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Actual and potential hazard represented by Naturally Occurring Erionite (NOE)

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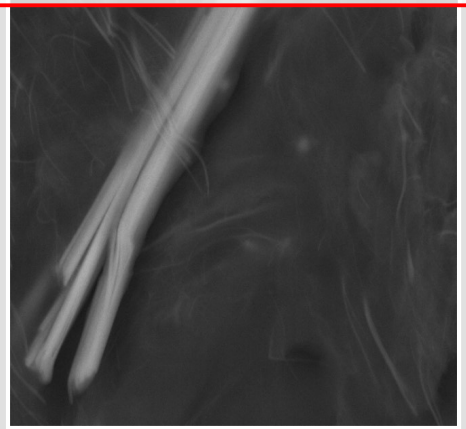
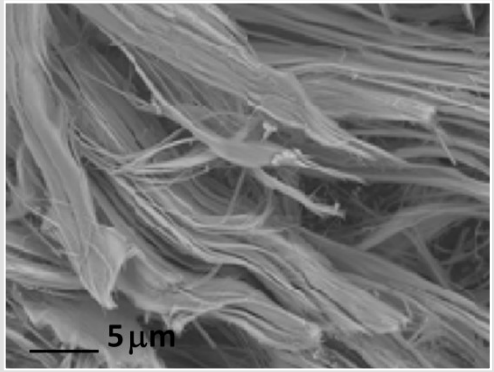
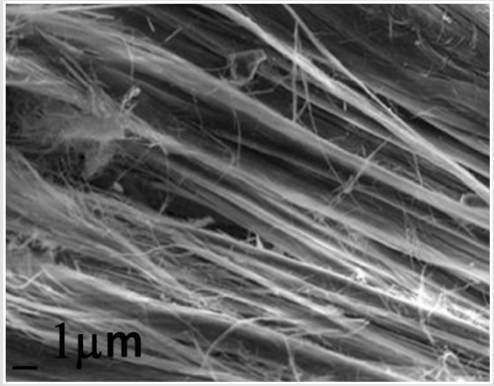
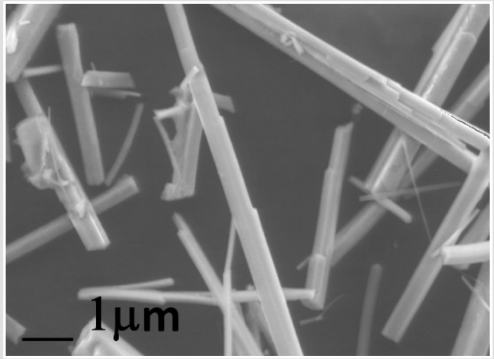
Mineral fibers

IARC (International Agency for Research on Cancer) **carcinogens** ***"Group 1"***









"A generic term applied to the asbestiform variety of serpentine (chrysotile) and the asbestiform variety of amphibole group minerals (anthophyllite, cummingtonite-grunerite, tremolite-actinolite and riebeckite), which have been exploited, prospected, described in the literature, traded and sold commercially for their unique physical properties resulting from fibril dimension 0.5 µm or smaller in width (IMA comm., 2022).

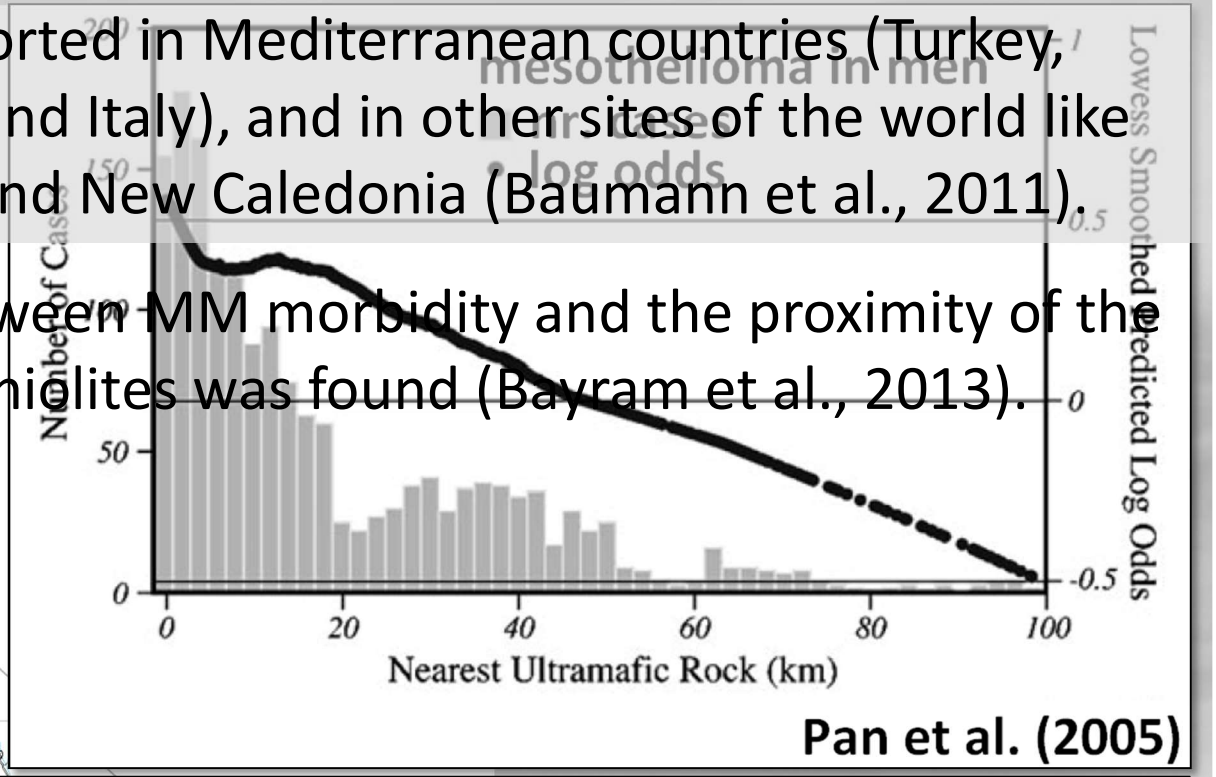
Naturally occurring asbestos (NOA)

