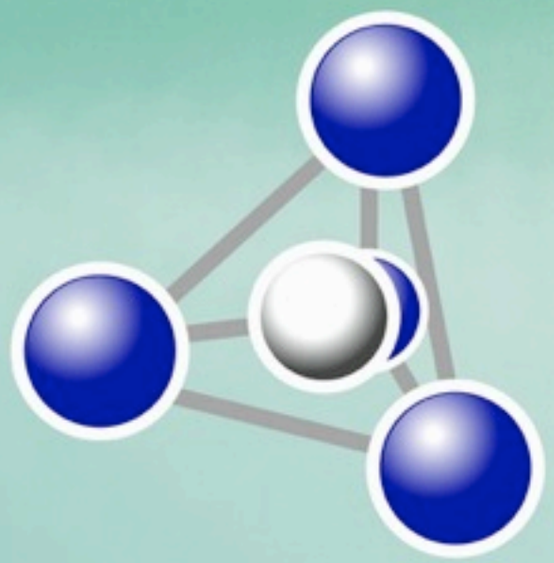
GEOPOLYMER CAMP 2012

IUT Aisne

www.iut-aisne.fr

Saint-Quentin (France)

July 9-12, 2012



INSTITUT GÉOPOLYMÈRE

Prof. Dr. Joseph Davidovits

www.geopolymer.org

82 participants 2012

State of the Geopolymer R&D 2012

2012 GEOPOLYMER CAMP

Previous State of the Geopolymer R&D on VIDEO (*vimeo.com*)

Previous State of the Geopolymer R&D on VIDEO (*vimeo.com*)

Geopolymer-Camp 2009:

Previous State of the Geopolymer R&D on VIDEO (*vimeo.com*)

Geopolymer-Camp 2009:

Mass Produced Geopolymer Cement > 2750

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Previous State of the Geopolymer R&D on VIDEO (*vimeo.com*)

Geopolymer-Camp 2009:

Mass Produced Geopolymer Cement > 2750

Geopolymer-Camp 2010:

State of the Geopolymer R&D 2010 > 880

Previous State of the Geopolymer R&D on VIDEO (*vimeo.com*)

Geopolymer-Camp 2009:

Mass Produced Geopolymer Cement > 2750

Geopolymer-Camp 2010:

State of the Geopolymer R&D 2010 > 880

Geopolymer-Camp 2011:

Previous State of the Geopolymer R&D on VIDEO (*vimeo.com*)

Geopolymer-Camp 2009:

Mass Produced Geopolymer Cement > 2750

Geopolymer-Camp 2010:

State of the Geopolymer R&D 2010 > 880

Geopolymer-Camp 2011:

State of the Geopolymer R&D 2011 > 500

State of the Geopolymer R&D 2012

State of the Geopolymer R&D 2012

1) Geopolymer science

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

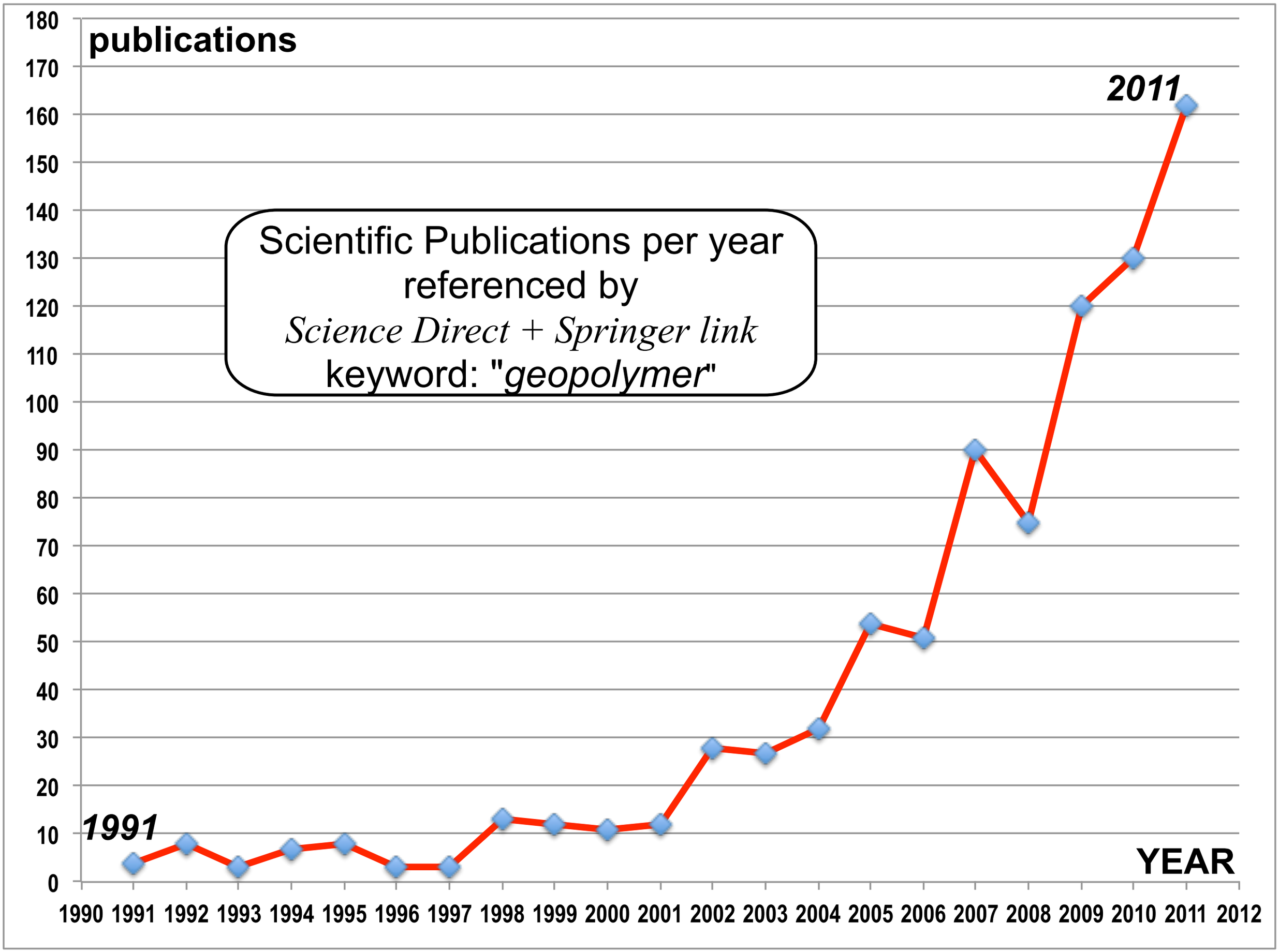
3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

Geopolymer research 1988

1st Geopolymer conference

Geopolymer research 2012


publications
Scientific Publications per year
referenced by
Science Direct + Springer link
keyword: "geopolymer"
2011
1991
YEAR
180
170
160
150
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130
120
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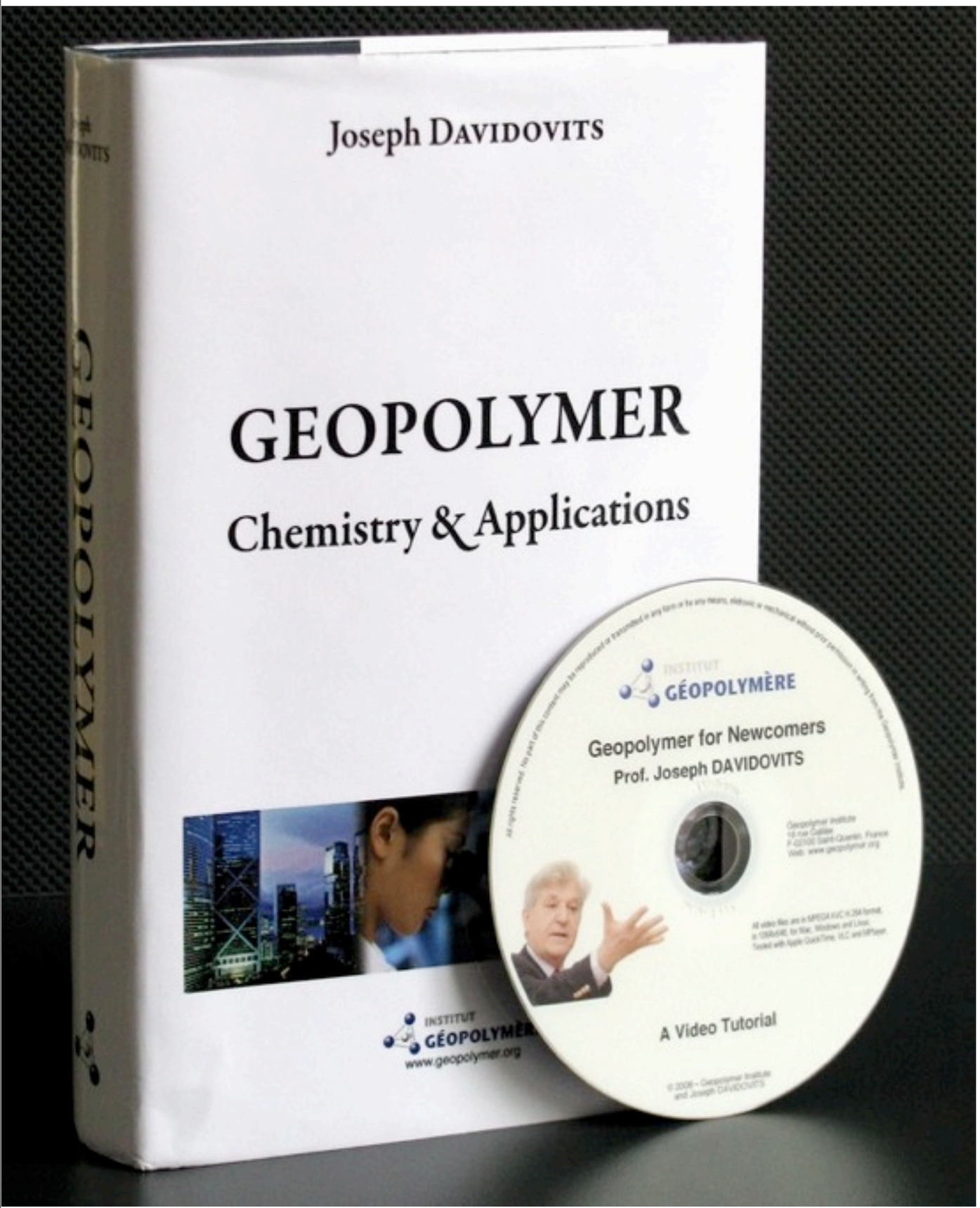
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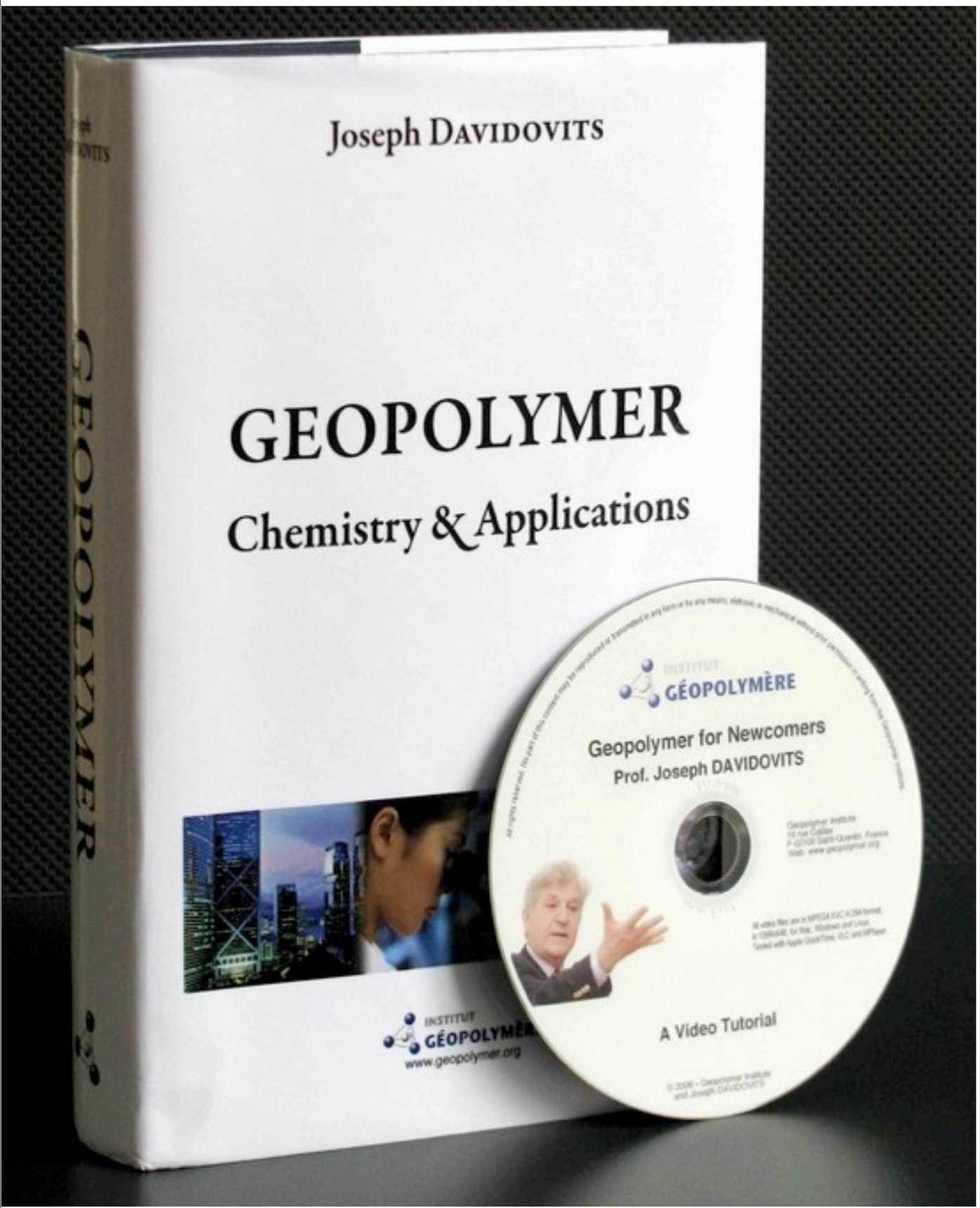
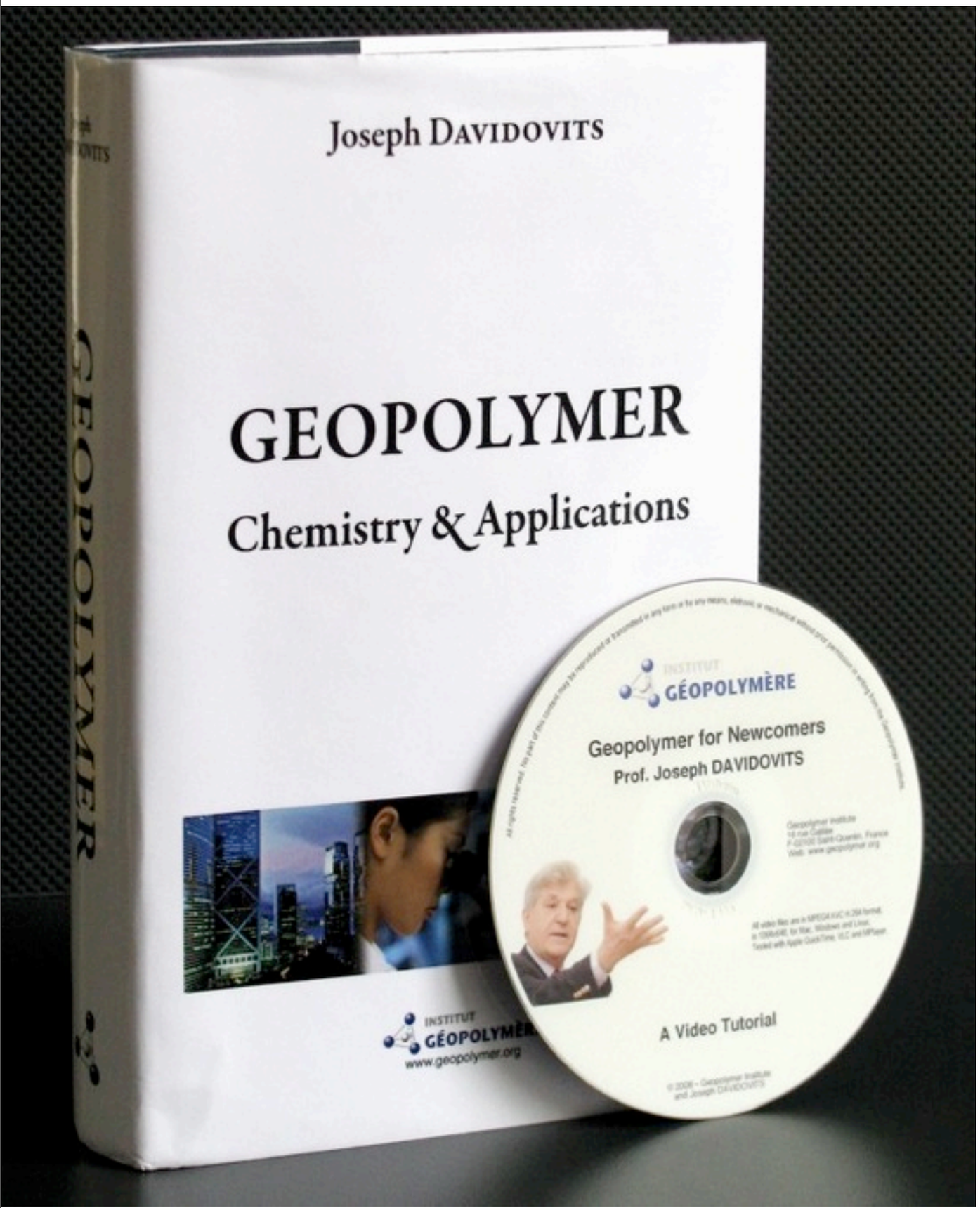
Geopolymer for Newcomers
Prof. Joseph DAVIDOVITS
A Video Tutorial

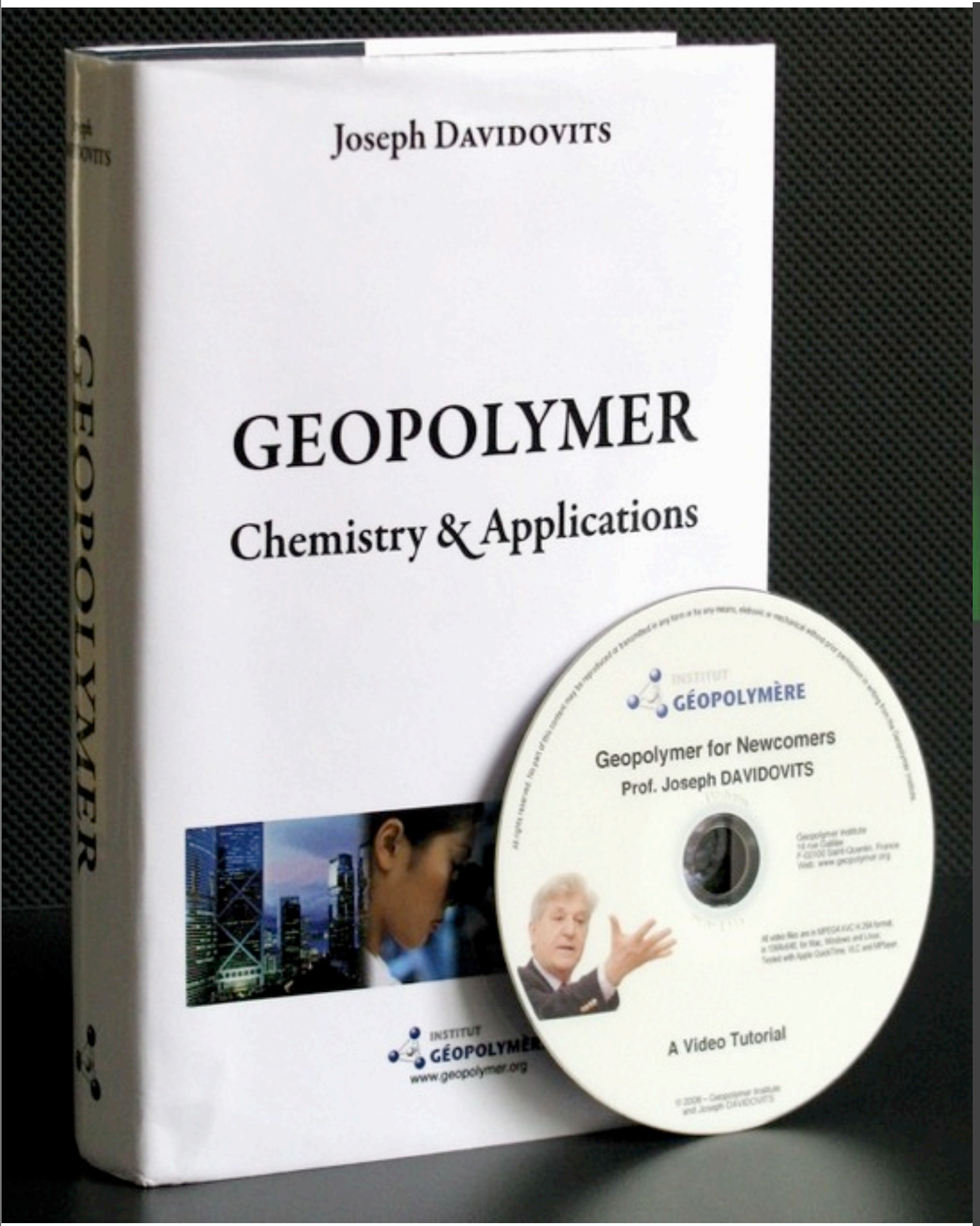


3rd edition July 2011



3rd edition July 2011

2nd edition translated in Chinese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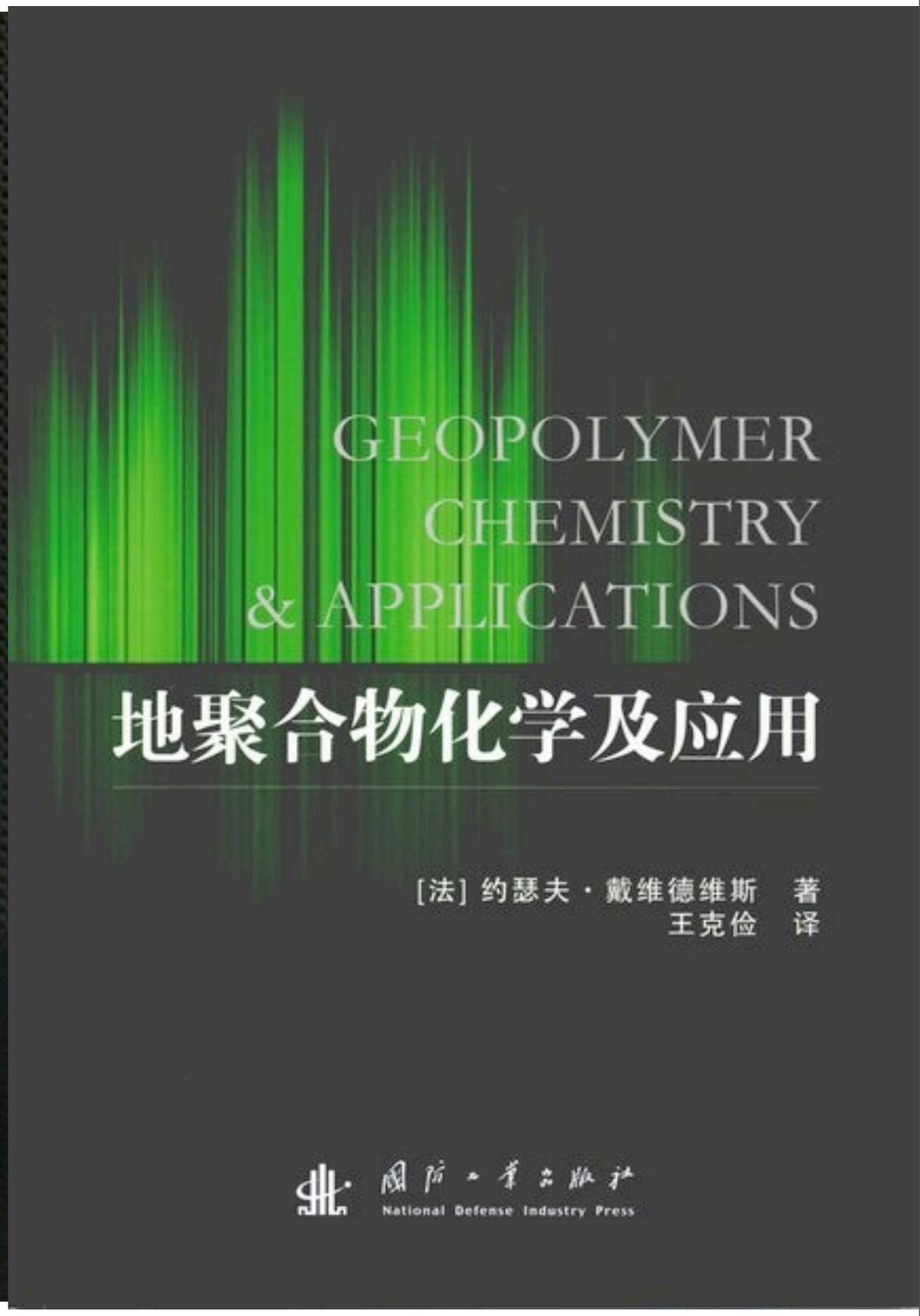
GEOPOLYMER
CHEMISTRY
& APPLICATIONS
地聚合物化学及应用
[法] 约瑟夫·戴维德维斯 著
王克俭 译
National Defense Industry Press

Geopolymer Terminology vs Cement Terminology

Geopolymer Terminology vs Cement Terminology

Australia

geopolymer ALLIANCE

Geopolymer Technology; an opportunity to enhance the sustainability of the mining and construction industries

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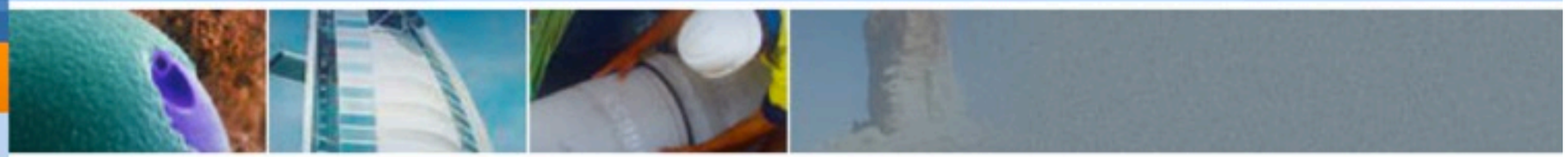
- Future Plans
- Alliance Team
- About Geopolymers
- Projects
- Publications



Home > About us

About us

Background to the Alliance

The Geopolymer Alliance was an initiative of the Centre for Sustainable Resource Processing. It formed part of the Centre's Geopolymer Program for the period 2007 to 2010.

