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RADIOCARBON DATES FROM THE LAKE FROME AREA (TARKAROOLOO BASIN), SOUTH AUSTRALIA.

Proposed Contribution for "Radiocarbon".

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COMMENTS ON RADIOCARBON DATES

The following dates were determined from non-marine shell and calcareous paleosols from the Lake Frome area in South Australia (Tarkarooloo Basin, Callen and Tedford, 1976), mainly in an attempt to establish the late Quaternary phases of sedimentation (alluvial and aeolian) in the southern Strzelecki Desert, and partly of lake levels in Lake Frome. Ultimately it is hoped to determine the climatic history of the region, and establish regional mapping units and their chronology as part of the South Australian Department of Mines and Energy 1:250 000 geological atlas programme.

The following should be read in conjunction with numbered sections on Fig. 15, of Callen & Tedford (1976). New geographic names appear on Fig. 1 of Callen & Tedford. Non-marine molluscs were identified by M. Buonaiuto, in his capacity as consultant to the South Australian Department of Mines and Energy.

Original data sheets and radiocarbon reports by Gillespie are held by R.A. Callen and at Sydney University Radiocarbon Laboratory, Department of Physical Chemistry, University of Sydney N.S.W. 2006.

Specimen numbers are in order of radiocarbon laboratory numbers e.g. SUA (Sydney University) or Gak (Gakushuin University of Tokyo, Japan). Numbers appearing beneath these are Department of Mines and Energy numbers.

LAKE MOKO (Section 7)

Type Section, Coonarbine Formation. Samples from calcareous horizons of pedogenic origin exposed on a cliff face on the west side of Lake Moko. $30^{o}54'00"$ $140^{o}10'14"$

SUA 607 7170±125 yrs. B.P. Top Unit 4

6936RS30

Micrite to microspar (calcite), rimming sand grains, and in cylindroids resembling root casts and moulds. Some rounded patches.

SUA 916 24000±320 yrs. B.P. Top Unit 3

6936RS83

Micrite (calcite) Forming distinct pellets with weak spheroidal lamination. Includes 2% charophyte oogonia and unidentified algal pellets.

SUA 1263 16340±180 yrs. B.P. Calcite nodules

6936RS86

As for SUA 916, but 2-3 m from it in the same horizon. Closer to undulating erosional surface on top of this bench than SUA 916.

Date is very significantly different (using the root mean sequence error method) from SUA 916, and is thought to result from the presence of the c. 15 000 yrs. B.P. soil , dated by SUA 607 or the superposition of Unit 4 soil (SUA 607) on the soil dated by SUA 918. There are no signs of incorporation of older carbonate in SUA 916, the presence of which might provide an alternative explanation.

SUA 918 25700±390 yrs. B.P. Top Unit 2

6936RS81

Microspar and drusy calcite in diffuse patches, with gypsum nodules.

Apparently recrystallized. Thin, diffuse horizon.

The above dates bracket aeolian activity between 7170±125, to 25700±390 and beyond.

SUA 915 30900±700 Unit 1

6936RS82

Dense micritic calcite nodules and cylindroids, the latter branching, and resembling root casts and moulds. Clay skins on detrital grains.

SUA 1264 26050±440 yrs. B.P. Unit 1

6936RS87

Dense calcite micrite nodules from same horizon as SUA 915.

This date is significantly different from SUA 915.

The rootlets were expected to be younger than the nodules. The proportion of calcareous rootlets in SUA 915 is small, however. Carbonate nodules may have been reworked from older exposed parts of the soil profile beneath.

This confirms the idea that this horizon is anomolous in the sense that dates on it are inconsistent.

The soil in this reddened horizon is continuous with that described below in the top of the Eurinilla Formation, and the sediments are similar. Hence the unit is now regarded as part of the Eurinilla Formation, though its texture and sorting suggest it may be aeolian.

It suggests aeolian activity may have extended back to this time at this site. Both this and SUA 918 suggest aeolian activity began here earlier than suggested by Williams & Polach (1971) for about the same latitude, west of the Flinders Ranges.

The horizon is truncated by the overlying dune, and has not been positively identified elsewhere.

Eurinilla Formation

SUA 608	25 570±540	Top Unit 3
6936RS28		
SUA 917	22 250±300	Top Unit 3
6936RS28	Corr. 21 910±290	

SUA 917 was about 2 m horizontally from SUA 608 in the same horizon.

