Saturday, 9 September 2023

Mordenite in New Zealand Distinguishing and Defining

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Outline

- Zeolites
- Fibrous Zeolites
- Mordenite
- Occurrence
- Morphology
- Chemistry
- Toxicology?
- Next Steps

Zeolites

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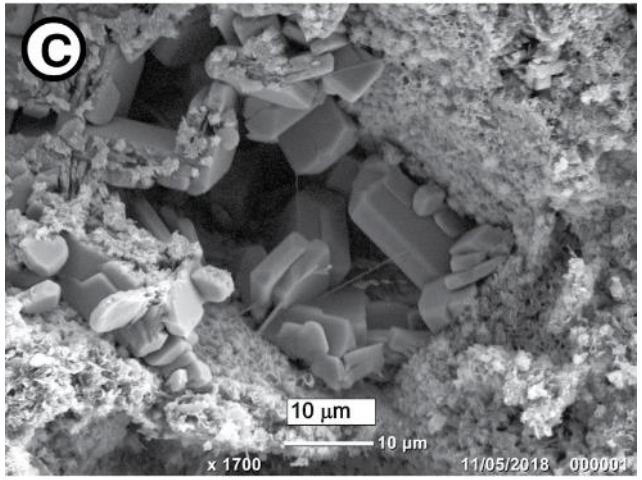
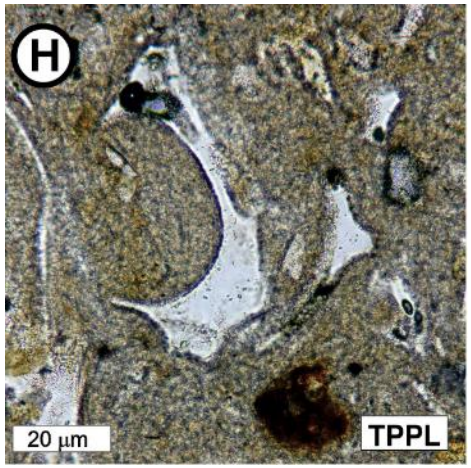
- Hydrated Aluminosilicates
- Altered Volcanics
- Form in Alkali Conditions
- 3D Network with open cavities in the forms of channels and cages
- > 40 Naturally Occurring
- > 200 Synthetic





(Brathwaite And Rae, 2021)

Zeolite Fibres

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- 14 zeolites can be fibrous
- Clinoptilolite, edingtonite, **erionite**, ferrierite, gonnardite, dachiardite, kalborsite, mesolite, **mordenite**, natrolite, offretite, paranatrolite, scolecite and thomsonite can be fibrous
- Only erionite classified as carcinogen
- Morphology of erionite is primary reason toxicity

Mordenite

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Mordenite

- 6th most common zeolite
- $(Na_2,Ca,K_2)_4(Al_8Si_{40})O_{96}\cdot 28H_2O$
- White
- Mohs = 3.5
- Forms at < 40 °C

Erionite

- 8th most common zeolite
- $(Na_{10},Ca_5,K_{10})(Si,Al)_{36}O_{72}\cdot 28H_2O$
- White
- Mohs = 3.5 – 4
- Forms at < 110 °C

Occurrence

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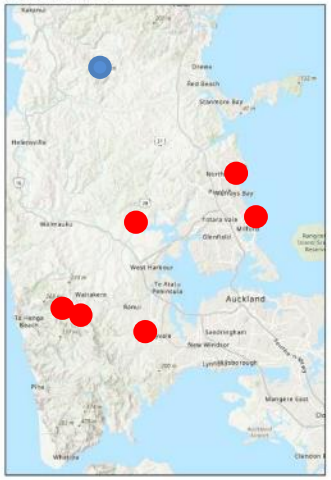

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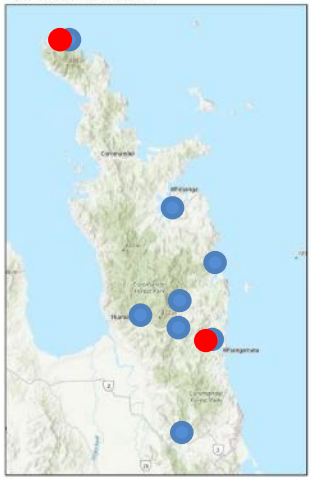

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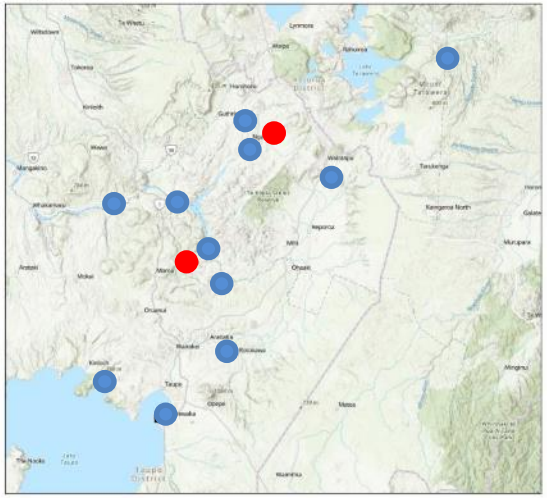

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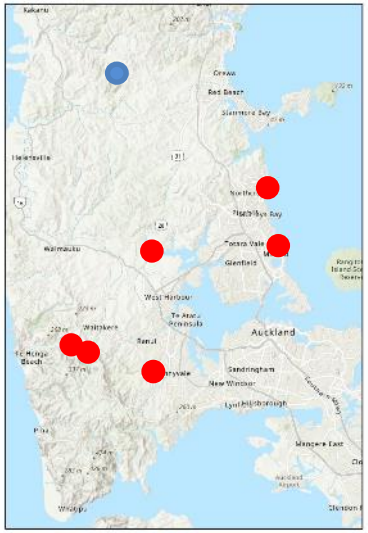

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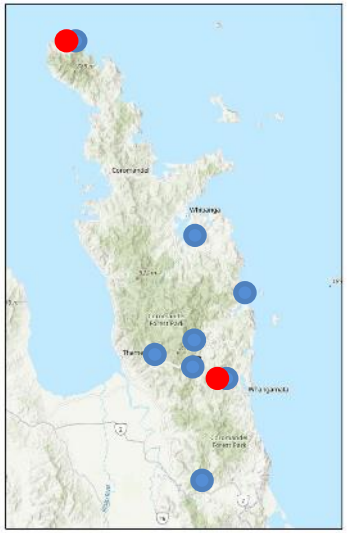

