DINOSAUR DREAMING

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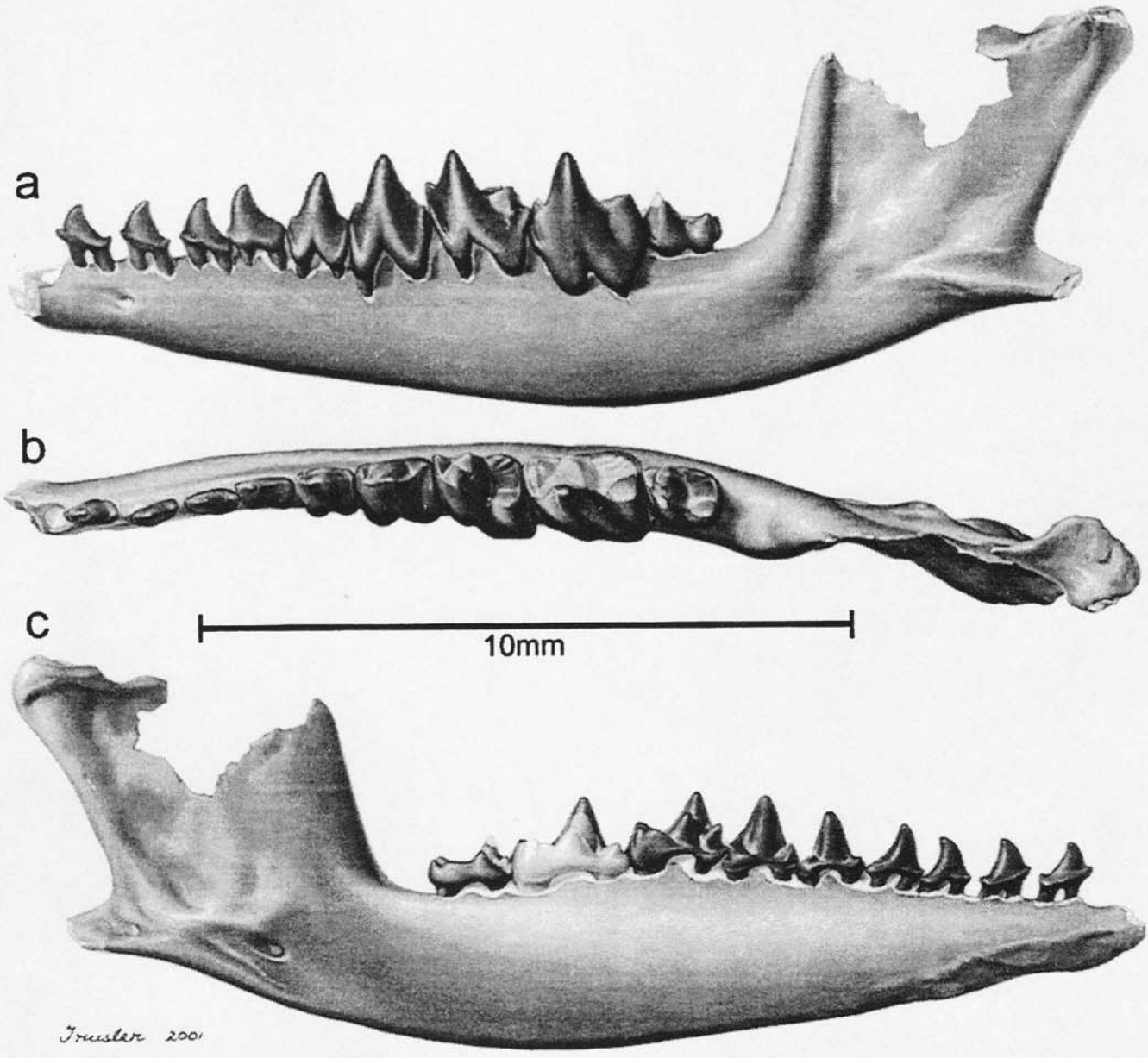

FLAT ROCKS SITE REPORT 2001

DINOSAUR DREAMING

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FLAT ROCKS SITE REPORT - 2001

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About the cover

Peter Trusler's magnificent reconstruction of the left mandible of *Bishops whitmorei*, adorns the cover of this year's report.

a) Labial view

b) Occlusal view

c) Lingual view

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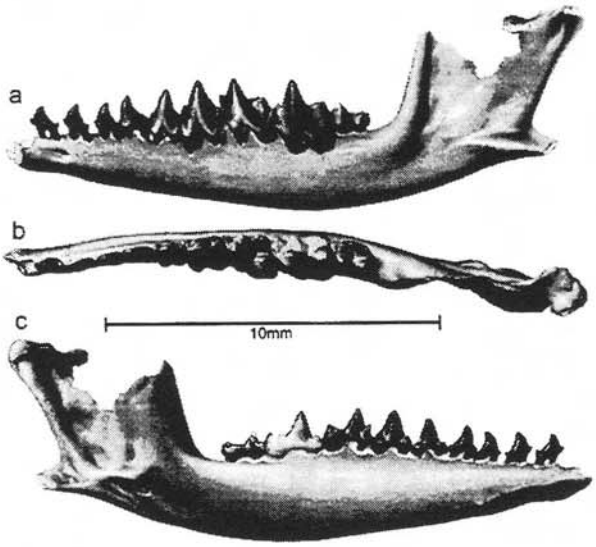

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Expedition report

Lesley Kool

The discovery of the two best preserved mammal jaws ever found at the Dinosaur Dreaming site on December 3rd 2000, during the one-day field trip for the new volunteers, led to a last minute change of plans for the Dinosaur Dreaming 2001 field season. After the recovery of four mammal jaws among 1000 other fossil bones and teeth during the previous field season, we were keen to continue where we left off, approximately five metres east of where the one-day excavation was situated.

However, when Tom Rich returned from Japan in early January 2001 and was able to examine the two new jaws he suggested that we consider expanding the one-day excavation in the hope of finding more of the exquisitely preserved mammal material. One of those jaws has been beautifully reconstructed by artist Peter Trusler and appears on the front cover of this field report.

The decision to move the excavations further up the beach from where we originally planned was not a difficult one to make. As the excavations are all part of the same fossil layer, which extends from the intertidal zone on the shore platform into the cliff, it simply involved "leap-frogging" a five-metre section of the shore platform to excavate the targeted area.

The previous three field seasons involved excavating the eastern end of the fossil layer, situated up to 150 centimetres below the level of the shore platform. By the end of the 1997 field season it required approximately three hours labour each day to expose the site. As we only had an optimum three to four hours either side of low tide to extract the fossils, it became obvious that we needed to do something to shorten the site preparation period. Nick van Klaveren, the excavation manager, put his considerable talent for invention to work and created a system used to plug the excavation hole and prevent the bulk of the sand from being washed back into the excavations during high tide.

Over the next three field seasons this system was improved to a point where it was taking less than an hour to expose the site each day. But as the proposed 2001 excavation was higher up the beach and the fossil layer was closer to the surface of the shore platform, the system was not necessary.