Both were micritic calcite nodules with blotchy texture and concentric structure. Some charophyte oogonia and ? algal or shell platelets (micritized) were present (2%). Microspar occurs in voids and around detrital framework grains.

The carbonate zone from which these samples were derived is about 30 cms thick, with a sharply defined top.

SUA 912	30 600±700	Near top Unit 3, base
6936RS84		carbonate horizon

This sample was taken from the lowest of a series of carbonate nodule horizons, the uppermost of which is represented by SUA 608 and 917. The pedogenic carbonate horizon can be traced continuously along the same cliff face, and SUA 917 was collected about 50 m distant from 608.

Petrologically, the dated samples was almost identical to 608.

SUA 1262 34 775±1300 yrs. B.P. Calcite nodules
6936RS88

The sample was from approximately the same horizon as SUA 912, but about 4 m horizontally from it. The two ages are significantly different, though of the same order.

SUA 608 and 917 are statistically significantly different from one another and are anomalously young when compared with those of the overlying Coonarbine Formation and the reddened horizon. Even if SUA 915 were found to contain older carbonate reworked from the lower in this horizon, the ages seem too young.

The ages from the base of this soil profile (SUA 912 and 1262) seem most reliable, and correspond with those from Lake Pinpa. The top of the profile, about the level of SUA 912, is probably about 28-29 000, and the base around 35 000 yrs. B.P. The younger dates probably result from percolation of later groundwater along the boundary, the Eurinilla Formation being of lower porosity than the overlying loose aeolian sand. It is disturbing that samples taken from the same horizon differ from one another by amounts varying from 900 to as much as 8 500 yrs B.P.

EURINILLA CREEK, SECTION 18 km SOUTHEAST OF LAKE MOKO

West side of creek, from cliff face in gully.

Eurinilla Formation

SUA 611 23 300±550 yrs. B.P. Top Unit 3
6936RS27 30°57'17" 140°01'10"

This carbonate horizon appeared identical to that at the top of the Eurinilla Formation at Lake Moko. Although physical

by SUA 608, 917, 912, 1262.

No thin section was examined.

SUA 612 — 34 800±1600 yrs. B.P. — Top of Millyera Formation, equivalent to Unit 4, Section 5

6936RS9 — 30°58'56" 140°00'42"

Collected from gully in bench along edge of Eurinilla Creek. There was a calcareous paleosol 1 m above the shell sample.

The date was on non-marine shells mainly of Coxiella dda gilesi Angas (F 48/76) (97.7 to 98.2% aragonite). Some of the calcite was soil carbonate inside and the shell. No recrystallization could be detected in the shell, though the probable presence of some calcite indicates some exchange may have taken place. Thus it is possible this represents radioactively dead carbonate contaminated with modern carbonate, though it is more likely to be contaminated with c. 23 300 years old carbonate rather than modern.

LAKE MILLYERA (southwest) Section 5. 31°03'16" 139°56'43" except SUA 919.

Coonarbine Formation

SUA 670 — 8150±120 yrs. B.P. — Carbonate horizon

6835RS92

A thin diffuse crust from the top of a pedestal of Coonarbine Formation - similar situation to SUA 607 at Lake Moko, though carbonate much more weakly developed.

Thin section shows calcite micrite has partly recrystallized to coarser patches. Clay skins on framework grains. Minor contamination by old carbonate.

The age is significantly different from SUA 607, though the sediment appears to represent the same horizon.

SUA 609 — 15910±190 yrs. B.P. — Calcareous horizon

6835RS87 — 30 cm below 670

SUA 925	14900±170 yrs. B.P.	Repeat of above
6835RS123		1 m along strike

The soil was morphologically similar to that of SUA 607. A thin section showed the calcite was micrite with minor oogonia of Chara, and irregular patches of microspar.

The dates are significantly different at two standard deviations. The difference could be accounted for by exchange with more modern CO_2, as suspected at lake Moko.

Thus the Coonarbine Formation at this sample area may contain a calcareous paleosol not represented at Lake Moko. However the explanation used for SUA 607, 916 and 1263 at Lake Moko could be applied - superposition of a younger on a older soil.

Eurinilla Formation (as defined). Probably Coonarbine Formation (from reinterpretation).