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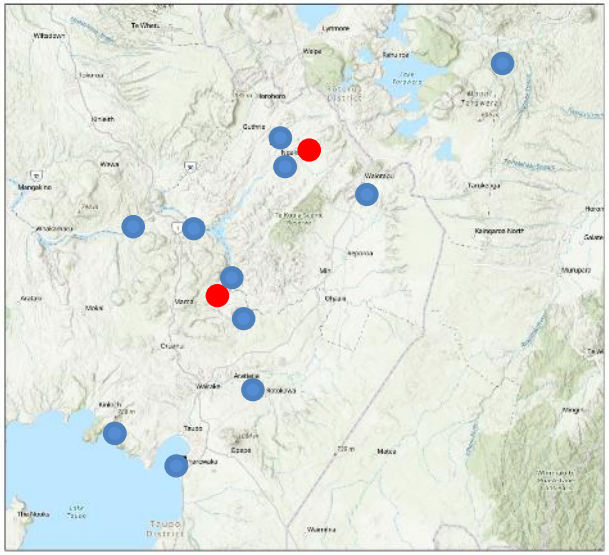

Occurrence

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Disseminated

Cavities

Veins

Occurrence

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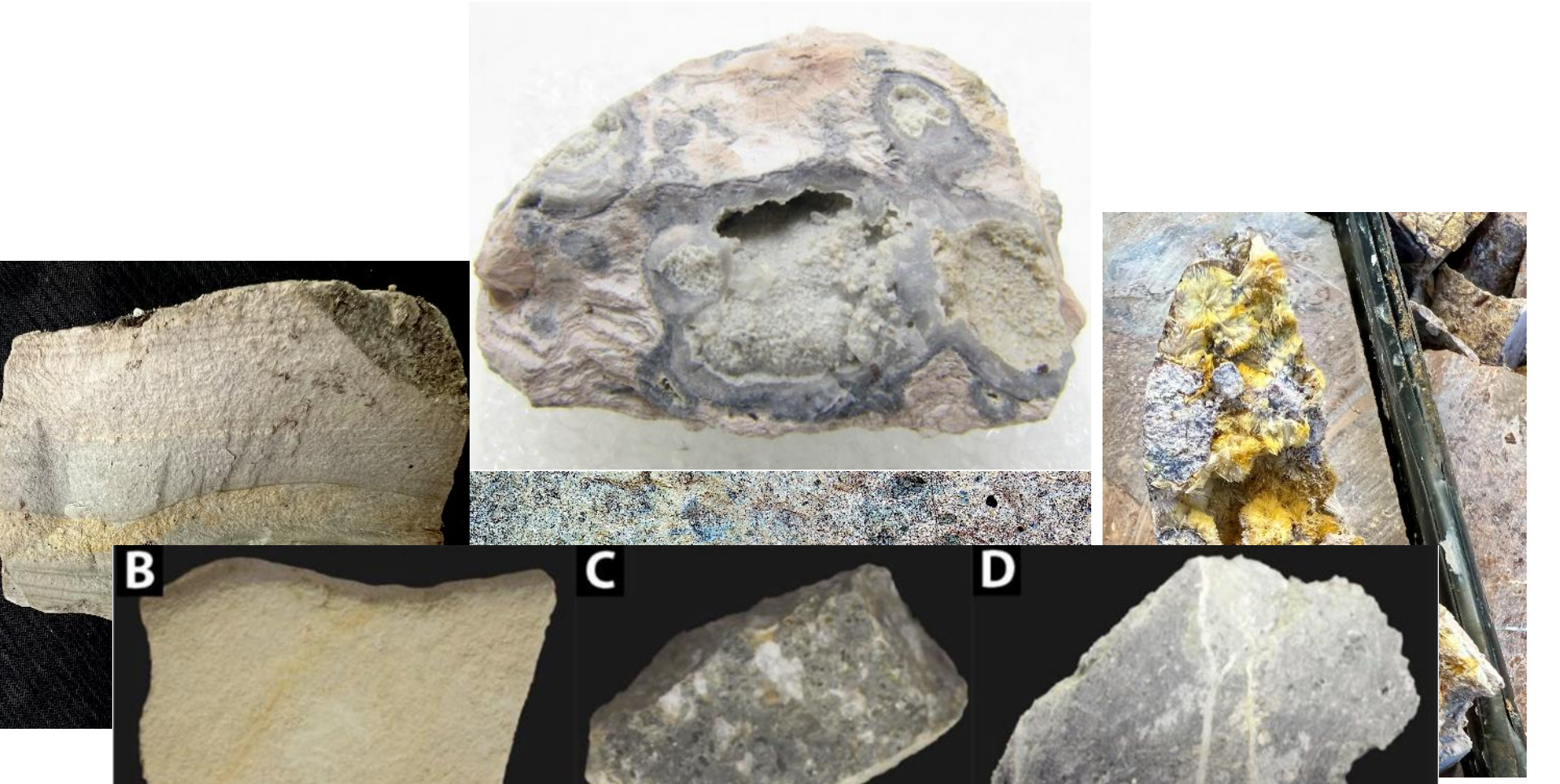


