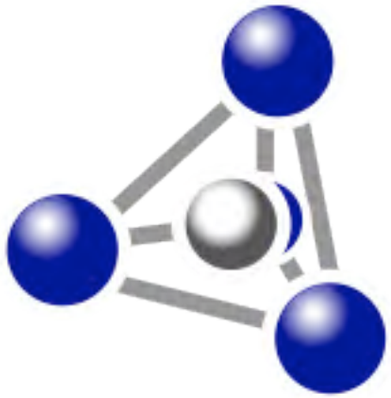


2013

GEOPOLYMERCAMP

www.iut-aisne.fr

Saint-Quentin (France)

July 8-10, 2013

INSTITUT

GÉOPOLYMÈRE

Prof. Dr. Joseph Davidovits

www.geopolymer.org

State of the Geopolymer R&D 2013

2013 GeopolymerCamp

Previous State of the Geopolymer at GP-Camps

2009: Mass Produced Geopolymer Cement

2010: State of the Geopolymer R&D 2010

2011: State of the Geopolymer R&D 2011

2012: State of the Geopolymer R&D 2012

State of the Geopolymer R&D 2013

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

State of the Geopolymer R&D 2013

1) Geopolymer science

2) Geopolymer technologies

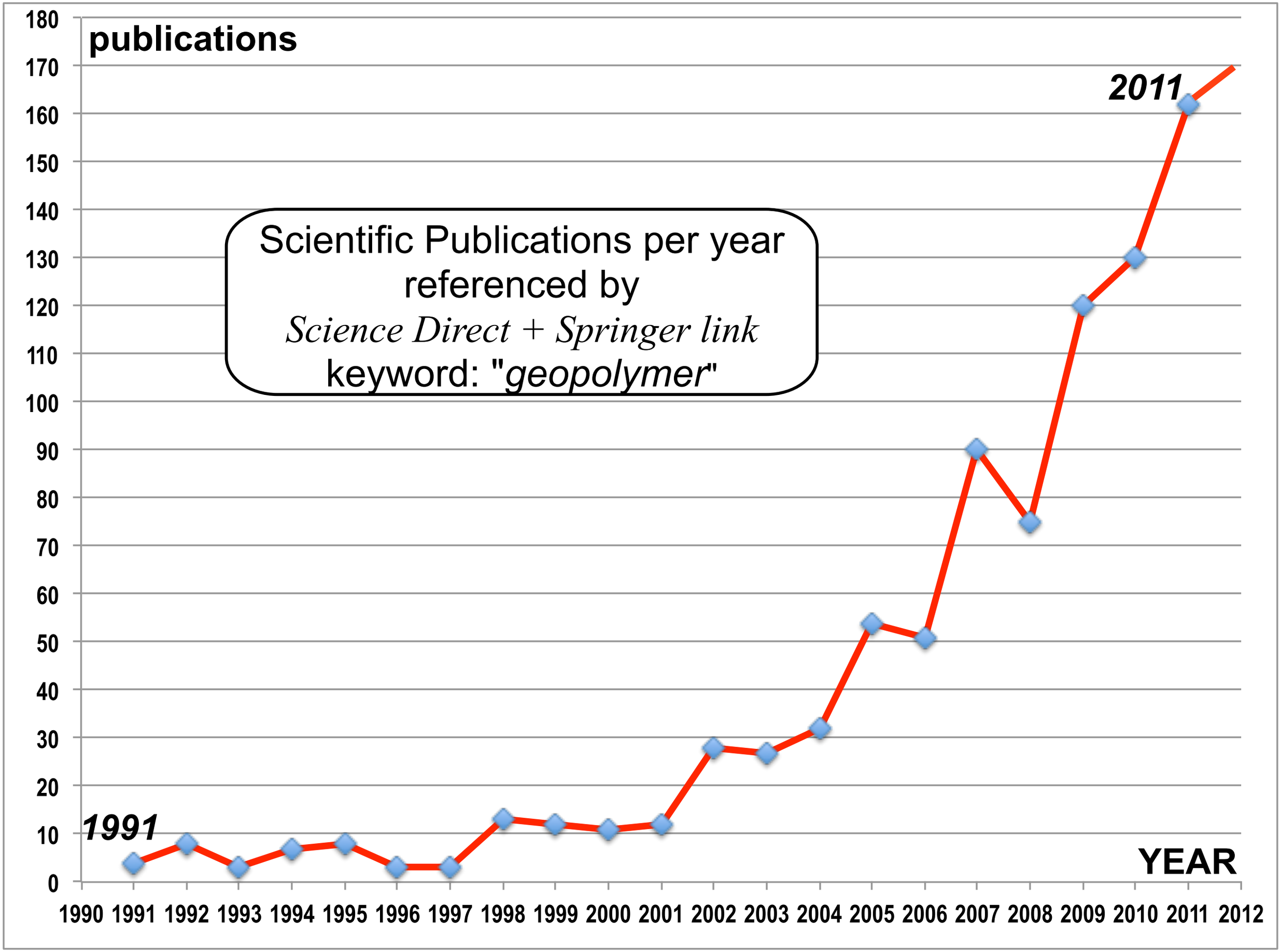
3) Geopolymer Cements / Concretes

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
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012

GEOPOLYMER INSTITUTE

Prof. Joseph Davidovits

WEBINAR 2013

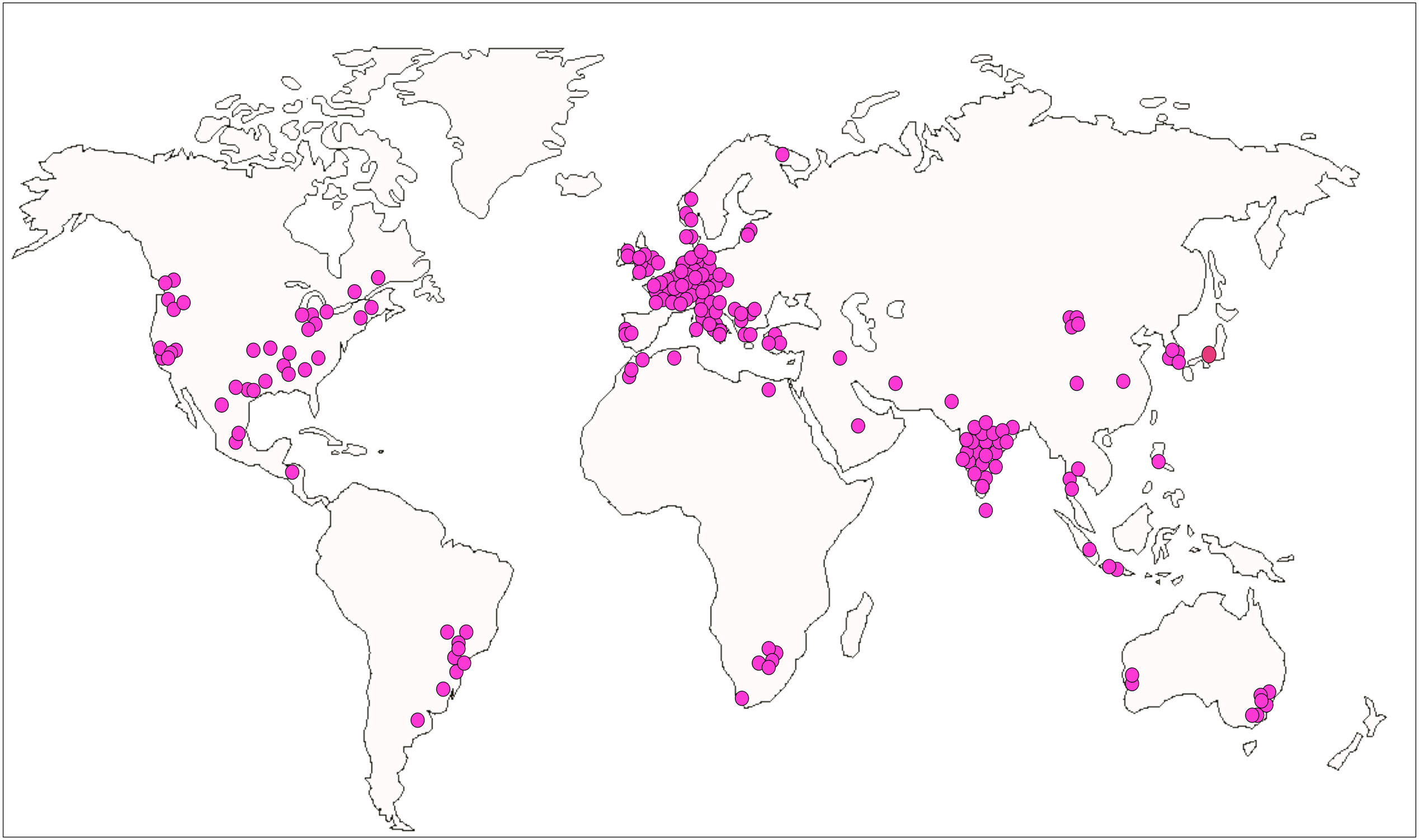
April 16-17

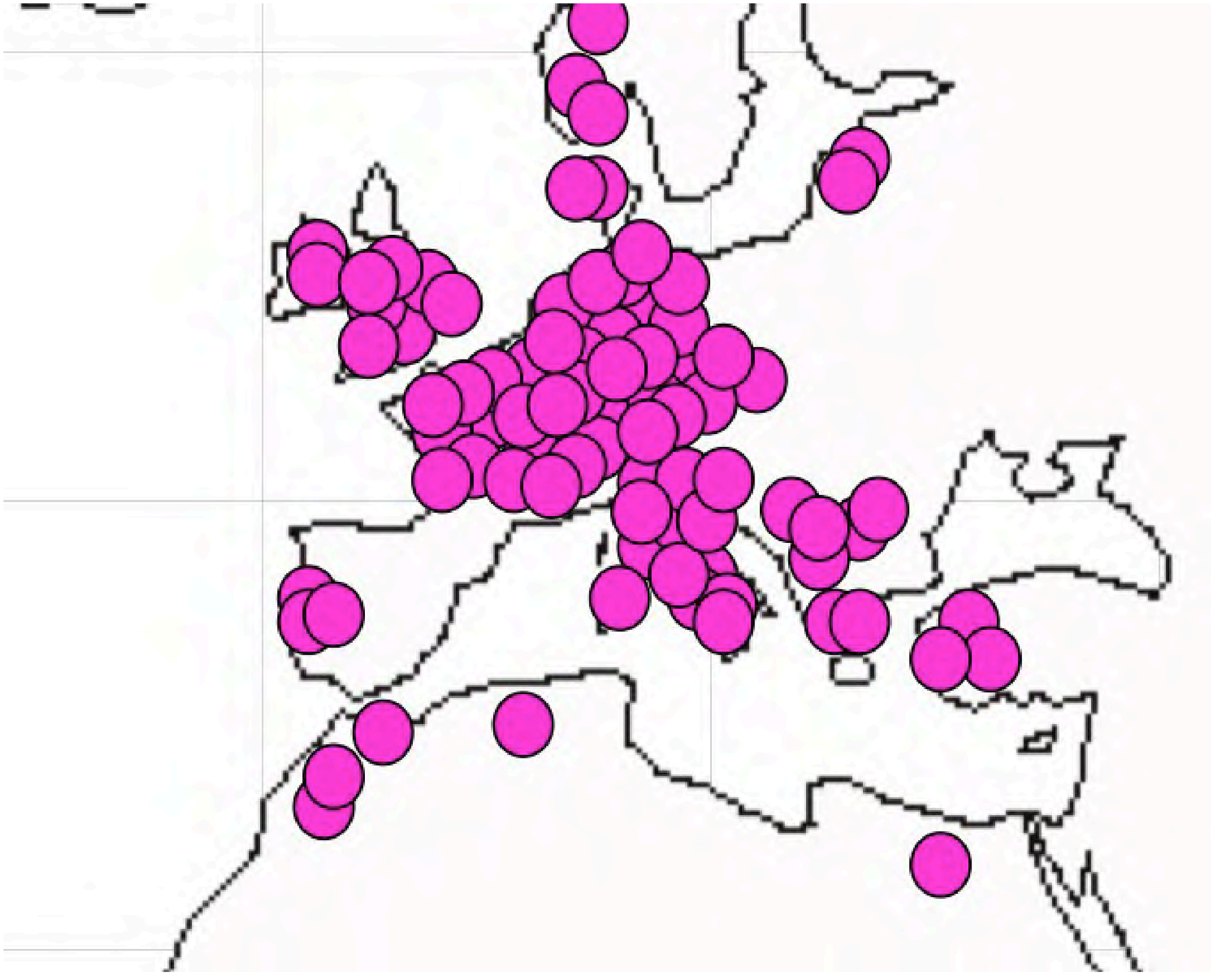
The basics of geopolymer science

Part I

Geopolymer WEBINAR 2013

Registered Participants



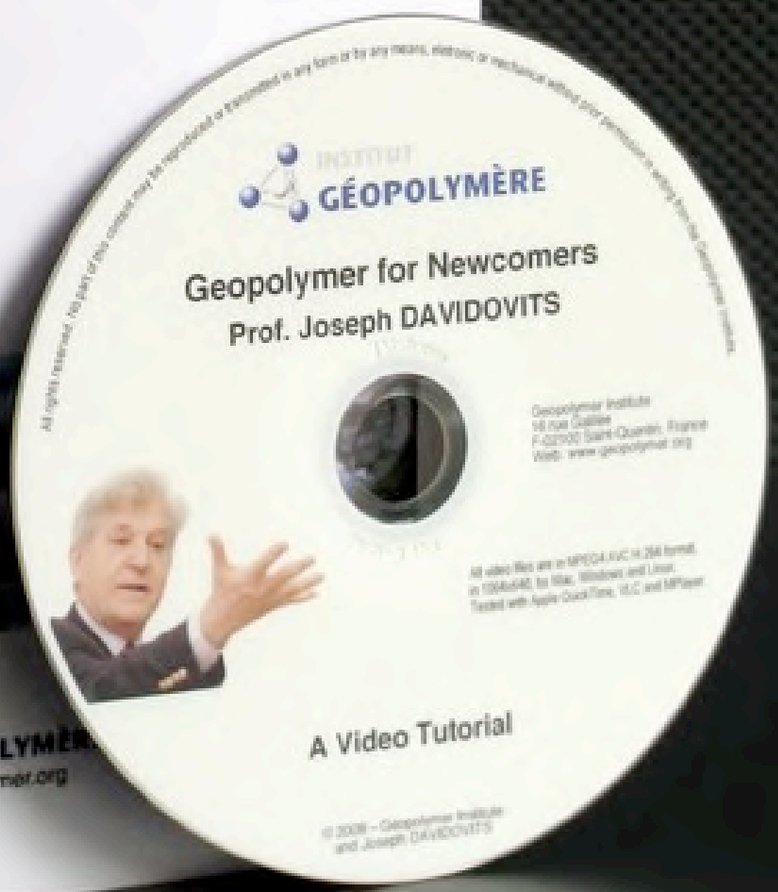


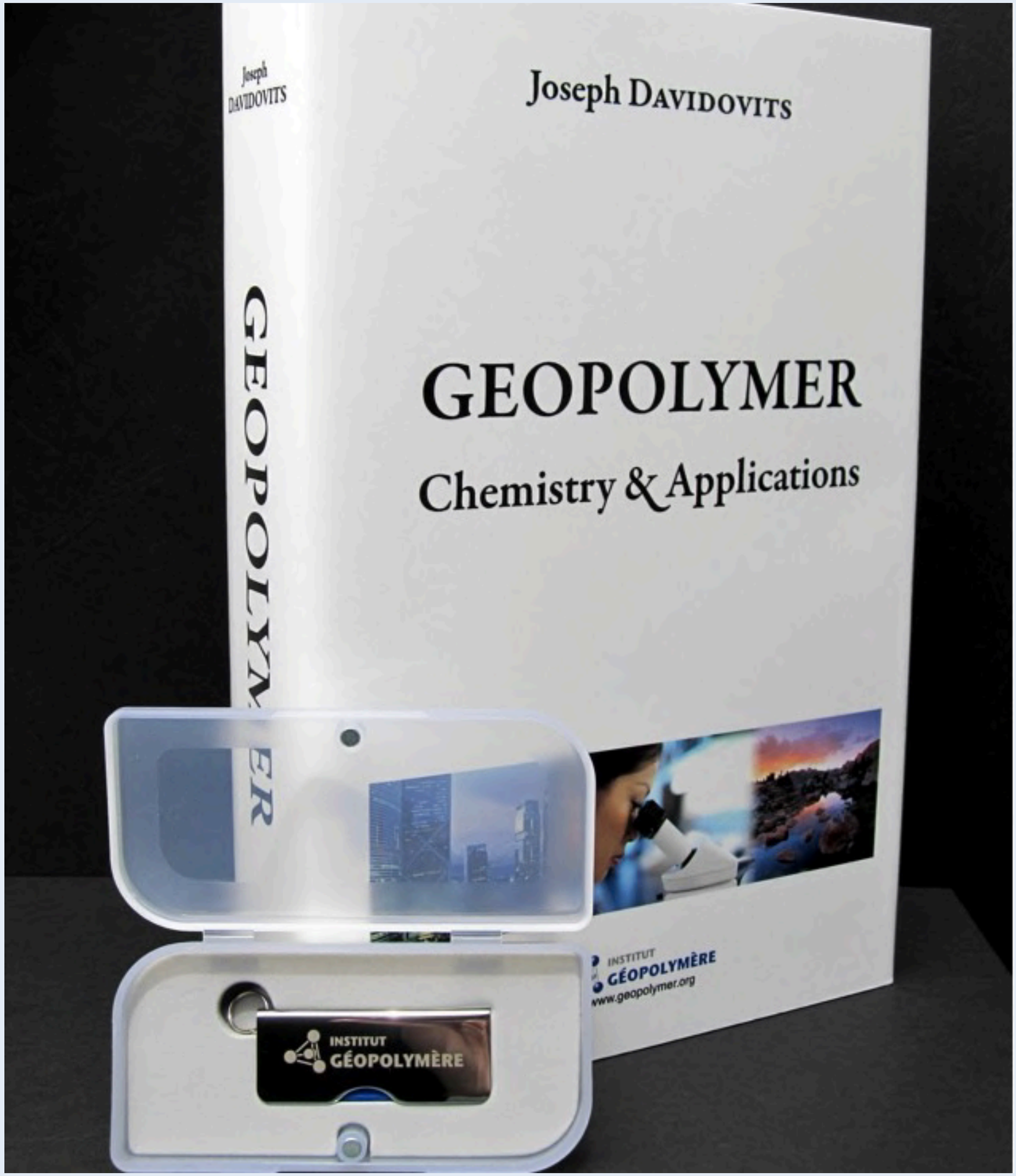
Joseph DAVIDOVITS

GEOPOLYMER

Chemistry & Applications

INSTITUT GÉOPOLYMÈRE
www.geopolymer.org




Joseph DAVIDOVITS
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SCIENCE

Innovation and further researches

Posted by: Editor on Apr 5, 2006 | No Comments

Prof. Joseph Davidovits presents the road map for the next couple of years on geopolymer science innovation and research, at the 2nd International Congress on Ceramics, Verona, Italy, July 4th, 2008.