NOA regards the asbestos fibers that occur in rocks and soils as a result of natural geological processes.

NOA and MM: the distance paradigm

NOA-related MM are reported in Mediterranean countries (Turkey, Corsica, Cyprus, Greece, and Italy), and in other sites of the world like China (Wei et al, 2012?) and New Caledonia (Baumann et al., 2011).

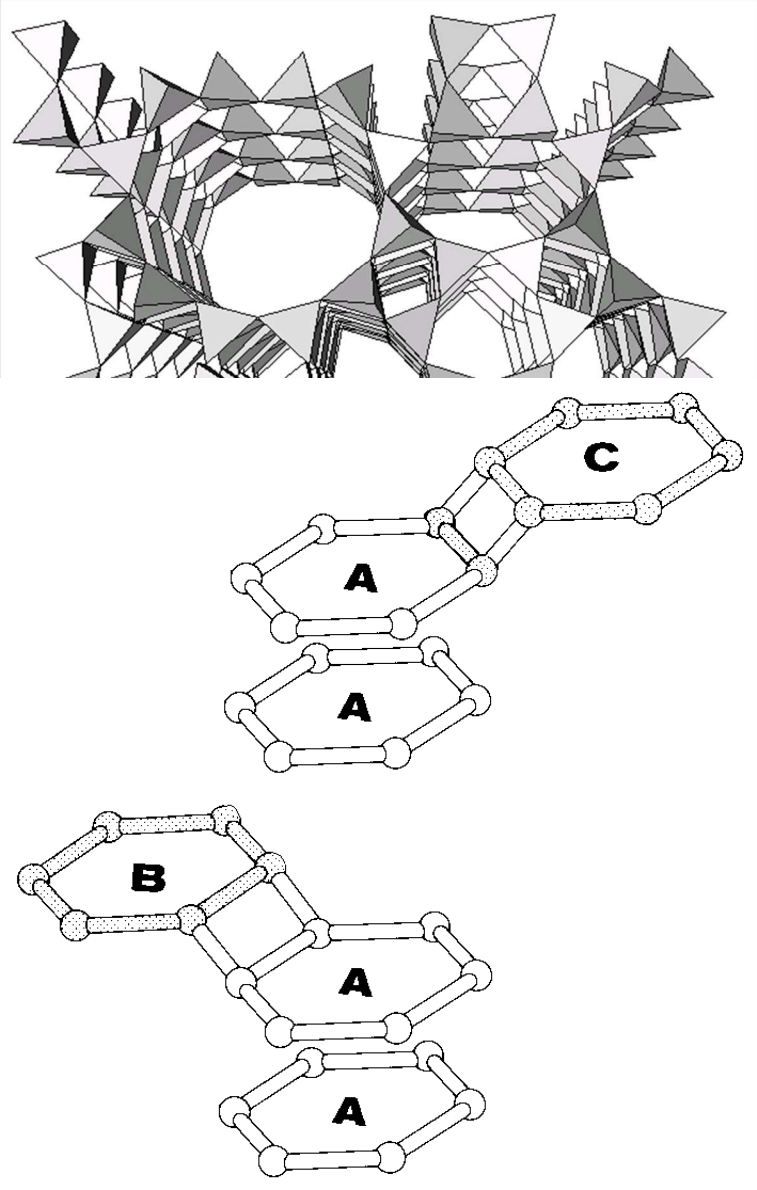
In Turkey, association between MM morbidity and the proximity of the subject's birthplace to ophiolites was found (Bayram et al., 2013).