Disseminated Cavities Veins

Occurrence

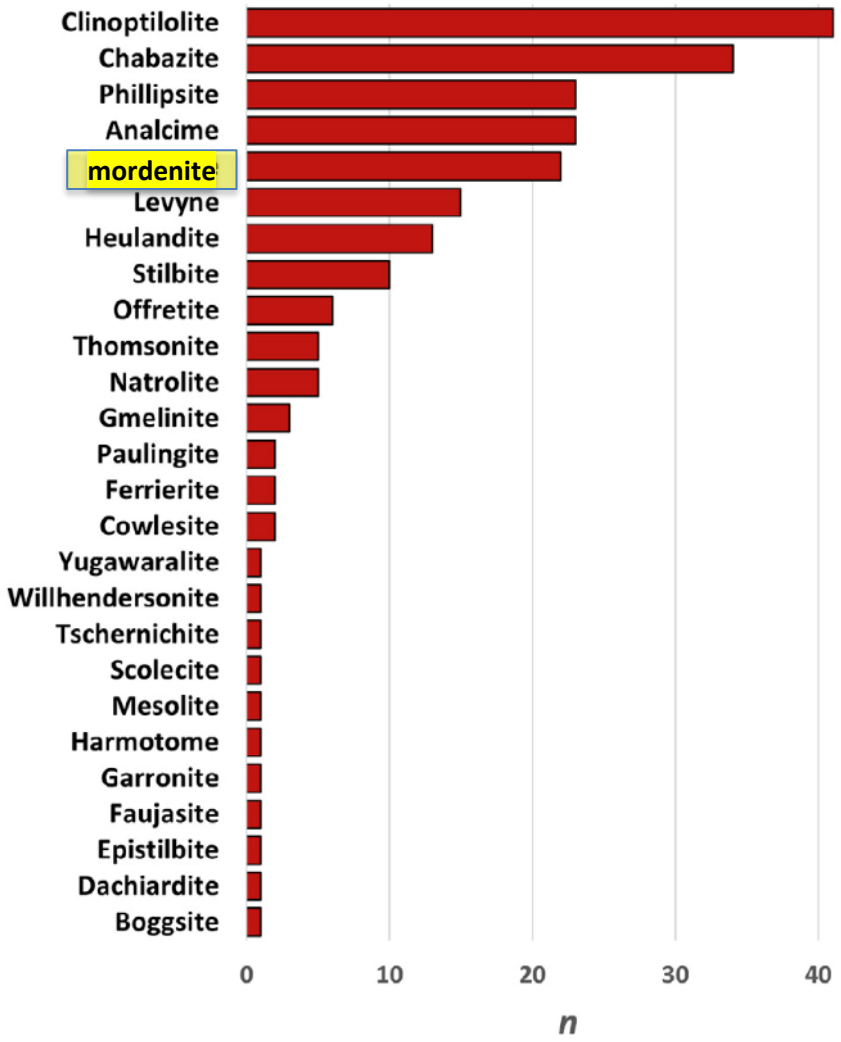
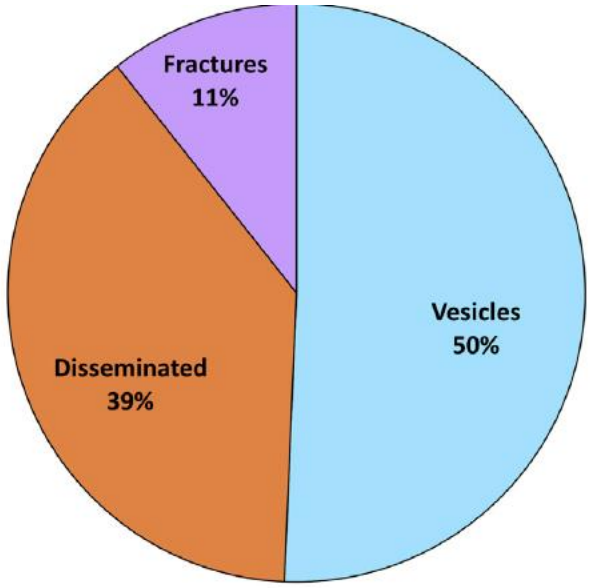


FIGURE 6
Frequency chart of other zeolites reported to occur alongside erionite, with clinoptilolite and chabazite being the most prevalent.



(Patel et al., 2022)

Morphology

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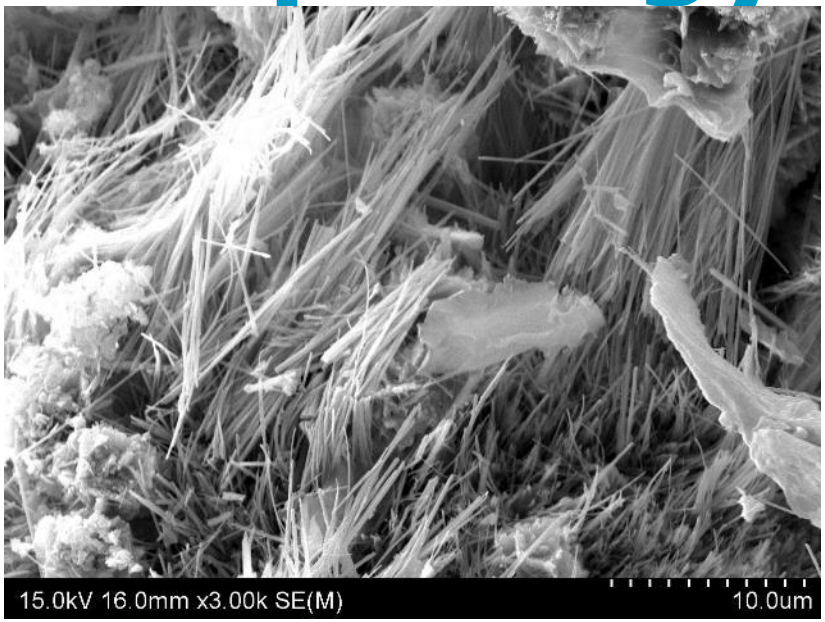

