Geological Notebook No. 42

West. Vict.

Edmund Gill

Photo: Alex Wilkins, professional photographer, of Warrnambool who accompanied me on my field trips. E.D.G.

Notebook 42

Western Victoria

Continued from Book 36

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Transgression Maxima

The highest line reached during a marine transgression is not always preserved because the sea erodes as it retreats. ~~Presentation~~ Evidence of transgression maxima may be preserved in coasts of minimal retrogradation rate i.e. very resistant lithology.

Thus at Pt. Fairy the fresh basalt preserved ancient beach deposits. The negligible wear since the Flandrian Transgression demonstrates the strength of this lithology to retain the impress of a higher sea level.

That an ancient shore is not preserved does not mean it did not exist. However,

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some shorelines can be expected to retain a record whereas others can be expected not to do so. It is a matter of ecology.

Australian Height Datum at Warrnambool

W'bool Council B.M. at

123 Wellington St.

14.34'

= 4.371m

Subtract 1.430

A.H.D. 2.941m

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Polygenetic Cliffs

Diagram: Schematic drawing showing polygenetic cliff and other shoreline features

Such at Port Campbell (Vict.) Worthington (Cumberland) and Aberarth (Wales).

Also cliffs with vegetated talus slopes e.g. Mollymook & Pebbly (S. Coast NSW) Crayfish Bay. Not an open-ocean aeolianite coast because recede too fast.

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Lunettes

1. Classification is descriptive based on new-moon outline but this is incidentally genetic bec. related to the shape of a curved lake shore.
2. Structure varies greatly according to grain size
    a. Clay dunes (L. Colongulac)
    b. Sand dunes (L. Colac)
    c. Alternating clay and sand (L. Mungo)

Clay dunes built up by material from seasonally dried lakes.

Sand dunes from beaches – otherwise a sandflat i.e. lake full.

Where alternate change in dynamics of supply stream or source.

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Dennington

Diagram: Calcreted duneline in relation to flat and River Merri.

Calcrete extends unchanged round the river frontage with steep slope, therefore the Merri must have been flowing past here at least since the calcrete began to form ~ 20,000 years ago.

Tower Hill Tuff lies in the present Merri channel (at Cassidy's Bridge for example) & also in Kelly's Swamp, a former channel. During the Last Glacial, the Merri

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apparently debouched at Tower Hill beach, then c.7300 yr B.P. the eruption blocked * the mouth of the river & the new course behind the first duneline from Kelly's Swamp to W'bool was established.

Lacustrine sediments on top of tuff at W end of Kelly's Swamp.

When tuff deposited, the channel extended below sealevel because

1. Sea lower? Yes.
2. Channel graded to lower sealevel. Yes.
3. Eustatic rise just occurred or occurring so channel not infilled. Yes as in Merri Estuary still.

*Later found this theory incorrect. River flowed round Dennington Spit till this route untenable, then SE to W'bool Bay.

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Hummocks Road N.W. of Yambuk

pp. 26-27

Diagram: Map showing Hummocks Rd with Quarry, river and aeolianite outcrop .Point marked 'X'

x A little NW of this at base of dune slope is a terra rossa with c 1' of gray uniform soil on top. Peaty flats round river.

These flats surrounding outcrop of dune rock shows regrading & infill. On car speedo measured river bridge to quarry as 0.3 mile.

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The quarry is on a crest & consists of shoreline deposits that are approx. horizontal i.e. no dune bedding. Essentially a calcarenite.

Diagram: Showing cross-section of layers exposed in the quarry.

Slabs can be from (a) cliff-fall, or from (b) a beach ridge such as is formed of tuff slabs in front of each of the 2 sand ridges at Tower Hill beach, i.e. (a) cliff present while (b) no cliff. cf. slabs E side Hopkins Est.

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Notes on layers

1. terra rossa 7.5 R 4/4 Darker at surface where organic matter. Pales towards calcarenite. Uneven base but merges. Pieces of rock angular with slightly rounded to well rounded edges. Probably excavated from low cliff, which then briefly abraded before emplacement. When in situ further rounded by solution. Some of the shapes could only be produced by solution because recessed. Lagurus ovatus on these marine sediments – Cu deficiency. Always so, but not the terrestrial beds of same age. Calcarenite

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is marine biogenic & so diff geochemical origin fr. terr. Beds. Some soil pipes up to 0.5m

2. The contrast between the loose sand & the calcrete blocks shows that only a small amount of eluvial/illuvial action has occurred. This can be inferred from the detail of the block surfaces. A large block examined had some small amt. of sand cemented on a flat surface but the sides of the block showed signs of removal of cement.
   White earthy carbonate from soil horizon occupies some cracks (joints?)
   Little compaction. Penetrometer readings of 0.2-3 kg/cm^2.

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Sand runs in places. Any consolidation appears due to very slight cementation. However, in some parts of the quarry, at the base of this bed, are some narrow horizontal zones that are relatively firmly cemented.

Sand consists of forams, pieces of bryozoa, molluscs & other marine organisms. Grade about medium sand. A little quartz.

Among the calcrete rocks horizontal pieces of solid remanie rhizomorph were seen, so the top of the eroded cliff (that produced the abundant calcrete blocks) had been a land surface. This inferred also by the presence of lumps of terra rossa lower in the profile

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pieces of bivalve seen but too earthy to collect, appear marine.

3. Merges into beds above & below. Characterized by absence of calcrete blocks. More compact, usually 3kg/cm^2. Firm appar. bec. more fines. Lower dynamics?
4. Grading from 3 to 4 but better defined than those above; the latter (4) characterized by marine shells. Same matrix & similar firmness 3.5kg/cm^2. Shell fragments & small strong gasteropods (often worn). Where exposed to weather, the shells are white but inside the matrix some have part anyway of their original colour. Finely bedded. Appreciable % of silt. Grades light yellowish brown (10YR 6/4) to dark grayish brown (4/2)

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due apparently to organic matter. Finer grain help up drainage & so protected shells. Largest shell fragment seen was 1cm diam. Shell bed cuts out at S.W. end of quarry.

Supratidal deposit

Dr. B.J. Smith (Nat. Mus. Vict.) reported Hydrobiidae Potomopyrgus. Fresh water streams just above tidal influence. The commonest shell “Wide salt tolerance fr. hypersaline to practically fresh.”

Planorbidae one planispiral shell “possibly referable to Gyraulus”

Cerithiidae “A frag. of what appears to be a creeper.” Very sheltered marine usu. on mud flat.

Naticidae some larger pieces suggest (only) sand-snails.

“The marine shells are fewer & broken while the Potomopyrgus are largely intact & in much better shape & are in the majority.”

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5. Fine calcarenite 0.23m, 10YR 7/4 very pale brown. Similar to 3 but darker on the whole, & has small (up to 1cm diam.) pieces of red silty fine sand from the horizon below = 6. Varies in firmness from 1.5-5kg/cm^2.

Further S.W. in the section this bed is marked by white patches which are masses (soft nodules) up to 10 cm diam. of carbonate.

6. A thin red (weak red 10R 4/4) band, 0.1m on the section line, catches the eye when the site is first seen. It consists of silty fine sand & is the most quartzose bed in the series & is a soil.

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The reason (along with the colour) appears to be that it is leached i.e. a soil horizon. It is lightened in colour in places by white carbonate, which is probably a later product derived from above. In the less impermeable parts of the shell bed, chalky shells occur i.e. leached.

The red bed is co-existensive with the shell bed. It extends to the SW end of the quarry = over 7 m of exposure. The thickness varies from 0-0.2m.

A mid gray bed of similar material often underlies the red bed & appears to be the reciprocal of it, i.e. the red is the oxidized phase of the gray. Some of the gray is cemented by the carbonate leached from

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Diagram: Showing layer of red over layer of grey bed.

above. The band is light gray (5Y 7/1) to gray (W5) with a little dark gray (W4). Part of the bed is cemented with some small white patches of carbonate. At SW end of quarry the gray bed is well developed for 4 m, with a max. thickness of 9 cm. Top soft & bottom hard due to carb. cement. Fossiliferous with pieces of bivalve & numerous small gasteropods like the shell bed above. Some small pieces of red bed included in this bed, so gentle erosion of the soil layer further landwards.

The bed 7A is the equivalent lithologically of bed 3 above i.e. calcarenite, sometimes silty, without calcrete slabs & with scraps of shell.

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7. Repeat of bed 1/2 above i.e. calcarenite sand with lumps of calcrete. Sand fine in places.
   Cemented rock sample is pale yellow 2.5Y 8/3.
   In SW of quarry below gray fossil bed is an oyster layer partly free but more often cemented.
   Pale yellow to light brown to grayish brown (2.5Y 5/2). Cemented layer an old watertable before the Eumerella R. incised the formation. Ostrea sinuata shows facies definitely marine.
   Sand full of forams pieces of marine molluscs, bryozoa etc.
   In this bed are lumps of terra rossa presumably eroded

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from the soil on the cliff. Rhizomorphs from shrubs or trees growing there. One patch 0.33m wide above the red bed but most below it. Appears that sea undermined cliff. so that calcrete & masses of terra rossa fell into sand without a great deal of abrasion.

Lagurus ovatus grows on surface & in the quarry in profession – mark of copper deficiency. Characteristic of this biogenic calcrete but not of the Pt. Campbell Limestone – Miocene marine earthy limestone. Can this be used as evidence of terrestrial origin of some of these sediments?

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Summary. Calcarenite series subhorizontal. Bed 2 to NE slight dip then steep dip to floor of quarry.

Diagram: Summary Cross-section of layers with interpretation

Diagram: Dip in terrain of terra rossa and underlying layers (due to karst?)

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N.W. of Yambuk

See pp 132-3

Map: Showing Swamp and house in relation to roads

After 200 milepost the aeolianite reaches the Princes Highway.

Fitzroy River Outlet

For map see Boutakoff 1963

463.6 (speedo) Princes H'wy

64.1 Crest of aeolianite ridge

Road bifurcates. Took E one first. Minor crest 64.4

Turns E 64.45 End at farm house 64.6

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65.05 Back at road bifurcation. Followed W. road

65.5 Dune line where road turns E.

66 Minor crest

66.4 Crest at junction with track

66.75 At Estuary. Did not follow to mouth. Holocene dune on seaward side of estuary. Holocene flat on landward side.

Appears suitable for auger hole succession.

69.0 Back at Princes H'wy.

71.3 Tyrendarra School

72.1 High crest at school

72.2 Quarry in ~~aeoleanite~~ calcarenite terra rossa

72.25 Cutting in minor crest

72.35 Highest crest (~70'?)

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Cf. pages 141-146

at entrance to "Avonlea"

72.35 Cross-bedding in road cutting, but mostly low dips to horiz – beach or shallow marine

72.5 Another crest in same complex.

72.75 Road turns to follow direction of "dune".

73.2 Road bifurcates in "swale" that to seaward turns c. S over "dune"

73.45 "Quamby Park" gate. Turned back.

