ENEGeol 2017 – PART 2

APPLICATIONS OF TEPHROCHRONOLOGY

Volcan Chaiten, 2008

Key References

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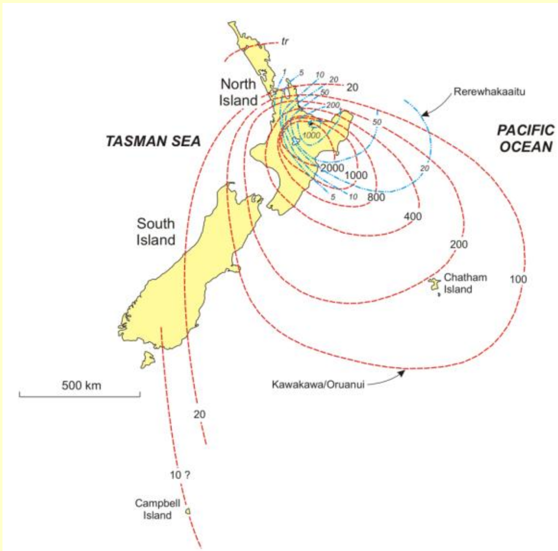
- **Lowe, D.J., Alloway, B.V.**, Tephrochronology. *In:* Rink, W.J., Thompson, J. (Eds.), **Encyclopedia of Scientific Dating Methods**. Springer, Netherlands, pp. 1-26. **(2014)**

Applications of Tephrochronology

GEOMORPHIC & LANDSCAPE RECONSTRUCTION

Kawakawa Tephra



Map of distributions of Kawakawa/Oruanui (red dashed line) and Rerewhakaaitu (blue dot-dash line) tephras.

Isopachs in centimetres.

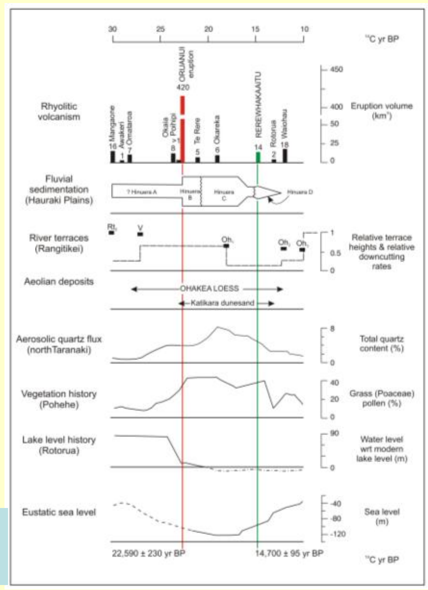
McKay's Crossing, Wellington

Taranaki

Howard Valley Nelson Lakes

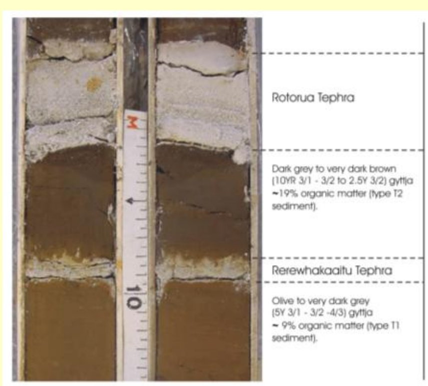
GEOMORPHIC & LANDSCAPE RECONSTRUCTION
Kawakawa Tephra

Section near Putaruru, North Island, showing Kawakawa/Oruanui tephra as prominent pinkish-white marker bed ~0.5 m thick in middle of section overlying tephric loess and paleosol. Pale tephra bed near base (by person) is *c.* 50,000 cal.-yr old Rotoehu Ash, which overlies a dark paleosol on loess.

