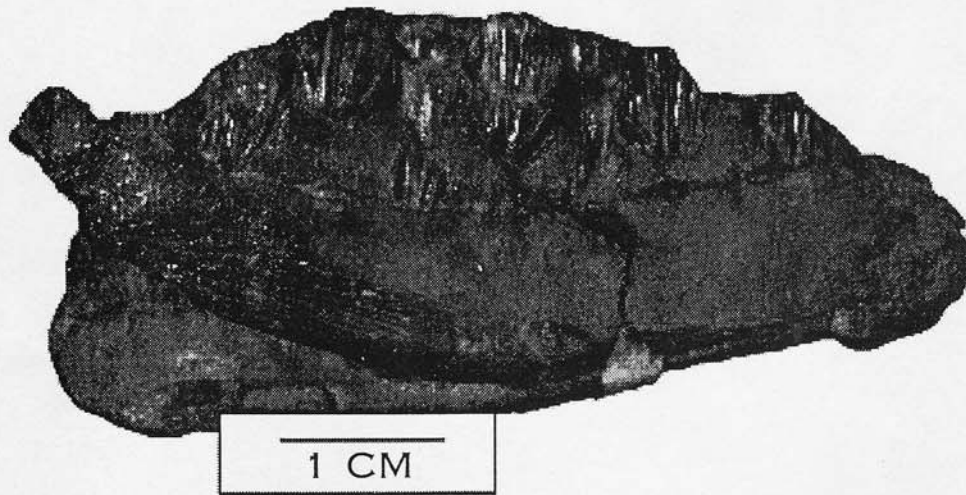


DINOSAUR DREAMING



ONE OF 15 HYPHILOPHODONTID
DENTARIES FOUND DURING
DINOSAUR DREAMING '96

1996

INVERLOCH SITE REPORT

FLAT ROCKS SITE EXCAVATION REPORT, 1996

SITE REPORT

Lesley Kool

Excavations at the Flat Rocks site near Inverloch, Victoria commenced on 5th February and ended on the 30th March; a duration of 8 weeks. The site is an ancient river channel, dated at approximately 120 million years old, exposed in cross-section on the shore platform. The river channel is represented by a series of interbedded conglomeratic sandstones, overlying the mudstone, deposited on a floodplain. This site was discovered in 1991 as part of a prospecting program whereby the Strzelecki coastline from San Remo to Inverloch, is systematically searched for exposed fossil bones. Although fossil bones have been found elsewhere along the coast, they have not been found in the concentration that occurs at the Flat Rocks site. This was the third field season at this site and most of the excavations involved Area 1 (see map 1), where work continued from where we left off in 1995. This area produced the largest and most complete hypsilophodontid dentary found so far, as well as a number of isolated hypsilophodontid and theropod teeth. Evidence of juvenile hypsilophodontids was discovered in the form of 3 tiny femora, one measuring only 44mms in length. Two small hypsilophodontid dentaries were also recovered. The presence of these juvenile elements implies that this area may have been a nesting area, at least for the hypsilophodontid dinosaurs, although no egg shell fragments have been found.

Area 2 (see Map 1) which during a previous test dig had only yielded a large fish jaw, produced at least 4 hypsilophodontid dentaries and some large limbs preserved in cross section. Most of the bones were found at the contact between the underlying sandstone unit and the conglomerate layer.

The third area excavated (Map 1) in some ways was probably the most significant as a number of bones were discovered in a previously barren overlying sandstone unit. The most exciting specimen found was the ungual from a theropod dinosaur, which has recently been identified as belonging to an ornithomimid dinosaur (R.Molnar pers. comm.). The significance of this bone lies in the fact that it is the first evidence of this group of dinosaurs from this site. This find also indicates that there could be more skeletal remains in this sandstone unit and strongly recommends continued excavation in this area. Also discovered in this unit was the largest skull fragment so far found at this site. After preparation the fragment was identified as part of the palate of a large teleost fish.