The advantage of not having to put the system in place was not lost on the more experienced members of the crew. It meant that instead of spending four days at the start of the season drilling holes for the rock bolts and building sandbag walls, the crew only had to dig out the sand each day that had been washed into the excavation by the previous high tide. It took about an hour to remove the sand and wash down the fossil layer in readiness for the day's

excavation. It also meant that we were able to work the site right up to the last day of the season instead of having to remove all evidence of the system in accordance with the permit issued by the Department of Natural Resources and Environment.

On the first day of the 2001 field season, Monday 22nd January, excavation of the new location at 185 metres East was begun[1]. A small amount of fossil layer was excavated before a section of the overburden above and to the north of the fossil layer was removed with Atlas Copco jackhammers. An area of approximately 2.5 metres by 1.5 metres of overburden was removed to a depth of 60 centimetres on the northern face. This was done to facilitate the removal of the fossil layer below.

The excavation of the fossil layer in this defined area took four weeks. Doris Seegets-Villiers mapped the face of the fossil layer a number of times over this period, and recommended that the fossil layer which contained the two mammal jaws recovered the previous December, continued west of the excavation. Her suggestion was that we should consider moving in that direction instead of east back towards last year's excavations.

At the end of the fourth week of the field season we had removed the entire targeted fossil layer in the original excavation, cataloguing over 600 fossil bones and teeth, including two more mammal jaws.

John Wilkins found the first mammal jaw during the second week of the dig, but unfortunately, it was not complete, and the two preserved molars were badly damaged.

On the last day of the fourth week, Saturday 17th February, we held the "Friends of Dinosaur Dreaming" day where close to 100 supporters joined us for a special tour of the site. It was during this activity that Gerry Kool discovered the second mammal jaw, and it is the tiniest jaw found so far.

As we finished removing the last of the fossil layer from the excavation, it was decided that we would sample part of the lowest layer directly above the mudstone. There was only a small part of the lowest fossil layer exposed on the edge of the channel. A number of small bones had been exposed in this layer in the past, but we had never sampled the layer, preferring to concentrate on the upper fossil layers below the overlying sandstone.

Fish and turtle bone fragments were quickly discovered, which was to be expected, as they constitute the highest percentage of fossil bones found at this site. However, a small tooth was also discovered, which was later identified as a possible pterosaur tooth. Further excavation of this part of the fossil layer revealed a number of other bones, including a nice dinosaur toe bone and the shaft of a small dinosaur limb. This lowest layer does not appear to be as fossiliferous as the upper layers, but warrants further investigation.

On Doris Seegets-Villiers advice it was decided that we spend the last two weeks of the field season expanding the excavation by one metre to the west. This required a small amount of overburden to be removed, which was

1. See maps at the end of this report.

accomplished in a few hours. As with the previous four weeks, most of the fossil bones recovered were less than five centimetres in length, reflecting the reduced carrying capacity of the original stream at this point in the deposit. An exception to this was the discovery of an almost complete hypsilophodontid femur by Dale Sanderson, which at 15 centimetres in length, was the largest bone found during the field season.

A number of shed theropod dinosaur teeth are found each field season and this year was no exception. Since excavations began at the Dinosaur Dreaming site in 1992 more than 50 small theropod dinosaur teeth have been recovered. With one exception, all the teeth were shed from the mouths of these meat-eating dinosaurs while they were still alive. The evidence for this is shown in the absence of roots on the teeth.

All dinosaurs replaced their teeth throughout their lives. When a tooth was worn or broken the root was resorbed into the jaw, leaving just the crown of the tooth held in place by the gums. The tooth would often become embedded in the flesh or bone of the animal the theropod dinosaur next bit into, or sometimes it was swallowed. Eventually, these isolated teeth ended up in the fossil deposit, only to be discovered many millions of years later.

The discovery of these beautiful, shiny serrated teeth are always cause for excitement, as they represent animals that may have been feeding in this area so long ago. Towards the end of this field season Astrid Werner, an experienced volunteer who has joined us for the last five field seasons, found a small theropod tooth. Her tooth was the exception to the rule and gave us all hope for the future, for this tooth had a root.

This was not a shed tooth, but a tooth which would have still been in place in the jaw of a small theropod dinosaur when it died. This discovery, along with several small theropod vertebrae and some isolated skull fragments also recovered this field season, suggest that maybe a small theropod dinosaur died in the vicinity and its scattered bones and teeth found their way into this part of the fossil channel. There is no guarantee that more of this individual will be found during future excavations, but it does give us reason to hope.

Before the field season commenced Barry Clarke, a local geologist who was keen to become involved in the project, contacted us. Barry's knowledge of the Strzelecki area was a great asset, which we felt was important to use. Barry joined us at the site on a number of occasions and when we expressed interest in prospecting some of the inland outcrops, he generously arranged for us to gain access to some private properties that had exposures that could be of interest.

Although the excavation of the fossil site near Inverloch is our primary aim, it is also important to spend some time prospecting for new sites. The idea to prospect inland of Inverloch was suggested when it was discovered that the local shire was planning to straighten parts of the South Gippsland Highway, which winds its way through the Strzelecki hills to the north of Inverloch. The important fossil site at Koonwarra was discovered during the original building of the highway in the 1960s and so it was hoped that by straightening some of the bends in the highway, more fossiliferous sites might become exposed.

As it turned out the Shire had only just begun work on the Highway and not in the area we wanted to prospect, so Barry suggested we travel to the small town of Jumbunna not far from Inverloch and check a property that he had permission for us to enter. Here, he believed, we would find outcrops of the upthrown side of the Kongwak fault, exposing Early Cretaceous sediments.

We travelled in convoy to the property where we checked along the banks of the creek and climbed to the top of a nearby hill looking for exposed outcrops. Small outcrops of mudstone and interbedded sandstone were found along with a few plant fossils, but no evidence of fossil vertebrates.

We then prospected some road outcrops along the Jumbunna-Outtrim road. We surveyed the road first, noting there were a number of outcrops to be explored. Then we turned around and drove back along the road, one car stopping at each outcrop and then leap-frogging the other cars to the next free outcrop. This way the six vehicles covered all the outcrops quickly. Most were comprised of massive sandstone, with small amounts of interbedded mudstone.

A fairly extensive exposure of sandstone/mudstone and coal was discovered that was part of the old rail cutting. An extensive investigation of the cutting took place once permission from the owners was obtained, but no evidence of vertebrate fossils was discovered.

Although no evidence of fossil vertebrates was found during the prospecting trips, both Barry Clarke and Mike Cleeland are keeping in touch with the Shire's progress of straightening parts of the South Gippsland Highway as there is real potential for new fossils sites to be exposed.

As well as the inland prospecting we also spent one day working the "Ferguson site" at Eagles Nest. This site is named after William Ferguson, a geologist who found the first dinosaur bone in Australia in 1903, and although the map he drew does not exactly pinpoint the location, we are fairly sure that the fossil site discovered by Mike Cleeland in 1995, is the same locality. The site is also situated in the intertidal zone and often covered with sand. Although not as fossiliferous as the main Dinosaur Dreaming site at Flat Rocks, it has yielded some interesting specimens in the past, including a partial pterosaur or bird humerus, which Pat Vickers-Rich is currently studying. This field season eleven specimens were collected, including a small plesiosaur tooth, approximately 1.5 centimetres long. The rest of the specimens were mainly fish and turtle, but we will return to the site again next year.

