



Indagini sulla colonizzazione lichenica delle coperture in cemento amianto



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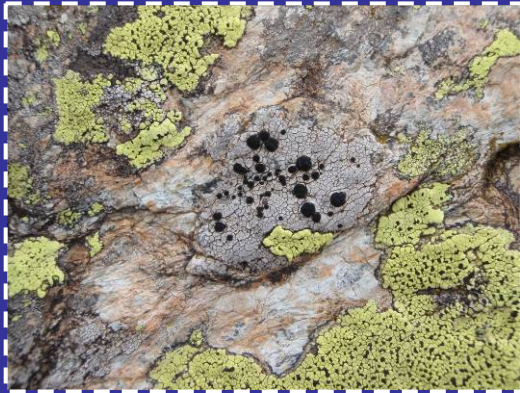
Centro Interdipartimentale Scansetti per lo Studio degli Amianti
e di Altri Particolati Nocivi

Dipartimento di Scienze della Vita e Biologia dei Sistemi

MONZA - 27 maggio 2015



Licheni ... dappertutto



SIMBIOSI LICHENICA



Lichene
in sezione



FUNGO (MICOBIONTE)

+

ALGA (FOTOBIONTE)

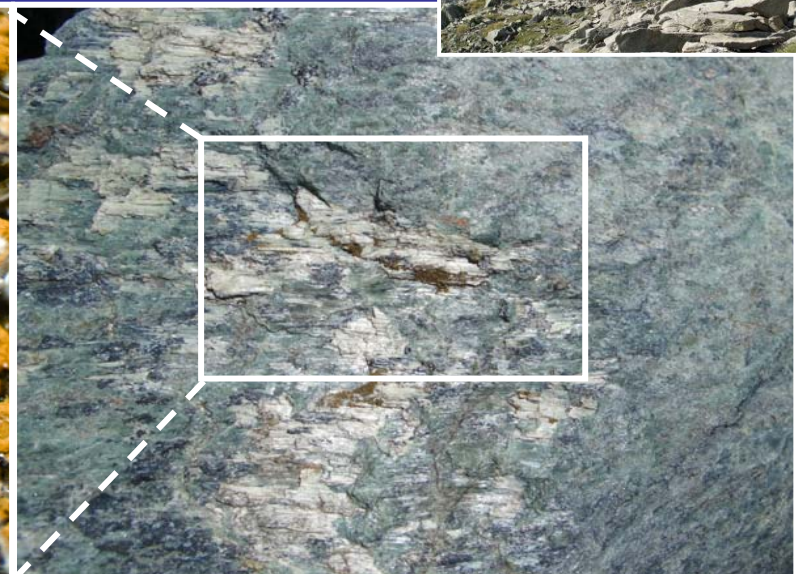
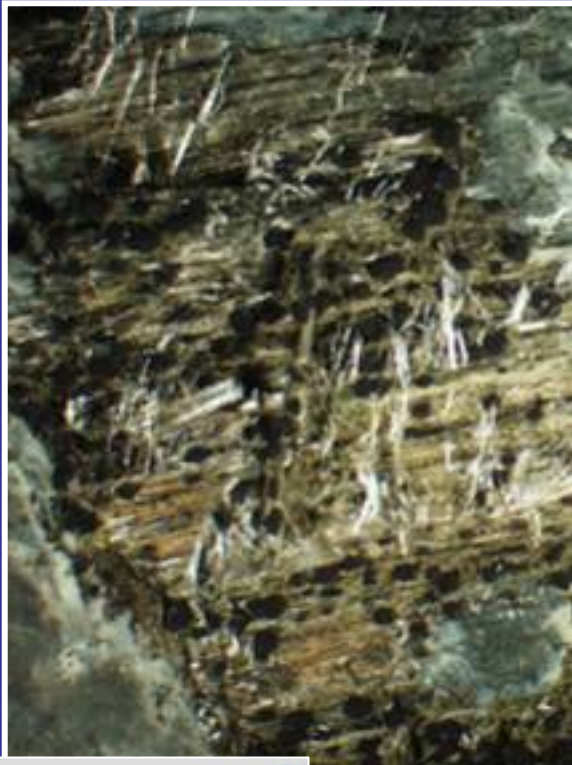


Simbionti "separati"
(colture *in vitro*)

Colonizzazione lichenica di
substrati asbestiferi ...

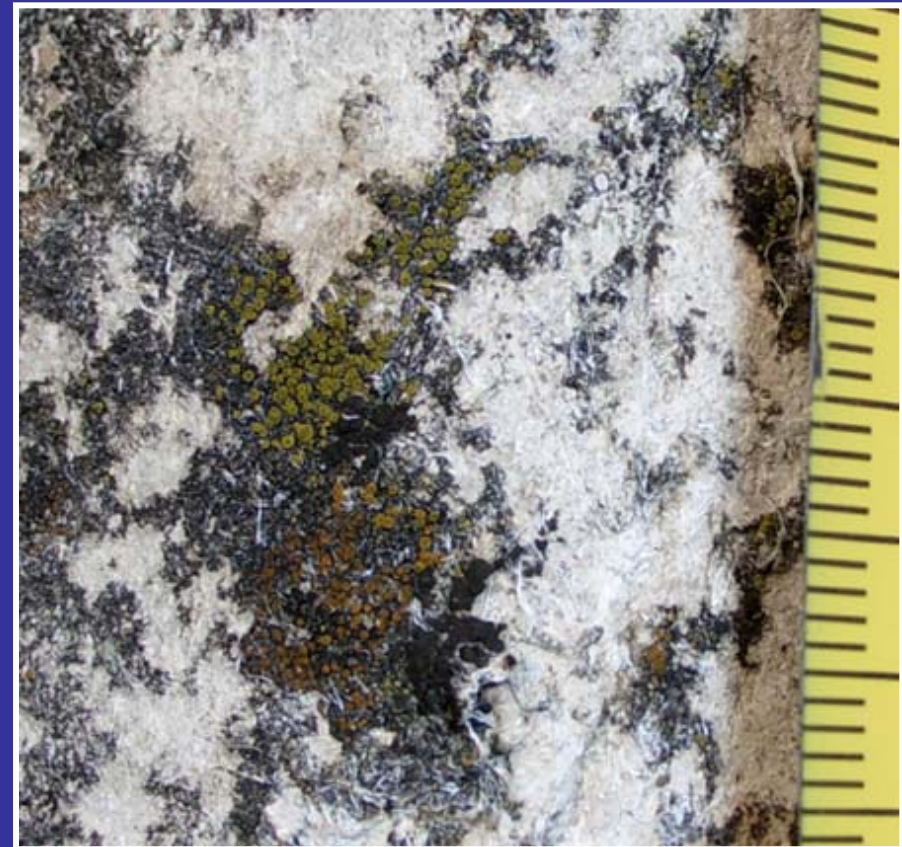
... naturali:

SERPENTINITI
ASBESTIFERE





Colonizzazione lichenica di substrati asbestiferi ...



