Dinosaur Dreaming

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2002 Flat Rocks Field Report

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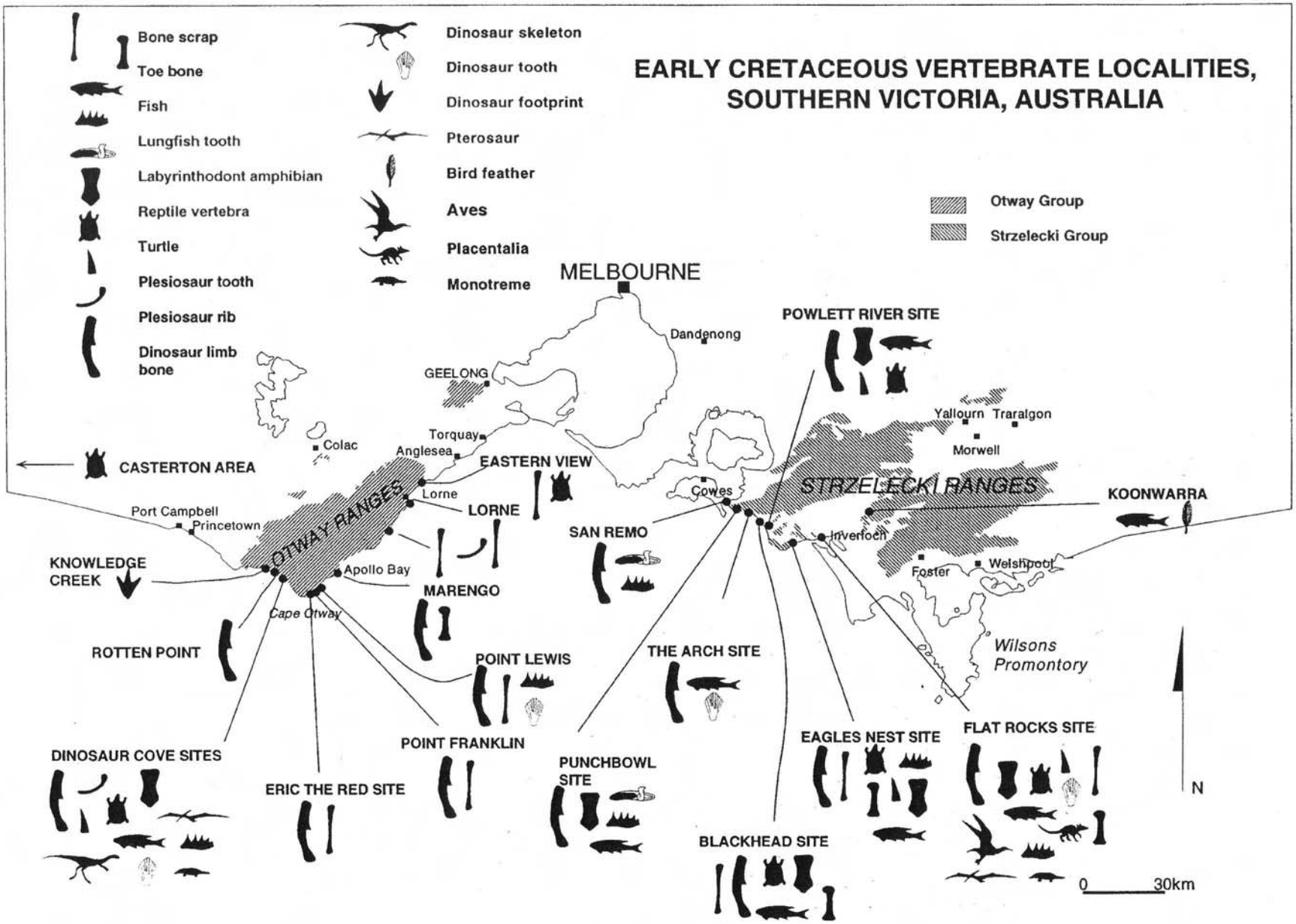
Photographs

The photos reproduced on pages 12, 19 and 22 were taken by volunteers Al Fraser and Laurie Fletcher, during the 2002 field season, with permission.

About the cover

Koolasuchus cleelandi lurks below the surface of a sun-dappled pond amid drifting gingko leaves in this pre-production painting by Peter Trusler. The final painting, with the 3-metre long amphibian depicted at life-size, will take pride of place in the Monash Science Centre in 2003.


EARLY CRETACEOUS VERTEBRATE LOCALITIES, SOUTHERN VICTORIA, AUSTRALIA
Bone scrap
Toe bone
Fish
Lungfish tooth
Labyrinthodont amphibian
Reptile vertebra
Turtle
Plesiosaur tooth
Plesiosaur rib
Dinosaur limb bone
Dinosaur skeleton
Dinosaur tooth
Dinosaur footprint
Pterosaur
Bird feather
Aves
Placentalia
Monotreme
Otway Group
Strzelecki Group
MELBOURNE
Dandenong
GEELONG
Torquay
Anglesea
Colac
Lorne
Port Campbell
Princetown
OTWAY RANGES
Apollo Bay
Cape Otway
CASTERTON AREA
EASTERN VIEW
LORNE
MARENGO
KNOWLEDGE CREEK
ROTTEN POINT
POINT LEWIS
POINT FRANKLIN
DINOSAUR COVE SITES
ERIC THE RED SITE
SAN REMO
PUNCHBOWL SITE
THE ARCH SITE
BLACKHEAD SITE
POWLETT RIVER SITE
Cowes
Inverloch
STRZELECKI RANGES
Yallourn
Traralgon
Morwell
Foster
Welshpool
KOONWARRA
Wilsons Promontory
EAGLES NEST SITE
FLAT ROCKS SITE
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Field report

Lesley Kool

The Flat Rocks site, near Inverloch on the south-east coast of Victoria was discovered by a group of researchers in 1991, who had been systematically prospecting the coastline between San Remo and Inverloch since 1986. The site is only one of a number of fossil localities along this part of the Victorian coastline, but it contains the biggest concentration of Early Cretaceous fossil bones found so far in this area of Australia. The fossils are preserved in a series of conglomerates, sandwiched between thick underlying mudstones and overlying sandstones.

The conglomeratic layers represent the beds of ancient streams and rivers that flowed in this area about 115 million years ago, and can be seen cropping out in many places along the coastline. As these outcrops are slowly eroded by the continuous ebb and flow of the tides, new fossil bones become exposed, which makes periodic reprospecting very important. A small amount of prospecting occurs during the field season, but we tend to concentrate on the major excavation. It is up to people like Mike Cleeland, a geologist who lives on Phillip Island, who along with a small band of fellow enthusiasts, spends his weekends combing the rocky outcrops, looking for newly exposed bones. Results this year have been exceptional as you will read in Mike's report.

