XATICO
PERFORMANCE MINERALS

SEMINAR ON GEOPOLYMERS

by Carine LEFEVRE

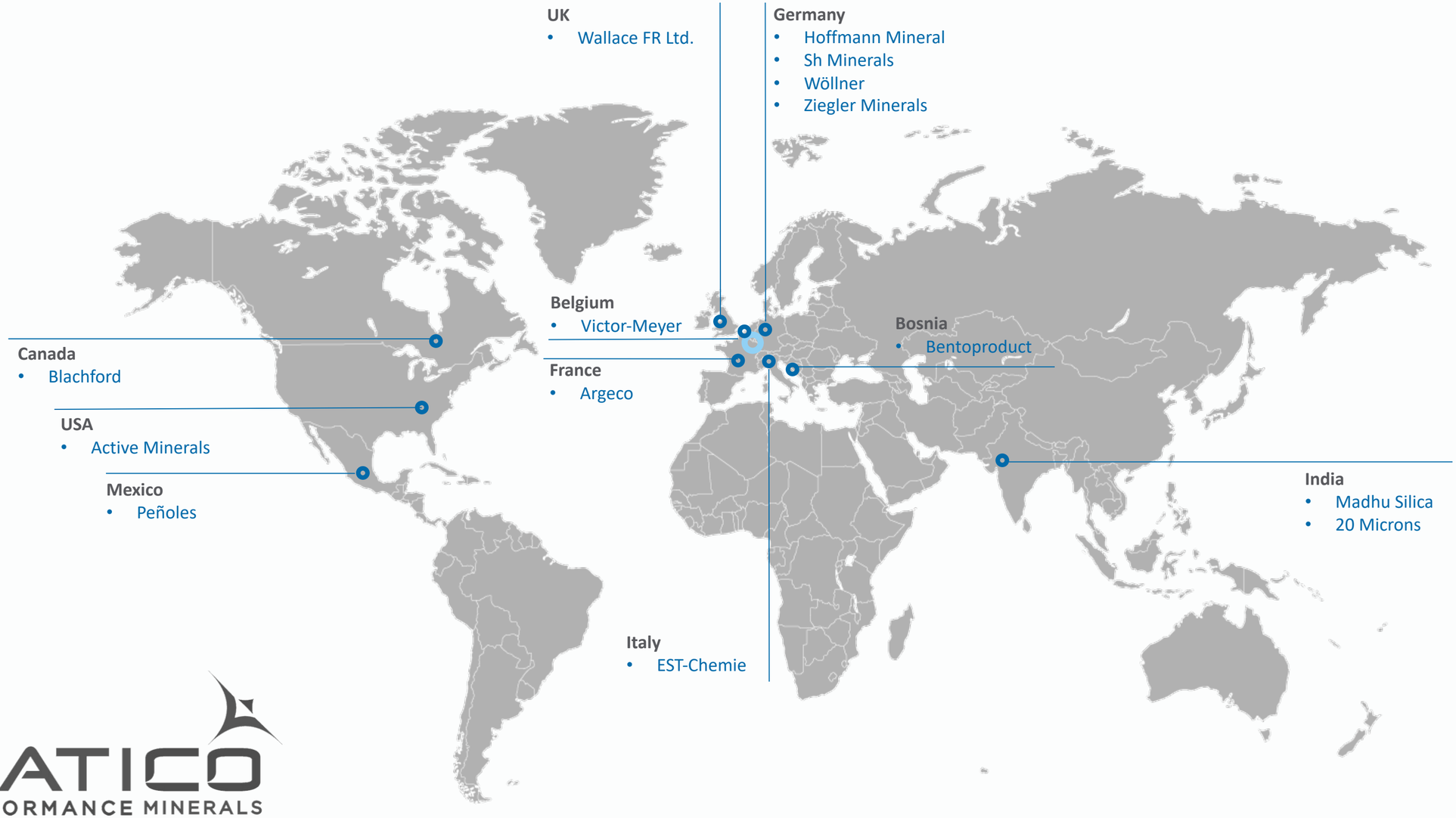
OUR GROUP

- **Foundation**: 2006
- **Countries**: Benelux, Germany, France, Spain, and Portugal
- **Turnover**: ~5 M € per year
- 8.500 MT sold per year
- More than 700 active clients
- 6 warehouses
- Collaborating with external laboratories

