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VOLCANIC ASH BEDS IN THE WAIKATO DISTRICT

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INTRODUCTION

This report lies somewhere between the "pathfinder" variety and the completed account for the reason that the results of detailed mapping and identification are still being prepared for publication. For the younger beds less than 36,000 years we now know both the source and the distribution, but for the older ashes commonly referred to as the Hamilton ash, sources are unknown and a knowledge of distribution restricted to the Waikato district. The principal source is the Okataina volcanic centre with Taupo as a subsidiary (Healy, 1964; Thompson, 1964:44), and on this information, current mapping into the Waikato district proceeds from the east.

Under the circumstances of partly completed work it seems prudent to discuss relevant ash beds already known (Vucetich and Pullar, 1963:65-6; 1964:45-6) to introduce briefly current work by the same authors and by W. T. Ward, and then to relate all of this to previous work portrayed in a soil-forming ash shower map by Taylor (1953).

ASH STRATIGRAPHY

The beds are described in order of increasing age and with reference to the correlation line, Mamaku plateau-Parewera (Fig. 1). For some, descriptive names have had to be borrowed from Vucetich and Pullar (1963:65-6) until formal geographic names are allotted later.

Tarawera Ash

(erupted 1886 from Mt. Tarawera); Eastern Waikato District may have received a dusting but no sighting documented.

Kaharoa Ash

(erupted from Mt. Tarawera 930 ± 70 years before 1950): measurable deposit is about 1 in. on Mamaku plateau and about 2 in. at Waihi Beach. Fine white glassy grains have been noted in the surface peat at Hamilton and these could represent Kaharoa Ash.

Taupo Pumice (Fig. 2)

Largely Taupo Lapilli (Member 3 of Healy, 1965:65); erupted 130 A.D. from Waitahanui. Pronounced lobe at Tirau where the bed is 6 in. thick and thinning towards Hamilton. The lapilli may be angular and jagged and appear to be less yellow and more greyish white than those at Te Whaiti and further east, and as well, are more clear-glassy and honeycombed and so easier to crush in the hand. They are also less obviously vesicular and may have flow texture with flattened or eliptical vesicles. These attributes suggest a later phase in the eruption of the Taupo Lapilli regarded as an isolated shower (Ewart, 1963:399).

Air-fall Taupo Pumice at Hamilton is discussed in more detail by P. J. Tonkin (Appendix A).

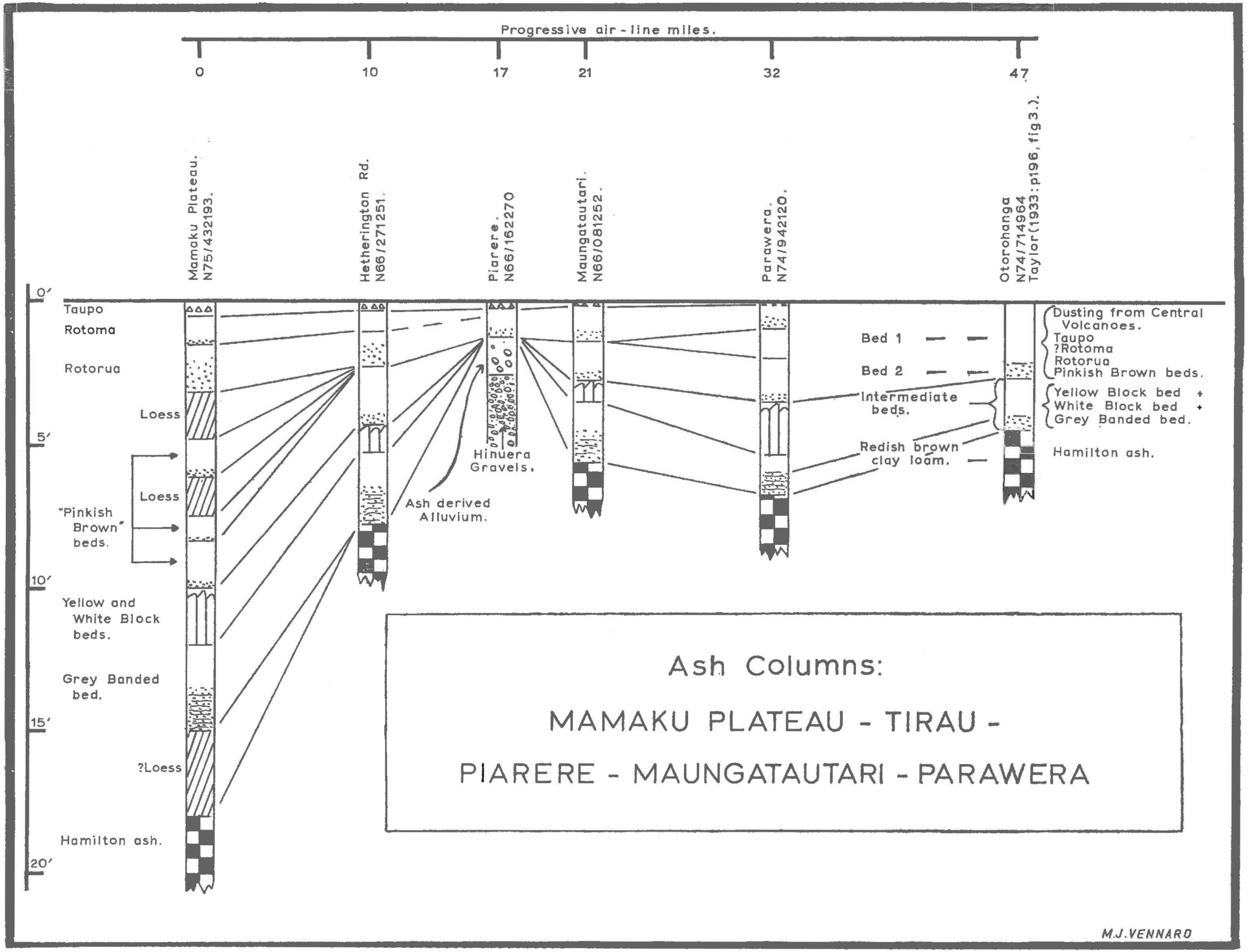

Figure 1: Ash columns on traverse from Mamaku plateau to Otorohanga. Otorohanga column after Taylor (1933).