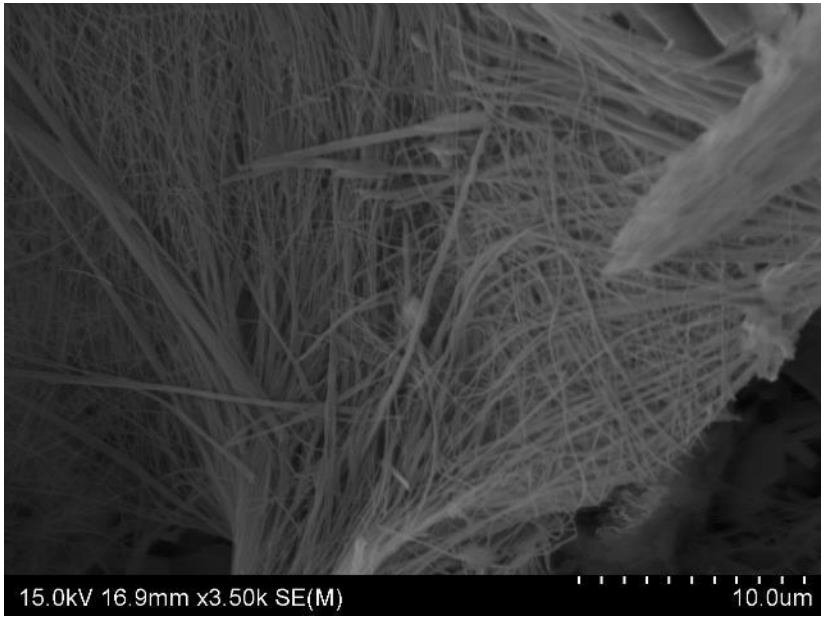

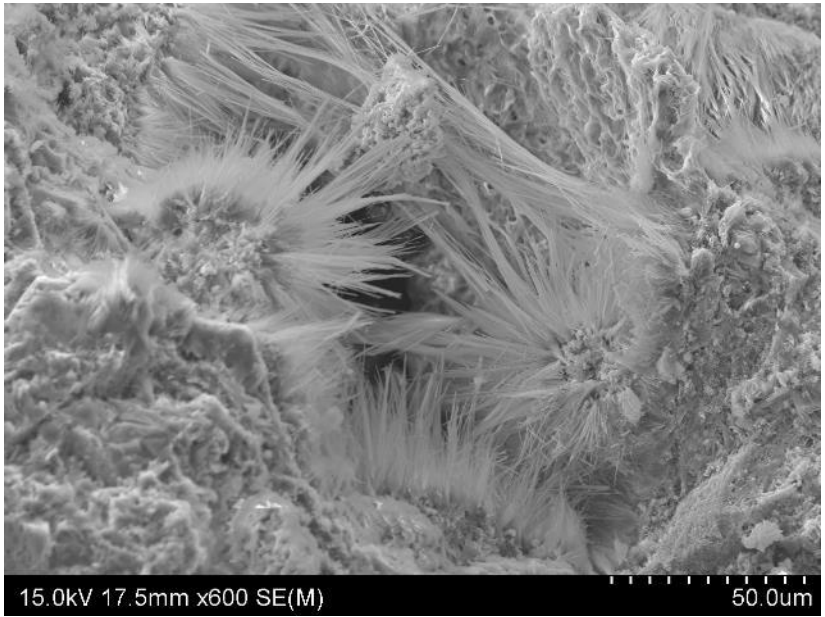

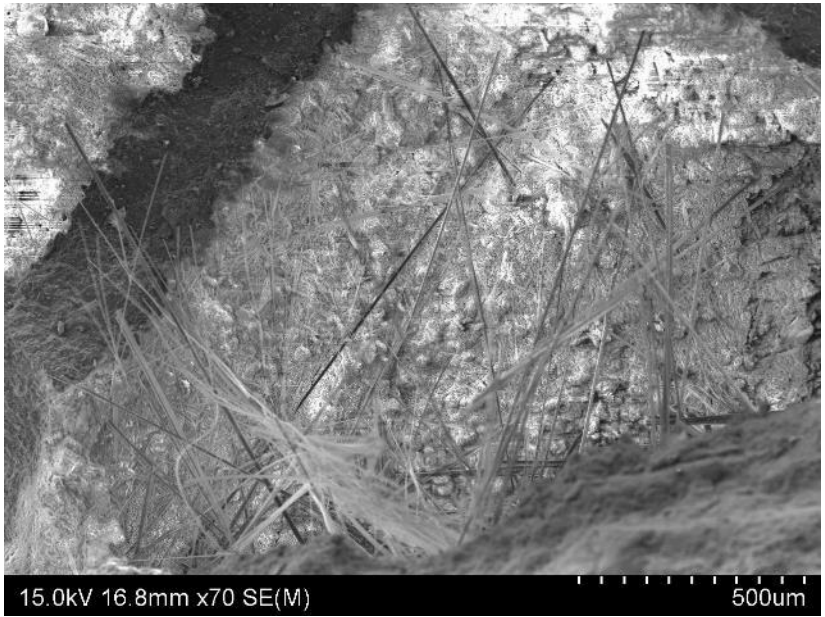

Morphology

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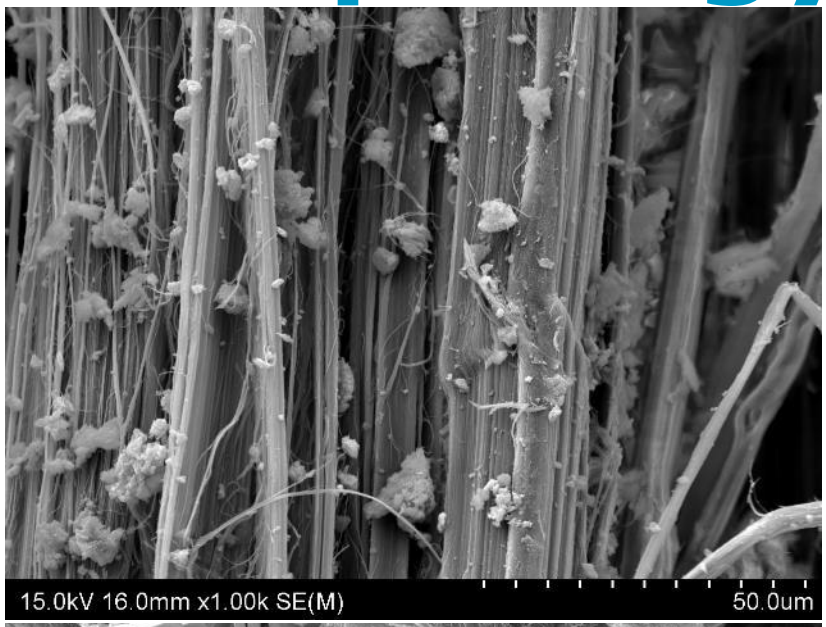