73.55 Quarry in calcarenite ridge

73.7 Back at bifurcation.

Dune Sequence:

1. Holocene on present shoreline
2. Four Pleistocene dunes over c.2ml. & possibly remnant of 5th inland Telescoped series & not extended as in S. Aust.

Not dunes but downs eroded in shallow marine/beach complex.

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8/1/75

76.1m Highway again.

Between this branch road & last is Crowe's Hill 146 ft. in aeolianite.

Height suggests higher S.L.

Darlot's Cr. a trib. of Fitzroy R. passes thro' Tyrendarra village.

Narrawong 346km from Melb. On S side of H'wy & W of Surrey R. is calcarenite with Ninella torquato (operculum)

Subninella undulata

Tellina

?Katelysia

Pt. Fairy calcarenite

Camping ground behind low Holocene dune on extensive flat which appar. a mid-Holocene tidal flat. Bore to check stratigraphy.

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20.2.75

Sediment. conf. Melb

Ripples

Dr. J.F.A. Sleath of Engin Dept Univ. Cambridge

Evolution

1. Flat bed
2. Rolling grain ripples
   h/2 = < 0.06, and symmetrical. Different wavelength from
3. Vortex ripples
   Diagram: Ripples with current direction

a. Little exchange of sediment
   Diagram: ripples with erosion/sedimentation direction
   Vortex not strong enough to carry to next ripple
b. Considerable exchange
   Diagram: Ripples with sediment direction. 'Over like a fan'

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h/2 0.10~ 0.20 for (a)

4. Vortex mechanism breaks down n/2 tends to 0.
Sand flows over.
5. Folk (1976 in Sedimentology 23:649) says as energy increases longitudinal dunes developed.
1-4= "lower flow regime"
5 = "upper flow regime"
If so, can infer energy level & wind shear from type of dune.

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8.1.75

Hummocks Rd Quarry

N.W. of Yambuk

Photos 1-2 Book 43 p25 Otways

Photo 3 &4: Quarry face

For this section see pp. 7 ++. probably should be regarded as an unusual facies of the Port Fairy Calcarenite.

Photo 5: Close up of the bed with pieces of marine shell & numerous small Hydrobids

Photo 6: Close up of layers (labelled):

Breccia

Sandstone

Fossil bed

Sandstone

Red bed

Sandstone

Breccia

See pages 7 & 39

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Photo 7 At corner in quarry.

Photos 8 Unlabelled section of quarry wall

Photo 9 & 10: Oyster bed (cemented) at top of ruler.

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Weathering & Erosion

1. Where rocks have negligible abrasion like the Woodbine basalt at Cape Reamur the weathering factor is clear bec. the products of weathering are often not carried away.
2. Where shore platforms are cut in unoxidized rock, the abrasion must be due to abrasion chiefly & very little to weathering.
3. Australian terrains are on the whole deeply weathered. cf UK where most outcrops are still fresh. Due to (a) climate & (b) minimal tectonics in Aust.

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Sat. July 26th, 1975

Goose Lagoon Drain

Tides H.W 1:23am 0.7m

2:06pm 1.0m

L.W. 7:15am 0.2m

8:36pm 0.3m.

Tidal range – Springs 0.91m

The fossil site is where this drain flows through the duneline N. of the Princes Highway. Drain recently cleaned & water flowing fast. Much water in lagoon & on land S. of highway where water runs on way to sea.

Ninella torquata, some very large, are characteristic of this locality bec. it was an open coast high energy one. Char' ic operculum collected. Photos 11-13.

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Diagram: Showing layers from drain floor to top of L/IGl dune

Soil dark gray to black. Three rhizomorphs seen, up to 1 ½" diam. Fossil bed c 0.5 m extending to c 1 m when extended between rocks. The bed is thus a thin one & efforts to get suitable sample at top & bottom of the bed not successful. Fewer fossils & more sand in the higher

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part. Matrix a calcarenite ranging from off-white to limonite yellow. Lighter in colour & more leached at top. Yellow (sometimes reddish yellow) rising when close to basalt boulders.

Some pieces found with the shells & matrix cemented.

Further N the drain passes through basalt. It is here narrower & the walls vertical. No marine shells found in that part of the drain. This prob. above HWL.

Diagram: Showing cross section of basalt, shell bed and fine grey sand in drain

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26-7-75

Crossley Scarp

1. The presence of valleys in this scarp with bedded Tower Hill Tuff in their floors shows that the scarp is older than the eruption.
2. The presence of 300,000 yr old Woodbine Basalt in front of the scarp shows that it is older than the basalt.
3. The presence of marine sand & shells at the scarp shows that it has been a former seashore – as the sand continues when the basalt stops it is prob Sunnyside Sand (Pen/IG1) as met in many bores in that area. The scarp is therefore Pen/IGl or older.

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27-7-75

Hopkins River Mouth

Tides: HW 2am 0.7m

2:25pm 0.9m

LW 7.47am 0.2m

8:34pm 0.3m

River very full & after 10pm before the tide could overcome the river flow. “Reef” offshore ringed with ~~kelp~~ seaweed. This a large residual platform at about the level of present low platforms. Still in sight at 10.30am. Its level is about mean LWL, & may be compared with other such residuals. These were cut with the sea at about its present level. Some were stacks & islets which have been planated.

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The constantly breaking water on them & solution must reduce the level but this must be very slow.

On the S. side of the islet between the cliff & the river channel is an open ocean high energy deposit consisting of pebbles (of various kinds & colours of calcrete, mostly rounded but some angular), rounded fragments of shells (usually the strongest parts such as opercula & columellas) in a matrix of calcarenite cemented to varying degrees. The vertical height of the deposit varies

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to a maximum of 0.47m. The deposit dips E at 12^{o} but because of irregularity not easy to measure precisely (N.H. McNeill made it 15^{o}). The deposit is Interglacial as shown by the presence of Ninella. The fauna recognizable in the field in this deposit was:

Ninella torquata (incl. 4 opercula)

Subninella undulata (more numerous than above)

Dicathais orbita

Limpet

Chiton

Some facies as Pen. I/Gl further up the estuary! This one duneline further seaward (S).

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This beach deposit occupies a recess up to 0.45 m thick judging by the extent of the rounded pebbles in one place. Deposit at swash limit? Shells alone are thrown higher but such a conglomerate of poorly sorted pebbles & shell fragments belongs at the rear of the beach.

At W. end (nearest car park) the base of this deposit is 3.7m above sand level wh. is above LWL. Proper survey needed.

On the W. side of the small headland where car are parked, masses of similar conglomerate were found on the cliff

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and near the beach but non in situ. Could well be the same horizon.

The cemented estuary bar is unparalleled in this area – none in Merri R or Sandy Bay mouth of Hopkins R. Not at Moyne R. mouth or any of the Portland Bay debouchments. Connected apparently with the diversion of the Hopkins R. 7m beds extend far up the river, but 4 m debouchment is at Sandy Bay.

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Flagstaff Hill see Bk 48 p. 58

Pertobe Cutting Warrnambool see p. 156

On E. side of Ctg., works in progress to prepare the site for the construction of the maritime village.

Diagram: Showing Pertobe Road cutting and former cliff, dips and small valley before construction of maritime village.

Diagram: Showing cross-section of layers exposed in cliff above new pool.

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Hummocks Rd Section

see pp. 7-19, 26-27

One of the problems in measuring former sea levels is the difficulty in the field of defining the maximal transgression. The soil in the middle of this sedimentary cycle defines the limit of marine encroachment. The inland limit of the beds with marine shells now requires definition plus what can be learned of facies.

June 1976 Further oyster shells (complete) collected. At same level but near Princes H'way casts of pelecypods. Casts prob. bec. leaching under soil. Notospisula?

Diagram: Outline of shell cast.

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Australasian Sedimentologists Group mtg Melb. Feb. 1976

Tapped in – double sided page reading:

Abstract for Australasian Sedimentologists Group meeting, Monash, February 1976

Sedimentary Structures Associated with the Cainozoic Volcanoes of the Western District Plains of Victoria

E. B. Joyce

Department of Geology, University of Melbourne

Introduction

The Newer Volcanic province of southeastern Australia has about 400 eruption points which range in age from 4.5 m.y. to about 5,000 B.P. Many of the volcanoes are low shields or cones built up largely of successive thin basaltic lava flows, but the most obvious are the 140 or so cones constructed mostly of coarse lapilli, known locally as scoria. The other volcanic landforms of sedimentary interest are the low 'tuff rings' which surround wide maar craters, and some forty of these have been identified, mainly in the area between Colac and Warrnambool in the central part of Western Victoria. The tephra associated with the maar craters can sometimes be traced for up to 8 or 10 km to the east of individual craters. A recent account of the province is given in Joyce (1975).

Structures of the Scoria Cones

The eruption which built the scoria cones was of the Strombolian type, with regular, mildly-explosive activity building up poorly-bedded layers around the vent, to give cones which average about 90 m in height and outer slopes of 20^o to 30^o, accordant with the outward dip of the tephra. The scoria can be classified as coarse lapilli (lapilli covers the range 4-32mm) and blocks and bombs (over 32mm in diameter), and is characteristically rounded to elongate fragments with smooth glassy surfaces. The term 'achnelith' from the Greek achne = spray has been proposed for this material by Walker and Croasdale (1972). The interior of the scoria is highly vesicular.

Bombs cored with peridotite, or country rock such as granite, or basalt, may have ropy or breadcrust surfaces, and can range in size up to several metres across. Impact structures due to falling bombs or blocks are one of the main structures, and there may be graded bedding, occasional layers of ash, and interbedded thin lava flows. Some small cones were built up of more plastic tephra or 'spatter' and accumulations of this material may give rise to rootless flows which can travel short distances. The scoria cone material is often black, but can be red due to oxidation during eruption.

Structures of the Tuff Rings

The tuff rings appear to have been built up by more or less continuous but weak ejection of fine material of dust, ash and lapilli size, which formed an annular ring around the wide crater, generally highest on the eastern or downwind side, and with the finest tephra extending several kilometres downwind. Quarried sections of tuff rings, such as just north of Mt Leura at Camperdown, show the bedding is arched over, dipping at 5^o to 10^o into and away from the crater, and paralleling the inner and outer slope of the tuff ring.

The tephra includes varying proportions of essential glassy volcanic material (i.e. vitric tuff) and also fragments and dust derived from the underlying Tertiary sediments (lithic tuff). Individual beds can range from several millimetres to several metres in thickness, and the tephra can be found in various combinations of size grades, from wholly dust beds, to all coarse lapilli, with mixed beds of ash, fine lapilli and some dust also being common. The lithic lapilli is often well-rounded, and the vitric lapilli is generally in the form of equant clasts with surfaces formed by fracture, contrasting with the achneliths of the scoria cones. Sub-horizontal bedding, following the general slope of the tuff ring, is most common, and graded bedding and reversed grading can be found. Impact structures due to falling blocks can be found in most tuff rings at different levels, and scour and fill structures, and minor fault and slump structures are present but not common.

