core ends at 1425 cm. Three microtektites were recovered from the bottom of the undisturbed core and none were found above that depth. Thus the microtektite layer occurs below 1425 cm in the location at which this core was taken. The paleomagnetic stratigraphy of this core is not clear; however, paleontological correlations with other cores containing better paleomagnetic stratigraphies indicate that the M-B boundary probably occurs at 1180 cm in this core (*7*). Extrapolation from this boundary indicates that the Ivory Coast microtektites fell to the ocean floor more than 840,000 years ago. Thus evidence from both core V19-297 and core K9-56 indicates an age of deposition distinctly older than that of Australasian microtektites.

Potassium/argon ages of ash layers in core V19-153 (*8*) indicate that the microtektites in this core (Fig. 2) were deposited about 1.2 million years ago rather than 0.7 million years ago as suggested by the magnetic stratigraphy. We have just shown, however, that the microtektites from this core have a fission track age of 0.71 million years, thus confirming the age of deposition determined by paleomagnetics.

Australasian tektites have K/Ar (*9*) and fission track ages (*10*) of about 0.7 million years, and Ivory Coast tektites have K/Ar ages (*9*) and fission track ages (*11*) between 1.0 and 1.2 million years. The fission track ages of the microtektites agree very well with K/Ar and fission track ages of tektites from the tektite strewn fields to which they were previously linked; hence, the fission track ages of these microscopic glassy objects strongly support the conclusion (*1*, *12*) that they are microtektites and that they belong to previously known strewn fields.

For each microtektite group the measured fission track ages and the stratigraphic ages agree within their limits of error. Thus, there appears to be no difference between the age of formation and the age of deposition.

Despite K/Ar, fission track, and stratigraphic ages indicating that the tektites from the Ivory Coast strewn field are distinctly older than the tektites from the Australasian strewn field, Chapman and Scheiber (*13*) have proposed (on the basis of chemical similarity between Ivory Coast tektites and a small group of Australasian tektites) that the Ivory Coast tektite strewn field is part of the Australasian strewn field. However, the measured fission track ages of 0.71 ± 0.10 million years for the Australasian microtektites and 1.09 ± 0.20 million years for the Ivory Coast microtektites are distinctly different beyond what may be attributed to experimental errors. It is thus clearly demonstrated that the Ivory Coast tektite strewn field is older than the Australasian strewn field.

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## Ages of Fossil Penguins in New Zealand

Abstract. *The age of a New Zealand specimen generally believed to represent the oldest known penguin, hitherto considered early Eocene (Heretaungan), has been restudied by the New Zealand Geological Survey and is early Miocene. The oldest known penguins are from the late Eocene. The reported great range of a single species,* Palaeeudyptes antarcticus, *from late Eocene to late Oligocene or early Miocene (Kaiatan to Waitakian) is not acceptable. Dating of some other specimens is less precise than previously reported.*

Review of the fossil penguins of New Zealand indicates that the generally accepted ages of some of them are dubious or incorrect. A poorly preserved femur from Gore Bay, unidentifiable beyond pertinence to the Spheniscidae, was stated by Finlay (*1*) on indirect evidence to be Heretaungan, early Eocene, in age. This has been accepted in all subsequent references [for example, (*2*)] as the oldest known penguin. Its age has been reinvestigated (*3*), and the specimen is from the Pareora Series (Otaian to Awamoan stages) of the early Miocene although redeposition from the underlying Landon Series is possible. In either case it is not the earliest but one of the latest known fossil penguins from New Zealand.

The oldest known penguins are from the late Eocene of New Zealand (Kaiatan, Runangan, or both) and Australia [Blanche Point marls (*4*)].

In a quarry at Burnside, immediately west of Dunedin, two relatively good specimens of penguins were found in a lower formation, now designated as Burnside mudstone, and six poorly preserved fragments were found in an upper formation now known as the Concord greensand. Marples (*5*), the leading student of New Zealand fossil penguins, referred all of these specimens to *Palaeeudyptes antarcticus* Huxley, 1859, and considered the age of Burnside ("marl") specimens to be Kaiatan and that of the Concord ("greensand") specimens to be Waitakian. The indicated range, late (not latest) Eocene to late Oligocene or early Miocene, would be the greatest known for any species of bird and one of the greatest for any vertebrate. On restudy it appears that the specimens probably represent more than one species and that none can be confidently referred to *Palaeeudyptes antarcticus*. Brodkorb (*6*) placed the two Burnside specimens in a distinct species, *Palaeeudyptes marplesi*, which is probably valid for the holotype. The other Burnside and Concord specimens cannot be clearly identified to species on present evidence.

The Burnside mudstone is in part Kaiatan and in part Runangan (*7*), and the penguins from it may be of either age. The Concord greensand is Waitakian, but its microfauna is in part redeposited from the Burnside mudstone (*7*), and there is a strong possibility that its penguins are also derived from the older formation. Thus the specimens from the two formations in this quarry probably do not represent a single species, probably did not live over the long Kaiatan-Waitakian span, and may well all be of nearly or even precisely the same age.

The holotype of the first fossil penguin ever described, *Palaeeudyptes antarcticus* Huxley, 1859, came from the vicinity of Kakanui and has been generally considered Whaingaroan, early Oligocene, in age, as probably derived from the formation now called McDonald limestone (*8*). Such origin does not exclude the possibility of its being of Duntroonian, middle or late Oligocene age. From the scanty original data it seems at least equally probable that the specimen was in what is now called the Otekaike limestone, typical Waitakian, late Oligocene or early Miocene. It is also possible, but apparently less probable, that it was in the Totara limestone, Runangan, late Eocene. At present no specimens other than the holotype can be certainly referred to this species.