Industry participants in this CRC included Alcoa World Alumina, Anglo Platinum, BHP Billiton, BlueScope Steel, GHD, Newmont Australia, OneSteel, Orica, Rio Tinto, Rocla and Xstrata.

Research providers included ANSTO, Curtin University of Technology, CSIRO, Murdoch University, The University of Newcastle and The University of Queensland.

Geopolymer Terminology vs Cement Terminology

Background to the Alliance (Australia)

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Geopolymer Terminology vs Cement Terminology

Geopolymer Terminology vs Cement Terminology

Excerpt from «Geopolymer Alliance, Australia»

Geopolymer Terminology vs Cement Terminology

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..... Davidovits developed the notion of a geopolymer (a Si/Al inorganic polymer) to better explain these chemical processes and the resultant material properties.

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.....To do so required a major shift in perspective, away from the classical crystalline hydration chemistry of conventional cement chemistry

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Excerpt from «Geopolymer Alliance, Australia»

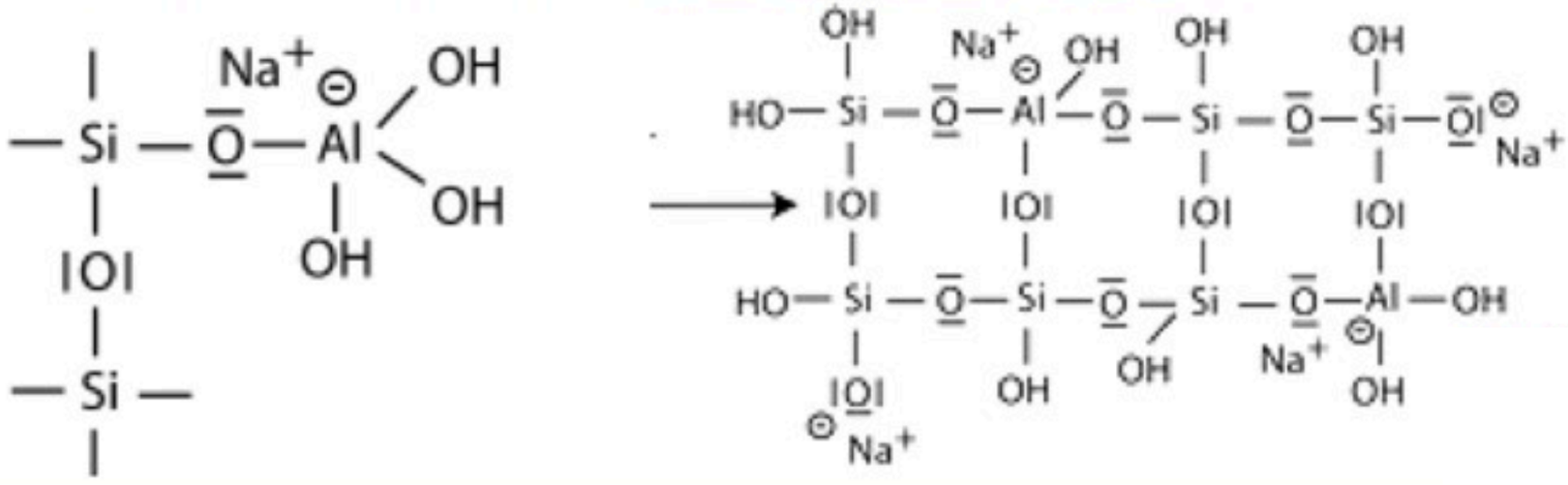
..... Davidovits developed the notion of a geopolymer (a Si/Al inorganic polymer) to better explain these chemical processes and the resultant material properties.

.....To do so required a major shift in perspective, away from the classical crystalline hydration chemistry of conventional cement chemistry

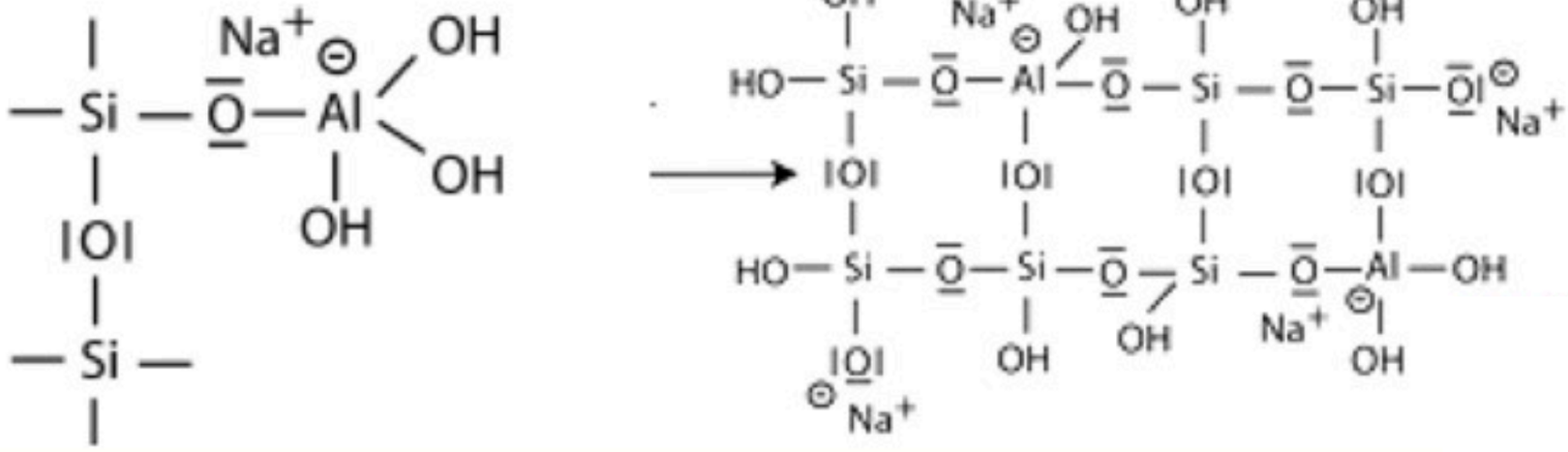
....**To date** this shift has not been well accepted by practitioners in the field of alkali activated cements who still tend to explain such reaction chemistry in portland cement terminology.

Geopolymer Terminology vs Cement Terminology

- Activation alkaline : « GEOPOLYMER »



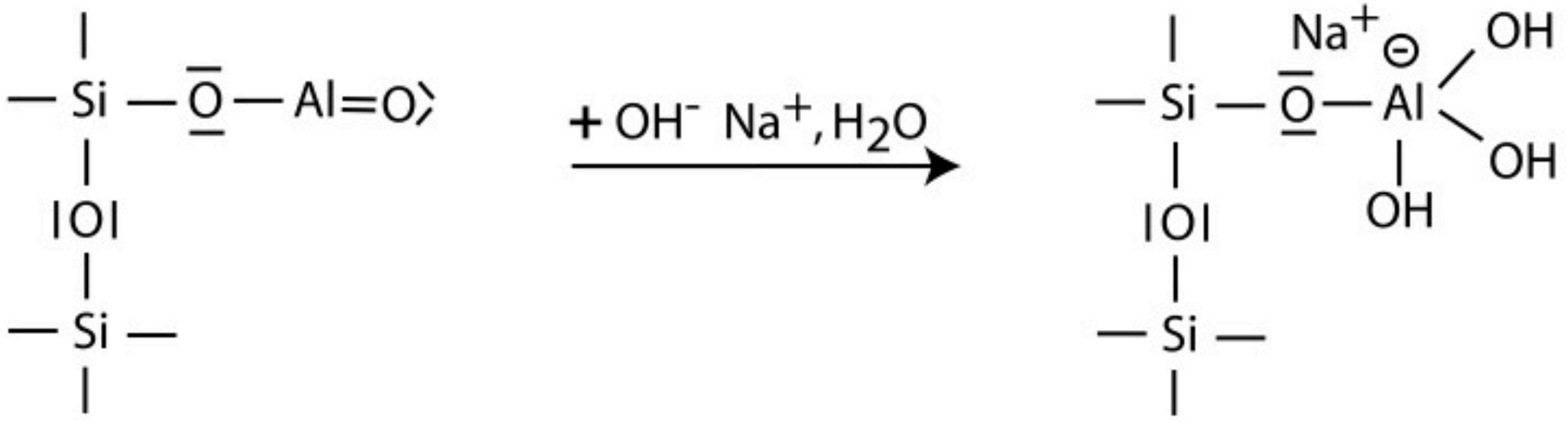
- Activation alkaline : « GEOPOLYMER »



8.3.1 Chemical mechanism with Al(V) -Al=O alumoxyl.

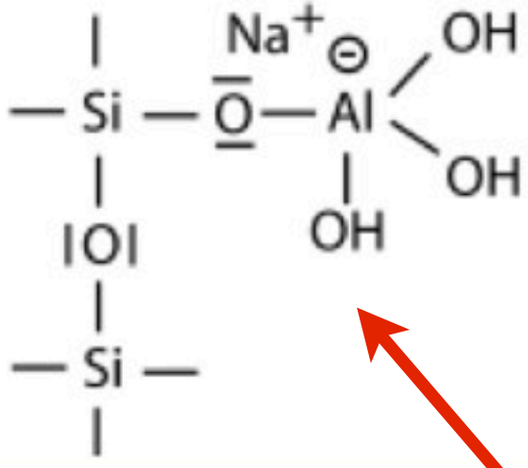
The chemical mechanism can be interpreted in the following way, with NaOH or KOH (steps 1 to 5) :

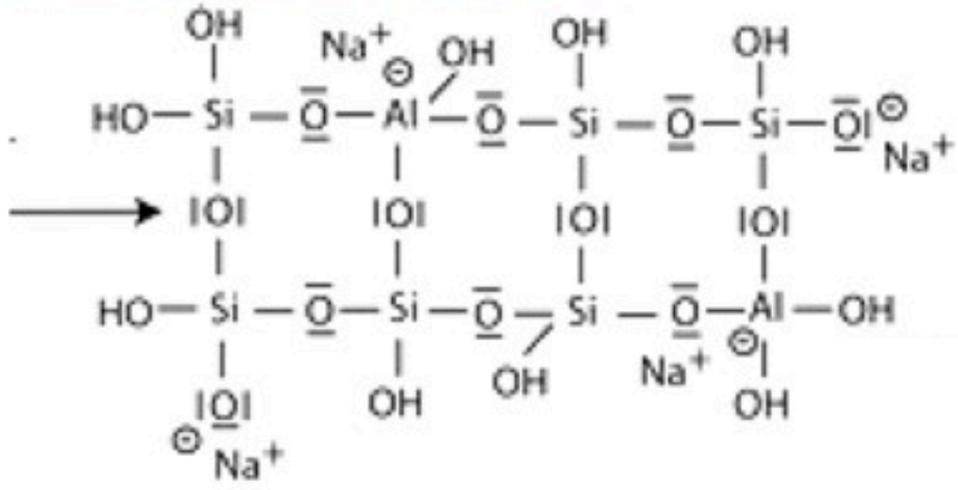
Step 1: alkalination and formation of tetravalent Al in the side group sialate O_3-Si-O-Al-$(OH)_3^-Na^+$, identical to the mechanism described in Step 1 of kaolinite geopolymerization (Chapter 7).



(1)

- Activation alkaline : « GEOPOLYMER »





ESPCI ParisTech

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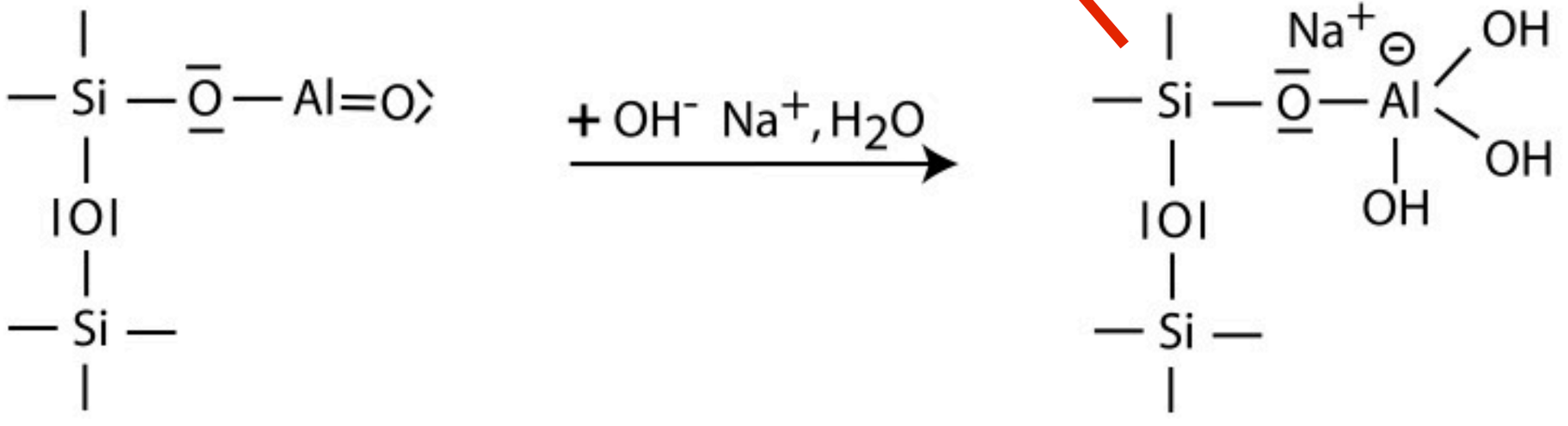

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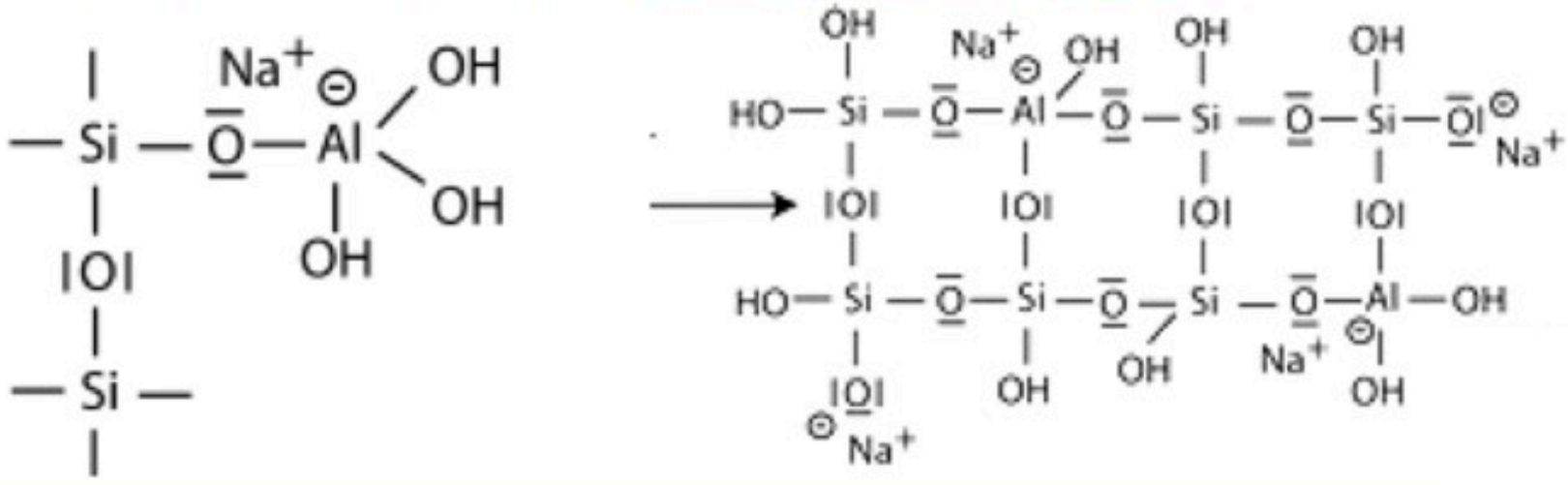

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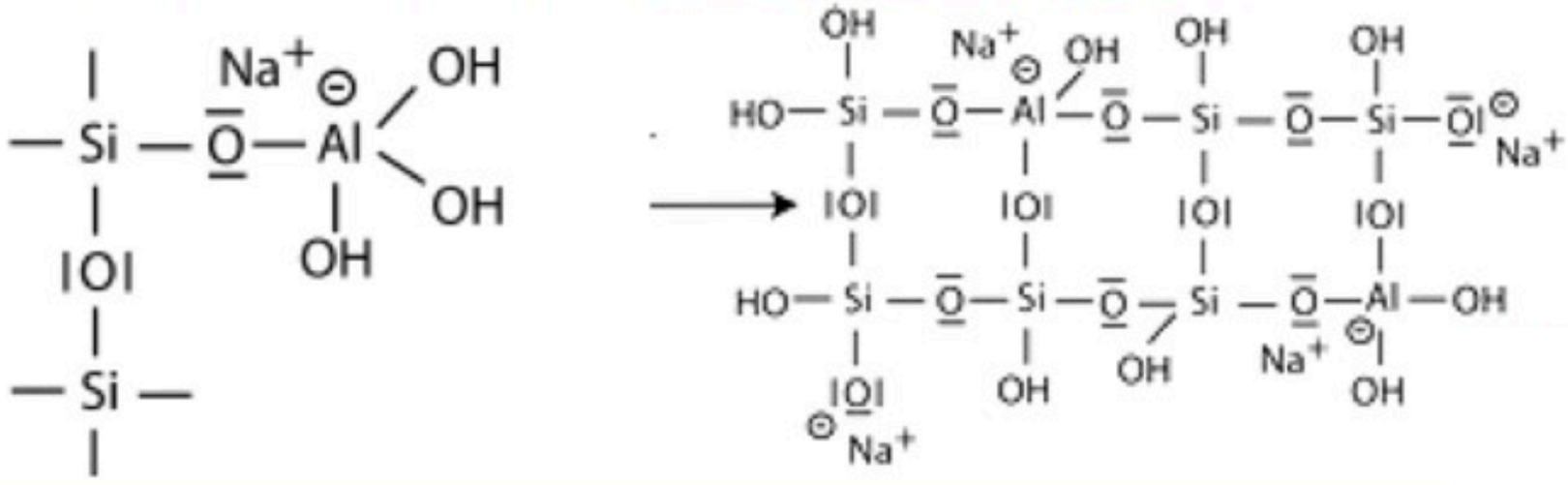
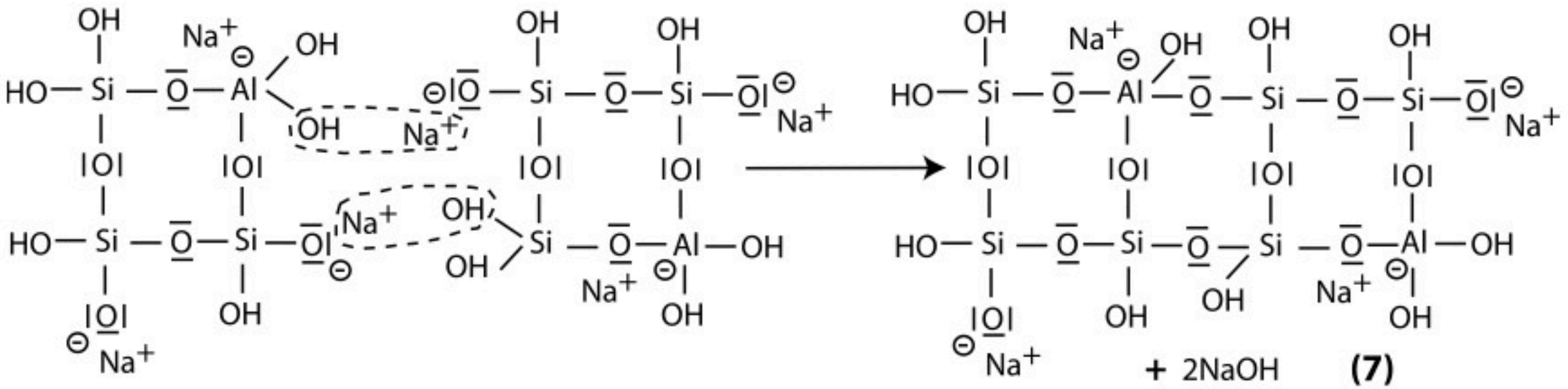


Step 7: further polycondensation into Na–poly(sialate-disiloxo) albite framework with its typical feldspar crankshaft chain structure.



