Murray Gulf. This idea would date the episode about the start of the Pliocene.

An alternative model for cave development matches the Cathedral Cave with certain parts of Jenolan Caves on the south side of Grand Arch. There are parts of the system here which have wall sculpture like the Cathedral Cave and I have interpreted it as a rising outlet of Jenolan Underground River, active when it had its outlet high and well south of its present position. At Jenolan there is an abrupt change in style of cave driven by gravel input. The zone south of the Grand Arch was never modified to transport gravel and retained the segments-of-a-sphere wall sculpture characteristic of nothephreatic conditions (deep and slow-moving). The Grand Arch itself shows what happens when gravel enters the conduit. It is dumped into the open water until the channel is confined enough to move the gravel on and in the process tends to force the stream up into the ceiling and make ceiling channels such as the superb examples cut up into the ceiling of the Arch. The difference between Jenolan and Wellington is that there is no gravel-input-modified cave that can be seen. Yet it is not unfeasible that the Bell River was once at a higher level, and had a bouldery bed crossing the limestone at two points with a head difference between them enough to drive a cave through the limestone. Furthermore consider a situation in which a stream cave attempts to survive the kind of alluviation implied by the 47 metre borehole. A likely response would be to develop a new rising outlet just like Cathedral Cave.

BEDROCK GEOLOGY

Armstrong Osborne has come up with more detail on the two limestone facies in the Garra Formation. The, grey bedded limestone occurs (a) marginal to and (b) overlying (c) the white massive facies. Readily datable material (Middle Devonian conodonts) has been recovered only from (a) though there are fossil corals in (c) including Favosites in the wall of Cathedral Cave. This cave is very good for showing the relationship between the limestone facies. The white massive limestone is older and shows signs of having been consolidated prior to deposition of the grey, well-bedded limestone. There is a very clean contact between the two limestone types showing that there was a cliff with karstic hollows in a solidified body of the white limestone that had the grey limestone building up against it. My impression is that the white limestone is a good deal older and stood up as a rock pinnacle in the Middle Devonian sea. In Central Queensland the Lower Devonian limestones are all white and massive and the Middle Devonian ones well bedded and grey. If this rule holds the white limestone would be Lower Devonian.

The white limestone itself has filled karst cavities in it that can be picked by reddish beds in the sediment in-filling them. The beds are tilted owing to later folding movement. The grey limestone adjacent to the old cliff line is brecciated in places probably by compaction soon after sedimentation. One of the field trips went to Borenore Caves, which are close to Orange. In the Arch there was some similar looking red and white sediment that was actually a bed that had been broken up by minor faults while the sediment was soft and then annealed.

CAVE SEDIMENTS IN CATHEDRAL CAVE

There is a huge travertine column that probably goes down through the surrounding floor sediments. Because of old records recording a dig going down 25 feet another sondage to 7 metres was done in modern times (Dawson and Augee 1997). My impression is that these floor sediments are basically a talus cone of soils fed in from the modern entrance area except for the travertine input, which includes both flowstone from adjacent formations and little plates of calcite. This must be calcite flottante deposited on a water surface; so some of the sediment pile would have been deposited in a pool. Probably the end pool of the cave was generally at a higher level, but periodically the water became saturated and the level dropped.

There is a cleft near the big column, which contains a cave breccia with blocks of both the grey and the white limestones. This fill would pre-date the Cathedral Cave. There is a crystal coating surviving in patches on the cave walls indicating a time when the cave was full of lime-saturated water. My impression is that the cave was sealed until fairly late and so escaped being filled up like the Phosphate Mine.

CAVE SEDIMENTS IN THE PHOSPHATE MINE

There were papers presented on the topic by both Mike Augee (on how the bones got in) and Armstrong Osborne on general stratigraphy (towards an upgrade of Osborne 1997). I got two trips into the cave, which isn't enough. It is just too confusing. Part of the problem is that the cave has had different entrances functioning at different times, and also the sediments can at times be removed from some part of the cave by subsidence, or being eroded out horizontally. With subsidence it is possible to open a gap in an old deposit when the ceiling stays put and the floor goes down, then to fill the gap with younger sediment. Also pockets of old sediment can remain stuck to the wall while the interior fill of a cavern goes down like a piston. Orderly superposition of strata it is not. Still a general picture of the talus cone is of debris including limestone boulders near the entrance point with layering of sorts determined by the angle of the boulder slope. There is an abrupt transition as the steeper bouldery material changes to the red earth dominated outer zone of the cone (which is more often a segment of a cone, not a whole one) where the gradient is gentle and the deposit is well stratified. The richest bone material is just past the limit of boulders

I would tend to group the sediments as (1) phosphorite sandstone and the laminated and graded-bedded units (2) the mottled clay unit confined to Phosphate Mine West and (3) the red and bone-bearing units, going from old to young. (I include the bone bearing material of Phosphate Mine West in this group). The sediments of group (1) have about them the look of being deposited under water and as they reach the present surface they are an odd lot. Connected with them is the phosphate rim rock that is at least partly a result of reaction with the wall rock, or maybe a phosphate mineral equivalent to the calcite crystal coating of Cathedral Cave, or a crust sweated out of the sediments. It shows up very prettily in a section where you can view it by ultra-violet light. Its most typical form is white opaque mineral matter with botryoidal texture around 20cm thick.