A great example of the results of prospecting along the Cretaceous outcrops of south-east Victoria can be seen on the front cover of this year's field report. The illustration is a reconstruction by artist Peter Trusler of one of the most unexpected groups of animals found in these rocks. It represents an ancient amphibian, a labyrinthodont, which belonged to a group of animals, that mostly went extinct at the end of the Permian. A distant relative of *Koolasuchus cleelandi* the Victorian labyrinthodont, was

discovered in the Jurassic rocks of Queensland a number of years ago and was thought to be the youngest evidence of labyrinthodonts anywhere in the world. Imagine our surprise when their bones were found in the Early Cretaceous rocks of Victoria, some 50 million years younger than the Queensland counterpart. This means our labyrinthodonts are the youngest, youngest labyrinthodonts in the world, to date.

A new painting

Monash University has honoured the discovery of these amazing ancient animals by commissioning Peter Trusler to paint an almost life size illustration of *Koolasuchus cleelandi*. It will hopefully be on display at the new Monash Science Centre, in the Clayton campus of Monash University, later this year. In the meantime we are privileged to have a sneak preview of Peter's preliminary work for the front cover of our report. Examples of some new labyrinthodont material found by Mike Cleeland during this year's prospecting will be on display at the "Friends of Dinosaur Dreaming" evening in October.

The best-laid plans

This year was the ninth field season at the Flat Rocks site, near Inverloch. We continued to concentrate our excavations on the main part of the fossil layer, which has produced over 8000 bones and teeth in the last eight annual field seasons.

We began the Dinosaur Dreaming 2002 field season with a definite plan in mind, but after only a week into the dig circumstances occurred which led us to abandon our original excavation and continue in another area. The plan was to excavate from the lowest conglomerate layer, just above the underlying mudstone and remove a wedge shaped section of the fossil layer along the most westerly boundary. By the end of the field season we hoped to have a complete stratigraphic column from the just below the overlying sandstone layer to the underlying mudstone layer, showing as many of the conglomerate layers in between. Unfortunately, we were unable to realise these goals, but the change in plans led to the discovery of two more tiny mammal jaws as well as a number of other exciting finds.

The deepest layers, just above the mudstone, were partly exposed on the shore platform and therefore not difficult to excavate, but they were very carbonaceous and contained mostly turtle and fish fragments. Nick van Klaveren, our excavation manager, was recovering from a hernia operation and so was unable to lift anything heavy or use any large tools. His role was primarily as supervisor, with Norman Gardiner, a seasoned excavator, taking over his role as excavation manager. Nick felt that we should divide our excavation time between excavating the lower layers and returning to the main excavations where two mammal jaws where found the previous field season. So, it was decided that we should alternate the two excavations, thereby giving the rest of the crew the opportunity to break rock from different fossil layers.

This plan went well for a week or so with a small hypsilophodontid lower jaw as well as two isolated hypsilophodontid teeth being recovered from the lower layers, which

helped to raise the crew's enthusiasm after finding little else but fish and turtle from that part of the excavation.

Paydirt

However, Nick's decision to continue excavating the area started in 2001 turned out to be a good plan as a nice hypsilophodontid femur was exposed on the underneath side of a large block from the middle conglomerate layer. While trimming this block, many more bones were exposed, including a juvenile hypsilophodontid femur and many "small interesting" bones. When we returned to the house, I began the daily ritual of checking all the tiny cross-sections under the microscope and was pleased to find that a small shaft that Dale Sanderson had pointed out to me on the beach, turned out to be a mammal jaw. It appeared that the back of the jaw was preserved, but it was broken midway along the jaw and, unfortunately, there were no teeth preserved. However, there was enough detail preserved for Tom Rich to later identify it as *Teinolophos*, the only group of monotreme mammals from this site so far.

Unfortunately, Norman had to return unexpectedly to Melbourne at the end of the second week of the field season, but by this time Nick had recovered enough from his operation to take over the management of the excavations. Therefore, it was decided that we would concentrate on the main part of the excavation and leave the lower layers for the time being.

Again this decision proved profitable as a second mammal jaw was discovered a few days later. This jaw was broken between two teeth and had a cross-section no larger than a match head exposed. This is a very good example of how important it is for the volunteers to be trained to recognise tiny cross-sections of bone. An untrained eye would never have spotted the broken surface of this tiny jaw. Although the jaw was also incomplete, it did have three molars preserved and Tom Rich, our joint head researcher, was able to identify it as another specimen of *Bishops whitmorei*, the most recent mammal published in 2001.

Turning turtle

Although the discovery of mammal jaws is always exciting, this year we also found the most complete example of a turtle skull from this site to date. Fragments of turtle and fish are the most common fossil bones we find at the Flat Rocks site. The main reason for this is that we are excavating an ancient riverbed, and the turtles and fish lived in the river, whereas the bones of dinosaurs, birds and mammals were washed into the river during periodic flooding events. Therefore, it is logical to expect there to be many more turtle and fish fossils preserved in their own environment.

However, we do not find complete fish or turtles as their remains became quickly disarticulated in the fast flowing water or were scavenged by other occupants in the river. It has long been a puzzle to us that we have not found a turtle skull before this year, as their skulls were quite solid and robust. So, it was with great delight, especially on my part, that the partial skull was recovered. We are hoping that there is enough detail preserved in the skull to finally give our enigmatic turtles a name. We have a

number of partial turtle shells from other localities along the coast between Inverloch and San Remo, which when fully prepared, may give us the additional information we need.

Enigma

Another exciting find was not discovered until almost the last day of the field season. The crew were breaking up the last of the back log of rock in the back garden of the house we rent each year when John Wilkins broke open a small piece of rock no bigger than a walnut. Inside was a tiny thin walled bone, which we initially thought was a fish vertebra. Although we find many fish scales and fish jaws, we have very few fish vertebra, so John's bone was interesting. It was not until it was prepared that it became even more interesting.

The complete bone is smaller than a sugar cube and has features on it that are reminiscent of the braincase of a very small animal. Much smaller even than the skulls of the tiny mammals from Flat Rocks. At this stage we really do not know what it could be, but a visiting researcher who specialises in unusual isolated bones will be going through the collection early next year and we are hoping that he may be able to shed some light on this tiny oddment.

The hypsilophodontid lower jaw that was recovered from the lower conglomerate layers before we ceased excavating in that area, is quite small (3cms in length) and has lost all its erupted teeth. However, it does possess three unerupted teeth, which confirmed that it was in fact from a hypsilophodontid dinosaur. Although this jaw is smaller than *Qantassaurus* it is much more gracile than the robust little jaw after which *Qantassaurus* was named. It appears that there may have been at least two other species of hypsilophodontids living in the same area as Qantassaurus, although we cannot rule out sexual dimorphism, which maybe be reflected in the robust and gracile forms.

Once again a number of shed theropod dinosaur teeth were recovered. They are all quite small with an average length of one centimetre and they all possess serrations only on the back edge as do most of the other theropod teeth collected over the last 9 field seasons. One tooth had most of its enamel worn off and only had a few serrations remaining near the base. From the condition of the tooth it looks like this tooth may have been swallowed by its owner and lost most of its enamel before being excreted.