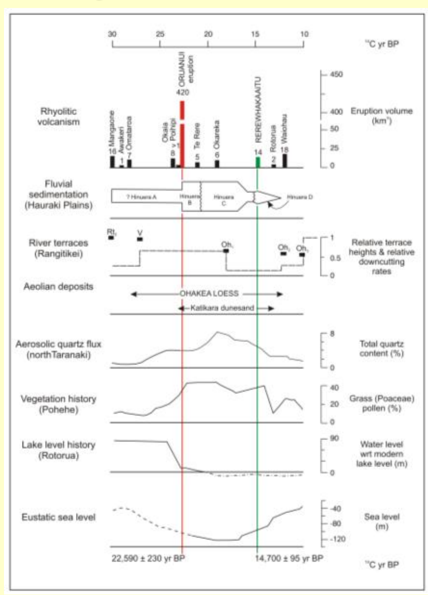


Summary diagram for the period *c.* 30,000 to 10,000 ^{14}C yr BP in central and southern North Island, New Zealand

GEOMORPHIC & LANDSCAPE RECONSTRUCTION
Rerewhakaaitu Tephra

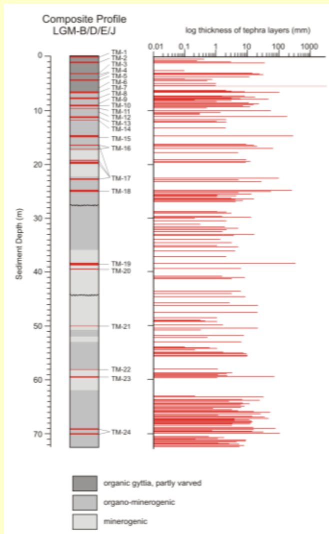


Close-up photo of core from Lake Rotoroa (Hamilton, New Zealand) showing darkening in sediment colour just above *c.* 17,600 cal. yr BP Rerewhakaaitu Tephra that reflects an increase in organic content because of re-afforestation and amelioration in climate



Applications of Tephrochronology

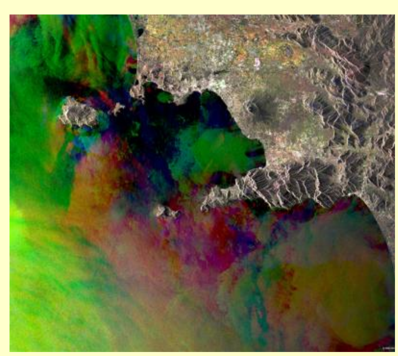
VOLCANIC HAZARD ASSESSMENT & ERUPTION FREQUENCY FROM LONG TEPHRA RECORDS



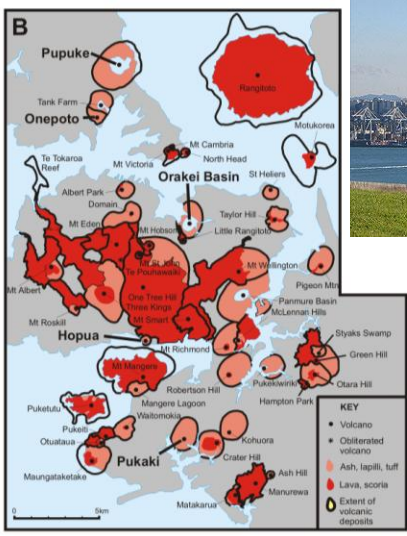
Long tephra records can contribute significantly to an understanding of eruption frequency and tephra dispersal.

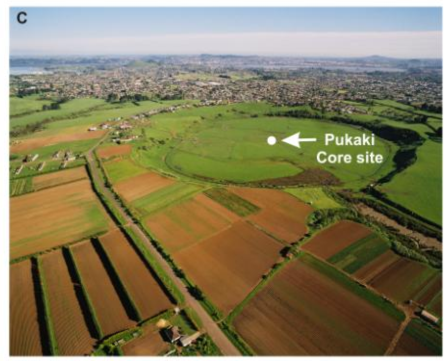
A notable example: Lago Grande di Monticchio in southern Italy. Here, 340 distal tephra layers are preserved within 72.5 m of lacustrine sediments deposited over the last 100,000 years.

Most tephras (n = 313) derived from volcanic eruptions of the **Campanian province**, which still represents an area of volcanic risk for the Naples metropolitan area. Other tephras are related to high-explosive events of **Roman and Sicilian-Aeolian volcanoes (n = 17)** or **cannot be correlated with any distinct volcanic source (n = 10)**.