Road map R&D presented at *2nd International Congress on Ceramics*, Verona, Italy, July 4th, 2008.

(14) 15 research topics

#1 Polymeric character of geopolymers:

geopolymer micelles or nanoparticulates / sol-gel

#2 Poly(siloxonate), soluble silicate (water-glass):

microsilica-based (silica fume, rice hulls)

#3 Metakaolin MK-750-based geopolymer:

lithomarge, synthetic MK-750

#4 Calcium-based geopolymer

15 research topics

#5 Rock-based geopolymer

Ferro-sialate (-Fe-O-Si-O-Al-O-)

#6 Silica-based geopolymer

#7 Fly ash-based geopolymer

no alkali-activated fly ash (user hostile)

#8 Phosphate-based geopolymer:

AlPO4 isomorphs

15 research topics

#9 Organic-mineral geopolymer:

phenolic, water-based latex, ethyl ester silicate

silane, epoxy

#10 Long-term durability

#11 Geopolymer-fiber composites:

high-temperature up to 1300°C

flax fiber

#12 Geopolymer in ceramic processing

high temperature ceramics (Cs, Li, Ga, Ge)

15 research topics

#13 The manufacture of geopolymer cements

new raw materials: ferro-sialate based

#14 Geopolymer concrete

#15 Material for medicinal applications

The Journal of Adhesion
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gadh20

Adhesion of Geopolymer Bonded Joints Considering Surface Treatments

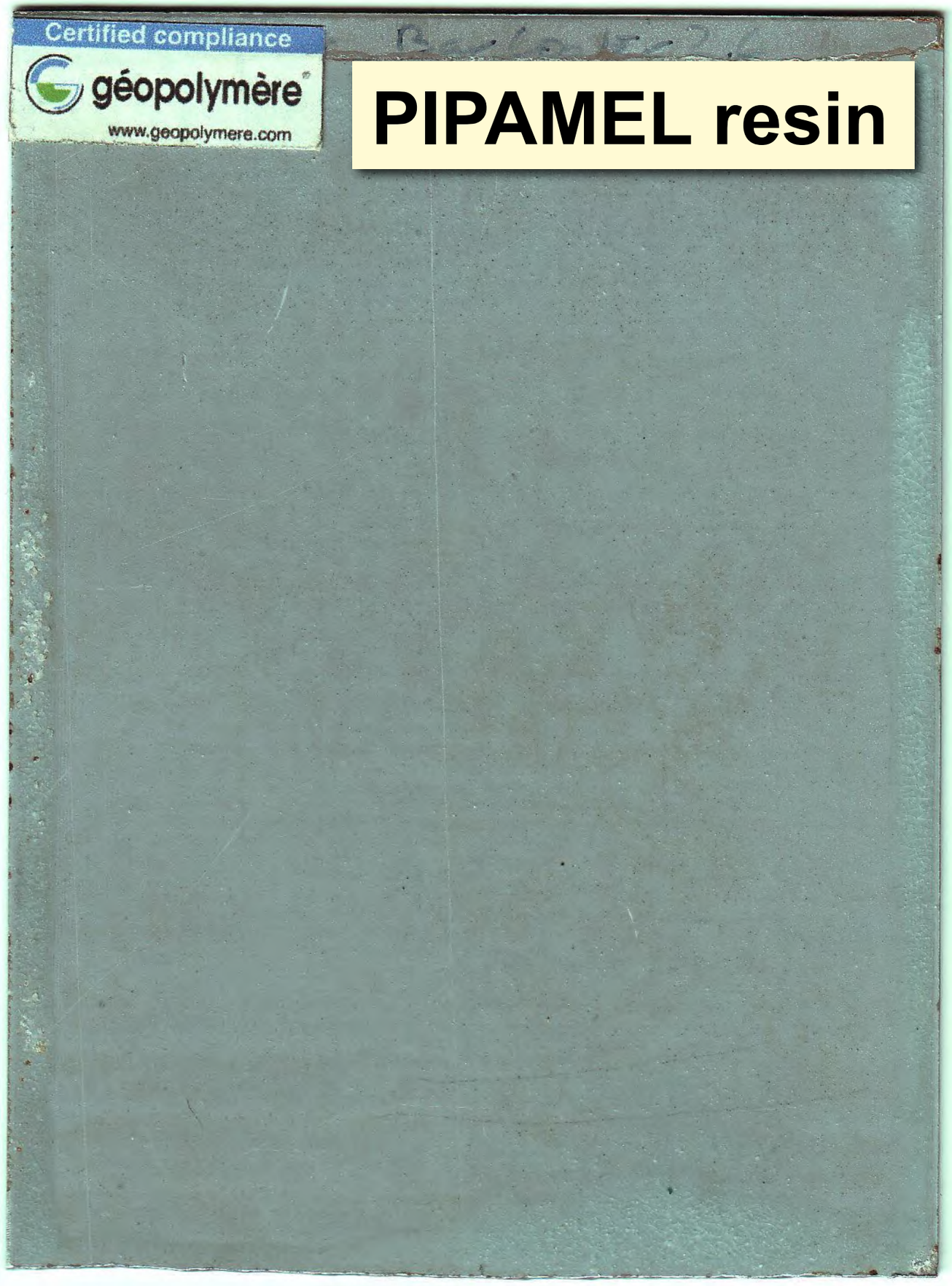
S. De Barros [a] , J. R. De Souza [b] , K. C. Gomes [b] , E. M. Sampaio [c] ,

Abstract: ...adhesion properties of a MK-750 geopolymer-based adhesive on metallic substrates: steel and aluminum ... different surface conditions: Mechanical treatments (grit-blasting and sand-blasting) and chemical treatments (nitro-phosphoric acid and silanization). .....

The results indicated that the effect of individual surface roughness parameters alone is not statistically significant when correlated with bond strength...The geopolymer adhesive developed *twice the strengths in steel* when compared with *aluminium* plates for any surface treatment type, reaching strengths up to 5 MPa.

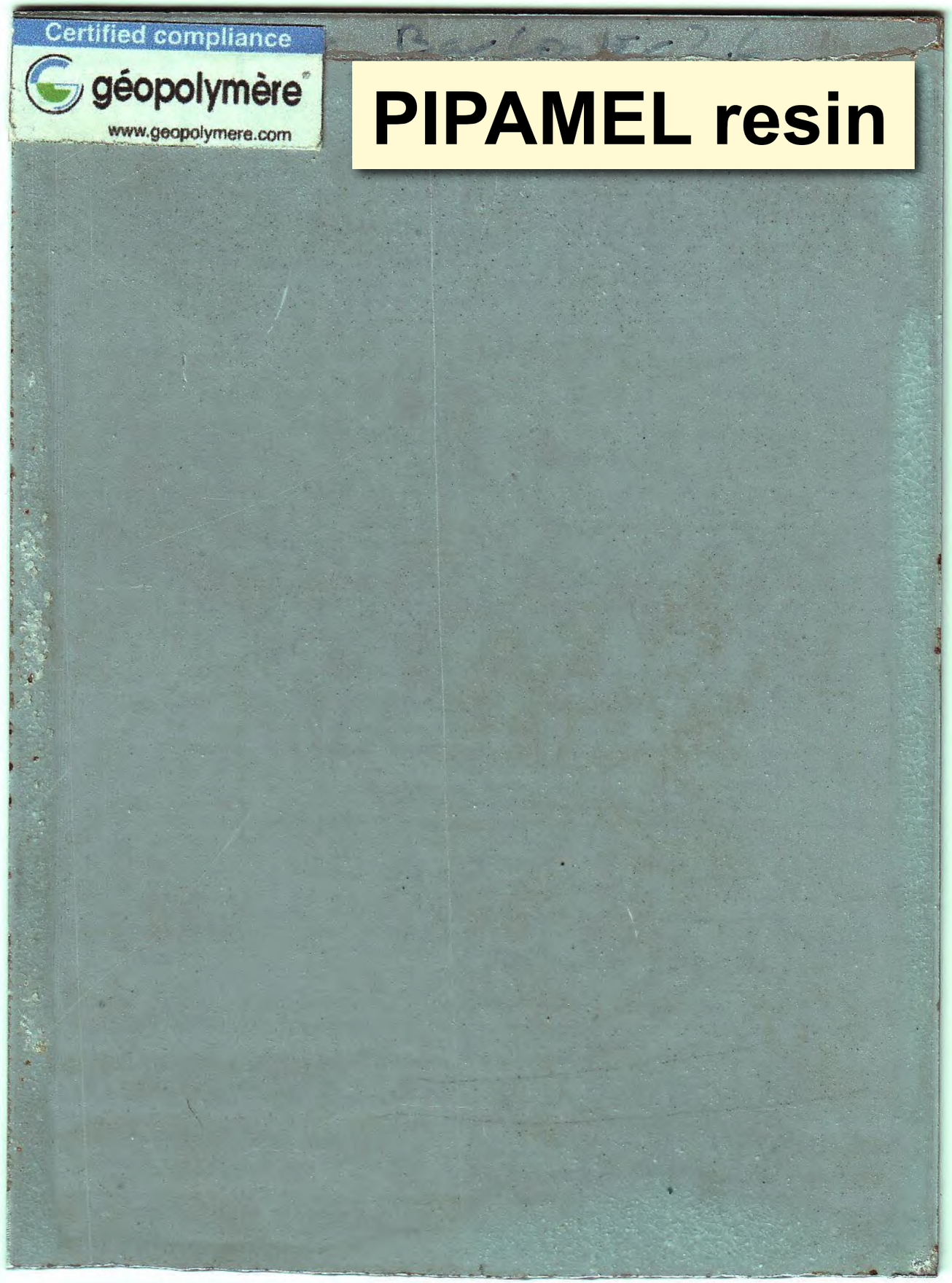
EZ/Zincor (Arcelor)

(2,5 - 7 microns Zn)



EZ/Zincor (Arcelor)
(2,5 - 7 microns Zn)

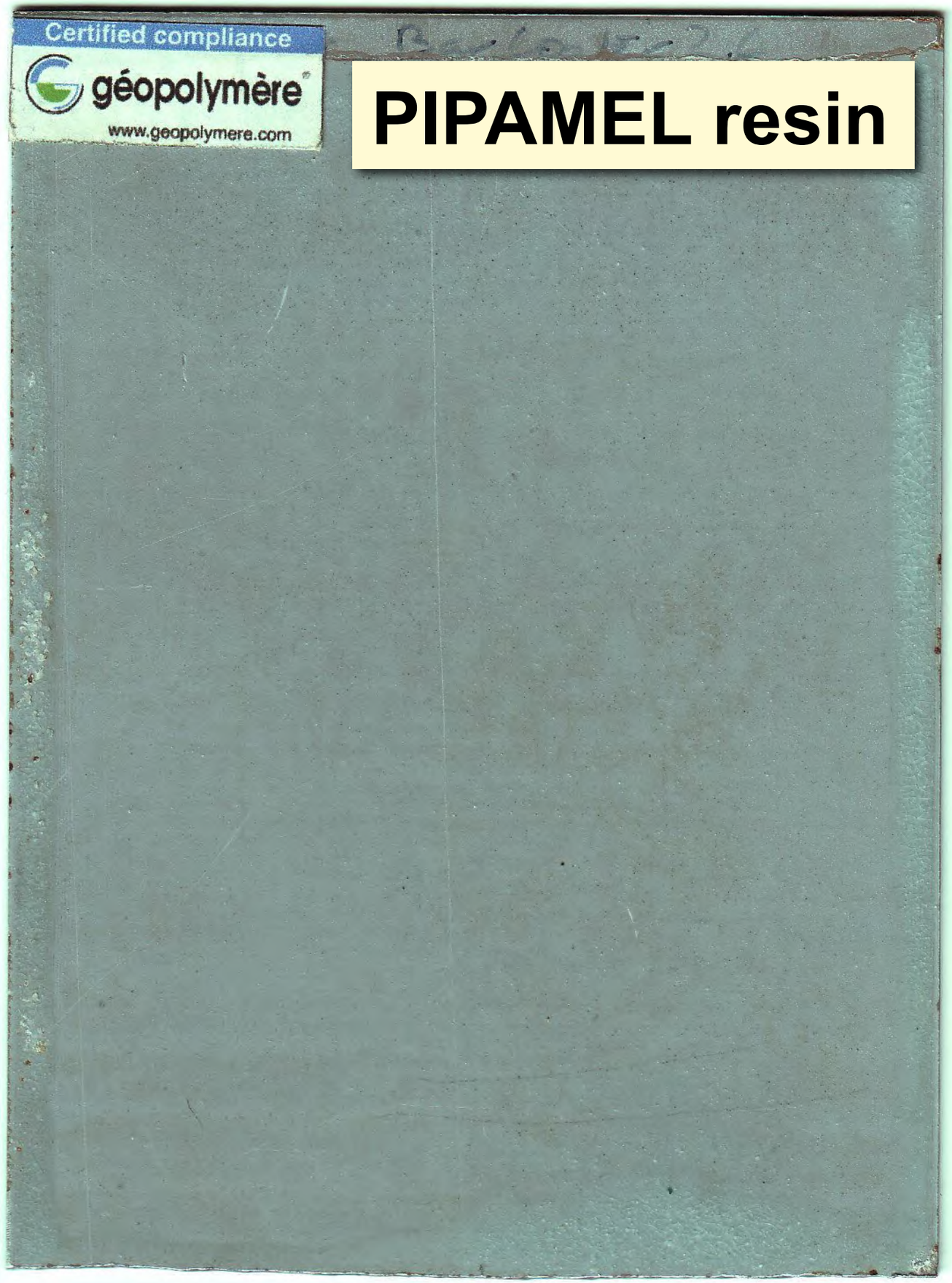
and geopolymer
PIPAMEL resin
7-20 microns



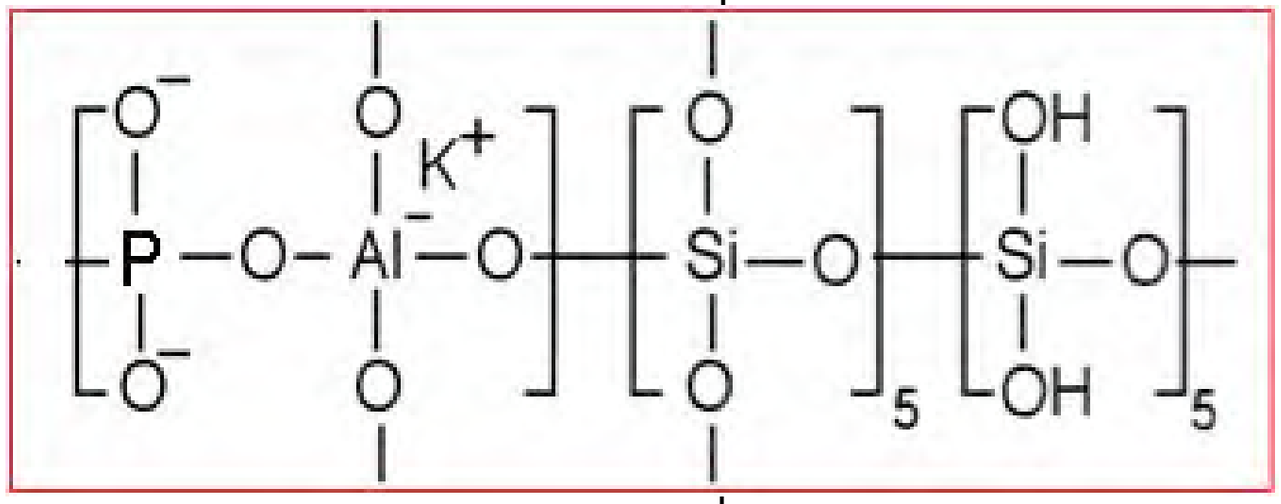
EZ/Zincor (Arcelor)
(2,5 - 7 microns Zn)