There are at least two other theropod teeth in the collection that also have this type of wear. Earlier this year Dr. Phil Currie from the Royal Tyrrell Museum in Alberta, Canada, examined nearly 40 of the theropod teeth from our collection and was able to distinguish at least three different genera of small to medium meat-eating dinosaurs at the Flat Rocks site. We are hopeful that a theropod dinosaur jaw with teeth will eventually be found at the site, which will allow us to finally name one of these ferocious animals.

From little things, big things grow

During the last two field seasons we have concentrated on a section of the fossil layer, which according to Doris Seegets-Villiers, represents an area close to the edge of the original channel. We expected smaller bones to be deposited in the shallower waters at the edge of the channel and that certainly seems to be the case when comparing the size the fossil bones recovered this field season.

Of the 1000 specimens catalogued during the 6 week dig, the majority of the bones were either small bones or fragments of larger bones. The largest bone was a hypsilophodontid femur recovered from the middle conglomerate, which traditionally yields larger specimens. Most of the fossils collected from the lower conglomerates averaged only 2 to 3 cm long. This area is where we were hoping to find more of the tiny mammal bones, but no mammal material was recovered from the lower conglomerate, which yielded mostly fish and turtle fragments. The two mammal jaws found this field season came from the middle conglomerates, which is why we will be continuing in this area next year.

Ferguson's claw redux

2003 also marks the centenary of the discovery of Australia's first dinosaur bone. It was found by William Ferguson, a geologist looking for coal seams on the south east coast of Victoria. While he was prospecting along the coast at Eagles Nest, one kilometre from our site at Flat Rocks, he noticed a small bone exposed on the shore platform. He carefully removed the bone and took it back to the National Museum of Victoria in Melbourne where he tried to identify it. However, there were no other dinosaur bones to compare it to so he was forced to compare it with some English dinosaur bones. He realised that it looked very similar to the claw of a medium sized meat-eating dinosaur called a *Megalosaurus* and that is how Australia's first dinosaur bone was identified.

Unfortunately, William Ferguson's field notes were not very clear on the actual date that he discovered the bone and it has taken some detective work by Danielle Shean, a Monash University science student to track down the information. It appears that Ferguson found the bone in April 1903 and Tom Rich is planning on celebrating the centennial next year.

Ferguson's claw is not the only evidence of large meat-eating dinosaurs along the coast between San Remo and Inverloch. Over the past 16 years or so, a small group of enthusiasts has combed the rocky shore platforms, looking for fossil bones newly exposed by coastal erosion. This year Mike Cleeland has made a concerted effort to revisit most of the old fossil localities along the coast and has had remarkable success. His report has been included in this year's issue and makes interesting reading.

Recently Andrew Ruffin, an amateur enthusiast who has been associated with the prospecting for a number of years, discovered a theropod dinosaur vertebra in a large boulder near the coastal town of Kilcunda. The vertebra has been prepared and appears to belong to a medium-sized theropod dinosaur as its internal structure contains large air pockets typical of this group of dinosaurs. Further research is necessary to pinpoint which group of theropod dinosaurs it may have belonged to.

Each field season we try to spend at least one day prospecting another potential fossil locality. This year we revisited an old locality called Black Head, near the town of Kilcunda. We discovered this locality before we found the Flat Rocks site in 1991. Until the discovery of the Flat Rocks site, Black Head was the most prolific fossil locality along the coast between San Remo and Inverloch.

When it was discovered in May 1989, we found 14 bones exposed over an area of some 30 square metres. The bones were scattered over a number of different fossil layers, not concentrated in the one channel as at Flat Rocks. The rock is also much harder that the rock at Flat Rocks. Consequently the erosion rate is much slower. We had not been back to Black Head for at least 18 months and were pleasantly surprised to find a number of new specimens that had become exposed since we were last there. One bone in particular was quite interesting. It looked very much like a large theropod phalanx or toe bone in the rock, but when it was prepared it turned out to be much broader than was anticipated. Again, more research is necessary to find out which group of dinosaurs it belongs to.

Grants, and works

Earlier this year we applied for a Parks Victoria grant on behalf of the Friends of Dinosaur Dreaming. This was the second grant we have applied for to pay for the creation and construction of enamel information panels to be erected in The Caves car park, which is the access point for the Flat Rocks site. The first grant paid for the services of a graphic artist to design four panels explaining the history of the area and the animals that lived in the area 115 million years ago. The second grant, which we recently heard was successful, will pay for the production of the enamel panels, which will be erected by Parks Victoria, hopefully before the 2003 field season.

Two new pieces of preparation equipment were purchased this year with funds from the Friends of Dinosaur Dreaming. Both pieces of equipment augment the preparation of the specimens collected this year and from previous field seasons.

We are also considering the purchase of a GPS (Global Positioning System) unit, so that we can record the exact location of all the Early Cretaceous fossil localities along the south coast of Victoria for future reference. ❖

Excavation report

Nick van Klaveren

The Flat Rocks fossil locality was excavated for a period of six weeks, from late January to early March 2002. This period was chosen to coincide with the university holidays and to avoid the tourist season at Inverloch.

All the fossil material was collected in accordance with permit 100001660 of the Department of Natural Resources and Environment Victoria.

This year's excavation continued at the same location because of the large number of mammal jaws found previously in this part of the channel, with another two more added this year.

The excavation was of a shallow enough depth that with the aid of a small sandbag wall, the construction using girders, mesh and drums was unnecessary.

Excavation methods

The excavation method this year continued with the use of large iron wedges and sledge hammers to remove the bulk of the fossil layer from the targeted area. Exposed specimens were removed with a diamond saw blade-equipped *Stihl TS460 Cutquik*.

The technique of removal used last year was continued with wedges driven into the semi-continuous coal layer at the base of Middle Sandstone Unit, then a second level extracted with the wedges driven into the Lower Sandstone Unit. The lower most fossil-bearing conglomerate, which directly overlays the black basal mudstone, was

extensively sampled this year with the thin coal layer between them providing a plane of weakness to drive in the steel wedges. The fossil-free sandstone overburden was removed with the two Cobra petrol driven jackhammers. Once the majority of the overburden was removed the method was then switched to sledge hammers and wedges so as to provide greater control to protect the underlying fossil layer from damage.

Equipment

The Flat Rocks fossil locality is located at the bottom of a cliff in the inter-tidal zone facing Bass Strait. This presents a number of difficulties with regard to the access to site, with sand, weed and large waves at high tide.

In previous years, a construction consisting of packing material, plastic tarpaulins, steel mesh and rock bolted down iron beams was built to help exclude sand and thereby increase access time to the fossil-bearing units. A number of innovations were to be tried this year to improve the efficiency and reduce the laborious tasks at the site.

Solar power unit and pump

Constructed two years ago but only regularly used this year was the solar power unit and small salt-water pump. The continuous trickle of salt-water drains from the sand surrounding the excavation area has usually necessitated the unpleasant task for a volunteer to scoop and bucket this water throughout the day. To combat this problem, a 12 watt, 8 volt, photovoltaic array coupled with 18 D-cell nickel–cadmium batteries to form a solar power unit was constructed.