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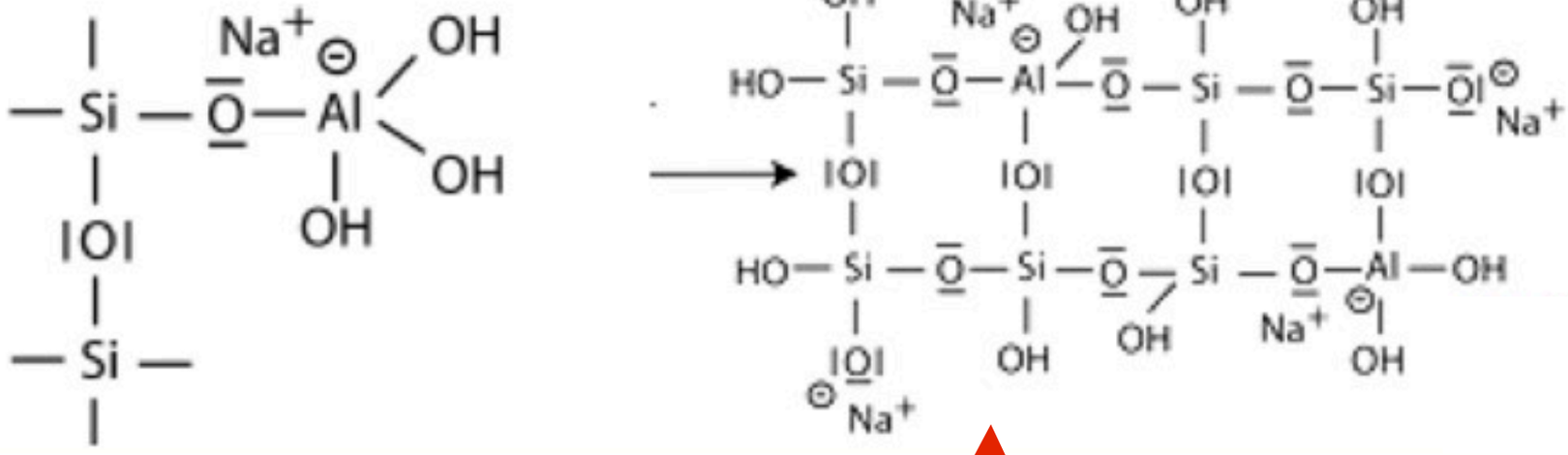

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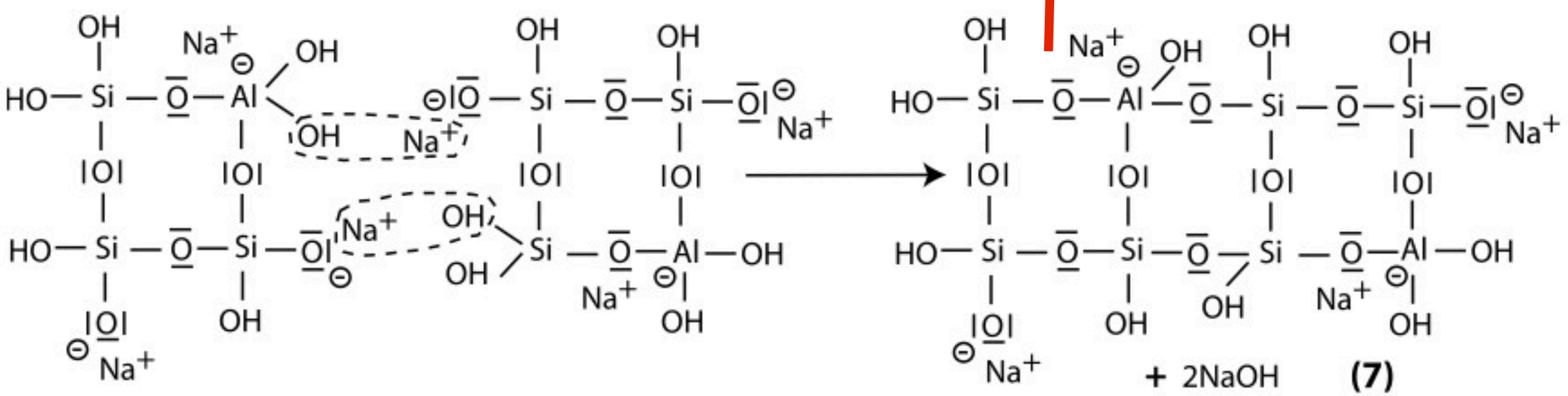
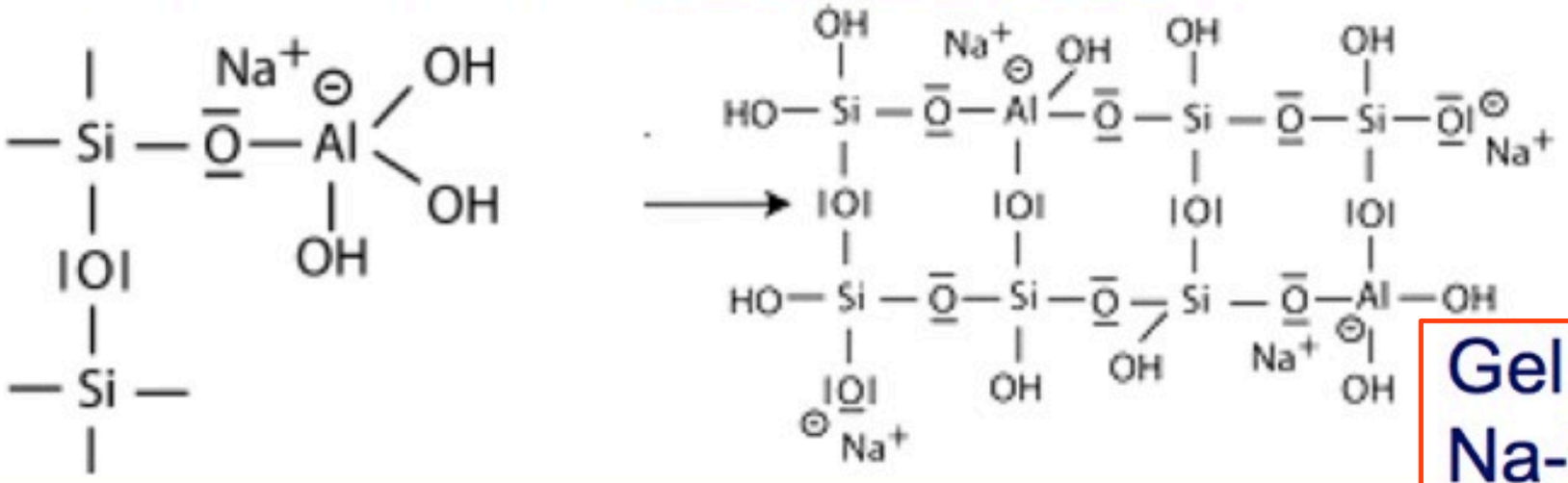


Geopolymer Terminology vs Cement Terminology

- Activation alkaline : « GEOPOLYMER »



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Geopolymer Terminology vs Cement Terminology

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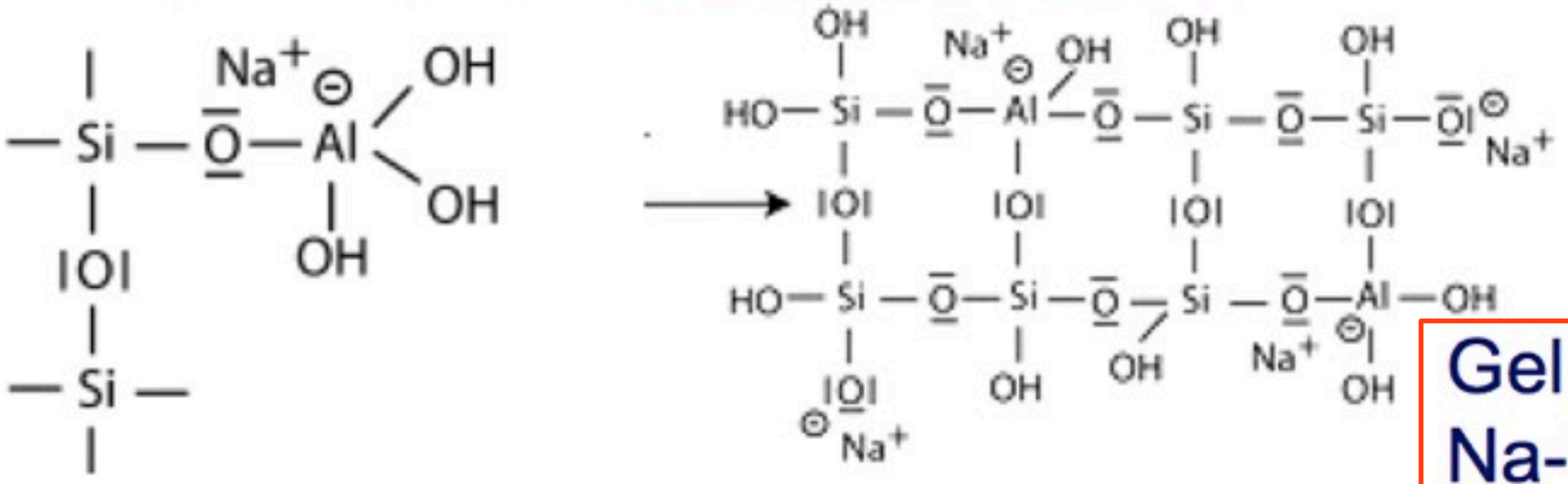

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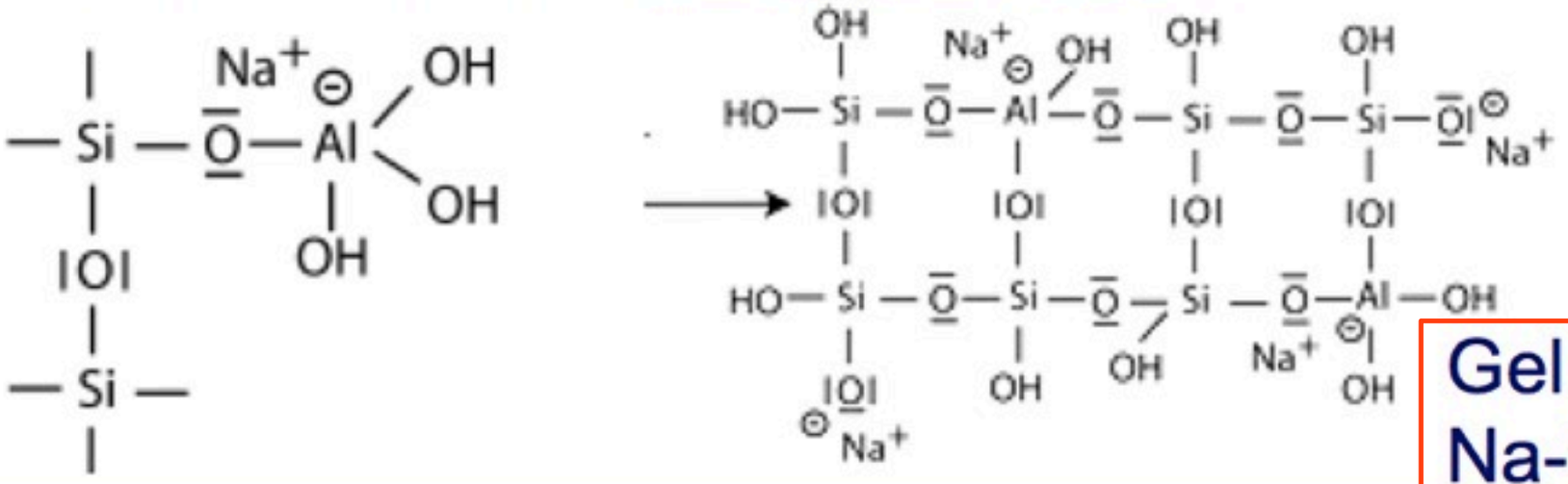
Portland: C-S-H

Geopolymer Terminology vs Cement Terminology

- Activation alkaline : « GEOPOLYMER »



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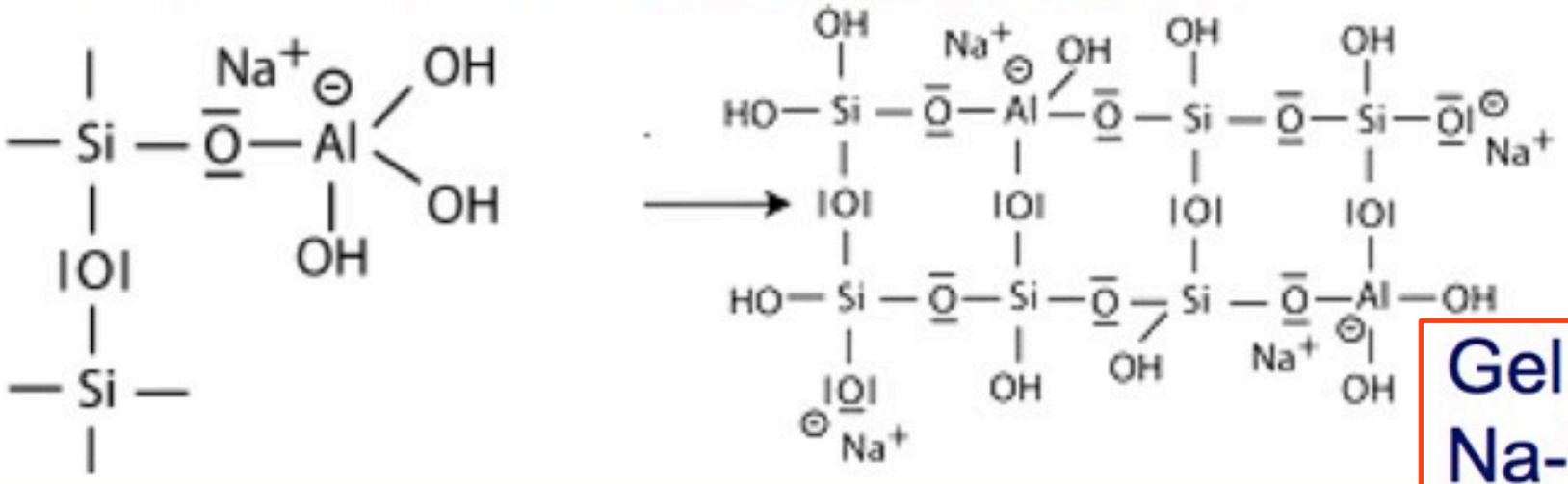
Portland: C-S-H

$CaO.SiO_2.H_2O$ Calcium Silicate Hydrate

Geopolymer Terminology vs Cement Terminology

- Activation alkaline : « GEOPOLYMER »



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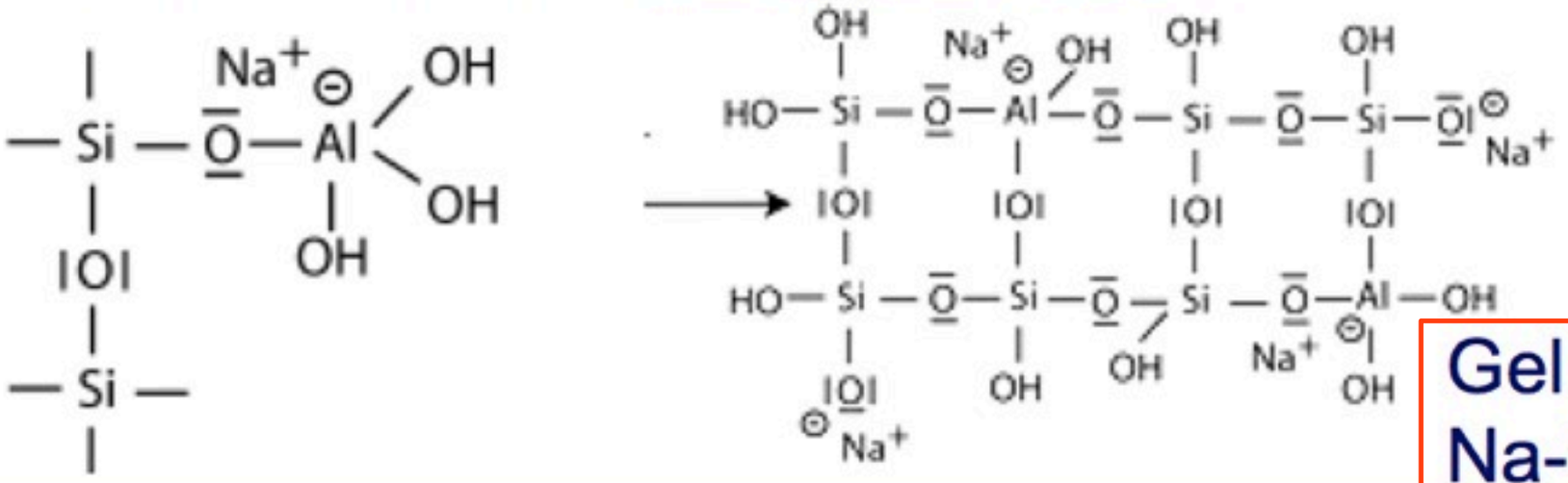
Portland: C-S-H

$CaO.SiO_2.H_2O$ Calcium Silicate Hydrate

Geopolymer: Na-S-Al-H

Geopolymer Terminology vs Cement Terminology

- Activation alkaline : « GEOPOLYMER »



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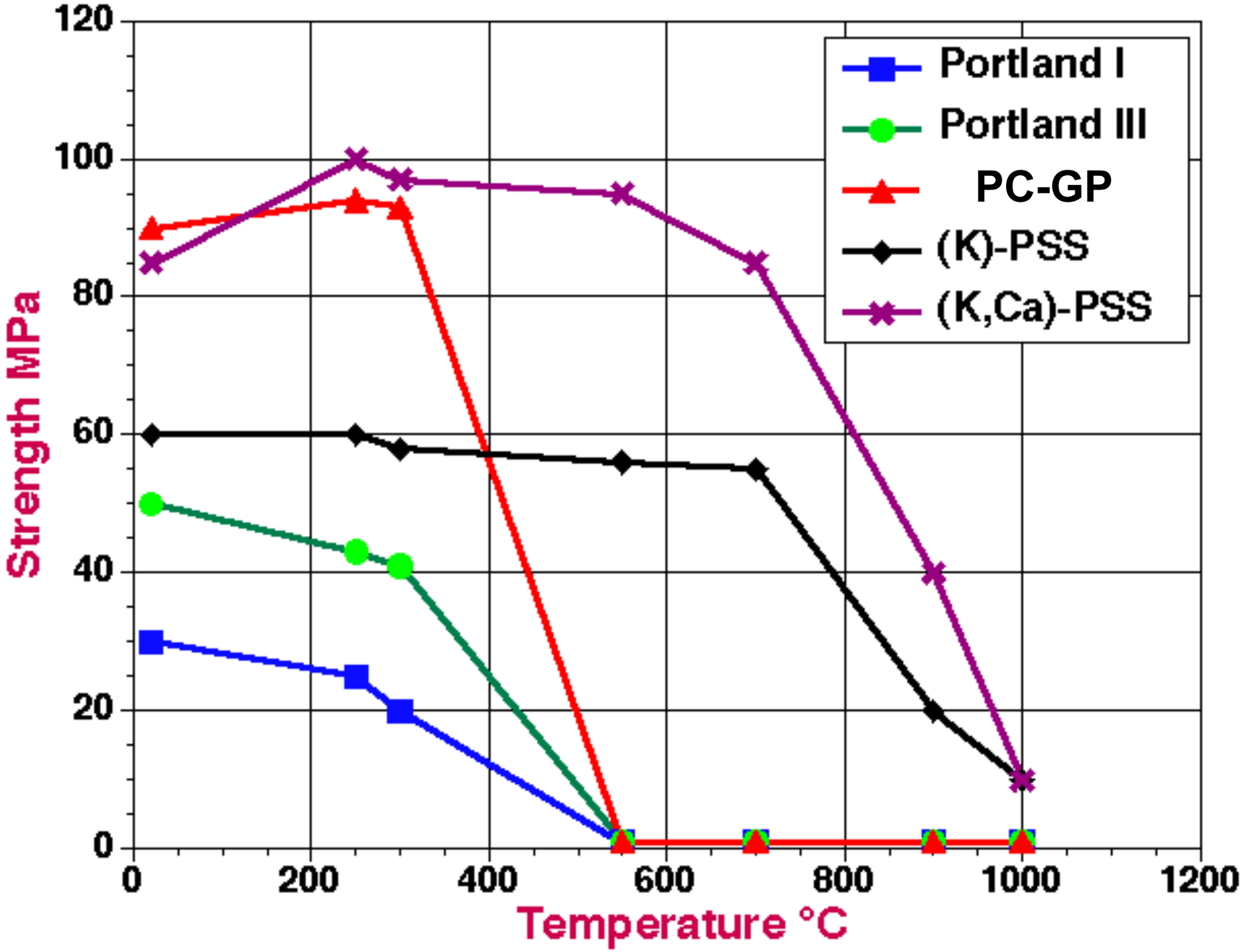
Portland: C-S-H