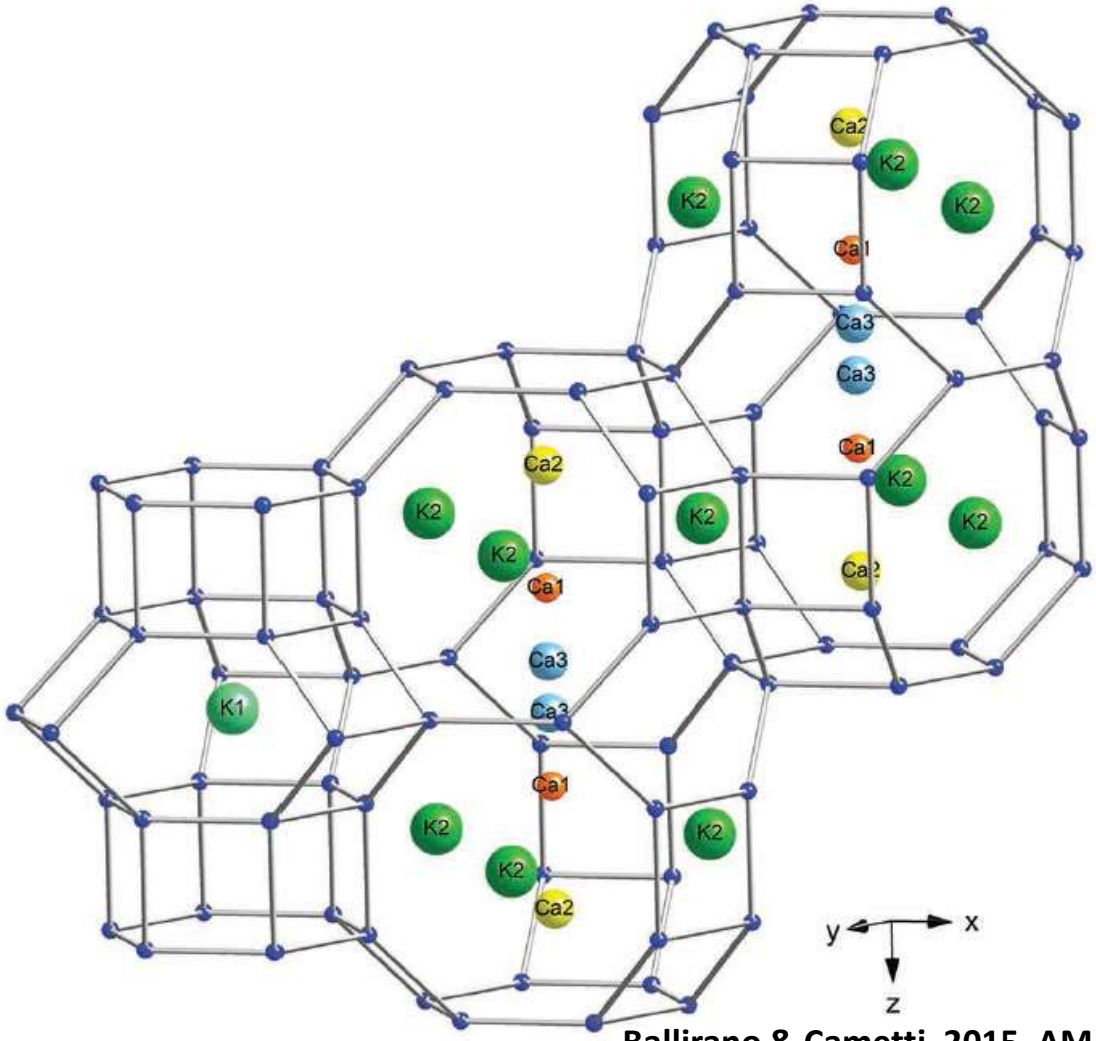
Pan et al. (2005)

Although the study of **Pan et al. (2005)** has limitations as it does not allow determination of a causal association between sources of naturally occurring asbestos (NOA) and mesothelioma: ***…data support the hypothesis that residential*** **proximity to NOA is significantly associated with increased risk of MM in California.**

Not only NOA. Naturally occurring erionite (NOE)

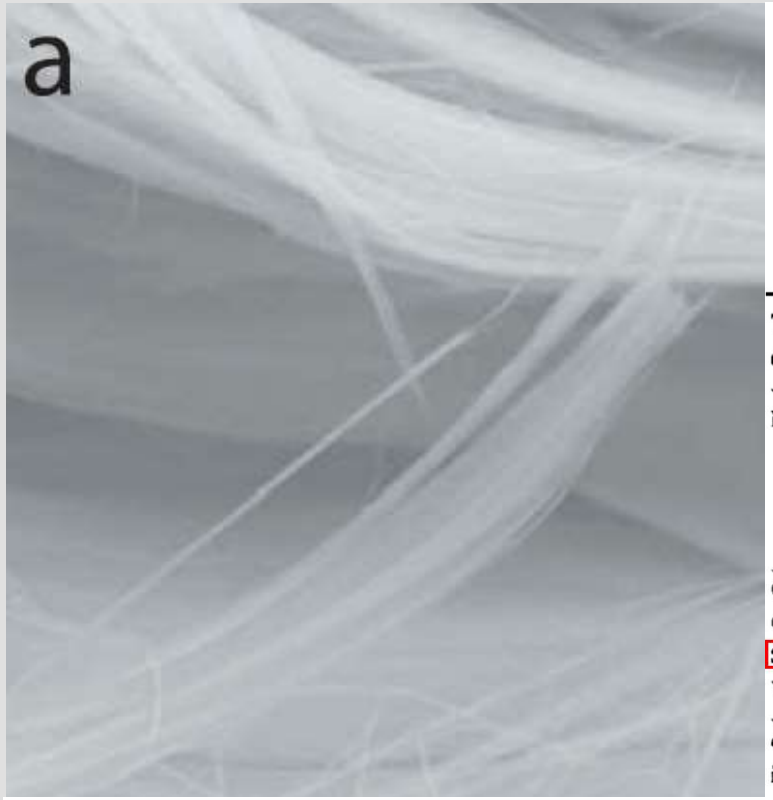


Erionite-Ca



Ballirano & Cametti, 2015, AM

Erionite crystal habit and carcinogenicity



RECENT RESULTS OF CARCINOGENICITY BIOASSAYS OF FIBRES AND OTHER PARTICULATE MATERIALS

C. Maltoni & F. Minardi
Institute of Oncology, Bologna, Italy

Table 3. Final results of tests on crocidolite, chrysotile (Canada) and sedimentary erionite[a]