The pump was battery assisted in cloudy times and self-charging in times of low usage. The charging of the batteries was assisted by four AC/DC recharge units, which were used to top up the batteries overnight. The unit powers a 12 volt salt water pump housed in a filter with a stabilizing steel base plate with a total output of around 5 litres per minute depending upon the height of head.

A number of problems were encountered with the continuous use of the pump and power unit:

- Corrosion of wire joins and impeller shaft
- Kinking and shortness of the outlet hose
- Mains power recharge for only 16 of the eighteen batteries
- Use of an old rock saw air filter as a sand filter which was to effective and kept out the water as well.

A new pump and housing have since been constructed to remedy these problems.

New construction and splines

It is envisaged that with increasing depth at the present location the construction will be once again used next year with the following improvements. A new system using extra underlying girders and mesh to support the weight of sand and the impact of waves and overlying mesh and girders to inhibit the slosh effect of passing waves. The new system should dispense with the need of drums and the labour of unpacking and packing the hole each day.

An ever-present problem with the construction used in previous years is the surge of waves driving sand and seaweed beneath the edge of the tarpaulins. Borrowing from the method of securing fly wire netting in windows with rubber splines, large wooden splines fitted into grooves cut into the surrounding rock around the construction was to be used to secure the heavy truck tarpaulin. Previously heavy sandbags were used which were unreliable being swept away and also potentially back damaging when moved each day. The splines are to be secured by flat steel extensions, which are pinned down by the overlying girders.

Excavated areas

A small excavation west of the fault at 185mEast, 99mNorth, which had always been characterised by frequent jointing and small scale faults with strongly sericitised gouge has been worked sporadically since 1997. This site was once thought to contain mostly turtle and fish remains, unexpectedly yielded two mammal jaws in a single day in December 2000 and continues to be the focus of the excavation effort.

Area 1

The excavation at Area A was a direct continuation from the previous season and concentrated upon the western wall and surface expose of the main unit along strike. The conglomerate here yielded two more mammal jaws but increasing amounts of fish bones. The units still extend along strike but are increasingly separated by thickening sandstone and the uppermost conglomerate unit becoming thin, discontinuous and sparse in clasts.

Area 2

The lower most conglomerate was extensively sampled this year and yielded well preserved interesting small bones with a tendency toward aquatic fauna.

The unit was exposed at the surface along a considerable length of strike so was collected with ease, but with increasing amounts of less fossil-bearing overlying sandstone made this area less attractive.

Area 3

A small excavation 1 metre wide and 3 metres deep section of laminated siltstone to the south of the main workings was sampled for one day only and yielded only plant fossils.

Future excavations

Next year's excavation will once again concentrate on the westernmost and down-dip extension of upper units of the fossil-bearing conglomerate. The use of the construction will be necessary as will be the building of sandbag walls to the south and west. ❖

Prof. Pat Vickers-Rich and dig leader Lesley Kool, with volunteers at the hole.

Affinities of the Ausktribosphenidae, 5 years on

Tom Rich

A key innovation in mammalian evolution was the acquisition of the tribosphenic molar, a tooth that can both cut food, and crush it. All marsupials and placentals either have tribosphenic molars or are descended from ancestors that did. It may well be that this was a key feature that explains the predominance of these two groups within the Mammalia today. All the other known Mesozoic mammalian groups lack this feature and it is contentious whether or not the monotremes ever possessed such molars.

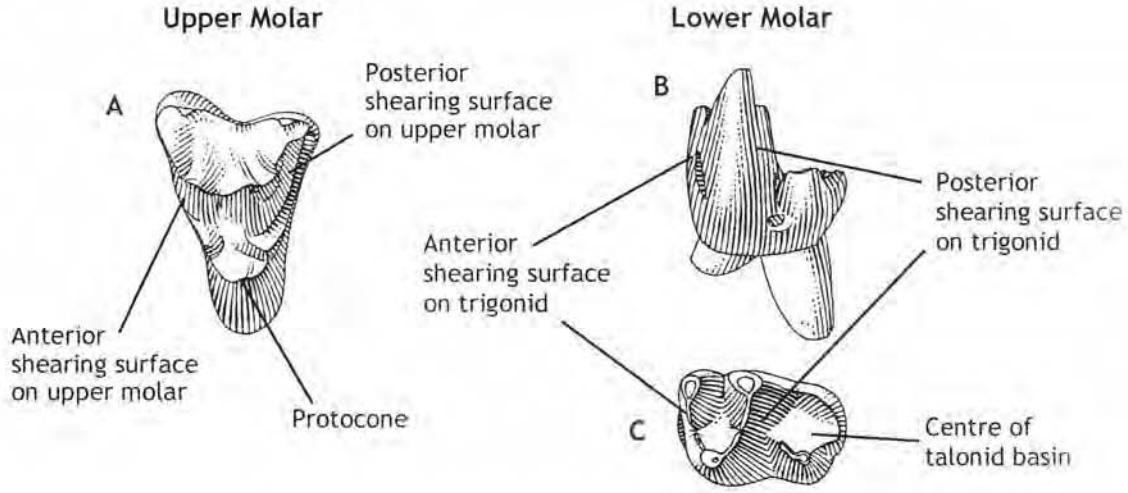


Figure 1: Upper and lower tribosphenic molars.
Upper molar, A, occlusal view (as the food would see the tooth).
Lower molar, B, outside view; C, occlusal view.

On lower tribosphenic molars there is a triangular pillar, the trigonid, against which surfaces of the upper molar slice food (fig. 1). Behind the trigonid is a basin-shaped structure, the talonid. A cusp of the upper molar (the protoconid) occludes within the talonid so that there is a mortar-and-pestle arrangement to crush food. This combined ability to both slice and crush food on the same molar is unique within the Mammalia to the tribosphenic forms.

On the memorable day of 8 March 1997, long term volunteer Nicola Barton found the holotype of *Ausktribosphenos nyktos* Rich et al. 1997 at the Early Cretaceous (115 million years before present) Flat Rocks site near Inverloch. As the generic name implies, *A. nyktos* possesses tribosphenic molars. Since then, more than a dozen additional ausktribosphenid specimens, all lower jaw fragments, have been found at this site. Amongst these is the holotype of a second ausktribosphenid genus and species, *Bishops whitmorei*.

Based upon the structure of the jaw as well as the dentition, when first proposed, the Ausktribosphenidae were regarded as members of the Placentalia. Several alternative suggestions have been made. One is that they were allied with the symmetrodonts. These exclusively Mesozoic mammals have lower molars with a trigonid but no talonid; *i.e.* their molars were suited for cutting food but not crushing it. Two other suggestions have been that they are monotremes or represent an entirely new group of mammals that although functionally tribosphenic and possessing a number of characters typical of placentals, are not in fact placentals at all but rather convergent on them.