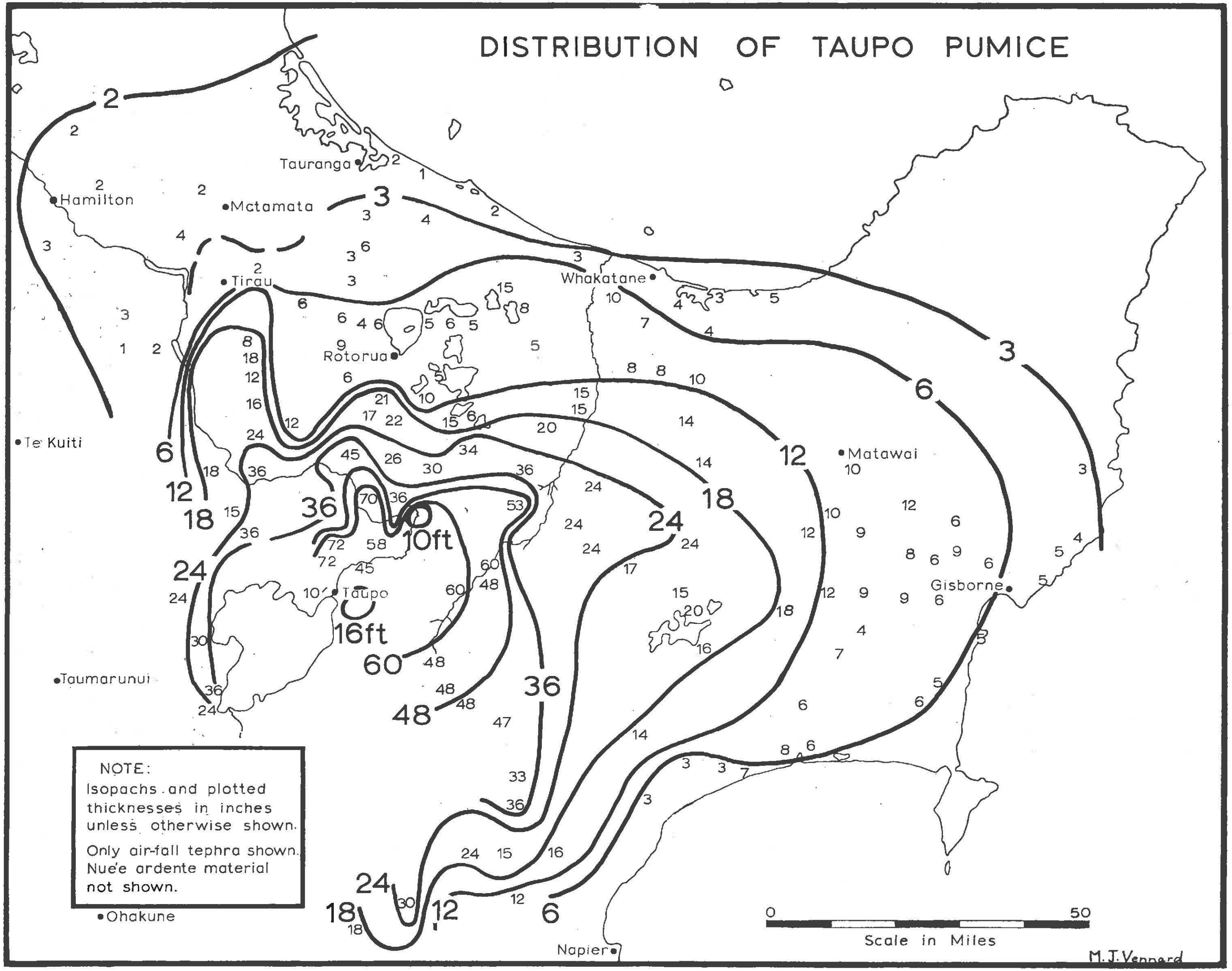

Figure 2: Distribution of Taupo pumice erupted AD 130. (Isopachs revised 1966).

Rotoma Ash (Fig. 3)

Erupted from Eastern end of Lake Rotoma ca. 8,000 years ago. At the source, mineral assemblage comprises plagioclase, quartz, hornblende, hypersthene and magnetite with hypersthene increasing towards the top. On Mamaku plateau, the upper part is blackish grey and the lower is a pale grey ash with a thin discontinuous layer of pale yellow fine ash (silt) at base. At Tirau, where the ash becomes incorporated in the soil, shower bedding is unrecognisable but the material is fluffy, loose and dry with a sharp break at 11 in. This ash is not identifiable with certainty west of the Mamaku plateau, but is thought to be associated with the sandy portions of topsoils, at least, as far west as Kiwitahi School near Morrinsville where a thickness of 6 in. was recorded.