This field season was outstanding for the number of dinosaur dentaries that were recovered - 15 in total. They all appear to belong to the Hypsilophodontidae, although some of them have no teeth exposed and others only have one or two unerupted teeth showing. However, it does appear that there are at least two different species of hypsilophodontids represented in the jaw types. One species has a particularly robust dentary with a short tooth row. The second species is more gracile, with a straighter jaw line. The largest dentary (55mms in length) is the best preserved of any hypsilophodontid found in Australia. It has nearly all its erupted teeth preserved as well as 3 unerupted teeth exposed on the lingual surface. The smallest dentary (20mms in length) found this field season also has 5 beautifully preserved, erupted teeth and would have belonged to a juvenile. The addition of these dentaries to the collection, especially the ones containing teeth, will greatly add to the on-going research by Drs. Tom Rich and Pat Vickers-Rich on the diversity of these small cosmopolitan dinosaurs.

Apart from the dentaries, a number of isolated hypsilophodontid teeth were also recovered, as well as 15 small theropod teeth. The theropod teeth consist of crowns only, which suggests they were 'shed' while the dinosaurs were still alive. Most of the theropod teeth collected so far are approximately 1cm long, but there is one specimen which is 2cm long, and the smallest tooth is less than 0.5cm long. This variation suggests at least 3 individuals produced them, as the teeth in each individual dinosaur were all the same size. The largest tooth from this site is almost identical to one collected from Dinosaur Cove, which has been identified as a 'dromeosaurid' tooth.

A small number of possible theropod postcranial elements have been identified, including some phalanges, caudal vertebrae and a tibia. They are much rarer in the fossil assemblage but still give some indication that they lived and died in the vicinity.

A number of unidentified teeth were also discovered during the excavation period and only careful comparative study with other collections may reveal their identity. There are 4 small teeth, each approximately 1cm long (crown only), all bilaterally compressed, but not recurved or possessing serrations like the small theropod teeth.

Also found was a tiny tooth with large denticles which looks similar to the larger nodosaur teeth also from this site. However, it does not possess a cingulum, which is characteristic of the nodosaur teeth. According to Dr. Ralph Molnar it is possible that it may be a nodosaur premaxillary tooth. Unfortunately there are no premaxillary teeth preserved in the *Minmi* specimens, so we may have to compare it with nodosaurs in overseas collections.

Another plesiosaur tooth was recovered this year, which makes 3 in total from this site. No other material of this freshwater species has been identified from this site. A large rib that was discovered this season (45cm long) was originally believed to be plesiosaur, but when prepared, turned out likely to be ankylosaur/nodosaur - although Dr. Molnar does not rule out the possibility of it being stegosaur.

The hypsilophodontid dinosaurs were well represented as usual. This year the largest femur (16cm in length) from this site was discovered, as well as the smallest femur (4.4cm in length). Eight femora have been prepared so far from this season's collection. Some are badly abraded, indicating they may have travelled some distance before finally coming to rest. Palaeo-orientation on some of the larger limbs indicated they were either parallel to the palaeo-current or at right angles to it. Apart from the femora, other hypsilophodontid post-cranial elements included: tibia, a humerus, pubes, vertebrae, metatarsals, phalanges and unguals (claws).

The most common vertebrates recovered in this channel are the turtles, represented by shell fragments, girdle elements and limbs. This year, however, a number of possible turtle skull fragments were also recovered. This is very promising, as the skull is most diagnostic, and we are hopeful that we may be able to determine if the turtles from the Strzeleckis are the same species as *Otwayemys* from the Otways.

Being an ancient river channel, one would expect to find fish fossils in abundance. This is certainly the case, but so far no complete fish have been found. The most common elements recovered are fish jaws and scales. A number of fish species are represented at this site, but so far none have been identified. However, a number of well preserved lungfish tooth plates have been prepared, and all appear to represent the genus *Neoceratodus*.

This year, for the first time at this site, freshwater molluscs have been identified. One almost complete internal mould and another partial cast have been recognised, but further research is necessary before they can be identified, as very little work has been done on Australian Mesozoic freshwater mollusca.

EXCAVATION MANAGER'S REPORT

Nick Van Klaveren.

The Flat Rocks fossil locality was excavated for a period of two months from the start of February to the end of March 1996. The method of excavation was with large wedges driven into the underlying sandstone units. The method was further refined this year by producing a working face consisting of the Middle Sandstone and Upper Clay Gall Conglomerate units. This concentrated on the richest zone, consisting of the upper and lower contact of the Upper Clay Gall Conglomerate.

