Report Book

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
BIOSTRATIGRAPHY DIVISION

PROPOSED QUARTERLY NOTE

# POTASSIUM-ARGON (GLAUCONITE) DATES FOR THE BASAL BLANCHE POINT FORMATION, ST. VINCENT BASIN, SOUTH AUSTRALIA.

by

SCANNED

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Biostrat.No. 10/78
D.M. No. 1020/69

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## INTRODUCTION

A local radiochronology for the South Australian marine Tertiary succession will in principle be a useful check on the present biochronology which is based on long-distance biostratigraphic correlations. In the absence of igneous and pyroclastic rocks, we are attempting to derive a set of local radiometric ages from the dating of glauconites, although glauconite has the reputation of being "one of the least reliable chronometers for providing accurate age data" (Obradovich & Cobban, 1975, quoted by Berggren et al., 1978). South Australian marine Tertiary formations are often glauconitic, including some notable greensands; and therefore a start has been made on testing their suitability for radiochronology.

The European Tertiary radiochronology has been based largely on the K-Ar dating of shallowly-buried glauconites, although Berggren et al. (1978) have recently moved away from this basis. The large body of literature on glauconite and its use in radiometric dating may be traced in McRae (1972), Berggren et al. (1978), and references therein.

The very few glauconite dates (K-Ar) hitherto obtained from South Australian Tertiary samples are enigmatic and

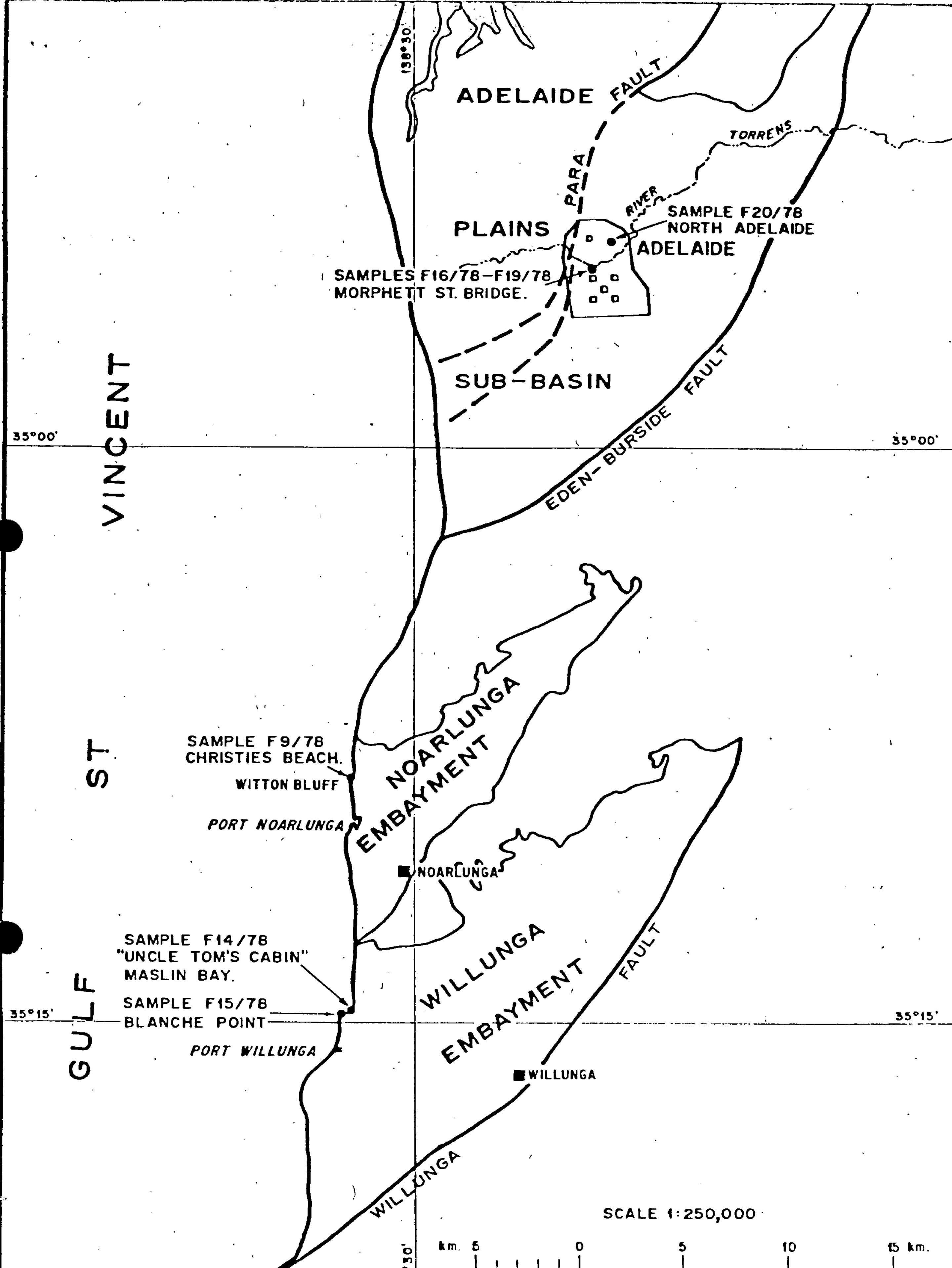


FIG 1.