Rotorua Ash (Fig. 4)

Erupted from Lake Tikitapu; date unknown but thought to be about 13,000 years ago. On the Mamaku plateau it is identified by its rusty lapilli, which at the summit, change sharply to small lapilli and coarse ash, and at Fitzgerald's Glade to coarse ash. At Tirau the bed becomes a yellowish brown fine sandy loam with grains of rusty coarse ash, but further west, the latter seem to disappear. It is likely, however, that Rotorua Ash mantles most of the eastern Waikato district. Eventually, refugia containing identifiable Rotoma and Rotorua ashes will be found.

Pinkish Brown Beds (Vucetich and Pullar, 1963:65; 70)

Three beds, the upper two of which are thought to have been erupted from near Mt. Tarawera about 20,000 years ago and the lower a little earlier from near Taupo. The lower bed is noted for chalazoidites (volcanic hailstones) particularly at Ngongotaha, Ngakuru basin, and at Oruanui near Wairakei. The beds have also been called "X" beds and "mauve" beds (op. cit.) but from extensive mapping are now known to be the same; also comprise part of the mantle of Late Quaternary brown ashes (a) (Healy et al, 1964). For purposes of this account they are referred to as "pinkish brown beds".

On the Mamaku plateau, the upper two of pale brown ash are separated by beds of loess (Fig. 1) and the lower is a grey greasy silt with a thin basal layer of white ash. At Tirau, the upper two collapse into a single bed and this along with the lower persists well into the eastern Waikato District (Fig. 1).

Yellow Block and White Block Beds (Vucetich and Pullar, 1963:65, 66, 70); Late Quarternary pumice block and lapilli beds (b) and (c) (Healy et al, 1964): erupted possibly from two centres at Matahina and Rotoehu about 27,000 years ago.

On Mamaku plateau (Fig. 1), the beds are recognised by their pale yellow rotten lapilli which on the Kaimai range and coastal hills from Te Poi to Tauranga and Katikati, change to reddish yellow small lapilli and coarse ash crushing easily to clay. At Tirau, the beds collapse to a pinkish brown or mauve hard sandy clay 4 to 19 in. thick, with marked vertical cracking and giving prismatic structure as in a paleosol; in road cuttings, the bed is marked by a "nick" sculptured by wind and rain. At Parewera, however, the bed protrudes as a firm massive silt loam with vertical cracks and reacts strongly to an allophane field test.

The pumice block and lapilli beds (b) and (c) differ from Rotoma Ash and Rotoiti Breccia in that they are dacitic in composition (Ewart and Healy, 1965; 26). They contain no quartz, but have plagioclase, hypersthene, augite and magnetite.

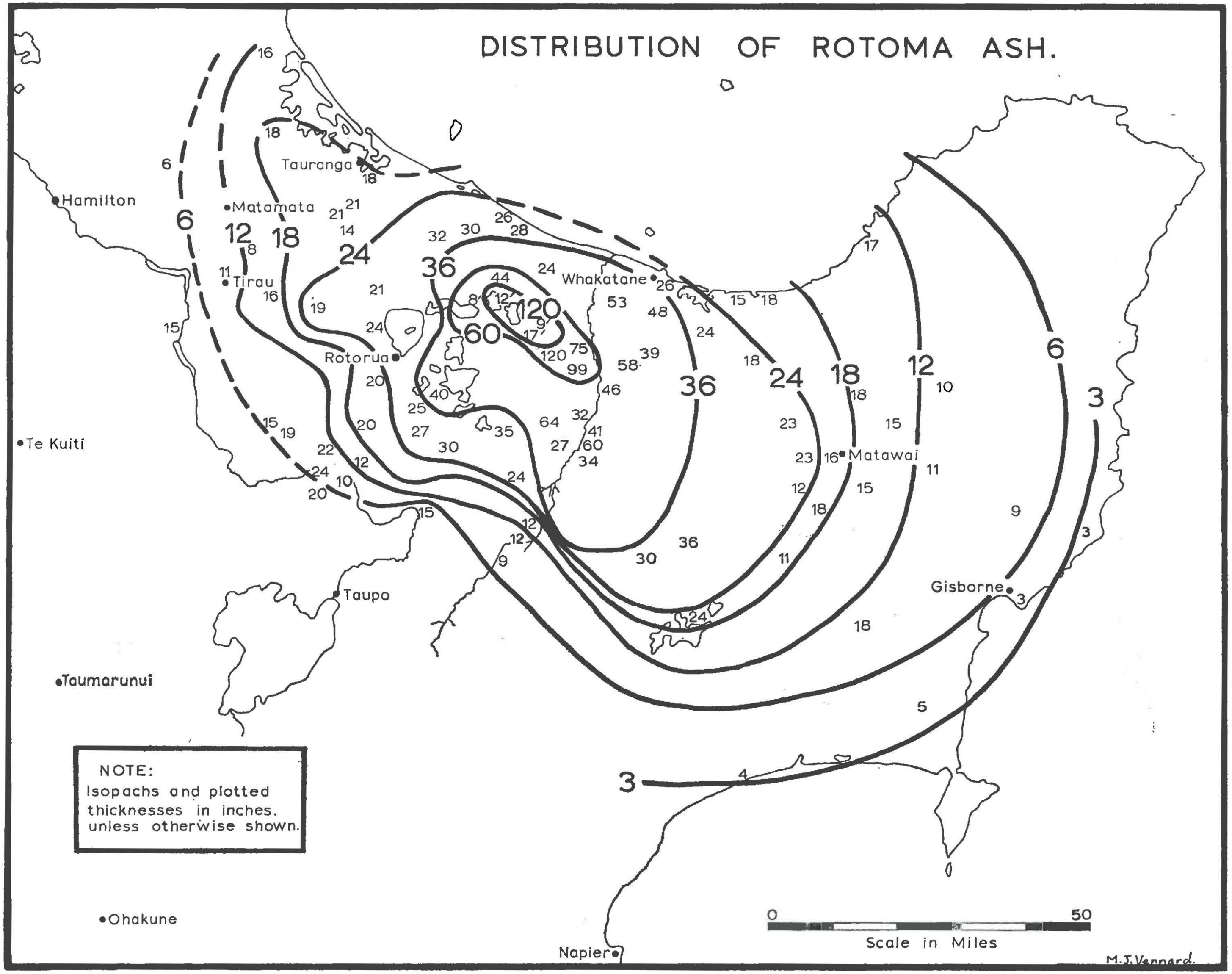

Figure 3: Distribution of Rotoma ash erupted ca. 8000 years ago. (Isopachs revised 1966)