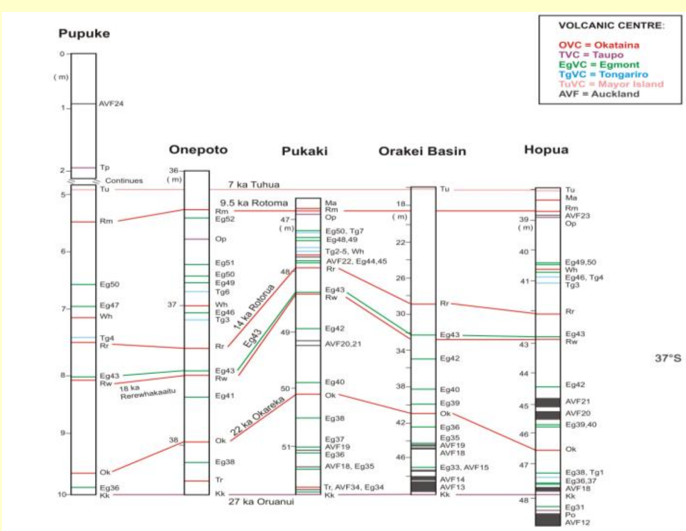
Synthetic Aperture Radar (SAR) multi-temporal colour composite image showing the Bay of Naples which lies in the centre of the Campanian volcanic province - which is now flanked by the active Vesuvius & Phlegrean Fields.

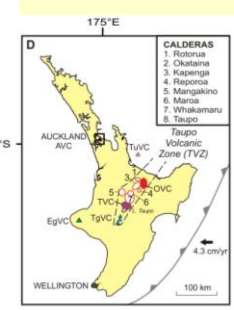




Between 27,000 and 9500 cal. yr BP, fallout from 44 eruptions were recorded in the maars, an average recurrence of *c.* 400 years.

These comprise events from OVC (1 per 2,200 yrs), TVC (1 per 5,800 yrs), EgVC (1 per 830 yrs), TgVC (1 per 2,900 yrs) and AVF (1 per 2,900 yrs).





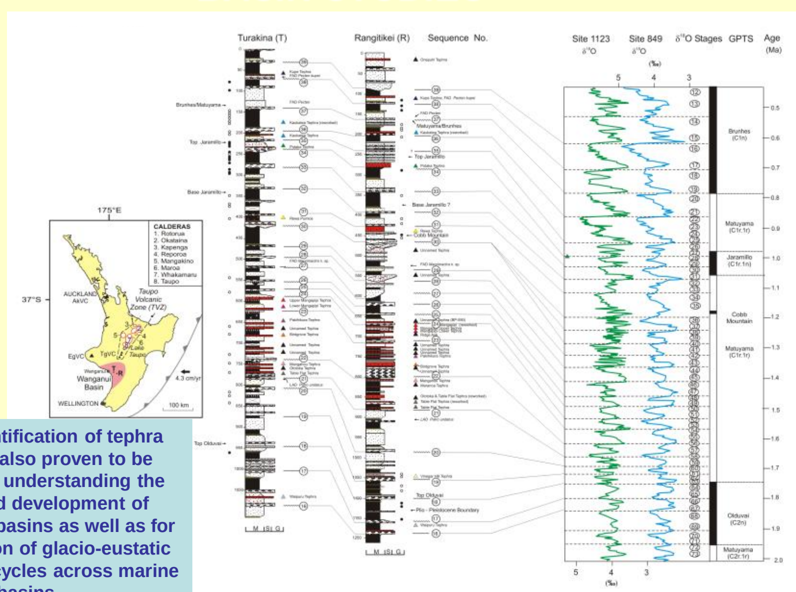
A total of **106 different tephra layers from local and distant volcanoes (>0.5 mm thick) in the last 80 kyr** have been recorded in the Auckland maars, an **average recurrence of ca. 755 yr** (Molloy *et al.*, 2009).