Visitors

One of the most enjoyable aspects of the field trip is interest shown by overseas researchers. This field season researchers visited us from Patagonia, England, Alaska and Japan.

Raúl Vacca from Patagonia is a very experienced field worker, who spent three weeks with us and gave us the benefit of his extensive knowledge in excavation and preparation. Our site is very different to the arid desert conditions of Patagonia where Raúl has excavated large complete dinosaurs. Recognising tiny bone fragments was quite an experience for him.

Dr.Robert King works for the Bureau of Land Management in Alaska and had heard about our dig from Katch Bacheller, our "Evil Overseer" and fellow Alaskan. As he was in Australia visiting relatives it was a perfect opportunity for him to see the site first-hand. We were very fortunate that Bob had brought with him slides of another Polar dinosaur site on the banks of the Colville River in Alaska and we enjoyed a very pleasant evening viewing excavators on the other side of the world working in even more difficult conditions than ours.

For the last week of the dig three researchers from Japan and one from England joined us. **Dr. Makoto Manab**e, from the National Science Museum in Tokyo, works on hypsilophodontid dinosaurs and was particularly interested in our excavation techniques. His colleagues included **Dr. Yoshitaka Yabumoto**, who is a palaeoichthyologist and was interested in the fossil fish we were collecting. **Dr. Sue Evans** from Imperial College, London, was interested in fossil frogs and lizards, but unfortunately we were unable to help her in either of these groups, as they both appear to be absent from our fossil fauna.

The fourth member of the group was **Ryoko Matsumoto**, a young preparator who wanted to learn more about our method of preparation. Ryoko stayed on in Melbourne after Makoto, Yoshi and Sue returned to Japan, and spent three weeks learning how to use our preparation tools and consolidants. In that time she prepared a number of small fossil bones that she had brought with her from Japan using her new knowledge.

Follow up

Preparation of the four new mammal jaws was completed after the field season and has produced some interesting results, which Tom Rich outlines in his report (page *13*). Two papers have recently been published; one describing *Bishops whitmorei*, the newest genus and species belonging to the Ausktribosphenidae and a brief report on *Teinolophos trusleri* and its monotreme nature. Tom is currently working on the tiniest mammal jaw, found this field season, which may also be a new genus and species.

One of our field crew, Natalie Schroeder, was lucky enough to procure a preparation job at the Royal Tyrrell Museum of Paleontology in Alberta, Canada. She left Australia in May and carried with her a precious cargo of most of the theropod teeth from Inverloch, including the tooth with a root. When she arrived at the Museum she handed the teeth over to Dr. Phil Currie,

who specialises in theropod dinosaurs. He has been studying the teeth and we hope to have his thoughts on them in the near future.

Late last year we successfully applied for a Community Grant through Parks Victoria on behalf of the "Friends of Dinosaur Dreaming". This grant will pay for the creation and construction of a series of interpretive panels to be erected at the Dinosaur Dreaming site near Inverloch. We have provided text and illustrations for the panels and graphic artist Graham Kenneday will produce the enamel panels. It is hoped that the panels will be finished in time for the Dinosaur Dreaming 2002 field season.

Excavation Report

Nicholas Van Klaveren

The Flat Rocks fossil locality was excavated for a period of six weeks, from late January to early March 2001. This was one week later than the previous year and was chosen to coincide with the university holidays and to avoid the tourist season at Inverloch.

All the fossil material was collected under permit No. 10001158 of the Department of Natural Resources and Environment Victoria.

The excavation this year was moved up the beach about five metres westward toward the cliff because of the discovery of two well-preserved mammalian jaws at 185 metres East, 100 metres North during a one-day field trip during December 2000. The relative shallowness of the overlying sand at the site higher up the beach meant that the construction of girders and tarpaulins was unnecessary.

Excavation Methods

The excavation method this year continued with the use of large iron wedges and sledgehammers to remove the bulk of the fossil layer from the targeted area. Exposed specimens were removed with a diamond sawblade-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 the Middle Sandstone Unit, then a second level extracted with the wedges driven into the Lower Sandstone Unit.

The unfossiliferous, overlying sandstone overburden was removed with two *Cobra* petrol-driven jackhammers. Once the majority of the overburden was removed the method, was then switched to sledgehammers and wedges so as to provide greater control to protect the underlying fossil layer from damage.

Equipment

Due to its location[1], the Flat Rocks fossil locality presents a number of difficulties with regard to the difference in elevation, and large waves at high tide.

For the previous three 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 fossiliferous units.

1. At the bottom of a cliff in the intertidal zone facing Bass Strait.

A number of innovations were to be tried this year to improve the system introduced three years ago.

Solar Power Unit and Pump

In expectation of the use of the construction this year, a solar power unit and small salt-water pump were constructed.

A continuous trickle of salt-water draining 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 dispense with this onerous (and odorous) task, a 12-watt, 8-volt, photovoltaic array coupled with 18 D-cell Nickel - Cadmium batteries form a solar power unit, which is battery assisted in cloudy times and self-charging in times of low use.

This 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 the head.

Splines

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 were 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 were to be held down by rock bolt washers fitted over the rock anchors used to secure the girders.

Without the use of the construction this year, this new innovation will have to be tested at a future date.

Excavated Areas

A small excavation west of the fault at 185 metres East, 99 metres North, 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.

Area A

With the decision to concentrate on this area it was necessary to remove the overlying sandstone with the petrol driven jackhammers. During the process a thin (5 centimetre) brown, oxidized carbonaceous clay layer of limited extent (40 centimetres wide) was encountered. This new unit located at 183 metres

East, 101 metres North probably represents a small pool or puddle, which was exposed for some time between the major flooding events. A number of small bones were unexpectedly found in this unit and consisted of a small hollow limb and a shard of turtle carapace. A possibility that entire small animals may be preserved in this unit due to the different environment and energy of deposition warrant further investigation next year as the majority of this small layer is still exposed in the northern face of this year's excavation.

The main fossiliferous conglomerate produced specimens at a rate and quality equal to the down-slope excavations of previous years, including a further three mammal jaws.

A major development from this year's excavation was the recognition of micro-channelling within the major conglomerate units. The deeper parts of these small channels were found to yield bone concentrations ten times that of the surrounding rock. Numerous other small channels could then be discerned all throughout the fossil layer including the lower units, in which material left behind in previous years was thought to be substandard because of the paucity of specimens.

Area B & C

Minor amounts of rock were excavated at these two points and were found to contain adequate amounts of fossil material of a medium grade.

