Stratigraphy and chronology of late Quaternary tephras in Lake Maratoto, Hamilton, New Zealand

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Abstract A 3 m piston core from Lake Maratoto (37°53'S 175°18'E) near Hamilton shows at least 12 thin, well-preserved distal airfall tephras intercalated with humic copropel (dy) deposits. Most of the tephras have been identified by their dominant ferromagnesian mineralogy, their stratigraphic position, and 5 radiocarbon dates. The majority of the tephras are derived from the Taupo and Okataina Volcanic Centres, while others originate from Mayor Island, Tongariro, and possibly Mount Egmont sources. The tephras dated (Libby ages) are: Taupo Pumice (Wk215) 1730 ± 60 years B.P., Tuhua Tephra (Wk214) 6210 ± 70 years B.P., Mangamate Tephra (Wk213) 10 120 ± 100 years B.P., and Rerewhakaaitu Ash (2 dates) (Wk237) 14 700 ± 220 years B.P. and (Wk238) 14 700 ± 180 years B.P.

The identification of the tephras in Lake Maratoto extends the previously mapped distribution of North Island post-glacial (Holocene) tephras, and complements studies of soil genesis and weathering in the Waikato region. The core also provides a geochronological basis for further multidisciplinary studies of the paleolimnology, paleoclimate, and sedimentological history of the region.

Keywords pyroclastics; carbon dating; paleolimnology; late Quaternary; tephrochronology; Hamilton Basin; Lake Maratoto

INTRODUCTION

As part of an investigation of the paleolimnology of the small lakes in the Hamilton (or Middle Waikato) Basin a sediment core has been taken from Lake Maratoto near Hamilton (Fig. 1). The core reveals a succession of distal, well-preserved, discrete tephra layers separated by organic lake sediment. In this paper the tephras are identified on the basis of their stratigraphic relationships and dominant ferromagnesian mineralogy. New radiocarbon dates are reported for 4 of them.

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LAKE MARATOTO SAMPLE SITE

Lake Maratoto is one of a number of small lakes in the Hamilton Basin formed by aggradation of the ancestral Waikato River system (McCraw 1967). It occupies an embayment in low Pleistocene hills dammed by alluvium of Hinuera Formation (Hinuera–2) deposited mainly between 20 000 and 17 000 years ago (McGlone et al. 1978). The lake lies on the perimeter of the Rukuhia peat bog (Fig. 1) and is dystrophic. Its paleolimnology has been described by Green (in press).

The core was taken in 4 m of water from the northern end of the lake (N65/813353*) using a hand operated piston corer with 4 m of 60 mm I.D. PVC tubing. It was transported to the laboratory in the tube, split longitudinally, and sampled immediately.

DESCRIPTION AND STRATIGRAPHY OF THE CORE

The core, which was not compressed during sampling, comprises about 3 m of very fine grained brownish-black organic lake sediment (known as humic copropel, or dy) intercalated with at least 12 thin (2–40 mm) distinct layers overlying basal greenish-grey muds (Fig. 2). Most of the layers are pumiceous and highly vitric, occasionally finely bedded, and range from fine ash to very fine lapilli. Their total thickness is 20–25 cm. The layers, exceptionally well preserved and clearly distinguished from the dy by their contrasting colour and lithology, are unweathered and unmixed, and hence are considered as primary airfall tephra deposits.

The stratigraphy and dominant ferromagnesian mineralogy of the tephras, and their probable identification, are given in Fig. 2. The tephras can be readily related to volcanic source areas from their stratigraphy and mineralogical assemblages (as in

* Grid reference based on national thousand-yard grid of the 1:63 360 topographical map series (NZMS 1).

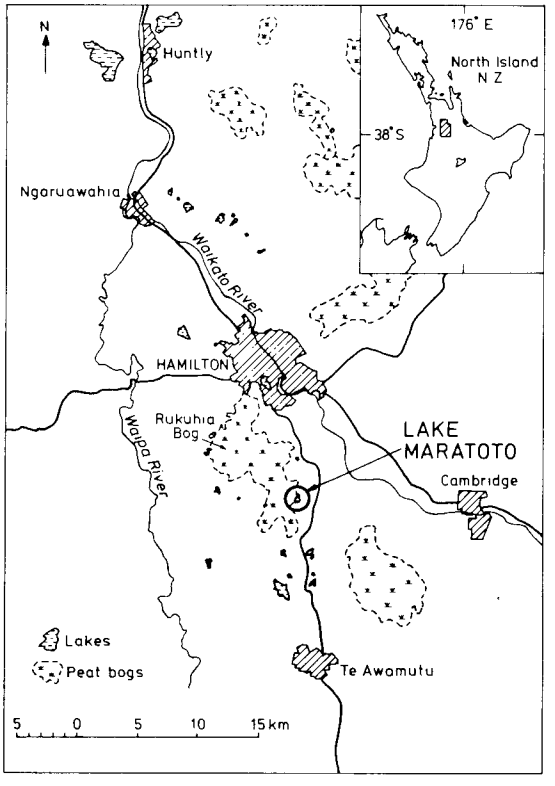

Fig. 1 Location of Lake Maratoto in the Hamilton (Middle Waikato) Basin.