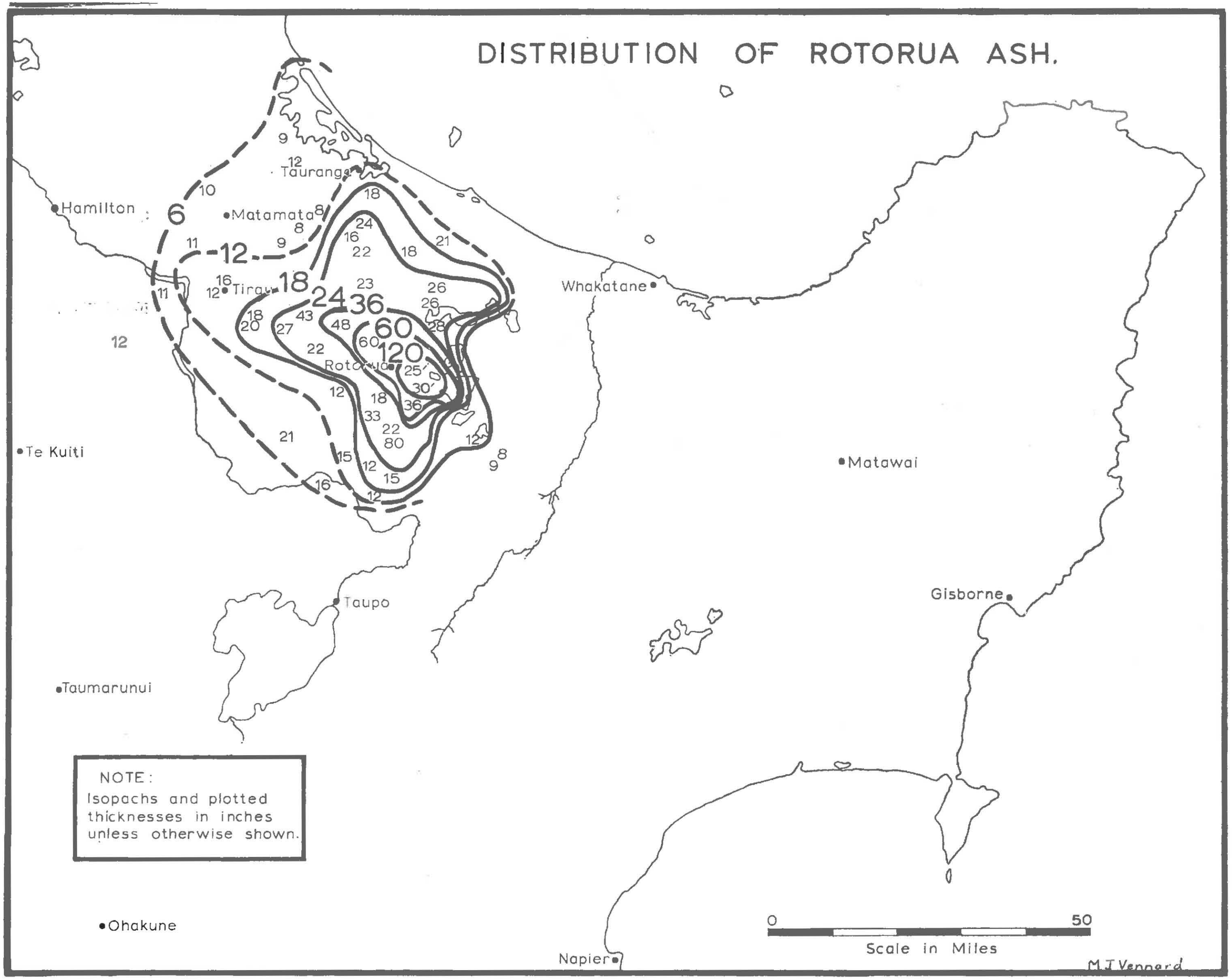

Figure 4: Distribution of Rotorua ash erupted ca. 13000 years ago. (Isopachs revised 1966).

Grey Banded Bed (Vucetich and Pullar, 1963:66, 70); Late Quaternary volcanic ash member (d) (Healy et al, 1964): Shower bedded ash associated with the Rotoiti Breccia eruption and erupted from a little north of Lake Rotoiti about 36,000 years ago. The mineral assemblage comprises plagioclase, quartz, hypersthene, hornblende, and magnetite (Ewart and Healy, 1965:26).

This bed of whitish grey ash is distinguished by its fine shower bedding which persists well into the Waikato District; the contact with the underlying brown and reddish brown Hamilton beds is always clear and sharp.

Relationship of Previous Work to Current Work

In this report, previous work refers more to that of Taylor and Grange and distribution to that of Taylor's map (1953). For convenience, previous work is set up and then examined and criticised.