Material	Peritoneal mesotheliomas			Pleural mesotheliomas		
	Tumour-bearing animals		Average latency time (weeks)	Tumour-bearing animals		Average latency time (weeks)
	No.	%		No.	%	
Crocidolite	39	97.5	59.5	18	45.0	104.8
Chrysotile (Canada)	32	80.0	92.2	26	65.0	111.1
Sedimentary erionite	20	50.0	106.1	35	87.5	64.2
Water (controls)	0	–	–	0	–	–

[a]Sprague-Dawley rats (20 males and 20 females) were given a single intraperitoneal and intrapleural injection of the material (25 mg in 1 ml of water) and kept under observation for their full lifespan.

IARC (1987, 2012) classifies "Erionite" as **carcinogenic to humans (*Group 1*)**.

NOE and the erionite *holocaust* in Cappadocia

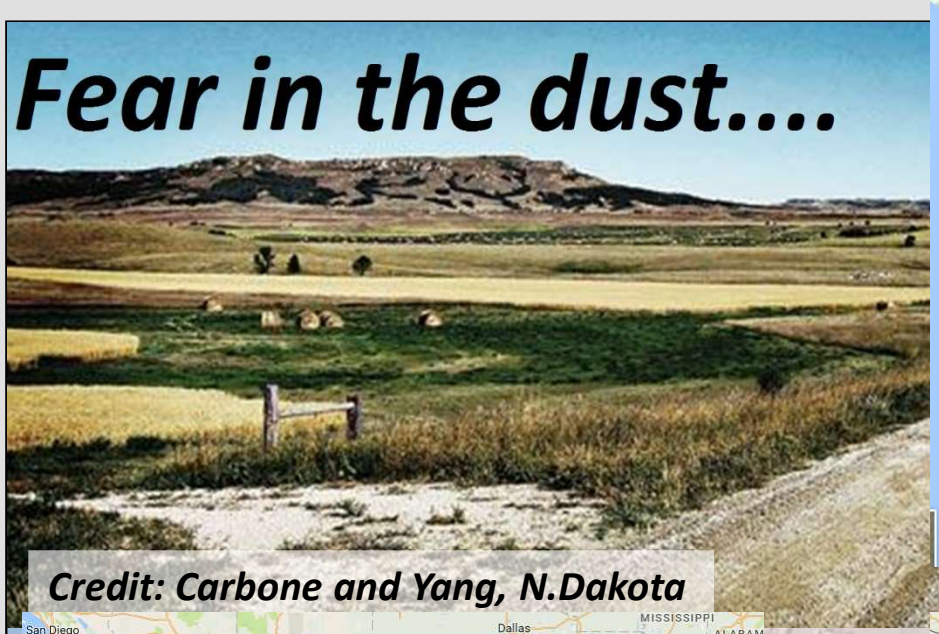
In 1978, Baris discovered an unprecedented epidemic of mesothelioma in three villages, Karain, Tuzköy and Sarihidir, in Cappadocia, Turkey… Selikoff and co-workers proposed that the epidemic was caused by exposure to asbestos… (**Carbone et al., 2007**).

Hydrothermal vs. diagenetic zeolites

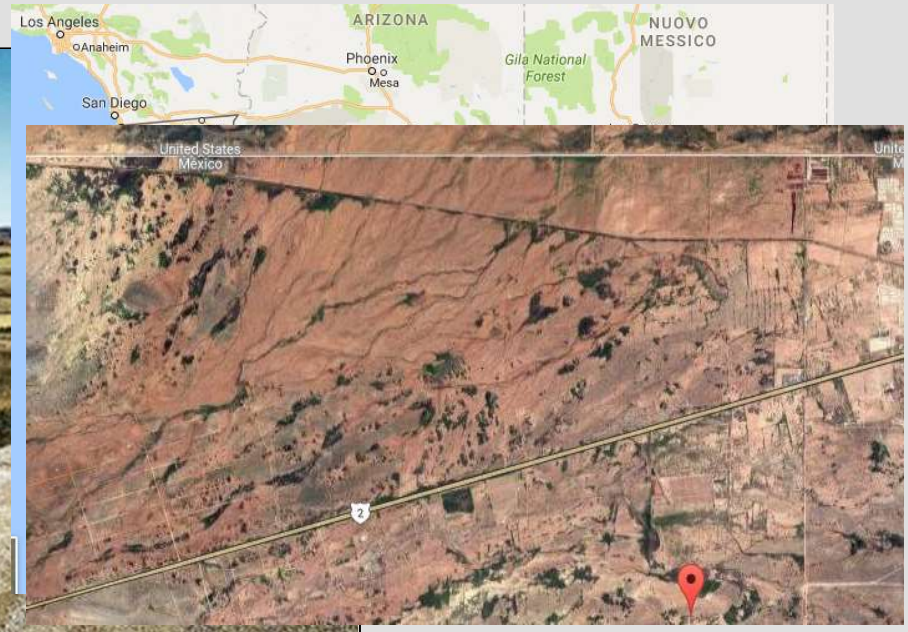
Hydrothermal: from lavas to mineral exhibitions