The most interesting of the sedimentary features are the accretionary lapilli, the blocks of country rock affected by the volcanic activity, and the cross-bedded units. The first of these have been found at Tower Hill, and a few other volcanoes, and consist of round lapilli 1 to 4 mm in diameter, made up of concentric layers of dust-sized particles and contained within dust-size beds, the material being largely comminuted Tertiary marl and limestone. Accretionary lapilli are believed to form by dust collecting around nuclei falling through a steam or rain-charged atmosphere during eruption.

The blocks of country rock average 2 to 8 cm in diameter and show rounding, pitting and cracking which can be explained by the effects of heat and abrasion on fragments moving to the surface within the vent. These features have been fully described elsewhere (Ollier and Joyce, 1974).

Cross-bedded units are developed in both fine and coarse beds, and show various sizes of climbing ripple lamination ranging from dunes with a wavelength of two to four metres and amplitude of 10 to 20 cm, to scale ripples in dust and ash-size beds with a wavelength of about 30 cm and an amplitude of 3 to 6 cm. Some of the small-scale features may be due to wind action but the larger features can be traced along the strike over some distance around the tuff ring, and show cross-bedding radially directed from the centre of the crater. At Mt. Leura the cross-bedding can be seen to climb up the inner slope of the tuff ring from the direction of the crater, pass across the crest, and continue down the outer slope. This type of dune cross-bedding has been ascribed to a volcanic 'base surge', an eruption feature first described by Moore (1967) and since observed during a number of volcanic eruptions.

Away from the crater, the grain size of the tephra decreases, cross-bedding becomes uncommon, and the tephra lies as mantle-bedding over the pre-existing landscape.

Other structures

Reworking of the volcanic tephra by other sedimentary processes is not widespread. In the maar craters which have lakes there are beaches of tuff and also deeper water lake deposits with interbedded tuff and lake marl. Tuff has also been reworked by streams, and ripple-marked tuff containing Coxiella shells is found at the southern edge of Lake Corangamite.

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Diagram: Showing Eruption with base surge.

Various structures on surface of blocks of limestone from volcano. Some with cracks or crusty. Some rounded & some not.

X-bedding of small (<0.5m) & large scales. Wave length & amplitude indic. direction of wind & prob. force.

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P.J.F. Coutts on

Mound People

Sites situated to permit optimal exploitation of available resources. 176 mounds mapped; 7 excavated. 2-20m diam. <100m^3. Tend to be circular in plan.

Byrne, Denis on Ararat Site Survey

Mounds are a phenomenon of the lowland flats. Sites related to water & food resources. Four clusters of sites – one related to George Cr. & the others to Lake Lonsdale. Largest cluster = Barton sites extending over 2km. Near creek. Not been cultivated. Show on aerial photos. Height now averages 32cms. Higher originally (before compaction)

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Australasian Sedimentologists Group Monash Univ., Feb. 1976.

Steven S. Allnutt

Bridgewater Caves area.

Stuck in diagram of lagoon with cross-section legend for the Nelson Bay formation.

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Stuck in diagrams of N-S and E-W cross sections shown on map on previous page.

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Bridgewater lakes not fault. Abandoned cliff. Lakes c.2m above S.L. Calcarenite 90-95% carbonate [Prob. this high bec., basalt reduces terrigenous element]. Only quartz. no lithic material. Rich in forams. Biocalcarenite. Bone bed of small marsupials with some terrestrial snails lacustrine shells in Bridgewater lakes found in lagoonal system in section.

At Hopkins Mouth sand bar absent in June '76 but common in summer. River power vs sea power. If river cannot push out, the sea piles up the sand.

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26-3-76

Hopkins Mouth

Also pp. 63-64

Diagram: Map of entrance showing River, beach, shore platform and stacks

Survey of L/IG1 Deposit

Back (to level of 0.3 tide 9:30am) 3m

For'd 1.945 1.55m

Back Ford to deposit – Base: 0.73

Top: 0.17m

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Including 0.3 tide

Base of deposit c3m above LWM

Top of deposit 3.6m above LWM

L/IG1 because Ninella present. cf. 4m level at Sandy Bay. Left as L/IG1 sea retreated to L/G1 low. See pp. 33-37

No Durvillea at mouth appar. bec. of freshwater from river.

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~~?Penultimate~~ Interglacial

Hopkins Estuary Deposits

See pp. 66-68, 62-63

Diagram: Showing bridge, original Lyndoch house, Sites 1-5 on East bank of river.

1. Molluscs from this site dated 400,000yr by U/Th. Deposit at beach level to

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~3m above. At base aggregations of boulders pebbles & shells.

Diagram: Showing Boulder shapes and dimensions.

Spaces filled with pebbles, quartz gravel up to 1cm max. diam., shells and shell fragments. All coarse poorly sorted & almost random orientation. Included boulders all horizontal except one which leaning up against another at c45^{o}

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Biota also estuarine is Eumareia fumigata found in Pertobe Coquina

Anadara trapezia all very worn & more often in fragments. Very thick. From estuarine or lagoonal facies whereas most of the shells high energy open ocean facies. Prob. recycled shells.

Subninella undulata Numerous opercula & pieces

Ninella torquata Two operculae not in situ.

Limpets 3 spp.

Littorina (Austrolittorina fasciata)

Dicathais orbita

Two gasteropods

~~“Mytilus~~” Brachidontes rostratus

and other bivalves.

Chiton

Loligo see p. 52

Above this is an horizon of shelly sand with cross-

Page 51

bedding. Pieces of non-shelly calcarenite with different bedding. The boulders measured were

0.71 x 0.19m

0.76 x 0.23

0.53 x 0.18

0.23 x 0.07

0.66 x 0.14

0.71 x 0.13

0.79 x 0.07

0.23 x 0.23 at 45^{o} resting against another.

This horizontal bedding with cross-bedding ~ 15m thick. Change in hillslope above this. Prob. remnant of 70 ft (21m) platform.

Further north in this section the big boulders cut out but pebbles are frequent. Shell sand common – shells occasional. This

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where squid guard collected some years ago (in NMV).

[as MML surrounded by Pleist rocks may have been stack or island.]

The beach debris gives the clue as to what is in the cliff bec. it is not carried far. Serpulids on shore rocks.

Outcrop at base of cliff with numerous joints & rounded rather than jagged limestone (i.e. weather differently). Earthly limestone. Fossils show is

2. Miocene – corals, bryozoa Lovenia? fragment serpula & numerous casts of shells (presumably aragonitic bec. all carbonates not leached).
   Smooth top to MML suggests old platform. Joints unusual in aeolianite but one large one at main site which visible for (20') 6 m up cliff & has some secondary carbonate.

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Site 3 of p. 48. Large area of boulders & pebbles with shells & shell fragments. Subninella operculae. Bed ~3m thick. Quartz grains up to 1cm diam. as at site 1. Bivalves present. Boulder bed poorly sorted & almost random orientation of materials. Even so, the boulders & pebbles are very well rounded. High energy open ocean facies.

Site 4. Cliff of finely bedded horizontal calcarenite with fine honeycomb. The strong cross-bedding of Site 1 not seen further North here – decline in energies probably. Some fine shell debris.

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Below this cliff is a bed with small bivalves – lagoon facies?

Interpretation

Holocene & L/IG1 have low energy estuarine facies. Penultimate I/G1 open ocean high energy beach facies with Ninella – Subninella and species of limpets. Sediments different – latter with boulders & pebbles, cross-bedding.

Presence of Anadara in bed ~400,000 yr. shows this migrant came to S. Aust earlier than previously thought. Check NZ entry.

Anadara this cycle or an earlier on? U/Th age. Probably different deposit same cycle.

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Tides

	Time			
March	HWL	Height	Time	H't
25TH	1:42	0.6m	-	-
26Fr	0:56	0.6	23:57	0.6m
27Sat	11:57	0.4	23:49	0.7
28Sun	11:53	0.5	24:00	0.7

	Time			
March	LWL	Ht.	Time	HT
25TH	9:54	0.2m	-	-
26Fr	9:57	0.3	-	-
27Sat	7:26	0.3	16:30	0.3m
28Sun	6:32	0.3	17:47	0.3

Tidal ranges

Springs Neaps

Warrnambool Port Fairy

25-6-76

N. of shell bed, a block of calcarenite was noted with ripples in it.

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27-3-76

E. of Cape Reamur

Volume of Holocene Calcarenite

Woodbine basalt substrate. Beach of shells & shell grit. Sand size blown up into dune. prevailing winds S.W. Dune lowers to W. between Horseshoe Bay & Cape Reamur. Then larger calcarenite dunes come in that are blown from the W side of the cape, but these include sand from long-shore drift.

Diagram: Showing Traverse 1 from peg on dune top on W. side of Horseshoe Bay to the ~750yr terrace (south)

Page 57-58

Table Showing survey data for traverse 1

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East of traverse 1 the dune about 3-4m higher but this seems to be a post-European entry effect.

Traverse 2 28-3-76

Cross-section of dune c2/3 way from Horseshoe Bay to Cape Reamur. The two traverses are 390m apart.

Traverse 2 is near end of swale behind dune-line i.e. where effect of dune building from W side of Cape Reamur comes in.

The zone between traverses 1 & 2 definitely a Holocene construction from the adjacent beach & platform. Net construction after all the Holocene oscillations.

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Table: Showing survey data for traverse 2

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28-3-76

2.40pm

Extension of traverse 1 to MSL

Level at approximate edge of shell grit among boulders (Datum boulder at seaward edge of shell grit beach) Salicornia growing on shell grit among boulders. A few small patches seaward of level.

Table of survey data:

Back	F'D	RL	Notes
0.65m			Datum boulder of traverse 1 34m p. 57
	2.6-	1.95	45.5 to top of Galeolaria zone = MSL basalt extends another c10m

Between level & sea are 2 zones

1. Boulders with lichens & occas shell grit & Salicornia between
2. Gray eroded in situ basalt.

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Hopkins Estuary

See pp. 66-68, 46-53

Photos 1-2: Point Ritchie. Stacks on east side of River Hopkins channel. 1. Ordinary lens; 2-4 Telephoto

Photos 3-4: Remnants of platform at base of nip as platforms cut to just above MLW survey this level. Nips on landward side of aeolianite stacks.

Photos 5-6: Lenticle of open rocky coast high energy environment at Pt. Ritchie on W. side of channel & immediately above it.

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Photos 7-8: Lenticle with Plastic pen for scale. Note (a) pebbles of calcrete (b) Gravel of quartz (mostly clear) up to 1cm. diameter.

Photos 9-10: detail of lenticel

(c) Calcarenite (d) Shells mostly fragmented and worn. Ninella, Subninella, Dicathais, limpets, chiton etc.

Photos 11-12: Entrance to Horseshoe Bay E. of Cape Reamur.