ISO 9001
since 2015

ISO 14001
since 2015

OUR PARTNERS



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OUR PRODUCTS

- Aluminium Trihydrate (ATH)
- Attapulgite
- Barium Sulphate (Barite)
- Bentonite
- Silicate based inorganic binding agents (Betol®)
- Betolin® - Sapetin® - Sikalon®
- Calcined Neuburg Siliceous Earth
- Calcium Carbonate (Cacite – Marble)
- Calcium Sulphate Anhydrite

- Collosil® – Special Adhesives
- Diatomaceous Earth
- Dolomite
- Geosil®
- Kaolin
- Ligasil® - Stabisil®
- Magnesium Hydroxide
- Metakaolin
- Metal Stearates
- Mica
- Natural Silica
- Nepheline Synite
- Neuburg Siliceous Earth
- Perlite
- Precipitated Silica
- Synthetic Sodium Magnesium Aluminium Silicate
- Talc
- Vermiculite
- Wollastonite
- Zeolite
- Zinc Borate
- Zinc Hydroxy Stannate
- Zinc Stannate

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PARAMETERS INFLUENCING GEOPOLYMERISATION

- Composition of the hardener and the various mineral fillers added
  - Particle size
  - Composition in amorphous phase
  - Composition in SiO_2 and Al_2O_3
- Nature and composition of the alkaline activator (molar ratio and nature)
- Solid/liquid ratio
- Cross-linking temperature
- Humidity condition

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ALUMINOSILICATES

- Materials rich in silica and alumina: $SiO_2 + Al_2O_3 > 80\%$
- Synthetic: metakaolin, fly-ash, calcinated by-products
- Mining, calcination process and milling will influence the final properties
- The more amorphous the material is, the more reactive it will be
- Acts as a hardener in the geopolymer formulation

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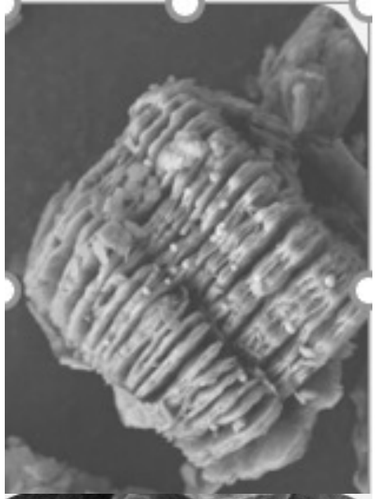
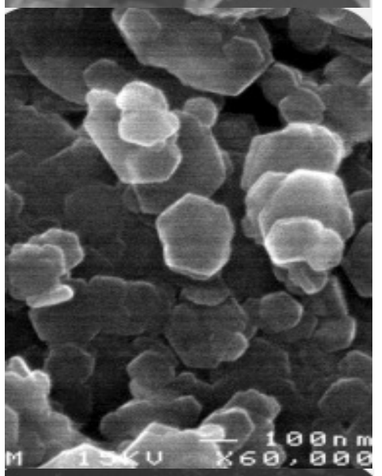
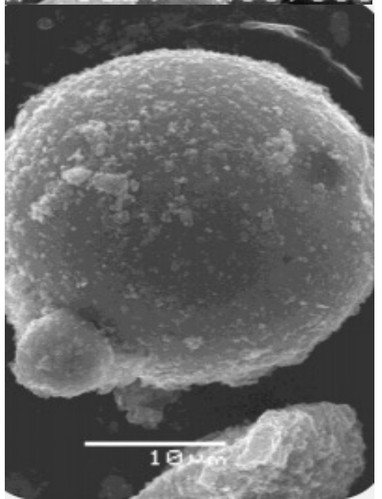
METAKAOLIN

- Material delivered from kaolin which is dehydrated by heat treatment
  - With heat, water is released from the crystalline structure
  - This step generates the disappearance of the crystalline structure of kaolinite
  - This disorganisation allows its reactivity

- There are several industrial processes to calcine a kaolin clay
  - Continuous furnaces: residence time ~ 4h
  - Flash kilns: residence time less than 1h







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REAKTIVITY OF METAKAOLIN

- Their reactivities have been tested according to the standard method

  https://www.geopolymer.org/news/26-standardized-method-in-testing-commercial-metakaolins-for-geopolymer-formulations/