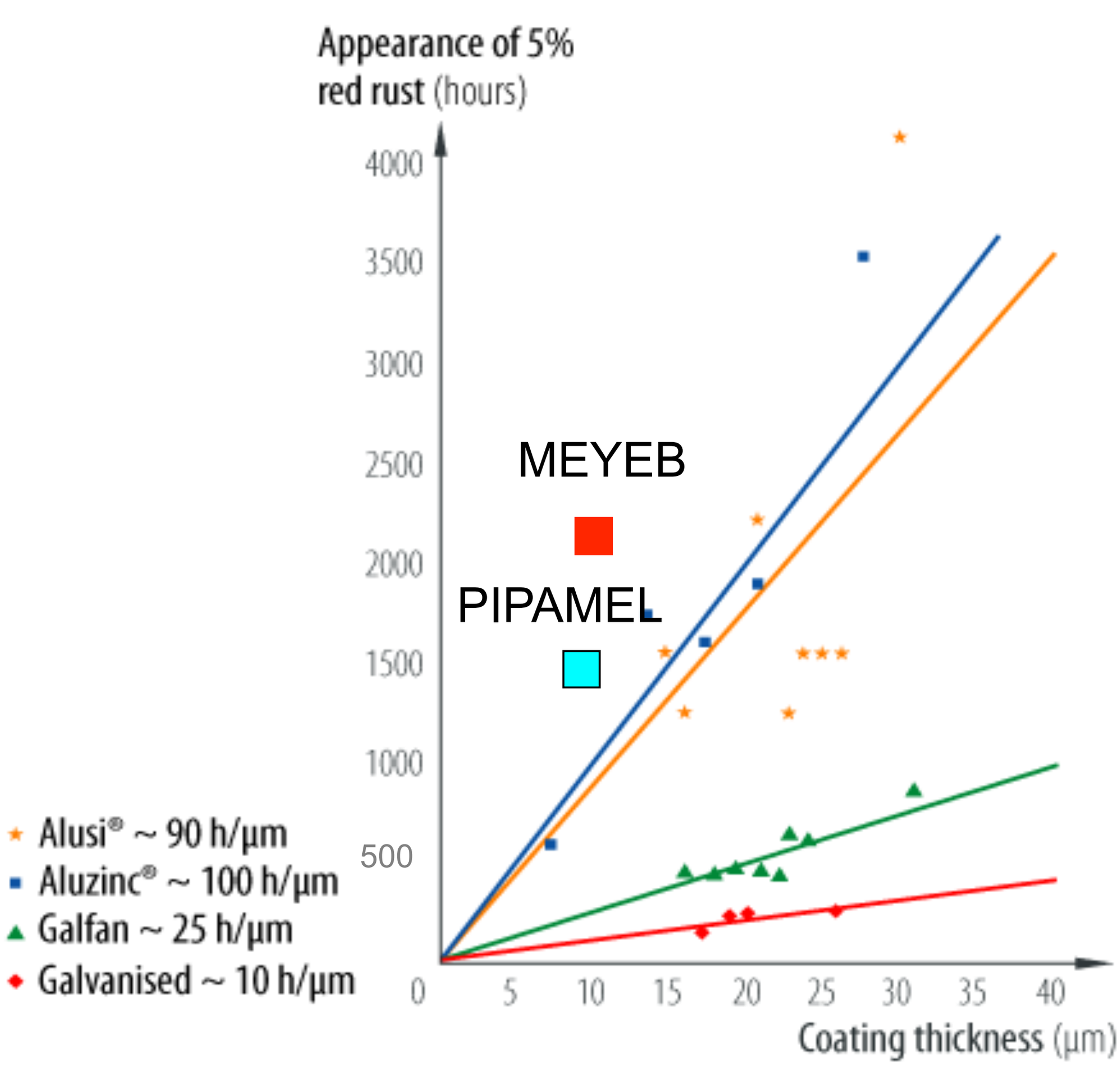
and geopolymer
PIPAMEL resin
7-20 microns

1) coating
2) dring at 85°C
3) polyconsensation
250°C



Geopolymer PIPAMEL™




Appearance of 5% red rust (hours)
4000
3500
3000
2500
2000
1500
1000
500
0
5
10
15
20
25
30
35
40
Coating thickness (µm)
MEYEB
PIPAMEL
Alusi® ~ 90 h/µm
Aluzinc® ~ 100 h/µm
Galfan ~ 25 h/µm
Galvanised ~ 10 h/µm

Materials Science Forum Vols. 727-728 (2012) pp 186-189
Online available since 2012/Aug/24 at www.scientific.net
© (2012) Trans Tech Publications, Switzerland
doi:10.4028/www.scientific.net/MSF.727-728.186

2012

Adhesion Tests in Quasicrystal Powders Reinforced Geopolymer Composites

Jaqueline Dias Altidis [1, a], Silvio de Barros[2,b], João Dellonx Régis Barboza de Souza [3,c], Sandro Marden Torres[4d] and Severino Jackson Guedes De Lima [5e]

[1]Universidade Federal da Paraíba – UFPB - João Pessoa PB CEP 58051-900.
Tel.: 55 83 32167906; fax; 55 83 32167905 – Brazil

Abstract. The composite studied here consisted of a MK-750-based geopolymer matrix reinforced with quasicrystal powders. The investigations were performed on $Al_{62.2}Cu_{25.5}Fe_{12.3}$ quasicrystal composition, the substrate consisted of *anodized aluminum*.

In this work the adhesion of composites with 5, 10 and 15% of ***quasicrystal*** powder in aluminum joints was investigated.

Materials Science Forum Vols. 727-728 **189**

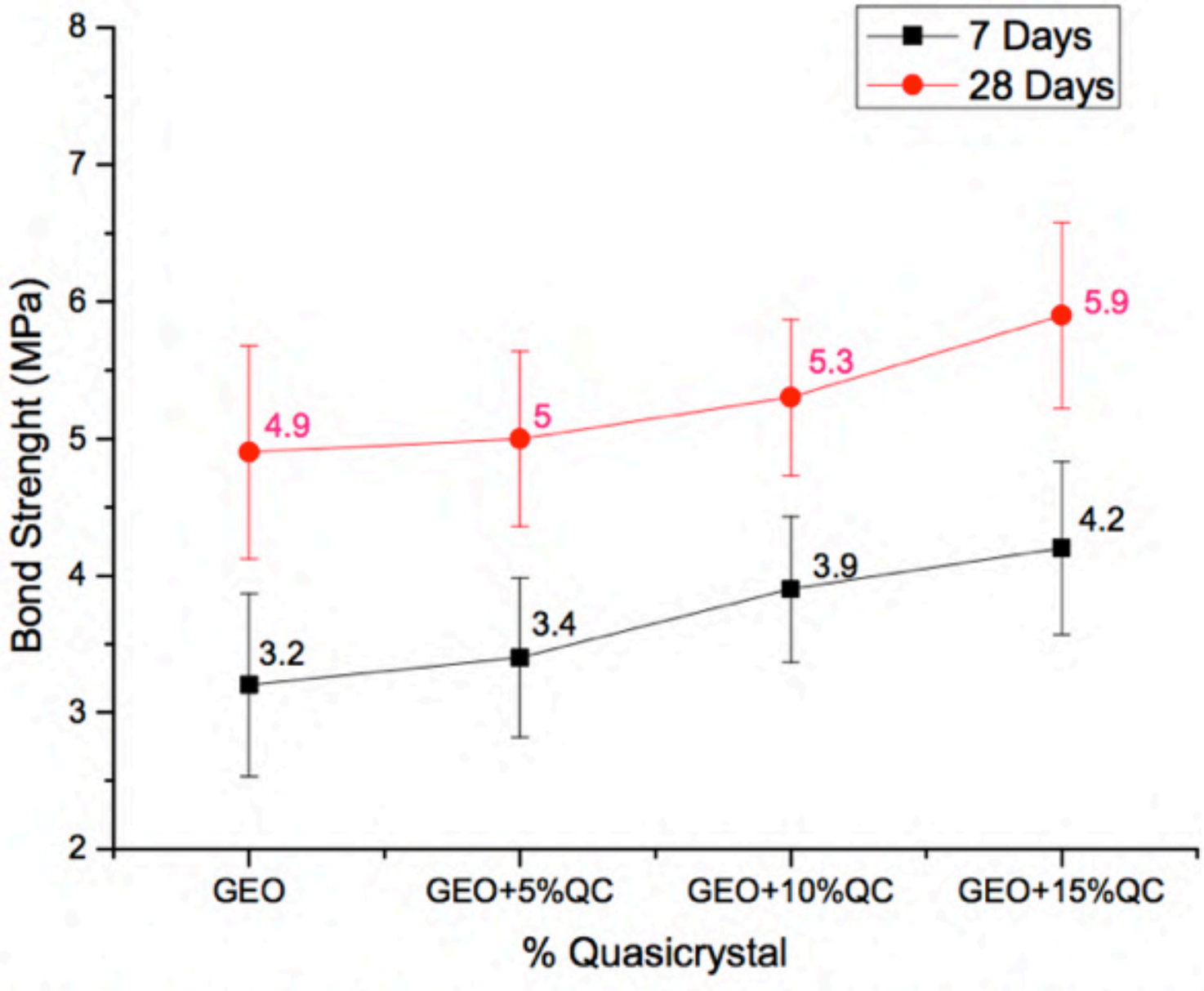


Fig. 4 Composite containing 0,5,10 and 15% QC with seven and twenty-eight days of curing

Quasicrystals are complex metal alloys with atypical structures discovered in 1982 by Daniel J. Shechtman. ...

Revenge for ridiculed scientists: 2011 Nobel Prize in Chemistry

News | Science | 24 oct 2011 |

The revenge for the ridiculed scientists.

In September 2006, my article Publish or Perish: the disease of scientific research highlighted how the 2005 Nobel Prize winners in Medicine had been forbidden for years to publish the results of their research, simply because they contradicted what was taught in the faculties world-wide, and accepted by the majority of the scientific community at that time.

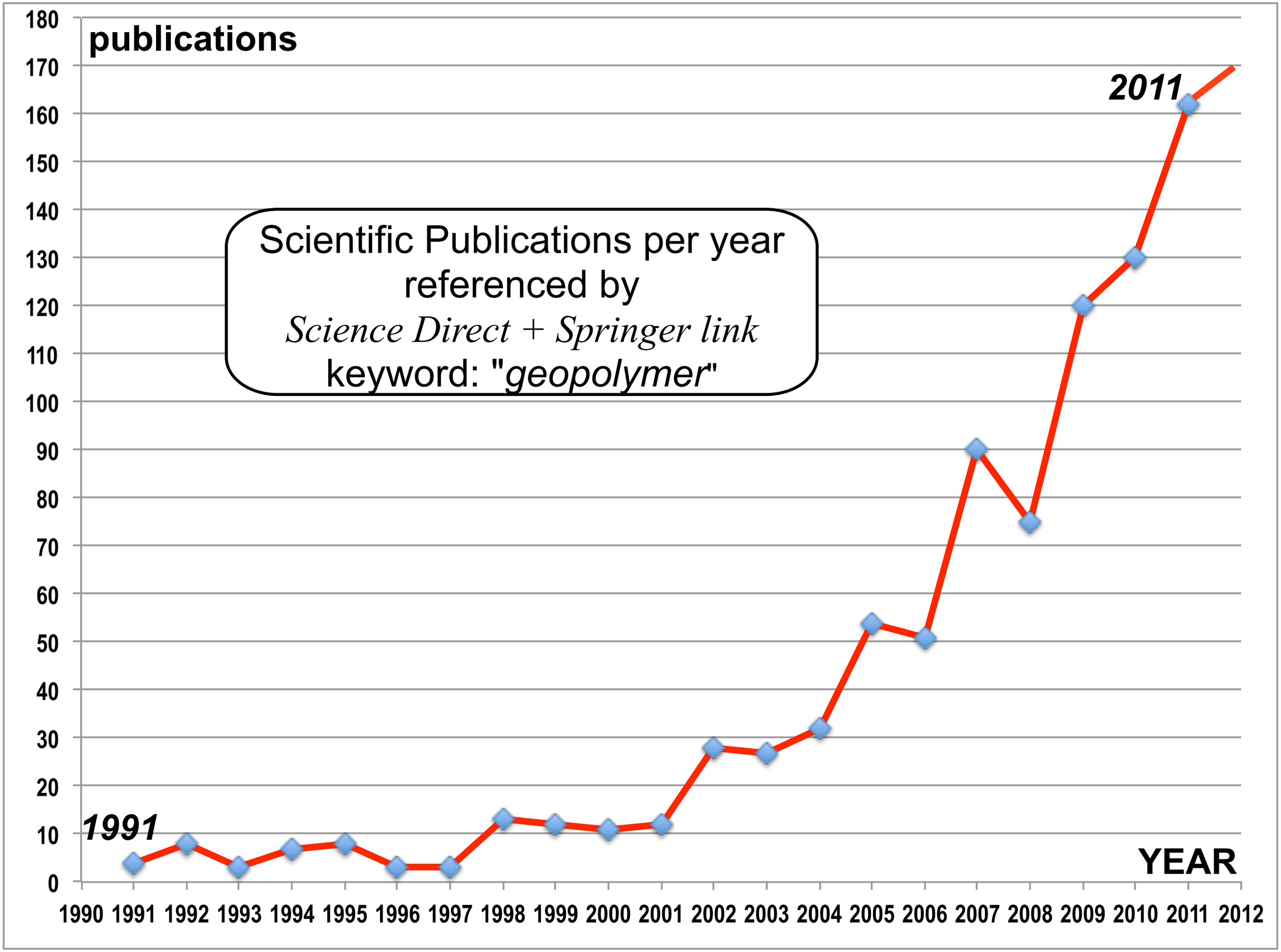
The recent 2011 Nobel Prize laureate in Chemistry, Daniel Schechtman, experienced a situation even more vexing. When in 1982, thirty years ago, he made his discovery of quasicrystals, the research institution that hosted him fired him because he « *threw discredit on the University with his false science* ».

The press release from Reuters News Agency dated of October 6, 2011 was entitled:

Ridiculed crystal work wins Nobel.

I have often quoted in my books the philosopher Schopenhauer (1788-1860): *the establishment of the truth passes through three stages: during the first it is ridiculed, in the second it is resisted, in the third it is considered as self evident.*

Daniel Schechtman has crossed the 3 steps. He was the subject of fierce resistance from one of the greatest scientists of the 20th century, Linius Pauling, Nobel Laureate in Chemistry and Peace Nobel Laureate. In 1985, he wrote: *Daniel Schechtman tells non-sence. There are no quasi-crystals, there are only quasi-scientists*!


publications
Scientific Publications per year
referenced by
Science Direct + Springer link
keyword: "geopolymer"
2011
1991
YEAR
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012

Suitability of Geopolymers for Space Applications

B.T. Cesul and S. Mall
Dept. of Aeronautics and Astronautics
Air Force Institute of Technology

Optics & Space Environment

- Optics used in the space environment
  - Hi-resolution imaging satellites
  - Astronomical telescopes
  - Laser communications and defense (SDI)
- Space environment presents unique challenges
  - Large thermal swings
  - Vacuum
  - Radiation environment

Geopolymer Advantages

- Can be adhesive or cast (looking at both applications)
- Low curing temperature
  - Most space qualified adhesives are high temp. cured epoxies
- Low initial Coefficient of Thermal Expansion (CTE)

Material	*CTE Value (ppm/deg C)*
Amicon D125 F3 low T curing epoxy	70-80
Silica filled amine-cured epoxy	55
Loctite 3610	45
Uralane 7760	29
Cyanate Ester	21
Silver glass paste	16
Ablebond 84-1 space adhesive	55
AFRL/RX geopolymer (as tested)	8-15

AFRL/RX geopolymer (as tested) 8-15

Space Qualification Process

- Any new material to be used in space must go through a rigorous test regimen
  - ***Outgassing***
  - Thermal cycling
  - Radiation exposure (UV, high energy particle)
  - Chemical interactions (atomic oxygen, etc)
- Additionally, processes need to be defined
  - ***Curing shrinkage***
  - Thermal tailoring

Applicability to Small Sats

- Optical designs
  - Low CTE telescope structures at reduced mass
  - Low mass mirrors
- Space qualified adhesive with limited UV aging effects
- Lightweight structures in castable forms?

