Ferro-sialate geopolymer

Joseph Davidovits

Definition

Ferro-sialate geopolymer designates a binder or cement of the type poly (ferro-silico-aluminate), which has part of the Al atoms substituted by Fe atoms.

The Fe atoms are in structural tetrahedral Fe[IV] or pentahedral Fe[V] position in the ferro-sialate geopolymer sequence

[Fe-O-Si-O-Al-O].

Geological raw-materials

Ferro-sialate [Fe-O-Si-O-Al-O] geopolymer binder,

results from a geopolymerisation of geological elements

rich in iron oxides and ferro-kaolinite,

- formed in weathered acidic rocks :

  sandstone, granite or gneiss,

- or in basic rocks (mafic) :

  basalt and gabbro.

Geological raw-materials

P.J. Malden and R.E. Meads, Substitution by iron in kaolinite, *Nature* 215 (1967) 844-846.

letters to nature

Nature **215**, 844 - 846 (19 August 1967); doi:10.1038/215844b0

Substitution by Iron in Kaolinite

P. J. MALDEN & R. E. MEADS

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Department of Physic

KAOLINITE o

detection and se

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References

1. Weaver, C., Wa
2. Kündig, W., Bö

KAOLINITE often occurs in admixture with other minerals (for example, micas and iron oxides) in which iron is a legitimate constituent. Because of the difficulties of detection and separation, it bas always been doubtful whether iron actually substitutes in the kaolinite lattice. We provide here evidence for substitution of iron(III) in the octahedral (Al) sites.

Geological raw-materials

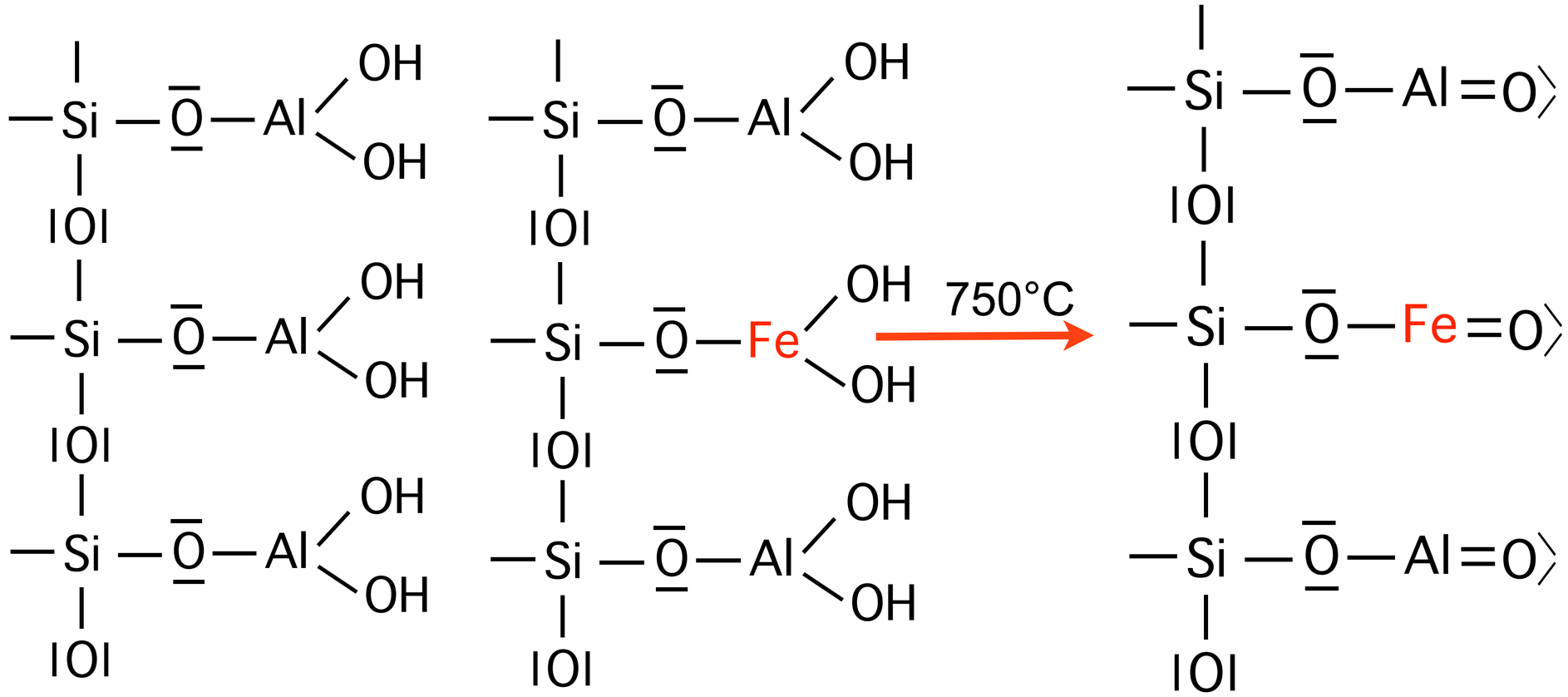
This substitution occurs only when Fe is the ***trivalent Fe^{3+}.***

This substitution can reach 25% of the Al atoms, transforming the sequence ≡Si-O-$Al(OH)_2$ of kaolinite into ≡Si-O-$Fe(OH)_2$.