The most recent version of this latter idea is that ausktribosphenids are grouped with monotremes, and two mammals recently described from the Middle Jurassic of Madagascar and South America respectively which represent a radiation of tribosphenic mammals entirely independent of the marsupials and placentals in the Northern Hemisphere. This controversy has generated about a dozen scientific papers in the past five years as scientists as far away as Poland, the United States and Argentina voiced their views as to what ausktribosphenids are.

What makes the allocation of the ausktribosphenids to the Placentalia contentious is their geological age and location. Since the writings of Alfred Russell Wallace {co-discoverer with Charles Darwin of the Theory of Natural Selection} in the late 19th century on the biogeography of the mammals and continued through the 20th century by such authorities as William Diller Matthew and George Gaylord Simpson, the view has been that marsupials thrived in Australia because they reached the continent long before the terrestrial placentals did.

Until the discovery of a single isolated molar of a possible placental from Eocene (45 million years ago) deposits in SE Queensland and the Early Cretaceous ausktribosphenids, the fossil record supported this view. Rodents were the first unquestioned terrestrial placentals on this continent, appearing here in the Pliocene (3 million years ago). To overturn that long held view unequivocally supported by the fossil evidence until the 1990s with just a dozen partial jaws and a possible placental tooth is thus a legitimate cause for scepticism.

The traditional view of the reason for the success of the marsupials in Australia was just part of a broader picture which sees the origins of both the marsupials and placentals as having taken place in the Northern Hemisphere during the Mesozoic Era when dinosaurs dominated the land. It was thought that the placentals and marsupials only reached South America about the time that the dinosaurs went extinct. From there, the marsupials were thought to have successfully crossed Antarctica to reach Australia.

Whether or not a group of mammals reached Australia was viewed as a chance event because the connection between South America and Australia plus East Antarctica was across an archipelago of islands similar to the modern day relationship between Australia and Asia across the Malay Archipelago. The archipelago in question was that part of Antarctica today in the western longitudes. Were the ice on Antarctica to melt, West Antarctica would not be a single land mass but a series of islands. That would have also been the case when the movement of marsupials from South America to Australia took place.

Mammals island hopping across the West Antarctic archipelago would have been a chancey business. It seemed that the marsupials were lucky enough to have crossed all the obstacles along this route by 45 million years ago while the placental mammals did not utilise this route at all but only entered from the north as Australia approached Asia.

So the ausktribosphenid mammals from Flat Rocks, being 115 million years old and present in Australia at about the same time as the oldest known placentals in the Northern Hemisphere, suggests if they are in fact placentals, that this widely held view needs to be reconsidered if the alternatives suggested by other scientists are found to not stand up.

Another aspect of the ausktribosphenids that is quite intriguing is that if they are placentals, compared with their contemporaries in the Northern Hemisphere, they are quite advanced. Based on a comparison with Northern Hemisphere forms, one would estimate the age of the ausktribosphenids as no more than 60 million years instead of 115 million years they are known to be through both radiometric dating of the rocks they occur in and analysis of the fossil pollen found with them. They, in fact, have an uncanny resemblance to the European hedgehogs, the oldest known examples of which are specimens about 60 million years old that lived in North America.

While vertebrate palaeontologists are generally quite unhappy with such a conclusion, thinking as they do that none of the 18 living orders of placental mammals arose until after the dinosaurs became extinct 65 million years ago, molecular biologists are quite pleased. This is because the latter, on the basis of comparison of genetic material, have estimated that the living orders of placental mammals had arisen by the time the ausktribosphenids found at Flat Rocks were living animals.

This is part of a general disparity between the time estimates for these events as made by vertebrate palaeontologists and molecular biologists. Hence, a fossil, which appears to support the molecular biological viewpoint as the ausktribosphenids do, adds an important element to this debate.

Given all that has now been published about just what members of the Ausktribosphenidae are, it is unlikely that the disputants will come to a consensus as long as what is known about the ausktribosphenids is restricted to lower jaws. The critical discovery that will provide the evidence to decide between the competing hypotheses will probably be in the form of an ausktribosphenid upper dentition and/or petrosal (the bone in the skull which contains the semi-circular canals of the inner ear together with the organ of balance).

Although the sediments at Flat Rocks site were deposited in such a manner that there is a pronounced bias against these more fragile elements, skull fragments of small dinosaurs have been recovered there as well as two frontal regions of mammals comparable in size to platypus or quoll. Thus, they are three to five times the dimensions expected of the named ausktribosphenids.

As mentioned briefly above, another line of evidence relating to this problem that has come to light since 1999 are the occurrence of Middle Jurassic mammals in both southern South America and Madagascar of single jaw fragments that have what have been interpreted as tribosphenic teeth in them. If that interpretation is correct (thus far no one has challenged it), they would be the oldest tribosphenic mammals on Earth.

So, it seems even more reasonable that ancestors of placental mammals might have already been on the Gondwana land mass in the Middle Jurassic. If that is so, then putting the ausktribosphenids in the placentals is not such a radical step as it was when this was originally done in 1997.

Flat Rocks is the only place in the world where ausktribosphenids are known. To date, about six person-months of effort mechanically breaking down the fossil-bearing rock have been required in order to recover each mammalian jaw fragment found there. Despite this low rate of yield of mammalian fossils at this locality, continued work there should eventually produce the kind of specimen needed to decide between the various ideas that have been proposed concerning the affinities of the Ausktribosphenidae.

Fortunately, if need be to settle the issue, the extent of the fossil-bearing units at the Flat Rocks site is sufficient to make possible at least another two decades of collecting there at the current rate of excavation. ❖

Taphonomic report

Doris Seegets-Villiers

For this year's field season it was decided to take the excavation further up the beach or towards the cliff than in any of the previous field seasons so far. This decision had its advantages. Since we were closer to the cliff, Nick's system of tarpaulins, drums, girders and the likes did not have to be put in. Also the amount of sand that needed to be shifted on a daily basis was much less, leaving us with more time for the actual excavation since the time needed to clear and prepare the hole every day was cut down quite considerably.

Working further towards the cliff also meant working closer to the edge of our ancient river system. During most of the field seasons so far we had been concentrating our work more towards the middle part of the channel where each of the three different pulses (or layers) we are excavating are quite thick and fairly uniform.

However, having said that, the top layers, which had already shown some changes in its make-up towards the end of the 2000 season, continued to be different from the make-up found towards the centre part of the channel. Until 2000, the usual sequence of deposition for all of the three pulses started with a pebble sized (particle size can range from 4-64mm in size - in our deposits they are mainly up to 10mm large) mainly clast-supported (particles are in contact with each other) conglomerate (particles are rounded), which is followed by a section of sandstone.

By the end of the 2000 field season the top layer had started to change in its appearance. The so far typical fairly small grained and often quite thick conglomerate at the base of the layer was replaced by a mainly single, seldom double layer of very well rounded

mud particles that could be up to 70mm in size. The make-up of the other two layers had not changed at all.