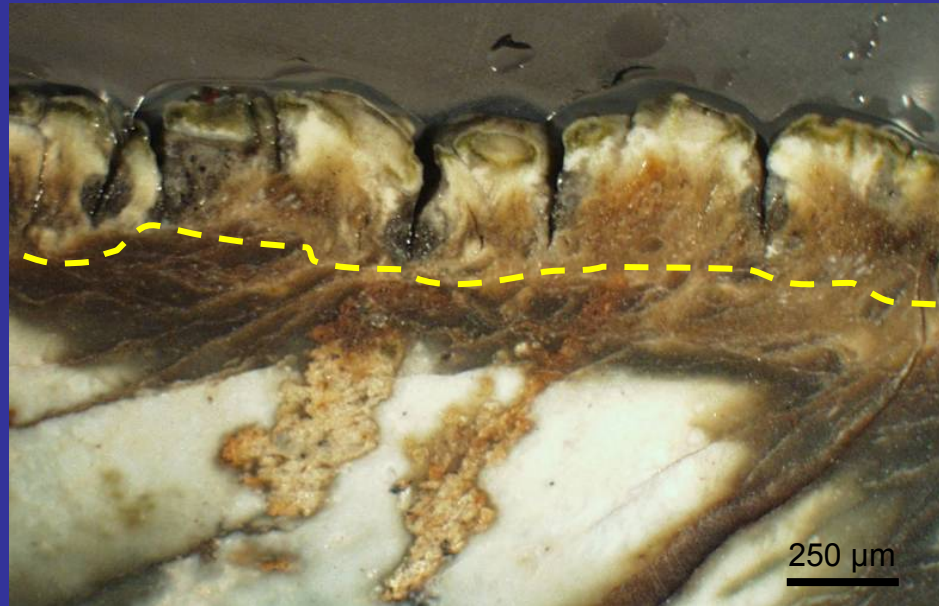
... artificiali:

CEMENTO
AMIANTO

Interazione con il substrato (1)



Interfaccia lichene-roccia



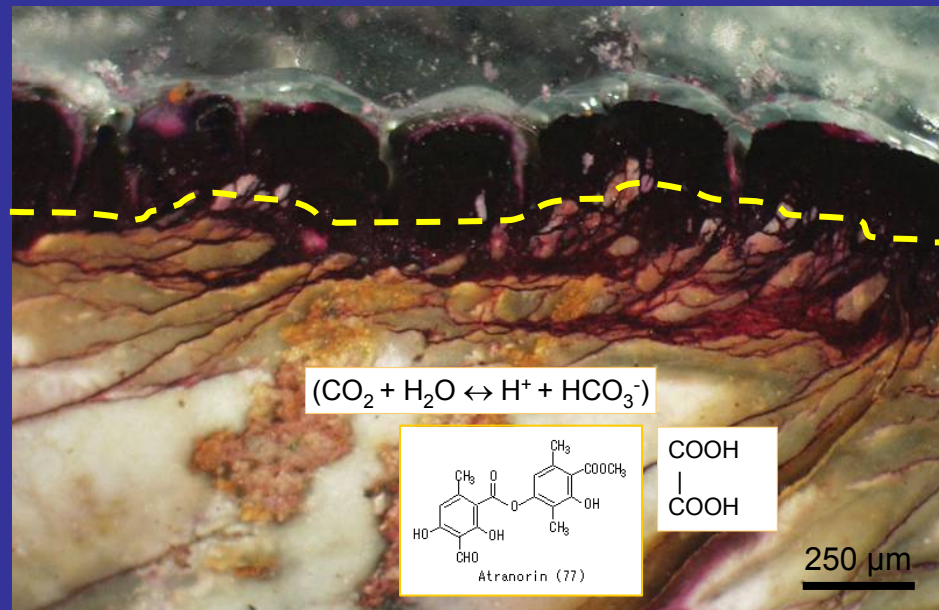
← Lichene

← Roccia

Componente tallina

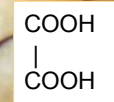
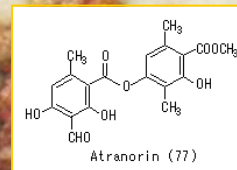
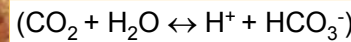
Interfaccia tallo-roccia