SUA 610	21640±345 yrs. B.P.	Calcareous paleosol
6835RS90		about ½ m from top
		Unit 2

This soil resembles that dated by SUA 916, though it was at first regarded as equivalent to the paleosol at Lake Moko, in the top of the Eurinilla Formation.

The unit in which it is developed is fluviatile, and is correlated with the Eurinilla Formation at Lake Moko. This seemed reasonable from relationships to the sequence dated by SUA 611, though outcrop is not continuous.

Thin section showed micritic calcite in patches and more solid nodules, with rare patches of microspar. It is less recrystallized than SUA 608.

SUA 921	24150±350 yrs. B.P.	As for 610, but a
6835RS124		lower profile (about
		20 cms lower) and
		30 m distant horiz-
		ontally.

The micrite is in dense patches, with some patches and particles of microspar.

The date is in good agreement with SUA 610.

There are two possibilities for correlation:

(1) With the horizon represented by SUA 916 (Coonarbine Formation). Recent reinterpretation of the petrology of the deposit suggests it is aeolian, not fluviatile as formerly thought.

(2) With the anomalously young SUA 608, 917 and 611

Millyera Formation (as defined). Now reinterpreted as equivalent to the lower part of the Eurinilla Formation.

SUA 919 23500±170 yrs. B.P.

6835RS121 30°02'44" 139°56'21"

Non marine shell, 98% - 99% aragonite.

Coxiella c. f. striata, Potamopyrgos s.p., Neopisidium poontanenses sp. nov., with minor Coxiellada gilesi (Angas), Corbiculina desolata morpha triangularis. m. nov.

This diverse fauna contrasts with that from other Eurinilla Formation and ?Millyera Formation shell samples (SUA 612, 924) except Gak 4984.

The age was expected to be similar to that from the other shell samples (viz. c. 34 000 or older). If the 1-2% calcite in this sample were modern, a true age of c. 30 000 would be expected, which is still too young.

This date cannot be correct according to SUA 610 and SUA 921, unless younger beach material is here superposed on the old beach. This has been trenched, and demonstrated by correlation and sedimentology to be a beach deposit, apparently equivalent to the beach in the main section to the east.

Further dating and trenching is proceeding to resolve this problem.

QD14 BORE 17 km south east of Mooleulooloo Homestead on CURNAMONA (approximately 110 km SSE of Lake Moko). 31°44'31" 140°39'33"

SUA 811	28600±750 yrs. B.P.	Calcareous paleosol in borehole, top of Eurinilla Formation
7034RS34		
SUA 812	37250$^{+2570}_{-1950}$ yrs. B.P.	
7034RS36		

These two samples were taken from 10 cm diameter core at 0.60-0.75 m and 0.75-0.90 m respectively in QD 16 bore drilled for Sedimentary Uranium N.L.. The well-developed calcareous paleosol here is widely developed and can be seen in dams and creeks throughout the district, beneath about ½-2 m of red brown sand. It strongly resembles the Belmont Paleosol of Wasson (1979) in outcrop, but is apparently much older.

The unit in the bore is about 1.1 m thick and overlies with sharp contact another 2.9 m of similar material, also regarded as part of the Eurinilla Formation. This in turn rests with sharp contact on the Willawortina Formation at 4.3 m.

The dating was done to test the identification of the Eurinilla Formation in the borehole, and apparent similarity of the paleosol to that at Lake Moko and Pinpa on the same unit. The dates suggest this correlation is correct.

SHORELINE DEPOSIT		31°02'07" 139°38'04"
SUA 924	36800±1700	Shoreline deposit at about 9 m above sea-level (0 m S.L. is approximately. equivalent to the floor of Lake Frome). South end of L. Frome.
6835RS83		

The shell in this consists almost entirely of Coxiellada gilesi Angas, (Buonaiuto pers. comm.) mostly broken fragments

in loose coarse sand. The deposit forms a series of bars along the base of a cliff line.

A calcareous paleosol is developed on this material and resembles that on the Eurinilla Formation, but was not dated because of the large detrital content of dead carbonate from the Willawortina Formation, derived from the adjacent cliffs. The bars also contain charcoal in the form of twigs, but it was not possible to obtain enough for dating.

The shell is 98.0 to 99.6% aragonite, and unaltered in thin section, also being almost free of pedogenic calcite crust.

Of the shell dates obtained, it is regarded as closest to the true age of the shell.