However, the further towards the cliff we dug, the thinner these two layers became, indicating that we were getting closer and closer to the edge of the ancient river. For us, this meant getting into territory potentially even more exciting and this has got something to do with the flow velocity of water in a river.

In the centre of a river the flow velocity is the highest and close to the shore it is the lowest. In other words, if we place two identical objects (e.g. two large leaves), one in the centre and the other more towards the edge of the river, the one in the centre will travel much faster than the one close to shore. Having faster and stronger flow towards the middle of a channel also means that large objects readily get moved in this area whereas small objects only get transported towards the edge.

This was the potentially exciting part. Ever since the first mammal jaw was found, we had been hoping to find not only more, but also different skeletal elements of this little creature. Digging further towards the shore gave us a very good chance in achieving this. Not only that, but since the water flow was much less violent at the edge we also would have the best chance of finding an articulated skeleton (two or more bones still attached to each other) since the water velocity would not have been strong enough to rip entire bodies or body parts like legs apart.

Furthermore, the preservation should, generally speaking, be much better as well, since bones that are transported in a much quieter environments do not get abraded as much and do not collide with each other and other objects as much either, leaving them in much better shape. This field season, hence, started with quite a bit of hope and expectation.

Unfortunately, they were not quite met. We did not find any articulated skeletons although we did find at least two tiny limb elements, which are probably mammalian. We know that, if we are ever going to find more small, delicate bones and articulated skeletons, we have to stay in that area close to the shore of the ancient river system since this is the most likely place for it.

We have not given up on finding more mammalian post-cranial material. That's one of the reasons why we keep on going. After all, the articulated skeleton or the mammal element that we had been hoping to find this year might just be one or two days digging away from where we stopped this year.

In terms of the sediments, this year turned out to be a highly interesting one. Since we did not have to put in "the system", we decided that we could excavate over a wider stretch of rock that usual. We, therefore, had two holes going. One was Norman's hole (with Norman in charge of the excavation) and the other was Nick's hole (with Nick in charge). Norman's area started at the base of the fossil layer right above an organic layer, whereas Nick's took off where we had left off last year.

As soon as we had started targeting Norman's hole, we knew we were in for an interesting time. Instead of the previously mentioned subdivision of the different pulses in conglomerate and sandstone, we all of the sudden had a quite interesting

chaos of layers. They were still conglomerates and sandstones but they were following each other in a very rapid fashion or in other words the base pulse was subdivided into many little sub-pulses that were cutting in and out. Mapping this area turned out to be very difficult and time consuming.

Starting in Nick's hole seemed to be much easier, but not for long. Here too, the layers started, only after a day of excavating, to cut in and out. The first pulse with the large mudclasts kept on going for a while and then vanished only to resurface after a little while again. The second and third pulse started off slowly splitting up in two sub-pulses but then after a short while following the slightly chaotic sample of the deposits in Norman's hole.

Mapping turned out to be equally difficult and time consuming, but correlating of the different sub-pulses was at least sometimes easier here than in Norman's hole. Since we had started in an area where the two base layers had not really split up yet, it was possible to correlate the sub-layers. The only requirements were to remap straight after rock had been taken out and to make sure that an area with the previously mapped and marked sub-layers had been left for correlation purposes.

This sounds quite easy but, unfortunately, was not always the case. Often one of the previously-marked sub-conglomerate layers had, over a very short distance, divided again, leaving everyone wondering what was going on and how many sub-layers we'd end up having (lots). In the end we did a pretty good job. Thanks to Lesley, Norman, Nick (allowing time to access the hole) and especially Mary (dedicated holder of the

measuring stick), Anne, Nicola and at some stage every single member of the crew for holding the tape, level and other important items in the mapping process. In the end we had almost 1000 individual measurements.

Further along the beach towards Inverloch, we could actually confirm the existence of at least three more cryoturbation (or periglacial) horizons. Andrew Constantine had discovered two of these in previous years, and the third one had only been seen by a few of us during a brief episode of very low sand. This indicates that two of these areas are relatively easy to access, with the third one probably being impossible to sample. So far it has only been exposed on one occasion.

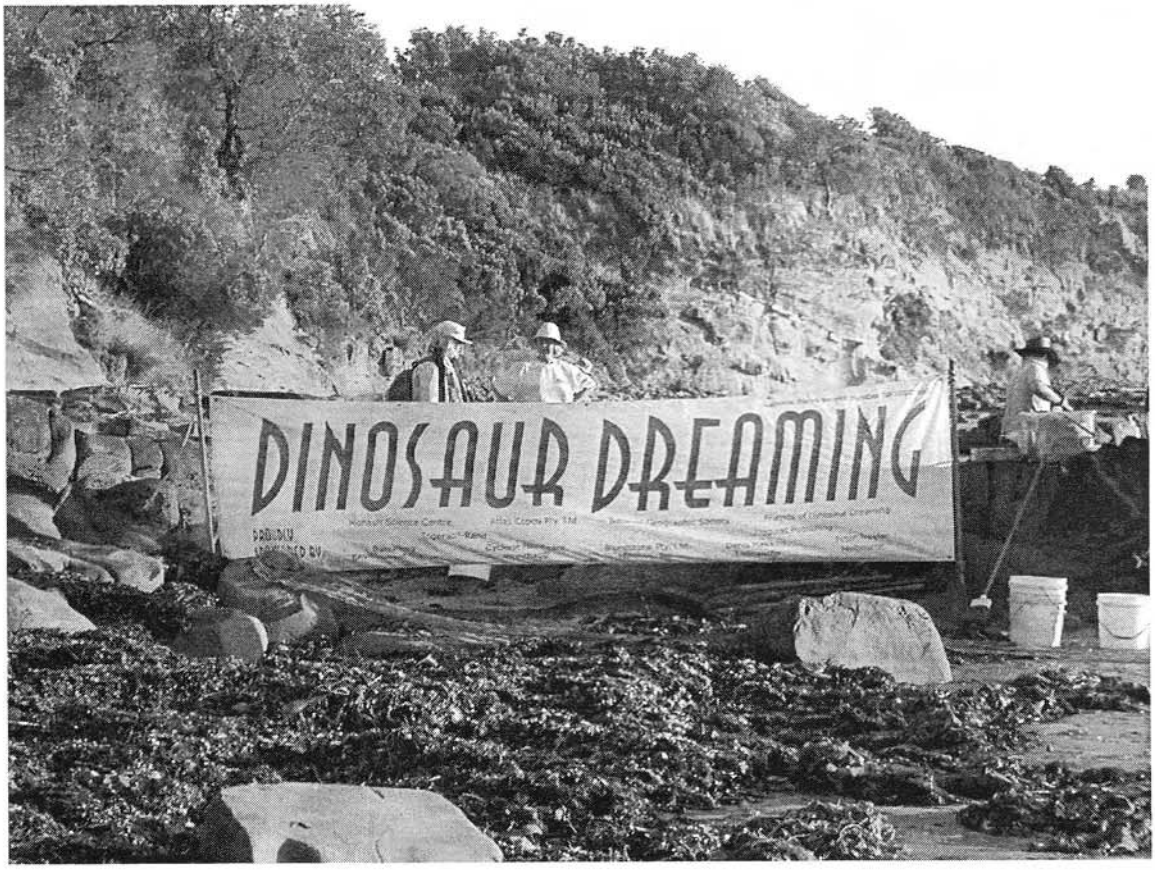
Trying to excavate the area by using plain shovel power has turned out to be quite fruitless as well. The area is far too big and the sand is much too high. In any case (ideally) all of these cryoturbations and their surrounding fine-grained sediments need to be sampled and the samples need to be processed and examined for pollen and spores. This will give us an idea what kind of flora was around during the Early Cretaceous and *hopefully* what kind of floral elements survived the cold climate during that time. ❖