$CaO.SiO_2.H_2O$ Calcium Silicate Hydrate

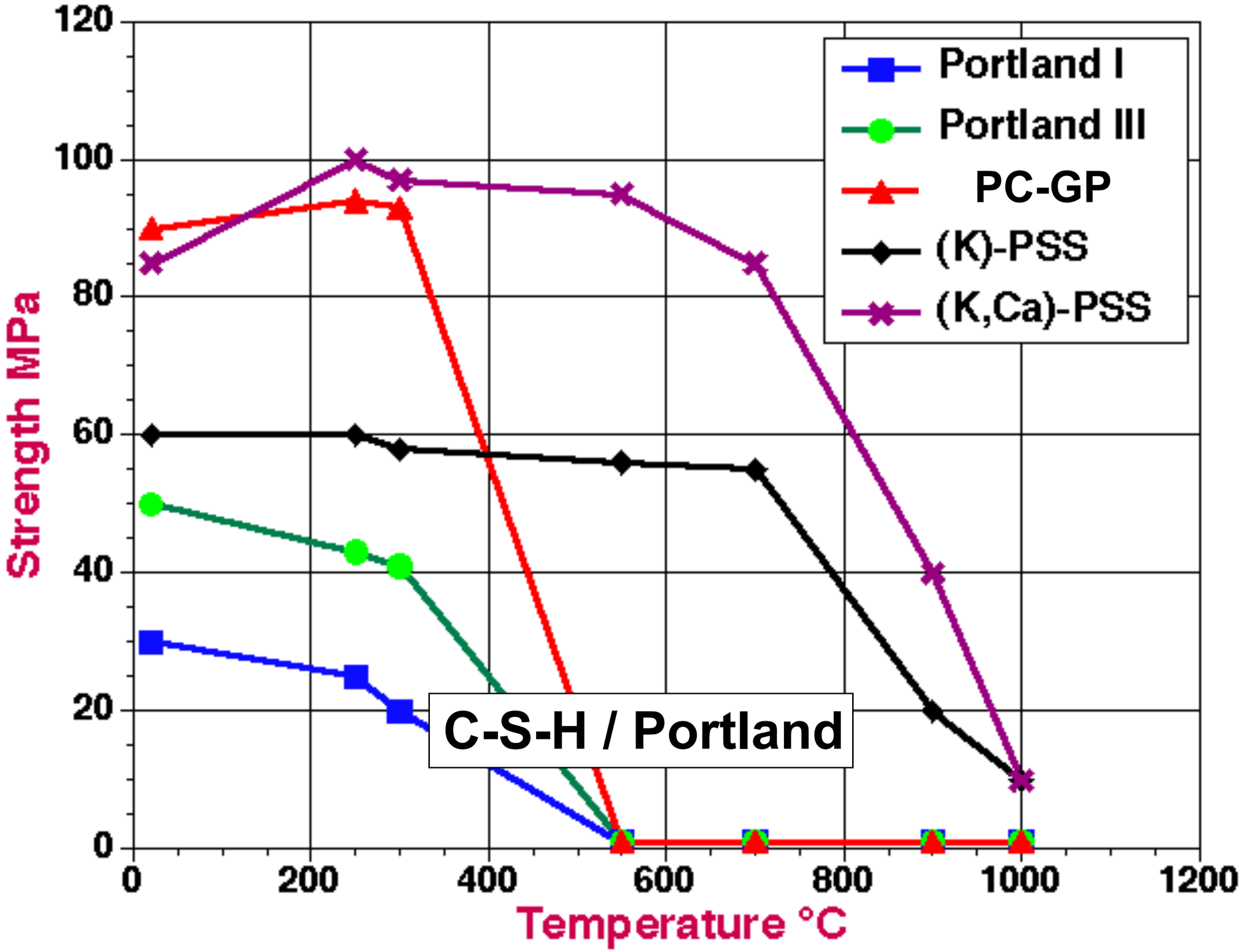
Geopolymer: Na-S-Al-H

$Na_2O.2SiO_2.Al_2O_3.H_2O$ Sodium-Silico-aluminate-Hydrate

Geopolymer Terminology vs Cement Terminology



Geopolymer Terminology vs Cement Terminology



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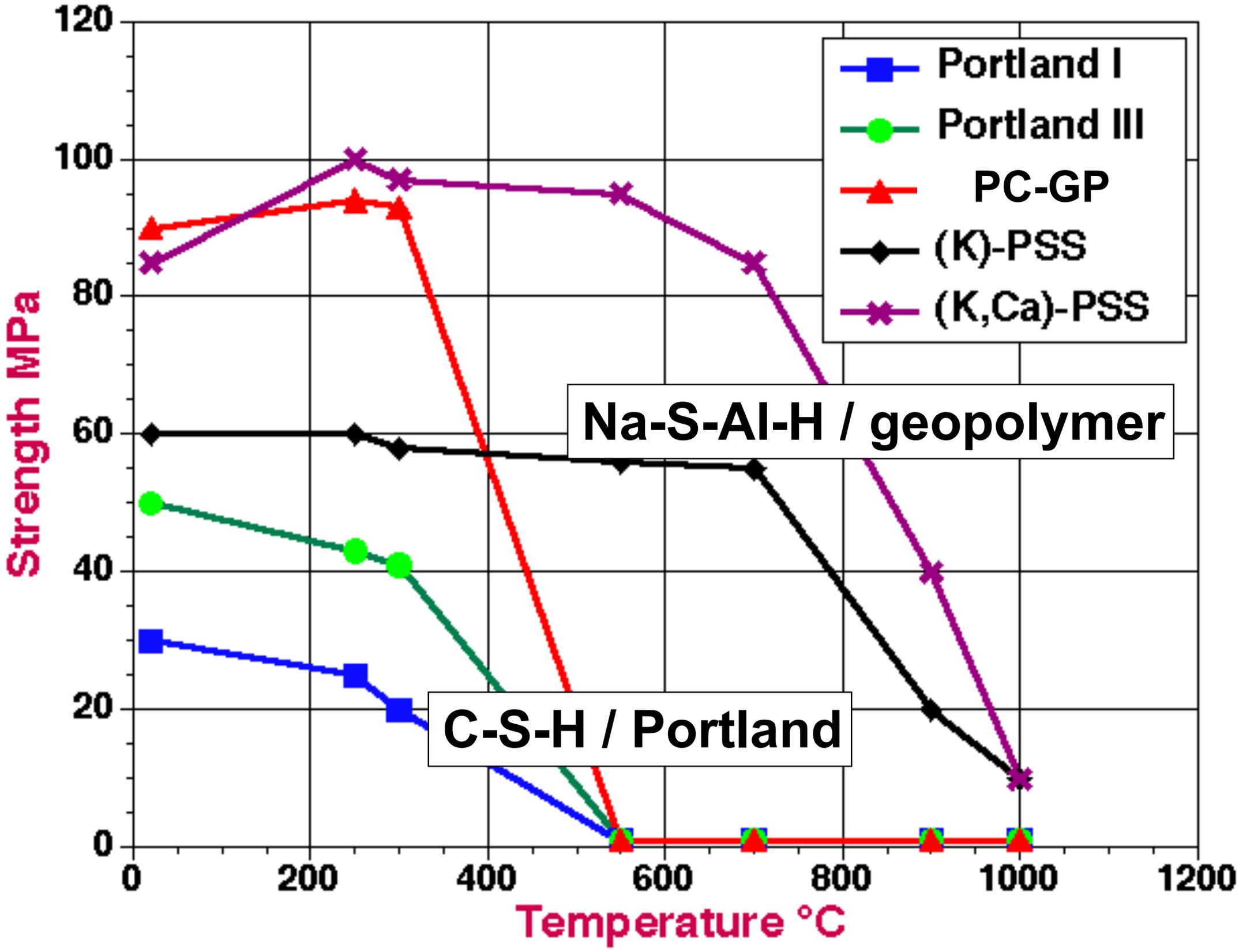

2 new geopolymer molecular units

2 new geopolymer molecular units

-Si-O-Si-O- siloxo, poly(siloxo)

-Si-O-Al-O- sialate, poly(sialate)

-Si-O-Al-O-Si-O- sialate-siloxo, poly(sialate-siloxo)

-Si-O-Al-O-Si-O-Si-O- sialate-disiloxo, poly(sialate-disiloxo)

-P-O-P-O- phosphate, poly(phosphate)

-P-O-Si-O-P-O- phospho-siloxo, poly(phospho-siloxo)

-P-O-Si-O-Al-O-P-O- phospho-sialate, poly(phospho-sialate)

-(R)-Si-O-Si-O-(R) organo-siloxo, poly-silicone

2 new geopolymer molecular units

-Si-O-Si-O- siloxo, poly(siloxo)

-Si-O-Al-O- sialate, poly(sialate)

-Si-O-Al-O-Si-O- sialate-siloxo, poly(sialate-siloxo)

-Si-O-Al-O-Si-O-Si-O- sialate-disiloxo, poly(sialate-disiloxo)

-P-O-P-O- phosphate, poly(phosphate)

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-P-O-Si-O-Al-O-P-O- phospho-sialate, poly(phospho-sialate)

-(R)-Si-O-Si-O-(R) organo-siloxo, poly-silicone

-Al-O-P-O- alumino-phospho, poly(alumino-phospho)

2 new geopolymer molecular units

-Si-O-Si-O- siloxo, poly(siloxo)

-Si-O-Al-O- sialate, poly(sialate)

-Si-O-Al-O-Si-O- sialate-siloxo, poly(sialate-siloxo)

-Si-O-Al-O-Si-O-Si-O- sialate-disiloxo, poly(sialate-disiloxo)

-P-O-P-O- phosphate, poly(phosphate)

-P-O-Si-O-P-O- phospho-siloxo, poly(phospho-siloxo)

-P-O-Si-O-Al-O-P-O- phospho-sialate, poly(phospho-sialate)

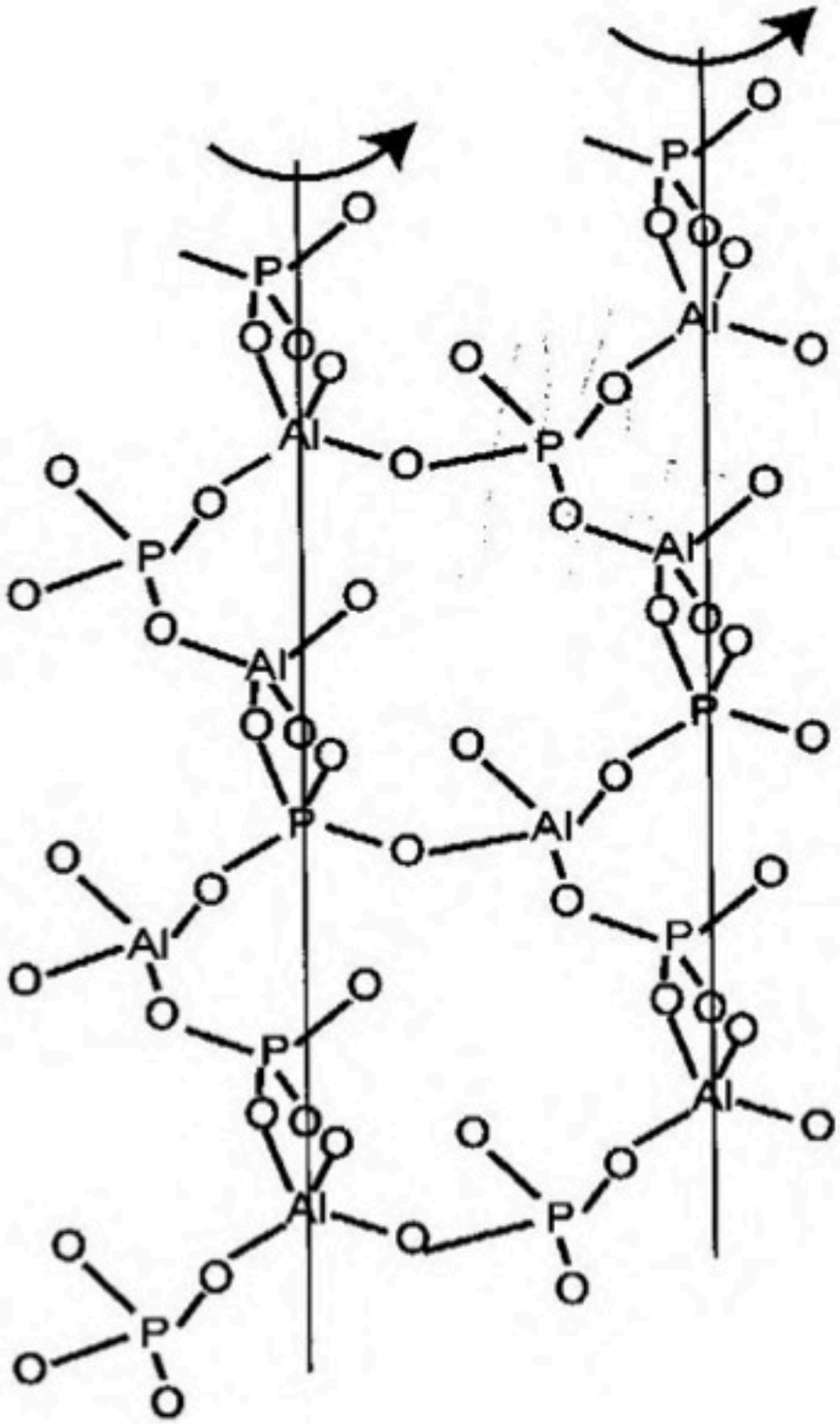
-(R)-Si-O-Si-O-(R) organo-siloxo, poly-silicone

-Al-O-P-O- alumino-phospho, poly(alumino-phospho)

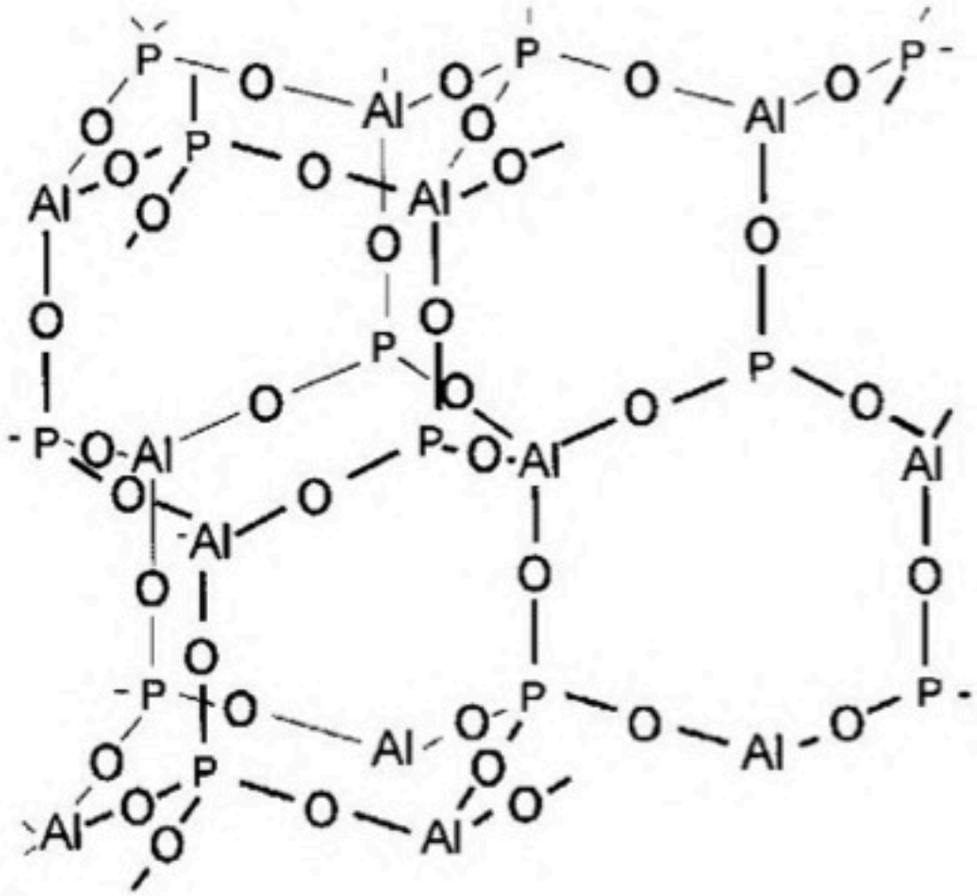
$AlPO_4$-based geopolymer

Geopolymer Chemistry & Applications, Chapter 13

Polymeric structures of $AlPO_4$-Geopolymers



⇒ Cross-linked (P-O-Al-O)n poly(alumino-phospho) chains



$AlPO_4$-tridymite/cristobalite

$AlPO_4$-berlinite (isostructural to quartz)

2 new geopolymer molecular units

2 new geopolymer molecular units

-Si-O-Si-O- siloxo, poly(siloxo)

-Si-O-Al-O- sialate, poly(sialate)

-Si-O-Al-O-Si-O- sialate-siloxo, poly(sialate-siloxo)

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-P-O-P-O- phosphate, poly(phosphate)

-P-O-Si-O-P-O- phospho-siloxo, poly(phospho-siloxo)

-P-O-Si-O-Al-O-P-O- phospho-sialate, poly(phospho-sialate)

-(R)-Si-O-Si-O-(R) organo-siloxo, poly-silicone

-Al-O-P-O- alumino-phospho, poly(alumino-phospho)

$AlPO_4$-based geopolymer

2 new geopolymer molecular units

-Si-O-Si-O- siloxo, poly(siloxo)

-Si-O-Al-O- sialate, poly(sialate)

-Si-O-Al-O-Si-O- sialate-siloxo, poly(sialate-siloxo)

-Si-O-Al-O-Si-O-Si-O- sialate-disiloxo, poly(sialate-disiloxo)

-P-O-P-O- phosphate, poly(phosphate)

-P-O-Si-O-P-O- phospho-siloxo, poly(phospho-siloxo)

-P-O-Si-O-Al-O-P-O- phospho-sialate, poly(phospho-sialate)

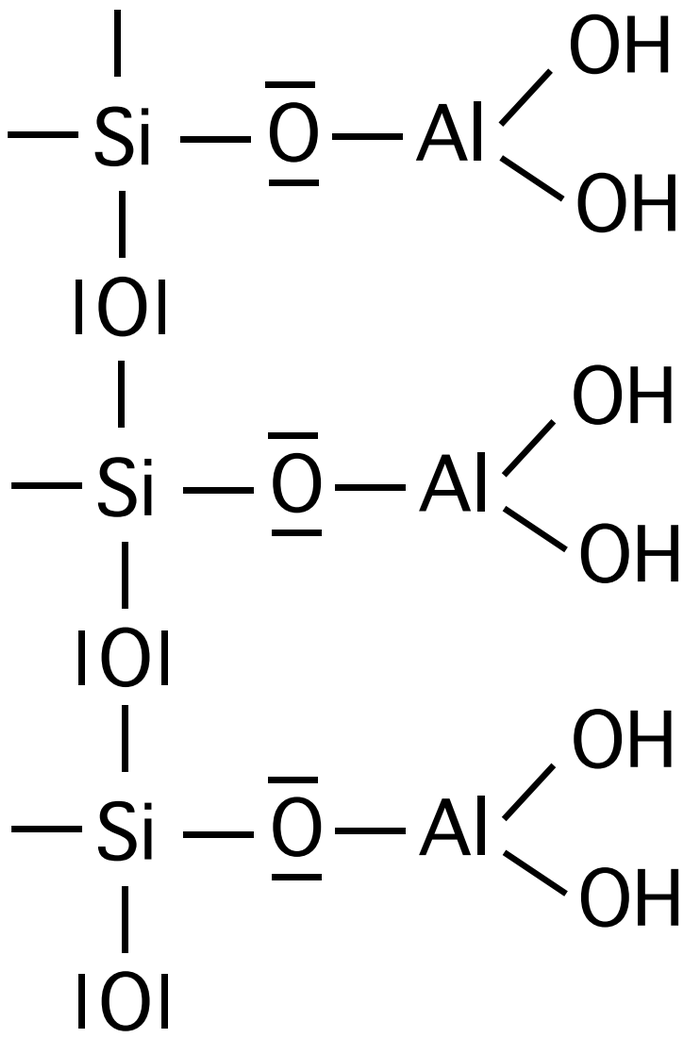
-(R)-Si-O-Si-O-(R) organo-siloxo, poly-silicone

-Al-O-P-O- alumino-phospho, poly(alumino-phospho)

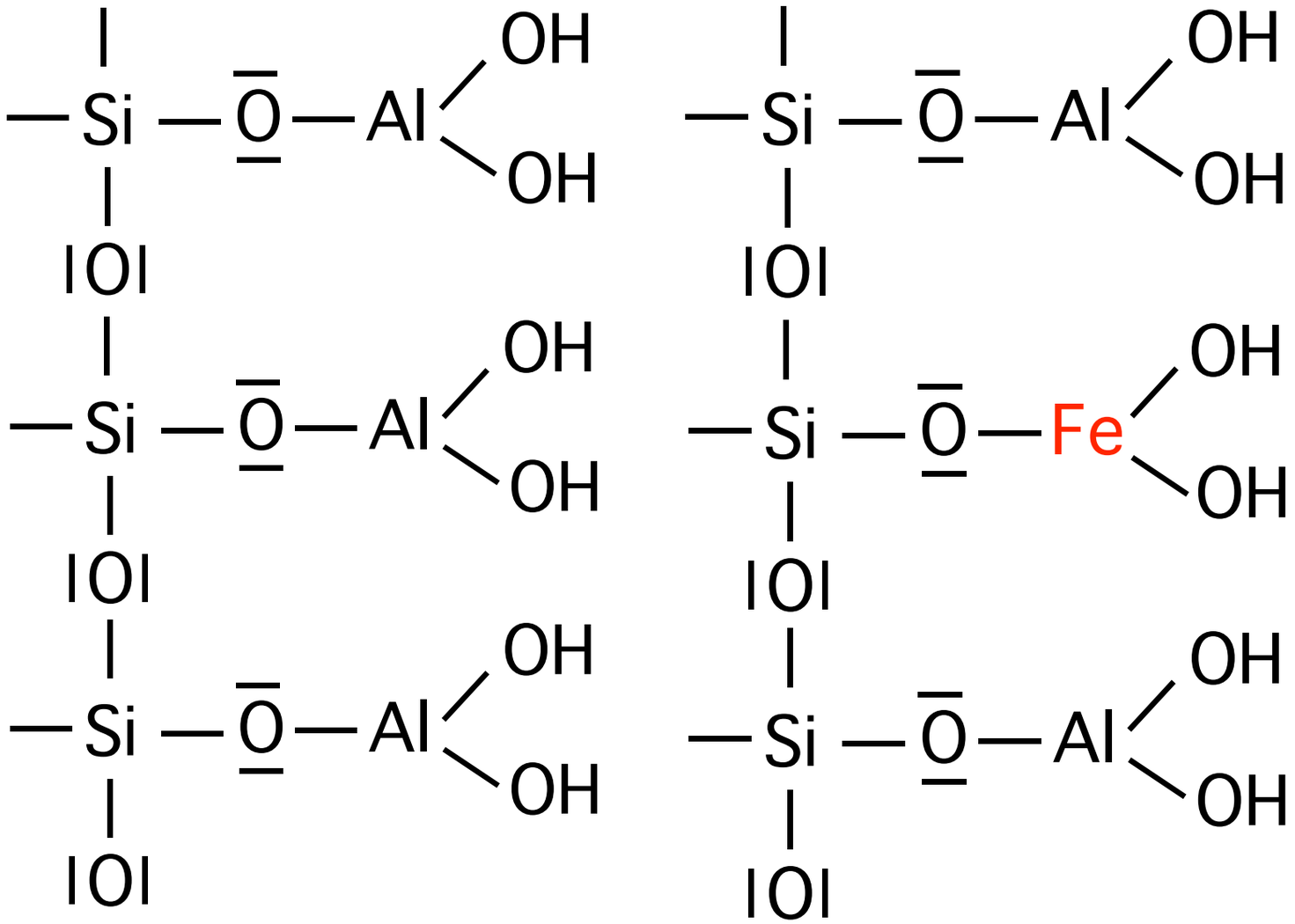
$AlPO_4$-based geopolymer

Fe-O-Si-O-Al-O-Si-O- ferro-sialate, poly(ferro-sialate)

