THE GEOLOGICAL OCCURRENCE AND MINERALOGICAL CHARACTER OF ERIONITE: A Health Hazard

Janki Patel[1], Martin Brook[1], Dario Di Giuseppe[2], Valentina Scognamiglio[2], Alessandro F. Gualtieri[2], Melanie Kah[1] and Ayrton Hamilton[1]

[1] School of Environment, University of Auckland, Auckland, New Zealand, [2] Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia, Modena, Italy

Caution!

Rates of malignant mesothelioma (MM) – a type of cancer, have been steadily increasing since the 1980s, within New Zealand (Gluckman, 2015). Commonly the cause of this disease is due to the inhalation of asbestos. But asbestos is not the only carcinogenic fibrous mineral found within New Zealand.

There is another more potent mineral forming, which has been the cause of an MM epidemic within three Turkish villages. This mineral is <u>erionite.</u>

Erionite is a naturally occurring zeolitic mineral series, which forms from rock – water interactions. Around the world erionite is commonly found within basalt and tuff deposits. In New Zealand erionite has been located within Kaipara, Auckland, Taupo Volcanic Zone and Moeraki (Fig 1).

This study aims to further identify the occurrence of erionite throughout New Zealand and determine its mineralogical character.

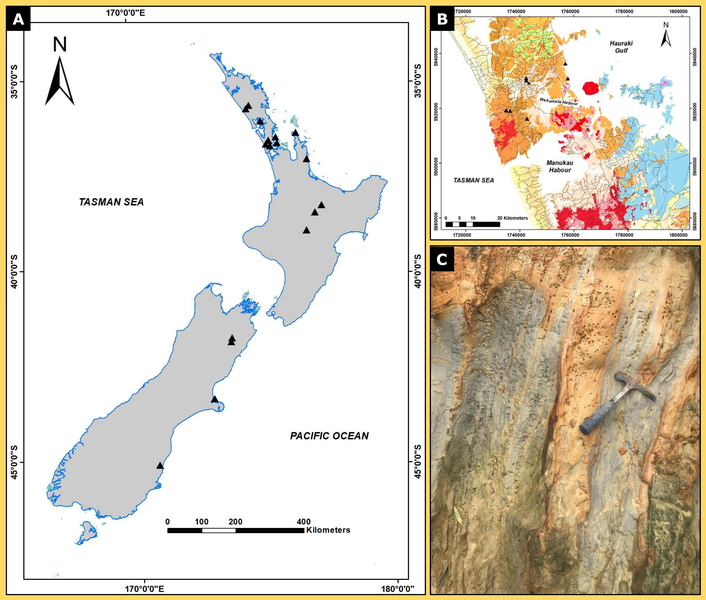

Fig 1. A) Map of confirmed locations (black triangles) where erionite has been found in New Zealand as of June 2021. B) Geological map of Auckland region with existing erionite sites (black triangles) and newly reported data from this study (black star). C) East Coast Bays Formation exposure at Riverhead, Auckland – where erionite has been found.

Risk Identification!

The requirements for a fibre to be respirable and airborne are length, L ≥5 µm, a diameter, w ≤3 µm, and L/w value ≥3:1 (WHO, 1986).

A multistep approach will be utilised to identify erionite within collected rock samples from across New Zealand.

1. **Bulk rock analysis using X-Ray Powder Diffraction (XRD)**
2. **Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS)**
3. **Transmission Electron Microscopy (TEM-EDS)**
4. **Raman Spectroscopy and Fourier Transform Infrared Spectroscopy (FTIR)**

Preliminary results from Riverhead, Auckland indicate the presence of bundles of erionite fibres in the East Coast Bays Formation (Figs 2 and 3).