Field report

Katch Bacheller

Dinosaur Dreaming 2002 was, overall, unseasonably cold. Short squalls were commonplace and the field crew were often digging the hole out in rainy weather. The excavation was high on the tidal platform and located initially in shallow sand. No measures other than hand digging the hole and laying a sandbag wall were necessary to prepare the site. The squally weather often stayed near Wilson's Promontory, which resulted in larger than normal waves on the incoming tide. Despite the unusually stormy season, the dig was not rained out once and was accident free.

As in years past, the volunteers were exceptional. The patience and fortitude of these people cannot be overlooked when describing the success of this field season. Volunteers from Germany, Alaska, the continental United States, Great Britain and Australia came together as a team. Contributing to this success was exceptional leadership shown by both Lesley Kool and Nicholas Van Klaveren. It has been my very great pleasure to work with the dinosaur dreaming team for the past four years and look forward to many more digs in the future. ❖


DINOSAUR DREAMING

Prospecting for Cretaceous Vertebrates 2002

Mike Cleeland

In addition to the excavation of fossils from digging operations at Inverloch and Dinosaur Cove, several hundred bones have been found at other sites along the Strzelecki and Otway coasts as a result of surface prospecting.

This began with Ferguson's discovery, nearly 100 years ago, of the dinosaur claw and other specimens near Eagles Nest. Nothing further was reported until Rob Glennie, Tim Flannery and John Long took up the pursuit in the late 1970s and together with Tom & Pat Rich, Cindy Hann, Mike Archer and others systematically prospected much of the Cretaceous coastline over the next few years.

Their efforts led eventually to the discovery of the Dinosaur Cove locality. During the 1990s and through to the present myself and many others have re–prospected virtually all of the areas covered by the earlier workers, and have discovered significant new sites including the main fossil locality at Flat Rocks as well as other significant localities around Inverloch, Kilcunda and San Remo.

During 2002 prospecting covered many of these sites, concentrating on those where erosion was known to be occurring at a significant rate in softer rock units. Several bones were found in the area from Flat Rocks to The Caves. Other localities along the Bunurong coast produced several bones including one limb of significant proportions as well as numerous fragments of turtle and fish.

The Kilcunda area produced a fine large theropod dinosaur vertebral fragment found by Andrew Ruffin, while a large fragment of turtle with both carapace and plastron represented was found nearby. This specimen was particularly unusual in that is was

fossilised in almost pure sandstone. This is perhaps a reflection of the different behaviour of larger, platey bone fragments in a fluvial depositional environment. A visit to another Kilcunda locality during the digging season resulted in the recovery of several bones including a theropod tarsal.

Several bones were found at San Remo and Rowells Beach including a large labyrinthodont rib and a significant fragment of labyrinthodont skull and a well exposed vertebra. Visiting groups at the Dig Site continue to find small bones in the erratics while on supervised searches. The Powlett River site continued to display its affinity with the ostrich family, remaining deeply buried under beach sand throughout the year.

A trip to the Otways in April 2002 concentrated on the area from Apollo Bay to Cape Otway. Much of the area had not been examined for several years and several new finds were made. These included a sizeable vertebra and an Ankylosaur rib, several hypsilophodontid femora, and an interesting concentration of material in a new locality. Although these bones have not been fully studied yet it appears that the occurrence of some 4 or 5 limb bones in close proximity may indicate a promising site.

Further work during 2002 is planned to investigate the area east of The Punchbowl in the Strzeleckis, and to return to Point Lewis and other sites in the Otways. Prospecting in future years will again concentrate on a combination of monitoring known sites and exploring for new ones.

Roadworks planned for the Koonwarra area are likely to expose further material from the known fish fossil beds. Arrangements have been put in place with Vicroads, which will require the removal and examination of any fossil-bearing rock.

I would like to thank Andrew Ruffin, Joe Leary, Ella Easton, Lisa Wangman, Dave & Andrew Pickering, Norman Gardner, Christine Anderson and several others whose names I may have inadvertently omitted for carrying the rocksaw when my knees couldn't, for laughing politely at my attempted jokes, and for generally helping out on an important part of this ongoing research of world significance. ❖

Acknowledgements

Volunteers

Each field season we rely heavily on the enthusiasm and dedication of many volunteers from Australia and overseas. This year was no exception. We enjoyed the company of a number of overseas visitors from as far afield as England, Germany and the United States.

In particular we were very fortunate to once again have the very able assistance of Katch Bacheller from Alaska. Katch first joined us in 1999 and immediately became an integral part of the crew. She came back the following year and took on the onerous task of "evil overseer". She has made this position her own since then and has always led by example. Many of her innovative ideas have been incorporated into the general running of the dig and we have all benefited from her amazing gift of problem solving. We look forward to her return for the 2003 field season.

Dinosaur Dreaming 2002 field crew

Marion Anderson	Sarah Edwards	Sara Jakica	Doris Seegets-Villiers
Katch Bacheller	Caroline Ennis	Gerrit Kool	Danielle Shean
Nicola Barton	Alan Evered	Lesley Kool	Leah Schwartz
Rachel Blakey	Nicole Evered	Jo Leary	Kerstin Thauer
Simon Burden	Laurie Fletcher	Anne Leorke	Daniel Timblin
Jeremy Burton	Al Fraser	Rohan Long	Nick van Klaveren
Deb Cameron	Katrina Fry	Dru Marsh	Mary Walters
Andrew Cheesman	Priscilla Gaff	Dee Milligan	Astrid Werner
Barry Clarke	Norman Gardiner	David Munz	Wendy White
Mike Cleeland	Uwe Gelius	Helen Mitchell	John Wilkins
Roger Close	Dean Gilbert	Dave Pickering	Dean Wright
Peggy Cole	Judy Humer	Dale Sanderson	
Shannon Davies	Matthew Inglis	Ian Seal	

Sponsors

We are very proud to be sponsored once again by the National Geographic Society, which has supported our project for more than 20 years. Without their support we would find it impossible not to ask our many volunteers to pay for their experience of being a part of this amazing adventure into Australia's past. Thanks to the Australian Research Council grant we were able to employ a second preparator, Dave Pickering, who has prior experience in preparing this material in a voluntary capacity and has already proved to be a great asset in speeding up the preparation rate this year. It has also given us funding stability for the next five years.