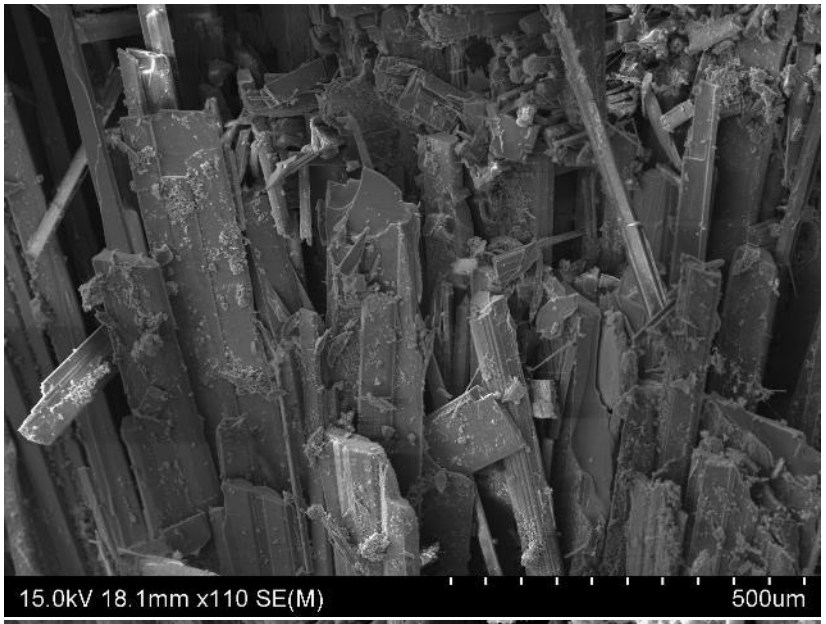

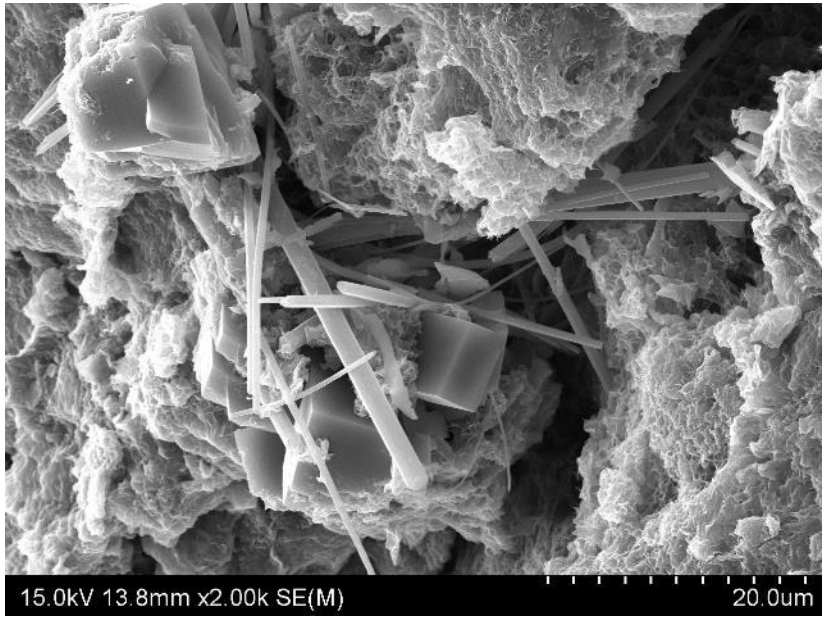

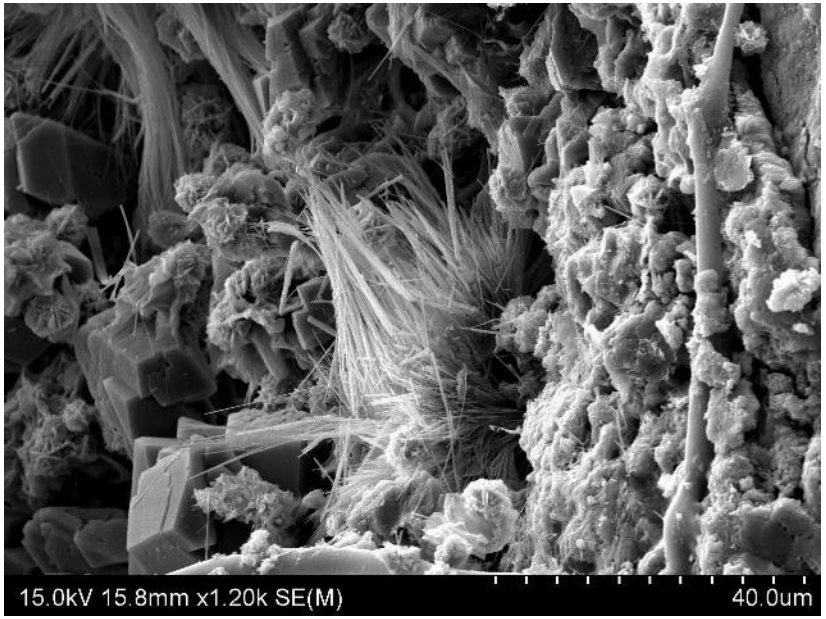

Chemistry

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Portable X-ray Florescence (pXRF)

Host rocks analysed
- 9 mordenite samples
- 7 erionite samples

Positives
- Quick analysis (35s)
- Non destructive (no disturbance)

Negatives
- Limited elements (no Na)
- Large errors (Mg, Ti)
- Homogeneity (non powder)