It is however impossible to separate the substituted kaolinite from that not-substituted.

This explains why, we designate the mixture of substituted kaolinite + not-substituted kaolinite by the generic term

"ferro-kaolinite".



kaolinite

ferro-kaolinite
25% Fe/Al
substitution

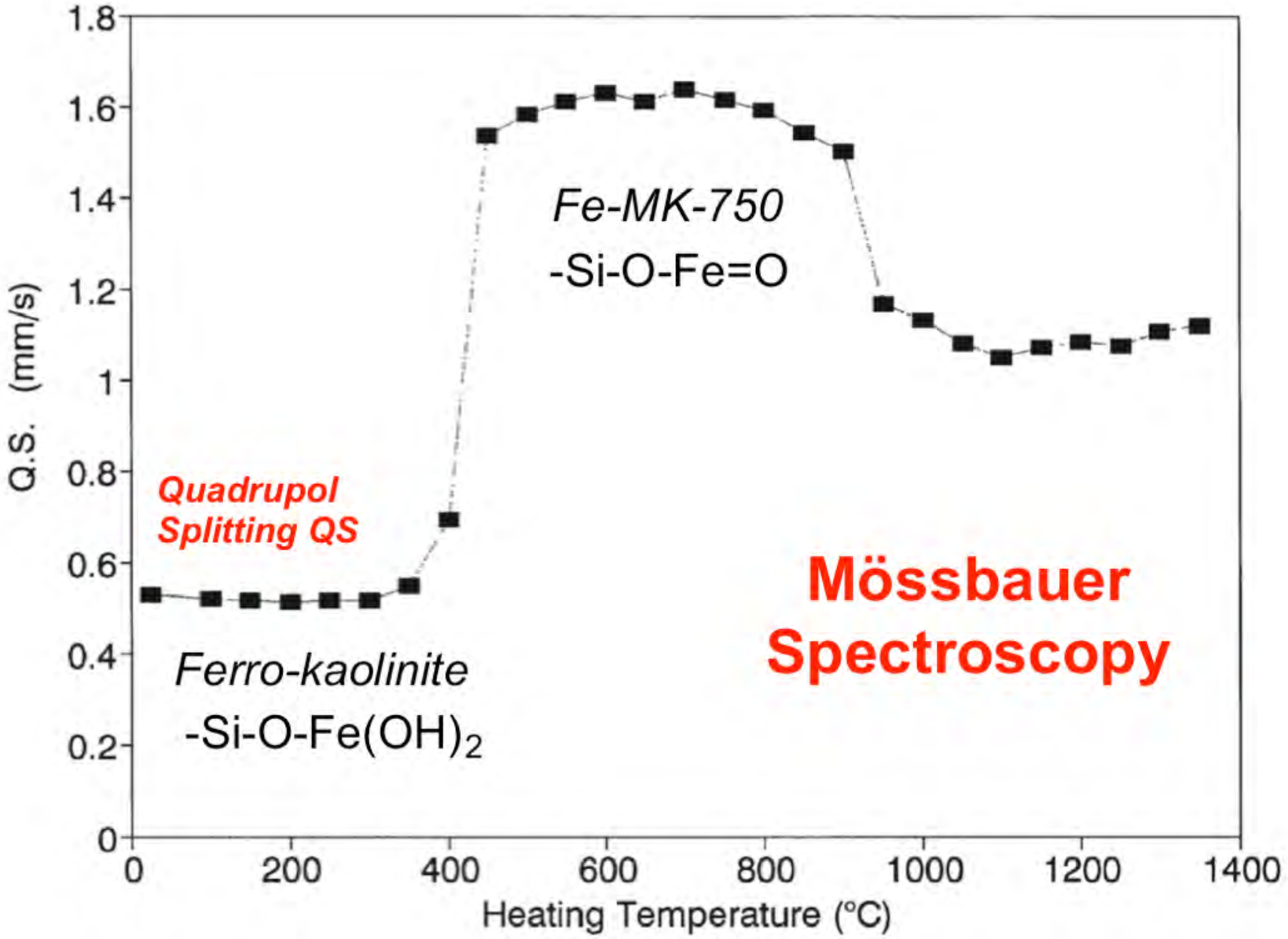
ferro-metakaolinite ?
Fe-MK-750

~~NMR spectroscopy~~

Mössbauer spectroscopy

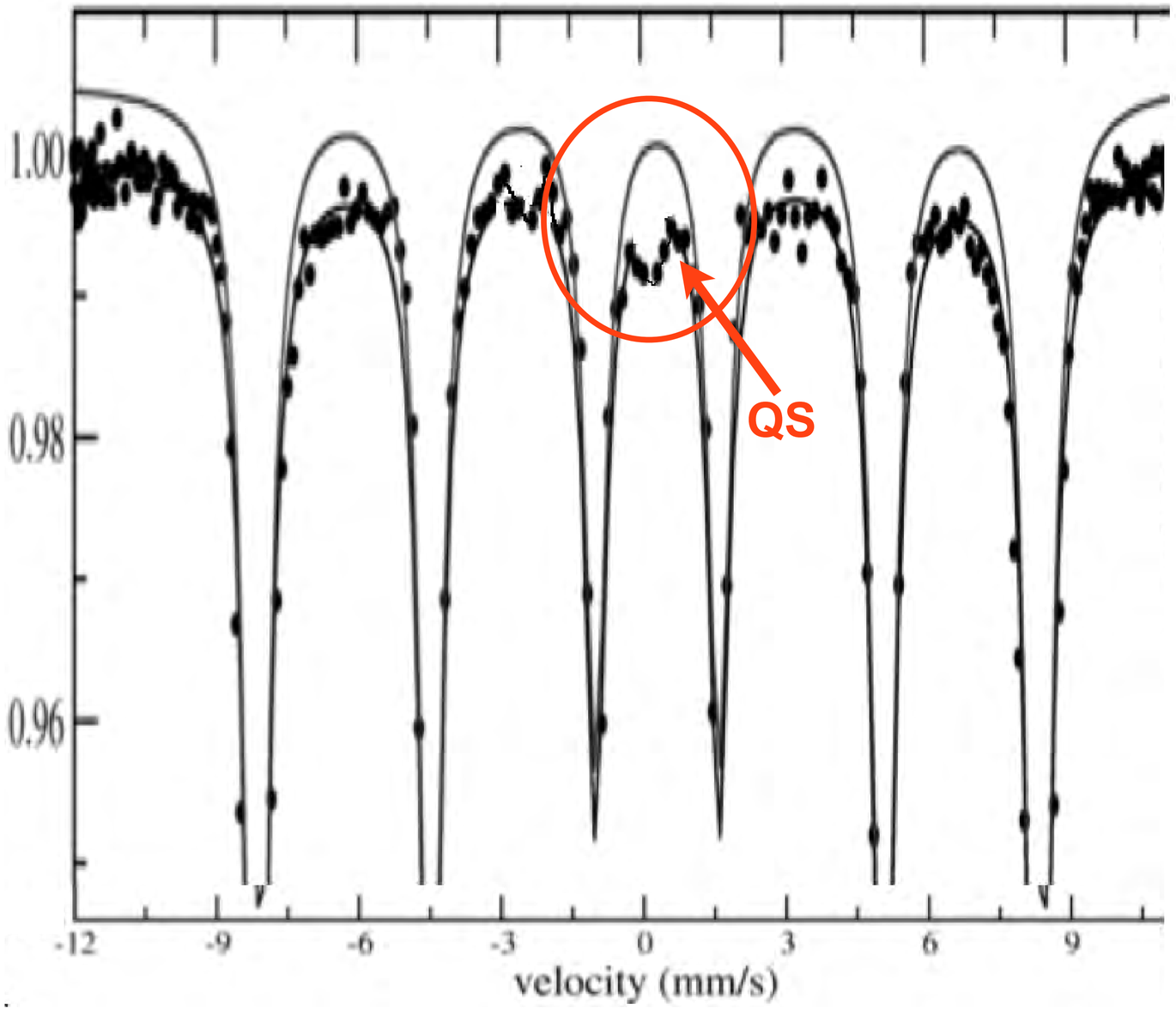
Transformation of ferro-kaolinite into Fe-MK-750

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



Mössbauer Spectroscopy (ferro-sialate)-geopolymer

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



Lateritic rock resulting from the weathering of basalt:

12% quartz,

45% kaolinite,

30% hematite, 3% goethite,

10% other elements (anatase + ilménite+ olivine).

- calcined at 750°C during 3 hours,

- ground to10-25 microns.