Reactivity test, observing exothermicity

Sample: 100 g of K-silicate MR=1.7, 60 g of metakaolin,
10 min. mixing, 1 hour at 80°C
Blank: 55 g of water, 60 g of metakaolin

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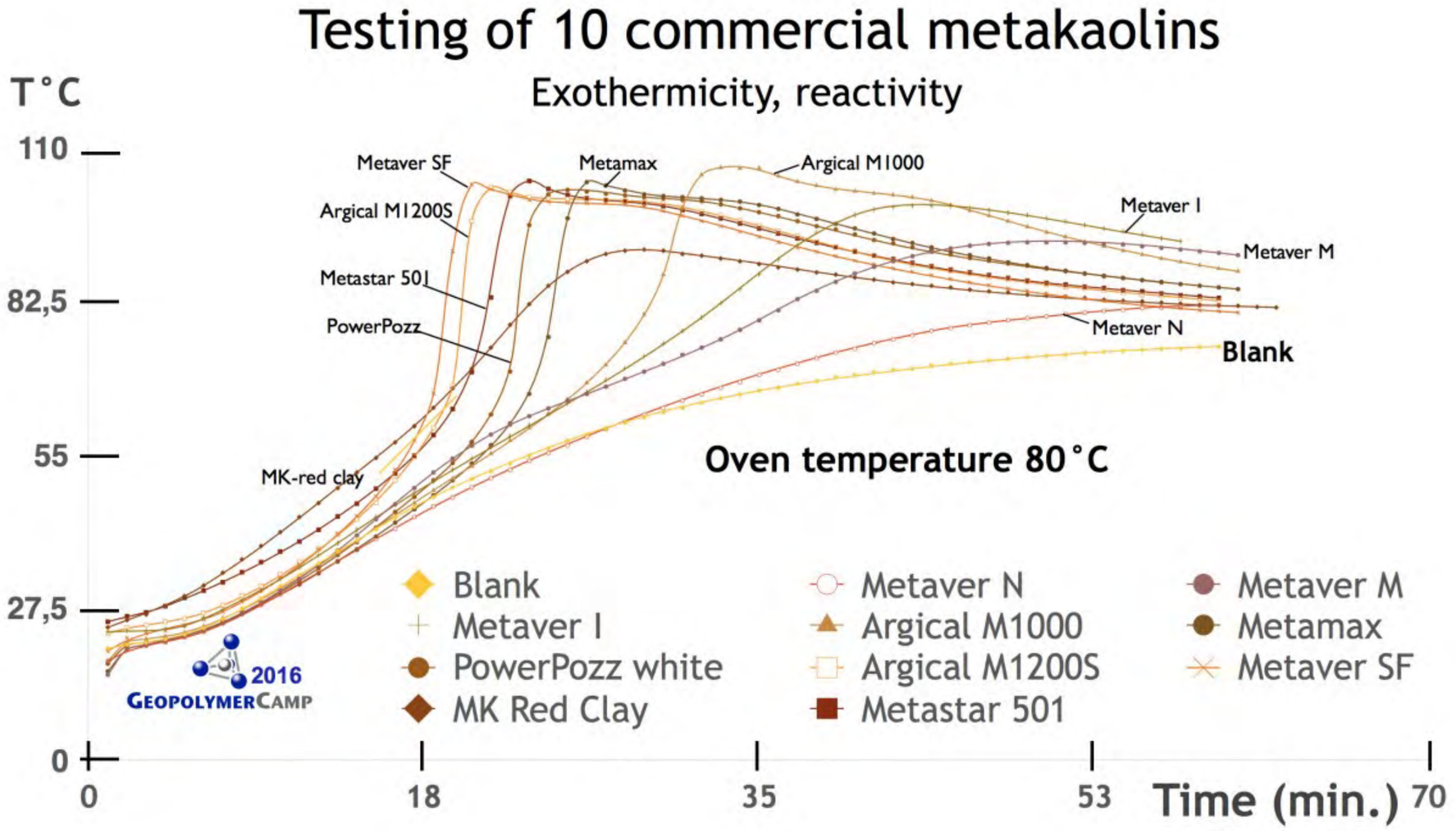
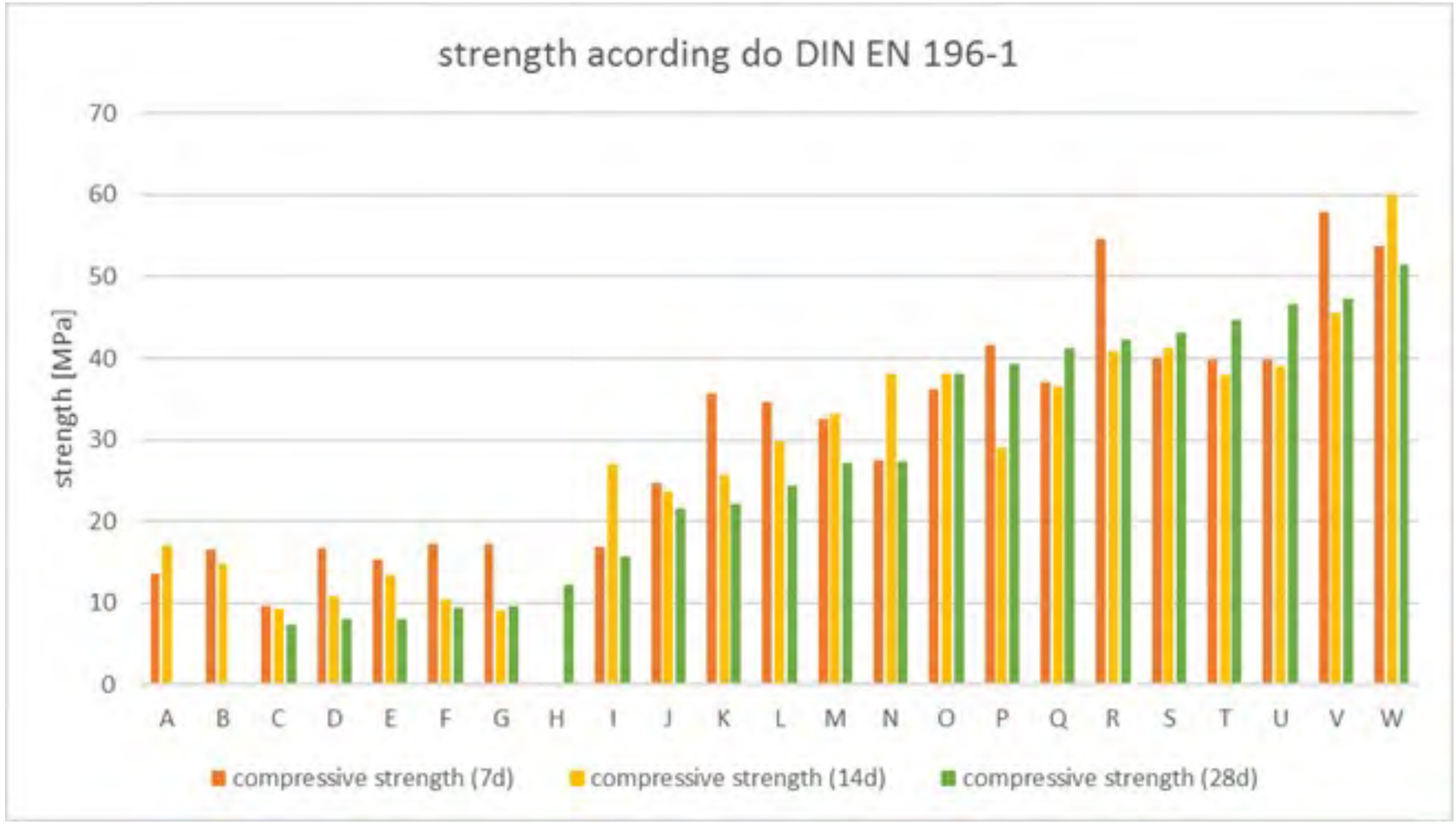
REACTIVITY OF METAKAOLIN