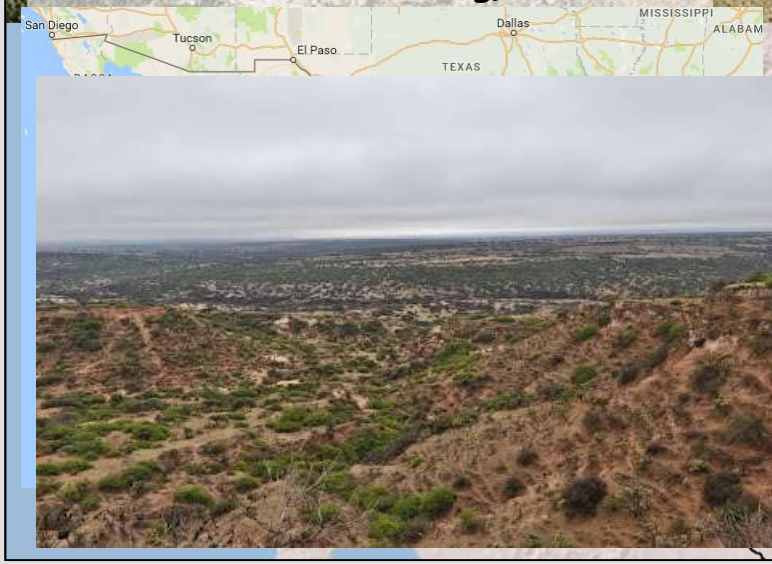
Diagenetic: from tuffs (**zeolitites**) to houses