Way Ahead

- Tests planned for
  - UV exposure
  - Thermal cycling of bulk material and representative applications
  - Atomic oxygen and radiation exposure at AFRL SPECTER facility
- Results to be presented at IAC in Glasgow, other conferences, journals, and thesis
- Geopolymers will get real life test in MISSE-7

AFRL SPECTER Facility

Materials International Space Station Experiment-7 (MISSE-7)

Composites: Part A 52 (2013) 99–105

Contents lists available at SciVerse ScienceDirect

Composites: Part A 2013

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

The development of a high temperature tensile testing rig for composite laminates ☆

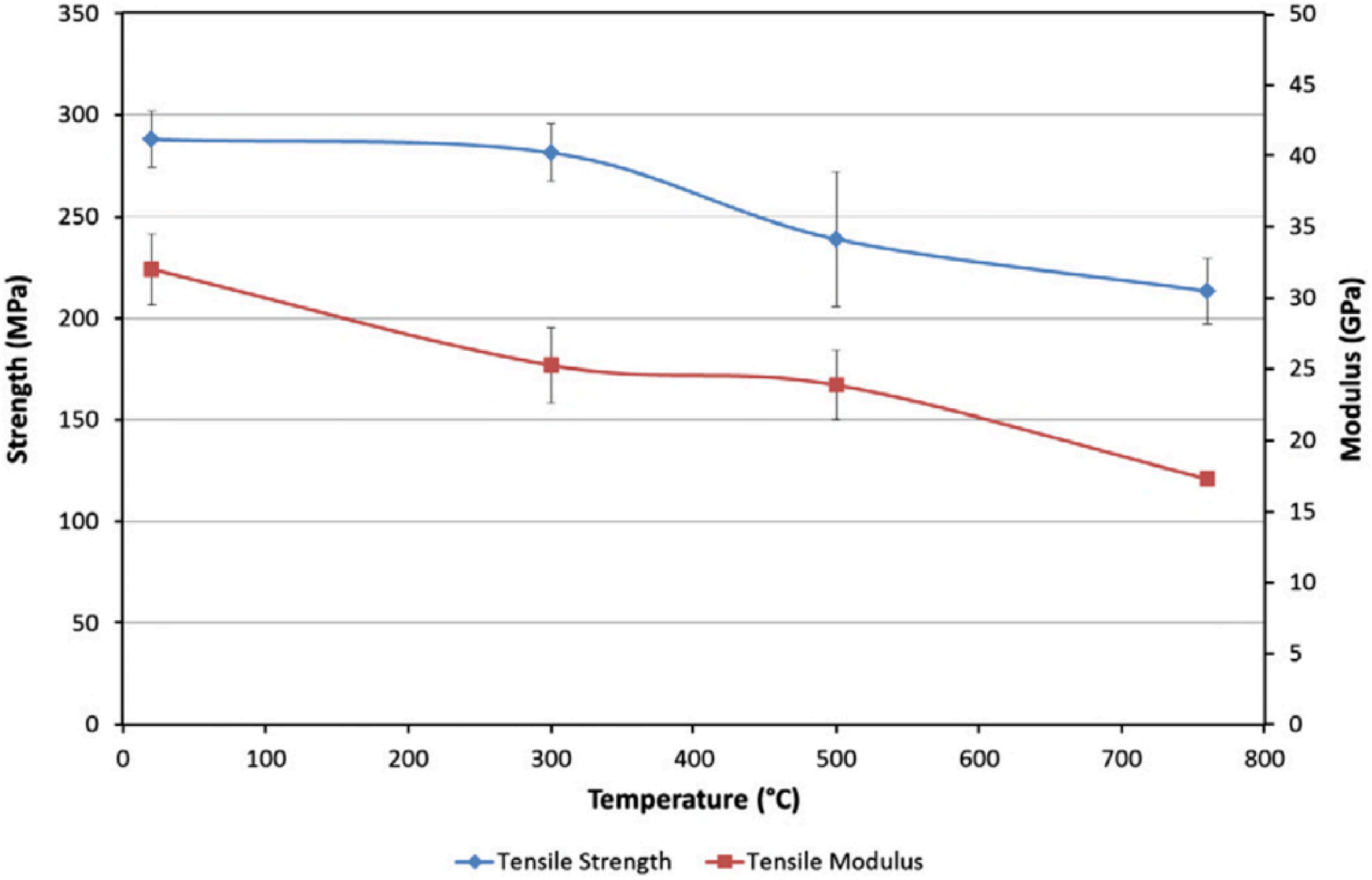
Joseph Mills-Brown [a,*], Kevin Potter [a], Steve Foster [b], Tom Batho [b]

[a] Advanced Composites Centre for Innovation and Science (ACCIS), University of Bristol, Queen's Building, Bristol BS8 1TR, United Kingdom
[b] McLaren Racing Limited, McLaren Technology Centre, Chertsey Road, Woking, Surrey GU21 4YH, United Kingdom

This study aimed to develop a high temperature tensile test capable of testing fibre reinforced composites up to 1000 °C, ..

Typically, traditional engineering ceramic matrix composites (CMCs) would be envisioned for these applications, however, one material which has shown potential for application in high temperature structures is *geopolymer-polysialate-SiC* composite.

*Polysialate*s are ceramics derived from inorganic polymers and processed through a polymerisation chemical activation, rather than the extreme temperature processing synonymous with traditional engineering ceramics. This gives them a number of advantages over typical CMC materials such as low production times, environmental friendliness and low density


350
300
250
200
150
100
50
0
Strength (MPa)
50
45
40
35
30
25
20
15
10
5
0
Modulus (GPa)
0
100
200
300
400
500
600
700
800
Temperature (°C)
Tensile Strength
Tensile Modulus

J. Am. Ceram. Soc. 2012

journal

J. Am. Ceram. Soc., 1–5 (2012)
DOI: 10.1111/j.1551-2916.2012.05433.x
© 2012 The American Ceramic Society

Polymer Adhesion to Geopolymer via Silane Coupling Agent Additives

Brayden E. Glad,[‡] Chan Han,[§] and Waltraud M. Kriven[‡,†,**]

[‡]Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801

[§]The Dow Chemical Company, Core R&D-Inorganic Materials and Heterogeneous Catalysis, Midland, Michigan 48674

This document details the successful synthesis of organic-functionalized GP through the addition of functionalized trialkoxysilanes directly into the GP matrix during the curing process.....The silane coupling agents PAMS, methacryloxypropyltrimethoxysilane ... were used as received and *added dropwise by mass* directly to the metakaolin immediately prior to the addition of sodium silicate solution ...to form a slurry, and applied to substrates:

High-impact polystyrene sheet and polystyrene foam (Styrofoam Ag board, bulk density = 0.03 g/cm^3) were used as substrates.

journal

2012

J. Am. Ceram. Soc., 1–5 (2012)
DOI: 10.1111/j.1551-2916.2012.05433.x
© 2012 The American Ceramic Society

Polymer Adhesion to Geopolymer via Silane Coupling Agent Additives

Brayden E. Glad,[‡] Chan Han,[§] and Waltraud M. Kriven[‡,†,**]

2 interesting point of views:

- terminology GP-Chemist
  - statement on organo-mineral geopolymer hybrids

GP-Chemist terminology:

$Na_2O:Al_2O_3:SiO_2:H_2O$ with a molar ratio of 1:1:4:11

The quantity of methacryloxypropyltrimethoxysilane added was:

0.072 mole/mole GP.

- $C_{10}H_{20}O_5Si$ molecular weight: 248.3
- GP: Na-PSS type: dehydrated molecular weight 428.

addition of silane: 0,072x248=17,9 / 428 = 4,1 % by weight

General statement on organo-mineral geopolymer hydrids

« Despite the potential value of this line of investigation, little or no study of how GP interacts with organic materials in general, and coupling agents in particular, has been undertaken.

This document concentrates on the adhesive properties, with the rationale that covalent or other strong bonding of the sizing agent into the growing matrix is necessary to ***prevent phase separation*** of organic and mineral materials.»

Contents lists available at SciVerse ScienceDirect

Applied Clay Science 2012

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

Research paper

Novel hybrid organic-geopolymer materials

Claudio Ferone [a], Giuseppina Roviello [a,*], Francesco Colangelo [a], Raffaele Cioffi [a], Oreste Tarallo [b]

[a] Dipartimento per le Tecnologie, Facoltà di Ingegneria, Università di Napoli 'Parthenope', INSTM Research Group Napoli Parthenope, Centro Direzionale Napoli, Isola C4, 80143 Napoli, Italy
[b] Dipartimento di Scienze Chimiche, Università degli Studi di Napoli "Federico II", Complesso Universitario di Monte S. Angelo, via Cintia, 80126 Napoli, Italy

Abstract: Novel hybrid organic–inorganic materials were prepared through an innovative synthetic approach based on a co-reticulation in mild conditions of epoxy based organic resins and an MK-based geopolymer inorganic matrix.

A high compatibility between the organic and inorganic phases, even at appreciable concentration of resin, was realized up to micrometric level. .....

These new materials present significantly enhanced compressive strengths and toughness .....

New synthetic approach:

- based on the incorporation of the resin to the geopolymeric matrix suspension when both polymerization reactions are not yet completed.

- good compatibility between the organic and the aqueous inorganic phases is obtained thanks to the *numerous hydroxyl tails* formed during the epoxy ring opening reaction that make the organic phase "*temporarily hydrophilic*" increasing the compatibility with the aqueous inorganic phase.

condensation

Section 8.5.1 GP-Book

Na-poly(sialate)
Nepheline framework

epoxy group

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

Contents lists available at SciVerse ScienceDirect

Applied Clay Science

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

Research paper

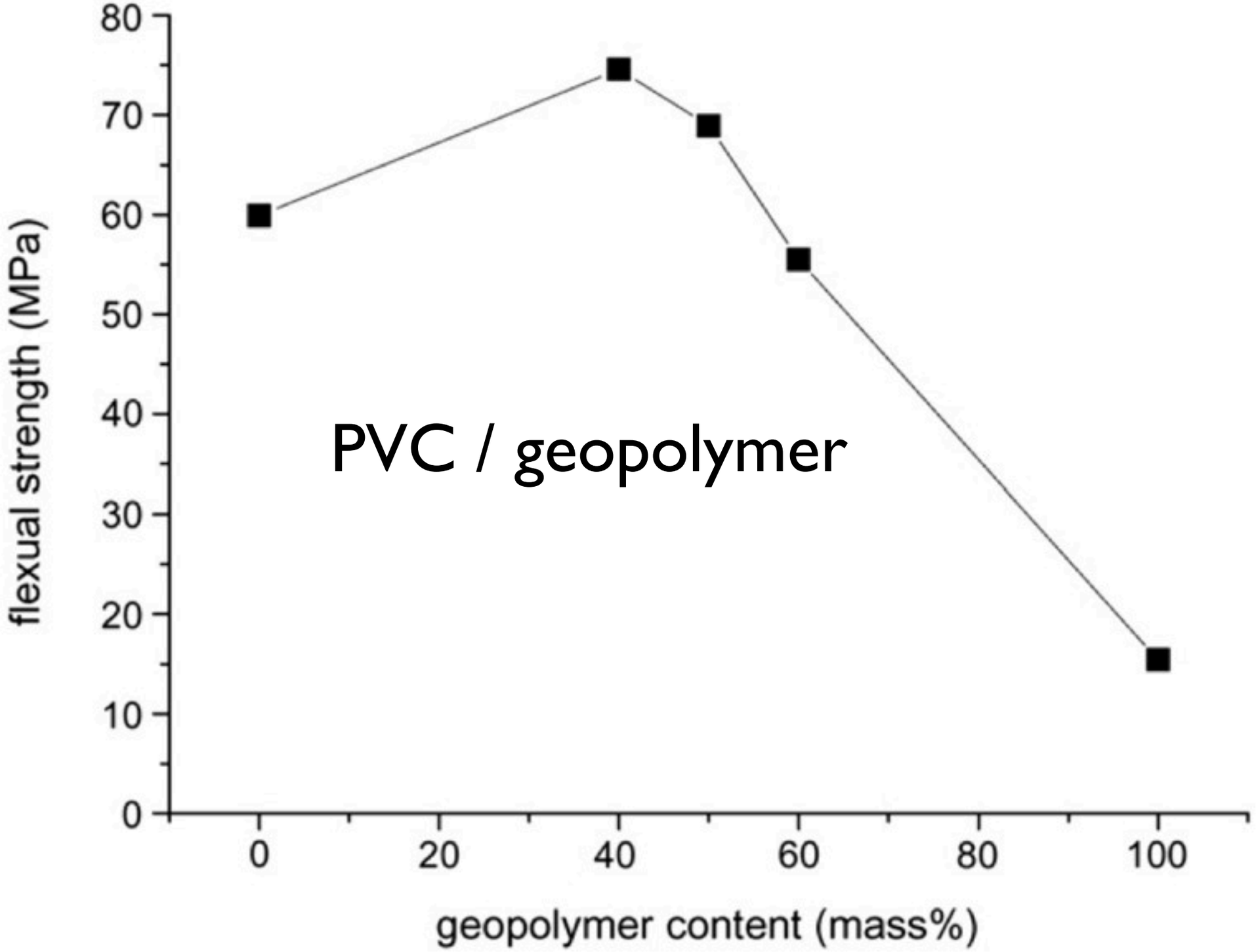
Hot-pressure forming process of PVC/geopolymer composite materials

Song Xiao-ling, Cui Xue-min *, Lin Kun-sheng, Zheng Guang-jian, He Yan

School of Chemistry and Chemical Engineering, Guangxi Key Lab of Petrochemical Resource Processing and Process Intensification Technology, Guangxi University, Nanning, 530004, PR China

After the pure MK-750-based geopolymer paste was prepared, PVC powder was mixed and stirred for approximately 10 min and then refined on a double-roller refining mud machine. After being repeatedly rolled at 140 °C–170 °C for 5 min, thin 1-mm-thick sheets were formed.

Subsequently, the sheets were laminated, stacked in a steel die and hot-pressed at approximately 170 °C and 10 MPa for 5 min on a plate vulcanization machine.



PVC price is higher than geopolymer materials....substituing some PVC resin with geopolymer, one gets higher temperature characteristics and lower fabrication costs.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 June 2011 (23.06.2011)

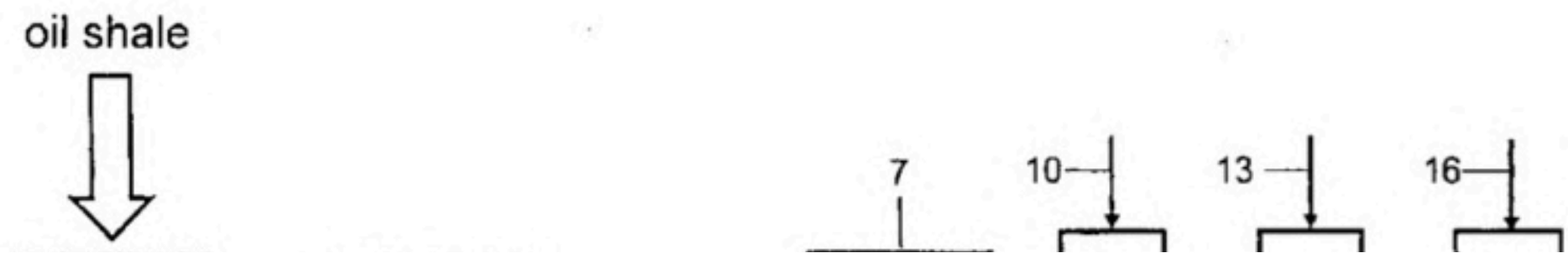
PCT

(10) International Publication Number
WO 2011/072777 A1

(71) Applicant *(for all designated States except US)*: **OUTOTEC OYJ** [FI/FI]; Riihitontuntie 7, FI-02200 Espoo (FI).

ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (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, SE, SI, SK,

(54) Title: PROCESS FOR PRODUCING GEOPOLYMERS



(57) Abstract: The present invention relates to the production of geopolymers from oil shale and / or mineral residues, which originate from the production of oil by means of oil shale. To use the residues left in the combustion of oil shale...they are subsequently ground, before they are mixed with an alkaline activator and water and cured.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY
(PCT Rule 43*bis*.1)

Box
indu

inventive step or

1. State

Nove

Inver

Indus

1. Statement

Novelty (N) Yes: Claims 7
No: Claims 1-6, 8-10

Inventive step (IS) Yes: Claims
No: Claims 1-10

Industrial applicability (IA)
Yes: Claims 1-10
No: Claims

The application does not meet the requirements of Article 6 PCT and Article 5 PCT.

1) The term "geopolymer" used in independent claims 1 and 10 has no well- defined, internationally accepted meaning in the prior art. As demonstrated by documents D1 and D2 the term "*geopolymer*" "*...lacks a uniform nomenclature*" (see D1, chapter 3: "Technical challenge").

Moreover, D2 gives evidence that terminological and technical transitions exist between "geopolymers" sensu strictu as defined by DAVIDOVITS ("having a... 27 Al NMR spectra having a peak at about 55ppm..." and "...obtained from the alkaline activation of metakaolin...") and "alkali-activated alumosilicate binders" (see D2; chapter: "Hence, what is a geopolymer?"; page 175).

Geopolymer

=

Geopolymer Concrete

=

Alkali-activated Fly ash

What is a geopolymer ?

not alkali-activated compound

no AAMK

no AAFA

no AAS

no AAxxxx

Geopolymerization

in alkaline or acidic medium

Geopolymer binder / resin

paint / coating / grout

Geopolymer cement

Geopolymer concrete

Geopolymer carbon/composite

etc...