| | | |
|---|---|---|
| | DEPARTMENT OF MINES AND ENERGY<br>SOUTH AUSTRALIA | SCALE 1:250 000 |
| COMPILED J.M.L. | NOARLUNGA & WILLUNGA EMBAYMENTS & ADELAIDE CITY | DATE October 1978 |
| DRN. G.J.T.   CKD. | RADIOMETRIC DATING OF TERTIARY GLAUCONITIC SEDIMENTS | PLAN NUMBER |
| | GLAUCONITE SAMPLES LOCATION PLAN | S 13708 |

unpublished. Therefore a suite of glauconites was chosen, all from the richly glauconitic basal Blanche Point Formation ("Transitional Marl Member" of Reynolds, 1953) and all pin-pointed biostratigraphically from within the thin southern Australian zone characterised by the distinctive planktonic foraminifer Hantkenina primitiva Cushman & Jarvis. This zone has been considered virtually isochronous (McGowran, 1978). Samples were chosen from localities shown in Fig. 1 and Table 1, to provide some indication of internal consistency, and to detect possible differences in argon loss between outcrop and bore-core material.

Results are from unpublished AMDEL Report AC 3614/78 (9/6/78) by A.W.W. The $K^{40}$ decay constants used in the age calculations (Table 1) enable direct comparison between these results and the radiochronology of the Eocene suggested by Berggren et al. (1978).

RESULTS

TABLE 1

Sample data, K-Ar Analyses, and dates

| D.M.E. Biostrat. Sample No. | Locality, borehole, depth. | %K | $*Ar^{40}/K^{40}$ | $\%Ar^{40}_{atm}$ | Age (Ma = millions of years before present) |
|---|---|---|---|---|---|
| F 9/78 | Headland N. of Witton Bluff, by S. end of breakwater, Port Noarlunga-Christies Beach. Auger sample 0.1-1.1 m into cliff face, 0.6 m above base of the formation. | 4.90<br>4.91 | 0.0020333 | 30.2 | 34.5 ± 0.5 |

| | | | | | |
|---|---|---|---|---|---|
| F14/78 | At "Uncle Tom's Cabin", Maslin Bay. Auger sample 0.05-0.85 m into cliff face, 1 m above base of formation. | 4.89<br>4.88 | 0.0019779 | 35.8 | 33.6 ± 0.5 |
| F15/78 | N. side Blanche Point, Maslin Bay. Auger sample 0.05-0.95 m into cliff face, 1 m above base of formation. | 4.77<br>4.78 | 0.0020574 | 41.3 | 34.9 ± 0.5 |
| F16/78 | Morphett St. Bridge foundn. test bore 11, Adelaide City Area, railway yard, 120 m S. of Torrens Lake, depth 25.0-25.9 m, tube core. Basal part of the formation. | 4.92<br>4.93 | 0.0019532 | 34.8 | 33.1 ± 0.5 |
| F17/78 | As for F16/78, but tube core from 26.2-27.1 m depth. | 5.16<br>5.12 | 0.0019826 | 28.5 | 33.6 ± 0.5 |
| F18/78 | Morphett St. Bridge bore 12, S. bank of Torrens Lake, depth 20.1-21.0 m, tube core. Basal part of the formation. | 5.04<br>5.05 | 0.0018911 | 23.5 | 32.1 ± 0.5 |
| F19/78 | As for F18/78, but tube core from 21.3-21.9 m depth. | 5.10<br>5.11 | 0.0019065 | 20.9 | 32.4 ± 0.5 |
| F20/78 | Adelaide Metropolitan Subway foundn test bore DH-6, cnr Brougham Place/ Stanley St. North Adelaide, 32.5-33.5 m depth, diamond-drill core. Basal part of the formation. | 4.37<br>4.38 | 0.0020630 | 27.0 | 35.0 ± 0.5 |

*Denotes radiogenic argon

Constants used: $K^{40}$ = 0.0119% atomic

$\lambda\beta = 4.72 \times 10^{-10} y^{-1}$

$\lambda\varepsilon = 0.584 \times 10^{-10} y^{-1}$

Errors are one standard deviation.