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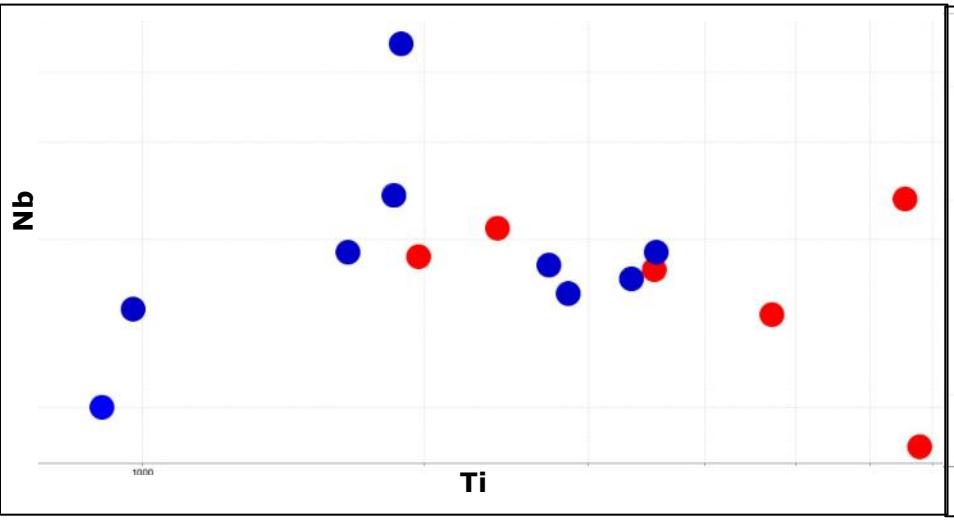
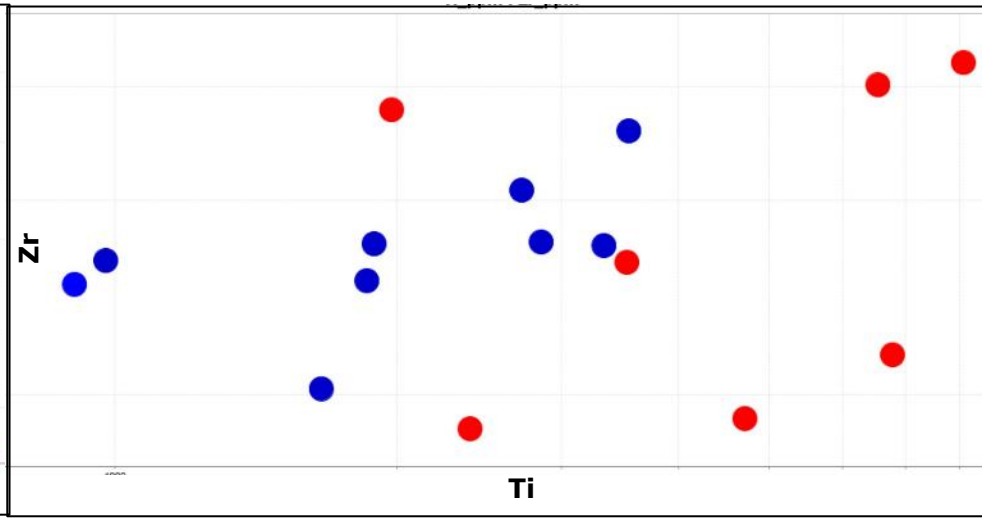
Conservative elements

Nb vs Ti



Zr vs Ti



Erionite

Mordenite

Chemistry

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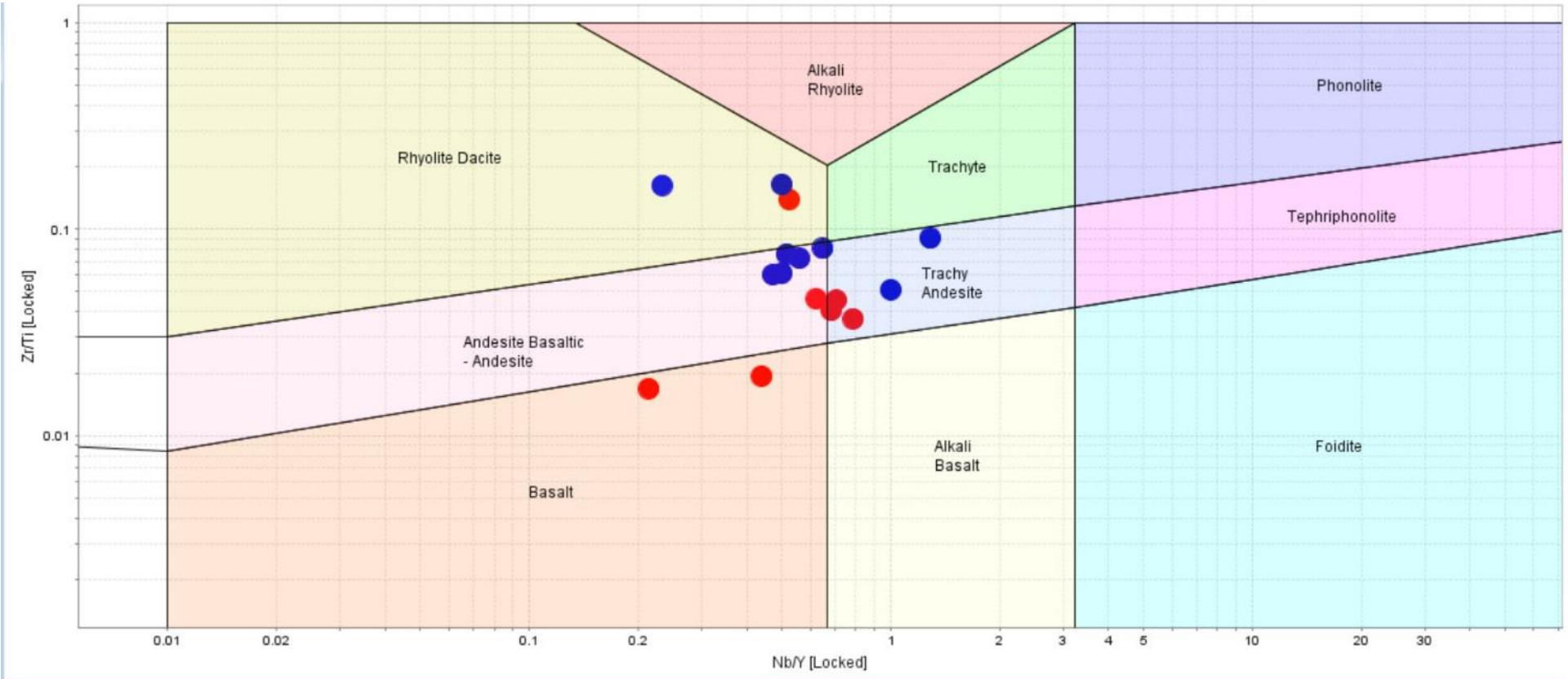
Volcanics



Erionite

Mordenite

(Modified from Pearce, 1996)