A program of overburden removal was commenced in the third week. This was between 192 metres East and 199 metres East and north of 100 metres North. Of the area uncovered, only about half was removed in the 1996 field season.

A number of areas at the site were excavated (see Map 1). The area at 186.50 metres East and 100 metres North produced a number of small bone fragments, but the volume processed was too small to represent a significant sample.

The area at 189 metres East and 99 metres North (Area 3 on map 1) was worked during the last week of the dig. The concentration of bones was lower in this area, but produced a number of interesting specimens, including a large skull fragment and a number of limb bones. Also of note were more than a dozen bones, including a theropod ungual and some well preserved limbs, in the Upper Sandstone Unit. Interestingly, most of these bones were found well within the Sandstone layer, up to 40 cm above the contact with the Upper Clay Gall Conglomerate. This differs from the rest of the site where most bones are found on the contact between the Clay Gall Conglomerate and the Sandstone Units.

The large area around 193 metres East and 99 metres North (Area 1 in Map 1) was excavated throughout the dig. The southern most part of this area consisted of Middle Sandstone and Middle Clay Gall Conglomerate. The number of bones found were few and poor in quality. The northern most half of this area, once the overburden was removed, produced many valuable specimens. A large number of limbs were found at 193 metres East and 99 metres North. Of particular note was a rib approximately 35cm long; a number of hypsilophodontid femora and up to twenty unidentified small limb shafts. Only half of this central northern area was excavated, and it is hoped that the remaining area will be removed during the next field season.

A small area at 201 metres East and 99 metres North was left at the end of the 1995 field season. Despite a number of large limbs previously found near this area, only turtle bone elements were recovered.

Area 2 at 201 metres East and 99 metres North was previously left untouched due to the thinness of the fossil layer and the lack of specimens found there during a small test dig in 1994. This year a number of large limbs and dinosaur jaws were found, even though specimens were much sparser than in other areas. An important piece of information was discovered in this area. A layer of sandstone underlying the fossil unit was undefined at its eastern edge. It was discovered that the sandstone (Basal Sandstone Unit) was lens shape and represents the earliest channel in the sedimentary sequence. Unlike the other fossil units, which were formed during flood events, the sandstone lens infilled an existing depression in the underlying flood-plain deposits. Because stream velocity was probably fairly low (only enough to move sand grains), any vertebrate remains would stay articulated. This supports the assumption that an animal had died in situ.

Map 2 includes a rose diagram indicating the cumulative orientation of the larger limbs found in situ this season. The majority of limbs trend NNW which is the estimated orientation of the channel's palaeocurrent (Andrew Constantine pers.comm.).

NEW PALAEO-CLIMATIC EVIDENCE

Andrew Constantine

Monash University Ph.D. student Andrew Constantine recently recognised some important sedimentary structures in the cross-section of the fossil layer exposed in the cliff. Approximately 2 metres below the conglomerate layers, in the underlying mudstone unit, he discovered large football sized mudclasts intruding into a fine grained sandstone unit. These mudclasts have been identified as permafrost cryoturbations which only form at temperatures between 0°C and -5°C. This physical evidence has been corroborated by oxygen isotope studies by Dr. Robert Gregory (Southern Methodist Univ., Dallas) on the concretions from the site which suggest a mean annual temperature of between -5°C and 8°C. This temperature range supports the suggestions by Drs. Tom Rich and Pat Vickers-Rich that at the time these rocks were being laid down, this area would have experienced polar winters with between 2-3 months of darkness and freezing conditions. It also poses a number of questions as to how the animals living during this period survived and thrived in this unique environment.

OTHER EXCITING FINDS IN THE AREA

Shortly before the 1996 field season commenced, a one-day excavation at the Flat Rocks site produced a large phalanx measuring 9.5cm in length. The significance of this particular bone lies in the fact that it came from a much larger dinosaur than had previously been discovered at this site. The phalanx was partly crushed, indicating that it was originally hollow and, therefore, from a theropod dinosaur. Ornithopod dinosaurs had solid phalanges. Another interesting feature was a circular depression close to the distal end of the bone, which is reminiscent of a tooth impression. The depression showed no evidence of healing, which suggests that perhaps the animal was bitten either just prior to death or by scavengers after death. The size and density of this bone is similar to that of larger elements from smaller dinosaurs and is a reflection of the original river's carrying capacity.