Future Excavations

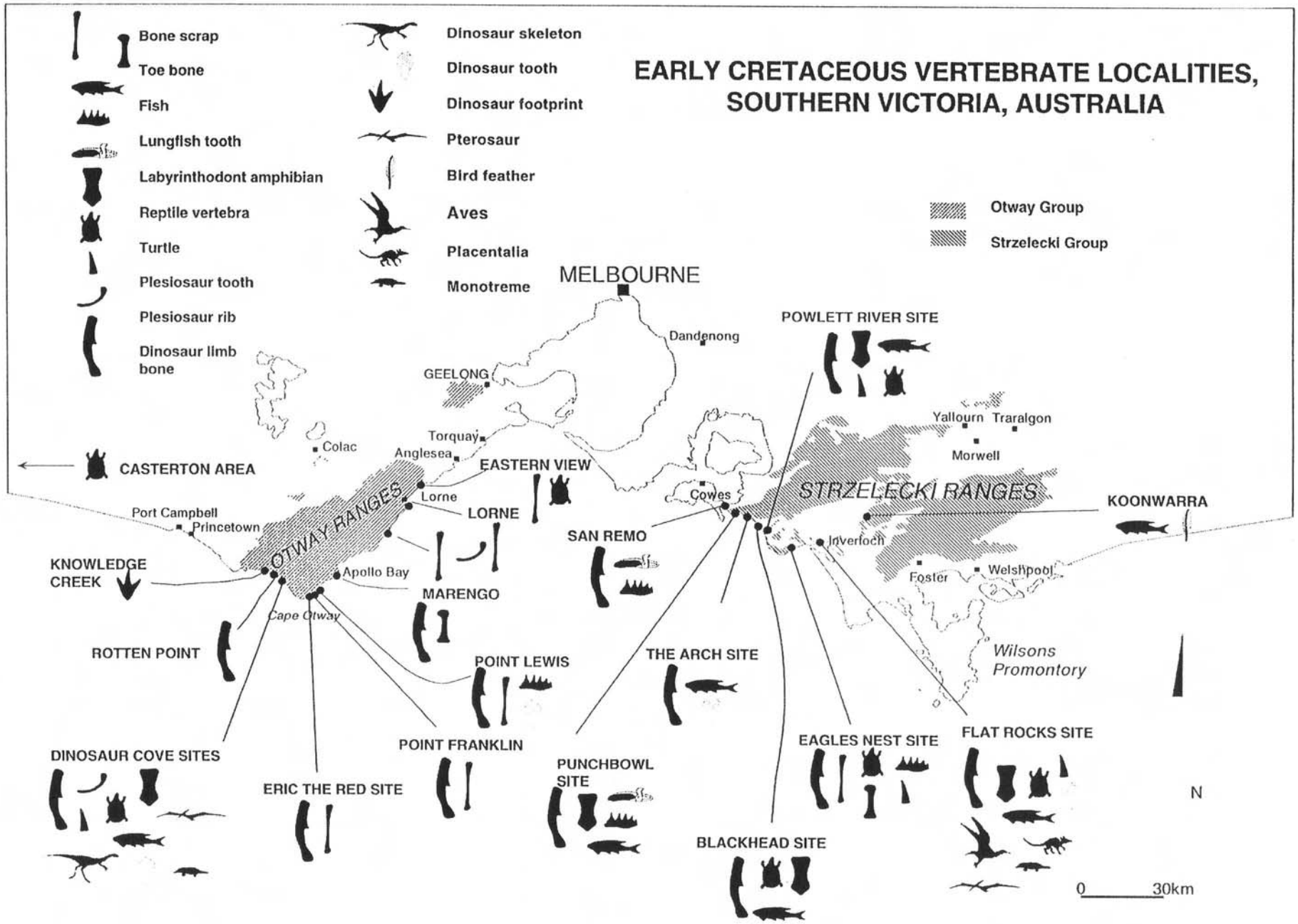
In consultation with Doris Seegets-Villiers, the units containing the mammal jaws excavated this year will be pursued westward next year.

These units again outcrop at the surface and are untouched except for a few exposed bones, which have already been cut out. It is notable that these bones are found in the base of the microchannels mentioned previously.

Excavation next year will concentrate upon the wedge-shaped lower units already exposed and then follow the main units subsurface, with some removal of sandstone overburden.

The problem of inflow of water from the mass of sand filling the previous year's hole will be countered with the building of a small sandbag wall[1] and the placement of a slotted drainage pipe with a geotextile sock. The sandbag wall will be only two or three bags in height so it is not exposed above the sand between daily excavations next year. It has also been proposed (by Marion Anderson) that the sandbags be armoured by hessian on the west side to protect against the daily shovelling out of the excavation.

1. See map 3 at the end of this report.


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
Colac
Torquay
Anglesea
CASTERTON AREA
EASTERN VIEW
Lorne
LORNE
Port Campbell
Princetown
OTWAY RANGES
KNOWLEDGE CREEK
Apollo Bay
MARENGO
Cape Otway
ROTTEN POINT
POINT LEWIS
POINT FRANKLIN
DINOSAUR COVE SITES
ERIC THE RED SITE
PUNCHBOWL SITE
BLACKHEAD SITE
THE ARCH SITE
SAN REMO
Cowes
POWLETT RIVER SITE
Yallourn
Traralgon
Morwell
STRZELECKI RANGES
KOONWARRA
Inverloch
Foster
Welshpool
Wilsons Promontory
EAGLES NEST SITE
FLAT ROCKS SITE
N
0
30km

Research Report

Tom Rich

Since 1994, when Lesley Kool, Pat Vickers-Rich, and I first went to Patagonia to search for fossils, our objective there has remained the same: to try and find fossils that would tell us whether or not land animals during the Early Cretaceous actually went between Australia and South America.

Why we think this might have been so was based on reconstructions of the continents at that time. With Australia then firmly joined to East Antarctica, and South America close to the West Antarctic Archipelago, the only barrier to such interchange would appear to have been the high latitude of Antarctica and the water gaps within the West Antarctic Archipelago. For although West Antarctica today (that part of the continent in the western longitudes) appears on a map to be solid land, if all the ice there melted, it would be a series of large islands much like the Indonesian region.

Over the years, mostly what was found by us in Patagonia were isolated bones of the giant sauropods along with a few specimens of large theropods. Missing entirely were the small dinosaurs so characteristic of the same aged rocks in Victoria. Because we do have the very rare remains of large dinosaurs in Victoria, fist-sized fossils that obviously come from elephant-sized animals, we know that the larger dinosaurs were here. However, because of the way they were buried in small stream channels incapable of transporting entire large bones, the evidence for such dinosaurs in Victoria is rare indeed. So the differences we see between Argentina and Australia, probably mostly owe to different burial mechanisms, not necessarily differences in the animals that were living in the two regions 115 million years ago.

Be that as it may, on that first trip in 1994, a site almost instantly dubbed "Turtle Town" was found in Patagonia. Loaded with turtle remains, the site was unlike the pattern so typical of the Early Cretaceous in Patagonia in that there were smaller vertebrates preserved there. We have just learned from Eugene Gaffney of the American Museum of Natural History, New York, that the skull of one of the turtles collected at Turtle Town shows a remarkable resemblance to the turtle *Otwayemys* that was collected from Dinosaur Cove. So, after all the effort put into Argentina since that first trip in 1994, a payoff for that is beginning to emerge.

A colleague, Elizabeth Smith, working on the fossils from Lightning Ridge that are about the same age as those from Dinosaur Cove, has been told by Dr. Gaffney that a turtle skull she has from the Ridge is very similar to both *Otwayemys* and the one to be named from Chubut. So turtles are linking the

three regions together. Elizabeth will visit our collection later this year to make direct comparisons.

The discovery on December 3rd 2000 of two additional mammal jaws, each far more complete than any ever previously recovered from Flat Rocks, came at a most propitious time. When they were found, a paper had been submitted to the scientific journal *Nature* describing the third species of mammal to be recognised at Flat Rocks. The specimens on which that paper was based were much less complete than the two December jaws. The two jaws could have been one or both of the previously described mammals from Flat Rocks.