DISCUSSION

1. The most recent recalibration of the Palaeogene time scale is by Berggren _et al_. (1978), not on the basis of glauconite ages but of "K-Ar ages in continental stratigraphic sequences and (bio) stratigraphic correlations with their marine equivalents". In this chronology, the Late Eocene is now dated 37-40 Ma by Berggren _et al_. (1978), commencing as usual with Zone P.15, but assigning the Bartonian Stage to the late Middle Eocene (Zones P.13, P.14) on recent microfossil evidence, rather than to its traditional place in the Late Eocene. They, and McGowran (1978), consider it much less disruptive biostratigraphically, to reduce the time span for the Late Eocene by excluding the Bartonian, than to transfer Zones P. 13 and P. 14 to the Late Eocene. It is generally agreed that the _Hantkenina primitiva_ zone in southern Australia lies rather low in the Upper Eocene, within the uppermost range of _Truncorotaloides collactea_ (Finlay) (Lindsay, 1969), and near the Zone P.15/Zone P.16 boundary (McGowran _et al_., 1971) as confirmed recently by McGowran (1978). The local _Hantkenina primitiva_ zone therefore has an age of approximately 39 Ma according to the chronology suggested by Berggren _et al_. (1978). It is worth noting that the age would approximate 37 Ma according to the time scale proposed by Tarling & Mitchell (1976); and 42 Ma according to that of La Brecque _et al_. (1977).

2. However even the upper limits for the eight ages obtained range between 32.6 and 35.5 Ma, that is, from 16% to 9% "too young". Hurley _et al_. (1960, p.1808) concluded "that there is some consistent mechanism acting to lower the age of glauconites by 10-20 per cent." Correspondence of the whole suite with the "expected" age of 39 Ma is only optimised if to each of our dates is added a factor of 16% of its median age; all results are then within $\pm$ 5% of 39 Ma.

Berggren _et al_. (1978) question whether Odin's (1975) revised glauconite ages (used by Tarling & Mitchell, 1976) may not be too young "due to the possibility of appreciable Argon loss at the elevated bakeout temperatures (180°C for periods of up to 12 hours) to which he subjected his samples". The glauconites used in the present study were pre-baked at 110°C for 12 hours and are unlikely to have lost radiogenic argon during this period.

Without assessing the detailed biostratigraphy, correlation and analysis of each of the glauconite samples of Odin and other workers, it is not possible to detect whether there is any systematic error in their dates. As it happens, Odin's earlier glauconite ages quoted and used by Berggren (1972) are compatible with the revised chronology of Berggren _et al_. (1978), notwithstanding that the latter authors discount Odin's pre-1970 ages as too old, because he made no correction for the presence of atmospheric $Ar^{40}$. It may be that various errors fortuitously cancelled one another out.

3. The results have an internal scatter that is greater than the experimental error. However, samples from the one locality, e.g. F16/78, F17/78; and F18/78, F19/78 give consistent results. Also, in each of these boreholes, the deeper core, which should have been more protected from argon diffusion loss caused by post-Eocene weathering, does give an apparently older age, although the difference is within the experimental error. The core sample from North Adelaide which apparently has been the most protected from post-Eocene weathering, yields the age which is closest to that expected. Samples F9/78 and F15/78, both from deep in coastal cliffs which appear to be eroding relatively rapidly, give similar ages to that of sample F20/78. Sample F14/78, from a locality which is being eroded less actively, and

also from relatively nearer the exposed cliff-top, gives an age slightly younger than these.

Factors to which argon leakage can usually be attributed, e.g. deep burial or heating by contact or thermal metamorphism, cannot be invoked in the present investigation. The potassium contents are normal for glauconites of Cainozoic age, so leaching does not appear to be a major cause of argon leakage.

4. All samples were examined by X-ray diffraction, mainly to check that other detrital minerals and carbonate grains or shells were absent. The glauconites were poorly crystallised, but a detailed analysis was not undertaken. According to the data in Hurley et al. (1960, fig. 2) the potassium content of our glauconites would correspond to a proportion of 15-20% of expandable layers (montmorillonite). This in turn (McRae, 1972, table 1) is consistent with a "disordered, non-swelling, low potassium lattice, micaceous and monomineralic but with subdued (XRD) peaks, displaying broad bases and asymmetric sides." However, more detailed XRD examination is needed to investigate the crystal structures of these glauconite minerals and hence their capacity to retain radiogenic argon.

5. Significant revisions to the Cainozoic time scale made in recent years serve to emphasise that there is still no "absolute" date with which to compare our results. This is in spite of the fact that our samples come from one of the most biostratigraphically distinct horizons in the southern Australian Tertiary, and one which can be tied in to the standard planktonic P. Zones with considerable confidence.

Glauconite dates, while appearing internally consistent for a given suite of rocks, are frequently too young by a factor that may vary between different suites of rocks. For the present group of samples this factor appears to be of the order of 16%, while for a group of glauconites from the Cretaceous of the Great Artesian Basin in New South Wales (Byrnes _et al_., 1975) the factor is about 7%. These differences may be due in part to a lack of accuracy in the radiometric time scale, and this possibility could be tested with other suites of southern Australian glauconites which are also biostratigraphically well dated and correlated.

It may also be possible to attempt to correlate the degree of lowering of the K-Ar age with the stage of development of the non-expandable crystal lattice of the glauconites.

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