Componente ifale di penetrazione

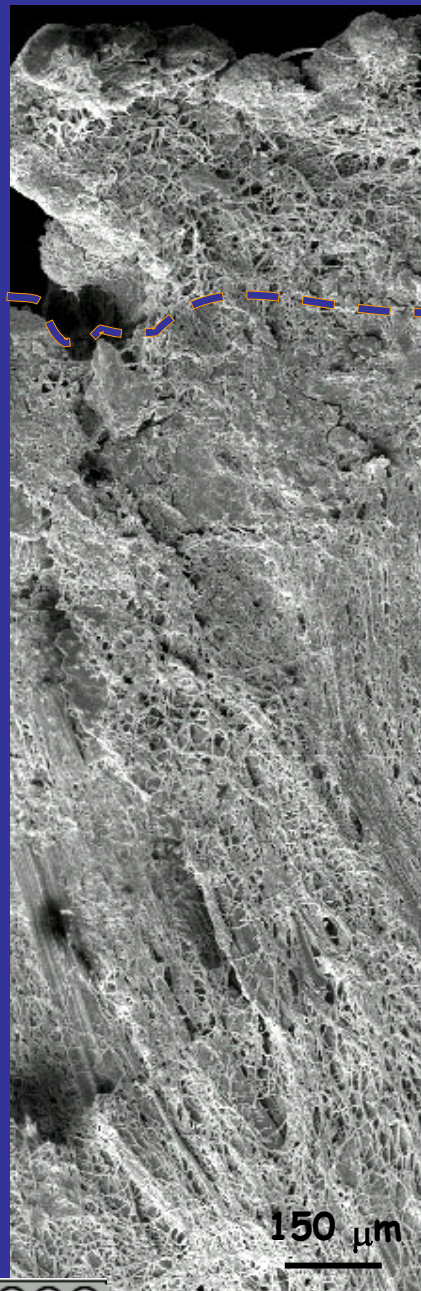


Ife fungine che penetrano nel substrato

Metaboliti chelanti e acidificanti



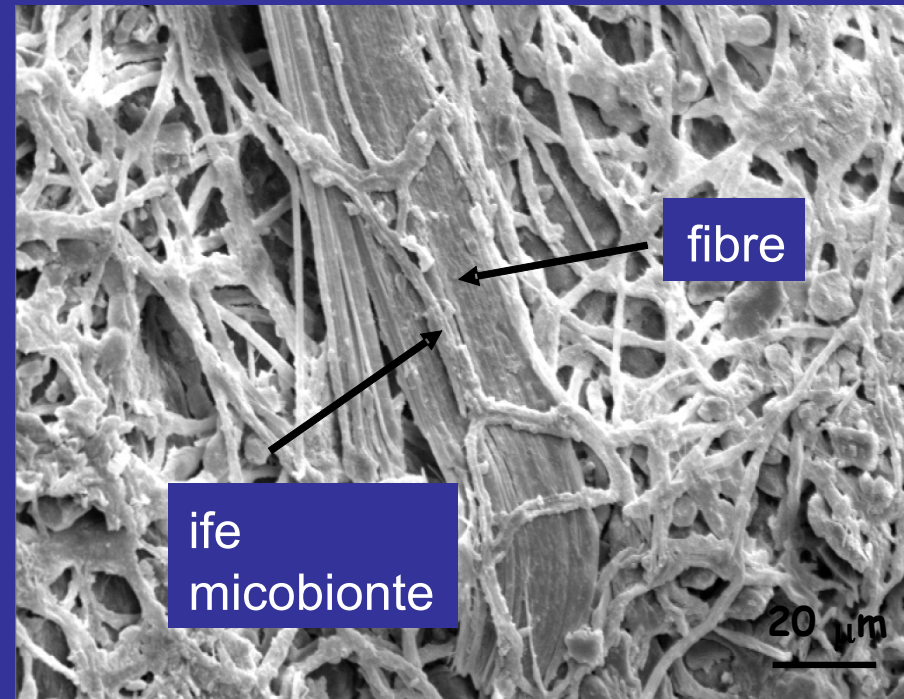
Favero-Longo et al. 2005 *Int. Biodet. Biodeg.*



Tallo

Componente
ifale di
penetrazione

Interazione con il substrato (2)



fibre

ife
micobionte

20 μm

Colonizzazione lichenica del cemento amianto



BIOPROTEZIONE LICHENICA?

... proteggono le superfici
da agenti di degrado abiologico?

BIODETERIORAMENTO LICHENICO?

... disgregano la superficie?
... alterano i minerali ?

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journal homepage: www.elsevier.com/locate/jhazmat



Lichens on asbestos–cement roofs: Bioweathering and biocovering effects

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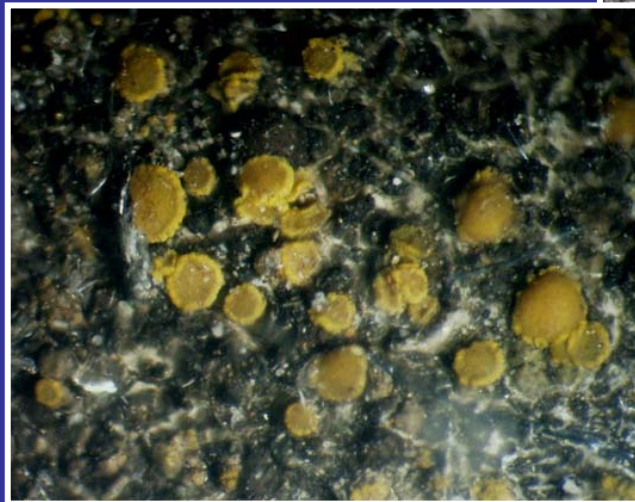
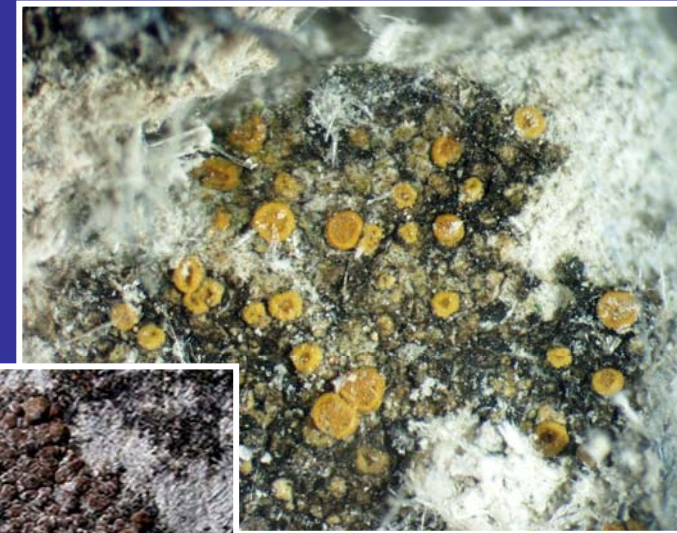
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Quanta colonizzazione? (=copertura % della superficie)

Relevés ^a	Av.
Lichen cover (%)	28.6
<i>Acarospora cervina</i> (Ach.) Massal.	24.3
<i>Caloplaca holocarpa</i> (Ach.) A. E. Wade	+
<i>Caloplaca teicholyta</i> (Ach.) J. Steiner	+
<i>Candelariella aurella</i> (Hoffm.) Zahlbr.	3.7
<i>Candelariella vitellina</i> (Hoffm.) Müll. Arg.	0.6
<i>Lecanora dispersa</i> (Pers.) Sommerf.	+
<i>Physcia dubia</i> (Hoffm.) Lettau	+
<i>Verrucaria nigrescens</i> Pers.	+
Cyanobacterial cover (%)	8.0

Favero-Longo et al. 2009 JHM



**Tante
specie
diverse!**

... contano fattori ambientali:
(micro)clima, qualità dell'aria, comunità
limitrofe, tempo di esposizione del substrato, ...

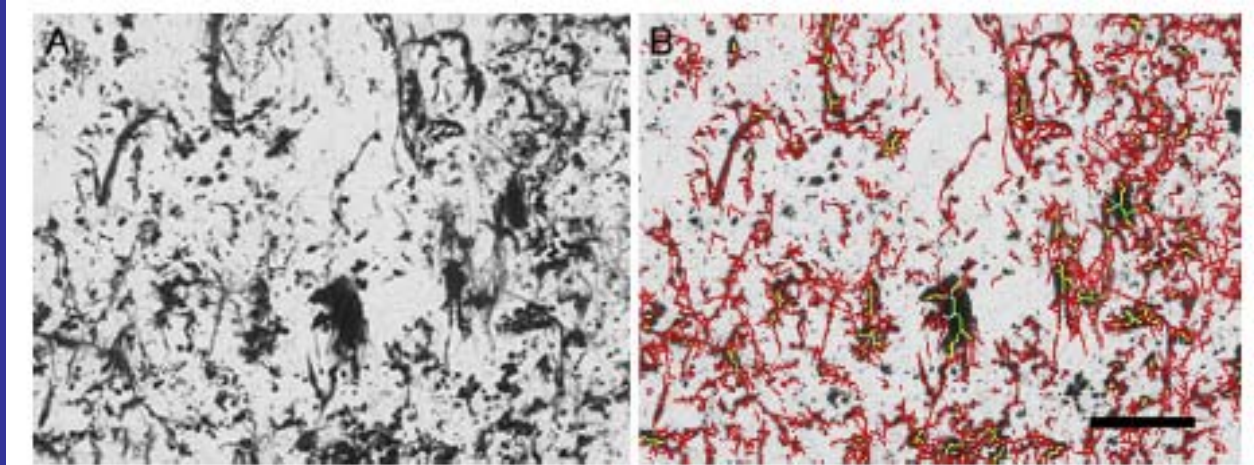
Effetto bioprotettivo ? (= rilascio di fibre)