But that did not prove to be the case, for they were clearly the same species as the new one being described. However, because the editorial process was so far along, we hesitated to withdraw the paper and redo it. But when another five months had passed and the editor at Nature could still not make up his mind exactly what he wanted us to do to make our paper "acceptable" for publication, we withdrew it. Then a frantic period ensued when Peter Trusler put in long, hard hours painting an exquisite illustration of one of the December jaws that would become the name-bearer (or *holotype*) of the new species instead of one of the far less complete specimens found previously.

To do this and keep to the schedule we wanted to meet (in order to have the new species available for addition to a book by colleagues overseas about the mammals that lived alongside the dinosaurs) Peter at times slept just two hours a night and that was on the floor of his studio so he could complete the illustration on time. The publication did appear a week ahead of schedule in early June, just seven months after the holotype was found, and so it will be included in the forthcoming book, to be published in late 2002.

The new mammal was named *Bishops whitmorei*. This was to honour two people at the National Geographic Society who supported Pat and Tom's efforts for years. They did this because they felt that if the National Geographic supported them over the long haul, eventually the birds and mammals that lived alongside the dinosaurs - always Pat and Tom's primary goals - would be found.

Even though Tom had long given up on ever finding mammals, they did not. And they were right. *Bishops* is in honour of the late Barry Bishop, for many years chairman of the Committee for Research and Exploration of the National Geographic Society, the arm of the organisation that dispenses funds for research. *whitmorei* is in honour of Barry's offsider, Frank Whitmore. Although in his mid-80s, Frank is still an active palaeontologist with about four papers currently in press concerning his favourite topic, fossil whales.

Bishops whitmorei is placed in the same family as the first mammal to be described from Flat Rocks, *Ausktribosphenos nyktos*. However, while about the same size, *Bishops* is more advanced in a number of features. These features make it more like typical placental mammals, the group which both have been assigned to by Tom and his coauthors. In this, they are a definite minority, for most vertebrate palaeontologists are quite certain that whatever these ausktribosphenids are, they are not placentals.

That difference of opinion has led to a lively debate in the scientific journals, which still continues and shows no sign of abating. It is that debate and the ramification of its outcome, whatever it may be, to the most basic ideas we have about the origin of mammals, that adds zest to the scientific results emerging from all the hard work and long hours at Flat Rocks. As even the opponents of the idea readily admit, the mammals being found at Flat Rocks are amongst the most interesting of Mesozoic age being uncovered anywhere in the Southern Hemisphere at the moment.

The willingness of one of the placental sceptics (Richard Cifelli of the University of Oklahoma) to be quoted saying that, may well have been the reason that the Australian Research Committee has committed funds to the Dinosaur Dreaming project. This will provide a salary for Lesley Kool and a partial salary for a second preparator to continue the preparation of the fossils at Flat Rocks for the next five years. That increase in preparation time by the second person should result in even more interesting fossils turning up much more quickly.

After the "Rookies Day" discovery, things went rather quietly in the fossil mammal business at Flat Rocks. But the completeness of those two specimens made it a hard act to follow. However, Gerry Kool was a man up to the job. What Gerry did was to find another mammal new to the site and new to science. But it was not just another mammal. The reason we knew - even before Lesley had performed one of her remarkable feats of fossil preparation - that Gerry had found a new mammal was because of its size.

Tiny though *Ausktribosphenos nyktos* and *Bishops whitmorei* are, Gerry's jaw is even smaller. It is only half to two-thirds the size of these other species. As yet, Gerry's jaw is unnamed. In part this is because there has not been time to describe and analyse it. But also because we are all hoping that as was the case with *B. whitmorei*, more complete material of the same species as Gerry's jaw will be found. Just how much smaller mammals at Flat Rocks could have been, we do not know. However, Gerry's jaw is getting close to the size of one of the smaller shrews, the smallest of living mammals.

While more mammal jaws will always be welcome at Flat Rocks, it is doubtful that more of them will ever provide the evidence to decide one way or the other whether the ausktribosphenids are true placental mammals or a group of mammals quite unrelated to the placentals. If that debate is ever resolved to the satisfaction of most of the present disputants, it will probably come about because of the discovery of a partial skull.

While in New York at the American Museum of Natural History at the end of May, Tom had with him two skull fragments. Experts on fossil mammals there all agreed that these fragments belonged to mammals but which one, they had no idea. From their size being significantly greater than the ausktribosphenids, it is likely that they belong to the other group of mammals known to occur in the Australian Mesozoic, the egg-laying monotremes.

Although not giants today, compared with most Mesozoic mammals, monotremes such as the Lightning Ridge *Steropodon* and *Kollikodon*, were amongst the largest mammals of their day. What these specimens are, though

intriguing in itself, is not their greatest importance. What they unequivocally demonstrate is that at the Flat Rocks site, skull material of mammals can be preserved. This means that in working towards eventually recovering skull material of the ausktribosphenids, we have not set ourselves an unrealistic objective, rare those such fossils might be at the site.

Taphonomic update

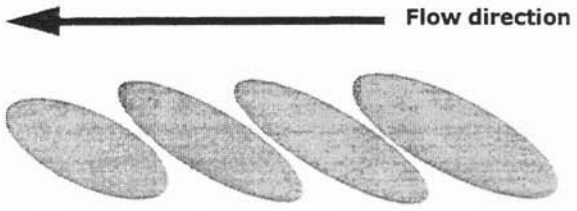
Doris Villiers

As in previous years and years to come one of the main activities undertaken during the field trip is the recording of the extent, thickness and the change in appearance of each individual layer of sediment within the ancient riverbed that we are excavating. The results obtained confirm that it is important to record any minor and major changes during every stage of excavation.

In most areas we are working, we find three different pulses, but their appearance has changed in one case this year. Each of the pulses mentioned is made up of two different sections. The top part consists of pure sandstone. The section underneath is made up of predominantly clast-supported[1] pebble (4 to 64 millimetres) sized conglomerate[2], with the pebble size ranging mainly between 2 and 10 millimetres. This conglomerate, however, has changed in the uppermost pulse.

Hints of these variations were present in last year's excavation area, but at that stage it was not clear that they were what seems now to be a permanent feature. Instead of being a mainly clast-supported conglomerate, the basal part of the last pulse has now been replaced by a layer of large mud clasts, which can consist of several clasts stacked on top of each other, but is mainly represented by a single layer of clasts. Though they usually are still within the pebbles size range, some of them are larger (up to 70 millimetres) and therefore must be called cobbles (64 to 256 millimetre, large fragments).

In some areas imbrication can be observed as well. To understand what imbrication means, imagine a modern alpine riverbed with an abundance of river pebbles and a little water flowing in between. Have you ever noticed that these pebbles usually are overlapping each other just like books on a bookshelf that have tipped over to one side? Well, that's exactly what imbrication is. Due to the current action under high flow velocity the pebbles become aligned in one direction. The resulting overlapping is an indication of the direction of the water flow. (See figure below).



1. Individual clasts (or particles) touch each other.
2. Clasts are rounded.

Further changes are again visible in the conglomeratic layer of the second pulse. The predominantly clast-supported sediments are now often split up into several small subpulses, conglomerate and sandstone alternating several times within a few centimetres of deposits.