substitution of Al with Fe

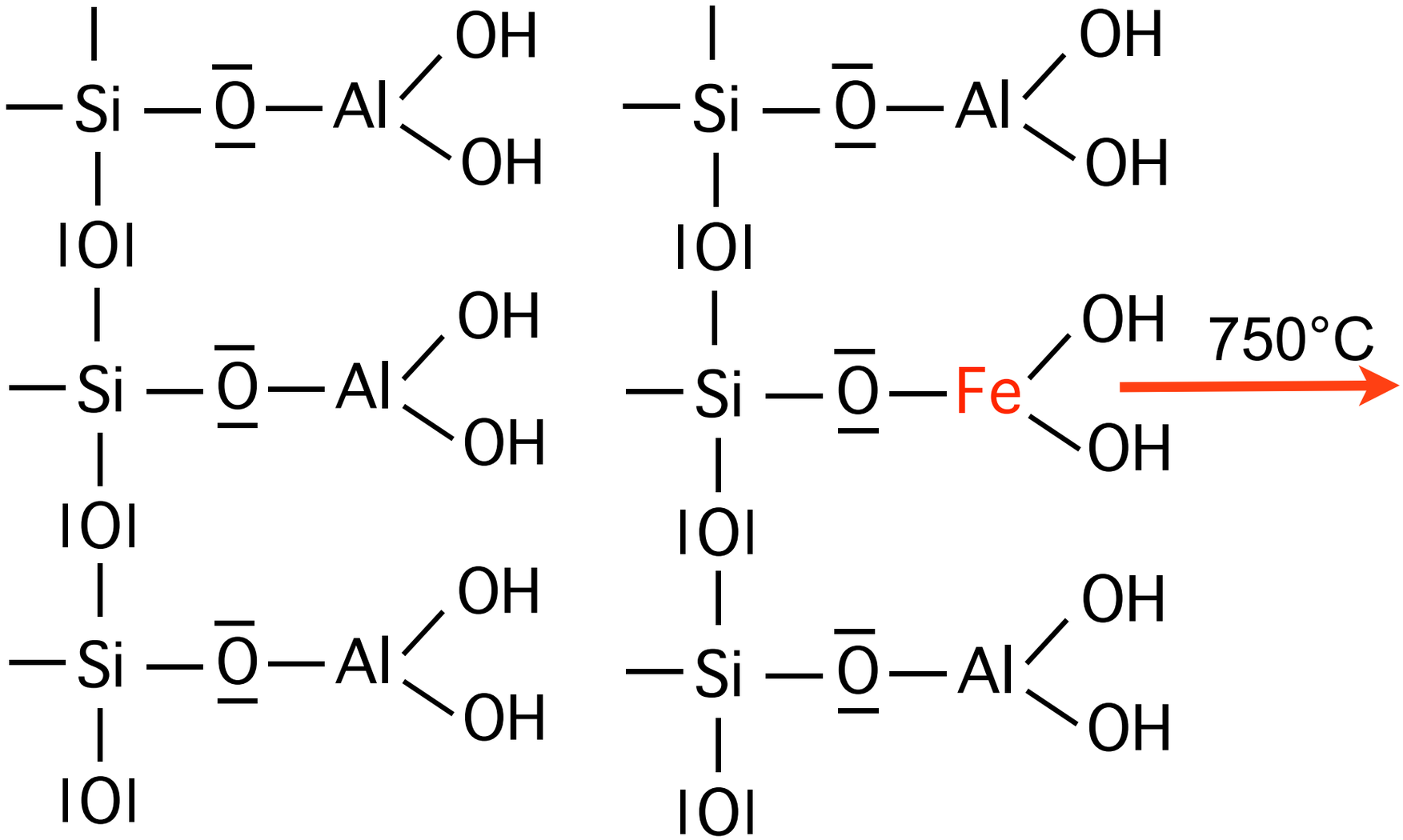


kaolinite



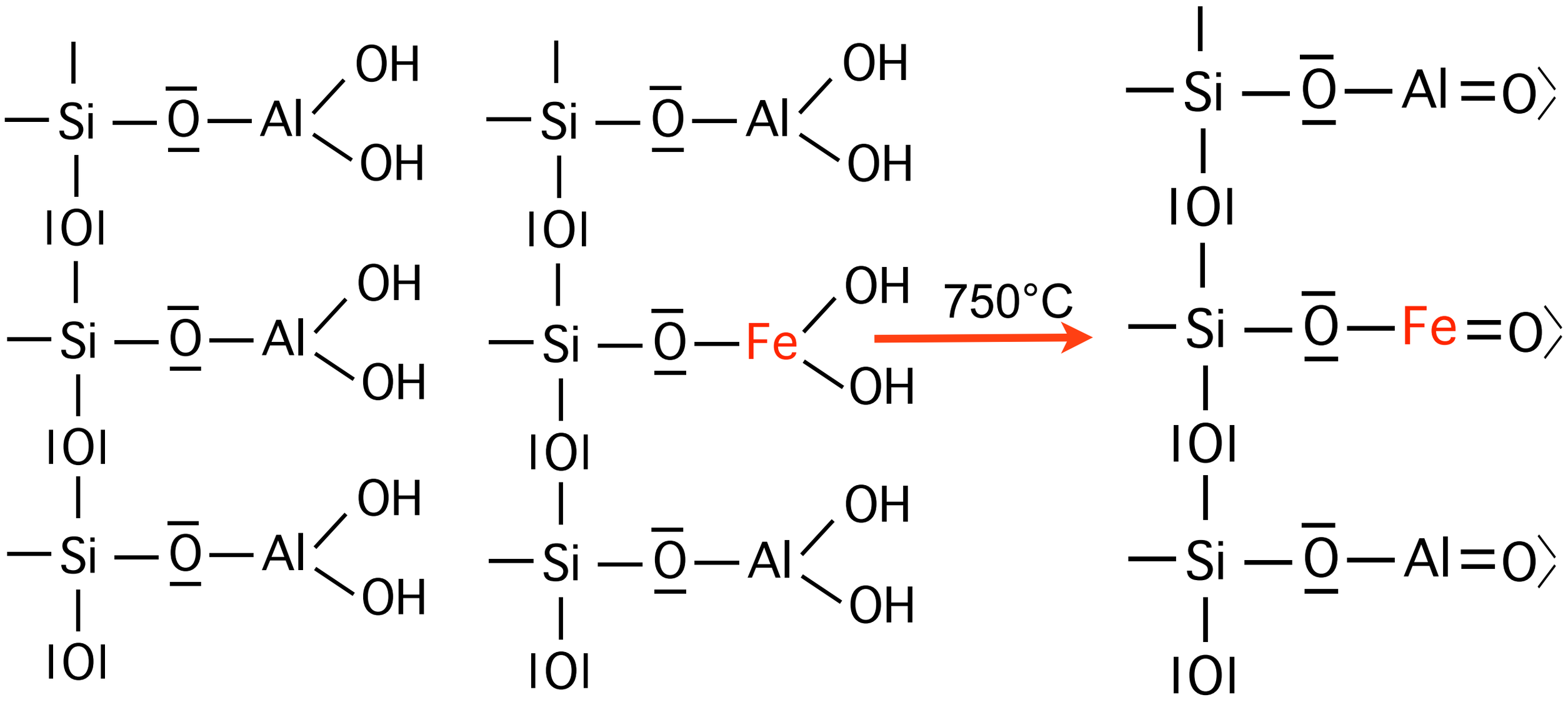
kaolinite

ferro-kaolinite
25% Fe/Al
substitution



kaolinite

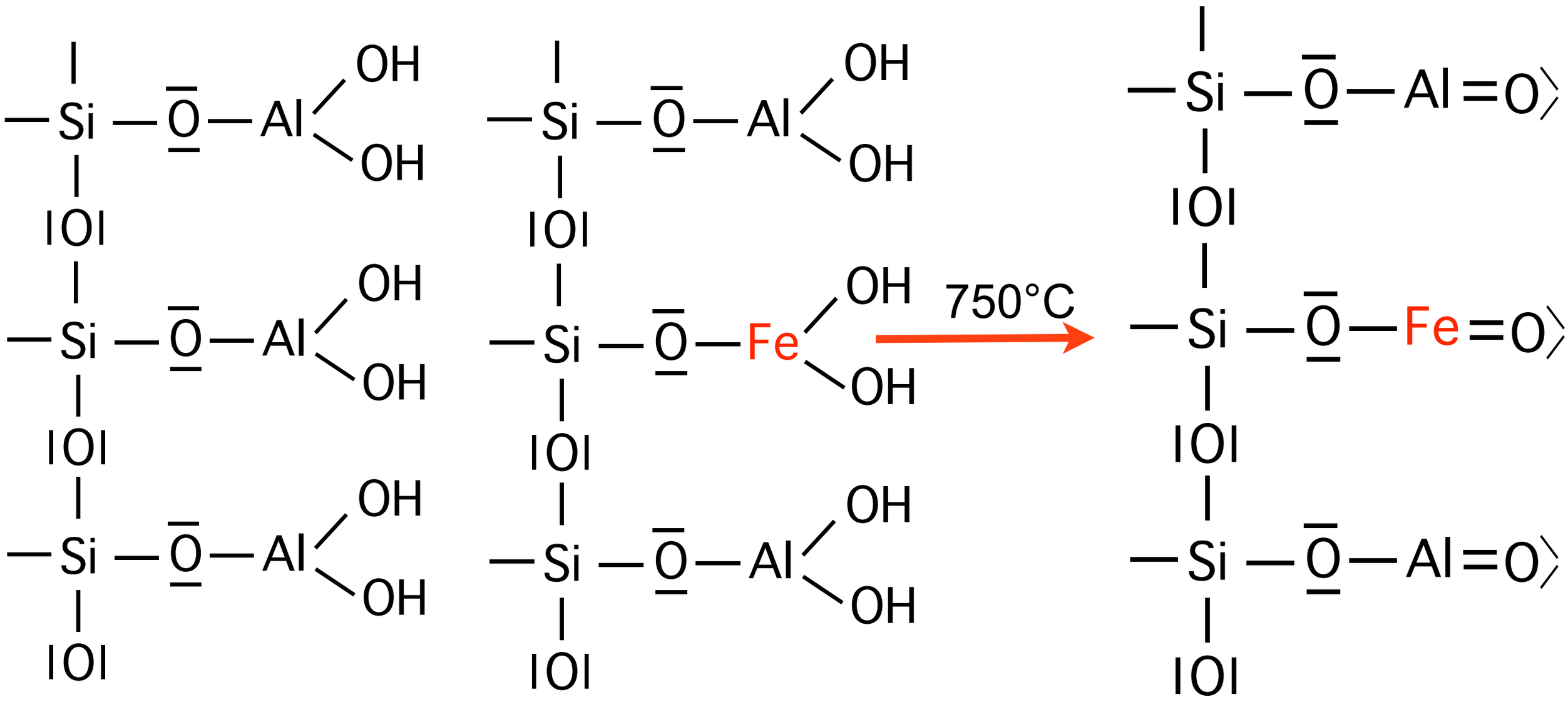
ferro-kaolinite
25% Fe/Al
substitution



kaolinite

ferro-kaolinite
25% Fe/Al
substitution

ferro-metakaolinite
Fe-MK-750



kaolinite

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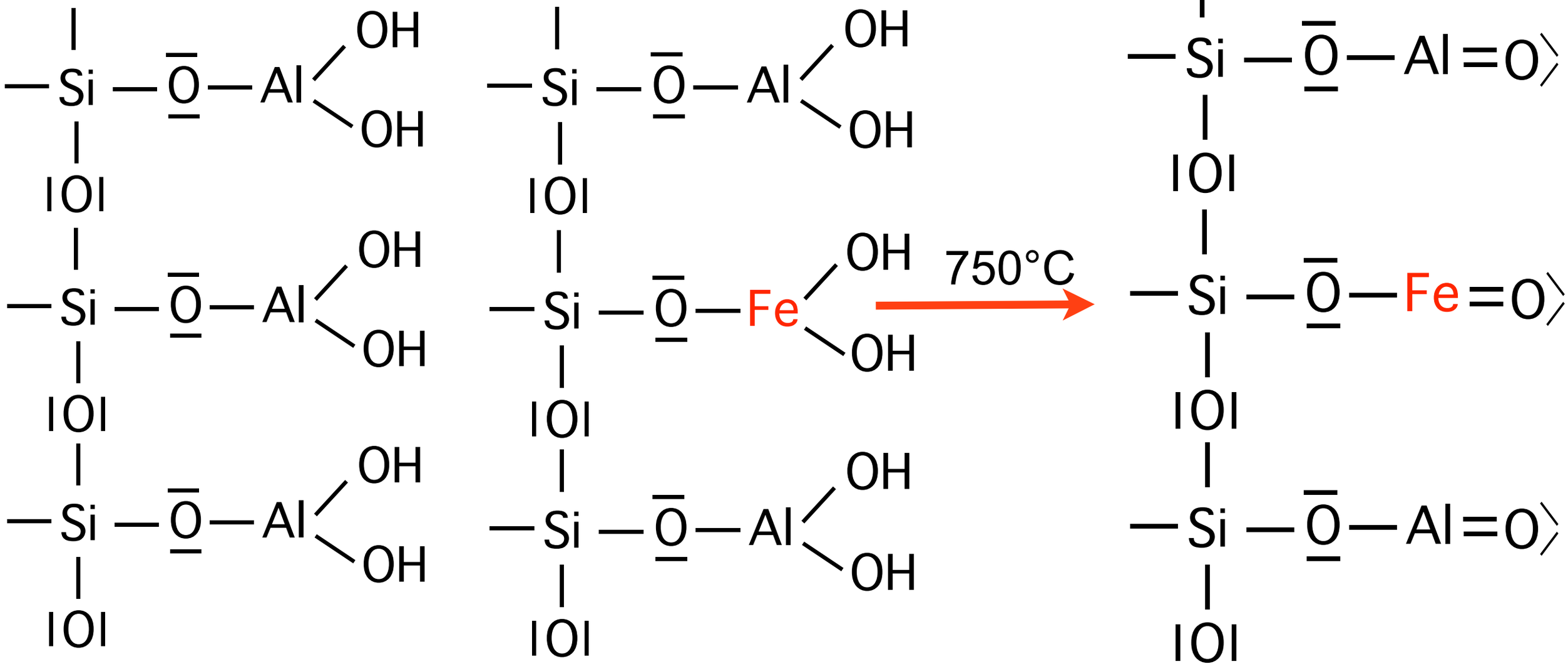
Fe-MK-750

NMR spectroscopy



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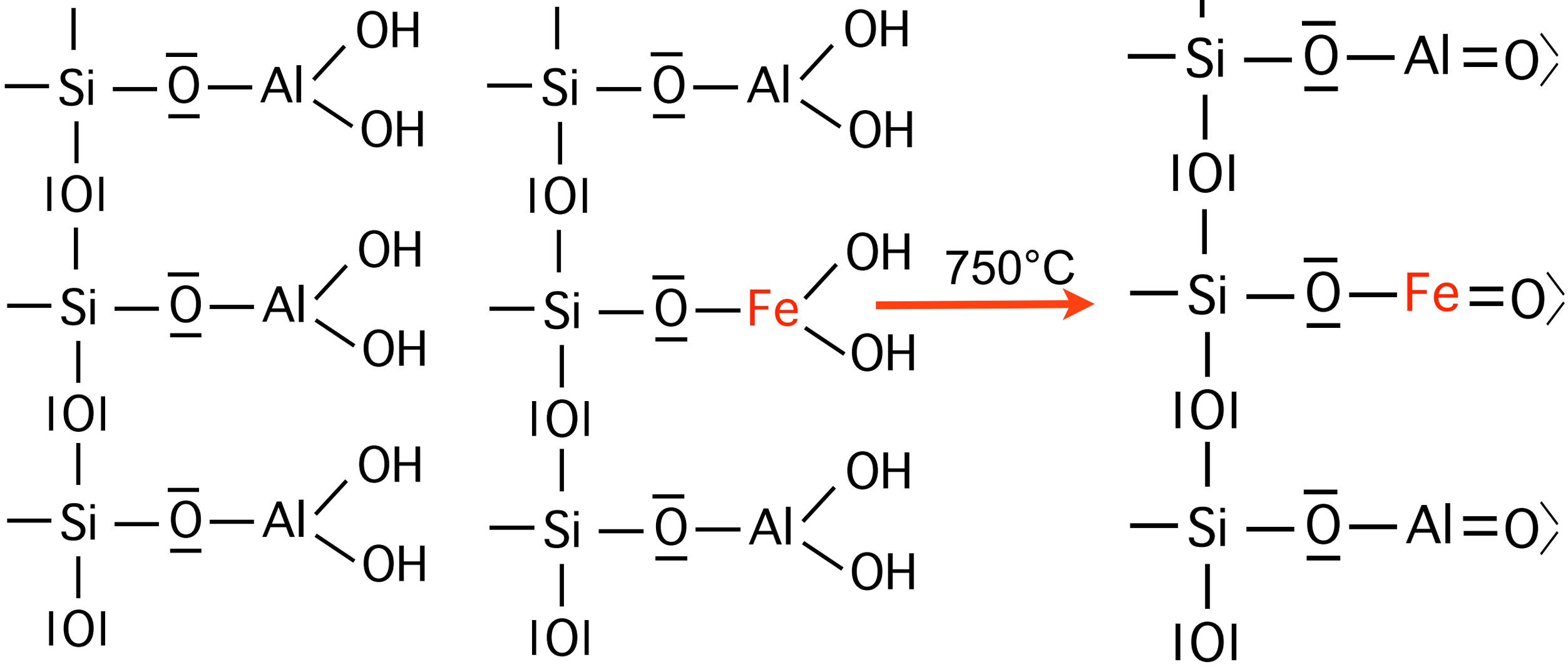

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~~NMR spectroscopy~~

Mössbauer spectroscopy

Transformation of ferro-kaolinite into Fe-MK-750

adapted from E. Murad and U. Wagner, *Hyperfine Interactions 117* (1998)

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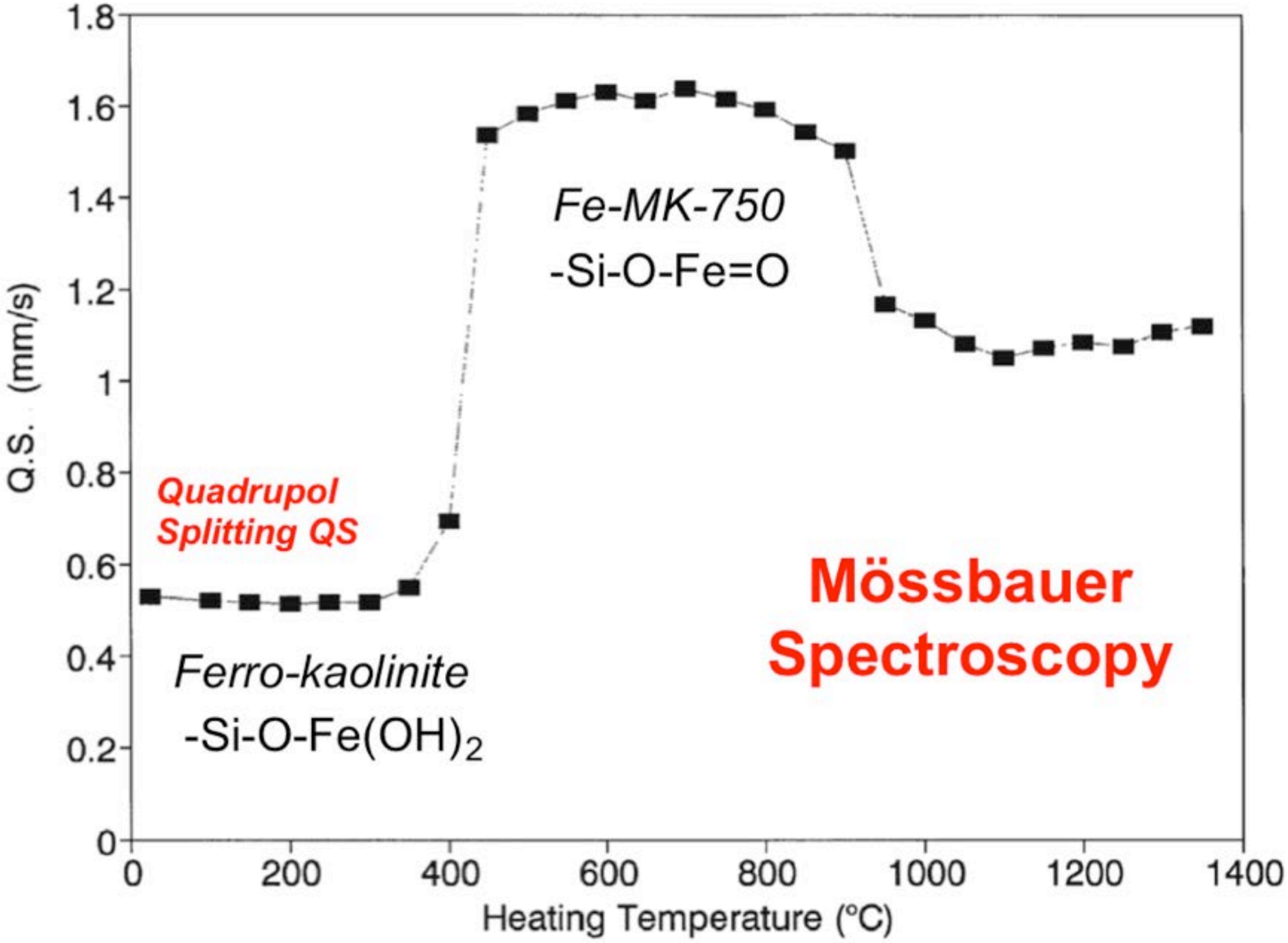
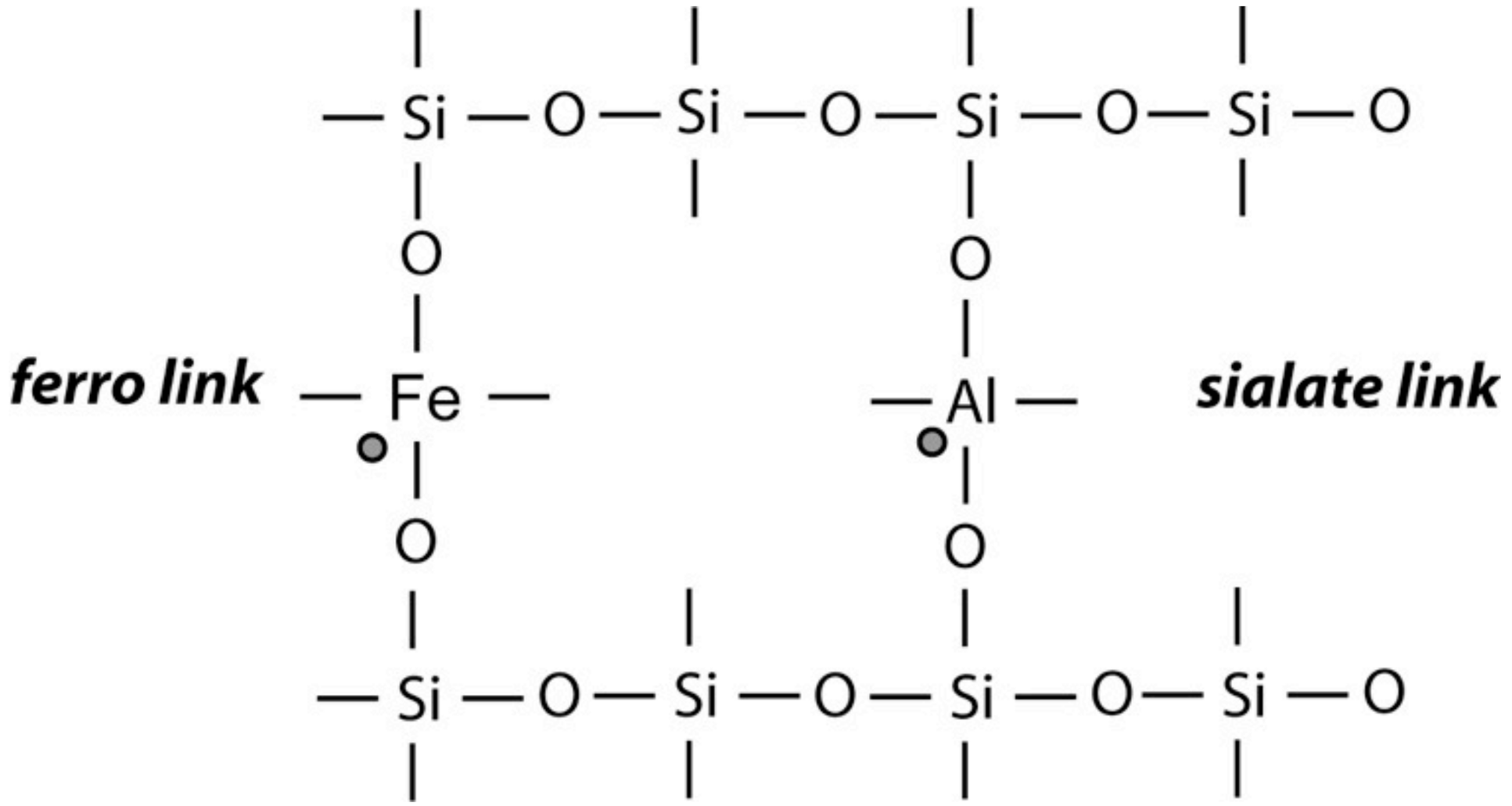
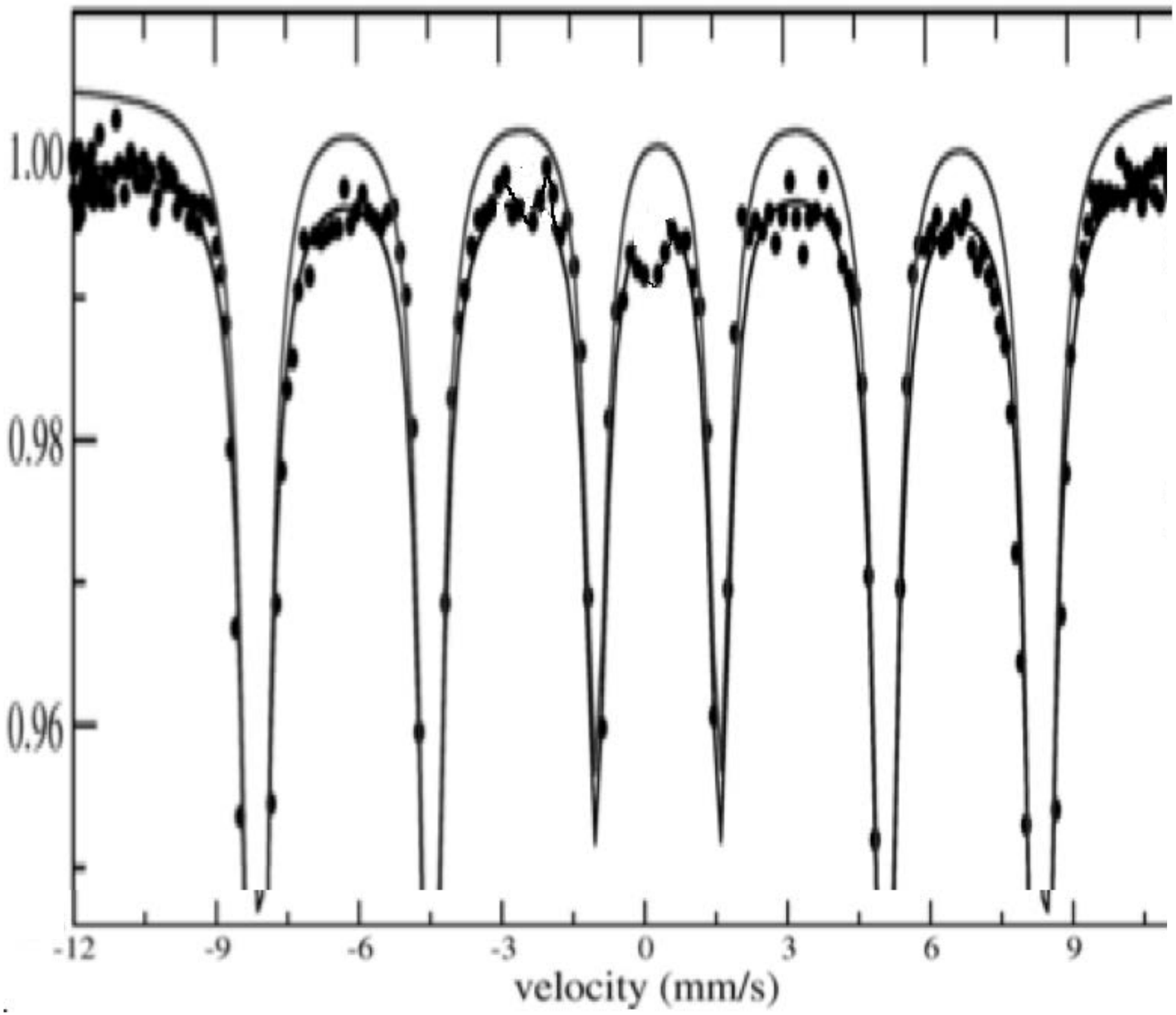