NOE around the world



Credit: Carbone and Yang, N.Dakota



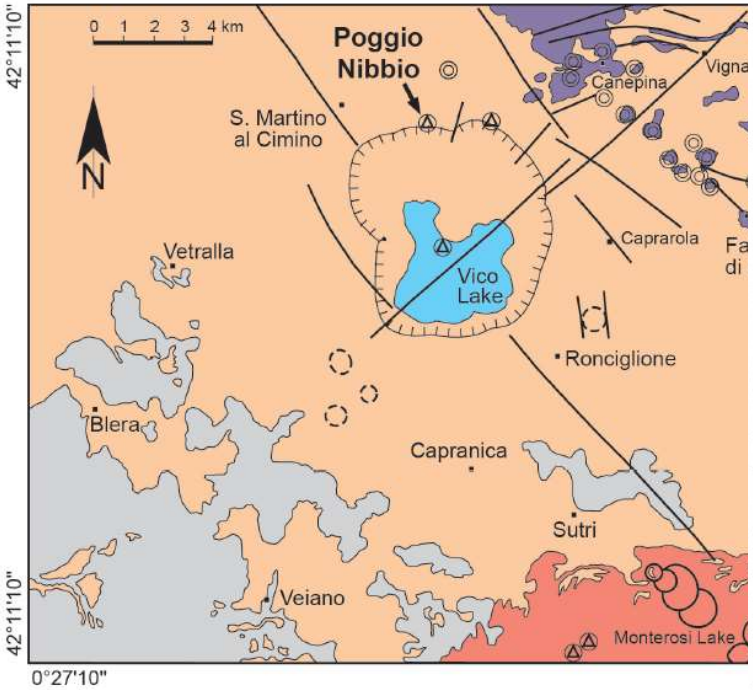


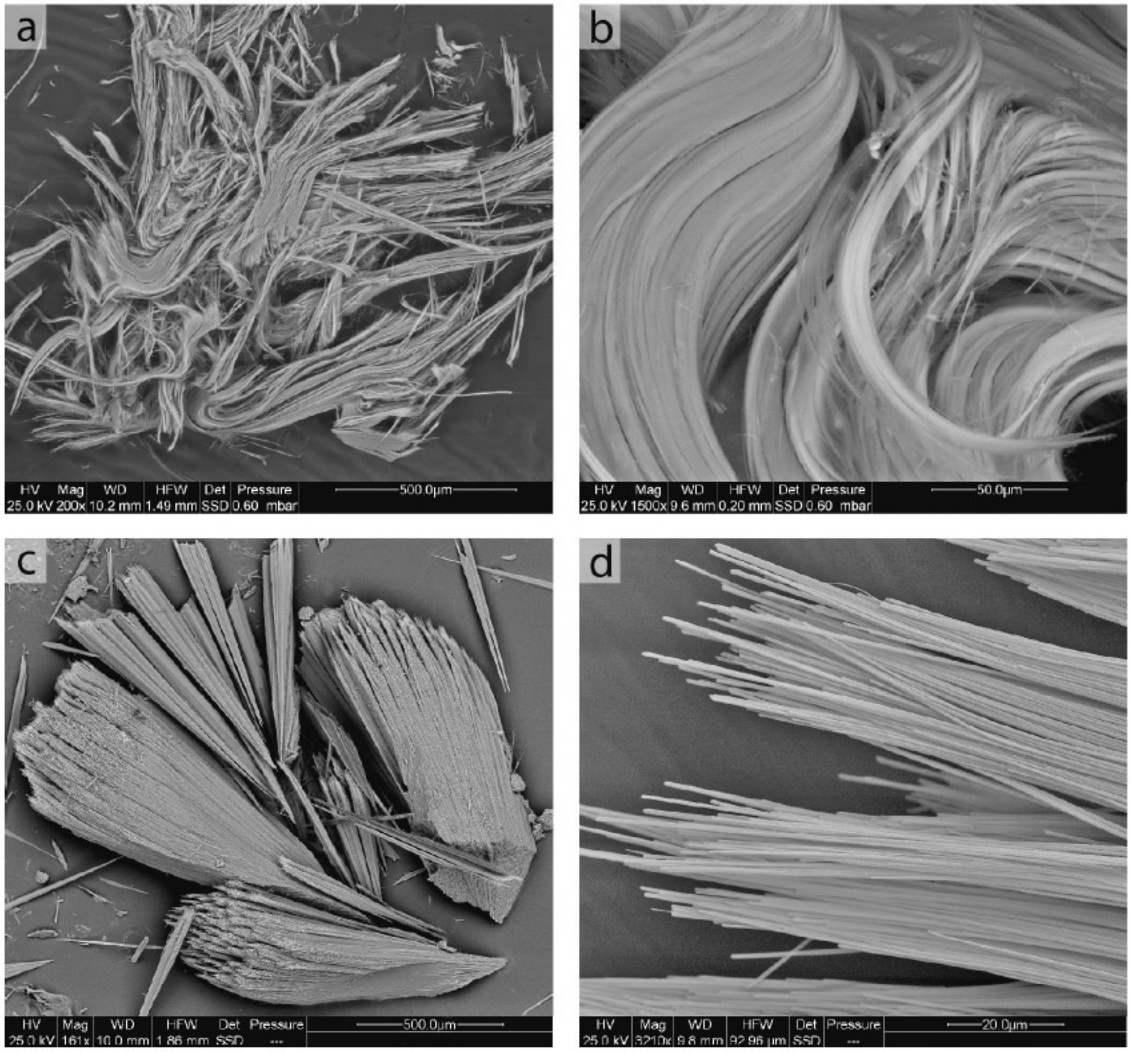
NOE around the world

Michele Mattioli [1,*], Matteo Giordani [1], Paolo Ballirano [2], Emma Salvioli-Mariani [3], Simone Bernardini [4], Giancarlo Della Ventura [4,5]

Periodico di Mineralogia (2023) 92, 159-178

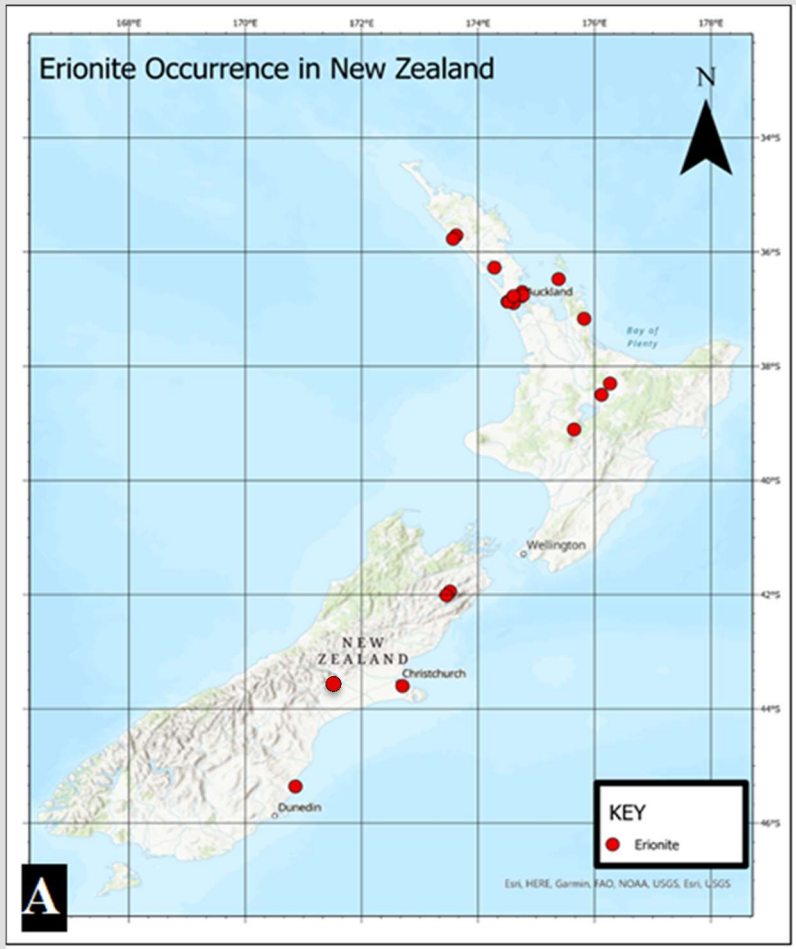
First occurrence, crystal-chemistry and structure of erionite, a carcinogenic fibrous zeolite, from the volcanic rocks of Latium (Italy)