These changes might very well be caused by a change of the digging position within the ancient riverbed. So far, we have been excavating in the deeper parts of the river channel, which explains the more or less uniformity and thickness of the individual layers. As we get closer to the edges of the river we get a lower energy regime, resulting in thinner layers (caused by a modest material transport and possibly resulting in a change of appearance as is the case in the last pulse).

Palynology & Dendrology

In the last few years palynology samples have been taken from and around the cryoturbation close to the excavation site, a further cryoturbation north of the site and some areas around the volcanic dyke.

Cryoturbations are periglacial structures that are associated with seasonal freezing and thawing of soils. They only occur within a certain temperature range of round the 0° Celsius mark. However, so far, a third cryoturbation whose location was roughly known could never be located exactly. This year we got lucky. The sand in the very area of this cryoturbation was low, and it seemed furthermore that a storm and/or a big wave had washed the debris off the cliff face revealing its treasure underneath. Now that the precise position of the site is known samples can finally be taken.

You might ask why this task has not been targeted so far. Although the sand was low at the site of this third permafrost feature, the rest of the area was buried. The problem with pollen samples is that they can only be taken in very fine-grained material such as mudstone and best from carbonaceous beds. The reason being that the grains of pollen and spores are so fine that they get washed away in any higher energy environment which is represented by, for example, the sandstones that we find at the site.

The area that needs to be sampled is along a quite large stretch of beach. Mudstones and siltstones, the bearers of pollen and spores are here interbedded by often very thick layers of sandstone that do not have to be sampled. In order to maintain a good overview of what has been and what still needs to be sampled it is best to have the entire area - or if that is not possible at least a large stretch of it - exposed, so that it can be certain that all samples necessary have been taken and that no doubling up has occurred.

It is going to be a time-consuming exercise and patience might be stretched but in the end it might hold a very interesting outcome. It might very well be that the species diversity and the amount of individual grains found within the sediments of samples taken around the cryoturbation is very different to the ones in the long reaches between the periglacial features. A result like this could then be interpreted as at least a slight change in climate with the cryoturbation sections representing the colder stretches and the areas in

between as the warmer ones. Furthermore, flora tolerant to colder climate could be identified as well.

Finding the third cryoturbation was not the only time we had luck, we also found one more fossilized tree trunk on the shore platform. It seems that the sand had shifted and exposed the fossil. Samples were taken with the help of Raúl and thin sections are being made of that to determine what kind of tree we are dealing with. This again shows that it is important to keep on going into the field in order to get more data and to continuously look for more clues, such as looking for the rings and structure of early and late wood.

Prospect for next year

Next field season the excavation area will be extended further towards the cliffs (at a safe distance, of course). As mentioned before, it seems we are getting closer to the edge of the river, where water energy diminished. Lower water energy means higher and better preservation potential for fossil material, as bones would have been less tumbled and therefore less damaged in the water and sediment mixture. This also means that possibly very small and fragile bones, such as the ones of our very tiny mammals, could have been preserved in this area. And if we are ever going to find any articulated skeletons this would be the best place to find them. As again lower energy environment would not have had the strength to rip carcasses apart.

Furthermore, it might be a good idea to actually excavate down to the lowest conglomerate. After a few trial seasons we had, in the last few years, decided against it. That layer seemed to produce fossils of mainly turtle and fish (the animals actually living in the river) but hardly any other remains. If the theory of being close to the edge of the river is correct, it is very likely that we'll find not only smaller material, but also a different assemblage fauna. The closer to the edge we get the more the deposits should be influenced by what happened and lived around the shores of the river. We could potentially find fauna that lived and fed along its edges. The reason why we do not find an abundance of other fauna in the lowermost pulse could, for example, very well be caused by the pulse that formed the deposit not being strong or big enough to actually go over the edges of the river and onto the flood plain, which means hardly any bone material of terrestrial fauna would have reached the channel. Alternatively, if the pulse was weak and only strong enough to reach over the edges of the river it would have, once it had done so, been too minute to actually flow back into the river let alone be strong enough to move any bone material. At this stage these are preliminary ideas and more work needs to be done to confirm or dispel them. To find out what really happened, however, we should try to do some more excavation within that first pulse.

As always at this stage, I have to thank everyone who has made my life of taking measurements and samples easier. Lesley, Mary, Nick, Norman, Cilla and Nicola of course, for halting the excavation process and doing my measurements for and with me and basically everyone else for collecting and keeping unusual items such as different coloured sediment particles and seed pods. You have done it again, you've kept me sane. Thanks for that.

Field Report

Katch Bacheller

Again, the necessity for a coordinator and right-hand person for the preparator and mining engineer was proven in Dinosaur Dreaming 2001. Though the returning volunteers clearly do not need coordination, new volunteers require orientation to the site and field house, and supervision in their first tenuous days breaking rock and identifying bone.

Additionally, this person act as the central coordinator between all parties and updates the information whiteboard as changes occur. Changes can occur every five minutes due to the capriciousness of the weather in Victoria. The opportunity to prove the importance of this position came, as there was no coordinator for the first two weeks of the dig. The coordinator clearly gave both Lesley Kool and Nick Van Klaveren the opportunity to focus on their expertise and not be continually badgered by minute details.

Opening the hole proceeded quickly as there was no need to install the lower tidal system because we were working higher on the tidal platform. The equipment needs were minimal and carry out restricted to shovels and rock. Strapping with Velcro straps again proved the most efficient and safe way to carry and transport nested shovels and flagpoles. The addition of six more WWII Swiss Army Ammunition packs was needed as three older back packs were retired after two years of arduous labour.

The volunteers were stellar. It was my privilege to again work with the many outstanding individuals who come together to support the effort of science in Australia.

The Future

Lesley Kool

This year marks the tenth anniversary of the discovery of the site near Inverloch. It was in May 1991 that a group of us were re-prospecting the coastline near The Caves when we came across the four metre wide exposure of fossiliferous rock, stretching from the intertidal zone up into the cliff. Within half an hour we had found more than 20 small bones exposed on the surface of the fossil layer and we quickly realised that we had found something special.

We did not realise how special this site was to become until years later and what makes it even more exciting is what is yet to be discovered. We have a tantalizing glimpse of a period in Australia's history that has no modern analogue with an amazingly high faunal diversity.

The discovery of the two mammal jaws during the 2001 field season, as well as the numerous small vertebrae and skull fragments, certainly suggests that we are excavating close to the edge of the original stream channel. Therefore, we will be acting on Doris' advise and continuing excavations where we left off at the end of the 2001 field season.

Nick van Klaveren has suggested a five-year plan for the site, which should see the removal of the most accessible part of the fossil layer. In the meantime, we will continue sampling the Ferguson site at Eagles Nest, as well as reaffirming our efforts to discover new fossil sites, particularly inland.

Acknowledgements

Once again we are very proud to be sponsored by the National Geographic Society, which has supported Pat and Tom's research for more than 20 years. In fact, in November 2000, Pat and Tom flew to Washington where The National Geographic Society presented them with an award in recognition of the many years of research they and the countless numbers of volunteers have performed in Australia. The Dinosaur Dreaming project has attracted a number of enthusiastic sponsors since we first began excavating in 1994 and we are grateful for every one of them.