Mössbauer Spectroscopy (ferro-sialate)-geopolymer



Mössbauer Spectroscopy (ferro-sialate)-geopolymer

adapted from K. C. Gomes et al., *Materials Science Forum (2010)*



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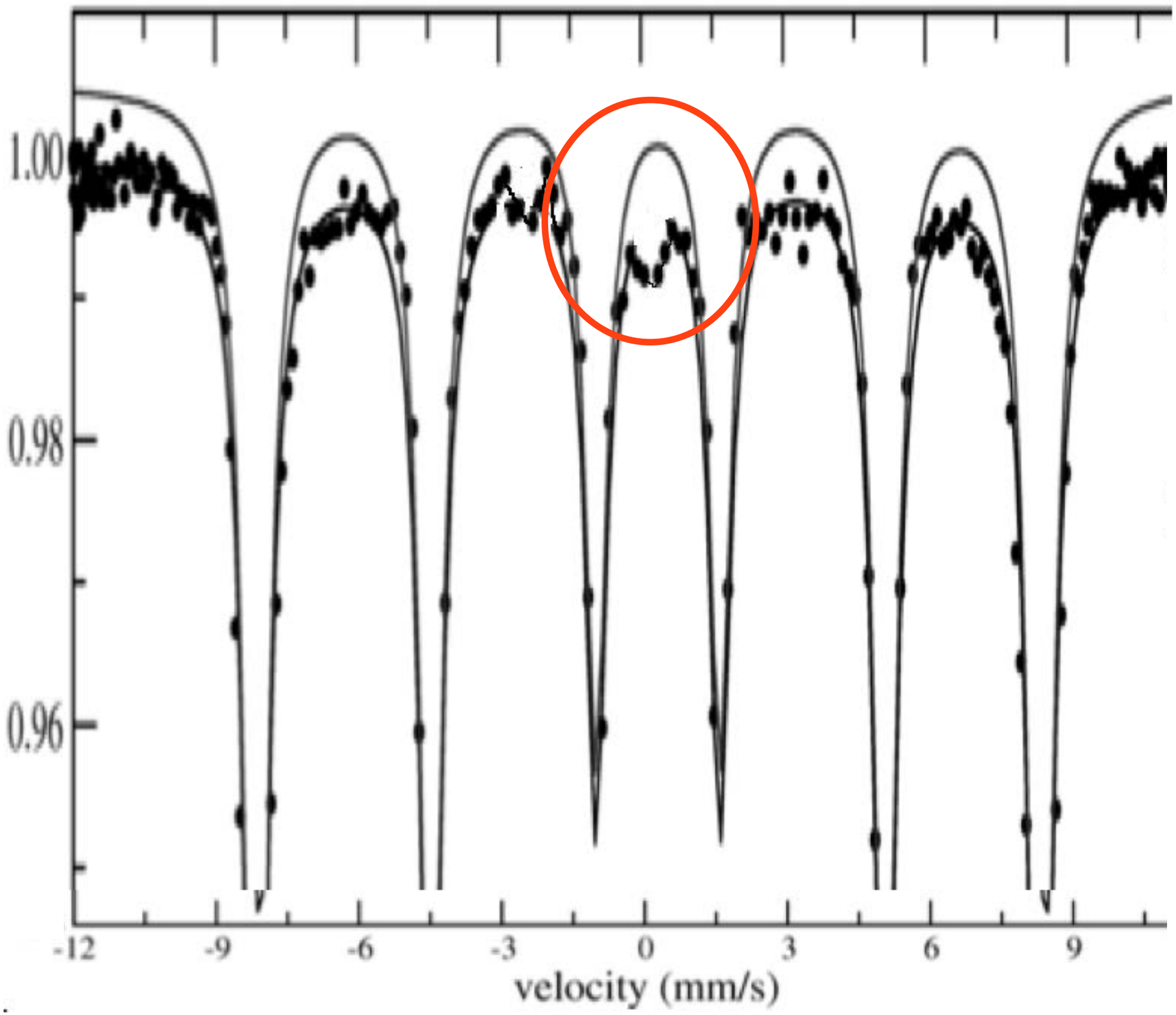

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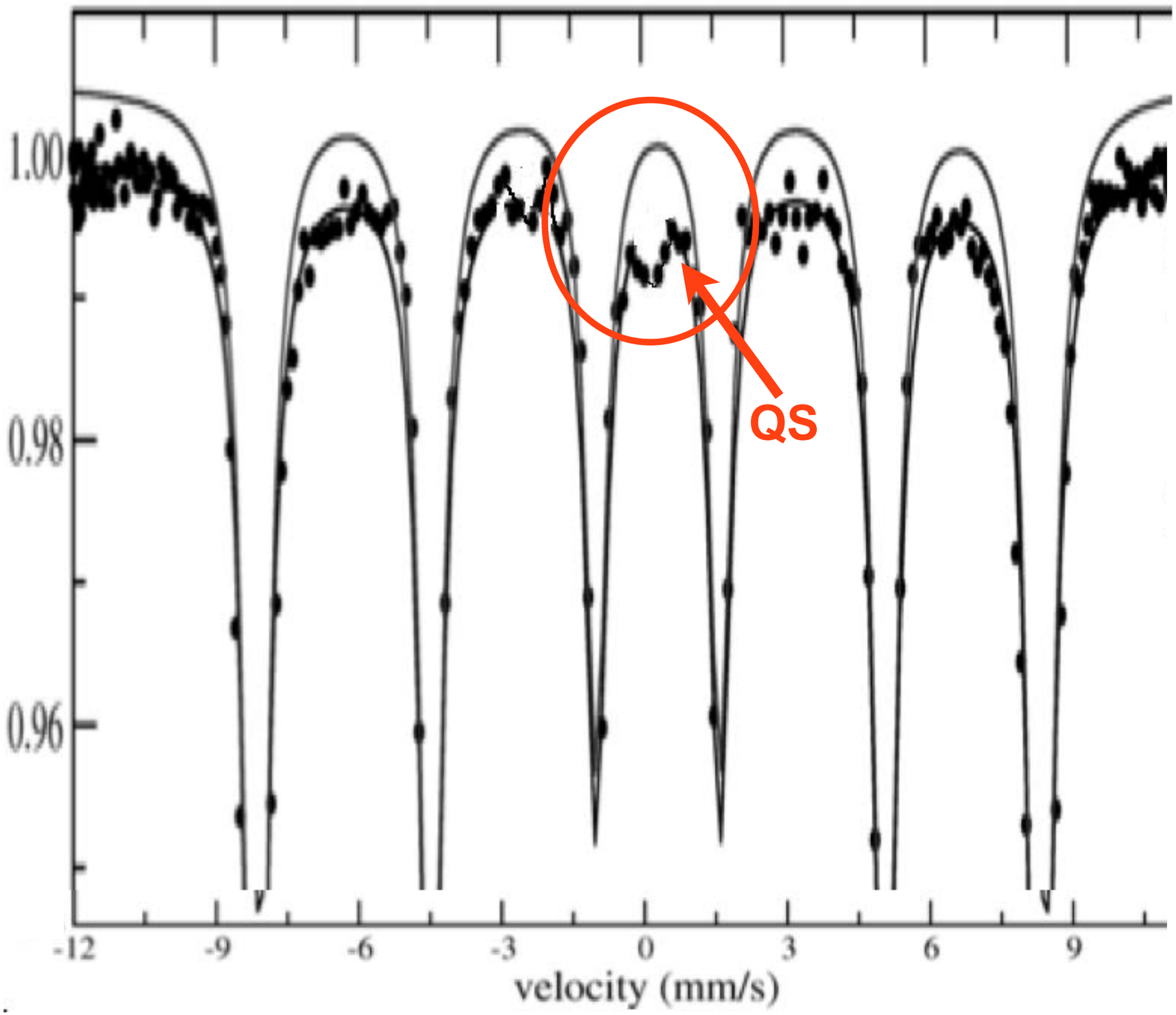

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

JOURNAL OF PHARMACEUTICAL SCIENCES, VOL. 101, NO. 5, MAY 2012

Influence of Drug Distribution and Solubility on Release from Geopolymer Pellets—A Finite Element Method Study

ERIK JÄMSTORP,[1] MARIA STRØMME,[1] SUSANNE BREDENBERG[2,3]

[1]Division for Nanotechnology and Functional Materials, Department of Engineering Sciences, The Ångström Laboratory, Uppsala University, SE-751 21 Uppsala, Sweden

[2]Division for Applied Materials Science, Department of Engineering Sciences, The Ångström Laboratory, Uppsala University, SE-751 21 Uppsala, Sweden

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....The parameters such as pellet size and composition may in the end be tuned to obtain an optimal microstructure and chemical condition for a safe and timely release from geopolymer pellets in oral administration of highly potent drugs (*opioids and the like*).

(12) DEMANDE INTERNATIONALE PUBLIÉE EN VERTU DU TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS (PCT)

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(71) Déposant *(pour tous les États désignés sauf US)* : **PYROMERAL SYSTEMS S.A.** [FR/FR]; BP 70251, F-60722 Pont Sainte Maxence (FR).

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Déclarations en vertu de la règle 4.17 :

(54) **Title** : MATRIX BASED ON NANOCRYSTALLINE CRISTOBALITE FOR A THERMOSTRUCTURAL FIBROUS COMPOSITE MATERIAL

(54) **Titre** : MATRICE À BASE DE CRISTOBALITE NANO-CRISTALLINE POUR MATÉRIAU COMPOSITE FIBREUX THERMOSTRUCTURAL.

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C04B 28/00 (2006.01) *C04B 35/80* (2006.01)

(57) Abstract : The invention relates to a matrix for thermostructural ***fibrous composite materials***, obtained by geopolymer synthesis based on ***nanocrystalline cristobalite*** ... The nanocrystalline cristobalite results from the crystallization of geopolymer micelles .... by a thermal treatment at a temperature ... between 600°C and 800°C.....

(54) Title : MATRIX BASED ON NANOCRYSTALLINE CRISTOBALITE FOR A THERMOSTRUCTURAL FIBROUS COMPOSITE MATERIAL

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Barbery, France

Pyromeral Systems

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Pyromeral Systems

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(51) International Patent Classification:
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(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
S2008/0826 10 October 2008 (10.10.2008) IE
2009/0248 31 March 2009 (31.03.2009) IE

(71) Applicant *(for all designated States except US)*: **EIRE-COMPOSITES TEORANTA** [IE/IE]; An Choill Rua, Indreabhan, Co. Galway (IE).

(74) Agents: **DUNNE, Sinead** et al.; Tomkins & Co., 5 Dartmouth Road, Dublin 6 (IE).

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(54) Title: A HEATED MOULD FOR MOULDING POLYMERIC COMPOSITES

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AEROMAT 2011
Conference and Exposition

ÉIRECOMPOSITES

ELECTRICALLY-HEATED CERAMIC COMPOSITE TOOLING FOR OUT-OF-AUTOCLAVE MANUFACTURING OF LARGE COMPOSITE STRUCTURES

Conchúr M. Ó Brádaigh, Adrian Doyle, Derrick Doyle, P.J. Feerick

ÉireComposites Teo., An Choill Rua, Indreabhán, Co. Galway, IRELAND

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(30) Priority Data:
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(71) Applicant *(for all designated States except US)*: **TNEMEC COMPANY, INC.** [US/US]; 123 West 23rd Avenue, North Kanss City, Missouri 64116 (US).

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- ***second***: epoxy resin + alkaline silicate solution. The two components are mixed to produce a SIN-GE composition that cures at ambient temperatures....

The compositions may be used as coatings, adhesives, mortars, casting materials, and the like.

(54) **Title**: GEOPOLYMER AND EPOXY SIMULTANEOUS INTERPENETRATING POLYMER NETWORK COMPOSITION, AND METHODS FOR THE SAME RELATED APPLICATIONS

dec. 2011 Australia

Rockwool Waste Briquette plant

CSR Building Products Limited

Insulation manufacturer develops a way recycle and reuse tonnes of rock waste

Australia's only manufacturer of Rockwool insulation has found a way to capture, recycle and reuse tonnes of waste generated from the manufacturing process.

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Rockwool is made from various rocks, such as basalt, limestone and iron slag. The rocks are melted in a furnace to form lava that can be spun into fibres ... generates ***450kg*** of waste for ***1 tonn*** manufactured.

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The $1.714 million project is using a ***geopolymer*** to bind the waste together. The geopolymer was developed with the assistance of chemical manufacturer, PQ Australia.

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The $1.714 million project is using a ***geopolymer*** to bind the waste together. The geopolymer was developed with the assistance of chemical manufacturer, PQ Australia.

The first of its type in the world, the plant was operational by March 2007. Using its own unique ***geopolymer***, the waste is bound and formed into little 100mm x 90mm x 60mm bricks. The ***briquettes are fed back into the furnace*** and made into fibres for Rockwool insulation.

2011

Geopolymer
A new standard in Fire rated façade materials

A2 Fire Rated

Sustainable Core & System Technology

Smartfix® Compatible

Nu-core® A2FR fills the gap for Aluminium composite panel applications where traditional ACP products were limited. Strict

Nu-Core® Australia

2011

Geopolymer
A new s
Fire rat

Geopolymer
A new standard in
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A2

A2 Fire Rated

Sustainable Core
& System Technology

Smartfix®
Compatible

Nu-core® A2FR fills the gap for Aluminium composite panel applications where traditional ACP products were limited. Strict

Nu-Core® Australia

World Chemical Company BASF launches Geopolymer product

Feb. 2011

in *News and Conferences*, on 24 Mar 2011. Tags: cement, ceramic, chemistry.

The German chemical company PCI Augsburg GmbH, a subsidiary of the world chemical company BASF, has launched a geopolymer joint grout PCI Geofug® product, for the general public.

Go to
PCI-Geofug Geopolymer Technology

and watch the product video.

PCI-Geofug ®

http://www.pci-augsburg.eu/en/


PCI Geofug
PCI
peciclean®
effect
GEOPOLYMER
TECHNOLOGY


À bas le ménage,
FINI L'ESCLAVAGE !
GEOPOLYMER
Forever
JOINTS PROPRES
pour tous !

Down with the housework, END OF SLAVERY


À bas le ménage,
FINI L'ESCLAVAGE !
GEOPOLYMER
Forever
JOINTS PROPRES
pour tous !
Down with the housework, END OF SLAVERY
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Desil Al – geopolymer binder

DESIL Al is a colloidal solution with an additive Al which differs in its composition and properties from classic colloidal solutions of alcaline silicates, designated as water glasses.

DESIL Al is a colloidal solution whose framework is very similar to zeolithic structures.

Your reliable business partner

vodni sklo

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

Dear Prof. Davidovits, ... I would like to share the commercial success of our geopolymer technology for Paving blocks & Tiles from ***Steel slag, fly ash and GBFS*** combination. The technology has been developed, transferred and commercial production started.....has produced around 0.5 million bricks and got first purchase order of USD 30,000,000 and supplying.

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..... Finally we are planning to have 10 commercial installations in India in coming 5 years.....

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..... Finally we are planning to have 10 commercial installations in India in coming 5 years.....

Dr. Sanjay Kumar, Principal Scientist Resource, Energy & Environment, National Metallurgical Laboratory, Council of Scientific & Industrial Research, Jamshedpur - 831 007, India

Paving Tiles from Steel Slag

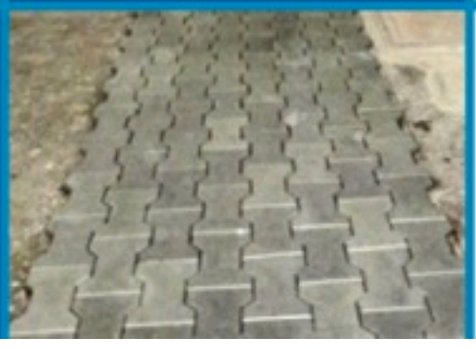
GOING green initiative

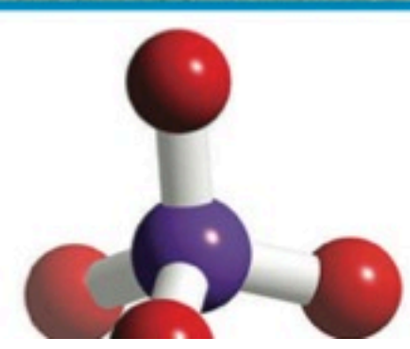
a green technology developed by

CSIR- National Metallurgical Laboratory & TATA TATA STEEL

Process Highlights

- A cement free process
- Uses eco-friendly geopolymerisation process
- Complies to IS 15658: 2006 specification
- Meet EPA 1311 specification for toxicity





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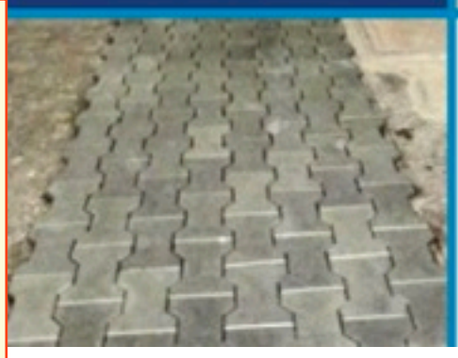
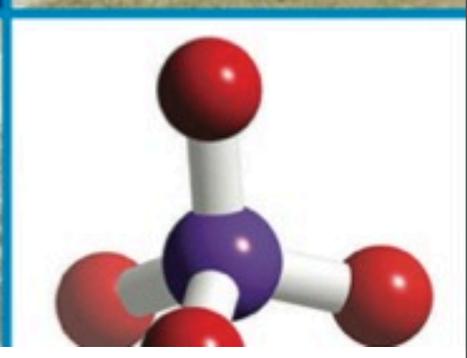