Adesivo
3M →

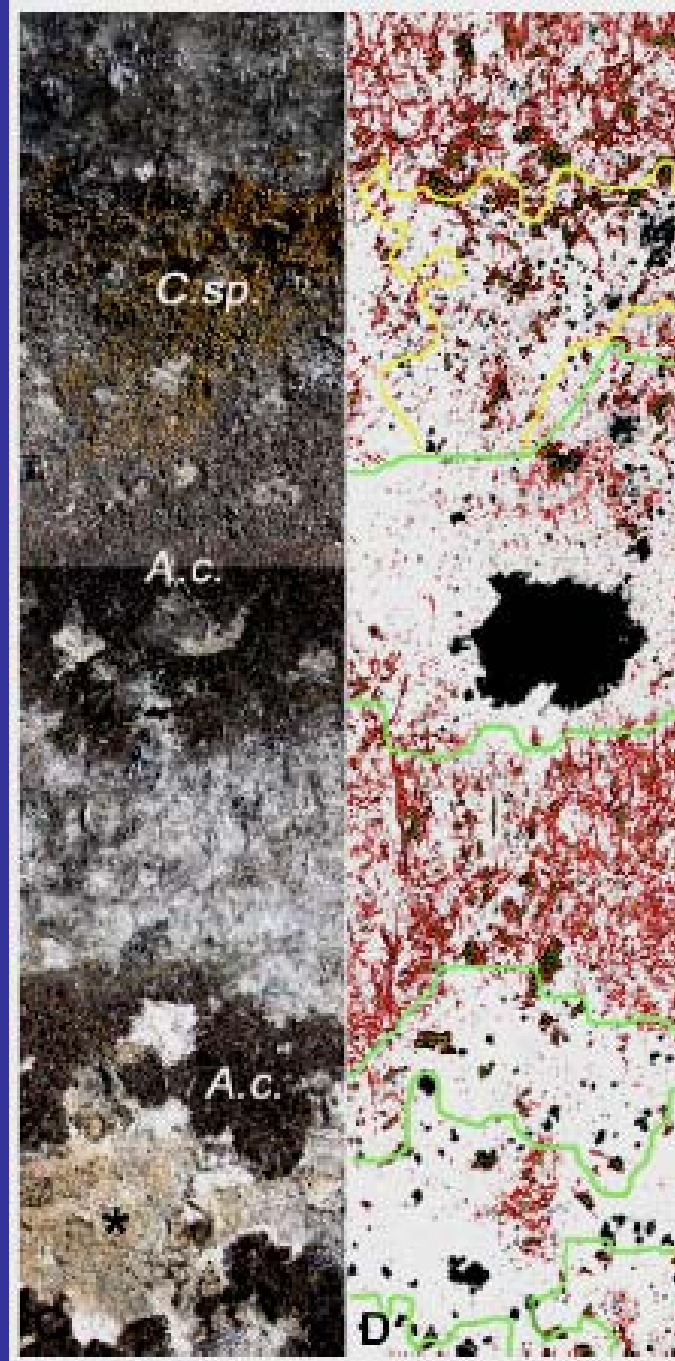
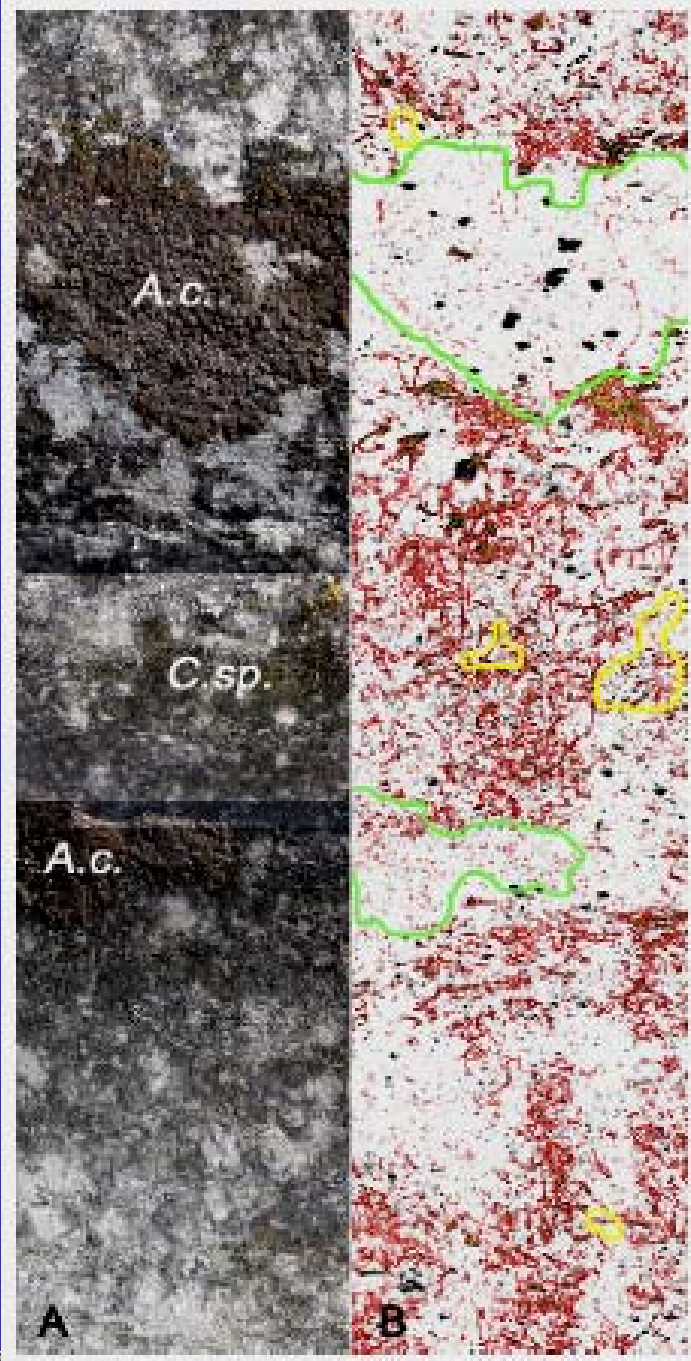