The date fits well with the lake-full stage recognised elsewhere in southern Australia (Bowler 1976), and is close to SUA 612. The real age of both these samples is probably around 50 000-60 000 yrs. B.P. assuming the calcite in the shell represents the 28 000 to 31 000 yr. B.P. carbonate, of the paleosol associated with the Eurinilla Formation.

LAKE PINPA $31^{o}07'50"$ $140^{o}12'36"$

Section 8.

SUA 668 6935RS46	39800±3000 yrs. B.P.	Top Unit 3, Calcareous paleosol on the Eurinilla Formation
SUA 667 6935RS42	32800±1300 yrs. B.P.	as for 668, but 5 cm lower.
SUA 669 6935RS18	43200±1550 yrs. B.P.	As for 668, but 3-4 m lower, near the base of the carbonate profiles.

SUA 926 B	29300^{+700}_{-690} yrs. B.P.	Soft nodules
6935RS77	$30^{o}07'53"$ $140^{o}12'30"$	
SUA 926 AR	>41500 yrs. B.P.	Hard centres
6935RS77	As for B	in soft nodules

The SUA 926 samples were taken from the same horizon as SUA 668, but about 10 m distant horizontally.

This site has one of the thickest developments of this calcareous paleosol in the Lake Frome area. It consisted of a number of horizons developed over a thickness of 4-5 m. The paleosol material is all dense micritic calcite, showing some brecciation, and clasts or clast-shadows of reworked micrite. The dating of the hard angular fragments in the centre of SUA 926 showed these contained radioactively 'dead' carbon. They are probably reworked from nodules in the Willawortina Formation, or carbonate cementing the Millyera Formation, or represent an older soil on the Eurinilla Formation reconstituted during a long period of exposure. In thin section the textures are quite distinct between hard and soft nodules, though the former have been partly reconstituted.

This is thought to account for the reversal in age shown by SUA 668 at the top of the sequence. All the ages except SUA 926B are probably too old, and should be closer to 30-31 000 yrs. B.P.

The ages are in agreement with the older ones obtained on the Eurinilla Formation at Lake Moko.

PASMORE RIVER SECTION

SUA 920	33100 ± 1000 yrs. B.P.	Calcareous paleosol
6835RS126	$30^{o}13'19"$ $139^{o}39'36"$	in Eurinilla Formation

The calcite nodules in this sample were taken from about 20 cms below the top of the Eurinilla Formation, which here infills a valley cut into the Willawortina Formation by the Pasmore River.

Remnants of Coonarbine Formation, with one of the younger calcareous paleosols, overly the Eurinilla Formation near the modern river bank. The modern river is a misfit stream.

This date is probably too young, as there were quite extensive patches of microspar in the nodule, which might represent recrystallization. The abundance of 'dead' carbonate in the vicinity, in the Willawortina Formation, makes it likely that some was also incorporated in the nodules, though this could not be definitely determined from thin section.

The age is close to others obtained for the soil on the Eurinilla Formation from QD 14 bore and Lake Pinpa.

POONTANA CREEK - LAKE CALLABONNA - LAKE FROME CONFLUENCE

This section is about 80 km NNW of Lake Moko ($30^{o}12'19"$ $139^{o}59'19"$) at the northern extremity of Lake Frome, and is therefore isolated from the others, which are relatively close to one another (except QD 14, which is in the southeastern corner of the CURNAMONA 1:250 000 map sheet area).

Coonarbine Formation

SUA 913	10440±170 yrs. B.P.	Soft patchy
6837RS102		calcareous
		paleosol.

The content of reworked shell and charophytes in the thin section of this micritic calcite material suggested the age would be somewhat older than the actual age of the calcareous paleosol. It was thought to represent the same soil horizon dated by SUA 670 at Lake Millyera and SUA 607 at Lake Moko, but statistically is definitely older (close to 100% probability). The amount of old carbonate present could not alter the age by more than about 1000 yrs., hence it is possible this represents a distinctly older horizon, or that SUA 670 and 607 have equilibrated with CO_2 in later groundwaters.

The material on which the soil is developed is much more texturally mature than the upper units of the Coonarbine

the underlying units. The sediment may represent a younger beach deposit.

GaK 4951 10760±180 yrs. B.P. As for SUA 913
6837RS79

This sample was taken from the same horizon as SUA 913, close to the same site, and confirms the date on SUA 913.