Tirau Ash

Not defined in Fleming (1959). Mentioned by Taylor (1953:12) as belonging to ash beds of the third period of accumulation and of the intermittent type . . . "The Tirau ash, recognised from the Waikato to Tirau, passes underneath the Taupo ash towards Taupo. It is hypersthene-rhyolitic ash attributed to a source near Taupo. It feathers out westwards beneath the more andesitic Mairoa ash . . ." Not otherwise described except as a soil formed from it, the yellow brown loams. (General Survey of the Soils of the North Island, New Zealand, p. 35) . . ."Topsoils of the yellow brown loams are grey or brown in colour, are very friable, and have a soft, granular or crumb structure. The subsoils are yellow-brown to brown, are very friable, and on handling break down readily almost to powder. When wet, the soils feel somewhat slippery rather than sticky and it was early recognised that they contained a clay fraction high in alumina (allophane) . . ." A further commonly known field criterion is that the subsoil is soft and springy yielding to gentle pressure with the fingers.

Even so, it is not at all certain what ash beds make up the Tirau ash, but in 1962, Dr N. H. Taylor informed the writer that near the Soil Bureau reference site in Hetherington Road, Tirau, he would regard the top 27 in. as the Tirau ash and the underlying 6 feet as his "intermediate beds". Later correlation of soil horizons with ash beds suggests that the top 27 in. most likely comprises the Taupo, Rotoma, and Rotorua ashes and the lower 6 feet the pinkish brown beds, yellow block and white block beds and grey banded bed. At this site, Tirau silt loam has been thoroughly documented (Wells, N.Z. Soil Bureau, pers. comm.), and for all horizons, the sand and clay mineralogy/and spectographic analysis reveal little difference except for relatively high and low Mn in the top 3 in. and bottom 24-30 in. respectively; but this element along with Ba and Sr can be much affected by weathering and leaching and so are of little diagnostic value. In the sand fraction, andesine feldspar is common, volcanic glass very abundant and hypersthene scarce to rare, and in the clay fraction, allophane is 100%. Hypersthene, however, is common in the top 3 in. of Taupo sandy silt at Wharepaina, 5 miles south of Waiotapu, and in Kaingaroa loamy sand at Iwitahi, 20 miles south east of Taupo; but it is likely a higher proportion of Upper Taupo Pumice is present at these sites than at Tirau and may account for differences in the amount of hypersthene in the surface soil.

With spectrographic analysis heretofore some doubt has always remained as to whether the results purport to refer to the ash beds sampled, but with our present knowledge of tephrachronology the risk of "grab" sampling should be minimised.

The age of Tirau ash is unlikely to be older than the Rotorua Ash of about 13,000 years. Casual reference is sometimes made to a radiometric age of 33,000 years but this figure refers to charcoal from logs buried in ignimbrite drift on the Tapapa-Putaruru Road and well below the Rotorua Ash (see Healy, 1964:37).

Waihi Ash

Not defined in Fleming (1959). Mentioned by Taylor (1953:12) as belonging to intermittent ash beds of his third period ". . . to the east of the Hauraki depression the ash coarsens and thickens to 5 or 6 ft. and the mineral assemblage changes to hornblende andesite. This is the Waihi ash which margins the Bay of Plenty and East Cape areas, and consists of at least two separate beds . . ." The distribution of this ash on Taylor's map suggests that Waihi ash is a composite of Taupo Pumice, Rotoma Ash, Rotorua Ash, pinkish brown beds, yellow block and white block beds, and grey banded bed, all thinning steadily from a total of 12 ft. at Tauranga to 7 ft. at Katikati and 6 ft. at Waihi. The mineralogy given by Taylor suggests that the dacitic yellow block and white block beds would have to be present, and in the field, it is the reddish yellow lapilli of these beds that distinguish Waihi ash from Tirau ash and Mairoa ash. At Tauranga the beds collapse into a single unit and west of Katikati the lapilli have become reduced to an ash grade which then makes the unit difficult to identify. The two separate beds mentioned by Taylor are most likely the yellow and white block beds and the grey banded bed. In the Tairua Forest on eastern Coromandel Peninsula, Mr J. E. Cox (pers. comm.) said he would regard the grey banded bed as being a part of Waihi ash.

Mairoa Ash

Healy in Fleming (1959:202) writes . . . "name applied by Grange (1931) to the topmost ash shower recognised as 'Shower A' by Taylor (1930) in the Mairoa district, near Te Kuiti. It is a brown, andesitic ash with an average thickness at Mairoa of 2 ft. . . . Grange stated that the ash contains felspar, quartz, augite, hornblende, hypersthene and magnetite, and suggested an origin from both andesitic and rhyolitic sources. . . . Later Grange and Taylor (1932) stated that the ash was derived chiefly from Egmont, with some rhyolite from Rotorua and Taupo centres, and mapped its distribution in Te Kuiti, Mairoa, Te Awamutu, and Kawhia districts. . . . The name Mairoa Ash should be applied to the topmost volcanic ash of the Mairoa district. If, as Grange suggests, it originated from more than one centre, it was the product of more than one volcanic shower, and is composite. . . ."

At Parewera (Fig. 1) a little east of Te Awamutu, the top 24 in. comprises collectively Taupo Pumice, (?) Rotoma Ash, Rotorua Ash, and the uppermost "pinkish brown beds" now collapsed into a single bed, and so is composite as suggested by Healy.

W. T. Ward (in press) who has made a careful field study of ash beds in the Waikato district does not regard the Mairoa Ash and the Hamilton Ash as separate showers but as differently weathered forms of the same parent ash and that the Hamilton is derived from the Mairoa shower by weathering and elutriation of clay. Furthermore, near Maungatautari School (Fig. 1) a common column has been examined by both

Ward and Vucetich and Pullar; the former would regard the top 52 in. as Mairoa, whereas the latter have mapped the upper portion of 41 in. as including Taupo Pumice, (?) Rotoma Ash, Rotorua Ash, pinkish brown beds, and a fine ash cap to the yellow block and white block beds.