Fieldes & Weatherhead 1968; Ewart 1971; Kohn 1973; Kohn & Neall 1973; Topping & Kohn 1973; Ewart et al. 1975; Kohn & Glasby 1978). Most of the tephras originate from the Taupo and Okataina Volcanic Centres, and others are derived from Mayor Island, Tongariro, and possibly Mount Egmont sources. Further work to identify the unnamed deposits in Fig. 2 is proceeding.

When considered in conjunction with stratigraphic position, aegirine, cummingtonite, olivine, and biotite are useful as marker minerals for 4 of the tephras. Aegirine is diagnostic of a peralkaline eruptive from Mayor Island (Hogg 1979) named Tuhua Tephra (Hogg & McCraw in prep. "Late Quaternary tephras of Coromandel Peninsula, New Zealand: the Whangamata Ash"). Cummingtonite, which originates from the Haroharo Complex in the Okataina Volcanic Centre (Ewart 1971; Ewart et al. 1971; Kohn 1973; Ewart et al. 1975), occurs in moderate amounts (15%)* in 1 tephra which is tentatively identified as ?Rotoma Ash. Olivine, recognised in some eruptives in the Tongariro Volcanic Centre (Clark 1960; Ewart 1965; Wood 1976; Cole 1978), is abundant (34%) in the dark greyish-black tephra below Opepe Tephra (Fig. 2). This tephra is therefore considered to represent the Mangamate Tephra Formation of Topping (1973). The dark colour suggests that the Te Rato Lapilli Member is represented, but the ferromagnesian mineralogy also resembles that of the Poutu Lapilli Member. Consequently the actual member correlative for this tephra is still uncertain. Biotite is the dominant (38%) ferromagnesian mineral in the lowest tephra of the core and hence is correlated with Rerewhakaaitu Ash (Cole 1970; Topping & Kohn 1973; Kohn & Glasby 1978).

CHRONOLOGY

To confirm the identifications of 4 of the tephras, and to determine accurate rates of sedimentation in the lake, samples of dy were ^{14}C dated (Table 1). Slices 1 cm thick were extracted from immediately beneath Taupo Pumice (Wk215†), Tuhua Tephra (Wk214), and Mangamate Tephra (Wk213), and give maximum ages ; 2 samples, one taken above (Wk237) and the other below (Wk238) Rerewhakaaitu Ash, give identical minimum and maximum ages for this tephra (Table 1). Further radiocarbon dates are being determined.

Table 1 Radiocarbon ages of 4 tephra formations identified in the core from Lake Maratoto.

Tephra	^{14}C Age * Years B.P.	University of Waikato Radiocarbon Dating Laboratory No.
Taupo Pumice	1730 ± 60	Wk215
Tuhua Tephra	6210 ± 70	Wk214
Mangamate Tephra (?Te Rato Lapilli Mb.)	10 120 ± 100	Wk213
Rerewhakaaitu Ash	14 700 ± 220 14 700 ± 180	Wk237 Wk238

Libby age based on mean life of 8033 years.

The youngest tephra in the core is Taupo Pumice, and the age determined (Table 1) is consistent with many other dates derived for this tephra elsewhere (Healy 1964). Similarly, a previous date on Tuhua Tephra of 6280 ± 70 years B.P. (Wk106 from Hauraki Peat Bog, Hogg 1979) closely matches the date determined for this tephra in Lake Maratoto (Table 1).

* Relative abundances (by point-count) expressed as a percentage of the total ferromagnesian silicate mineral assemblage in the 2–4ϕ fraction.

†Numbers prefixed Wk refer to the University of Waikato radiocarbon dating laboratory number.