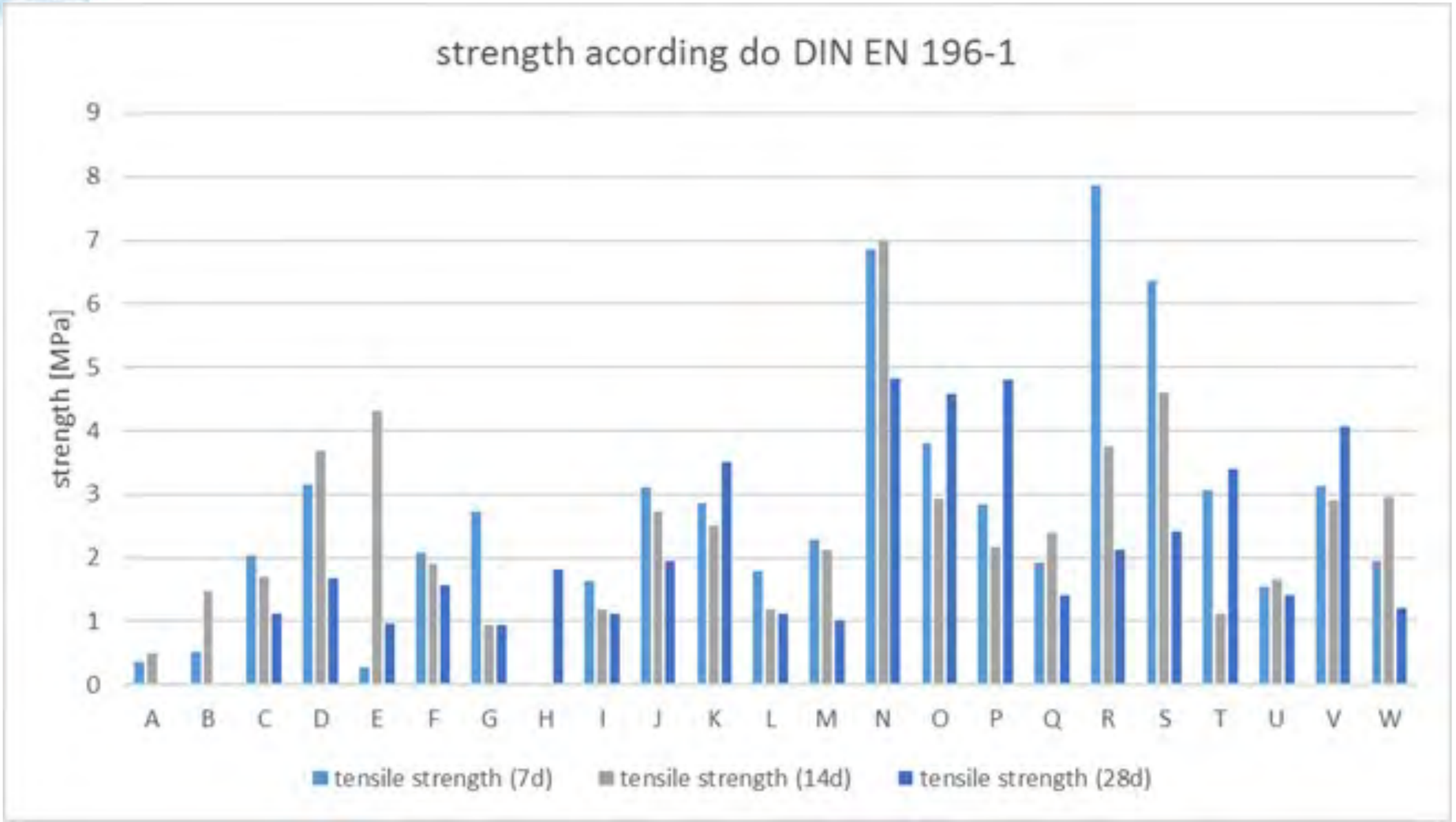
COMPRESSIVE STRENGTH

Compressive strength of 23 different Metakaolins mixed 55/45 with Geosil 14517

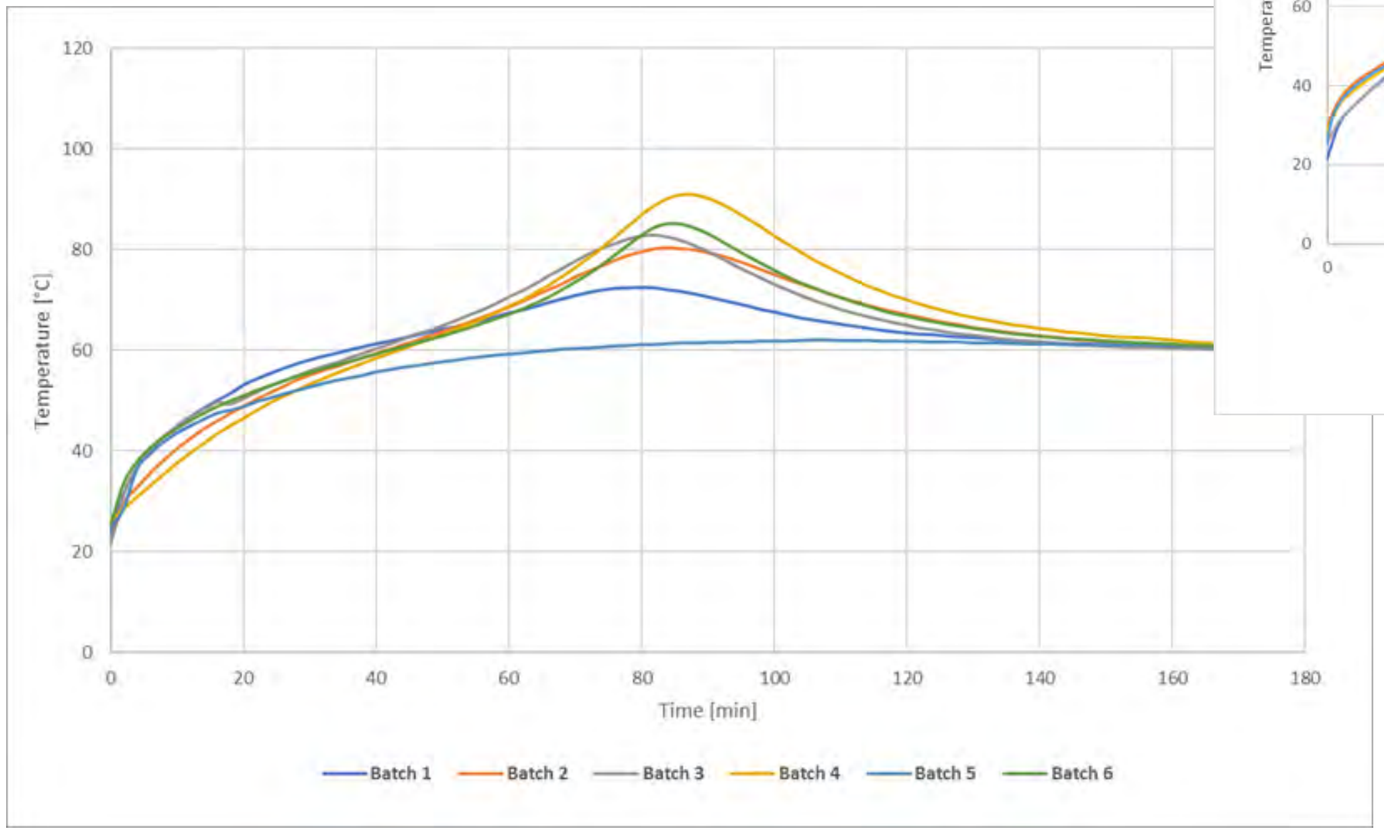


TENSILE STRENGTH

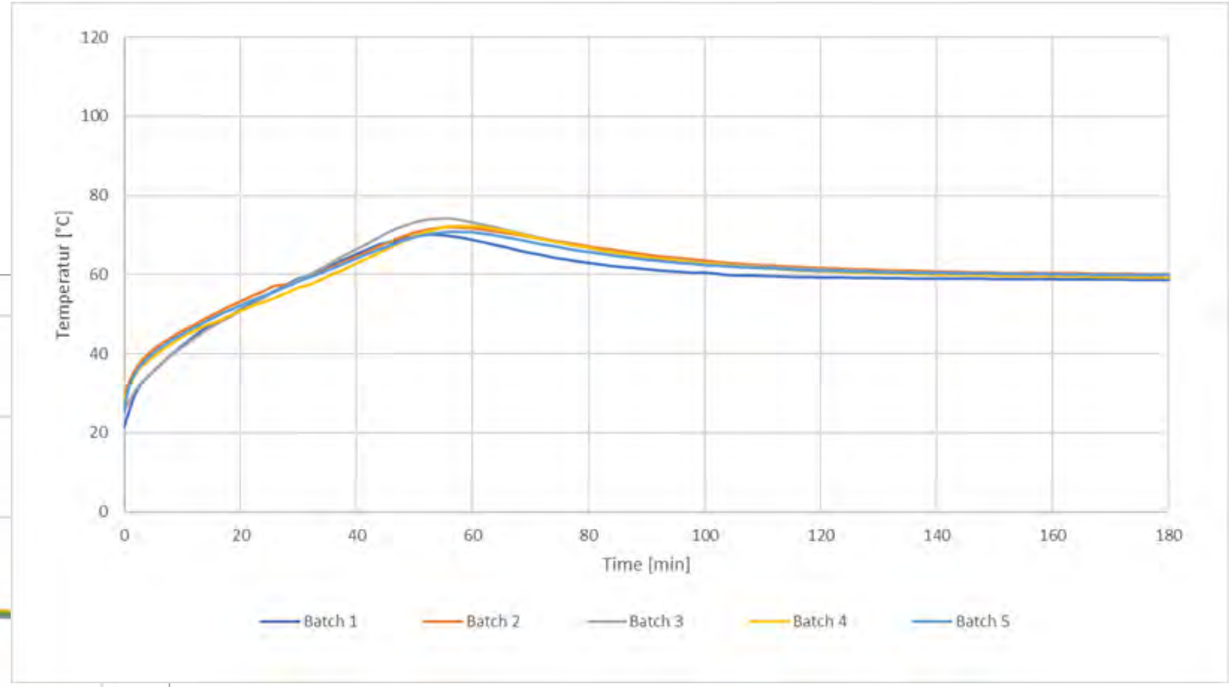
Tensile strength of 23 different Metakaolins mixed 55/45 with Geosil 14517.



Variation from batch to batch



Poor reproducibility from batch to batch



Reproducibility from batch to batch

METAKAOLIN FROM ARGECO

The quantity of the deposit of Fumel is estimated at 5

10^6 tons distributed as follows:

- South slagheap 200 kT
- East slagheap 700 kT
- West slagheap 4300 kT