*Platydyptes novaezealandiae* (Oliver, 1930), considered to be probably Waitakian (*5*), late Oligocene or early Miocene, could as well be Duntroonian, middle or late Oligocene. *Platydyptes amiesi* Marples, 1952, and *Korora oliveri* Marples, 1952, were described as from the Waitakian, late Oligocene or early Miocene, without explicit evidence as to age (*5*). The age assignment is acceptable on Marples' authority. The usual assignment of *Pachydyptes ponderosus* Oliver, 1930, to the Runangan, latest Eocene, is almost certainly correct. Nor is there any doubt that *Archaeospheniscus lowei* Marples, 1952, *A. lopdelli* Marples, 1952, and *Duntroonornis parvus* Marples, 1952, are Duntroonian, middle or late Oligocene in age.

These changes in the dating of New Zealand forms considerably dilute the data hitherto used in reference to penguin distribution [for example, (*9*)]. However, they do not introduce any positive evidence against Stonehouse's conclusions.

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## Ionic Radon Solutions

Abstract. *Radon is oxidized between —195° and 25°C by chlorine fluorides, bromine fluorides, iodine heptafluoride, and* $NiF_6^{2-}$ *ion in hydrogen fluoride with the formation of stable solutions of radon fluoride. Electromigration studies show that the radon is present as a cation, possibly* $Rn^{2+}$ *or* $RnF^{+}$*, in several conducting solutions.*

Radon fluoride does not closely resemble krypton or xenon fluorides, which are volatile at room temperature and dissolve in many solvents as molecular species. Weinstock (*1*) suggested that ionic bonds might be present in the radon compounds, in contrast to covalent bonds in the krypton and xenon compounds, since radon fluoride is involatile in vacuum below 200°C and the first ionization potential of radon (10.75 volts) is lower than that of krypton (14.00 volts) or xenon (12.13 volts). Solutions of radon fluoride in chlorine trifluoride, bromine trifluoride, and bromine pentafluoride solvents have been prepared (*2*); these offer new possibilities for exploring the chemistry of radon and differentiating between bond types. Some further studies of the oxidation of the element by halogen fluorides and metal fluorides are described in this report. Electromigration experiments are also described, which show that oxidized radon is a cation in several of the fluoride solutions.

Table 1. Free energies of reduction of some halogen and metal fluorides.

| Reaction | $\Delta G^\circ_{298}$ (kcal/ mole) | References |
|---|---|---|
| $ClF_5(l) \rightarrow ClF_3(l) + F_2(g)$ | 6.0 | (*8*) |
| $2ClF(l) \rightarrow Cl_2(g) + F_2(g)$ | 13.6 | (*8*) |
| $IF_7(l) \rightarrow IF_5(l) + F_2(g)$ | 13.7 | (*9, 10*) |
| $ClF_3(l) \rightarrow ClF(l) + F_2(g)$ | 21.4 | (*8*) |
| $BrF_5(l) \rightarrow BrF_3(l) + F_2(g)$ | 27.0 | (*8*) |
| $2BrF(g) \rightarrow Br_2(l) + F_2(g)$ | 35.3 | (*8, 9*) |
| $BrF_3(l) \rightarrow BrF(g) + F_2(g)$ | 39.9 | (*8, 9*) |
| $AsF_5(l) \rightarrow AsF_3(l) + F_2(g)$ | 61.2 | (*11, 12*) |
| $IF_5(l) \rightarrow IF_3(g) + F_2(g)$ | (79)* | (*9, 10*) |
| $SbF_5(l) \rightarrow SbF_3(s) + F_2(g)$ | (90)* | (*13*) |

* Estimated value.

Samples of gaseous $^{222}Rn$ (0.5 to 28 mc) were collected from a 30-mc radium chloride solution in a metal vacuum line, dried over calcium sulfate, and condensed in a cold trap at —195°C. After radiolytic hydrogen and oxygen were pumped off, the samples were distilled at —78°C into Kel-F test tubes that contained 0.5 to 3.0 ml of the following purified reagents frozen at −195°C: $ClF$, $ClF_3$, $ClF_5$, $BrF_3$, $BrF_5$, $IF_5$, $IF_7$, $HF$, $AsF_5$, and $SbF_5$; equimolar $Br_2$ and $BrF_3$; 5 mole percent $BrF_3$ in HF, $BrF_5$ in HF, and $BrF_3$ in $IF_5$; 0.1 mole percent $K_2NiF_6$ in HF. The mixtures were melted and then stirred with a Vortex stirrer. Solutions with very high vapor pressures ($ClF$, $ClF_5$, and $AsF_5$) were kept cold with refrigerant baths, whereas the others were allowed to warm to room temperature. After 1½ hours, the solutions were vacuum distilled to approximately one-third of their original volumes or to dryness. Distillate fractions and residues were allowed to stand for 3 hours to permit radon daughters ($^{214}Pb$ and $^{214}Bi$) to reach equilibrium again, then total gamma activity was determined. The radon remained behind as involatile radon fluoride in all of the solutions except $IF_5$, HF, $AsF_5$, and $SbF_5$. In the latter solutions, the radon was not oxidized and appeared in the first distillate fractions.

The composition of the radon fluoride has not yet been determined, since only very small amounts of solid have been obtained by evaporating the solutions to dryness [0.2 $\mu$g or less in these experiments and 2.0 $\mu$g or less