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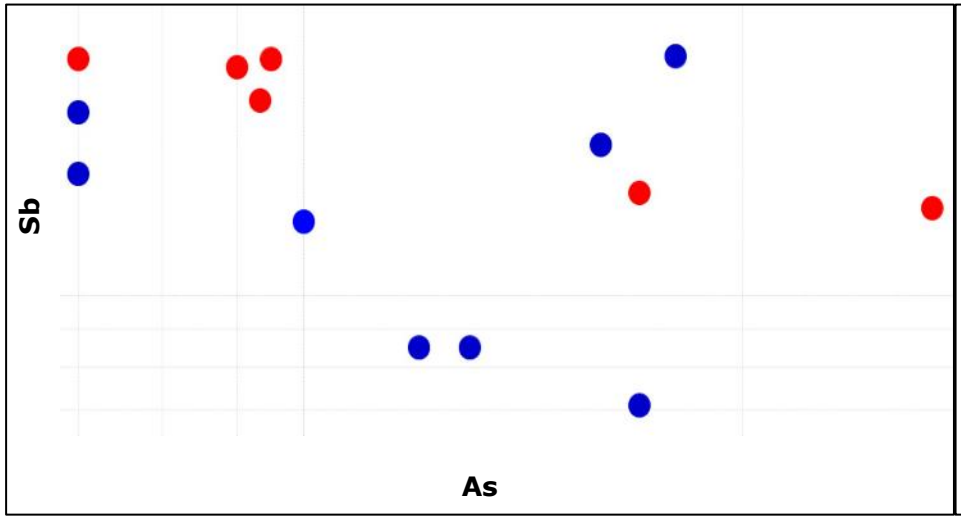
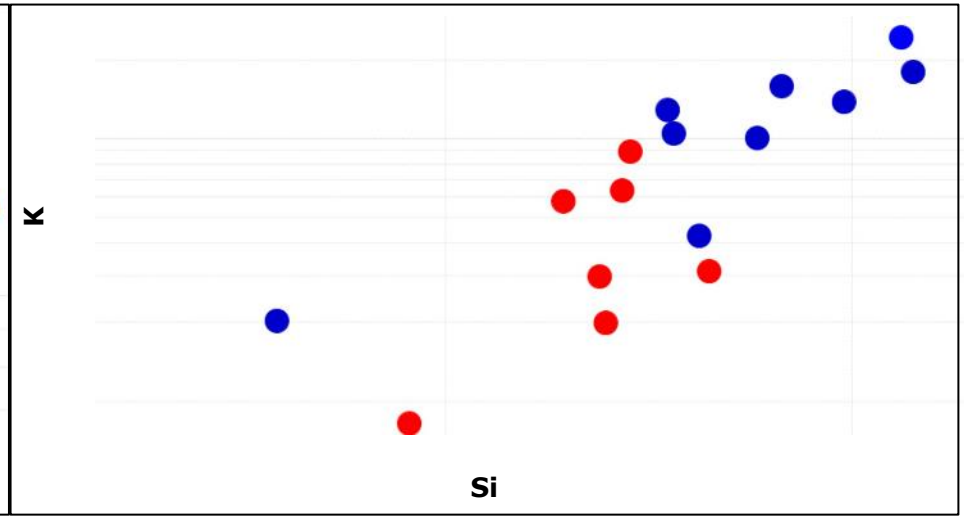
Alteration

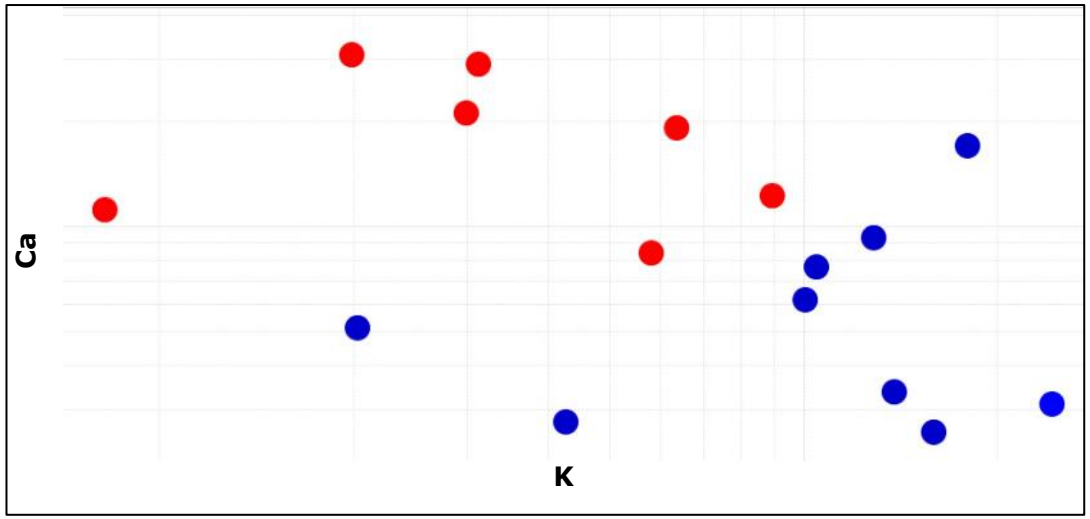
Sb vs As



K vs Si



Ca vs K



Erionite

Mordenite

Toxicity?

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TABLE 6. EFFECT OF SYNTHETIC ZEOLITE (4A) ON TUMOR PRODUCTION IN THE MOUSE PERITONEAL CAVITY

Group	*Total Peritoneal Tumors*
Amosite (20 mg)	4
Amosite (10 mg)	4
Amosite (2 mg)	15
Chrysotile (20 mg)	6
Chrysotile (2 mg)	0
Chrysotile (2 mg)	4
Erionite I (10 mg)	21
Erionite II (10 mg)	3
Erionite II (2 mg)	24
Erionite II (0.5 mg)	6
Mordenite (10 mg)	0
Synthetic Zeolite (4A) (10 mg)	0
Saline control	0
Untreated control	0

Source: Suzuki and Kohyama, 1984.

Mordenite samples are characterized by "respirable" fibres that could reach the lungs' deeper parts.