NOE in New Zealand

Janki Patel, Martin Brook, Alessandro F. Gualtieri, Melanie Kah & Ayrton Hamilton



North Island

- *Auckland region:* Miocene Waitemata Group sediments & Waitakere Group volcanics
- *Taupo Volcanic Zone:* Pleistocene ash

South Island

- *Moeraki point:* Paleocene tuff
- *Gawler Downs:* Cretaceous andesite-dacite ash
- *Christchurch:* Late Miocene basaltic andesite

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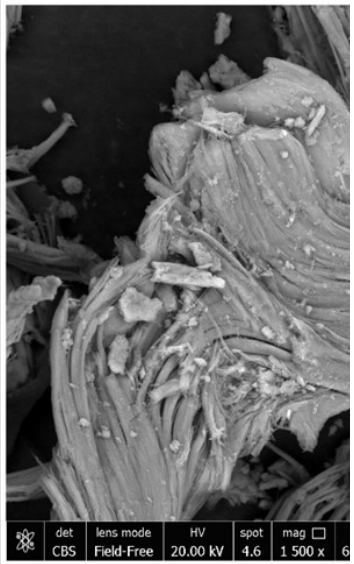
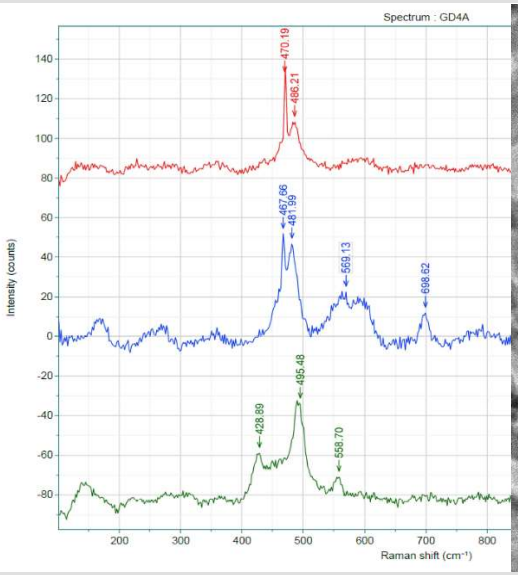
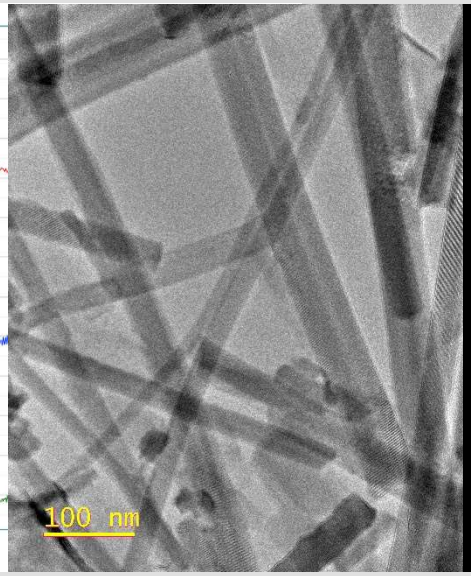
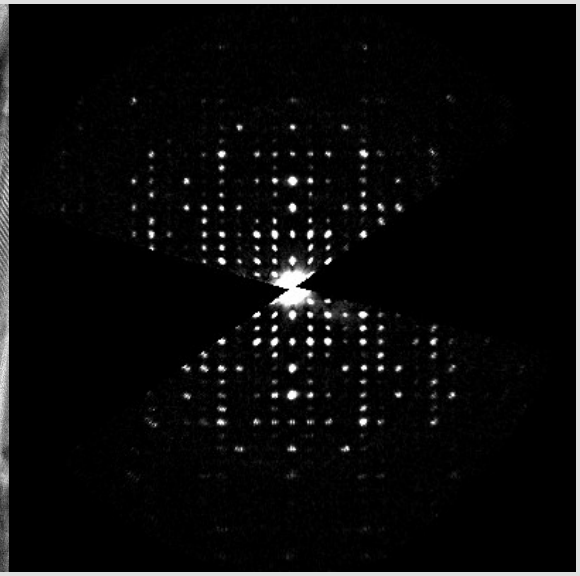
Gawler Downs

- Andesite-Dacite Ash deposit in Surrey Hills Tuff, Mt Somers Volcanics – Mid Cretaceous
- Woolly green erionite growing in vesicles