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Cape Reamur

Photos 13-14: “750 yr” terrace, marker fence. Top of dune on W side of Horseshoe Bay looking seaward (13) & to Cape Reamur (14)

Photos 15-16: Site of Traverse 2 (p. 59) 15-16 Beach between Horseshoe Bay & Cape looking W. (15) Slope of dune 12^{o}, varies to 22^{o}.

Photos 17-18: A piece of 5 ply (1m^2) on beach was lifted & crabs scampered away. Their tunnels shown in this photo.

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Cape Reamur

19-22: Beach between Horseshoe Bay & Cape Reamur

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Hopkins Estuary

See pp. 62, 48

Photos 1-3 Boundary Rd, Aireys Inlet

Photos 4-7 Mt. Eliza

Photos 8-9: Ord. lens. Cliff on E side of river N. of bridge fr. W. end of bridge. 8. Bridge over Hopkins River Estuary Road Ctg in dist. = Denington Sand =L/IG1 which overlies W’bool aeolianite (Pen. I/Gl) fence 60m ridge.

Photos 10-11: (a) Pt. Campbell (Miocene) L’st.

(b) L/IGl estuarine dep. N-S along estuary.

(c) Cliff = Sunnyside Sand (Pen. I/Gl) appar. merging up into W’bool Aeolianite. Covered by L/IGl Dennington Sand.

Photos 12: Repeat of 8 with telephoto lens.

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Telephoto shots 13-22:

Photos 13-14: Cliffs of horizontal Dennington Sand with some areas of cross-bedding

Photos 15-16: Pen. I/Gl fossils open rocky coast facies ~400,000 yr B.P. Shallow marine Pen. I/G1 over remnant of Miocene Mar. l'st. Coarse calcarenite & shell frag, & pebbles.

Photo 17: L/IGl beds, estuarine, fossiliferrous

Photo 18: Boundaries yet to be mapped. Rise to 6m+ above river level.

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Photos: 19-22: Tele. views from W. end of bridge towards the sea at different angles.

Note mobile dune on E side of mouth. On W side is L/IGl aeolianite, cemented by sea splash.

1. Calcarenite with small shell fragments in Sunnyside sand cf. below Warrnambool Aeolianite at Steeres Quarry on Princes H'way W'bool.
2. Gravel & shells cf. cliff section Guano Cave.

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Pebble beds are at various levels. One may compare "PCA 25 ft. Stand of the sea on Hawaii" Stearns Bull. geol. Soc. Am.

86: 1279-1280

MSL + 7.5m >400,000 yr. B.P.

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At Anzaas Hobart May 1976

Weathering

Don Currey SRWSC Vic

In massive rocks whether igneous, sedimentary or metamorphic can see a structural control in weather, but this diffic. to see in bedded rocks. Weathering pattern influenced strongly by joints, wh, allow preferential access of water & oxygen. tight bedding planes but joints open.

Diagram: Showing weathering along fault between hornfels and sedimentary rock.

Comment. Ponded water not give this weathering – must escape somewhere. Hornfels "gate valve" keep rocks wet or damp for a longer time.

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Tarago River area. In OB time.

Diagrams: Showing a layer of Older Basalt in fluvial sediments in original state and then after weathering

Diagrams: showing preferential weathering along basalt/sedimentary rock contacts in the Eppilock and Rossinn areas

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In granite hard outcrops & soil between. Trees follow the joints.

Diagram: Showing deep weathering areas of granite capped with basalt

When cleaning up a dam site by removing weathered bedrock, always finish in joints.

Diagram: Showing two joints

Tarago dam in Silurian bedrock and older basalt.

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at Dartmouth (100 ft. 30m) of weathered rocks. It is quite common to have 20m of weathering.

Discussion

1. Saline waters more aggressive than fresh. Nature & quant. of dissolv. salts.
2. Distinguish weathering processes from the resultant surviving weathering products (result of million of years of the processes; which vary with climate etc).
3. Mid-plate Australia has minimal tectonics so not the amt. of uplift to get the regolith stripped off. Tertiary soils common.
4. However (Currey) more common overseas that is

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generally realized. e. g. in England & Brittany deep kaolinization.

5. EDG Dipole moment of water basic to weathering therefore the amount of water, its temp (= level of chem. activity) & its salinity (= dissolved salts) are fundamental to the degree & kind of weathering. Thus in Vict. & N. Tas.
   Mid-Tert. climate to kaolinite (copious warm waters)
   Late Tert./Quat. clim to montmorillonite (less copious temperate waters)
   6.

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Ken Sharpe

Snowy Mts > 50% granite. Different granites weather to different depths.

Diagram: Showing a joint in fresh granite.

Joints provide preferential access of weathered solutions. In the Snowy Mts the chief factor is age of the land surface.

Diagram: Showing up to 1000ft of weathered material on granite.

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Geehi Dam Downstream on E side a site had to be abandoned because of the instability of the slope (valley wall). 40,000 tons fell into the river after a wet period, ponding the river temporarily.

Took a tunnel through as a continuing feature across the valley taking advantage of a knoll in the bottom of the valley which protected against slides.

Diagram: Cross section showing old river gravels, present river and tunnel

150 ft. complete weathering.

300 ft. variable weathering.

Murray 2 Developed head and brought

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tunnel out on any part of the escarpment. Found cheapest to have short penstock & place power house in 250 ft cut in weathered granite. After planned, the actual excavation revealed a place where the power-house could be set on fresh granite. Contract already let, but arranged to shift site a few hundred feet.

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ANZAAS 11-5-76 John Head ANU

C14

Widely disseminated charcoal (windblown so a mixture?) gave dates too young in spite of strong chemical treatment. In one series, treatment concentrated the containment. Divided sample into various constituents to see if consistent.

Diagram: Showing Mungo skeleton, charcoal & carbonate in earth with various carbon dates .

Only 1-2% contaminant (if modern) can spoil old sample. Collagen built up in long chains with 18 amino acids. Proline differs from fish to mammal & so any also acc. to whether terrestrial or aqueous. Agreement between 3 fractions suggests date correct but not necessarily so. Different

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bacteria destroy amino acids in diff ways. Preferential removal of amino acids & sometimes new ones introduced. No technique viable for all bones, but all for some. If understand amino acid spectrum can date & smaller samples needed.

Reservoir effect in sea. Deep water older. Where upwells biota have different C14 age

Diagram: Showing waves and CO_2 being transformed from air to sea & shell

After emplacement shell can exchange carbonate ions, so etch off surface. Also exchange in recrystallization. In doing so may include younger or

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older ions. Diff. isotopic fractionations betw. E & S coasts of Aust. atom bomb effect – different mixing times for E Aust. current & S. Ocean.

Joints & Off Loading

Diagram: Showing valley with joints.

Budel, Cotton & others have discussed whether a valley is there bec. a joint system provides a zone of weakness followed down by weathering or whether the formation of the valley generates the joints by off-loading. Don Currey said surficial joint as at A crosses from one bed-rock joint (1) to another (2) so releasing a slab of rock.

Diagram: Valley dip labelled A with joints 1 & 2

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at Bellfield dam such a block c30' x 10' x 15' but usually smaller. These a function of offloading. Such reach down to 14' depth only in his experience. Only the bedrock joints go deeper.

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Canberra AIAS May 1976

Lancefield

Richard Wright

No bones articulated. No pieces together or nearby of same skull. Artefacts found with bones. Evidence of resorting of bones. Unerupted took caps a few cms above bone bed. Light weight with much surface & so can be moved by low energy water. Pond spp pollen in bone bed.

Diagram: Cross-section of soil layers showing a disconformity.

Original matrix of bone bed washed away & so = lag deposit.

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C14 Bones

SUA- (1) Acid insol. fraction 12,550yr

(2) Apatite 16,070

Geochron (1) 8,775

(2) 19,800

Different methods used. Black clay sediments <2,000

Dates prob. minimal.

Fauna in channel smaller spp than in bone bed – wallabies etc. However, M. titan also present. Charcoal from channel. 26,600 yr. Teeth marks attributed to Thylacoleo carnifex.

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David Horton

Diagram: Graph showing hyperbolic curves 1(solid line), 2 & 3(dotted lines either side of 1) between No. of individuals (Y axis) & No. of species (X axis)

1. Usual – many bores of some species, and less of others.
2. Simpler fauna – fewer spp. lower numbers.
3. More complex fauna that usual. Greater range of species.

Man & carnivore both take animals selectively. Also men take both marine & terrestrial (if the opportunity present) while animal take terrestrial only.

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Climatic changes alter habitats & so the spp. present. Another approach is to compare the normal distribution of age in a living population with the number of various ages in a fossil population.

(1) Age in life (2) Age in death

Diagram: Graph Ashowing curves 1 & 2 against number of individuals (Y axis) and age (X axis) for a randomn popn sample

Diagram: Showing U-shaped curve (graph B) for selective killing

Diagram: Showing inverted U-shaped curve (graph C) for catastrophe

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B type graph where selection of young and old – the easiest to take.

C type where catastrophe wipes out a population at a particular time.

E.D.G. 1. What cause original ponding at Lancefield?

2. What broke it so that channel developed? And how established again?

3. What keep pH up so bones not destroyed? Rich. Wright said highest bones chemically attacked & this regarded as reason. A quantitive assessment is needed to see if this adequate explanation. Much acidity caused by decomposing veget. matter. No snail shells seen.

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Post-mortem sorting can also alter the position.

Lancefield not a normal population or a catastrophe. Altho' sex proportions usually 1:1, at L. low % males.

Bogging results in whole skeleton, largely articulated, if no subsequent disturbance, same applies to other nat. death (i.e. not involving action by other animals or people.)

Disarticulated skeletons a matter of degrd. Small bones more easily washed away (diff. bones have diff. hydro-dynamic qualities) & more easily destroyed – physically & chemically. Also certain bones more apt to receive special attention, eg:

(a) Fibula for bone tools such as awls & muduks.
(b) Heavy bone ends for engravers.
(c) Bones opened for marrow

Broken bones accidental or purposive – by people, animals or other. Wear on broken bones – human or other. How deposited? Kinds, number, spacing orientation. What missing & how lost? At L. sorting before channel formed.

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AIAS Canberra May 1976 Harry Lourandos

Abos W. Victoria

Hunters & gatherers used

1. year round resources of coast & permanent waters
2. seasonal resources – eels in rivers (autumn) & whales on coast (winter).

Stone, clay & brush traps to catch fat eels on way from inland breeding grounds to the sea. Temporary camps at Lake Colac, Salt Cr. (wh. flows from it) etc.

Brough Smyth records eeling. Long trenches connect swamps. Robinson gives details in his diary. Trenches

1. Connect swamps so eels caught as pass through
2. Connect to swamps beyond natural limit to increase

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Diagram: Map Showing swamps A, B, C and and trench across a low divide.

Diagram: Showing section with two pairs of swamps (a, B and C,D) either side of a divide

Water not run through but damp line along wh. eels could migrate.