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)

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

-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)

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

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

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

(19) Organisation Mondiale de la Propriété Intellectuelle
Bureau international

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

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

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

PATENT COOPERATION TREATY

TRANSLATION

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/FR2011/000576

Box No. V	Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-8	**Yes**
	Claims		NO
Inventive step (IS)	Claims	1-8	**Yes**
	Claims		NO
Industrial applicability (IA)	Claims	1-8	**Yes**
	Claims		NO

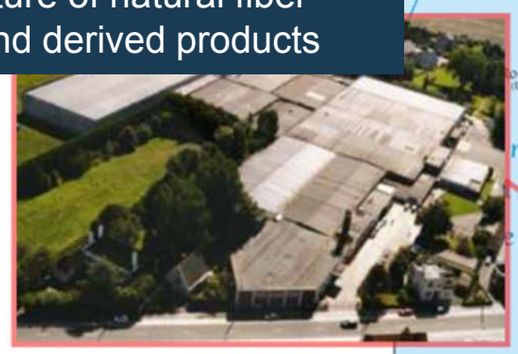
European R&D project :CAYLEY? 2012-2013

industrial implementation new flat panels from *renewable polymers* and *natural fibre* reinforcements for the aeronautical industry:

CAYLEY

Project Consortium

Manufacture of natural fiber fabrics and derived products



LINEO
Meulebeke
Belgium

R&D in materials for the aeronautical sector

BOEING
Research &
Technologie Europe
Madrid
Spain

Production of composite parts for the transport industry

INVENT
Braunschweig
Germany

R&D in thermoplastics and composites.

AIMPLAS
Valencia
Spain

Fire-resistant panels for aircraf interior: Flax fiber + geopolymer resin

BOEING R & TE
Madrid
Spain

- **Provision of technical requirements and specifications**
- **Development of panels based on geopolymers**
- **Evaluation of eco-indicators**

BOEING

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

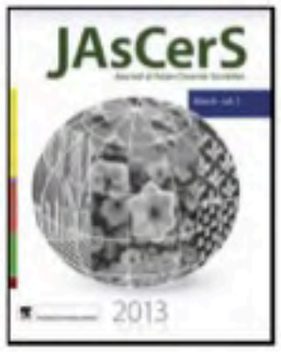
3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

Journal of Asian Ceramic Societies

Journal of Asian Ceramic Societies 2013

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



Synthesis and characterization of mechanical properties in cotton fiber-reinforced geopolymer composites (cement/mortar)

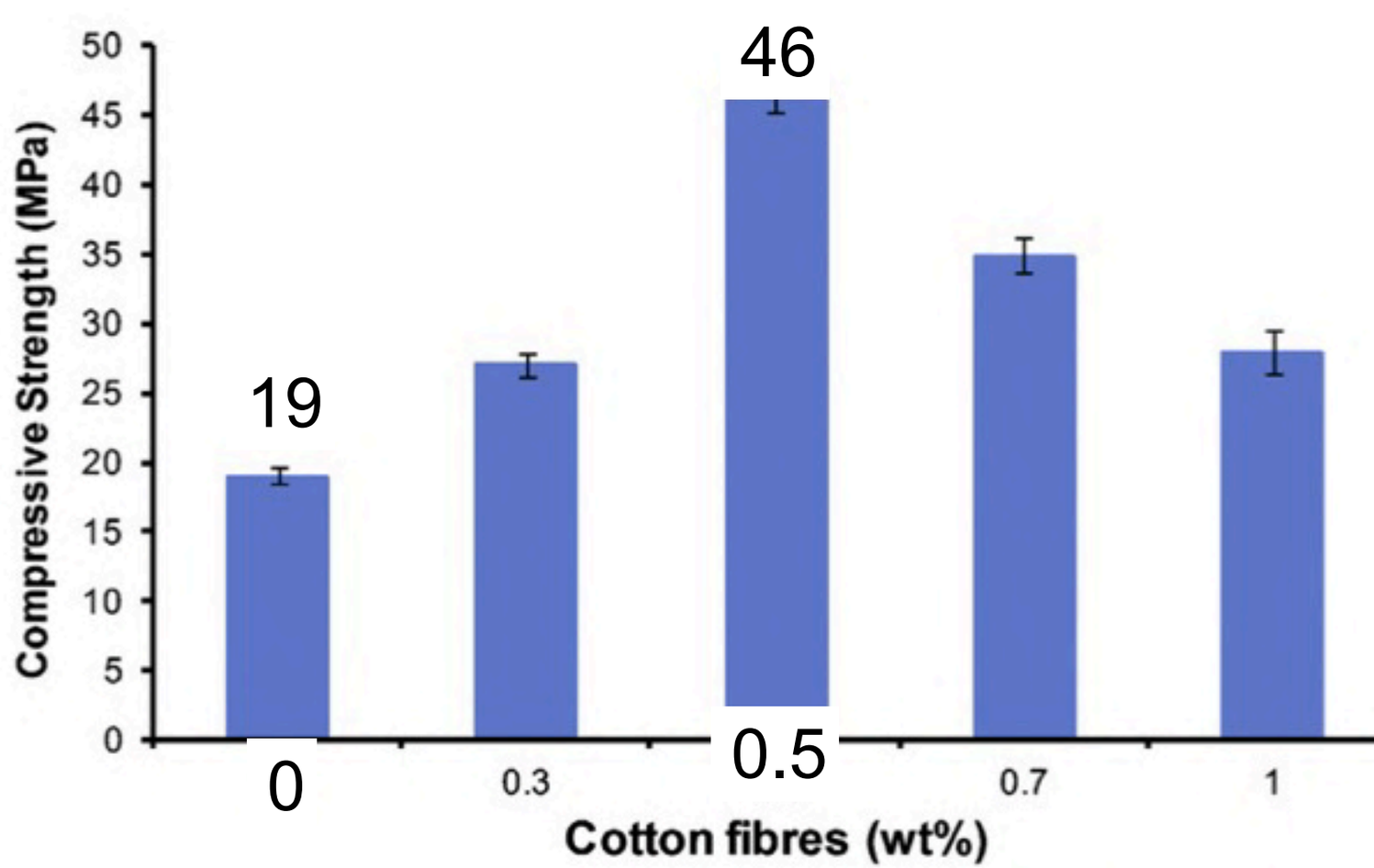
T. Alomayri, I.M. Low*

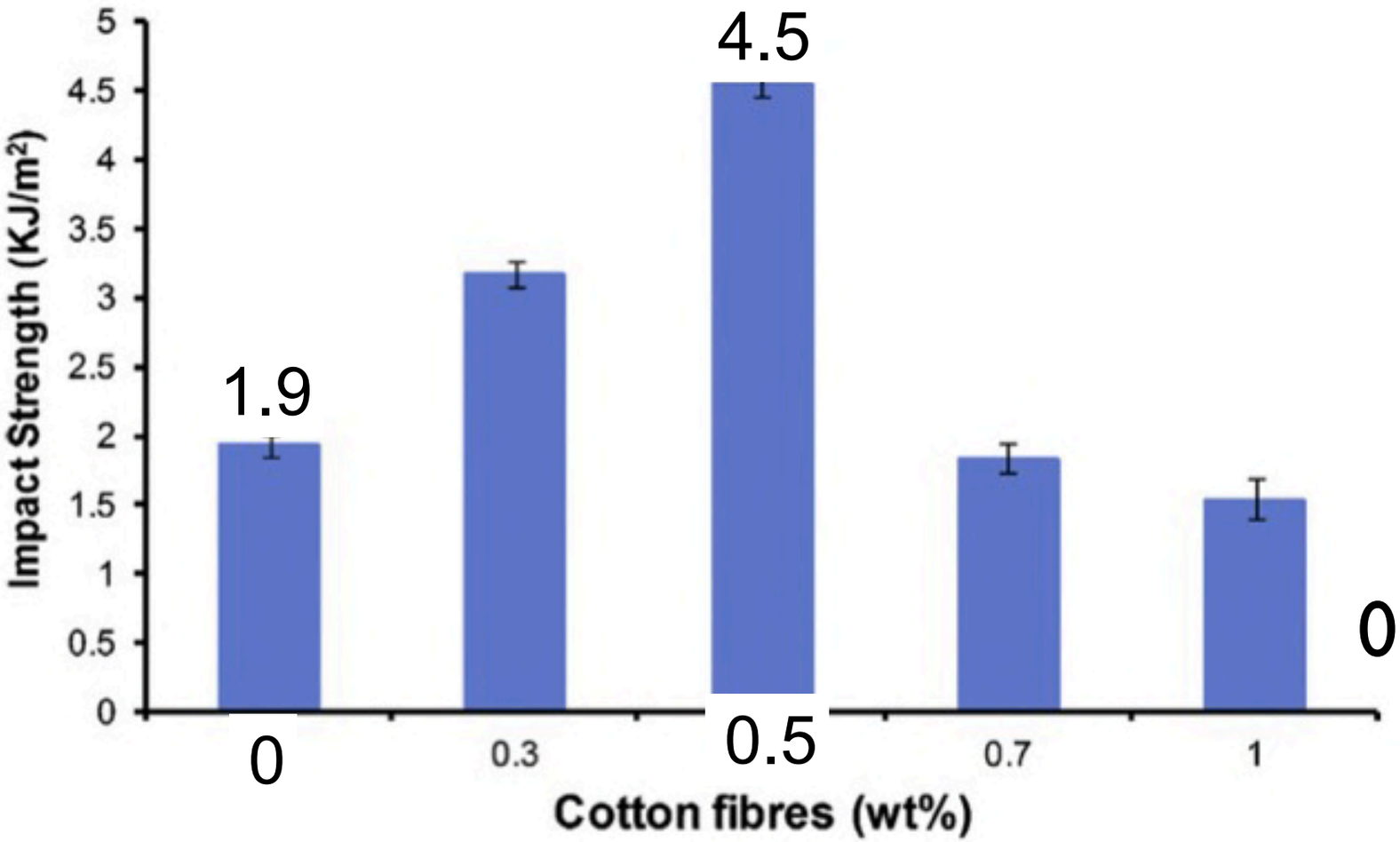
Department of Imaging & Applied Physics, Curtin University, GPO Box U1987, Perth, WA 6845, Australia

Fly ash-based geopolymer cement and room temperature hardening 28 days

Alkali resistant cotton fibers with an average length of 10 mm, average diameter of 0.2 mm, density of 1.54 g/cm^3 , tensile strength of 400 MPa, and Young's modulus of 4.8 GPa.

Compressive strength
0,5 % weight cotton fibres





Impact strength
0,5 % weight cotton fibres

Services & Products

- Cementing
  - Deepwater Cementing
  - Concrete-Based Oilwell Cementing
  - CO2-Resistant Cement
  - Gas Migration Control
  - Lost Circulation
  - Mud Removal

EverCRETE System

CO2-Resistant Cement

When CO_2 is stored underground, it has the potential to become highly corrosive to existing oilfield cements, compromising the integrity of the well. Such damage to the cement sheath would allow CO_2 to leak out of the reservoir and return to the atmosphere, leading to economic loss and reduction of CO_2 injection/storage efficiency.

EverCRETE CO_2-resistant cement—the latest wellbore isolation technology for CO_2 geological storage—provides an enduring solution for zonal isolation during injection and storage and monitoring and after abandonment. This technology can be applied for carbon capture and storage, as well as CO_2 enhanced oil recovery projects.

Request More Information

CO2-Resistant Cement Resources

- Brochures
- Product Sheets
- Technical Papers

Contents lists available at SciVerse ScienceDirect

Applied Energy

2013

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

The permeability of geopolymer at down-hole stress conditions: Application for carbon dioxide sequestration wells

M.C.M. Nasvi [a], P.G. Ranjith [a,*], J. Sanjayan [b]

[a] Department of Civil Engineering, Monash University, Building 60, Melbourne, Victoria 3800, Australia
[b] Faculty of Engineering & Industrial Sciences, Swinburne University of Technology, Victoria, Australia

CO2 permeability of *acid-resistant* fly ash-based geopolymer cement under tri-axial conditions .....

CO2 permeability of GP-cement: 2x10-21 to 6x10-20 m2

CO2 permeability of oil well OPC cement 10-20 to 10-11 m2.

This indicates that geopolymer is a good replacement for existing OPC-based cement as it has lower CO2 permeability.

GEOPOLYMER INSTITUTE

2012

Home | Science / Products | News | Shop | Books / Tutorial | GP Camp | About

NEWS AND CONFERENCES

'World first' production run: 2,500 tonnes of geopolymer

Posted by: Editor on Oct 16, 2012 | No Comments

MK/slag-based geopolymer cement

The Australian company ROCLA, one of the pioneers in geopolymer precast concrete for commercial production, issued the following news in dec. 2011:

In a display of industry-leading technology and innovation, Rocla has recently debuted its latest, award-winning capability – the successful use of geopolymer materials in commercial scale production. While many of its competitors have tried to produce

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 3,000,000 and supplying. ..... 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

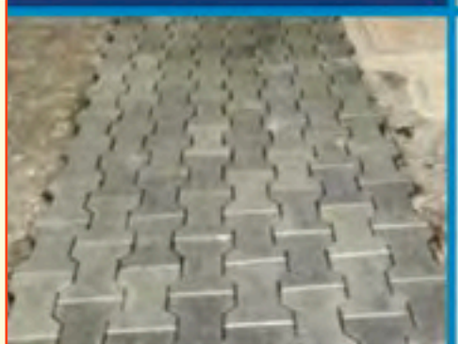
going green initiative

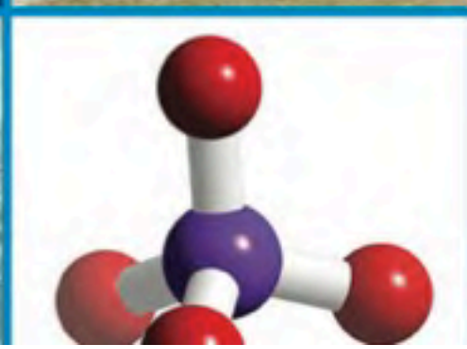
a green technology developed by

CSIR- National Metallurgical Laboratory & TATA TATA STEEL

Process Highlights

- A cement free process
- Uses eco-friendly geopolymerisation process





A cement free process

Uses eco-friendly geopolymerisation process

Date : 3 nov 2012 06:31

Devlopment of Cast In-Situ Geopolymer Concrete Structure At Csir-Ampri, Bhopal , India

Respected Prof. Joseph Davidovits,

You are the father of geopolymeric materials and we need your blessing in further R&D work in this field.

Further, we are happy to inform you that ....., our team has constructed cast -in-situ cement free, advanced reinforced green geopolymeric concrete.

With regards,

Dr.S.S. Amritphale, Chief Scientist, CSIR-AMPRI, India

CSIR - First to use fly ash for demonstrating

Cement Free

Green Concrete Structure

Cement Free Concrete Structure Demonstrated at CSIR-AMPRI

(Dimensions 4.5 Feet X 4.5 Feet X 8.0 Feet)

Engineering Properties

As per IS : 516-1999

Compressive Strength	30 MPa ± 2%
Flexural Strength	4 Mpa ± 1%
Density	2500 Kg/m^3

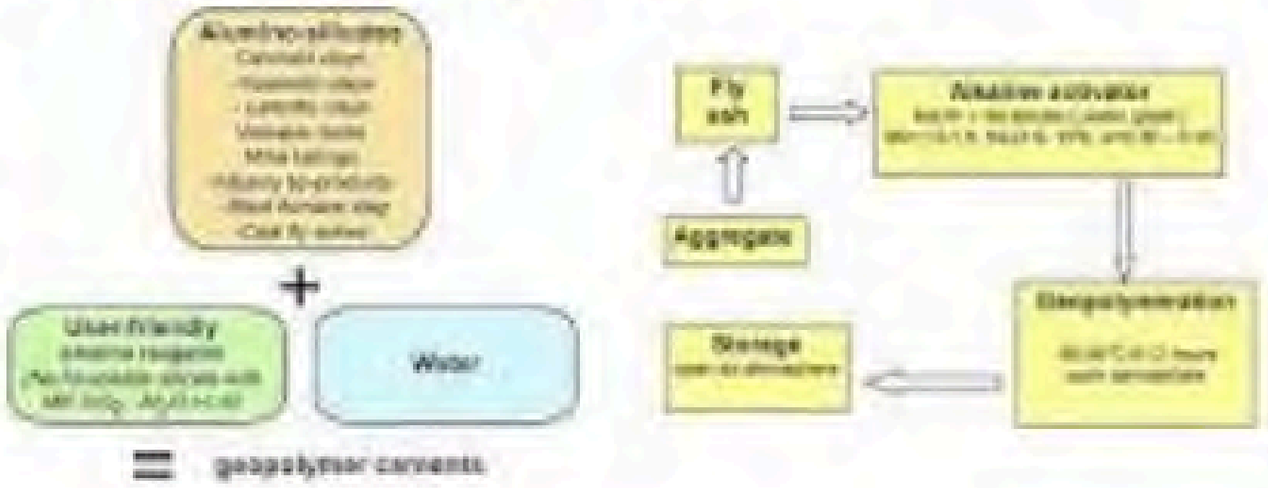
The developed binder (90% fly ash) replaces the conventional cement

Geopolymer - Wikipedia, the free encyclopedia

en.wikipedia.org/wiki/**Geopolymer** ▾ Traduire cette page

Aller à **Geopolymer cements** – [edit]. Main article: Geopolymer cement. There is oft
confusion between the meanings of the two terms geopolymer ...