The mottled clay unit (2) I put between these and the red bone breccia group because it **is** mottled, implying a prolonged "soil-forming" diagenesis after it got in to the cave. (The red breccia matrix does not show this feature; also I think the fossil bearing material in Phosphate Mine West supposedly in the mottled unit is reworked material with clasts from the mottled unit incorporated in a red fill). The fretting character of the deposit is a nuisance factor in the mine. It frets because it includes swelling clays that relate it to the gilgai-forming clays of the mysterious deposit that covers the limestone back along the access road, which gets up to high levels. Near the caves at present this stuff is mostly stripped off and the soil is more reddish and looks near enough to the matrix of the bone breccias. On this point I risk disagreeing with Dr Osborne, and also Henk Godthelp who has collected a limited fauna considered Pleistocene from what is supposed to be the mottled clay. I suspect the fauna comes from the reworked material, (part of group 3) not the in situ mottled clay, which is probably not bone-bearing.

The red soil making up the matrix of the main bone breccias contains frosted silt grains attributed to wind action, yet the red material looks like a terra rossa residual limestone soil, and is not a swelling clay. Perhaps both the iron-bearing clay and the quartz silt are wind deposited impurities of the Devonian limestone? Anyway it looks more like a residual limestone soil, so it makes better sense to have the swelling clay cover stripped off before it began to be fed into the cave. I have no problem with the talus cone model for group (3).

I spent some time on my second visit with Prof. Augee trying to work out if there was a genuine flowstone marker in the sequence and what some slickensides next to Dr Osborne's favourite exposure of a vertical unconformity meant. We had a problem with all the rechargeable torches failing.

I think that there probably is a common main flowstone-depositing interval, largely because only one thick crystalline mass seems to be present in any of the sections and they seem well enough aligned on the same level. This makes sense if flowstone deposition is climate-controlled and not often abundant, so that when a massive flowstone occurs in a section normally lacking much flowstone it is probably a peak of deposition episode, and likely to occur in other parts of the cave. There are associated pockets of wall canopy travertine which show some re-solution but this may result from contact with water draining through the fill and so not mean much.

There is a great cone of earth and rubble going up into the ceiling and the ceiling is itself mainly compact cave fill. The slickensides relate to a floor subsidence, which opened up the natural part of the cave you stand in at this point. The high point is one of two through which the rubble and bones got in. Away from the cone the sediment you can see has no big boulders and is better stratified. The shape of the cone in detail has bumps matching up with hollows in the ceiling and this implies subsidence of about 0.6m. The slickensides occur in two places where the subsiding cone rubbed against a projection in the ceiling. So there was not much disturbance to the deposit on the occasion producing the slickensides, but how much more of this sort of event occurred earlier on?

THE UNROOFED CAVE PROBLEM

There must be some effect on the limestone from direct solution from rainfall. Annalisa Contos delivered a group paper on solution rates from marble slabs in cemeteries and the indications are that the limestone can easily dissolve away at a rate of several metres per million years which would be enough, even too much to do the necessary within the Pleistocene Period.

A TENTATIVE EVENT SEQUENCE

Stage 1, **maybe latest Miocene**. Climate is sweaty jungley akin to Rockhampton, but wetter. There is a miniature Mt Etna of bare limestone on the present high point and a thriving Macroderma koppa colony in what is now airspace, but the elongate shaft elements which survive formed then as shafts associated with earth sumps. Boulders-in-fine-matrix conglomerates accumulate to several metres above the water table but much of the shaft complex is airspace. There is a distant connection to the bat colony cave, which has phosphate-rich guano deposits with exotic guano phosphate minerals. The bare limestone is a mass of pinnacles, such as survive under the swelling clay cover. The water table is lower than at present and perhaps there is a river cave running through McCavity, getting its water from a self-diversion of the Bell River. The river itself deposits gravelly alluvium in point-bar scrolls. The base of the coarse alluvium is higher than the present base of the alluvium.

Stage 2, maybe early Pliocene. The climate resembles the Darling Downs, perhaps drier overall. The river channel converts to a wriggly gutter, or even channel country braiding, without the capacity to carry its previous bedload. The alluviation event begins, bringing with it a rising water table. Once the water floods into the cave system the guano deposit is reworked and deposited in still water as ordinary phosphate in turbidites. Other fills without phosphate in their source materials form non-phosphatic turbidites, the phosphate rim rock forms chemically as concretions in a reaction with wall rock. The valley with the 47m in sediment drillhole is transformed from a deep gully to a shallow dip, and gives an idea of the magnitude of alluvial accumulation. The clay sediment seals off a groundwater reservoir combining the basal gravel aquifer in the Bell River alluvium with fissure water in the limestone belt. Previous outlets are blocked off and Cathedral Cave forms as a new higher discharge outlet. Its water source is the underflow in the basal alluvial gravel from the previous phase, tapped by the former river self-diversion cave. It is a vauclusian spring, a kind of natural artesian well. Because it taps water from a large gravel aquifer it is provided with lots of water but not sediment.

Stage 3, maybe Pliocene. Climate wetter than before, so that the river returns to a state capable of downcutting its bed. Removal of the alluvial swelling clay proceeds, with fall in water table. Other swelling clay penetrates into the Phosphate Mine filling all space above the phosphate deposits. With time and through drainage the mottled character develops. The crystal crust in forms in Cathedral Cave, probably as a consequence of diversion of the underground river to another outlet, maybe Water Cave.

Stage 4, maybe Pleistocene. Climate enters the glacial/warm interglacial/cool interglacial/high lakes/glacial roller coaster. Around the caves the swelling clay cover has been stripped off. Wet intervals are capable of producing red soils. There are fill removal events in the Phosphate Mine East, followed by deposition of talus cones and associated bone material with red matrix. Next, following another episode of fill removal that also affected Phosphate Mine West, and some flowstone deposition there was another input of talus and bones. Finally floor subsidence opened an air space through the breccia fill.