A cement free process

Uses eco-friendly geopolymerisation process

1992 Rio de Janeiro

1992 Rio de Janeiro world Eco-summit

1992 **Rio de Janeiro**

world Eco-summit

2012 **Rio de Janeiro**

1992 **Rio de Janeiro**

world Eco-summit

2012 **Rio de Janeiro**

world Eco-summit

1992 **Rio de Janeiro**

world Eco-summit

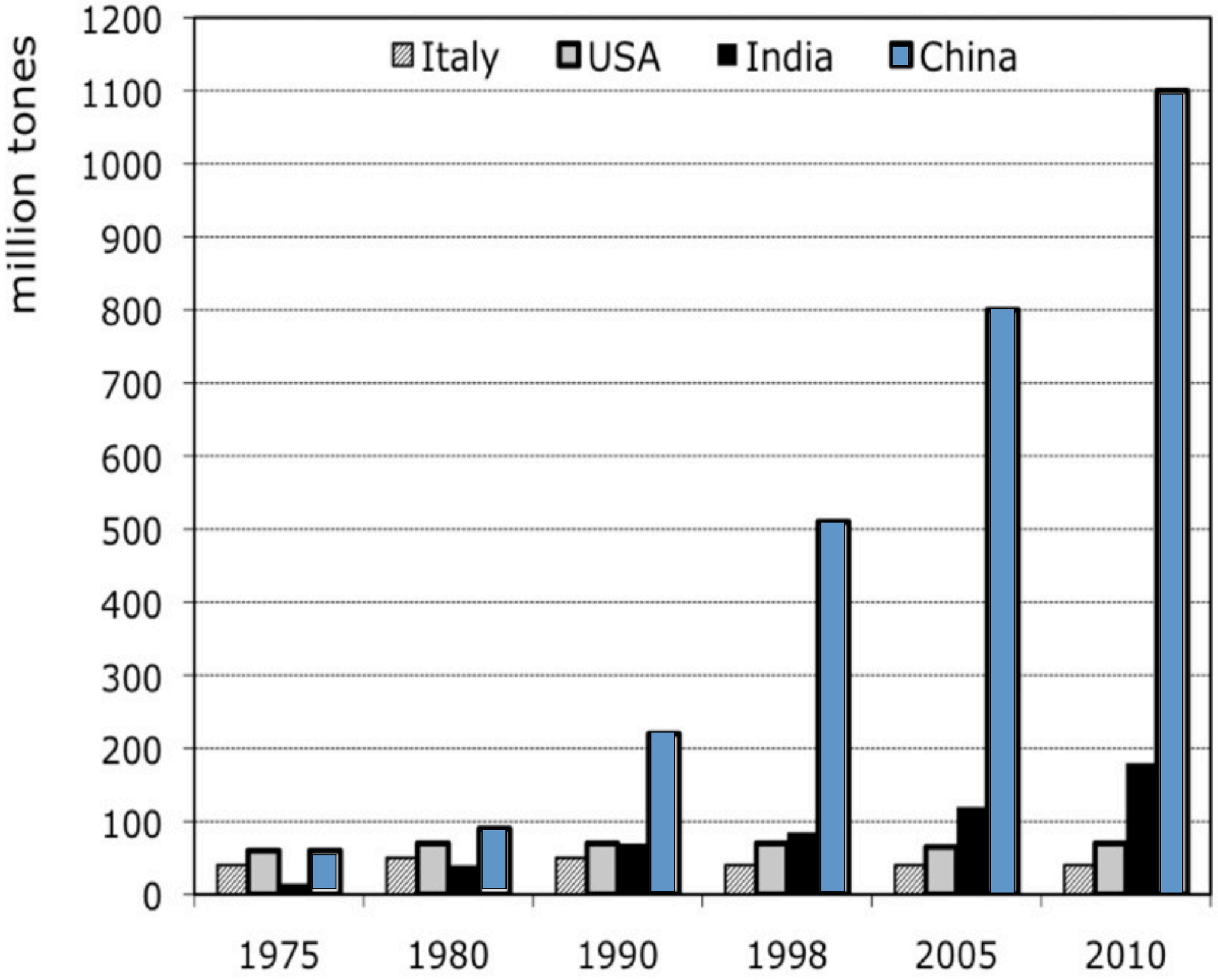
2012 **Rio de Janeiro**

world Eco-summit

Rio + 20

My 1992 CO_2 emission forecast for Portland Cement

My 1992 CO_2 emission forecast for Portland Cement



My 1992 CO_2 emission forecast for Portland Cement

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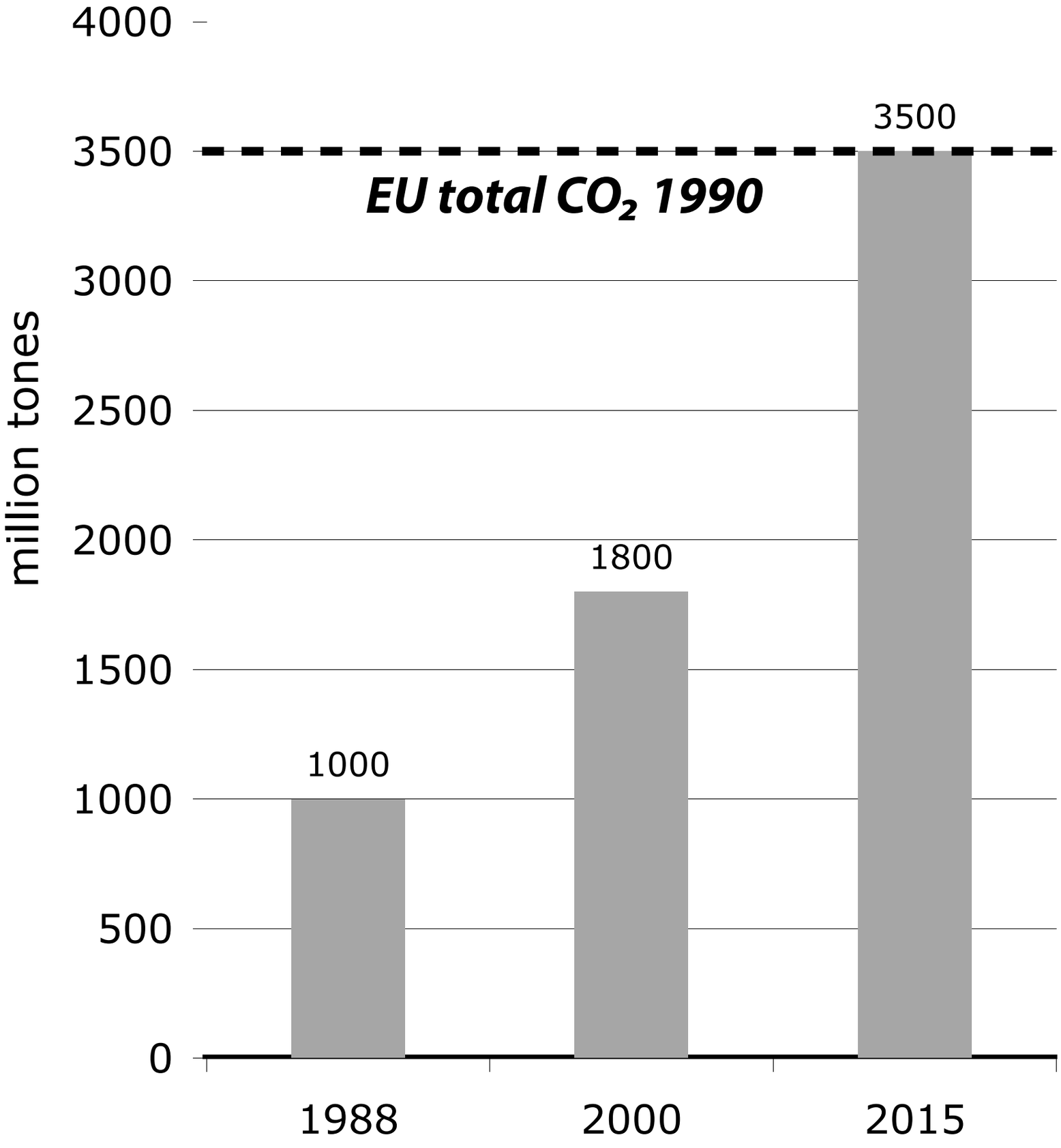
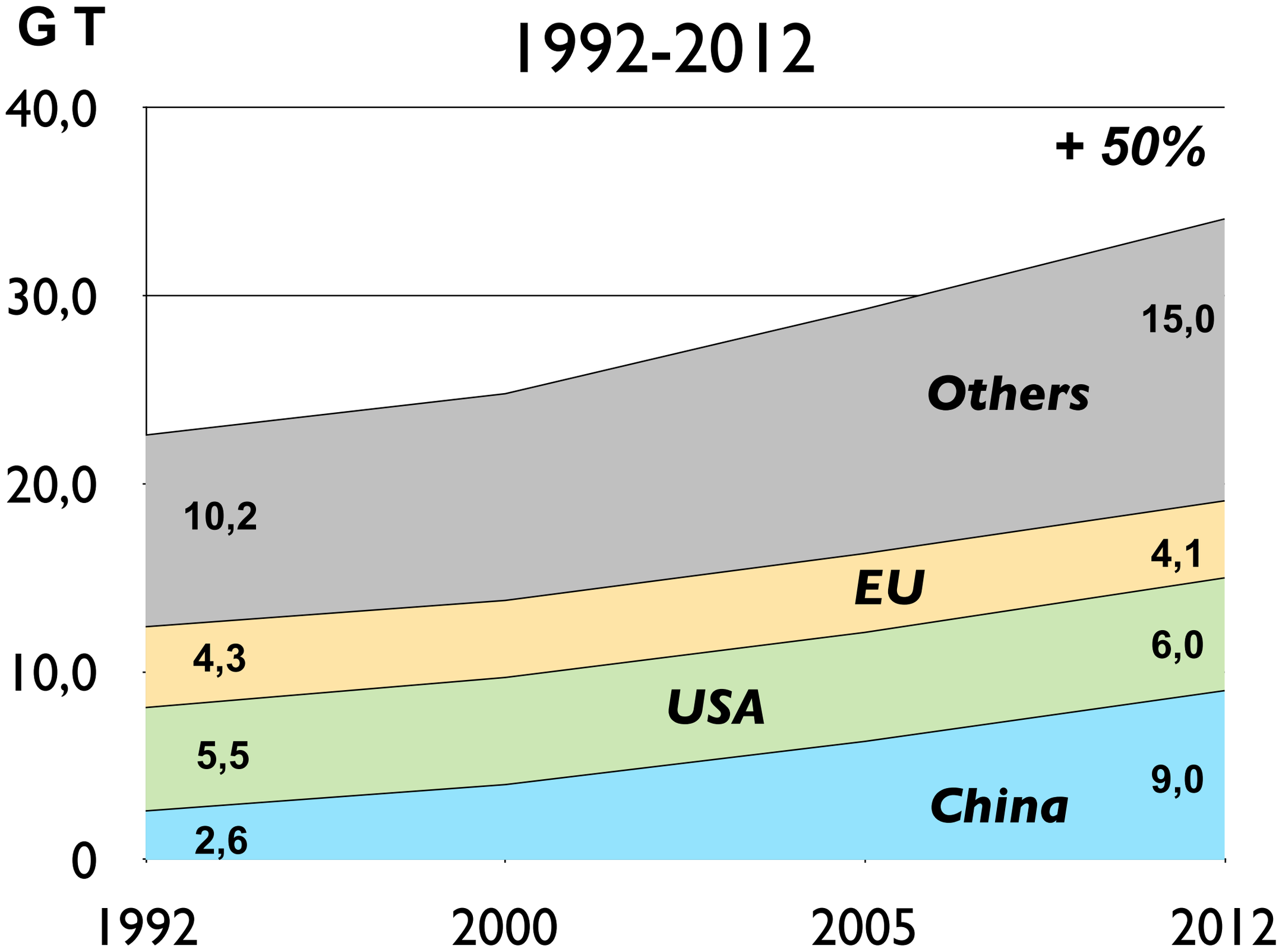
World Cement-CO2 emission



World CO_2 emission 1992-2012



Journal of Cleaner Production 19 (2011) 1080–1090

2011

Contents lists available at ScienceDirect

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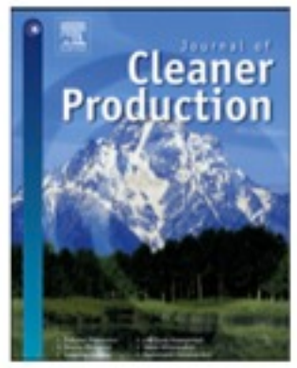

Costs and carbon emissions for geopolymer pastes in comparison to ordinary portland cement

Benjamin C. McLellan [a,*], Ross P. Williams [b], Janine Lay [a], Arie van Riessen [b], Glen D. Corder [a]

[a] *The University of Queensland, Sustainable Minerals Institute, St Lucia, QLD 4072, Australia*
[b] *Centre for Materials Research, Curtin University of Technology, Perth, WA 6845, Australia*

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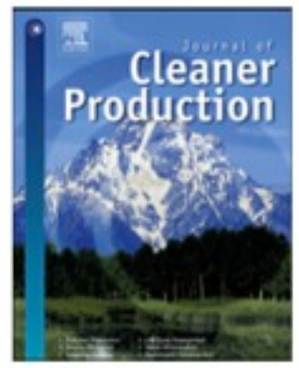

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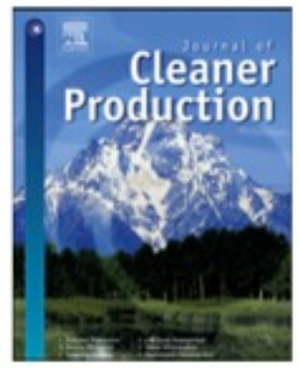

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Australia: Curtin U. + U. Queensland

.....examination of the lifecycle ***cost*** and ***carbon*** impacts of Ordinary Portland Cement (OPC) and geopolymers in an ***Australian context***, with an identification of some key challenges for geopolymer development.

5. Conclusions

...For “typical” Australian geopolymer product, there is an estimated ***44-64%*** improvement in CO2 emission over OPC, while the ***cost*** of these geopolymers can be up to ***twice*** as high as OPC.

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...For “typical” Australian geopolymer product, there is an estimated ***44-64%*** improvement in CO2 emission over OPC, while the ***cost*** of these geopolymers can be up to ***twice*** as high as OPC.

However, ... those benefits are only realisable given the most appropriate source of feedstock and the least cost transportation.

The broad range of potential feedstock sources leads to a very wide range of potential impacts:

compared with OPC, emissions from geopolymer cement can be ***97% lower up to 14% higher***.

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compared with OPC, emissions from geopolymer cement can be ***97% lower up to 14% higher***.

Each application for geopolymers therefore needs to be assessed for its ***specific location***, given that the impact of location on overall sustainability is one of the determining factors.

Session

Ancient Technologies

Thursday Jul.10, 16:30

co-chair:

Dr. Tomas Hanzlicek

Dr. Frédéric Davidovits

Acta Geodyn. Geomater., Vol. 9, No. 1 (165), 57–62, 2012

PRE-PORTLAND CEMENTS AND GEOPOLYMERS

Tomáš HANZLÍČEK [1)]*, Ivana PERNÁ [1)], Zdenek ERTL [2)] and Sean M. MILLER [3)]

[1)] *Institute of Rock Structure and Mechanics, Academy of Sciences of the Czech Republic, v.v.i., V Holešovičkách 41, 182 09 Prague, Czech Republic*
[2)] *Czech Development Agency o.p.s. (CzDA), Dykova 960/4, 101 00 Prague 10*
[3)] *Department of English and Department of History, University of Memphis, USA*

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[3)] *Department of English and Department of History, University of Memphis, USA*

ABSTRACT

This paper presents the historical background of the 20th-century technology of geopolymers in light of a literature research of the 15th to 19th centuries and offers a hypothesis on why this historical knowledge was forgotten when Portland cement appeared.

(*In the first half of the 19th Century*)...we are actually dealing with a small or very small circle of experts ..... mainly formed at military schools and therefore keeping certain "***secrets***" or "***specific knowledge***" as a part of the state's important matters.

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The major obstacle: Not even the experts were able to tell whether local material will suit the constructions or not – the physical methods of qualifications were not sufficient as well as chemical behavior....

The uncertainty of results, the necessity of permanent study of the local material used for construction, and the search for the proper proportions and technology were the ***main reasons of the decline*** of lime/clay combinations, when Portland cement appeared.

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Everything .... ***much more sophisticated*** than the simple use of standard Portland cement in an admixture with pebbles and water.

Establish standards for global economy:

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max. 2 universal and «User-friendly» geopolymeric processes

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1) (Na,K,Ca)-fly ash-based geopolymer cement

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1) (Na,K,Ca)-fly ash-based geopolymer cement

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and

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1) (Na,K,Ca)-fly ash-based geopolymer cement

2) (Na,K,Ca)-(ferro-sialate)-based geopolymer cement

and

one industrial hardener based on geology

pH

pH

CORROSIVE

IRRITANT

User- hostile

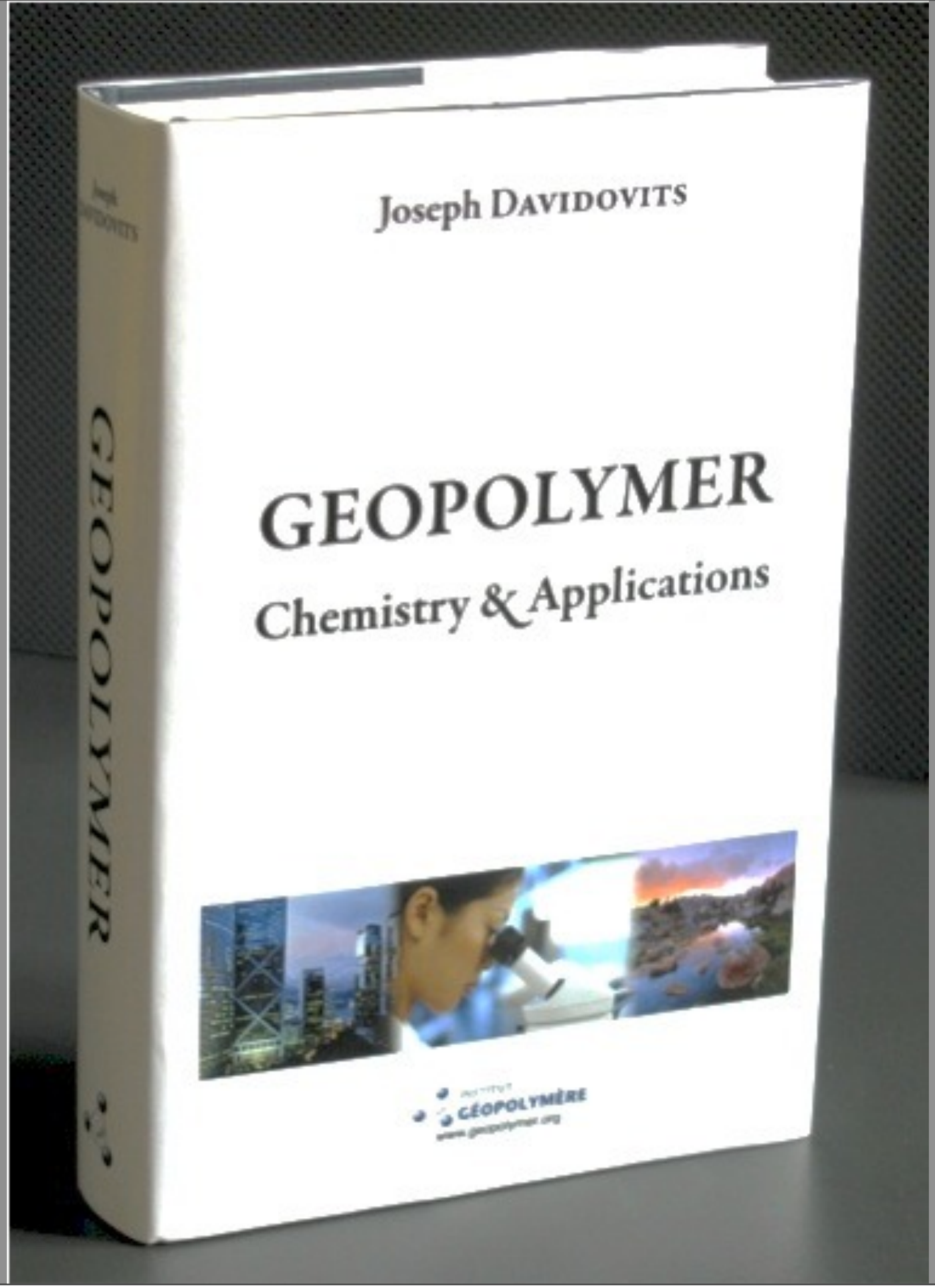
Systems

User- friendly

Systems

Corrosive and irritant chemicals

Hostile	Friendly
CaO (quick lime)	$Ca(OH)_2$
NaOH	Portland cement
KOH	Iron slag
Sodium metasilicate $SiO_2:Na_2O = 1$	Slurry soluble silicate/kaolin MR $1.25<SiO_2:M_2O<1.45$
Any soluble silicate MR $SiO_2:M_2O < 1.45$	Any soluble silicate MR $SiO_2:M_2O > 1.45$


Joseph DAVIDOVITS
GEOPOLYMER
Chemistry & Applications
GEOPOLYMER
INSTITUT GÉOPOLYMÈRE
www.geopolymer.org

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World Resource Review

1994

GLOBAL WARMING AND THE EXTREME EVENT INDEX

THE IMPACT OF INTENSIVE FOREST MANAGEMENT ON CARBON STORES IN FOREST ECOSYSTEMS

INCREMENTALITY AND ADDITIONALITY: A NEW DIMENSION TO NORTH-SOUTH RESOURCE TRANSFERS?

NATIONAL ENVIRONMENTAL PLAN OF AUSTRIA

AN ANALYSIS OF HUMAN-INDUCED LAND TRANSFORMATIONS IN THE SAN FRANCISCO BAY/SACRAMENTO AREA

FEDERAL GOVERNMENT - PRIVATE SECTOR PARTNERSHIPS FOR ADDRESSING ENVIRONMENTAL CONCERN AND TECHNOLOGY DEVELOPMENT

INDUSTRIAL ENERGY EFFICIENCY AND GLOBAL WARMING

COMPARISON OF RADIATIVE FORCING IMPACTS OF THE USE OF WOOD, PEAT, AND FOSSIL FUELS

GLOBAL WARMING IMPACT ON THE CEMENT AND AGGREGATES INDUSTRIES

World Resource Review

1994

World Resource Review Vol. 6 No. 2

GLOBAL WARMING IMPACT ON THE CEMENT AND AGGREGATES INDUSTRIES

Joseph Davidovits
Geopolymer Institute
Cordi-Géopolymère SA
20 rue de la Fère, F-02100 Saint-Quentin, France

GLOBAL WARMING IMPACT ON THE CEMENT AND AGGREGATES INDUSTRIES

Third World Development means implementing the use of electricity and building infrastructures and houses; in short, electricity and concrete. The by-product of electricity production with coal firing is ***fly-ash***.

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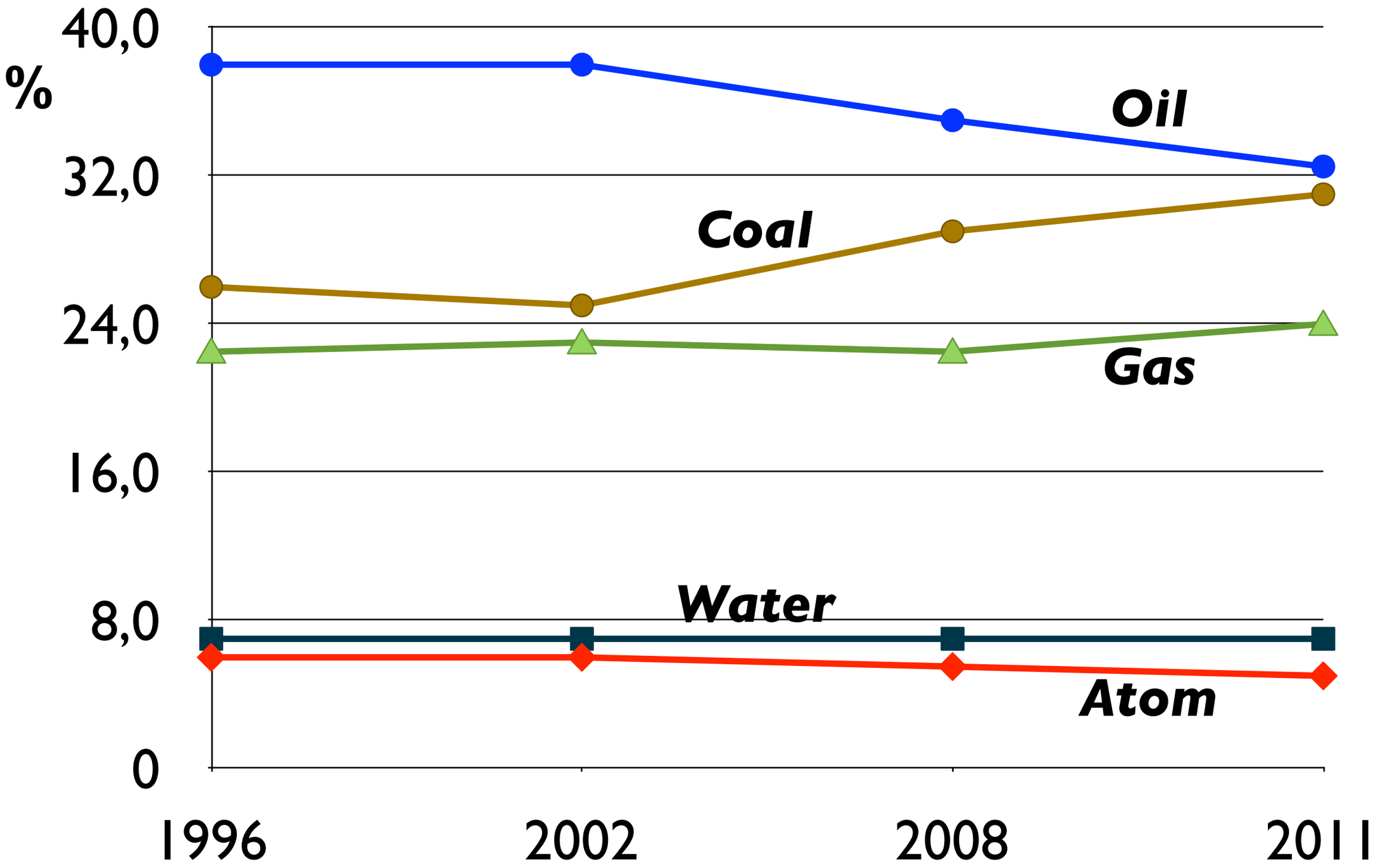
The innovative step would be to produce electricity and low-CO_2 cement (geopolymeric cement), in the same plant, by adapting and implementing fly-ash production into Geopolymeric raw-material, without any supplementary chemical-CO_2 emission.

World energy sources
1996-2011



COAL FLY-ASH GEOPOLYMERIZATION

COAL FLY-ASH GEOPOLYMERIZATION

Hardening at Room-Temperature

Based on

(K,Ca)-poly(sialate-siloxo) matrix

Conventional method: alkali-activation

Conventional method: alkali-activation

dissolution and zeolite formation

Conventional method: alkali-activation

dissolution and zeolite formation

- 0.3-0.4 L/kg, NaOH 12M, or Na-silicate with $SiO_2:Na_2O < 1,4$

Conventional method: alkali-activation

dissolution and zeolite formation

- 0.3-0.4 L/kg, NaOH 12M, or Na-silicate with SiO2:Na2O < 1,4

- 24h room temperature ageing,

Conventional method: alkali-activation

dissolution and zeolite formation

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- 24h room temperature ageing,

- curing at 80°C for 48h.