Diagram: Showing a cross-section of the trench in sand (aquifer) & clay (aquiclude)

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EDG:

Drain or trench still traceable by depression bec. rain readily soaked up in sand therefore little erosion. Local trad. is that these were eel traps.

Thus Abos. controlled & extended the eel resource at a time of year when food short. (Autumn).

Mt. William & Tulondo (spelling?) systems are at limit of eel distribution. Robinson describes group of huts (13 in one place) used by eelers. Base camp assoc. with focal areas of lakes & swamps – year-round resources. But not occupied all the time. Abo conventions (in literal sense) when gathered for food collection – tribal exchange & trading: could be 800-1000 people

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Traps across existing creeks to catch eels, so trenches over divide also for management Tulondo trench hundreds of yards long. To dig prob. take 50 people c30 days working a 10 hour day = 15,000 man-hours. Once dug, easy to maintain.

At Lake Bolac, sections of the shore appear to have belonged to various groups. Apparently the value of the work invested in the fishing industry respected.

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Igneous History

Diagram: Extends over pages 93-94 showing Victoria with NB on the west of Melbourne and OB on the east.

1983 Borings of recent years finding OB under NB in W. Vict.

East-west lines through Melbourne and below Otways/Wilsons Prom. define a L. Cretaceous Rift Valley

2km thick sediments

Lacustrine & swamp facies

Flatland ecology

No Volcanics

Marine transgression in Up. Cret.

Tasman Basin formed 80-60 my due to seafloor spreading from a NW tending mid-ocean ridge. NZ + Norfolk Is ridge drifted E.

Igneous activity in E. Aust. began c70 m.y. ago. While Taman Basin forming & N. Z. migrating.

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Igneous activity thro' this period

Eastern Highlands epeirogenically uplifted in belt 3000 x 300km.

Vulcanism much later than stabilization of Palaeozoic/early Mesozoic Geosyncline = Orogenic zone To E. granites younger.

V. high gravity anomalies assoc. with E. Highlands.

Vulc. provinces last <6 m.y. range 2-4000 km^3 in volume

intrusive calc. ~ x 2 extrusives prod. ~ 300km^3/m.y.

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Probably vulcanism only in areas of tension & that such restricted to rel'ly narrow band parallel to axis of E. Highlands.

Other areas in compression? Shown by (a) reverse faulting (b) Reverse & transcurrent fault-plane solutions obtained fr. the analysis of earthquakes.

Oldest anomaly betw. Aust & Antarctica c55m.y. Separation since then at variable rates. Average 5.6 cm/yr over the past 50 m.y.

Tasmantid guyots on oceanic crust along 156^{o}E. Summits drop S to N "fr. sinking of seafloor bec. of cooling of lithosphere as bec. older"

Vulcanism be. Aust. Plate moved across magma sources (plumes?) Mes. (Jur.) & Cainozoic vulcanism added

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~20,000km^3 extrusives

40,000 km^3 intrusives

= an average thickness ~70m. "Thus in the S'em part of the E. Highlands the addition to the crustal thickness has been ~ ½% from these two periods of igneous activity.

Wellman, P., & McDougall, I., 1974. "Cainozoic igneous activity in Eastern Aust." Tectonophysics 23:49-65

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Sea-Cut Quaternary Platforms

Warrnambool/Port Fairy region stable so platforms = sea levels.

Diagram: Showing details of sea level structure above and below present sealevel from present back to deposition of Sunnyside Calcarenite

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Tower Hill Beach

Diagram: Showing sand Ridges 1, 2 & 3 inland from the present beach with two soil layers (2800yr and 4-5000yr)

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Albert Park Q.

June 1976

Diagram: Showing cross-section of quarry wall with dips.

Top too recrystallized to be Warrnambool Aeolianite has broken shell in it like the Sunnyside Sand at Steere's Q. & E side of the Hopkins Estuary. There is ~300,000 yrs between the L/IG1 and the Pen/IG1. If same to next oldest then top formation of Albert Park Q may be antepenultimate Interglacial & the lower firmer the one older again ~ 1 m.y. old. If two dune lines eroded from Russell's Cr. Flat then these could be ~1.3 my & 1.6 my old.

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June 1976

Goose Lagoon Drain

Diagram: Cross-section showing fine grey sand, overlying shell bed, resting on basalt

Shell bed a wedge (measure) against basalt ridge. This level means sea in lagoon also, so this ridge like those in shallow water now, but rising above it.

1. Open coast rocky facies. Basalt boulders also evidence of this.
2. But bed horizontal with shell bed changing to grey sand (examine under microscope, measure extent & that of shell wedge).

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3. Many whole shells & mostly unworn altho' much shell fragments as well. Thus some shelter on this shore affording by ridges & tumuli.
4. Measure compaction & bed thickness lost by soil formation. Resultant level that of L/IG1 sand flat – probably inter-tidal. Shells washed shoreward as now.

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Portland Dyke

"At Portland, an igneous rock, possibly a sill or dyke, was intersected at a depth of 5,585 feet" (=c.1690m) Because of the great thickness of crust penetrated by a dyke its volume must be considerable. It may be inferred that large numbers of dykes lie beneath the cover of the W. Victorian basaltic plain cf. dyke at Gellibrand, reported to be dolerite. Top probably kaolinized in mid-Tertiary then eroded off because of strong erosion on the horst:

Quotation from McQueen, A.F., APEA JI 1961 pp. 25-29 (Quote p.25).

Con'd from p. 101

Portland Dyke K/Ar dating 17.1 my = early Miocene.

Lamprophyre, fine & coarse phases. Kenley in Otway Basin volume gives depth as 5638 ft.

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29/7/76

Bannockburn

Road cutting on W. side of town E side of Bruce's Creek, & S side of road. Ctg ~4m shows reddish-brown etc subhorizontal riverine deposits of clay (a small part still unoxidized – mid-grey) silt and sand. Accumulations of carbonate in soil profile.

Basaltic plain begins further west. E. of Teesadale strong reddish yellow soil in spoil heaps of "dams". At Teesdale mid-grey alluvium forms clear terrace on Native Hut Creek. No basalt immed. W. of Teesdale. E side of Shelford high ctg.

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29/7/76

Basalt comes in again on W. side of Shelford (in valley of Leigh River). Marine rocks outcrop in valley.

Further W. fine-grained sediments on top of basalt – loess?

Sow's Hill (577 ft.) with trig is a low cone, apparently volcanic.

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30/7/76

See p. 172

Horseshoe Bay

Shell Bed

See Book 36 p. 106

Diagram: Cross section of depression filled with basalt boulders, sand and capped with calcarenite labelled 1, 2, 3 & 4

1. In situ basalt.
2. Large basalt boulders
3. Shell bed turned to calcrete. Some small basalt boulders. Shells mostly gasteropods of rock facies. Shallow marine high energy?
4. Pitted (calcrete) calcarenite without shells but with some small basalt boulders. Browner in colour. Probably beach.

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Ninella torquata found today in situ in bed 3 for the first time. This bed of "beachrock" or a shallow water marine bed where shallow sea over rocks. Little bedding. Shells at many angles, i.e. orientation approaching random.

Ninella means Last Interglacial. This fits the high degree of calcification.

Probably a deposit left behind as the sea retreated. If so, < 110,000 yr. (which age of 4m level).

Being actively attacked still both chemically & physically.

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31-7-76

Warrnambool Woollen Mill

Diagram: Showing composition of ground around the Woollen Mill

Age. L/IG1 (or older) because of terra rossa.

Road. Highest 3m horizontal calcrete. Below that a variety of structures but all dips low.

Parking Area. Section rises east. Structure as on road. then typical aeolian dip.

E. Cliff. Highest & capped with terra rossa and calcrete & rhizomorphs.

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This rock intermediate in lithification between Warrnambool Aeolianite (Pen I/G1) and Dennington sand as on blank of Merri R. swale (tip) near Thunder Point. On present knowledge, the stratigraphy appears to be as follows.

Diagram: Map showing inland distribution of Interglacial and Holocene units from coast across Merri Canal and Merri River

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Perhaps when 70ft SL was cutting the City of Warrnambool (oldest L/IG1) this rock was deposited (debris from older duneline). If so this member older & therefore more lithified. Trimmed flat by 45' sea & dissected as sea retreated.

Diagram: N –S section showing two facies (Warrnambool and Nicholson Aeolianites) and their characteristics.

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Sunnyside Calc. Transgressive (mostly marine)

Warrnambool Aeolianite. Regressive (mostly stranded dunes)

Diagram: Map of Wellington Street/Crammond Street recreation reserve showing Aeolian cliffs

Diagram: Showing cross-section of Nicholson Aeolianite cliff below Merri Crescent.

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Diagram: Showing terra rossa & tuff on Younger Street near the Merri River cutting.

At West end of Golf Club there is a remnant of the Merri River.

Diagram: Map showing Scott St, small hilltop, City store yard, railway line and McMeekin Rd

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See p. 120

Hilltop Section 2m light yellowish brown (10YR 6/4) calcarenite. Bedding horizontal on top, but lower part with cross-bedding having dips up to 5° & involving only small stratigraphic thicknesses.

Sand coarse with numerous shell fragments up to 7 mm diam.

Photos 10-11 p. 120

Diagram: Showing cross-section of hill with palaeosol

Shoreline deposits then soil then shoreline again means SL oscillation

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On SW side of hilltop is small scale karst – a hole 2m deep & 0.3-0.5m wide with surface slightly cemented with secondary carbonate. Thickest rhizomorph seen in area 7 cm diam.

Diagram: Showing section of3.5m cutting in Sunnyside Calcarenite at store yard (see p. 111)

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Diagram: At North end of store yard section (pp111, 113) showing calcarenites 1 & 2 and a rhizomorph in infill.

1. Vertical cut hard probably medium sand
2. Sloping angle of rest soft Aeolian. Dennington Sand/Calcarenite. Coarser more variable & with shell fragments

Photos 1, 12: Rhizomorph as shows in section above

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31-7-76

Daltons Rd, W'Bool

At top of hill in D's Road about half way between Bloomfield St and Ardlie St, rock outcrops that is beach/ shallow marine rock as seen at hilltop section W. of Scott St (p. 112), SE of Scott St (pp. 113-114), ctg in Harris St near Woollen Mill & the section on the E. side of the Hopkins R. estuary. Elevation   m.

Cutting on N. side of road shows 2m to terra rossa with hard rhizomorphs & carbonate veins. On the W. side of Ardlie St. just S. of Bloomfield St is a storm water drain in process of installation.

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that shows deep terra rossa. Same soil on both sides of Caramut Rd. N. of Fairfax Ave (also S.). On E is playing field & on W. the Technical School. Further N, on N slope of hill is ?W'bool aeolianite but no terra rossa. At Coglan's Road more thick terra rossa.

Diagram: Map showing Merri River with Russells Cr winding through various roads. See Book 48 p. 23

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Hopetoun Rd, W'bool

Double ctg on hill N. of Princes H'wy. Diagram. Both formations give vertical cuts.