Carrière du Brétou - Argecodéveloppement

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PRODUCTION PROCESS

- Extraction of raw material from the quarry Reduction of
- the crude (0/3000 mm) by a crusher to obtain a 0/50 mm

  Drying and crushing of the 0/50 mm
- Selection of a 0/0,5mm to obtain a raw 0/0.1 mm
- Calcination of the raw to obtain metakaolin Mixing of
- powdered products
-

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GEOFLASH S & P

	Geoflash P	Geoflash S
Ratio SiO_2/Al_2O_3	2,04	2,7
Ratio SiO_2/CaO	34,7	108,9
Ratio SiO_2/Fe_2O_3	44,6	42,1

	Geoflash P	Geoflash S
SiO_2	62,4%	69,8%
Al_2O_3	30,5%	21,6%
Fe_2O_3	1,4%	2,2%
TiO_2	1,5%	1,0%
CaO	1,8%	0,3%
K_20	0,1%	0,3%
MgO	0,5%	0,2%
Na_2O	0,05%	0,1%
Sulfate	0,3%	0,13%
Sulphur	0,5%	0,12%
Chloride	< 0,01%	<0,01%
Actual density	2400 à 2600 kg/m³	2400 à 2600 kg/m³
Main uses	Geopolymer	Geopolymer

GEOFLASH P & S

- Limit the precursor’s water demand
- Have a maximum and optimal ratio between reactive amorphous phases, non-dehydroxylated kaolinite and over-calcined (mullite).
- Contains few Calcium oxides → Used alone or in combination with other precursors that do not contain CaO, it therefore does not contribute to the formation of CSH.