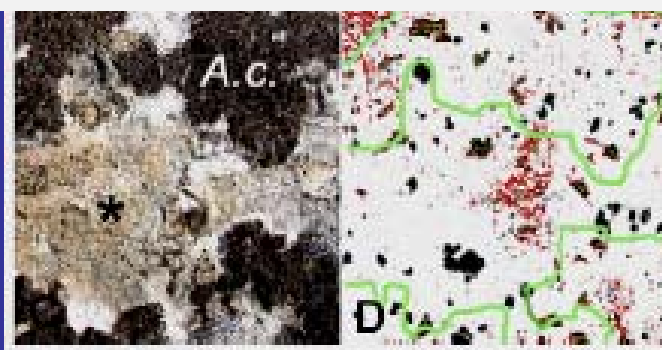
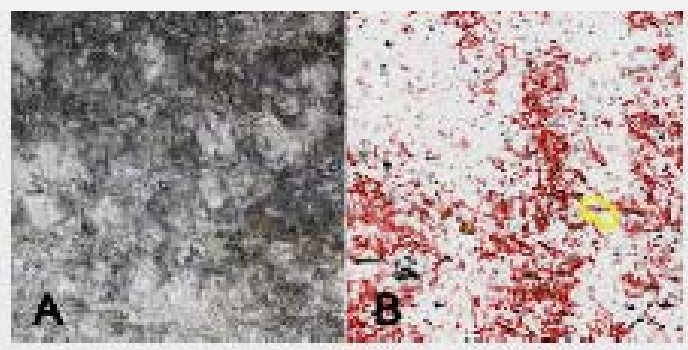
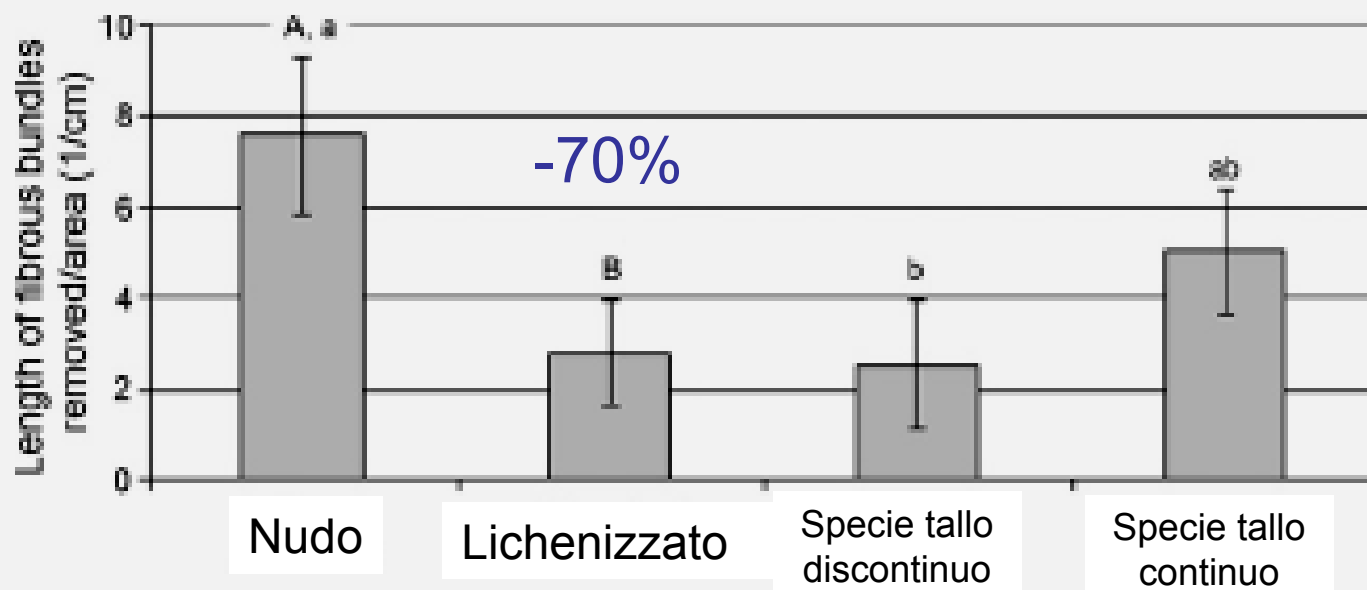
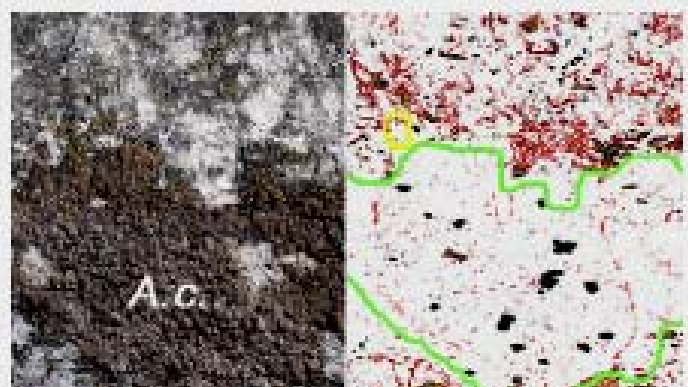
Test a strappo
(modificato)