Diagram: Showing Formations 1 & 2 as exposed in the cutting.

Formation 1: Darker, red soil pipes, with layers of dense calcrete, N dip, Aeolian, very hard. Albert Park Formation (really a group at present).

Formation 2: Lighter, no soil pipes, no dense calcrete, sub-horizontal to small N dip, beach/marine, softer. Sunnyside Sand probably

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31-7-76

Bacon Factory Section

Diagram: Map showing Williams St, dune, former bacon factory and house

See 6:111 Near old Bacon Factory excavation for well. Pebbles & sand at 14' and Haliotis at 16'. Exhibit in Museum cemented pebbles, sand & Haliotis so older than L/IG1

Diagram: Showing dune with remnant terra rossa to one side.

Calcarenite coarse & variable Horizontal & sub-hor., darker sand blow (saltation) terrestrial facies seen in Albert Park Quarry and elsewhere.

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1/9/76

Strong S. gale & very heavy seas. Spray flying over Thunder Pt. W'bool groyne & so on. Waves overran bar at Hopkins R. estuary. Waves at Hopkins R. mouth 4 per min = 1 every 15 secs.

Hopkins Estuary. Behind WDAC boat shed, cliff 2.3m of strong calcarenite with dense calcrete layers part of Sunnyside Sand on other sill of estuary?? Depositional & erosional terraces along estuary. L/IG1 & P/G1.

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See pp. 111-114 31/7/76

Scott St, W'bool

[1-4 Otways]

Photo 5: Horizontal to subhor. sands – dune blowout facies as on Portland Prom. poorly sorted & with pieces of shell up to 7mm diam. Palaeosol indicating oscillation of S.L.

Photo 6: Horizontal & X-bedding = dune blowout facies. Terrestrial facies (soil). Beach/shallow marine facies.

Photo 7: Large blocks of calcarenite left after area bulldozed for industrial sites.

Photo 8: Coarse sediments in one of

No photo 9.

Photos 10-11: Coarse shelly sediments of NW cnr of in situ calcarenite

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[Eclipse Day] 23/10/76

Warrnambool Racecourse

See p. 129

Diagram: Showing cutting, hillside and quarry.

The quarry floor appears to be approx the border betw. two formations (or members) the lower one being darker. The bedding in the lower one could not be determined in the time available but the upper one is clearly aeolian. The wall at the SE end shows a change in dip from 47^o to 58^o – an

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oversteepening of leeward bedding.

Diagram: Showing Quarry wall two differing dip regions, one with holes filled with terra rossa & rubble.

Dip is roughly E (towards course). The N. wall of the quarry shows no change in dip but there is a break with secondary carbonate accompanying a sharp change of dip in the S. wall. Prob due to collapse over karst. Two holes filled with terra rossa & rubble probably lead to a cave below into which collapse may have

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occurred. In the middle of the back wall of the quarry is a soil pipe 0.7m wide filled with breccia of all size up to about 0.25m (p. 121).

Caves are found in Pen. IG1 and older formations.

Section on pp. 121-2

Diagram: Map showing are surrounded by Moore & Cramer Sts & racecourse fence and the composition of Aeolian cliffs exposed there.

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Shell fragments up to 2.5mm diam.

Diagram: Map showing Kelly Swamp Fitzroy Road, Harrington Road and WalshRoad and various roadside cuttings in area.

Here & other Merrivale roads & along Merri Cutting in that area are outcrops of soft calcarenite with calcrete cover = Dennington sand. The canal meets "Pen. I/Gl" in vicinity of Woollen Mill. Thus a L/IGl embayment at Dennington as there was a Holocene embayment there in mid-Hol. Both stillwater marine facies so

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protected, presumably by a sand barrier. Dune line at Dennington = the inner barrier of N.S.W.

South Warrnambool road cuttings N. end Harris St at top of hill = Warrnambool Aeolianite 33^o dip c. E. Shell fragments in sand up to 2.5mm – one 5mm. Thin shell so could easily be blown. Small diam. rhizomorphs up to 1 cm diam. See Bk 48, pp. 56-57.

Thunder Point where once tried for building stone E side of trig. Horizontal beds at SL (Pt. Fairy Calc with boundary merging to) with gray (= short-lived) paleosol between PFC & low angle aeolian beds above. One

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slab with footprints.

Fitzroy Rd, Industrial Site

Diagram: Cross-section showing soil pipe between brown soil & tuff and L/IGl Calcarenite

Diagram: Cross section of two soil pipes

Bedding could not be made out in the small exposures so could not observe whether horizontal or aeolian dip. In view of height expect aeolian.

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Moulden's Quarry Dennington

24/10/76

Diagram: Cross Section from Dennington to the coast showing geological features including a L/IGl platform (1) and post Gl platform (2)

1. Platform is roughly at top of Pt. Fairy Calcarenite & so apparently a product of differential erosion. L/IGl
2. Platform is cut in Pt. Fairy Calcarenite by P/Gl sea.
   In between & c2 the L/Gl river channel cut below SL.
   When sea returned easy access along channel & platform cut. Because open water enough energy to cut platform.

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Later energy reduced by filling of channel & deposition of Kelly's Swamp & growth of coastal sand bodies. So change from marine waters that cut platform (2) as shown by fossil shells & freshwater of present river/swamp.

From Moulden Quarry N.M. collected Subninella undulata operculum

Chiton

Bivalve prob. sandy facies

i.e. open ocean rock facies

open ocean sand facies

as on the present coast.

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Warrnambool Photos

Racecourse

(photos 1-8 Otways)

Photo 9: Warrnambool racecourse quarry – see section p121

Photo 10: View from Trig. Station E. over Thunder Pt.

Photo 11: Thunder Pt – Tower Hill tuff over Dennington Sand. Collapse of cliff foll. marine undercutting.

Photo 12: Thunder Pt. where quarry in aeolianite for a time. Note horizontal Pt. Fairy Calcarenite.

Photos 13: unlabelled

Photos 14: unlabelled

Diagram: Showing Dip inland of Dennington sand overlying horizontally bedded sands.

Horizontal dune base (so near level of sea) sediments – transgressive as sea advanced. As sea retreated this formation was dissected then regressive (stranded dune) deposition or former blowout?

The result

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is that along this section of shore alternate shallow water marine (Pt. Fairy Calcarenite)and Dennington aeolian sediments outcrop at present sea level. Former merges up into sand-flat deposits because footprints of giant birds in it.

Photos 15-16: Horizontal Pt. Fairy Calc. below Thunder Point.

Photos 17-18: View E. from near Trig.

Photos 19: unlabelled

Photos 20-22: Tower Hill from NE

Diagram: Map showing photo site on crater rim.

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Cape Reamur – E. Side

Photo 1: Tower Hill.

Photo 2: Rhizomorph like concretions out-cropping in the beach.

Photos 3-4: Calcrete block mined from cliff and over-turned. Terra rossa underneath. 4-10 Rhizomorphs in Port Fairy Calcarenite.

Photos 5-10:

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NW of Yambuk

28/11/76

Diagram: Map showing location of 3m roadcut and swamp on Princes Highway west of Port Fairy.

Weathered calcarenite with nodules & irregular concretions of carbonate. Last Interglacial has a well-defined & continuous calcrete cover. This older cutting due to ridge set obliquely across highway. Deep zone of weathering indicates Pen. I/Gl or older.

Vertical facies around swampy area secondarily hardened with carbonate as on coast cf. at Goose Lagoon. If these vertical faces are relict cliffs then there may be

Diagram: Map showing possible Relict cliff next to Princes Highway.

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be shore platforms below them. If so, these good indicators in calcarenite of sea level.

Site c.1.5km SE of "Montana" and M315km post, and c4.2km SE of turnoff to "Bessibelle 16km" near the 198 milepost. See p. 20.

Boutakoff's map shows Tertiary limestone with flint inland of the highway area.

Nov. 29-30 Field Conference

Univ Melbourne Cliff Mallett & students

Vic. Mines Dept. Peter Kenley, Guy Holdgate

S.A. Mines Dept. Jon Firman

Flinders Univ. Doug Schwebel

and self. Based on Portland

29th Coastal sections. Whalers Bluff, Cape nelson, Nelson Bay, Cape Duquesne, Bridgewater lakes

30th Drik Drik, Dartmoor & the Glenelg River sections.

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Nelson Bay

W. of Portland

Mon 29/11/76

Horizontal flaggy limestones with limited stratigraphical thicknesses of foreset beds & cross-bedding. I think they are a pre-L/IGl shallow marine/beach series in embayment. Basalts act as aquiclude or aquitard. Intercalated clay beds non-marine & a junction of sea level oscillation. Beach to 2m bones (red) found at intervals. On this visit Vombaus tooth, piece if proximal end of shaft of femur of large kangaroo (?Procoptodon), tooth of carnivore (?Thylacinus) in fragment of ramus, & a couple of other pieces. Interpreted as advancing sea incorporating bone deposit. Matrix calcarenite & hence preservation. Clay bed appar. F.W. & represents an oscillation.

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Cape Nelson

29/11/76

Diagram: Cross section of cliff showing a wedge of later deposit in side of cliff of ?Sunnyside sand.

(Wedge:)

1. Cemented so L/IGl or older
2. Differs in colour, degree of cementation & internal structures (i.e. facies) from the cliff rock.
3. Boundary sharp.
4. Cliff of shallow marine facies but wedge of coarse high-energy, storm-beach materials – a conglomerate
5. ~10m above sea, so prob remnant of storm beach deposit of L/IGl. Fossils. Survey, measure pebbles, collect fossils, define facies.

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Jones Ridge Quarry

31/11/76

Beside Glenelg R SE of Dartmoor & NW of Portland. Globorotalia truncatulinoides present. Bridgewater Group present here found still further inland. Coquinas capped with aeolianite up against the Bridgwater/Drik Drik scarp. Basalt below 2.2 m.y. Basalt boulders up to 18" diameter – only such or part of a flow? Shells as casts & moulds due prob. to wetting & drying as a result of differential groundwater release. Water between this & Miocene.

Upton's Quarry (=CRB Quarry)

On W. side of Glenelg R. Par. of Wilkin. Furthest limit of Miocene transgression (Glenelg Group). Further inland are lower Tertiary rocks (Wangerrip Group). Pecten zone

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at top of section. Clay bed with Corbicula high in section = marine oscillation. Massive slipping in this area. Large crack in quarry.

Portland Bay 1/12/76

Diagram: Map showing Princes Highway and Hollis Road, cutting and beach ridges on Hollis Rd.

Intersection 3.7km W. of Surrey R. at Narrawong. Cutting c.100m S of H'way. Calcarenite with reddish brown terra rossa. 1.3 km E. of Hollis Rd on S side of H'way yellowish brick house with large

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excavation on NE side, with vertical walls so presumably lithified calcarenite (only viewed from road) therefore older than L/IGl. Dark brown soil.