Vucetich and Pullar cannot support the contention by Ward that the Mairoa ash belongs to the Hamilton ash; so far as the stratigraphy has been examined in the eastern Waikato district, Mairoa is a composite of known ash beds emanating from Rotorua and Taupo sources.

In soils formed from volcanic ash, radioactivity tends to decrease with increasing age; also soils of andesitic origin are less radioactive than those from rhyolitic parent material (McCallum, 1962; 189: Taylor and Pohlen, 1962:32, Fig. 3). Gibbs and McCallum (1955) have measured the radioactivity of some soils but, unfortunately, none were selected from the Waikato District; it would have been interesting to have compared the results from Tirau ash, Waihi ash, and Mairoa ash.

Taylor's Bed 2 and Intermediate Beds

At Otorohanga, Taylor (1933; 196, Fig. 3) has drawn up a column, a kind of reconstructed universal for the northern King Country; Bed 2 is a whitish fine sand with a layer of chalazoidites at its base and the intermediate beds are bottomed by a 6 in. layer of whitish fine sand resting on reddish brown clay loam. This column is similar to that obtained by Vucetich and Pullar at Parewera 15 miles to the north east (Fig. 1); Bed 2 can be correlated with the lowermost pinkish brown beds and the Intermediate Beds with the yellow block and white block beds plus the grey banded bed.

At Maungatautari (Fig. 1), Ward considers Bed 2 to be the 30 in. layer lying immediately above the Hamilton beds and below the Mairoa ash whereas we have mapped the same layer as the grey banded bed equivalent to Taylor's Intermediate Beds. Thus at this site it would appear that Ward has miscorrelated Taylor's Bed 2.

In the King Country, Bed 1 contains augite which suggests a dusting from sources other than Rotorua and Taupo. At the Soil Bureau reference site at Iwitahi, east of Taupo, the top 3 in. of Taupo Pumice has an unusual amount of augite also and its presence at both widely separated places suggests central North Island volcanoes as a source.

Loess

Loess, which is difficult to distinguish from air-fall ash, may turn out to be fairly widespread in the Waikato District. On the Mamaku plateau, sudden thickening of beds which should have been thinning out aroused suspicions of loess; at Arapuni, loess may be up to 5 ft. thick; on lowlands near Matamata, the topsoils possess an unusually hard and brittle consistence unlike the soft, mellow and springy properties of yellow brown loams and this difference suggests loess. J. D. McCraw (pers. comm.) informs the writer that loess is now being found at Hamilton and is detected by lensing of the deposit. Hand-over-hand work along with detailed soil surveys may yet establish loess as an important soil-forming factor on the Waikato fan.

Hamilton Ash

Under "Hamilton shower" Schofield in Fleming (1959:118) writes . . . "A volcanic ash bed giving rise to a 'dark-brown heavy loam . . . on the low hills at Hamilton and southward to within 4 miles of Te Awamutu." No more specific type locality was given.

Later Grange et al. (1939:16) refer to Hamilton showers (a change to the plural) and again to Older Hamilton Showers which yield similar soils. Thus more than one shower has been mapped as a Hamilton Shower and differentiation into separate showers may be difficult. "The ash is andesitic in composition . . . hornblende is by far the most important ferromagnesian mineral. . . ."

W. T. Ward has undertaken a detailed field study of Hamilton beds in the Waikato District. In his Hamilton Ash formation, he has mapped 8 beds along with a number of variants, and underneath but separated by a persistent unconformity, he has proposed another formation comprising 17 beds. Because of strong weathering, Ward was unable to adopt the mapping convention of Vucetich and Pullar whereby a formation consists of a soil or fossil soil capping unweathered ash and both representing the products of an eruptive event. Instead, he employed pedological features as differentiating criteria in separating beds and these include colour (original and rubbed), consistence, clay veins, and clay aggregates comprising mainly cutans and halloysite nodules. Nevertheless, not all beds could be designated on individual criteria and their place in the stratigraphic column had to be established by laborious hand-over-hand inspection over innumerable sites.

At the Soil Bureau Reference site, Church Road, Te Rapa, the soil has been thoroughly documented down to a depth of 40 in. (Wells, N.Z. Soil Bureau, pers. comm.), for the sand fraction, quartz is common in all horizons and acid feldspar very common except in the 33-40 in. horizon where it is scarce; volcanic glass is very abundant in the top 24 in. and muscovite abundant in the lower 25-40 in. horizons; hornblende, augite and hypersthene are all rare though not all lower horizons were examined. The fine clay fraction contains 30% kaolin and 40% halloysite rising to 100% in the 33-40 in. horizon. Rare hornblende, augite and hypersthene do not agree with the statement in Fleming that the ash is andesitic with hornblende by far the most important ferromagnesian mineral.

Spectographic analysis shows Al, Cr, Co, Sr, Mn and Ti to be at a higher level in the top 6 in. than in the lower horizons with Mn relatively very high; the Cu level, however, is higher in the 16-40 in. horizons. Compared with Tirau ash most macro and micro-elements occur in greater amounts particularly Co and Sr; a further comparison with Egmont black loam, a yellow brown loam formed from andesitic ash with abundant augite, shows a higher level of Zr and Mn in the upper horizons, but the levels in the Egmont soil do not fall as in the Hamilton clay loam.

Hamilton ash is older than 36,000 years. Ward is inclined towards an age greater than the last glaciation of more than 70,000 years.