Favero-Longo et al. 2009 JHM

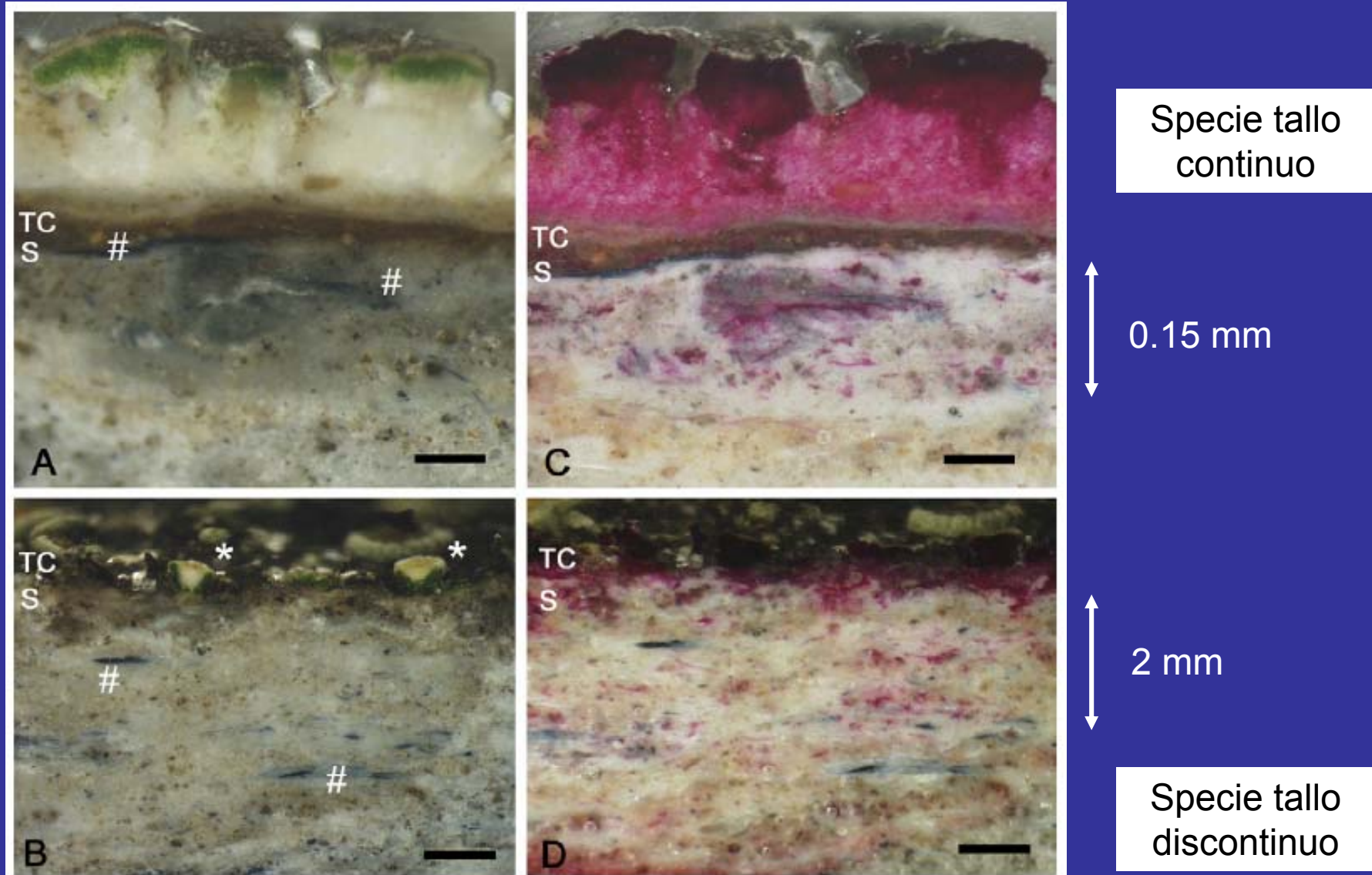


Analisi d'immagine strutture a sviluppo lineare (WinRHIZO™, 2004)

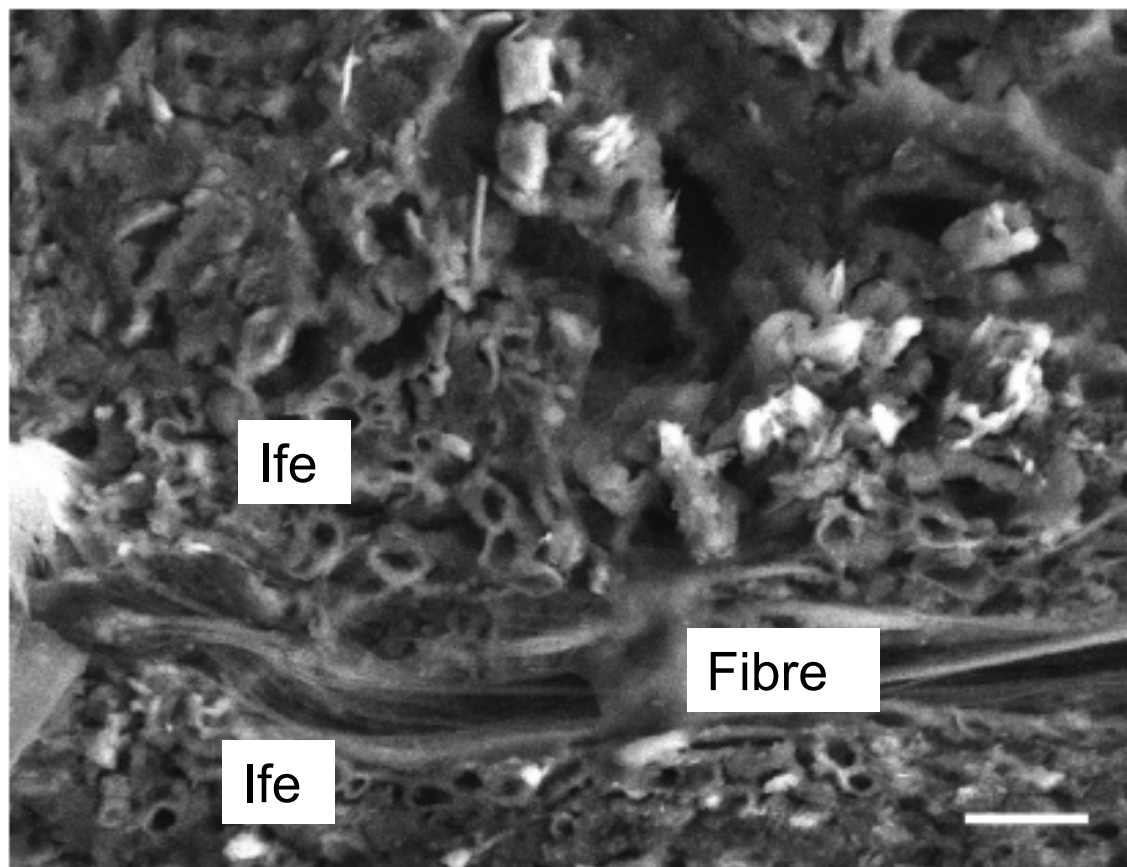




Interazione in profondità ? (= mm comp. ifale di penetrazione)



Interazione in profondità ? (= mm comp. ifale di penetrazione)



Favero-Longo et al. 2009 JHM

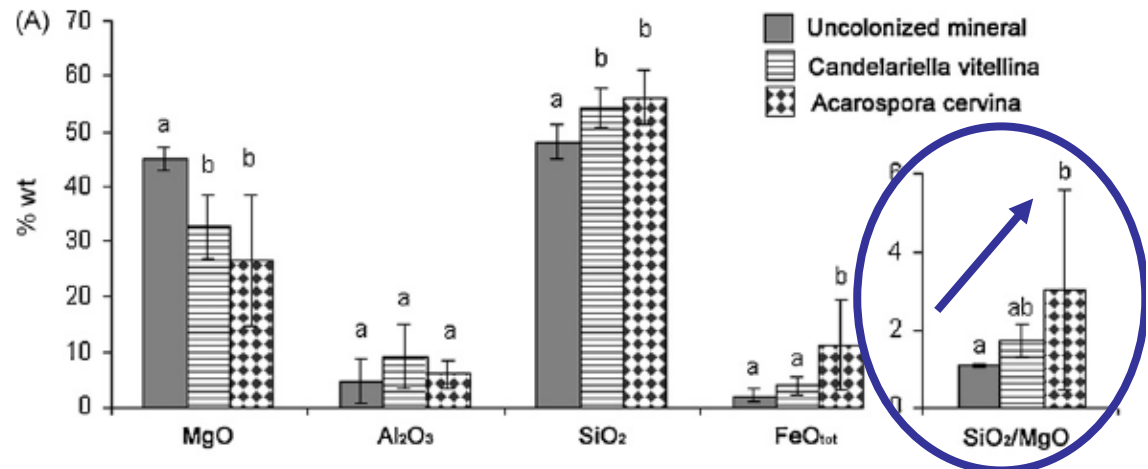
Interazione
ife
micobionte
vs.
fibre

Bioalterazione delle fibre? (= wt. % oxides)