Diagram: SCross-section showing swale between ridge 2 & 1 – Princes Highway on (2) a house on (1)

Narrawong

1/12/76

Diagram: Map showing cuttings 1 and 2 near Surrey River and on Princes H'wy.

Large cutting (1) E of Surrey R. in firm calcarenite mobile in places = Dennington Sand. Small cutting (2) similar

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sand with marine shells including Ninella torquata (operculum) therefore L/IGl marine= Port Fairy Calcarenite. Brown to gray soils on L/IGl dune. Due to winnowing of original soil then formation of a younger one, as at Moulden's Q, Dennington. At Narrawong, the beach ridge (nearer Portland) has grown into a dune gradually. So no absolute difference between a ridge & a dune; an arbitrary height difference. The 7.5m limit for a ridge proposed in Point Lonsdale paper still appears sound. As go E in Portland Bay leave shelter of Portland peninsular & increased energy to pile up biogenic sands; at same time terrigenous sand volume

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reduced by young basaltic terrain generated by lava flows (which yield no quartz sand) & the sand traps built by flows & tuff deposits.

E. of the Surrey R. a creek (no name on map) from Mt. Clay crosses the highway between "Walook" & "The Cottage" (see Portland Map). Roadcuts in both sides of creek. The NE cut examined is in calcarenite which mobile in places & rhizomorphs = L/IGl. Traces of terra rossa soil & rubble at surface indicates erosion. Later soil reddish brown to dark gray. Cf. rubble at Moulden's Q & many other places. Much Lagura ovatus.

4.6km E. of Surrey R.

1/12/76

where the Princes H'wy leaves the coast at the 213 milepost

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Appar. to avoid Fitzroy R. estuary confluence with Darlot Cr., & associated swamps, Tyrendarra basalt flow & plateau crossed by T. School Rd.) there is a high cutting because the road crosses a dune ridge. Debris used to fill swale. Steep slopes but grassed = Dennington Sand. Across swale is lower ridge with house on it.

Mt Clay Rd 81.2 km

Fitzroy R. 82

Darlot Cr. 82.5

T. School Rd 86.2

Tyrendarra School Rd

1/12/76

cf pp. 21-22

3.7km E. of Darlot Cr. (208 milepost is just E of this road) road runs S from H'wy.

At 1.1km (87.3) 0.2km N. of school is a very small roadcut or quarry which shows 0.5m terra rossa. On 1m calcrete rubble still in place over 1m lithified calcarenite. (E. side of road).

Diagram: Showing cross-section as above.

Softer than usual because weathered. So calcrete no

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longer forming but breaking up & calcarenite weathering therefore older than L/IGl & probably Pen/IGl.

Roadcut at 1.65 km from h'wy vertical facies in calcarenite. Degree of cementation = Pen/IGl. Mostly horizontal to sub-hor. bedding, & such cross=bedding as is present involves only up to 1m stratigraphic thickness. Dips in excess of dune dips (to 45^{o}). Beds with coarse quartz & shell fragments, cidaroid spine sections (up to 1.5 mm). One complete gasteropod. So ~~marine/beach~~ dune blowout facies = Sunnyside Sand. Rarity of shells due to recycling of much of the calcarenite (4cm/yr coastal retrogradation), & the high energy of the coast

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breaking up the shells. cf present beaches.

Surface of this plateau of c. 3 x 1km has summits over 20m & has a rolling topography of "downs" type – not dune ridges. It is appar. a platform at (c70') 21m like that on which Warrnambool stands & eroded to about the same degree or blowout level.

On this platform is commonly rubble from erosion & an essentially Holocene soil, so stripped during dry period at end of Pleistocene. The ~~lateness~~ recency of this winnowing explains why carbonate from it still in soils of basalt plains.

The seaward edge of this

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small plateau is 1.5-2km from the sea. The road follows the East dissected part of the plateau

2.5km from h'wy is a swamp with a causeway across it for the road = maximum dissection. Calcrete on valley walls; formed after sea retreated from cutting 21m platform therefore L/IGl. Its completeness fits this age.

2.9km from h'way road on hillslope sloping E. Below road is a quarry.

Diagram: Cross-section showing road on hill slope with quarry and platform in Sunnyside sand at its base

Platform may be marine, since but more likely a blowout surface

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then gully on E side & swamp area dissected. Solid calcite rhizomorph in quarry, & some evidence of a terra rossa near road. Horizontal bedding seen & a number of blocks of calcarenite with mostly broken shells of sandy facies coarse sand.

Diagram: Cross-section through hill in Sunnyside sand showing quarry on nortyh and marine platform at its base on south.

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Large quarry ascends most of hill ~15m. Mostly horiz & sub horiz. bedding & X-bedding. Some beds coarse-ground, higher quartz present & shell frag. No whole shells seen. Formation Sunnyside Sand

93.55 Back at Princes H'way

95.6 St. Lers Rd

97.3 Road to

Fitzroy River Outlet

1/12/76

Diagram: Showing points 1-4 on road to mouth of Fitzroy Riverfrom Princes H'way.

(1) Corner and intersection. Regular E dip of c 32^{o} = aeolian

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vertical faces in roadcut – level of cementation that of Pre/LIGl so formation = Warrnambool Aeolianite or new formation between. Here over 20m. Such summit prob. due to 21m L/IGl sea.

Because of low declivity of the terrain the Pen/IGl sea ran far inland (~110' = c. 33m), then left stranded dunes as retreated.

(2) Corner 99.0km on speedo.

300.25 Gate on S side but double fences show surveyed road continues.

300.35 Top of crest which stripped. Rubble quarry in property on S. side wh. rises 2m higher. Rocks outcropping mostly showed no bedding but one outcrop 7°E. Grain size very coarse, absence of dune morphology. Cementation Pre/LIGl so formation referred to Sunnyside Sand.

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Numerous rocks along old fence line. Many have coarse grained, thinly-bedded structure = shallow marine facies. Cannot drive further than next crest at 300.5km (3). Coast c. 3.4km away.

302.0 Back to bitumen road at (2) & foll. road to river mouth. Ruins on W. side as on map.

303.2 Crest with calcrete track to W (4). Abandoned house on E side. This dune or ridge prob L/IGl. Down seaward slope to Holocene flat. First Ti-Tree at 303.6. Holocene dune between river & sea.

304.8 Sand ridge on E side of mouth.

305.65 Wharf (on way back)

306.05 Start of ti-tree.

306.45 Small ctg shows calcrete & runny sand = L/IGl.

3 ridges behind this.

308.4 (1)

309.3 Princes Highway jctn.

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Highway passes over swampy area with fine quartz sand appar. from Tertiary l'st.

314.8 km Rd to Bessibelle 13 km

Track seawards taken.

315.9 Begin of duneline. Elevation too low to be other than L/IGl

317.5 H'way again. Ridge another km inland – check

321.8 Turn N.

Diagram: Map showing a Round hill-tumulus? and roads measured off along highway.

22.1 km Henshaw's road

33.85 Road N. L'st in paddocks

34.35 Outcrops of calcarenite on both side of a “creek” on Princes H’wy. Calcrete so L/IGi or older. Bedding horiz. to low dips so shallow marine? Milepost 193 at E end of ridge.

35.75 Shaw River Yambuk.

48 Road to Cape Reamur.

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East Warrnambool

2/12/76

Diagram: Map showing details of East Warrnambool streets, school etc points 1-9 marked - continued p. 153

(1) Cutting on N & E sides of playing field. Massive calcarenite without visible structures on N side. Limited area of dips on E side 15° and 30°. Pre/LIGl degree of cementation. Lack of aeolian structures Sunnyside Sand or W’bool Aeolianite probably latter or in between.
(2) Quarry for sand. Loose calcarenite & calcrete cover. Dennington Sand blown over older formation. Calcrete dips 12° on W and 15° on E side.
(3) Railway cutting includes vertical faces >100m long

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& up to 3m high. At W end dip 30°E but at E end flattens to 20° NE. X-bedding at E. end. ~~Sunnyside Sand~~ perhaps merging into Warrnambool Aeolianite or age between. Some small areas of runny sand covered by calcrete are ~~apparently~~ Dennington Sand blown over the older formation.

(4) Large rly. ctg. 7-8 m high. Horiz. bedding to 7° dip. Cementation status Pre/LIGl. Cross-bedding coarse sand in places with shell fragments = ~~Sunnyside Sand~~ Warrnambool Aeolianite or betw. At E end patch of loose sand with calcrete cover = Dennington Sand blown over eroded older formation.
(5) Long rly ctg further W than shown in between Japan St & Foster St. Bedding horiz. to 40° with much change in direction of dip.

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cross-bedding. Bedding irregular in places. Some with coarse sand & shell fragments “Pre/LIGl” level of cementation. Some sinuous dips at W end.

(6) W. side of Japan St. N. of Hotham St. roadcut with sub-horiz. bedding. Prob. crest of W’bool. aeolianite dune.
(7) Nicholson St. roadcut. At W end talus of calcrete rubble & dark qray soil: Dips 10°-25° with horiz rocks on top. Oppos. Ocean Grove sub-horiz. with numerous soil pipes. At E end beds dip 33°-38° E with horiz. beds on top.

Diagram: showing disconformity separating an upper strewn field (horizontal bedding) from Aeolian (dipping deposit)

Planation probably due to marine oscillation i.e. = shore platform. ~~Sunnyside Sand~~ (Calc) or W'bool Aeolianite prob the latter. Cut reaches Harper St to Ward St* SE cnr Barkley & Foster Sts. Small outcrop calcarenite.

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Diagram: Showing map continued from p. 150 with locations 1, 2 & 3 marked.

(1) Top of railway cutting with soil pipes. At W. end calcarenite is massive then near bridge E dip 33^{o} then massive again at bridge. At bridge 7^{o}W at rails & above that about same N, i.e. varying dip. Sub-horizontal under bridge with small scale cross-bedding. E of bridge follows same pattern. ~~Sunnyside Sand~~ or W'bool Aeolianite or between

(2) Coarse sand with shell fragments noted.

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(3) At 35 Simpson St. half way up hill on W side very small excavation for building ?garage. Soft calcarenite, no calcrete. Dips S. Disturbed ground or sand blown over slope. Dark soil.

± 21m platform

1. Warrnambool city area
2. Plateau with power house along Verdon St.
3. Plateau traversed by Tyrendarra School Rd & comparable high areas along coast.
4. Platforms in Miocene L'st along coast with L/IGl clifftop dunes on them. But bedrock under 1.95M basalt at Dooleys Hill at same height.

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Cut in Sunnyside Sand & W'bool Aeolianite. Pen/IGl sea rose to ~33m so a great volume of sand eroded & re-cycled. That W'bool Aeolanite descends 12-15m below the 21m platform shows it is a regressive phase deposited as the sea retreated in the valleys worn in it. So aeol. at Steer's Q & Pertobe Ctg.

New Caravan Park W. side of Simpson St. N of Verdon St. Warrnambool Aeolianite dip 32^{o} N. consistently along long cutting. Rhizomorphs were softer. Soil pipes at E end. Bore being put in – water at 120' ~3000 gall/hr. Site ~50' above SL so aquifer below SL.