We also thank the Australian Research Council (ARC) for their continued support of the preparation of the fossil bones once the field season is over and Qantas for support of the exhibition "Dinosaurs of Darkness", which highlights this research and generates more valuable funding.

It is always a pleasure to welcome overseas visitors to the site and this field season was no exception. Whether they are researchers, students or housewives (and househusbands), they all bring their cultural experiences with them that can be shared with the rest of the crew.

We again would like to sincerely thank all the volunteers, who give their time and enthusiasm, to make the dig such a success. We always manage to attract a diverse group of people from all ages and different backgrounds, yet with a common interest - a love of fossils and the sea air!

Dinosaur Dreaming 2001 - Field crew

Nicki Agron-Olshina
Marion Anderson
Katch Bacheller
Nicola Barton
Andrew Cheesman
Barry Clarke
Mike Cleeland
Roger Close
Peggy Cole
Maria Copello
Caroline Ennis
Susan Evans
Alan Evered
Nicole Evered
Katrina Fry
Priscilla Gaff
Norman Gardiner
James Gibbs
Dean Gilbert
Cindy Hann
Matthew Inglis
Lara Jakica
Sara Jakica
Robert King
Gerrit Kool
Lesley Kool
Anne Leorke
Rohan Long
Marlene McCarthy
Alanna Maguire
Makoto Manabe
David Marcollo
Dru Marsh
Ryoko Matsumoto
Helen Mitchell
Avi Olshina
James Rossetti
Dale Sanderson
Doris Seegets-Villiers
Danielle Shean
Natalie Schroeder
Rami Stigbec
Leah Schwartz
Elizabeth Thompson
Daniel Timblin
Raúl Vacca
Nick van Klaveren
Mary Walters
John Wilkins
Corrie Williams
Chris Wright
Dean Wright
Yoshitaka Yabumoto

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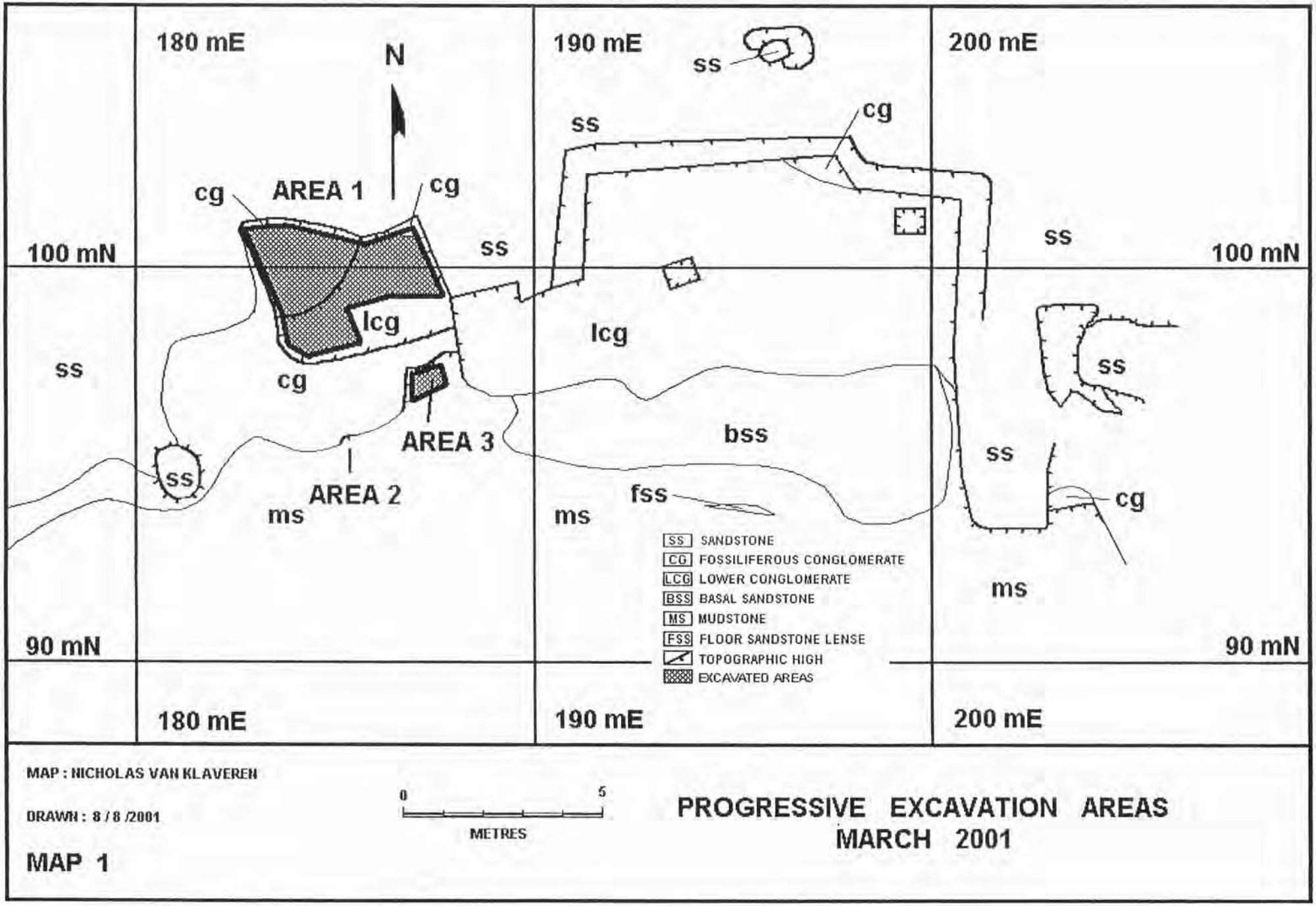
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AREA 2
AREA 3
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ms
SS SANDSTONE
CG FOSSILIFEROUS CONGLOMERATE
LCG LOWER CONGLOMERATE
BSS BASAL SANDSTONE
MS MUDSTONE
FSS FLOOR SANDSTONE LENSE
TOPOGRAPHIC HIGH
EXCAVATED AREAS
MAP : NICHOLAS VAN KLAVEREN
DRAWN : 8 / 8 /2001
MAP 1
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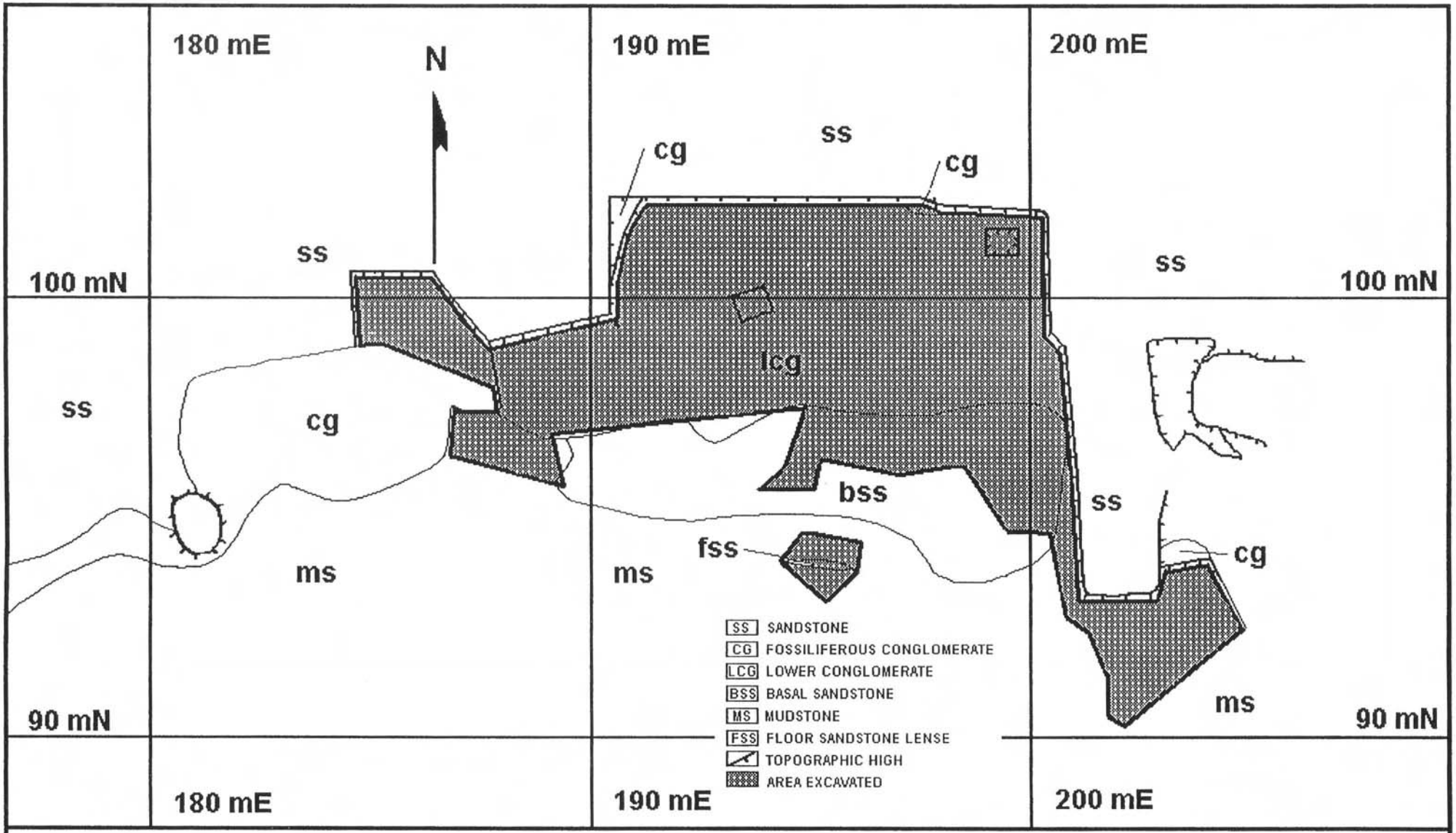
METRES
PROGRESSIVE EXCAVATION AREAS
MARCH 2001