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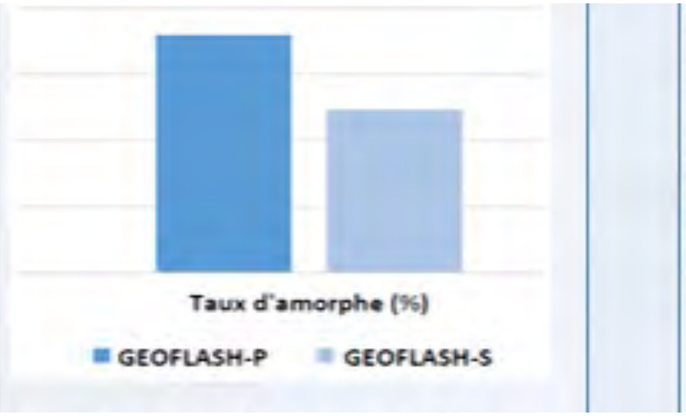
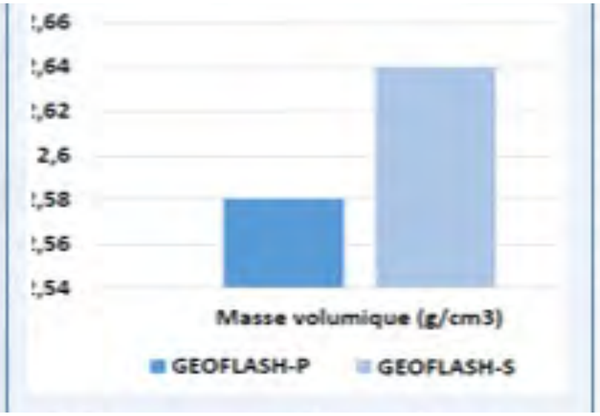
GEOFLASH P vs. S

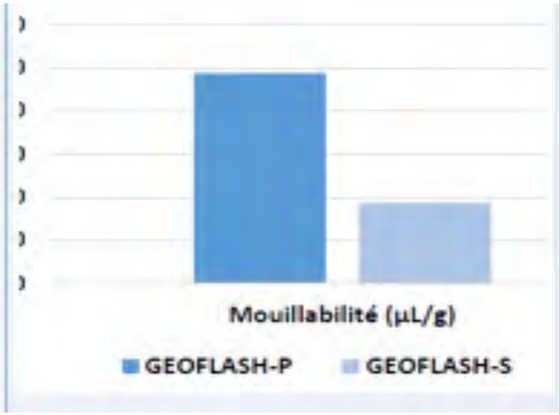


Amorphous ratio (%)

Specific surface (m^2/g)



Voluminal mass (g/cm^3)



Wettability (µg/g)

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GEOFLASH S versus P

- The results show a good reactivity, in the right average → both are well suited to be used as geopolymer binders. The values are:
  - GEOFLASH-S: 32 minutes, 96°C
  - GEOFLASH-P: 30 minutes, 103°C

Silicate	Molar ratio	Formula	MK	Formula	Curing 4 hours – 80°C Flexural test (3 pts)
Geosil 14517 (K)	1,7	100g	Geoflash P	107,64g	7,3 MPa
Geosil 14517 (K)	1,7	100g	Geoflash S	76,23g	3,7 Mpa (powder at the surface – silica)
Geosil 34417 (Na)	1,7	100g	Geoflash P	128,71g	9,3 MPa
Geosil 34417 (Na)	1,7	100g	Geoflash S	91,15g	5 Mpa (powder at the surface – silica)

INORGANIC FILLERS

Mineral fillers and reinforcements used to form a geopolymer composite

Fillers	Morphology	Material	Comment
Mineral fillers	Spherical shape	Silica Alumine	Reinforcement Inert & thermal stability
Mineral fillers	Acicular shape	Wollastonite	Passive anti-corrosion pigment - Reinforcement
Mineral fillers	Lamellar shape	Mica	High lamellarity – Chemically inert – High T° resistance
Mineral Fibers	Various length	Basalte	Reinforcement
Mineral Fillers	Powder Microsphere	Glass	Corrosion resistant Hydrophil (no surface treatment) – Smoothing cements

INORGANIC ADDITIVES

- Feldspar : is produced from naturally occurring combination of alumina and silicate having mix oxides and no free crystalline silica. This material is hard and has angular particles that create a rigid reinforcing network.

  Few particle size available

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INORGANIC ADDITIVES

- Wollastonite : natural calcium silicate that can form needle shape during its genesis (acicular structure)

SiO_2	Al_2O_3	Fe_2O_3	CaO	d50	d98	Blancheur*
> 44%		< 0,3%	> 49%	21 µm 33 µm 18 µm 8 µm	189 µm 136 µm 78 µm 37 µm	75% 87% 91% 86%

* Datacolor 200M, D65, 10°

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INORGANIC ADDITIVES

- Mica: Muscovite – high lamellarity – power & flakes

SiO_2	Al_2O_3	Fe_2O_3	K_20	Na_2O	MgO
46%	32%	< 5%	11%	0,30%	0,20%

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TANK YOU FOR YOUR ATTENTION

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