Gak 4950 14360±310 yrs B.P.
6837RS80

Gak 4952 16090±370 yrs B.P.
6837RS78

SUA 914 18950±145 yrs. B.P.
6837RS101

These dates were obtained from soft calcite lumps of micritic carbonate developed in Coonarbine Formation. There was some old shell and chara oogonia reworked by wind from the underlying coquinite, which would have made the ages, of SUA 914 at least, a little too old.

The dates are in sequence, Gak 4950 being from the uppermost calcareous horizon, and SUA 914 from the lowest, about ½ m below. The soil is regarded as equivalent to that represented by SUA 609 and SUA 925 from Lake Millyera. Statistically, there is no real difference in age between Gak 4950 and Gak 4952, but there is a difference between Gak 4952 and SUA 914.

There is a distinct disconformity between the unit from which these dates were obtained, and that with the c. 10 700 yr. B.P. dates.

Gak 4953 >33400 yrs. B.P. 1% aragonite
6837RS57

Gak 4959 26340±1230 yrs. B.P. all calcite
6837RS57

These two dates are on pedogenic carbonate from which

nearly all shell has been dissolved. The dates should be close to the the true age of pedogenesis. The soil represented by Gak 4950, 4952 and SUA 914 has affected this horizon. The material was derived from just below an irregular surface developed on the top of the coquinite. Slabs of coquinite are intermixed with the basal part of the overlying Coonarbine Formation. This suggests a disconformity exists here, and that the soil may represent one of the older soils on the Coonarbine Formation at Lake Moko, or an anomalously young version of the soil on the Eurinilla Formation at Lake Moko.

Gak 4958 (Process B)

6837RS28 35200±1200 Non marine shell

The shell was 79-83% aragonite, therefore the actual age was well beyond the range of radiocarbon dating. The following species were recorded Corbicula desolata, Potamophyrgos, sp. morphae, Pisidium poontanense sp. nov. were dominant, and Thiara sp. aff incerta, Coxiella striata morphae, and Coxielladda gilesi are minor components (F 156/70).

On the west side of Lake Frome at about the same level is a shelly beach ridge, thought to correlate with the 10 m ridge at the south end of Lake Frome (SUA 924). It contains a diverse assemblage similar to GaK 4984, and quite different from the Coxielladda - Coxiella assemblage of SUA 924. The assemblage consisted mainly of Coxiella striata, Potamopyrgus sp. morphae, Coxielladda gilesi, and Pisidium poontanense sp. nov., Thiara sp. aff. incerta, and minor Plotiopsis sp. aff. incerta, Coxiella striata sp. morphae, Potamopyrgos sp. morphae, and Corbicula desolata morpha triangularis (Sample P1.SA01)

The three faunas are thought to be from the same beach ridge, which suggests the southern part of the lake was much more saline than the north, or that the beach is a composite feature.

The coquinite from which GaK 4948 was derived was also though to be equivalent to Unit 4 in section 5, based on the

presence of fish vertebrae of similar type of both localities. The interpretation of GaK 4948 was from a beach bar or ridge can be questioned because the cross-bedding is rather unusual, with very long straight cross-sets facing east to north, on the east side of the lake. It is possible it may be a shell lunette. However, the contact with the underlying Millyera Formation is very irregular and erosional. The interpretation favoured is that the feature represents an offshore shell bar on the leeward side of the lake, shell being washed over by waves so as to tumble gently down the eastern slope and form the straight, even, foresets (sand waves).

The underlying Millyera Formation is similar to units 1 to 7 in Section 4 and 1, 2, 4 and 5 in section 5 of Callen & Tedford. The unit grades down into pebbly clays resembling the Willawortina Formation.

FINAL COMMENTS

The variation in dates of samples from the same horizon in the calcareous paleosols indicates problems with exchange between atmospheric CO_2 of younger age, and the paleosols. The meaning of the dates cannot be discussed adequately here, as this entails a review of all other dating in the area, and detailed inter-pretation of lithostratigraphy. A brief outline of events is to be published in the 1980 issue of the Australian Quaternary News letter, based on these considerations. A full discussion of this work will be published elsewhere. Published dates of relevance are to be found in Draper and Jensen 1976; Williams and Polach 1971; Wasson 1979; Buckley 1973.