The source of Hamilton ash is unknown, and even after much detailed work in the Waikato, Ward is unable to indicate a volcanic centre. The search for a source will have to be abandoned from the Waikato and possibly resumed from coastal Bay of Plenty where similar beds have been recorded by the writer with total thicknesses of 12 to more than 16 ft. They also occur at Hicks Bay, near Tolaga Bay, Whangara, Pouawa, Mahia, Cole's Corner (Lake Rotoiti), and Maleme Road, Atiamuri; other similar beds have been noted in the Wellington District (Leamy, 1964) near Pahiatua (J. G. Bruce, pers. comm.), and at Kimbolton. But widely separated outcrops may make correlation almost impossible.

PROBLEMS OF MAPPING

Vucetich and Pullar consider that an ash bed should not be named until its approximate source has been located and its distribution plotted on a plan. Furthermore, to have any value as a means of correlating Quaternary terrestrial deposits and erosion surfaces, volcanic ash beds have to be treated as representing an eruptive event, and for practical purposes of mapping, should have a soil or fossil soil at the top of the bed and unweathered primary ash at the base. The strongly weathered Hamilton ash may not permit this ideal and other methods will have to be searched for. In mapping every bed in the Waikato District, Ward may be in the same difficulty as Baumgart and Healy in mapping individual showers as products of a single eruptive phase at Taupo, for in many instances, these collapse into a single bed, away from the source. Exceptions, however, are Taupo Lapilli, Rotongaio Ash, and Hatepe Lapilli which have proved to be fairly widespread and so help to confirm the presence of Taupo Pumice; no such aids, however, were available in mapping ash beds from the Okataina centre.

It is only too well appreciated that it is risky to offer generalisations on the basis of a single approach from volcanic centres in the east; we need to confirm current work by hand-over-hand mapping from Tauranga to Waihi and from there to Whitianga; also from the central volcanoes and from Egmont in the south. Reconnaissance mapping along the Western Taupo Road from Turangi to Tokoroa, however, indicates that most known beds can be accounted for and no andesitic ash seems to be present as can be readily seen on the Taihape-Napier Road.

To map ash beds effectively, the field now covers most of the North Island and to restrict mapping to an arbitrary area such as a survey district or to a county is a mistake.

CONCLUSIONS

Current mapping suggests that Tirau, Waihi, and Mairoa ashes can be interpreted in terms of known ash beds erupted from the Okataina and Taupo volcanic centres. The Tirau ash comprises Taupo Pumice, Rotoma Ash and Rotorua Ash; the Waihi ash, all of the above plus pinkish brown beds and the yellow and white block beds; Mairoa, small amounts of Taupo, Rotoma and Rotorua plus with pinkish brown beds along with a surface dusting of ash from the central volcanoes. Hamilton ash can be mapped into an orderly sequence of beds but the sources are unknown.

A new factor is the widespread occurrence of loess, and in the field ways will have to be established of differentiating this material from air-fall ash.

In a general way, Vucetich and Pullar agree with Taylor on the stratigraphy but the former have located the sources and plotted the distribution of the separate ash beds. Even if identification of ash beds in the Waikato is uncertain Figures 5 and 6 show that not an insignificant amount of ash was erupted from the Okataina and Taupo volcanic centres.

ACKNOWLEGMENTS

Thanks are due to Mr J. D. McCraw for constructive comment and criticism.