These comprise 52 events from EgVC (1 per 1.5 kyr), 24 AVF events (1 per 3.5 kyr), 21 Taupo Volcanic Zone rhyolite (TVC and OVC) events (1 per 3.8 kyr), 7 TgVC events (1 per 11.4 kyr) and 2 TuVC events (1 per 40 kyr).

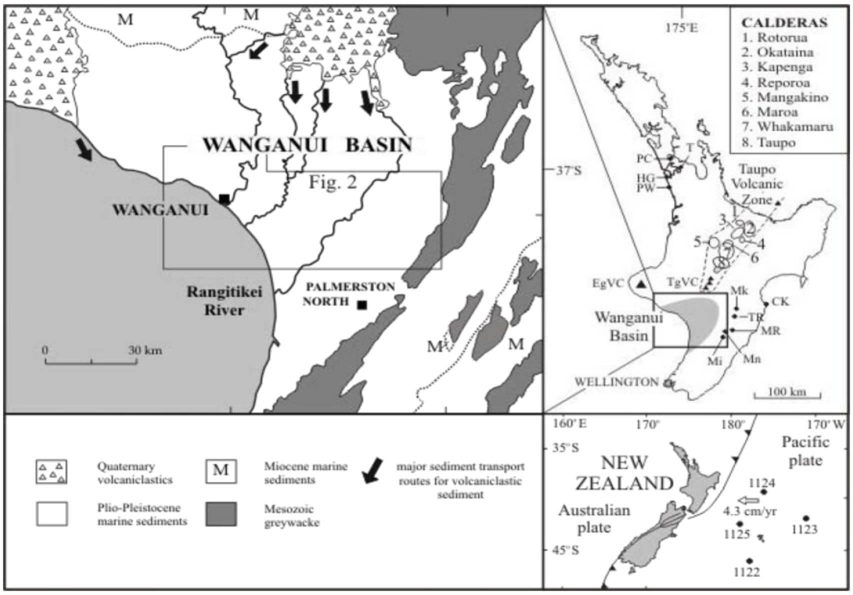
Unrecognised cryptotephras (<0.5 mm) are also likely to be present in the cores. Such cryptotephras also potentially have significant implications for hazard assessments as exemplified by the 1995-1996 eruptions of Ruapehu Volcano.

Applications of Tephrochronology

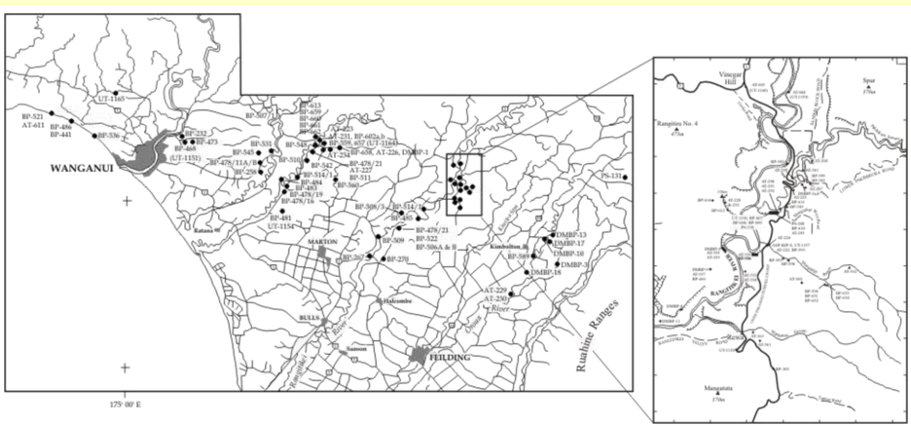
BASIN STUDIES



Precise identification of tephra layers has also proven to be important in understanding the growth and development of sedimentary basins as well as for the correlation of glacio-eustatic sedimentary cycles across marine basins.