Images correspondant à **geopolymer cement** - Signaler des images inappropriées



Geopolymer Institute » **Geopolymer cement**

www.**geopolymer**.org/applications/**geopolymer-cement** ▾ Traduire cette pag

7 avr. 2006 – Cement is sold to companies that make concrete. Geopolymer cement
mixed up with alkali-activated slag developed since 1956 in ...

2013

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GÉOPOLYMÈRE

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Tel.: +33/ (0)323 676 988
Fax: +33/ (0)959 977 711
e-mail: geopoly-info@geopolymer.org
web: www.geopolymer.org

GEOPOLYMER CEMENT

a review

by

Professor Joseph Davidovits

January 2013

The existing Portland cement standards are not adapted to geopolymer cements. They must be created by an *ad hoc* committee. Yet, to do so, requires also the presence of standard geopolymer cements.

Presently, every expert is providing his own recipe based on local raw materials (wastes, by-products or extracted).

There is a need for selecting the right geopolymer cement category.

The 2012 State of the Geopolymer R&D, suggested to select two categories, namely:

- *Slag/fly ash-based geopolymer cement*: fly ashes are available in the major emerging countries;
- *Ferro-sialate-based geopolymer cement (similar to rock-based)*: this geological iron rich raw material is present in all countries through out the globe.

Establish standards for global economy:

max. 2 universal and «User-friendly»

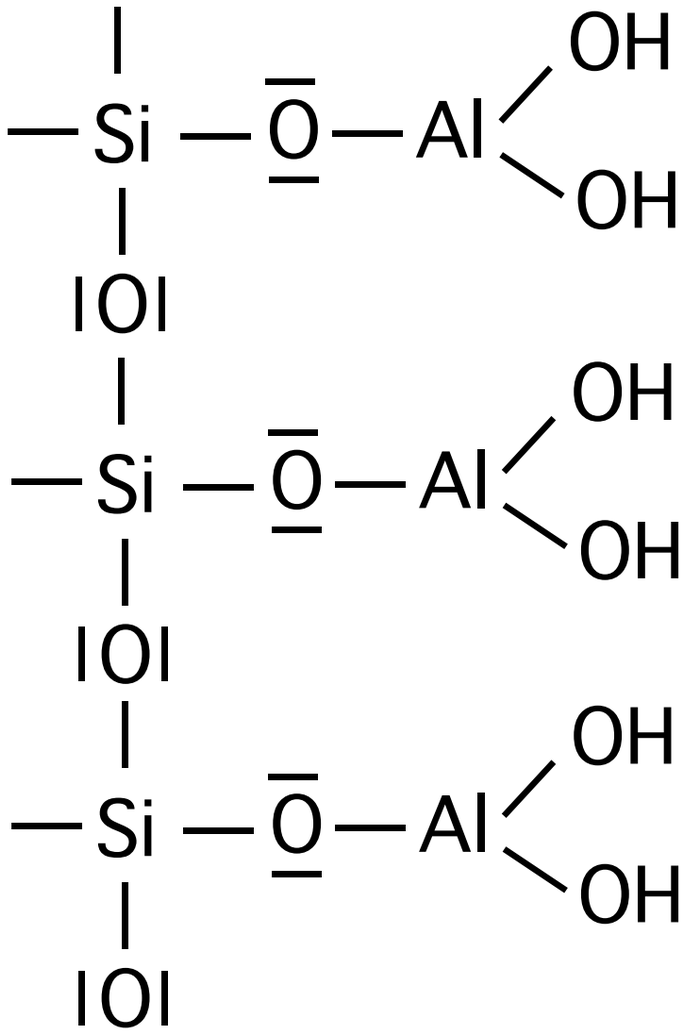
geopolymeric processes

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

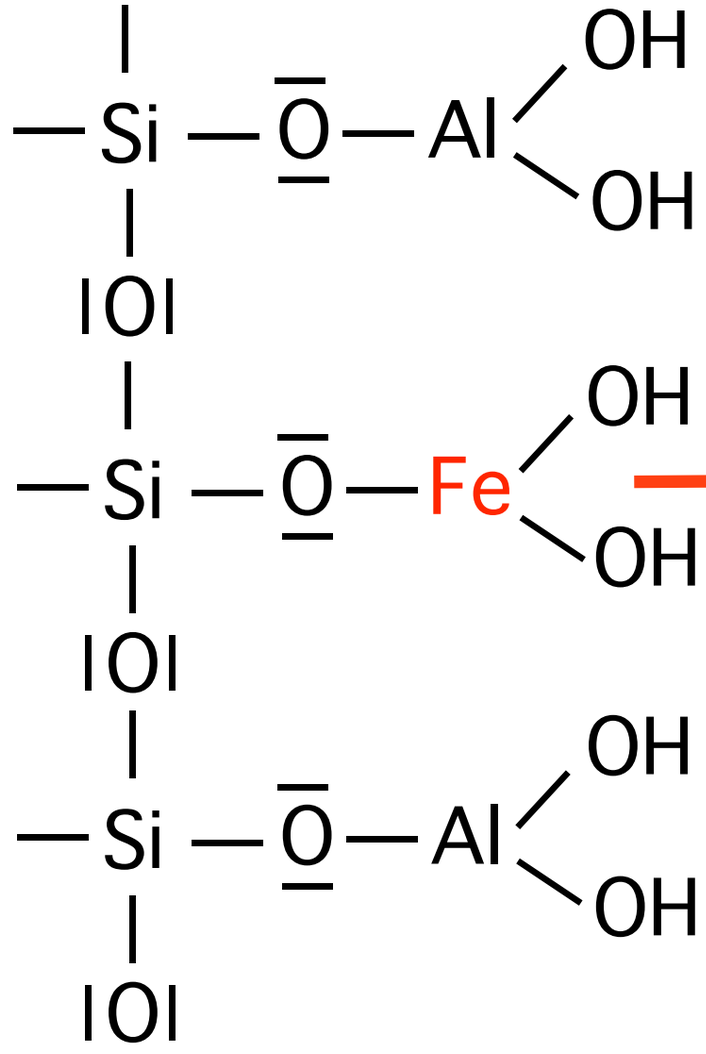
2) (Na,K,Ca)-(ferro-sialate)-based geopolymer cement