Andrew Ruffin, one of the volunteers from Dinosaur Dreaming 1996, and also one of our best prospectors, found a partially exposed bone on the shore platform approximately 1 kilometre north of the main site, which turned out to be the large dermal scute from an armoured dinosaur similar to a nodosaur or ankylosaur. A cast of the scute which is approximately 10cm wide was sent to Dr. Ralph Molnar for comparison with *Minmi* dermal scutes. He suggested it is practically identical to the *Minmi* dorsal pectoral or pelvic scutes. This isolated scute was found not far from where a nodosaur/ankylosaur rib was excavated some years ago and confirms that these small armoured dinosaurs were also living in this area along with the very successful hypsilophodontids and a variety of carnivorous dinosaurs.

Not satisfied with one outstanding find, Andrew then discovered a partial labyrinthodont skull exposed on the shore platform near San Remo. It was found approximately 500m from the large labyrinthodont jaws which were discovered by Mike Cleeland in 1991. This specimen measures approximately 45cm long and represents approximately one quarter of the original skull.

More than 1200 bones and teeth were removed and catalogued by the end of the 8 weeks Dinosaur Dreaming 1996 field season. Unfortunately, the preparation of the fossils is a much slower process. Approximately 100 bones and teeth from this site have been prepared since they were transported to Monash University, approximately 6 months ago. Preparation also continues on specimens collected from previous field seasons, both from the Flat Rocks site and from Dinosaur Cove which officially closed in 1993. An excellent example of how it can be a number of years before the importance of some specimens is discovered, was demonstrated earlier this year when a bone from Dinosaur Cove, collected in 1993, was prepared and appears to be a possible monotreme humerus. This is the first postcranial element of a Mesozoic monotreme so far discovered anywhere in the

world. Drs. Tom Rich and Pat Vickers-Rich are currently studying the specimen and hope to publish on it in the near future. The backlog of Victorian Mesozoic unprepared specimens now extends back to the early 1980's when prospecting of the Victorian coastline first began in earnest. It may take another 10 years of preparation before a more complete faunal list is completed, and that does not take into account future field seasons.

THE FUTURE - DINOSAUR DREAMING 1997

After the sandstone overburden from Area 1 was removed, only 50% of the fossil layer was excavated. The preferential removal of the Upper Clay Gall Conglomerate (the richest fossil layer) left the less fossiliferous Middle Clay Gall Conglomerate layer exposed over 50% of the entire excavated area. Although this middle unit has been less productive in previous seasons, its removal is necessary to achieve an accurate assessment of all the fossil layers.

The basal Sandstone layer encountered at Area 2 has yet to be fully sampled and, as previously noted, may have a good chance of yielding articulated vertebrate remains. Large areas of this unit have been exposed, but left untouched as it was thought to be barren. It is anticipated that during next year's field season we will 'plug and feather' this layer.

Area 3 also requires additional excavation to ascertain if the overlying sandstone unit, which produced bones this season, continues to any degree. The discovery of an ornithomimid ungual in this layer, along with 12 or so other small bones requires further investigation to determine if the bones represent an isolated depositional 'pocket' or a larger lens.