2020

crystals MDPI

Article

Characterization of Fibrous Mordenite: A First Step for the Evaluation of Its Potential Toxicity

Dario Di Giuseppe [1,2]

2022

minerals MDPI

Article

Another Potentially Hazardous Zeolite from Northern Italy: Fibrous Mordenite

Matteo Giordani [1,*], Paolo Ballirano [2], Alessandro Pacella [2], Maria Assunta Meli [3], Carla Roselli [3], Fulvio Di Lorenzo [4], Ivan Fagiolino [5] and Michele Mattioli [1]

"In vitro toxicity test and animal carcinogenicity studies should be performed"

Toxicity?

Long

Not completely enclosed by macrophages producing frustrated phagocytosis ; cannot be effectively cleared

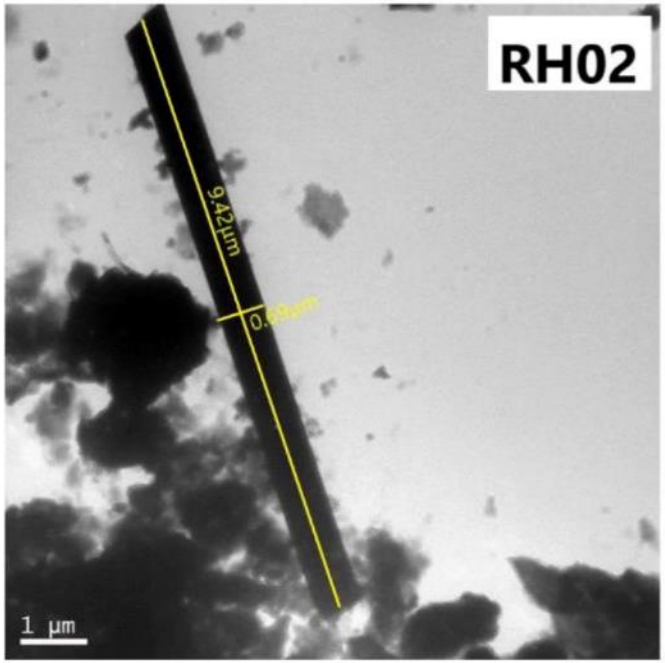
Thin

Small aerodynamic diameter enables deposition beyond the ciliated airways

Biopersistent

Retains fibrous shape during residence in the lungs and so long fibre dose accumulates

World Health Organisation defines fibres that have an aspect ratio of 3:1 or greater, a diameter below 3 µm and a length greater then 5 µm."



Toxicity?

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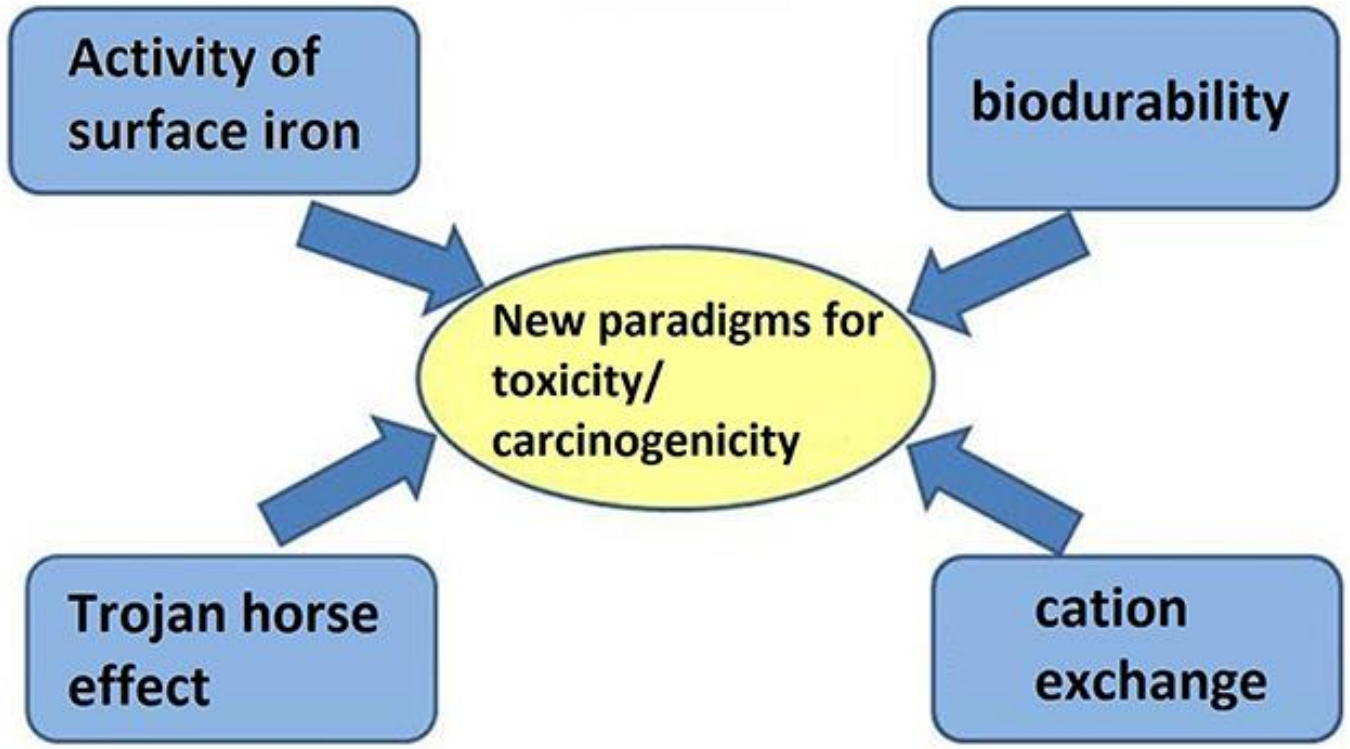
Toxicology of Mineral Fibers



(Gualtieri A.F. et al., 2017)

Next Steps

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More Geochemical Analysis –
further investigations

Transmitted Electron Microscope (TEM) –
measure length and with of fibers

In Vivo Testing –
determine toxicology

Conclusions

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The zeolites mordenite and erionite have similar occurrence, morphology and chemical properties

Identifying and distinguishing between these two fibrous minerals has important implications for hazard management

Further research needs to be carried out to understand the chemistry and toxicity

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Thank you

Questions?

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