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- 24h room temperature ageing,

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User-hostile

Geopolymeric method

Geopolymeric method

room temperature hardening

Geopolymeric method

room temperature hardening
polycondensation

Geopolymeric method

room temperature hardening
polycondensation

- fly ash.....50 to 85

Geopolymeric method

room temperature hardening
polycondensation

- fly ash……50 to 85
- K-silicate solution SiO2:K2O >1.4……..10

Geopolymeric method

room temperature hardening
polycondensation

- fly ash……50 to 85
- K-silicate solution SiO2:K2O >1.4……..10
- blast furnace slag……15

Geopolymeric method

room temperature hardening
polycondensation

- fly ash……50 to 85
- K-silicate solution SiO2:K2O >1.4……..10
- blast furnace slag……15
- water……5

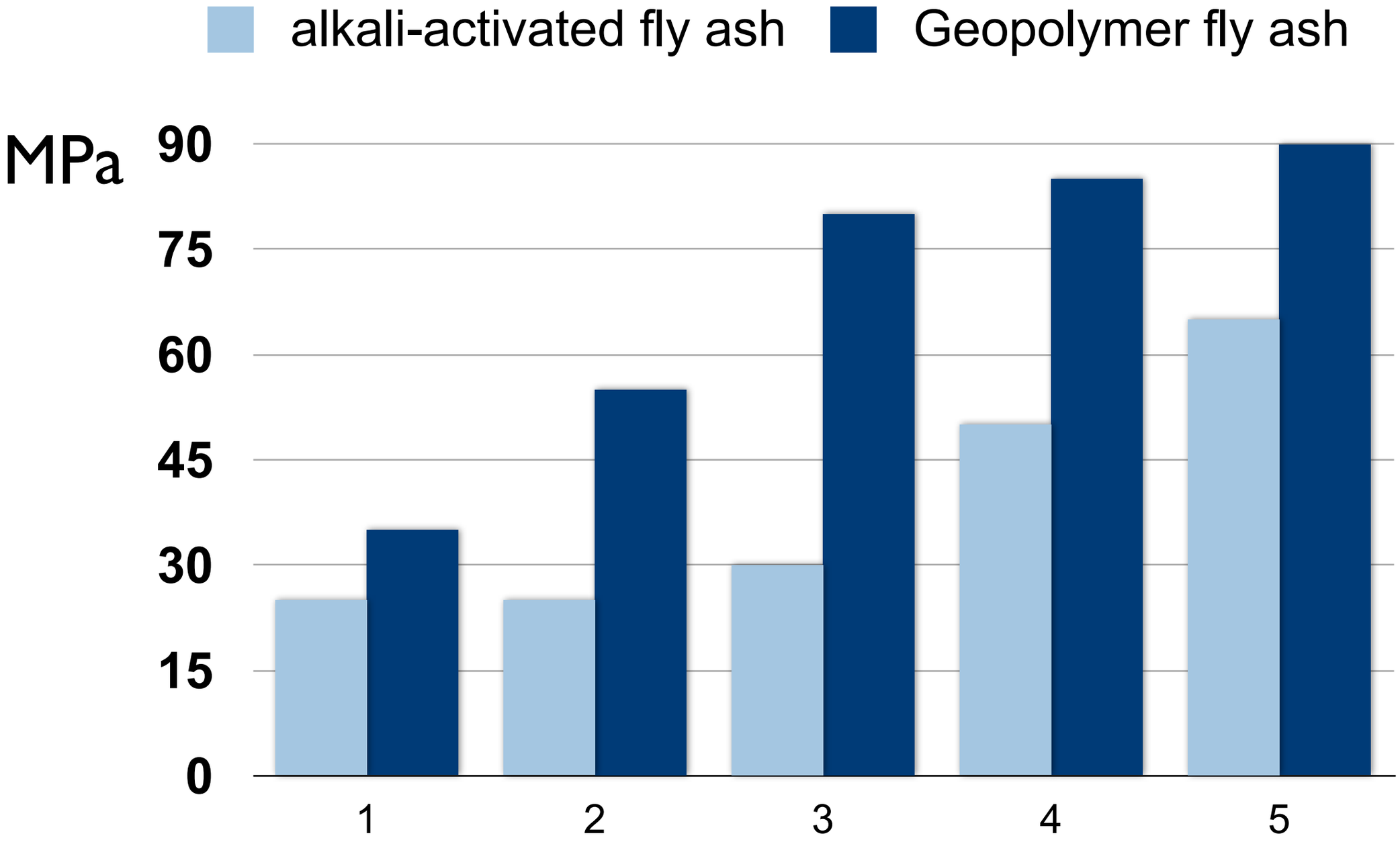
Geopolymeric method

room temperature hardening
polycondensation

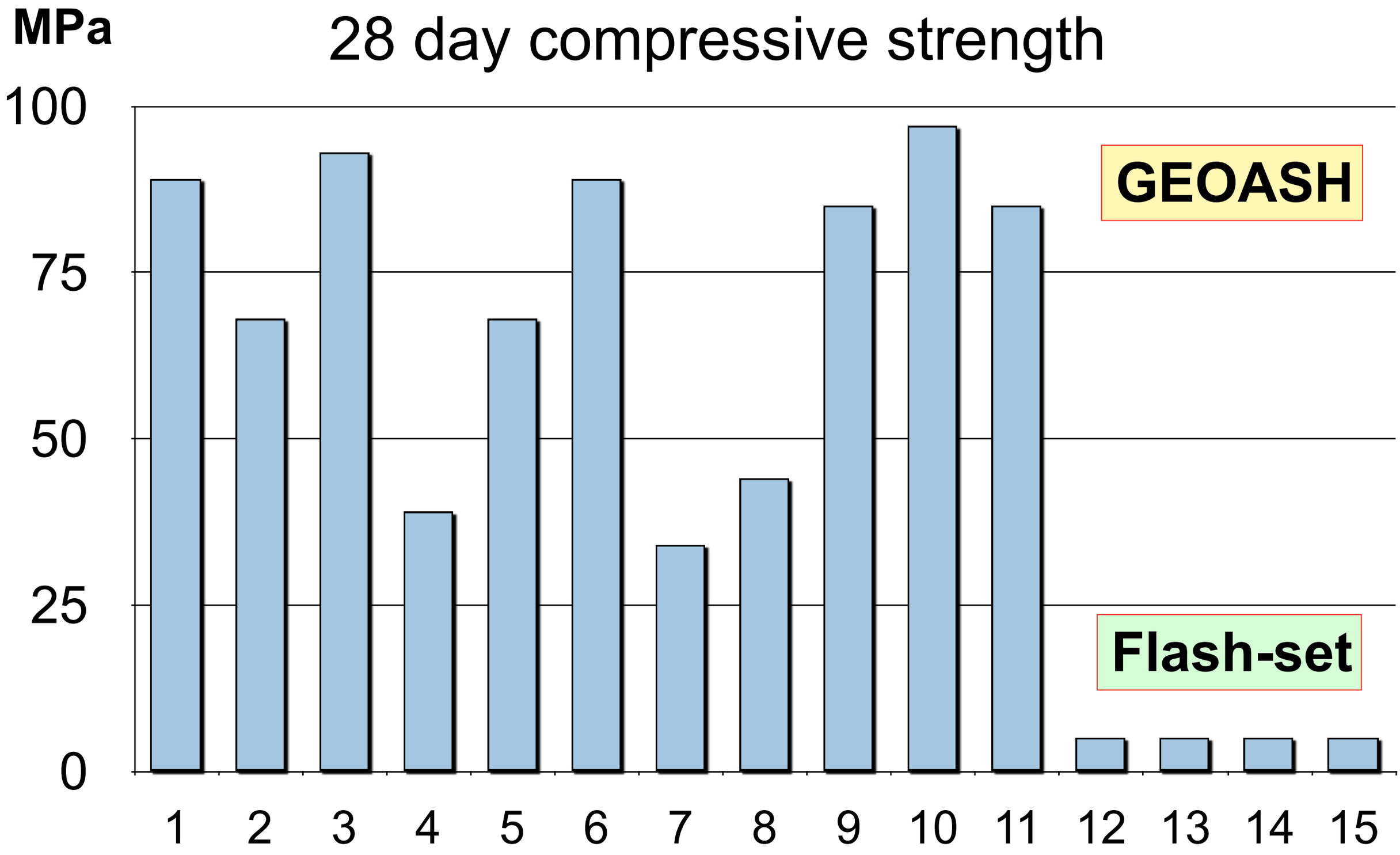
- fly ash……50 to 85
- K-silicate solution SiO2:K2O >1.4……..10
- blast furnace slag……15
- water……5

User-friendly

28 day compressive strength



Hardening at ROOM TEMP.



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(12) DEMANDE INTERNATIONALE PUBLIÉE EN VERTU DU TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS (PCT)

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Bureau international

(43) Date de la publication internationale
3 mai 2012 (03.05.2012)

PCT

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(25) Langue de dépôt : français

(26) Langue de publication : français

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(72) Inventeur; et
(71) Déposant : **DAVIDOVITS, Joseph** [FR/FR]; 16 rue Galilée, 02100 Saint Quentin (FR).

(84) **États désignés** *(sauf indication contraire, pour tout titre de protection régionale disponible)* : ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), eurasien (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), européen (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(72) Inventeur; et
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(84) États désignés *(sauf indication contraire, pour tout titre de protection régionale disponible)* : ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), eurasien (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), européen (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(54) **Title** : GEOPOLYMER CEMENT OF THE CALCIUM FERRO-ALUMINOSILICATE POLYMER TYPE AND PRODUCTION PROCESS

(54) **Titre** : CIMENT GÉOPOLYMÈRE DE TYPE CA-POLY(FERRO-SIALATE) ET PROCÉDÉ D'OBTENTION

(12) DEMANDE INTERNATIONALE PUBLIÉE EN VERTU DU TRAITÉ DE COOPÉRATION EN MATIÈRE DE BREVETS (PCT)

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PCT

(10) Numéro de publication internationale
WO 2012/056125 A1

(57) Abstract: ...binder or cement of the ferro-aluminosilicate [-Fe-O-Si-O-Al-O-] geopolymer type, ...with some of the Al atoms substituted with Fe atoms, the whole satisfying the following raw formula:

$$(Ca,Na,K)\cdot(Fe\text{-}O\text{-})_x\cdot(Si\text{-}O\text{-}Al\text{-}O\text{-})_{1-x}\cdot(Si\text{-}O)_y$$

with $x<0.5$ and $0<y<25$. This geopolymer binder or cement is the result of the Ca-geopolymer type geopolymerization with ferro-metakaolin Fe-MK-750.....

(54) Title : GEOPOLYMER CEMENT OF THE CALCIUM FERRO-ALUMINOSILICATE POLYMER TYPE AND PRODUCTION PROCESS

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(Na,K,Ca)-(ferro-sialate)-based geopolymer cement

(Na,K,Ca)-(ferro-sialate)-based geopolymer cement

(Na,K,Ca)-(ferro-sialate)-based geopolymer cement

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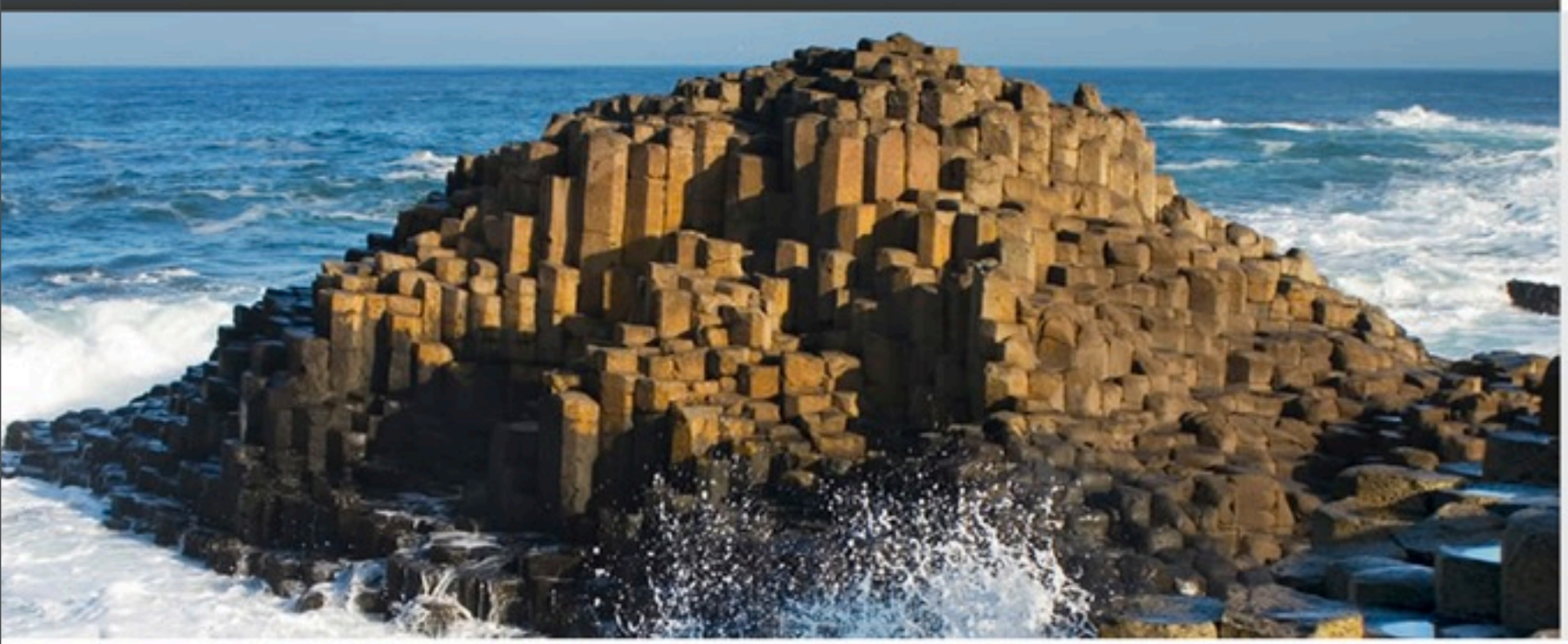

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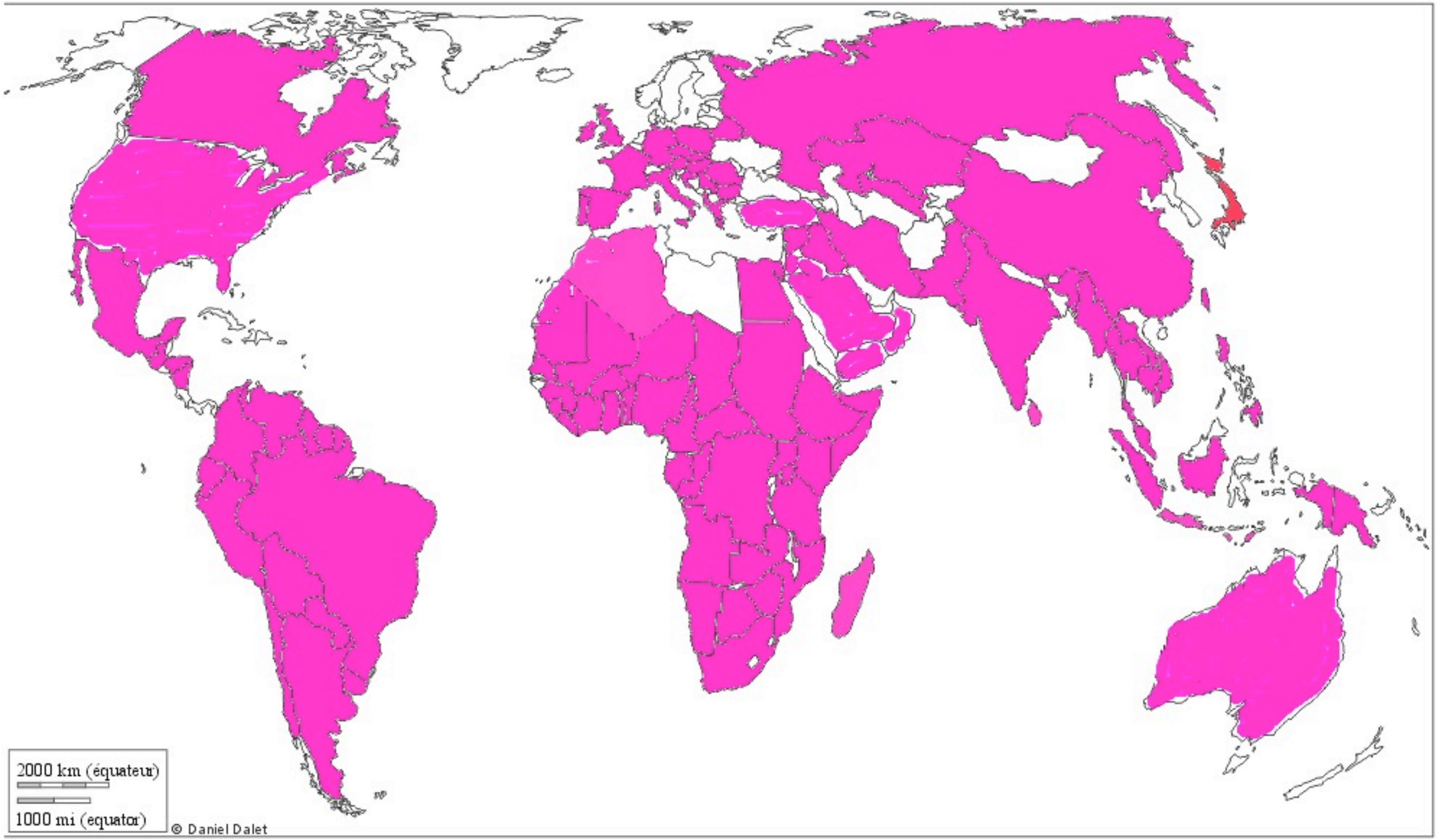
PRODUCTS

A range of building components available separately and also brought together in the building packages.

World-wide raw material for ferro-sialate geopolymer



Establish standards for global economy:

max. 2 universal and «User-friendly»

geopolymeric processes

1) (Na,K,Ca)-fly ash-based geopolymer cement

2) (Na,K,Ca)-(ferro-sialate)-based geopolymer cement

and

one industrial hardener in powder form

based on geology

User-friendly powder form

User-friendly powder form

molar ratio SiO_2:Na_2O > 1,45

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no silicate powder + NaOH flakes

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Chapters 19 and 24

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GÉOPOLYMÈRE

journal

2012

J. Am. Ceram. Soc., **95** [2] 565–572 (2012)
DOI: 10.1111/j.1551-2916.2011.04925.x

Thermal Activation of Albite for the Synthesis of One-Part Mix Geopolymers

Dingwu Feng,[‡] John L. Provis,[‡,†] and Jannie S. J. van Deventer[‡,§]

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[‡]Department of Chemical and Biomolecular Engineering, University of Melbourne, Victoria, 3010, Australia

[§]Zeobond Pty Ltd, P.O. Box 210, Somerton, Victoria, 3062, Australia

Table I. Compressive Strengths of One-Part Geopolymer Pastes After Different Periods of Curing

Raw material	Compressive strength, MPa			
	1 day	7 days	14 days	28 days
Albite*	–	–	1.5	2.2
Albite calcined at 1000°C*	–	–	1.8	2.5
Albite calcined with 50% NaOH at 1000°C†	15.5	32.3	38.5	44.2
Albite calcined with 50% Na_2CO_3 at 1000°C †	12.4	25.6	34.4	42.6

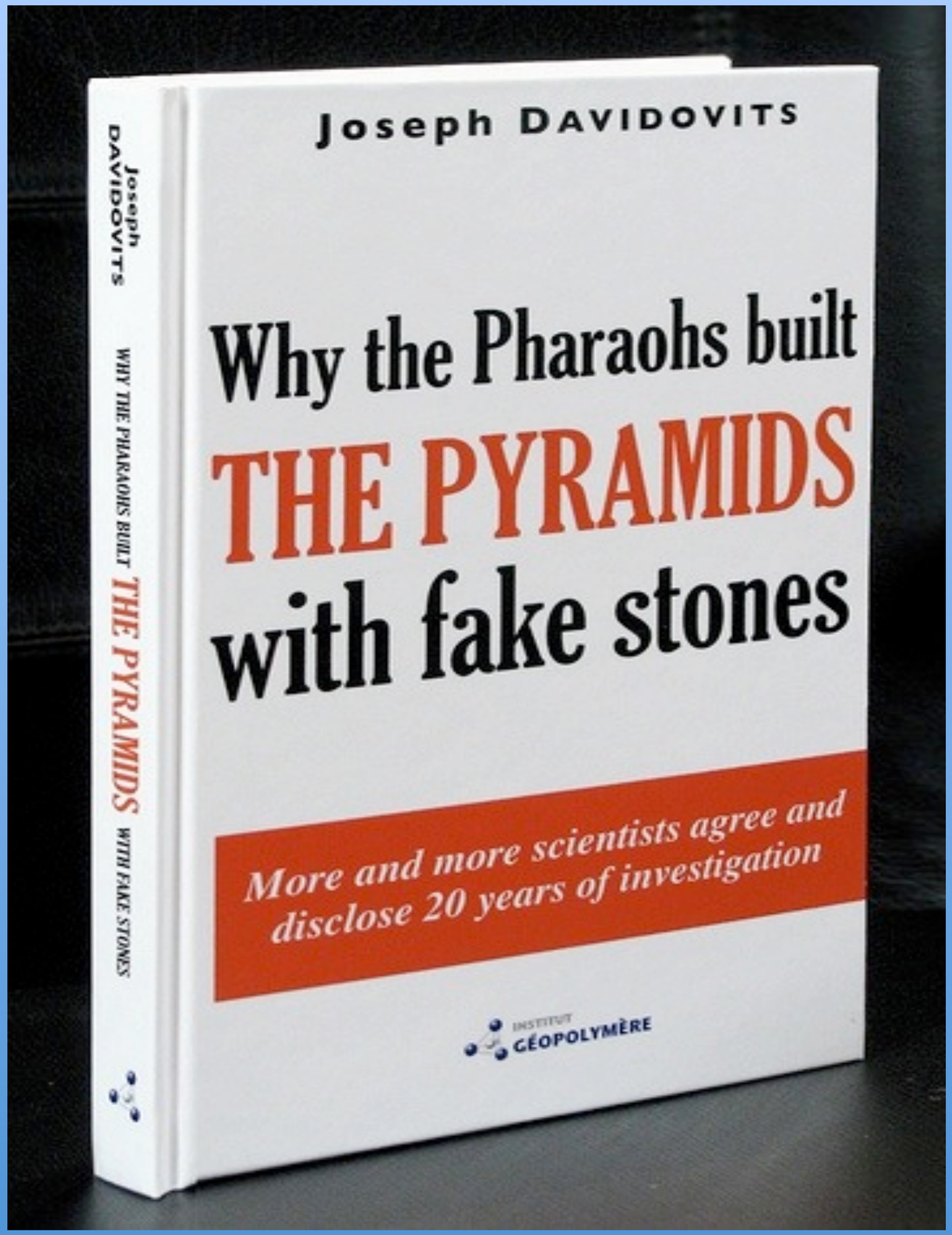
State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology


Joseph DAVIDOVITS
Why the Pharaohs built
THE PYRAMIDS
with fake stones
More and more scientists agree and disclose 20 years of investigation
INSTITUT GÉOPOLYMÈRE
Joseph DAVIDOVITS
WHY THE PHARAOHS BUILT THE PYRAMIDS WITH FAKE STONES

Non exhaustive list of scientific institutions

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endorsing the re-agglomerated limestone theory

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Were the casing stones of Senefru's Bent Pyramid in Dahshour cast or carved? Multinuclear NMR evidence

Kenneth J.D. MacKenzie [a,*], Mark E. Smith [b], Alan Wong [b], John V. Hanna [b], Bernard Barry [c], Michel W. Barsoum [d]

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[b] *Department of Physics, University of Warwick, Coventry, CV4 7Al, UK*
[c] *Institute of Geological and Nuclear Sciences, Lower Hutt, New Zealand*
[d] *Department of Materials Science and Engineering, Drexel University, Philadelphia, PA 19104, USA*

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Kenneth [illegible] [b],
Bernard [illegible]

[a] MacDiarmid I[illegible]
[b] Department o[illegible]
[c] Institute of Ge[illegible]
[d] Department o[illegible]

vendredi 20 juillet 12

A comparison was made of ^{29}Si, ^{27}Al and ^{43}Ca MAS NMR spectra of the ***outer casing stone*** from Snefru's Bent Pyramid in Dahshour, Egypt, with two quarry limestones from the area.

A comparison was made of ^{29}Si, ^{27}Al and ^{43}Ca MAS NMR spectra of the ***outer casing stone*** from Snefru's Bent Pyramid in Dahshour, Egypt, with two quarry limestones from the area.

The NMR results suggest that the casing stones consist of limestone grains from the Tura quarry, cemented with an amorphous calcium-silicate gel formed by ***human intervention***, by the addition of natural reactive silica (diatomaceous earth from the Fayium area ?).

On Standby

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Ancient Egypt and related topics

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- ceramics (low-temp. faience tiles)

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3000 BC (5000 years old)

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Megalithic stones

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