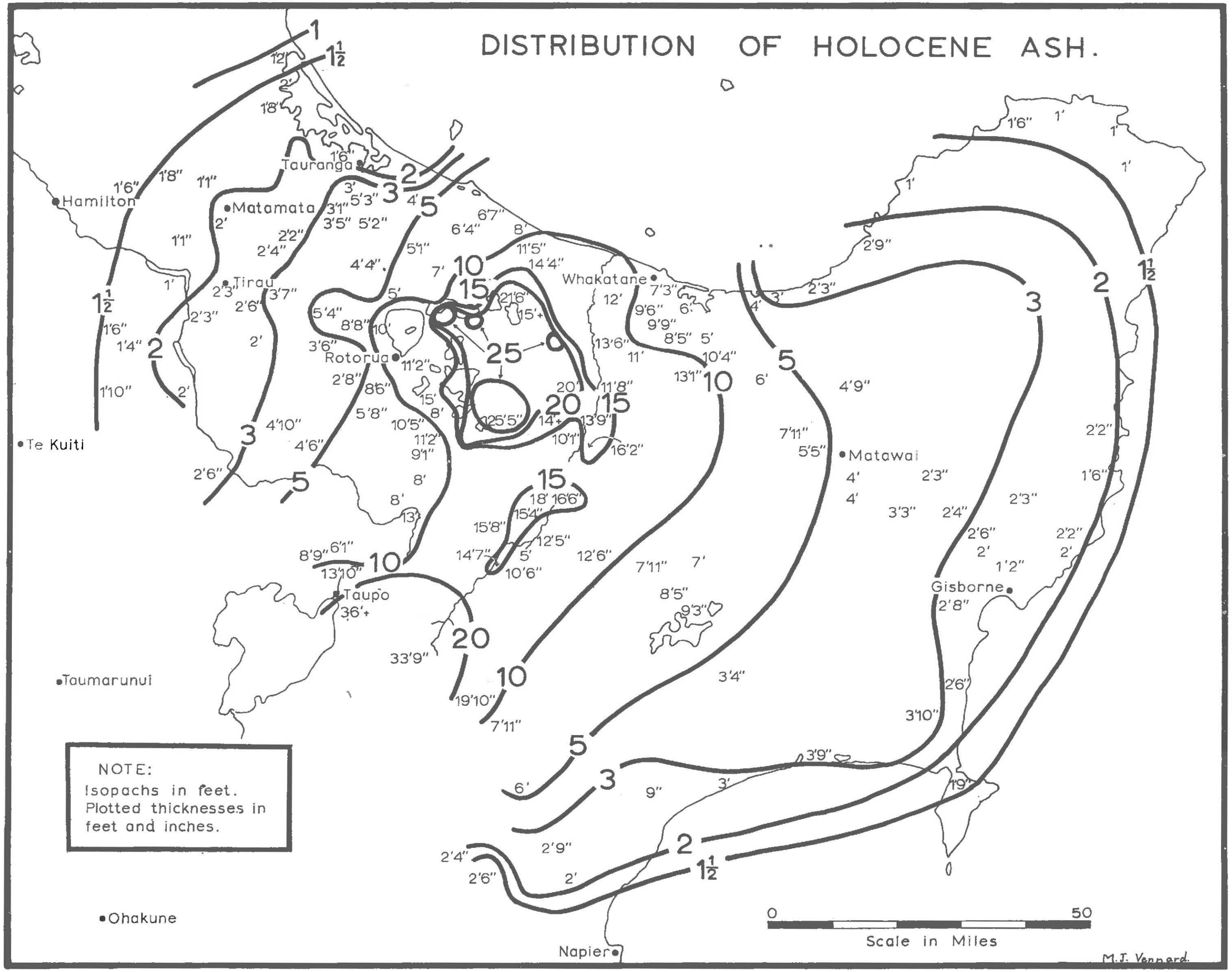

Figure 5: Distribution of Holocene ash. Products of eruptions during the last 15000 years.

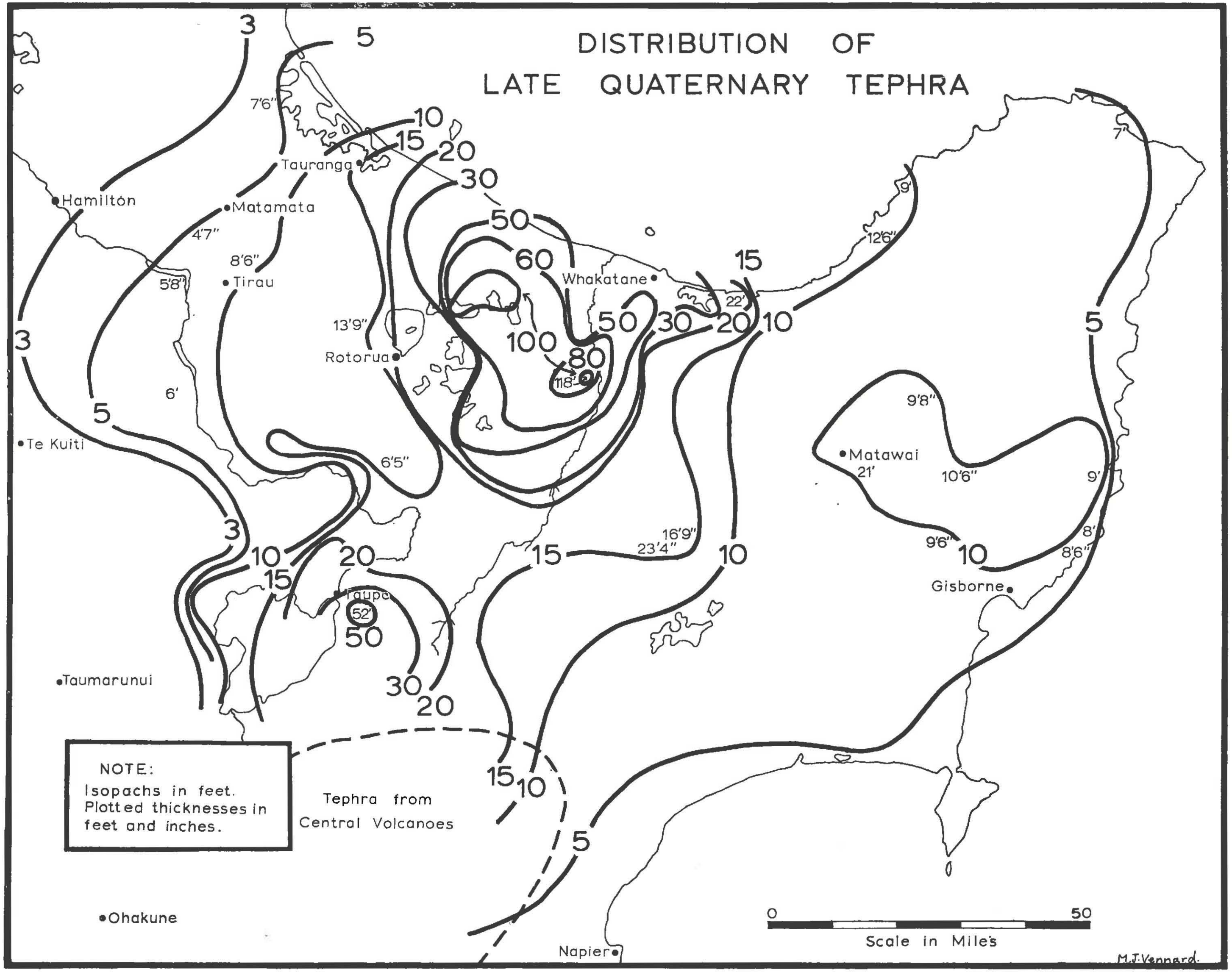

Figure 6 : Distribution of remnants of Late Quaternary Tephra erupted during last 36000 years.

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