and

one industrial hardener based on geology

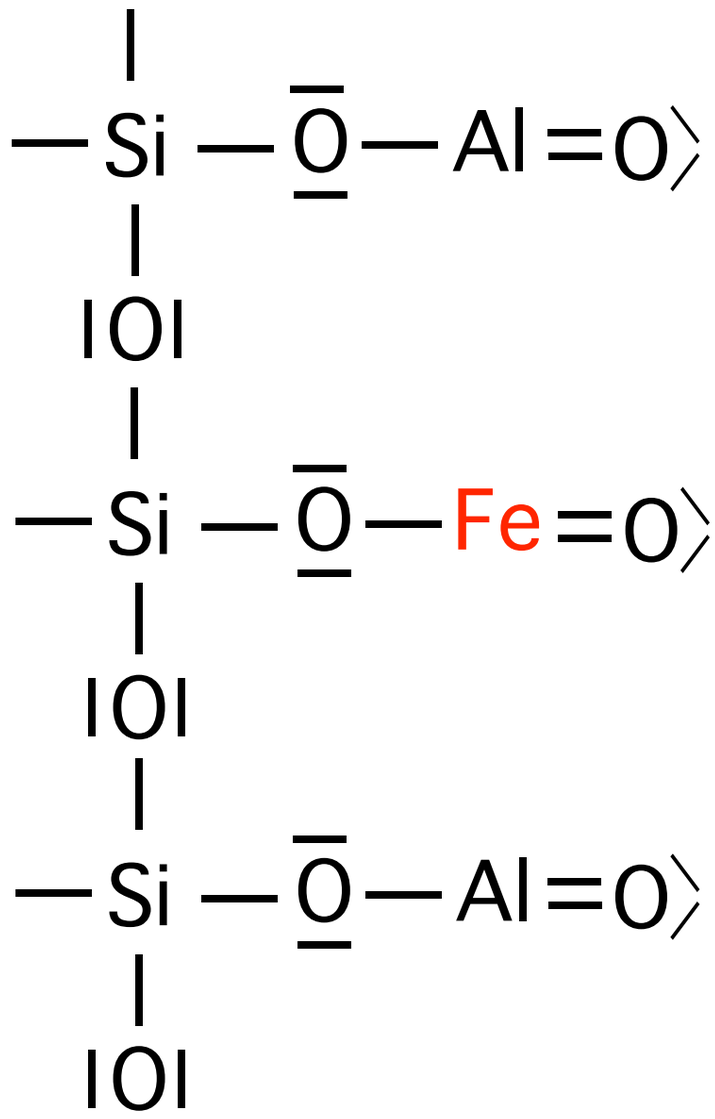


kaolinite



ferro-kaolinite
25% Fe/Al
substitution

750°C

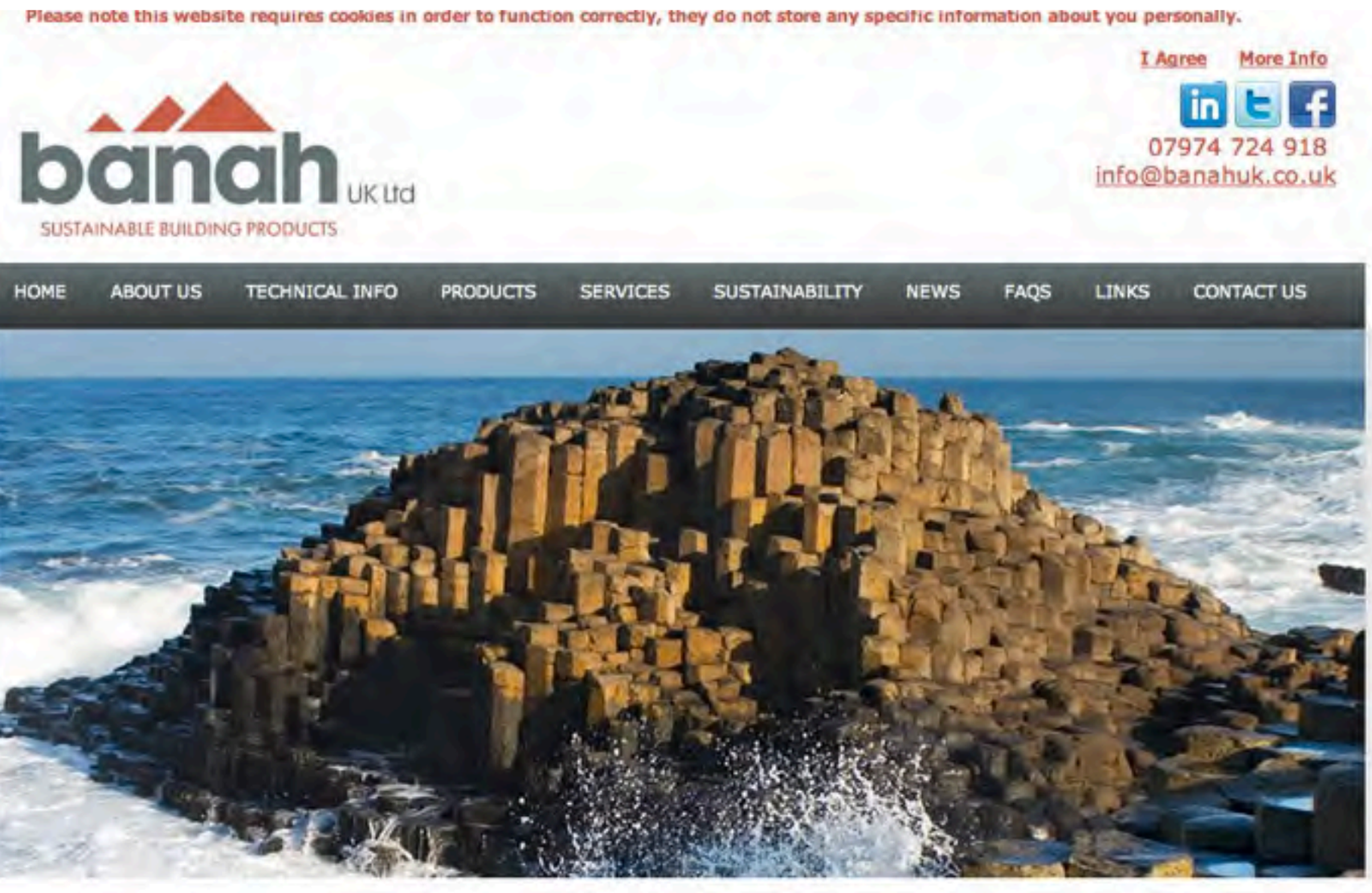


ferro-metakaolinite
Fe-MK-750

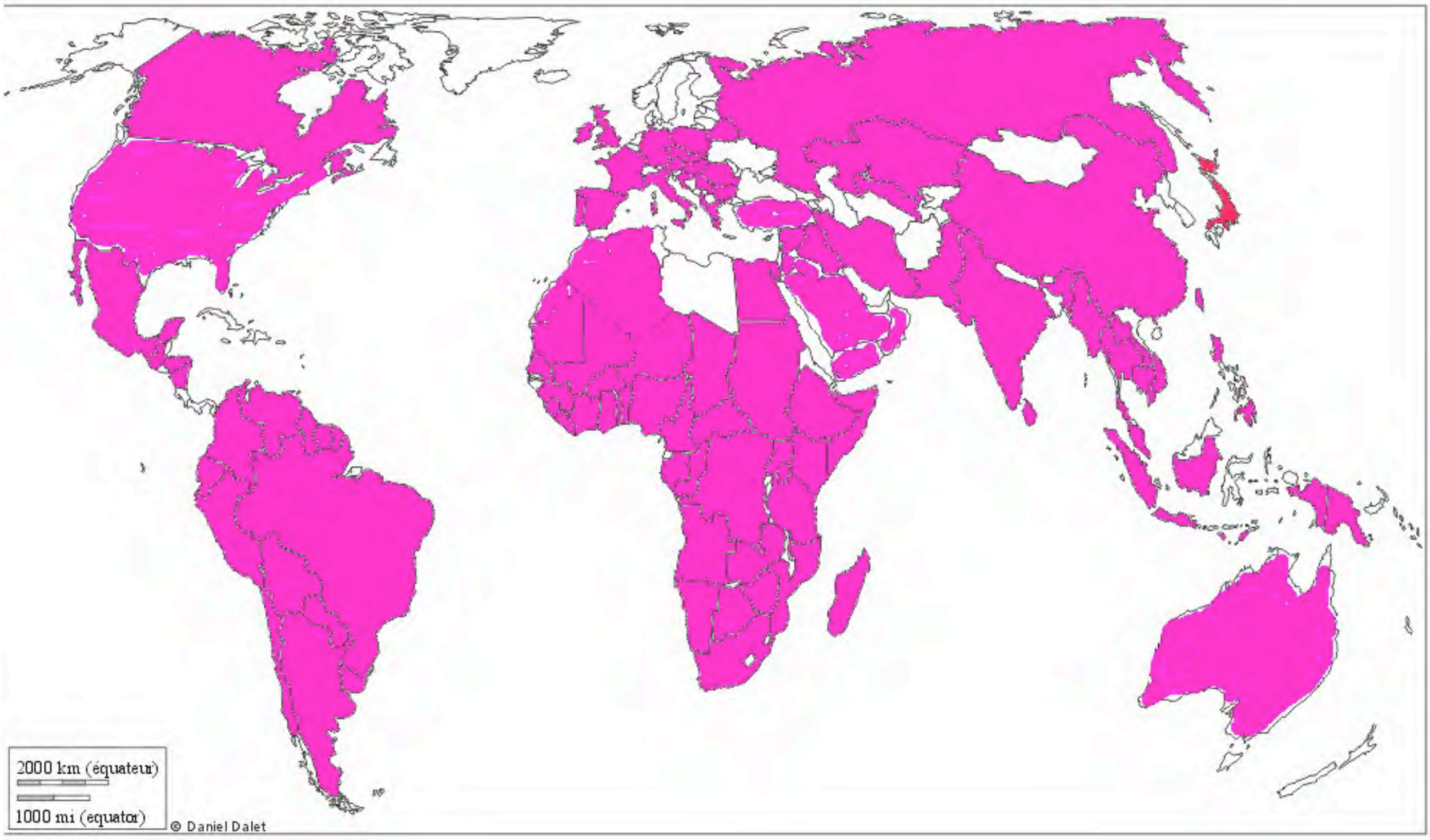
NMR spectroscopy

Mössbauer spectroscopy

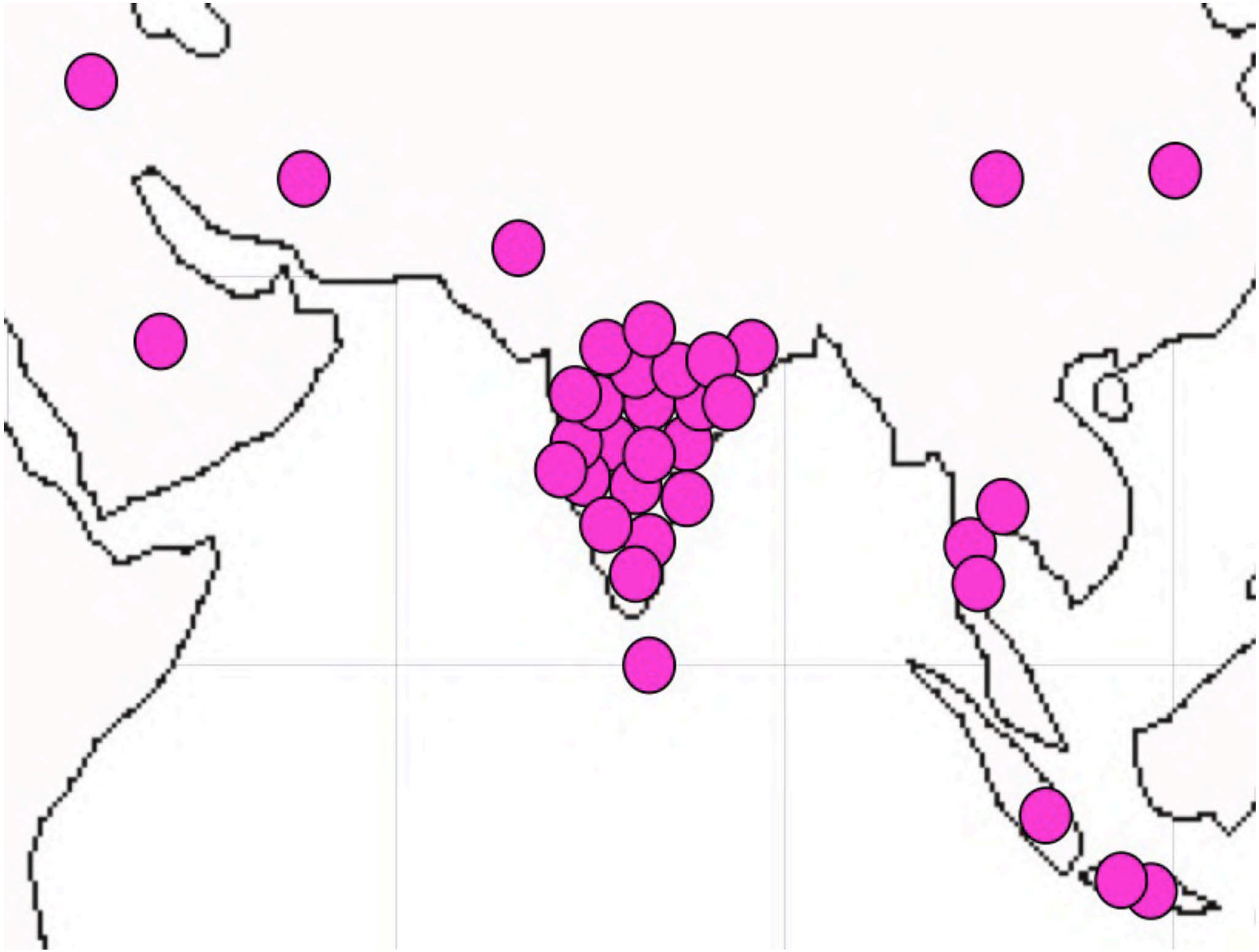
(Na,K,Ca)-(ferro-sialate)-based geopolymer cement



World-wide raw material for ferro-sialate geopolymer



Webinar 2013, Participants ASIA



Geological raw materials for ferro-sialate geopolymer in India

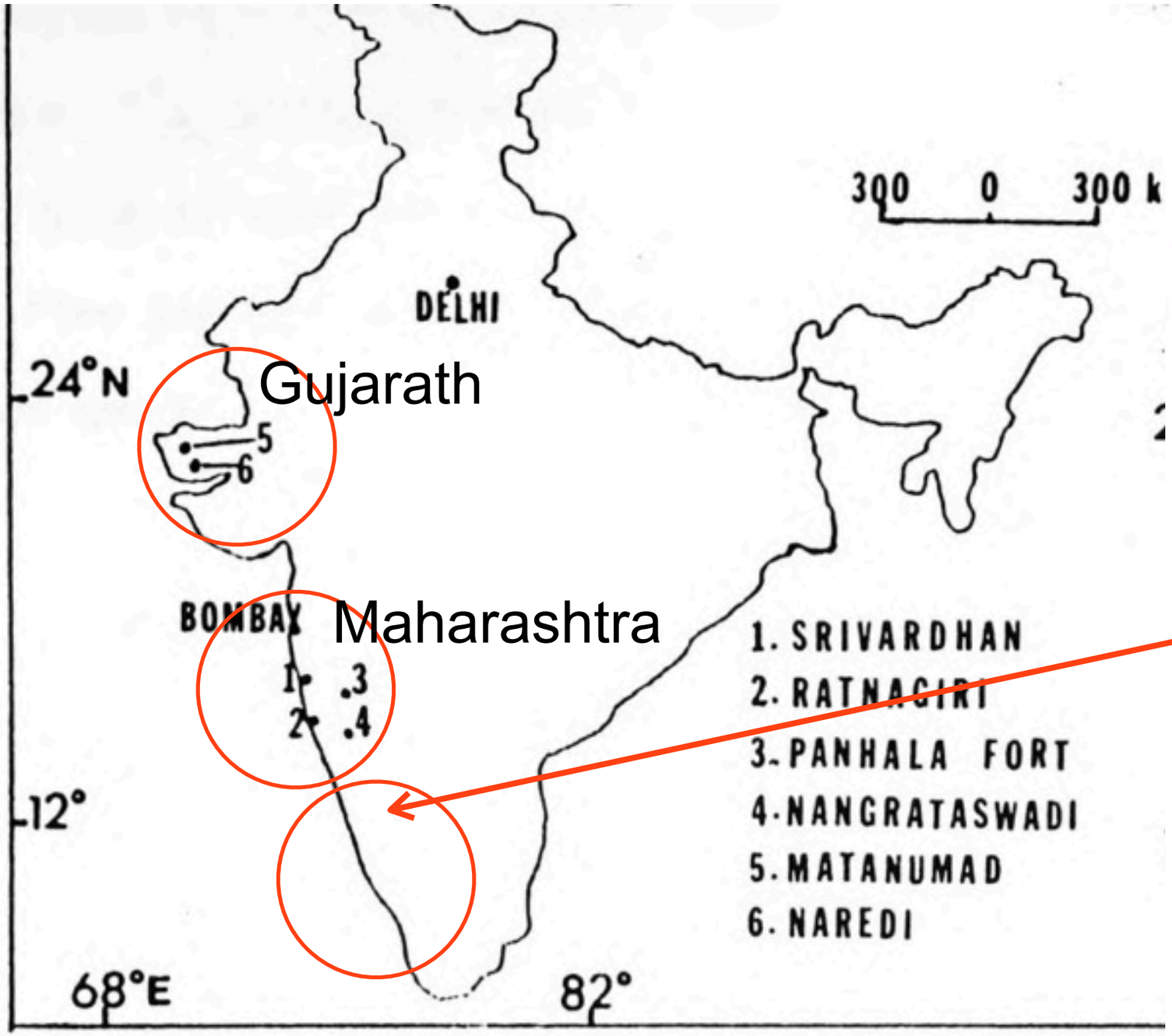
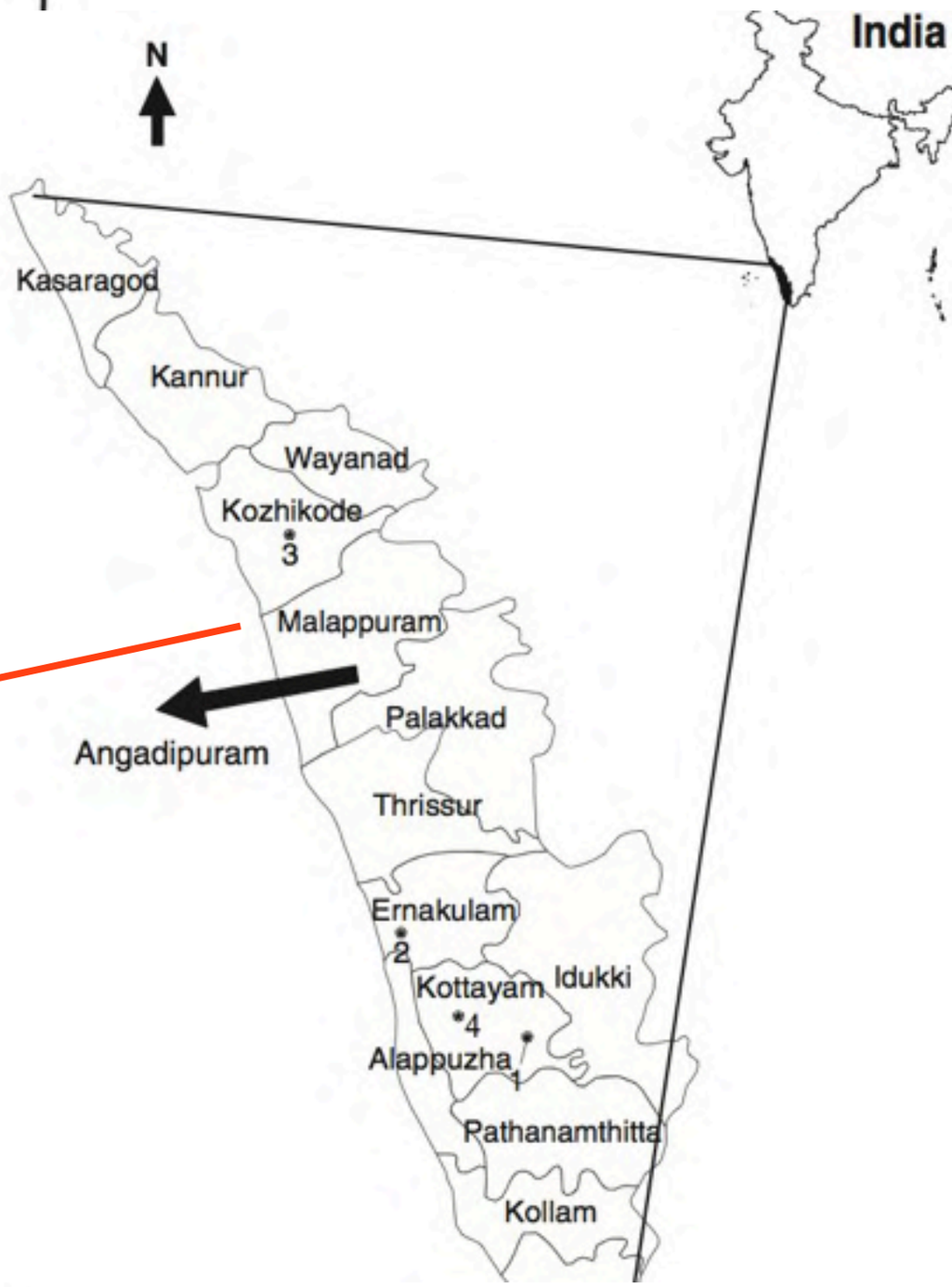


Figure 1. Map of India showing locations of study areas in western Maharashtra (1-4) and those in Kutch, western Gujarath (5-6).



Kerala State

CO_2 emissions

Portland vs. Geopolymer cements

batiweb Tous les services du BTP

Sept. 2010

DÉVELOPPEMENT DURABLE DU BÂTIMENT

LAFARGE implements a cement with a sharply reduced CO2 footprint

This new product, a clinker that is used in the manufacture of cement, one major constitutant of concrete, has 30% less limestone in it. Higher amounts of gypsum, clay or bauxite are used and Lafarge researchers claim achieving a 25% reduction of CO2 emission....

Patent filed in 2004, granted and issued in 2010; pilot plant funding through European Union

At the Geopolymer Camp 2010

GEOPOLYMER BASED CONCRETES : ENVIRONMENTAL IMPACTS OF CURRENT RESEARCH TRENDS

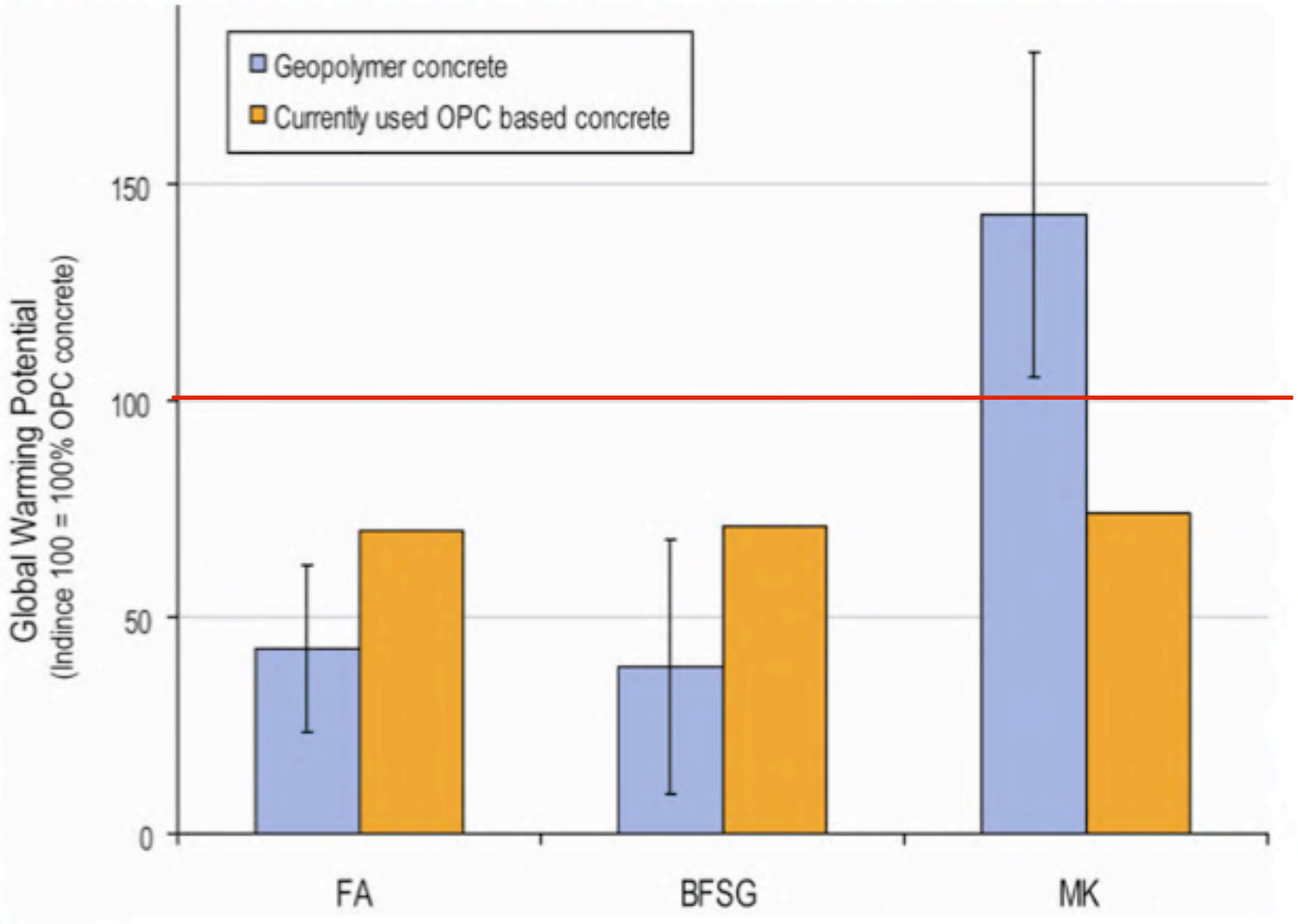
G. Habert (LCPC, Paris)
J.B. d'Espinose (ESPCI, Paris)
N. Roussel (LCPC, Paris)

LCPC Laboratoire Central des Ponts et Chaussées

Laboratoire Central des Ponts et Chaussées

Results: different geopolymer types

- **Concretes made with:** Fly ash, Blast furnace slag or metakaolin
  - **No allocation (waste)**



Journal of Cleaner Production 19 (2011) 1229–1238

July 2011

Contents lists available at ScienceDirect

Journal of Cleaner Production

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

An environmental evaluation of geopolymer based concrete production: reviewing current research trends