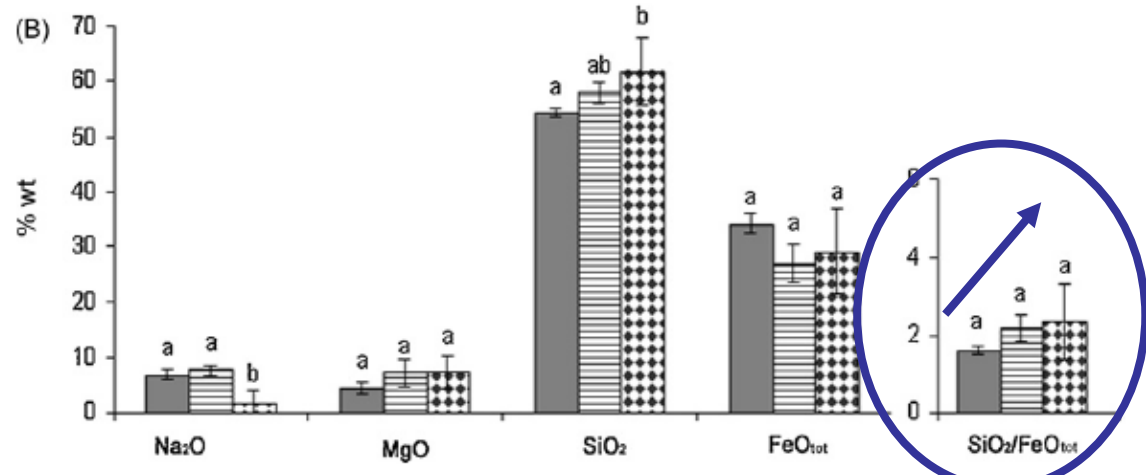
Cristotilo → Dissoluzione incongruente



Favero-Longo et al. 2009 JHM

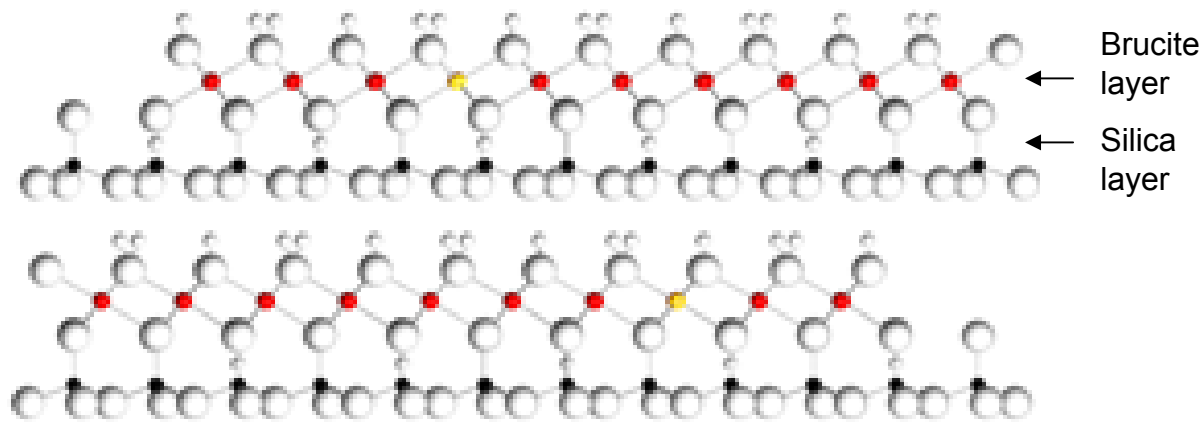


Crocidolite → Dissoluzione incongruente



Bioalterazione delle fibre? (= wt. % oxides)

Ideal crystalline structure



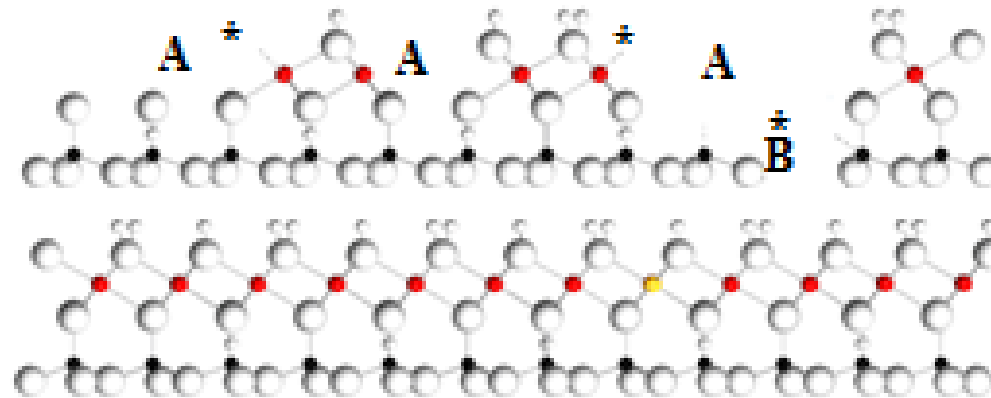
Crisotilo:



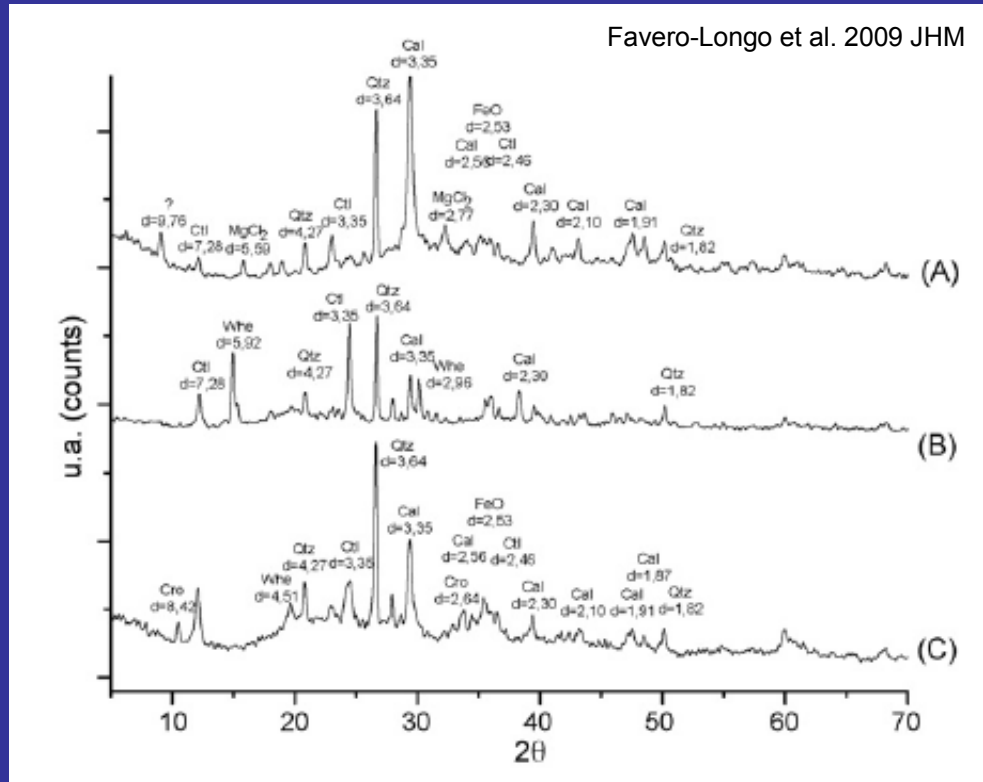
Dissoluzione incongruente

... del layer brucitico,
contenente **Mg** e, come
sostituente, **Fe**

Weathered crystalline structure (as supposed)



Bioalterazione delle fibre: quali metaboliti sono coinvolti?



Nessun lichene

→ Calcite, Crisotilo, Quarzo, derivati MgCl₂, Crocidolite

Specie tallo continuo

+ → OSSALATI

Specie tallo discontinuo

+ → OSSIDROSSIDI DI FERRO

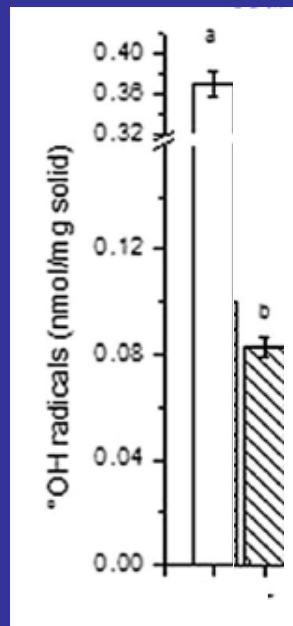
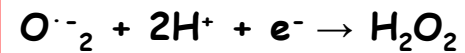
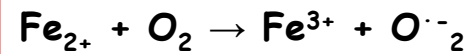
Diffrazione a raggi X di polveri

Reattività superficiale delle fibre? (= wt. % oxides)



Fe → ciclo di Haber-Weiss

FREE RADICAL GENERATION



Favero-Longo et al.
2009 JTEH

Fibre tal quali ("fresche")

-75%

Fibre di composizione simile a quelle osservate sotto i licheni, ottenute in laboratorio mediante incubazione in acido ossalico 0.5 mM per 30 giorni

Riduzione della reattività superficiale nelle fibre alterate

Licheni su cemento amianto:

- riduzione esposizione e attitudine alla dispersione delle fibre
- modificazione della composizione delle fibre, in laboratorio correlata ad una riduzione della reattività superficiale (reattività di Fenton)

... ma ...

- su superfici con licheni, esposte da tempo, le porzioni non colonizzate mostrano in genere forti tracce di degrado!
- la situazione può essere differente a seconda delle comunità licheniche presenti e delle condizioni climatiche

$$LPBA = \log \sum_{ij=1}^n \left\{ a_{ij} b_i \left[c_{ij} (d_{ij} + e_i) f_{ij} \right]^{g_j} \right\}$$

Lichen index of potential
deteriogenic activity (LPBA;
Gazzano *et al.*, Int. Biodet.
Biodegr., 2009)

... per i monumenti!

RINGRAZIAMENTI



**"INFLUENZA DELLA DEGRADAZIONE
BIOLOGICA OPERATA DAI LICHENI
SULLA PATOGENICITA' DEI MINERALI
ASBESTIFORMI PRESENTI NEL
TERRITORIO PIEMONTESE"**

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Francesco Turci
Maura Tomatis**

R.S.A. di Balangero



Nota: Prasad et al. 2015. Remote sensing and GIS for biodiversity conservation. Recent Advances in Lichenology. Vol I, 151-179.

[13] National Occupational and Healthy Commission of Australia, Management of asbestos in the non-occupational environment, Publication approval number 3663 (JN9050), Australian Government, Canberra, Australia, 2005, <http://enhealth.nphp.gov.au/council/pubs/pubs.htm>.

[14] Health and Safety Authority of Ireland, Guidelines on working with materials containing asbestos cement, Health and Safety Authority, Dublin, Ireland, 2005, http://www.hsa.ie/files/product_20050708112204asbcem.pdf.

[15] Health and Safety of UK, The Control of Asbestos Regulations 2006, Statutory Instrument 2006 no. 2739, Queen's printer of Acts of Parliament, London, UK, 2006, <http://www.hse.gov.uk/asbestos/regulations.htm>.

[11] NEPA of Jamaica (National Environment and Planning Agency of Jamaica), Proposed asbestos management policy, Ministry of Land and Environment of Jamaica, Kingston, Jamaica, 2002, <http://www.mle.gov.jm/Policies/ASBESTOSMGTPOLICY.PDF>.

[22] S.K. Brown, A.N. Souprounovich, Cleaning and painting of weathered asbestos cement roofing, Surf. Coat. Aust. 25 (1989) 6–9.

[23] UNI (Ente Italiano di Unificazione), Standard 10608: Asbestos–cement products. Evaluation of surface deterioration. Practical pull up method. UNI - Ente Italiano di Unificazione, Milan, Italy, 1997.

Lichen effects on the durability of this material, however, are still debated, also through the official guidelines for the asbestos management. Sometimes lichens are considered as responsible of the softening of the asbestos surface [13,17]: secreting oxalic acid, they attack the alkaline cement matrix over time leading to accelerated deterioration [11]; their dark color causes a substantial increase in roof cavity temperature [22]. In other case, the lichen growth, although visually unattractive, is retained to have no significant effect on the strength, durability or lifetime of asbestos–cement [14]. However, it is worth noting that the evaluation of the aging, in terms of disaggregation, of asbestos–cement roofs is currently performed by tests, as pull up test, e.g. [23], which do not take the biological colonization into account.

-
No effect
-