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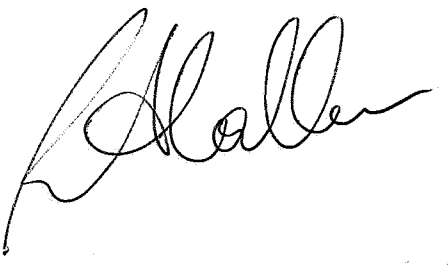

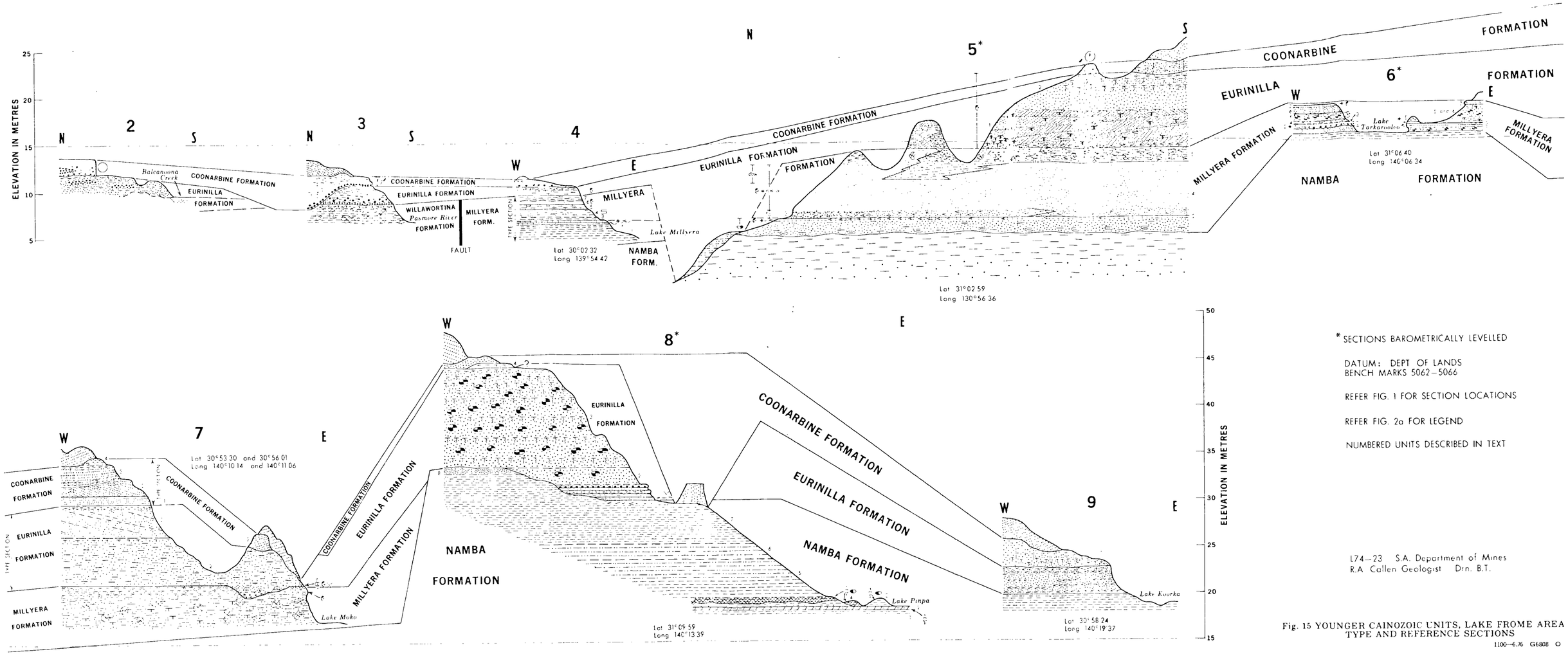

* SECTIONS BAROMETRICALLY LEVELLED

DATUM: DEPT OF LANDS
BENCH MARKS 5062–5066

REFER FIG. 1 FOR SECTION LOCATIONS

REFER FIG. 2a FOR LEGEND

NUMBERED UNITS DESCRIBED IN TEXT

L74–23 S.A. Department of Mines
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Fig. 15 YOUNGER CAINOZOIC UNITS, LAKE FROME AREA
TYPE AND REFERENCE SECTIONS

1100–6.76 G6808 O