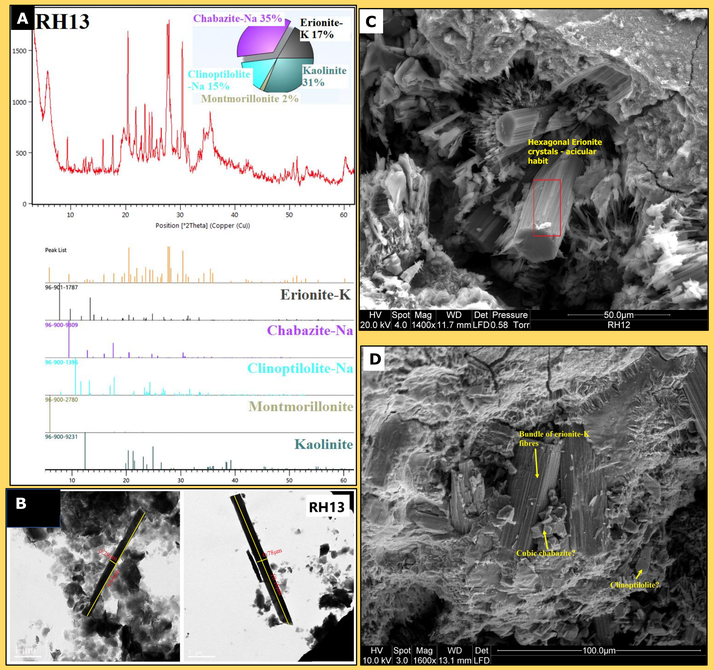

Fig 2. A) XRD plot of tuff sample from Riverhead, Auckland, displaying the minerals present within the rock. B) TEM images of elongated particles along with their measurements found at Riverhead. C and D) SEM images of erionite-K, displaying bundles of fibres within the rock mass.

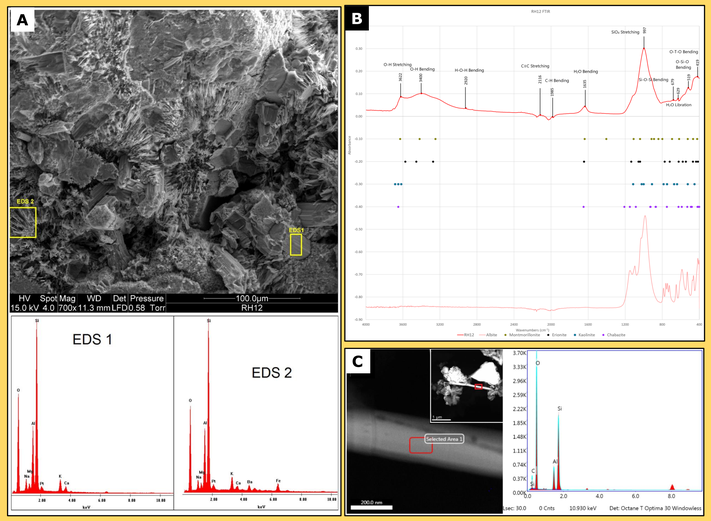

Fig 3. A) SEM image of tuff with EDS spectra from erionite bundle (EDS 1) and weathered minerals (EDS 2). B) FTIR spectra for tuff sample (RH12), with molecular bonds labelled on prominent bands with highest absorbance. Albite spectra is plotted along with the main bands present within other mineral constituents of the rock. C) Zoomed in TEM image of a fibre along with the EDS spectra.

Management!

A preliminary investigation at Riverhead determined the presence of erionite-K within Miocene tuff samples.

Dimensional analysis of elongated minerals identified with TEM indicated 45.6% of the minerals meet the WHO guidelines to be considered respirable and airborne, indicating the fibres have potential to induce MM within individuals.

Furthermore as the erionite has been found in bundles of fibres, this may increase its carcinogenic potential; as noted by Dogan et al., 2008, erionite forming in bundles made up of fibres and 'fibrils' will have an enhanced surface area to volume ratio.

Mitigation!

- **Erionite with a fibrous morphology and carcinogenetic potential has been found at Riverhead, Auckland.**
- **Future geological investigations will take place around New Zealand to determine the morphology of erionite present at other locations and if it satisfies the WHO requirements of being respirable.**

Undisturbed erionite fibres within rock and soil pose no risk to humans, however there are many erosive processes and human activities that can take place that may disturb the erionite particles and cause them to become airborne; some examples include: driving, erosion via wind and coastal erosion, topsoil removal and tunnelling. Hence it is necessary to determine where erionite is, in order to mitigate the potential for erionite exposure.

References

Dogan, A., Dogan, M., & Hoskins, J. (2008). Erionite series minerals: Mineralogical and carcinogenic properties. *Environmental Geochemistry and Health, 30*(4), 367-381.

Gluckman, P. (2015). Asbestos exposure in New Zealand: Review of the scientific evidence of non-occupational risks. A report on behalf of the royal society of New Zealand and the office of the prime minister's chief science advisor.

Patel, J. P. (2021). *Preliminary investigation of zeolites in the Riverhead Area, Auckland* [Unpublished Masters dissertation]. University of Auckland.

Patel, J. P., & Brook, M. S. (2021). Erionite asbestiform fibres and health risk in Aotearoa/New Zealand: A research note. *New Zealand Geographer*, 77(2), 123– 129. https://doi.org/10.1111/nzg.12291

WHO. (1986). Asbestos and other natural mineral fibres. In *Asbestos and other natural mineral fibres*. World Health Organization.