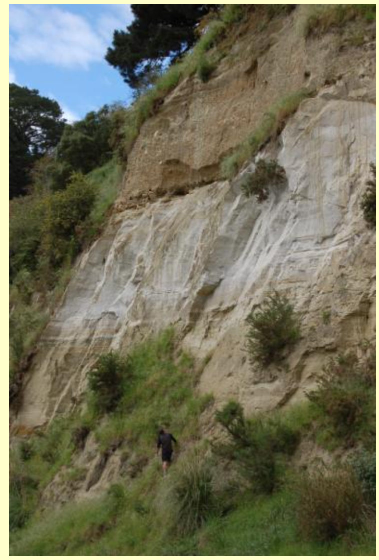
Wanganui Basin



Tephra Localities – Wanganui Basin

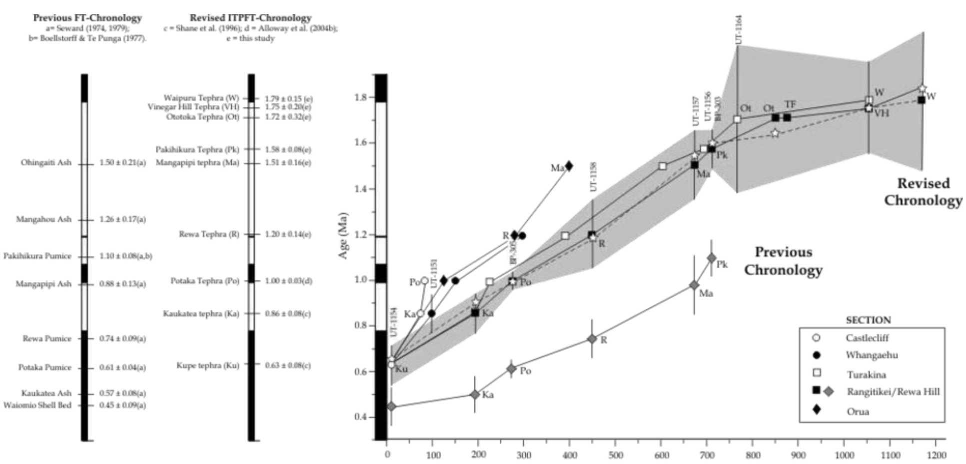
Inset - localities along the Rangitikei River

Fordell Ash,
c. 0.310 Ma,
MIS 9a



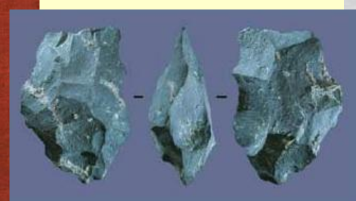
Vinegar Hill Tephra, c. 1.75 Ma,
MIS 61

Pakihikura Tephra, c. 1.60 Ma,
late MIS 55 – early MIS 54



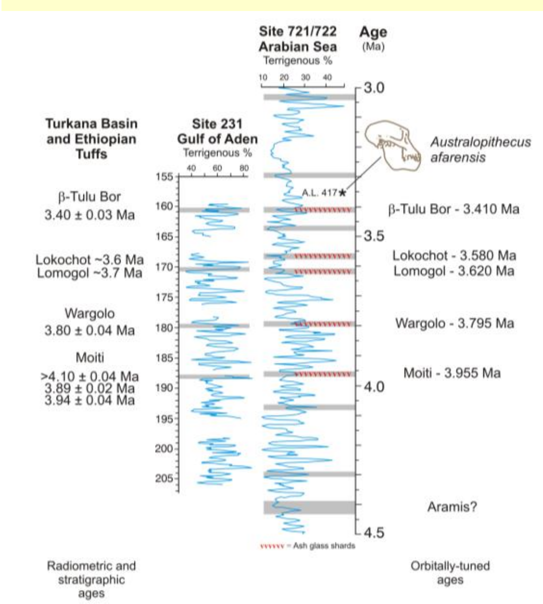
Applications of Tephrochronology

HOMINID EVOLUTION



An *Australopithecus Afarensis* was found at the Afar Depression in Ethiopia in November, 1973. Lucy was a 3.2 year-old – only 40% of Lucy's skeleton was found.

Most of the hominid remains and associated artefacts from the East African rift system have been found in Plio-Pleistocene volcaniclastic sediments.