G. Habert [a,*], J.B. d'Espinose de Lacaillerie [b], N. Roussel [a]

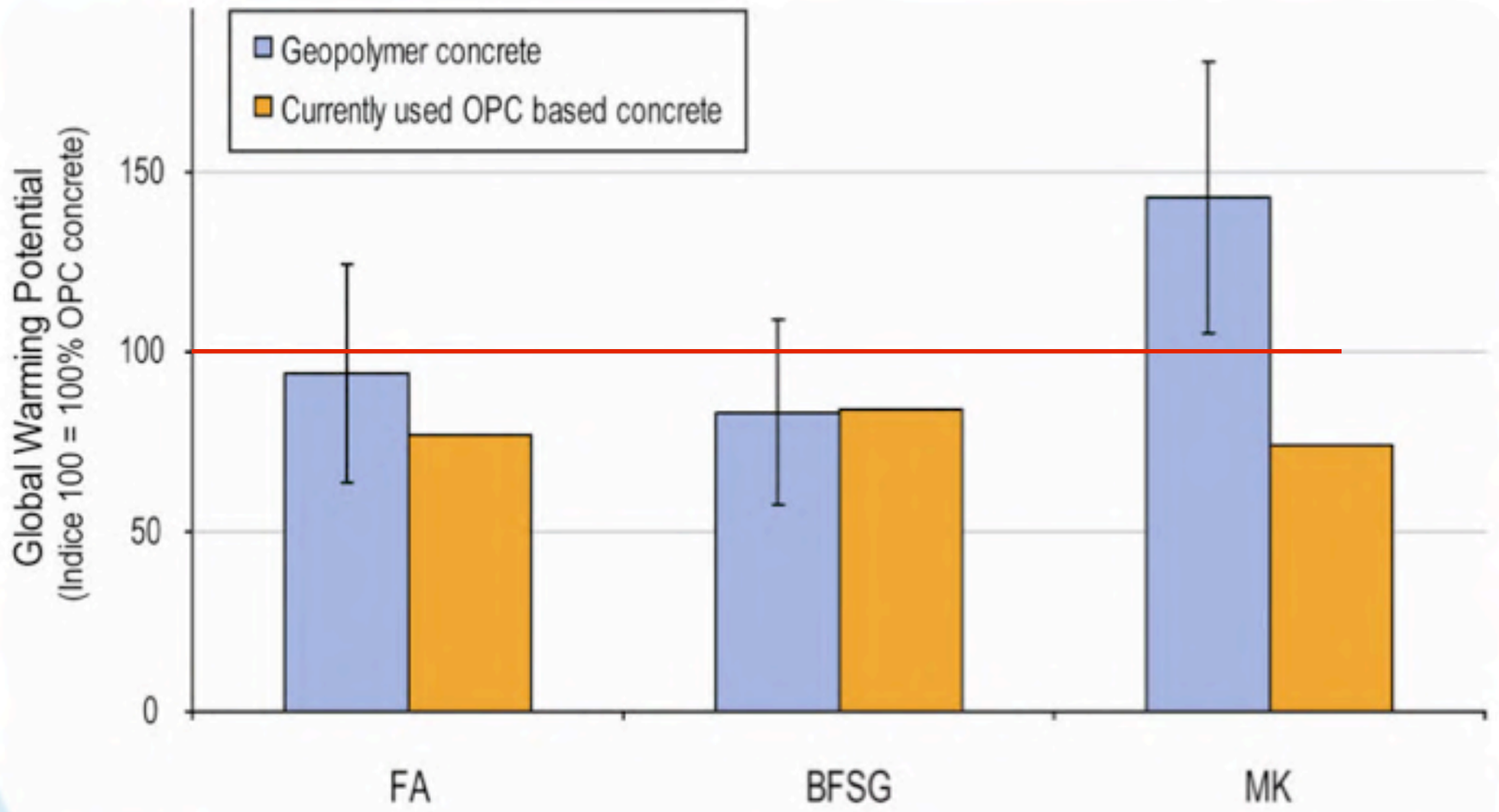
[a] Université Pari **Université de Paris-Est, IFSTTAR** rance
[b] Ecole Supérieu MC, 10 rue Vauquelin, 75231 Paris cedex 05, France

« ..... However, when the **production** of fly ashes and granulated blast furnace slags is taken into account,.... it appears that geopolymer concrete has a similar impact on global warming than standard concrete. »

Laboratoire Central des Ponts et Chaussées

Results: different geopolymer types

- **Concretes made with:** Fly ash, Blast furnace slag or metakaolin
  - **Economic allocation (by-product)**



No sensitive improvement of using geopolymer compared to currently used cement

« This study highlights that future research and development on geopolymer concrete should focus on two potential solutions:

- 1) the use of industrial waste that is not recyclable within other industries (?????)

-2) on the production of geopolymer concrete using a mix of blast furnace slag and activated clays.

It is only by adopting these directions that geopolymer concrete could allow us to achieve the current objectives for a long term reduction of CO2 emissions. »

They are re-inventing the wheel !!

Geopolymer cement categories

- Slag-based geopolymer cement (1984).
- Rock-based geopolymer cement (1997).
- Fly ash-based geopolymer cement
  - ~~alkali-activated fly ash.~~
  - slag/fly ash-based geopolymer cement (2006)
- Ferro-sialate-based geopolymer cement (2010).

CO_2 reduction for

Rock-based Geopolymer-cement

(1) no allocation (waste)

(2) all ingredients manufactured

Slag as waste and with K-silicate solution

Processing	Portland Cement	GP-cement uncalcined	GP-cement calcined
calcination	1,000	0,035	0,140
crushing	0,020	0,018	0,018
K-silicate	0	0,050	0,050
Slag waste	0	0	0
total	1,020	0,103	0,208
reduction	0	90 %	80 %

Slag manufactured and with K-silicate solution

Processing	Portland Cement	GP-cement uncalcined	GP-cement calcined
calcination	1,000	0,035	0,140
crushing	0,020	0,018	0,018
K-silicate	0	0,050	0,050
Slag manuf.	0	0,100	0,100
total	1,020	0,203	0,308
reduction	0	80 %	70 %

CO_2 reduction

Lafarge Portland cement

best case: 25%

Rock-based Geopolymer cement

worst case: 70%

best case: 80-90 %

Construction and Building Materials 43 (2013) 125–130

2013

Contents lists available at SciVerse ScienceDirect

Construction and Building Materials

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

Carbon dioxide equivalent (CO_2-e) emissions: A comparison between geopolymer and OPC cement concrete

Louise K. Turner, Frank G. Collins *

Department of Civil Engineering, Monash University, Wellington Road, Clayton, VIC 3800, Australia

HIGHLIGHTS

- Ordinary Portland cement (OPC) has high embodied energy arising from manufacturing
- Carbon footprint of geopolymers, an alternative binder to OPC, was estimated.
- CO_2-e of geopolymer concrete is 9% less than OPC: unlike past studies (26–80%).
- Key factors for high CO_2-e of geopolymers: energy expended on alkali activators.
- Geopolymers need high temperature curing for strength: a further source of CO_2-e

Fly Ash conventional method:

alkali-activation

dissolution and zeolite formation

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

- curing at 80°C for 48h.

User-hostile

Fly ash Geopolymeric method: room temperature hardening

polycondensation/surface reaction

- fly ash…….. 50 to 85
- K-silicate solution $SiO_2:K_2O$ >1.6…….10
- blast furnace slag……..15
- water…… 5

User-friendly

CO_2 reduction

Lafarge Portland cement

best case: 25%

FA-based Geopolymer cement

worst case: 75%

best case: 90 %

State of the Geopolymer R&D 2012

1) Geopolymer science

2) Geopolymer technologies

3) Geopolymer Cements / Concretes

4) Geopolymer and archaeology

Session

Ancient Technologies

Thursday Jul.9, 16:30

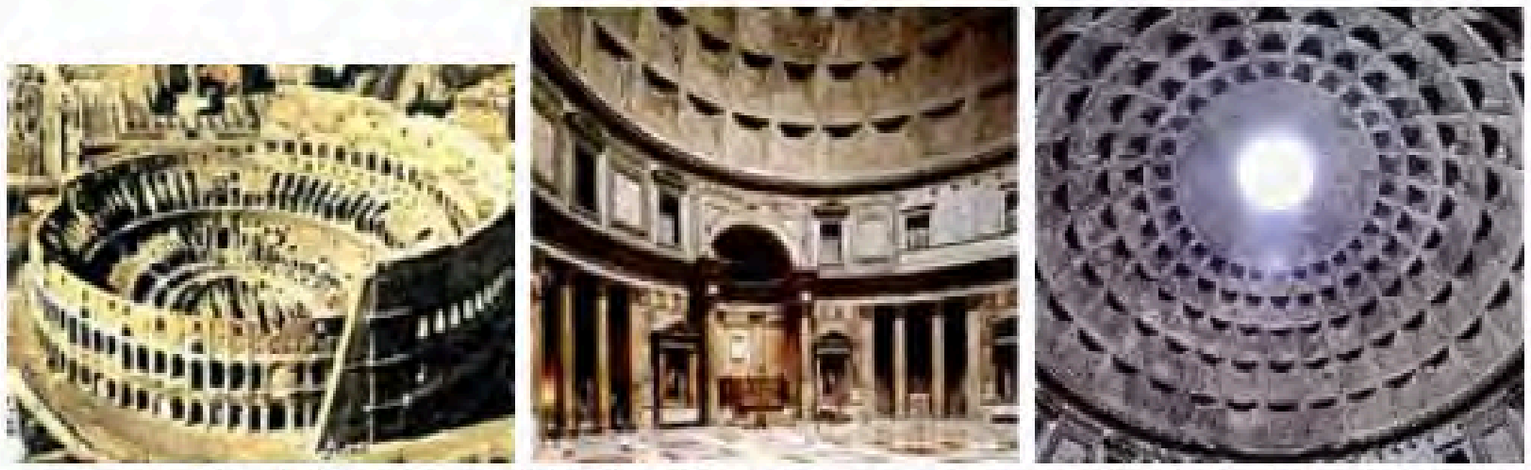
chair:

Prof. Guy Demortier

ROMAN CEMENT

High performance Roman cement and concrete, high durable buildings

Posted by: Editor on Apr 8, 2006 | No Comments



The Coliseo, Rome, 2nd C. AD (left) The Pantheon, Rome, 2nd C. AD, inside (center) The Pantheon, Rome, 2nd C. AD, the concrete dome (right).

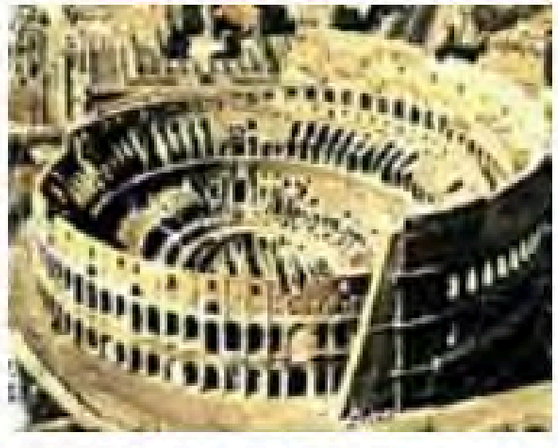
Concrete experts talk today about how to make concrete durable. Many ancient Roman concrete buildings are still in use after more than 2000 years. For these modern concrete experts, the Romans were fortunate builders in that they apparently simply used natural pozzolan deposits, which were found to be suitable for producing a hydraulic mortar. **Contrary** to this

APPLICATIONS

Archaeological Analogues (Roman Cements)

Posted by: Editor on Apr 6, 2006 | No Comments

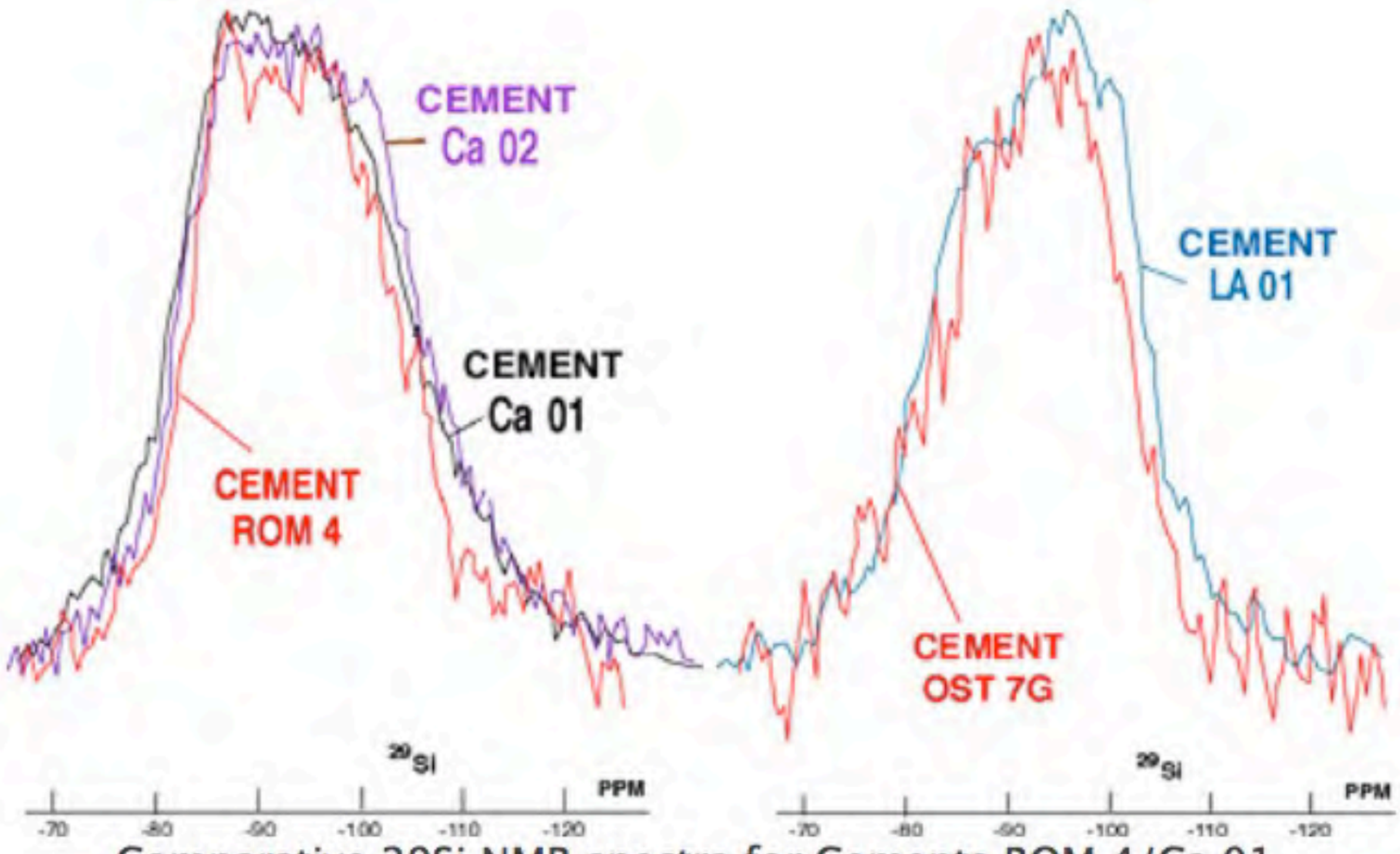
Long-Term Stability of Geopolymeric Materials



The task LONGTERM in the GEOCISTEM project dealt with the better understanding of long-term durability. It is difficult to predict extended durability on the basis of operating experience, laboratory experimentation and prototype testing. Two thousand years are generally accepted as a sufficient amount of time to permit decay of fission products that represent the most hazardous fraction in low-level rad-waste material. The present ongoing research involves geological, chemical and archaeological aspects by studying the durability of archaeological analogues and understanding their chemical make-up. Ancient Roman concrete structures like the Coliseo (2.000 years old) are still functioning today and thereby could provide historical documentation of the extended durability of geopolymeric cements.

NMR Analysis of Roman cements compared with GEOCISTEM cements.

We found at least two specimens of Roman cement (ROM 4 and OST 7G) whose ^{29}Si NMR Spectrum show the same resonances as those of GEOCISTEM cements. The spectrum for the cement ROM 4 (Opus Signinum) is similar to the spectra of Ca 01/Ca 02 GEOCISTEM cements. These particular GEOCISTEM cements were made of MK-750 (or kandoxi) and zeolithic tuffs Ca01, Ca02 (philipsite type). The spectrum for the cement OST 7G is equivalent to the LA01 GEOCISTEM volcanic tuff cement .



Comparative 29Si NMR spectra for Cements ROM 4/Ca 01, Ca 02 GEOCISTEM (left), and Cements OST 7G/LA 01 GEOCISTEM (right).

journal

J. Am. Ceram. Soc., 1–9 (2013)
DOI: 10.1111/jace.12407
© 2013 The American Ceramic Society

Material and Elastic Properties of Al-Tobermorite in Ancient Roman Seawater Concrete

Marie D. Jackson,[‡] Juhyuk Moon,[‡,§] Emanuele Gotti,[¶] Rae Taylor,[‡] Sejung R. Chae,[‡] Martin Kunz,[‖] Abdul-Hamid Emwas,[††] Cagla Meral,[‡,‡‡] Peter Guttmann,[§§] Pierre Levitz,[¶¶] Hans-Rudolf Wenk,[‖‖] and Paulo J. M. Monteiro[‡,†]

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[‡‡]Middle East Technical University, 06800 Ankara, Turkey

[§§]Helmholtz-Zentrum für Materialen und Energie GmbH, Institute for Soft Matter and Functional Materials, Berlin 12489, Germany

[¶¶]Université Pierre et Marie Curie, CNRS, Laboratory PECSA, Paris F-75005, France

[‖‖]Department of Earth and Planetary Science, University of California, Berkeley 94720, California

The differences likely arise from the presence of additional cations, Al^{3+} and small amounts of Na^{+} and K^{+} in the *Baianus Sinus* Al-tobermorite crystal structure, in addition to thermal vibration effects in the real crystals.

The bonding environments of Al^{3+} substitution for Si^{4+} in the crystal lattice described by NMR studies indicate *long silicate chain lengths* and pervasive tetrahedral *cross-linkages* of the silicate interlayer with overall Q^2/Q^3 about 2.59.

Long silicate chain lengths and low Ca/(Si + Al) = 0.8 suggest a *high degree of polymerization* and Si^{4+} binding energy, which typically produce strong cement paste

Paleomagnetic investigation of the great egyptian pyramids

Igor Túnyi[1], Ibrahim A. El-hemaly[2] - DOI: 10.1051/epn/2012604

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