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Warrnambool Maritime Village

2-12-76

See Bk 48, p. 58.   See p. 38

Lower area with barquentine "Speculant". Ctg E of ship has dips 25°-28° N. Pen/IGl level of cementation = Sunnyside Sand underlying the W'bool Aeolianite of the Pertobe Rd. cutting. Calcarenite near road 32° N.

Between is hollow infilled with stratified Tower Hill Tuff with fine lapilli in places. Dip in this 28° S at W. end of ship.

At Pertobe Rd gate W'bool Aeolianite vertical with calcreted & pitted surface = old cliff.

Pertobe Roadcut

Under paleosol dip flattens to 20° E, appar. merging into the base of the dune perhaps Paleosol dip 25° N. On paleosol surface dip 30-35° E Paleosol 1m thick & rhizomorph zone = 1.7m in all. In general cutting 33° E W'bool Aeolianite. Soil pipes & minor… Paleosols rare in W'bool Aeolianite contrast Dennington Aeolianite.

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Warrnambool Showgrounds

4/12/76

Section on S. side, cut by bulldozer. Tuff, terra rossa & calcarenite.

Diagram: Showing cross-section

At W end coarse calcarenite with shell fragments present; bedding horizontal to 40°. Great variation in direction and degree of dip. Cementation Pen/IGl level therefore Sunnyside Sand as Scott St., Woollen Mill, below Steere's Q., W'bool E, E side Hopkins.

Drain being dug c1m deep on N side of oval just (S of) inside new trotting track. Shows horizontal coarse-grained calc. = Sunnyside Sand. Area excavated by 21m (70')sea?

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Lake Keilambete

5/12/76

Sr more easily accommodated in aragonite than in dolomite so selectively in this mineral. Although the aragonite may now be changed to dolomite/ calcite, the Sr % remains as an indicator.

Different origin for dolomite than that proposed for the Coorong.

High water in the crater meant low status of carbonate & low Mg. When water level low in crater Sr Mg increase.

Lake Gnotuk comparable. Lower part aragonite & the upper dolomite. Responses to climate. Water levels geochemistry & sediments oscillate together.

From talk to Chinese Delegation by Jim Bowler.

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Council Q., Warrnambool.

Photos 1-7: Two formations separated by (a) paleosol Long period of time indicated also (b) by joints in lower f'm that do not continue into the upper i.e. the joints formed & the formation stabilized so no movement when new body of sediments imposed above. (c) Different colours – lower redder & upper browner (d) More lithification in lower formation.

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Murnane Bay

Photos 8-16.

Photo 9:Mernane Rock.

Diagram: Showing cross-section of cliff.

Diagram: Showing fossil platform & +4m notch – interpreting photo 15.

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Cape Duquesne

Photos 17-21:

? Last Interglacial calcarenite with fossil forest overlying thick basalt flow forming vertical cliff. Photo 20: Columns in calcarenite. See Boutakoff G.S.V. Memoir

Photos 22-24: Tower Hill caldera

Page 162

Two Mile Bay

Sat. 12.-2-77

2m W of Pt. Campbell

Much more of the sand ridge blown out than on the last visit. The fossil platform is wide & so is the existing one (compared with Port Campbell). Heavy swell oblique to shore, so longshore drift to E. Sand would be trapped in Pt. Campbell.

Erosion of the cliff between present & fossil platforms has extended since the last visit.

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Horseshoe Bay

E. of Cape Reamur

13-2-77

The volume of Holocene sand derived from the shell grit beach does not include

1. That lost by solution
2. That washed away.
3. The shells carried off by Aborigines, or eaten by animals (such as birds).

The volume calculated is the net volume after this period of time. The volume per m^2 of platform shell production is therefore minimal.

In small creek bed behind bay N. McNeill found 6 Ninella torquata + 2 opercula in situ. This bed apparently

1. Deposited by transgressing L/IGl sea
2. Eroded by P/Gl higher sea
3. Etched by splash from present sea level.

Page 164

Crag ME (cf. Ir. & Gael. creag, Manx Creg, Welsh Craig = rock)

1. A steep rugged rock.
2. A detached or projecting rough piece of rock ME
3. Geol. A name for deposits of shelly sand belonging to the Pliocene & Miocene strata 1735 “Bleak craggs & naked hills”.

Craig Sc. and north for Crag

SE area on W side of Cape Reamur = “McKechnies’s Craigs” & NW of that “The Crags”, sometimes give as “The Craigs”.

At Horseshoe Bay L/IGl shell bed, oval operculum of Subninella undulata measuring 2.1 cm x c.2.9 cm (incomplete) – the largest I have seen.

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Port Campbell

Taped in map of coast showing location of Loch Ard wreck: Traced from Vict. Nat. cover photos Vol. 91 (1)

Cf. Bk 57: 284 -6.

Page 166

NB.

1. Control by joint planes normal to the coast.
2. Second order central is tendency to form arcuate features eg. cave collapse at bay heads.
3. Beaches only in deepest & most protected bays – Loch Ard.

4. Residual islands and stacks (5)

One residual platform.

Page 167

Taped in page.

Re Photo of Lady Bay and Lake Pertobe taken between 1872 and 1878 from Cannon Hill, Warrnambool, Western Victoria. Made available by Mr. T. A. Wicking, ~~President~~, Warrnambool Historical Society.

Diagram: Showing Breakwater Rock, Middle Island, Merri Island, Point Pickering, Mouth of Merri River, Lady Bay, Pertobe Flats, tideway, Cannon Hill.

Time of taking of the photograph is determined by:

1. The lighthouse was originally built on Middle Island, but shifted from there to the present site in 1871.
2. The jetty was built in 1858 and this is shown.
3. The cannon were placed there in 1866.

Note. Although this photograph shows the sea entered Lake Pertobe from Lady Bay, this can hardly have been the normal condition because there is such a well-developed creek running from Lake Pertobe into the Merri River.

Break through sand ridge a function of easterly gales, which gives time viz early in year. Progradation in Lady Bay due to easterlies until sea broke through Pt. Pickering duneline & added a SW component.

EDG 21/1/77

Page 168

See photo p. 169 & interpretation p.167

cf modern photo 48:1

Taped in letter:

206 Lava St

Warrnambool 29-1-76

Dear Edmund

Thank you for your letter & enclosed cheque, I am glad that the photo met your requirements.

Re sketch of Bay & your questions on positions of old jetties etc. I have pencilled in what I consider to be the approx. positions.

(1) The Old jetty (Thorntons) 1854
(2) The Tramway Jetty used until 1890.
(3) Bond Store now Lady Bay Hotel.

T.T. Position of Tramtrack. Prior to the Tramtrack all goods landed up the Merri River were brought to the settlement around the sand to a point East of Flagstaff Hill thence into Merri St.

Other matters you mention, Middle Island was the situation of the Lighthouse & Buildings 1858 – 71.

The Spit as you define it was not so pronounced in the early days, as it is today. The area which now has the Yacht Club House etc built on it, was in my young days 12 ft under water, this of course was prior to the filling up of the viaduct. I have deleted the area & marked in where I have consider the sand spit would have been or ended in those days.

The Tideway you mention can still be noticed in the dip in the road near No 2 Caravan Park, so it is possible that the actual connection of the sea & lake was during an earlier period than the foundation of Warrnambool 1847.

I hope this clarifies these matters for you.

Kind regards,

Tom.

This an unusual event because

1. otherwise a sand deposit from such breakthroughs would be obvious
2. Pertobe Rd was then the main entrance to Warrnambool because passengers & goods all came by sea. Would not have used this road if passage interrupted.

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Lady Bay and Lake Pertobe between 1872 & 1878 see pp. 167-8.

Photo: Photo by Thomas Washbourne. Original in La Trobe) Library. Tom Wicking provided this print (see p. 168.

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Tower Hill

Feb 1977

Photos 1-5: Unlabelled

Page 171

Photos 1-3: Tower Hill unlabelled

Page 172

Horseshoe Bay, E. of Cape Reamur

13 Feb 1977

See p. 105

Diagram: interpretation of adjacent Photo showing curved clifflet with fallen rock formation lying inside it – due to marine abrasion.

Photo: Colour some enlarged photos to distinguish in situ basalt.

Photo: Dip of lava into the by which is a lava flow collapse feature.

Photo: At charge in direction here is the outlet of the small creek. Related structurally.

Page 173

6 Photos: 3 labelled;

Photo: Light colour – algal & lichen zones, Dark colour – erosion zones. Intertidal & littorinid zones.

Photo: From top of dune to medieval terrace (crossed by track)

Photo: Lichen to dicot zones.

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6 Photos: 2 labelled;

Photo: ramp 1 Basalt dipping into collapse area & 2 quarrying blocks which thrown landward. High blocks thrown by higher sea levels.

Photo: Beach in NW corner – the most sheltered. Also basalt ramp lower here. Sand white i.e. Holocene & from Intertidal biota chiefly yellow Pleist. sand.

Page 175

Waves

1. W. coast USA generally long-period waves c.10-18 secs E. coast short-period waves c.6-8 seas.
   "The waves & breaks along the W. coast are usually higher than those of the E. coast."
   Function of fetch.
   Longer & higher because from Southern Ocean? On east coast very low declivity on shelf & this also controls wave size.
   "The average period of swells reaching the shores of the U.S. is 22.5 seconds, wh. corresponds to a wave length of about 2600 feet & a velocity of about 78 miles per hour. The height of a swell decreases, & the period & wave length increases, with distance away from the storm area." Easterbrook, D. J. 1969. Principles of Geomorphology 1969, p. 309, 462 pp.

Page 176

Bay of Islands, west of Peterborough

19/3/77

Photos: Stacks well seawards of cliffs suggest remains of gorges, i.e. elongate bays following major joints. Why such joints when the tectonics are so mild?

Compare the sub-quadrilateral bays of The Standhope Bay – Childers Cove area compared with the gorges of the Port Campbell area.

Page 177

Plate Tectonics

The continuing break-up of continents (eg. Red Sea & African Rift) raises the question of how far break-up can go.

This leads to the question of how they get welded together again. How were the shields formed?

If metamorphic belts are old collision lines what size continents are involved? Does constant breakup mean get so small that there is not enough momentum?

Or is there endless welding & rifting so that Pangaea is not a standard evolutionary phase but an "accident" i.e. a rare con-catenation.

What is the relation between collision and suturing?

Page 178

Quotations

"The bitter satirist Jonathan Swift who was pouring out pamphlets & sharp tongued books throughout the Dampier Voyages sent his famous. Gulliver to odd corners of the Pacific. The nasty little Lilliputians lived where the state of Victoria, Australia, now prospers. The friendly, sensible giants of Brobdingnag were the forerunners of Californians." A. Villiers.

In "Captain Cook, a Seaman's Seaman." Hodder & Stoughton 1967.

Continued in Book 48

End book 42.