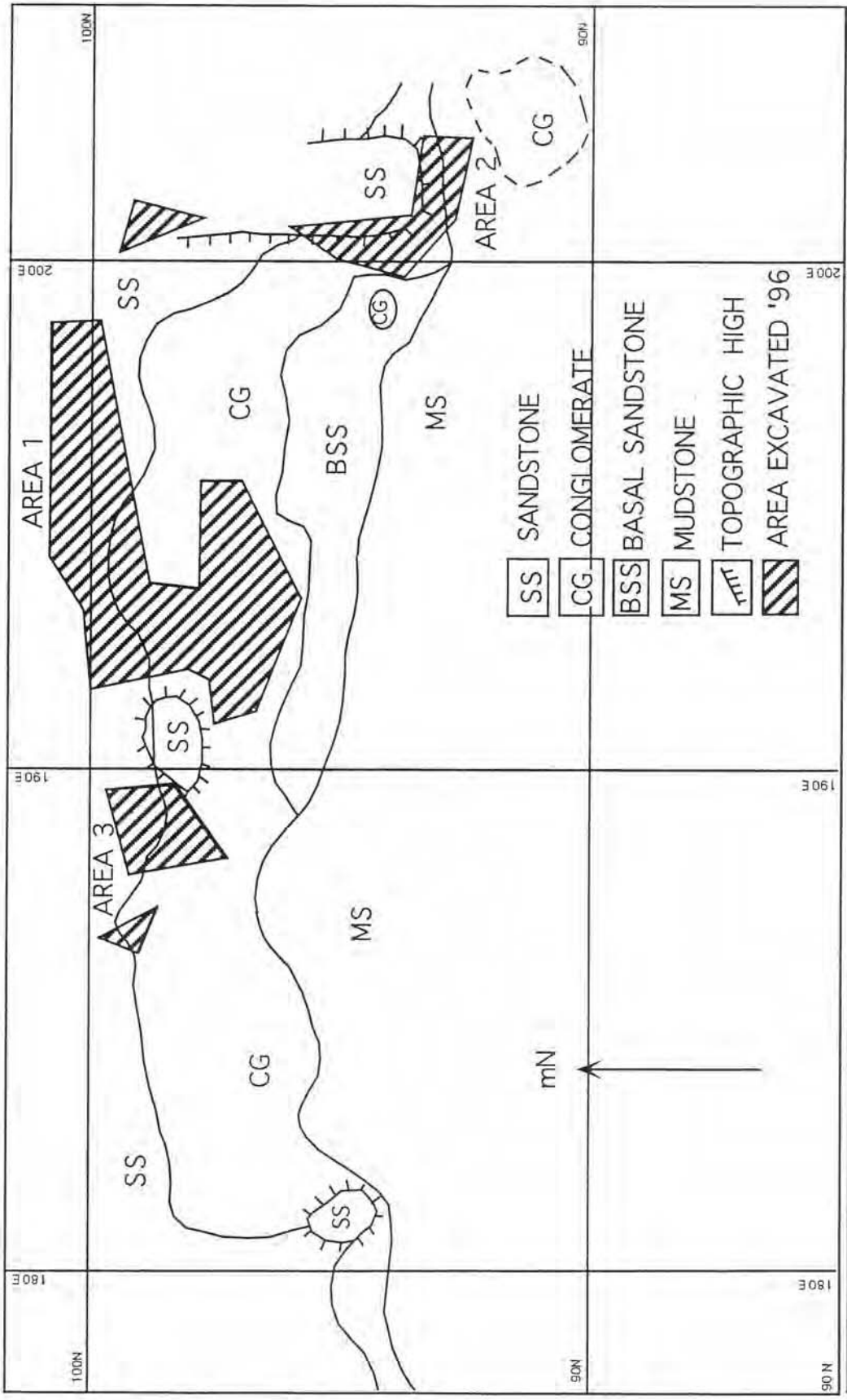
The exciting discoveries made by Andrew Ruffin underline the importance of continuous re-prospecting of the coastal platforms between San Remo and Inverloch. Constant erosion of the coastal areas will continue to reveal new specimens, which must be retrieved before they are lost forever.

ACKNOWLEDGEMENTS:

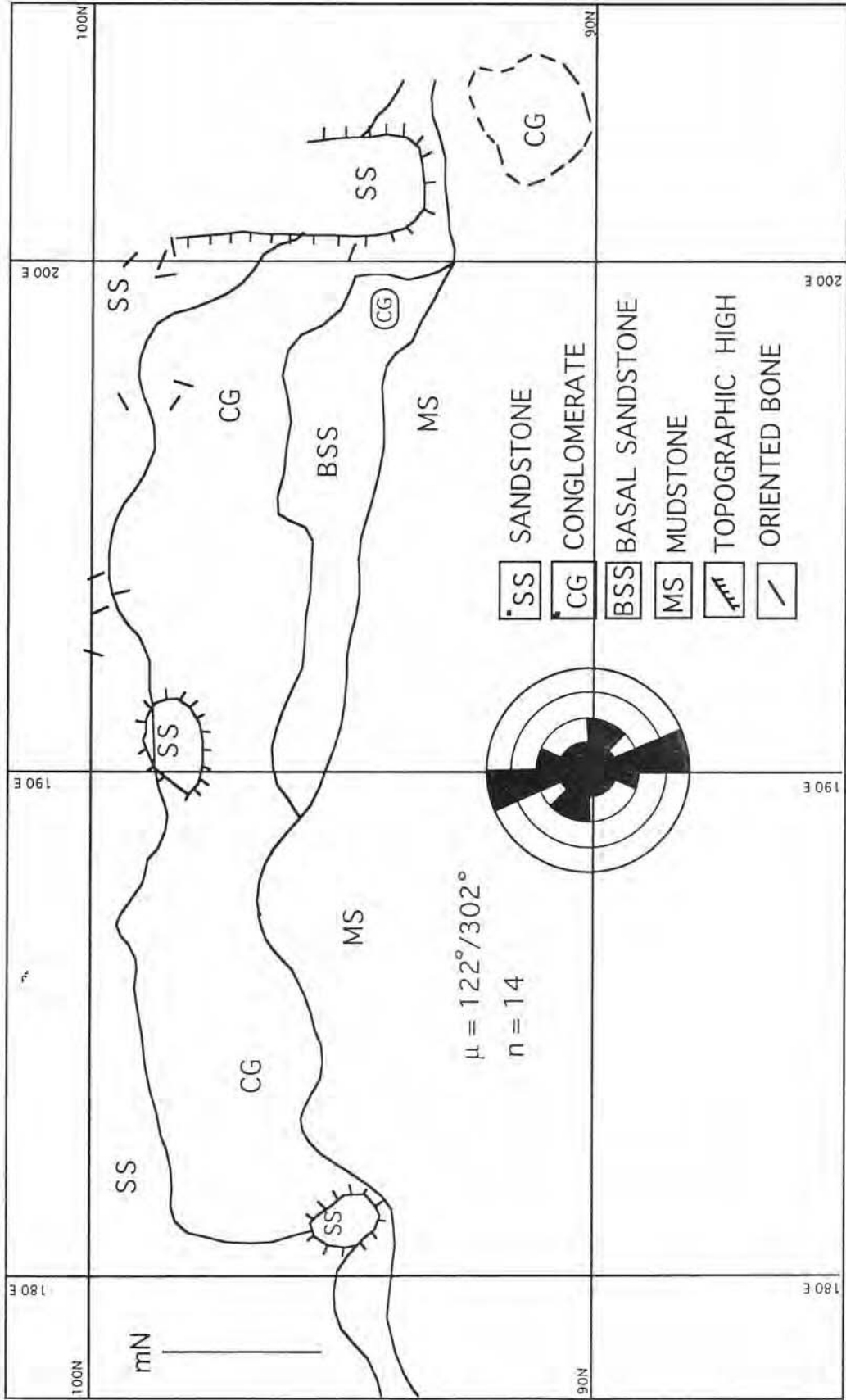
Many thanks must go to the dedicated volunteers of Dinosaur Dreaming 1996 who gave their time and enthusiasm in the retrieval of over 1200 bones and teeth. For some, this year's field trip was their first experience in fossil excavation; others brought their expertise from previous field trips like Dinosaur Cove. They came from different age groups and backgrounds, but all shared a common love of fossils.

DINOSAUR DREAMING 1996 CREW MEMBERS

Phil and Marion Anderson	Nina Herman	Natalie Schroeder
Nicola Barton	Walter Joyce	Leah Schwartz
Alby and Connie Brugman	Patricia Komarower	Doris Seegets
Mike Cleeland	Gerrit Kool	Cain Sidon
Andre Coffa	Anne Leorke	Lara Spina
Karina Craig	Mark Lockhart	Sue Spina
Caroline Ennis	Helen Mitchell	Dianne Tweedale
Nicole and Allan Evered	Larissa Morey	Johanna Van Klaveren
Dirk Fleischer	Toni Nacha	Nick Van Klaveren
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Christina Giatsios	Dave Pickering	Oliver Wings
Dean Gilbert	Trevor Powell	Corrie Williams
Scott Handsacker	Andrew Ruffin	
Cindy Hann	Rosie Rush	



Map 1
 PROGRESSIVE EXCAVATION AREAS
 FLAT ROCKS SITE, INVERLOCH 1996



Map 2
 CUMMULATIVE LIMB BONE ORIENTATIONS
 FLAT ROCKS SITE, INVERLOCH 1996