MAP : NICHOLAS VAN KLAVEREN

DRAWN : 3/7/2000

MAP 2

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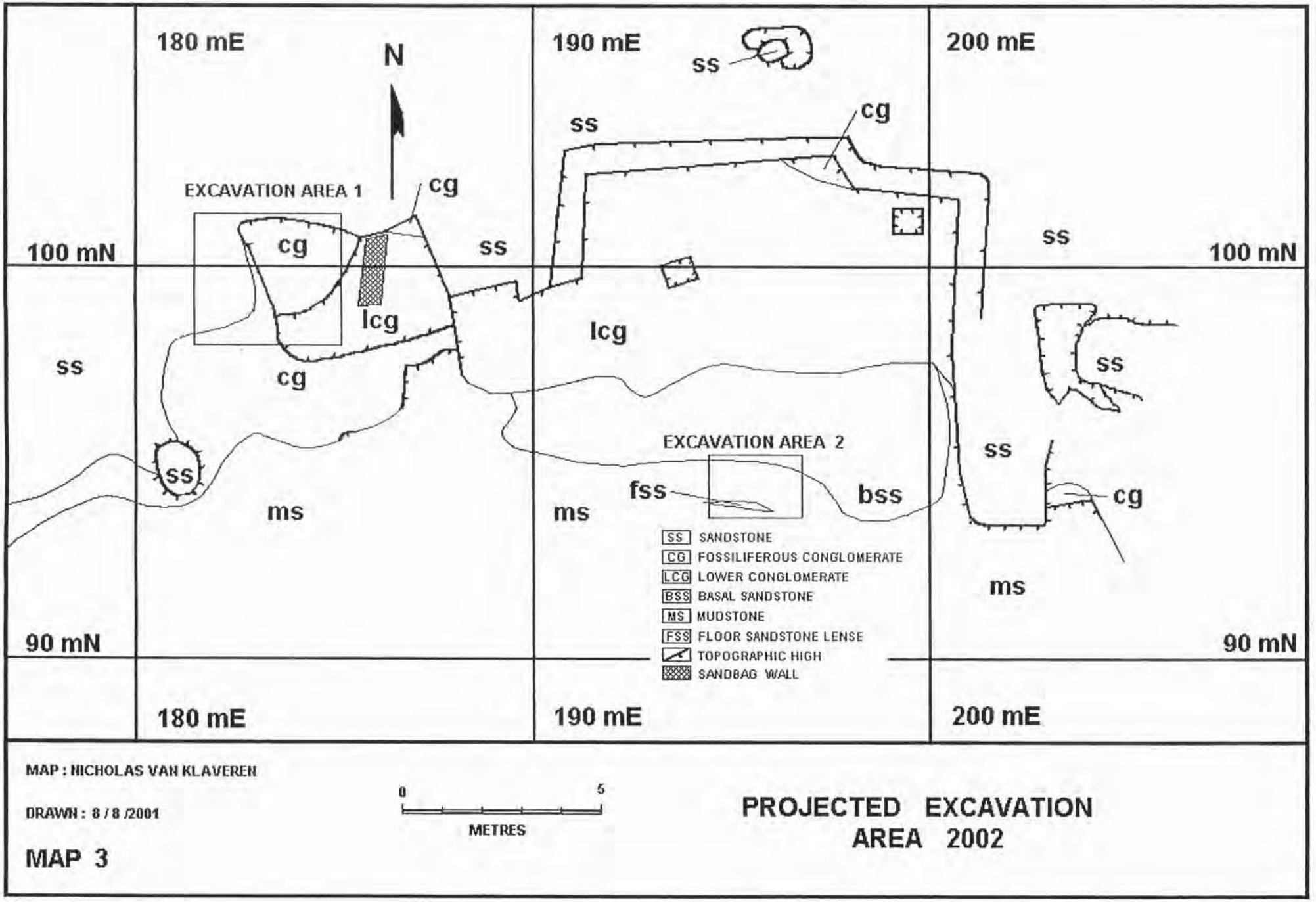
METRES

CUMULATIVE EXCAVATION AREAS
MARCH 2000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LCG LOWER CONGLOMERATE
BSS BASAL SANDSTONE
MS MUDSTONE
FSS FLOOR SANDSTONE LENSE
TOPOGRAPHIC HIGH
SANDBAG WALL
MAP : NICHOLAS VAN KLAVEREN
DRAWN : 8 / 8 /2001
MAP 3
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METRES
PROJECTED EXCAVATION
AREA 2002