We have been very fortunate to have the continued support of a number of companies and individuals, all providing a valuable commodity in the form of equipment or public relations. Once again we offer them our thanks.

Atlas Copco
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Denis Hawkins, Leongatha
Friends of Dinosaur Dreaming
Ingersoll-Rand
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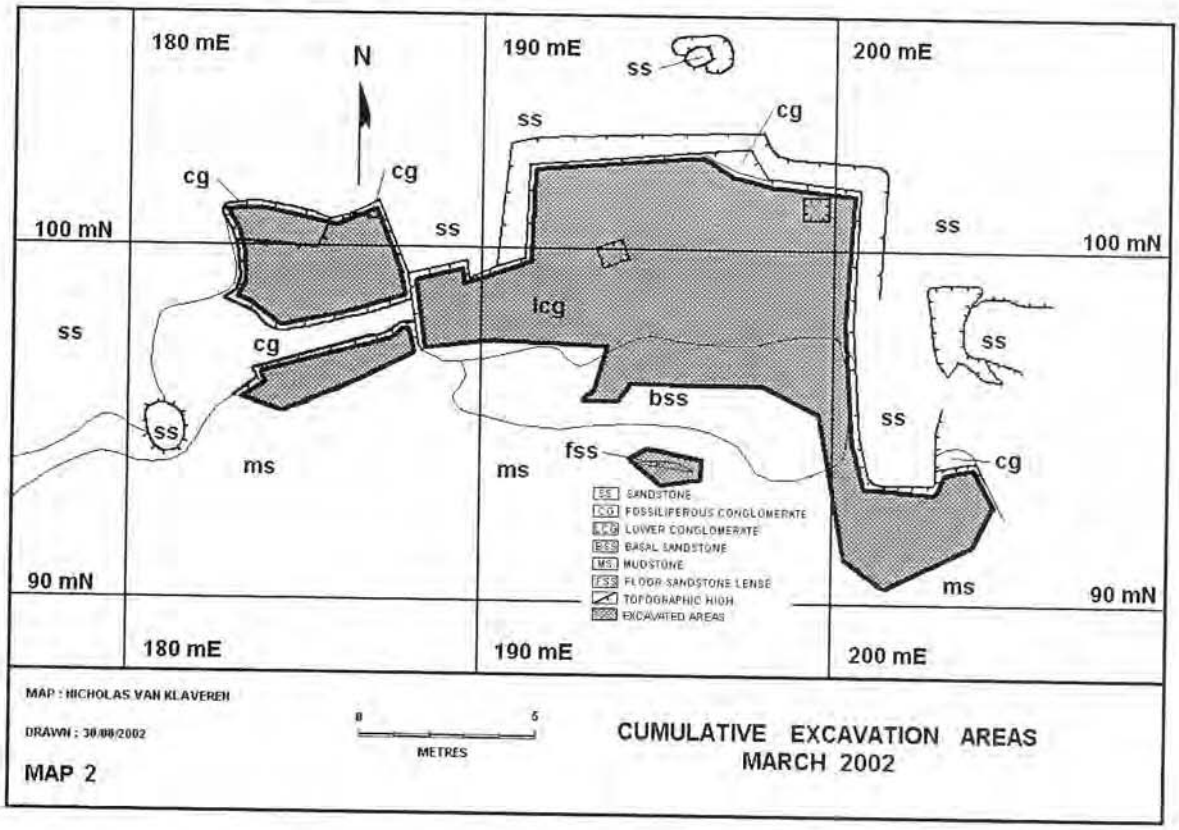
Monash University Research Fund
National Geographic Society
Peter Trusler, Melbourne
Ziggurat Creative & Technical Publishing

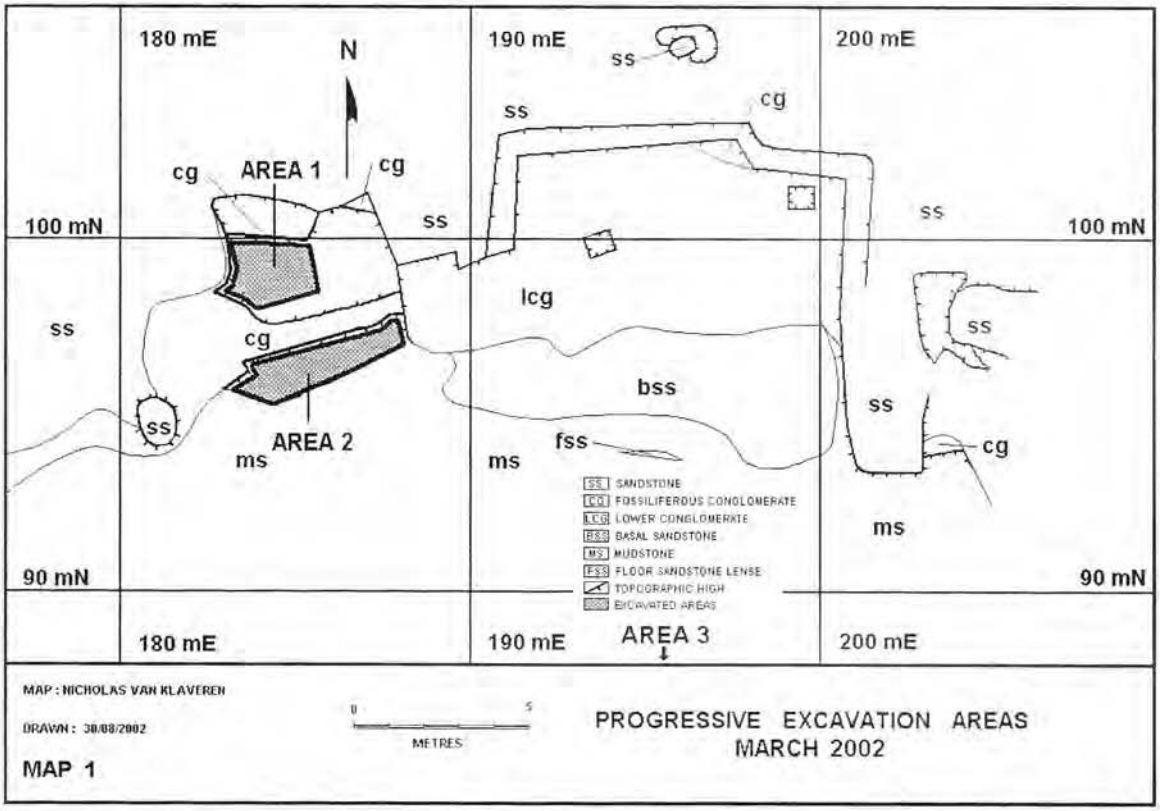
Maps

Nick van Klaveren

Cumulative excavation areas - March 2002



Progressive excavation areas - March 2002



Projected excavation area - 2003