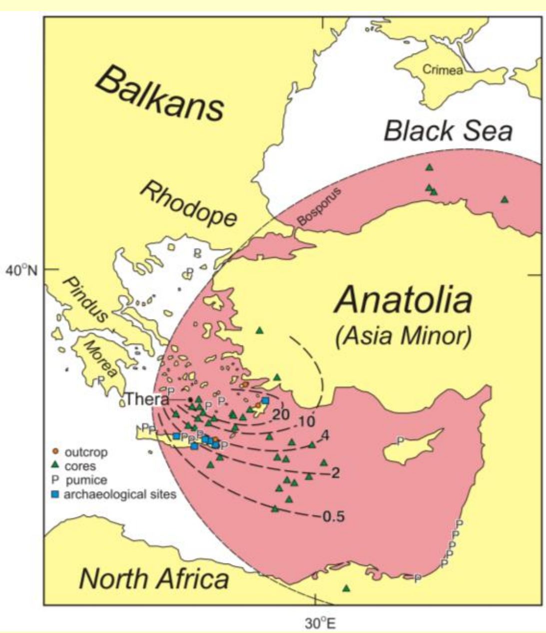
Comparison of radiometric & stratigraphic (interpolated) ages for East African tuffs between 4.0–3.4 Ma and their orbitally tuned ages derived from the marine sediment chronostratigraphy at ODP sites 721 and 722 in the Arabian Sea

Applications of Tephrochronology

ARCHAEOLOGY

Tephrochronology has increasing application in archaeological studies because they form isochronous horizons enabling the correlation of equivalent-aged successions.

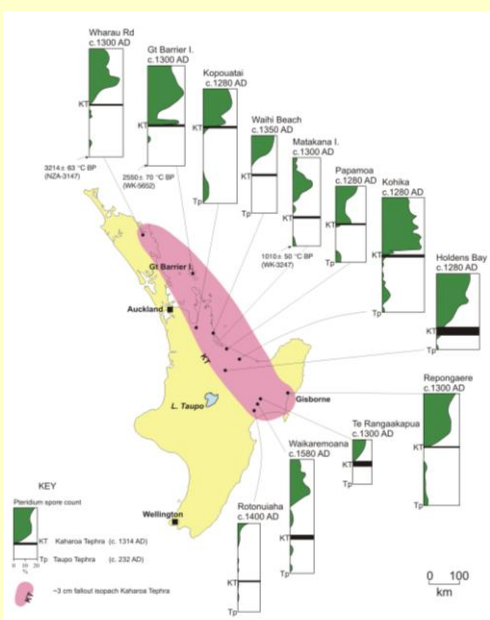
Late Bronze Age explosive eruption of Thera (Santorini) dated *c*. 1667–1644 BC



Regional distribution of tephra from the Thera eruption (shaded area) in the Late Bronze Age.

Tephra thickness isopachs are in centimetres. Symbols identify sites where tephra has been identified in cores (triangles) & at archaeological sites (squares)

Another example where tephrochronology has advanced archeological studies is in New Zealand where a key rhyolitic eruptive, Kaharoa Tephra (KT), has helped resolve the controversial timing of initial Polynesian settlement.



Summary diagram of 12 bracken (*Pteridium*) spore profiles, North Island, New Zealand, containing the Kaharoa Tephra settlement datum (KT). In most profiles, the deforestation signal (increase in *Pteridium* and charcoal, decline of tall trees) occurs at around or after the deposition of KT, but in four (Kopouatai, Papamoa, Kohika, Holden's Bay) it occurs just before, by perhaps a few decades.

SUMMARY

- Tephras are now routinely detected and dated in terrestrial, marine and ice-core records throughout the world in both macroscopic & microscopic (cryptotephra) forms
- Tephra's are used in a diverse range of disciplinary fields including stratigraphy, geomorphology, glaciology, sedimentology, archaeology, hominid evolution, and paleoenvironmental reconstruction.
- Tephrochronology is also an essential tool for establishing the frequency/periodicity of volcanic activity and for assessing volcanic hazards.
- **Finally, perhaps the most exciting development is the use of tephrochronology, uniquely, to effect more precise correlations between marine, ice-core and terrestrial records.**

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