NOE in New Zealand

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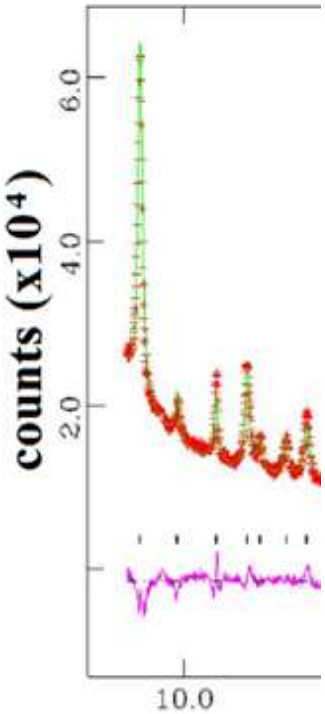
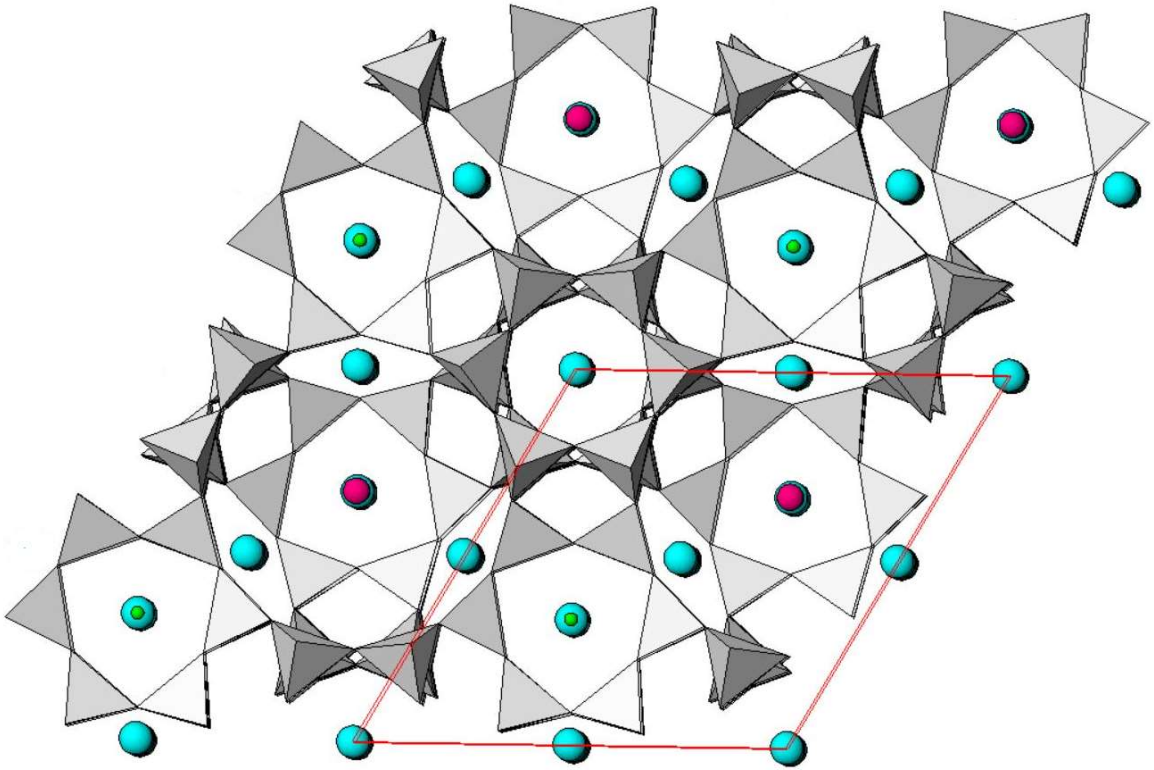
The calculated formula from the EPMA data is:

$(K_{2.63}Ca_{1.27}Mg_{0.98}Na_{0.37}Ba_{0.03}Sr_{0.01})[Si_{28.43}Al_{7.56}]_{35.99}O_{72}\cdot 29.07H_2O$





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American Mineralogist, Volume 83, pages 577–589, 1998

Crystal chemistry of the zeolites erionite and offretite

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Abstract

Many known occurrences of the zeolites erionite and offretite have been characterized by electron probe microanalysis, X-ray powder diffraction, and optical microscopy. For the first time, a substantial amount of experimentally consistent and homogeneous chemical and crystallographic data have been evaluated for these natural zeolites. Systematic analysis of the data, performed by statistical multivariate analysis, leads to the following conclusions: (1) the two zeolites have well-defined compositional fields in the chemical space describing the extraframework cation content, best illustrated in a Mg-Ca(+Na)-K(+Sr+Ba) diagram; (2) no discrimination is possible on the basis of the framework Si/Al ratio because of the extensive compositional overlap between the two species, however the Si-Al content in the framework tetrahedra is the major control on the unit-cell volume dimensions, particularly in erionite; (3) the crystal chemistry of the Mg cations is a major factor in controlling the crystallization of the mineral species; (4) cation compositions at the boundary of the recognized compositional fields might be due to chemical averaging of two-phase intergrowths, although these mixed-phase occurrences are much less common than previously thought; (5) the sign of optical elongation is not a distinctive character of the two phases, it is related to the Si/Al ratio in the framework tetrahedra of each zeolite type and cannot be used for identification purposes; (6) the zeolite mineral species epitaxially overgrown on levyne in all cases is identified as erionite; in a few cases offretite was found to be overgrown on chabazite; (7) erionite samples epitaxially overgrown on levyne are substantially more Al-rich and Mg-poor than the erionite samples associated with other zeolites.

Thank you all for your attention!