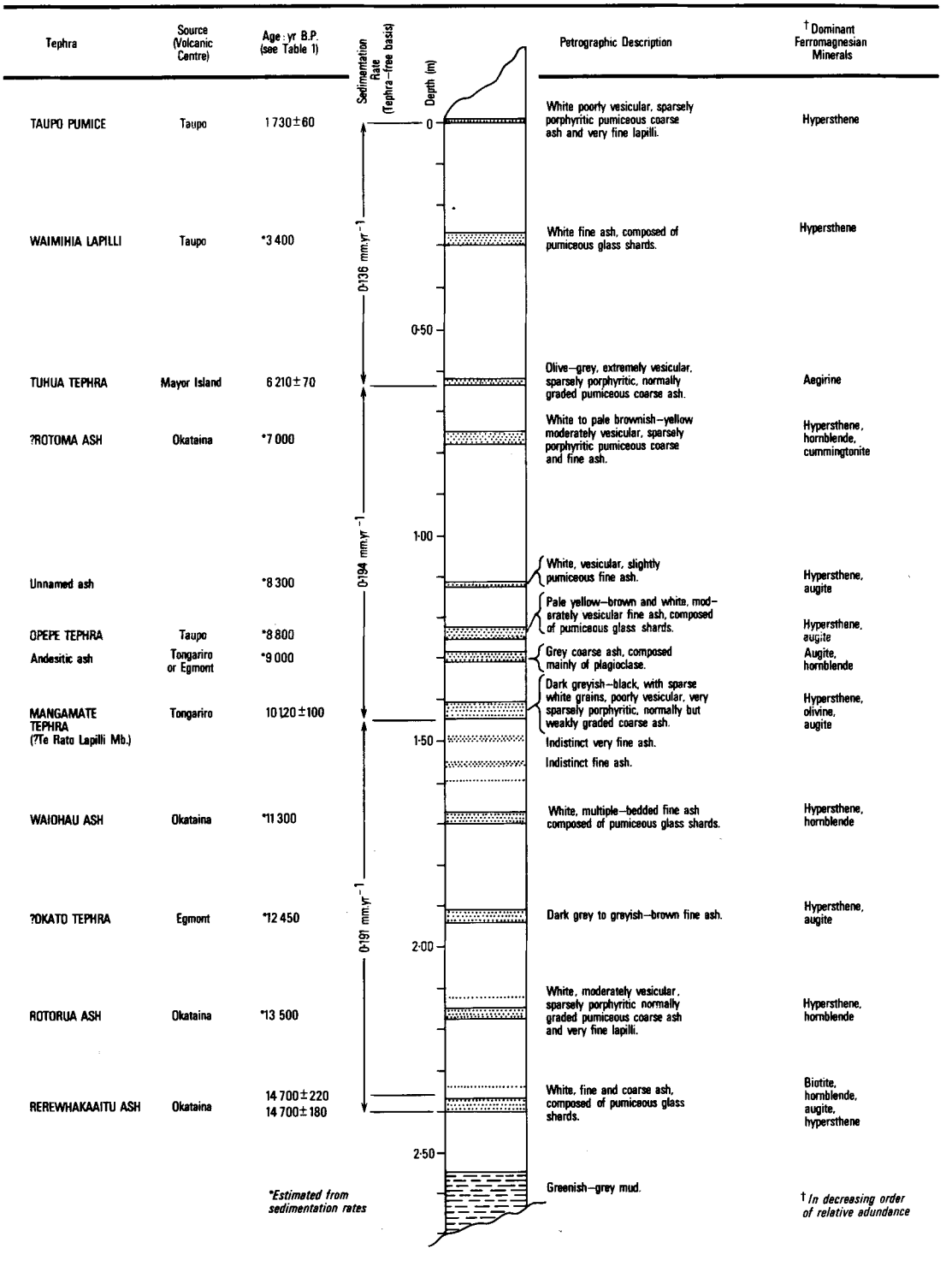

Fig. 2 Stratigraphy and chronology of late Quaternary tephras in the Lake Maratoto core. Tephrå layers shown in stipple.

The date (Wk213) of 10 120 ± 100 years B.P. for Mangamate Tephra Formation (?Te Rato Lapilli) in the Lake Maratoto core is only slightly older than an age (NZ1372) of 9780 ± 170 years B.P. given by Topping (1973) for the near-source Mangamate Tephra.

The only published date for Rerewhakaaitu Ash is (NZ716) 14 700 ± 200 years B.P. (Pullar et al. 1973), identical to those (Wk237 and Wk238) from Lake Maratoto (Table 1).

Estimates of ages of other tephras are interpolated from sedimentation rates (assumed to be constant) between the dated sections of the core (Fig. 2). The identification of ?Rotoma Ash cannot be confirmed from the estimated age (near 7000 years B.P.) because previously published dates (Grant-Taylor & Rafter 1971; Pullar & Heine 1971; Pullar et al. 1973; Vucetich & Pullar 1973) on this tephra and the younger Mamaku Ash are ambiguous. The tentative identification of ?Okato Tephra is based mainly on an estimated age of about 12 450 years B.P. (Fig. 2) which matches a previously published date for this tephra of (NZ1143) 12 550 ± 150 years B.P. (Neall 1975).

IMPLICATIONS AND FURTHER WORK

Identification of the tephras in Lake Maratoto enables tephra distribution to be extended beyond that mapped previously for the Waikato region (e.g., Pullar 1967; Vucetich & Pullar 1969; Pullar & Birrell 1973a; Pullar et al. 1973). Their occurrence also provides new information for pedological studies of soil genesis and weathering (Jessen 1977; Lowe 1979). The component tephric units of the Tirau and Mairoa Ashes, whose composite nature is well established (Gibbs 1968; Vucetich & Pullar 1969; Pullar & Birrell 1973b; Hodder & Wilson 1976; Pullar 1978) but only partly resolved at a few sites (Pullar & Birrell 1973b), are difficult to identify because of post-depositional mixing and weathering in the soil-forming environment. These problems, which tend to increase as the deposits thin with distance from source, do not occur in the Lake Maratoto environment where the tephras are remarkably preserved as unweathered and discrete units.

In addition, the tephrostratigraphy provides a geochronological framework for paleolimnological and palynological studies currently in progress on the post-glacial sedimentology, and climatic and biological history, of the Hamilton Basin.

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