Geopolymer formulation

90 parts calcined lateritic rock,

30 parts slag 10-25 microns

30 parts K-silicate sol. SiO_2:K_2O=1,56; H_2O: 55%

20 parts water

hardened at RT 20°C, covered;

Compressive strength

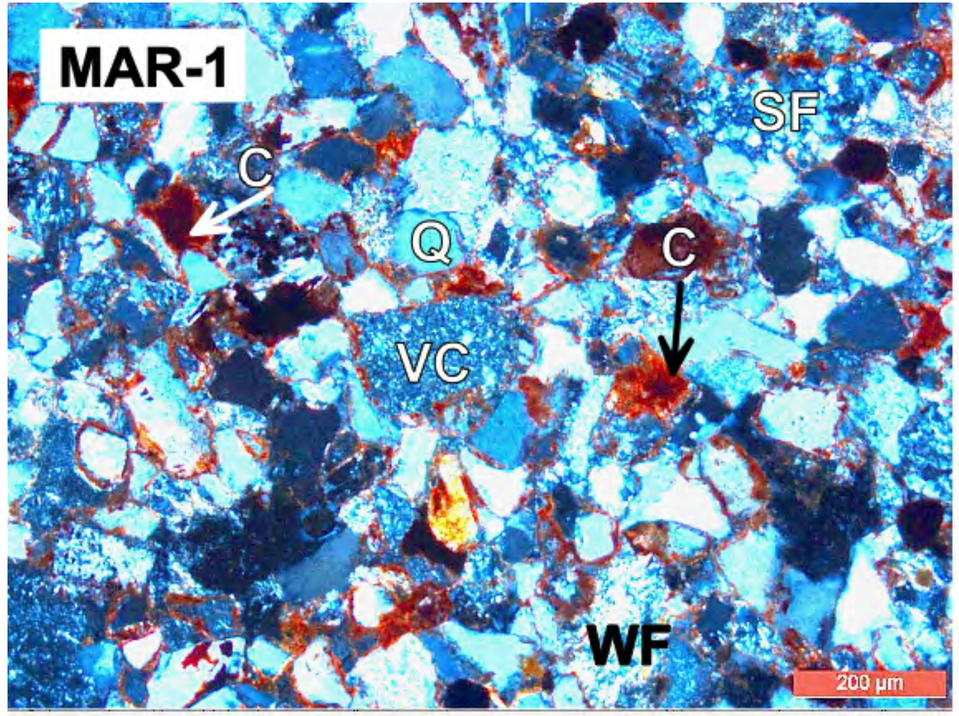
7 days: 30 MPa.

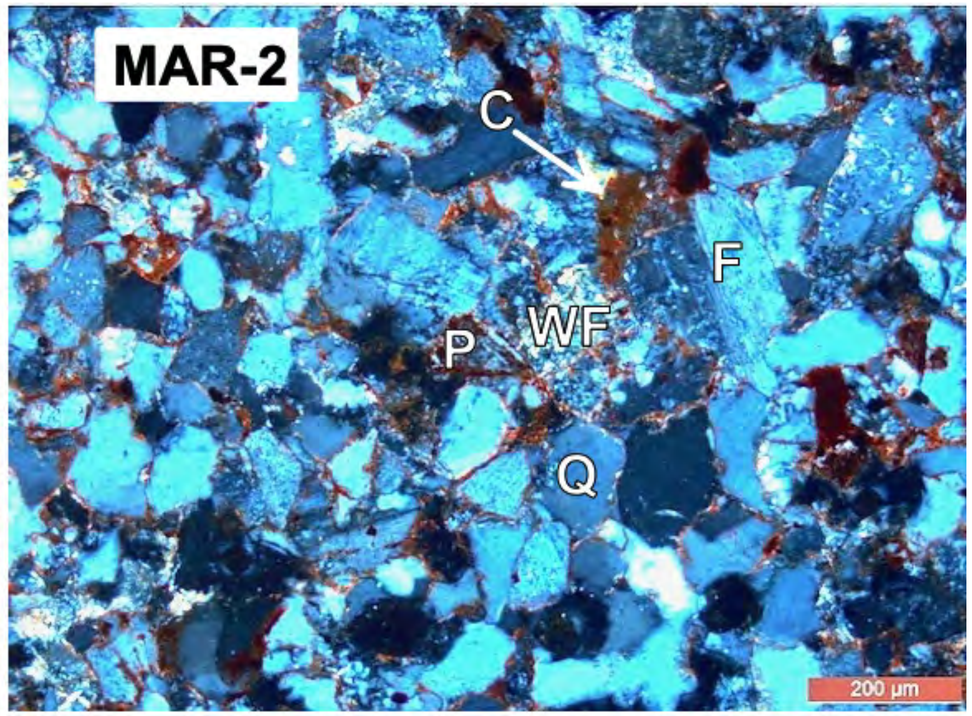
28 days: 75 MPa.

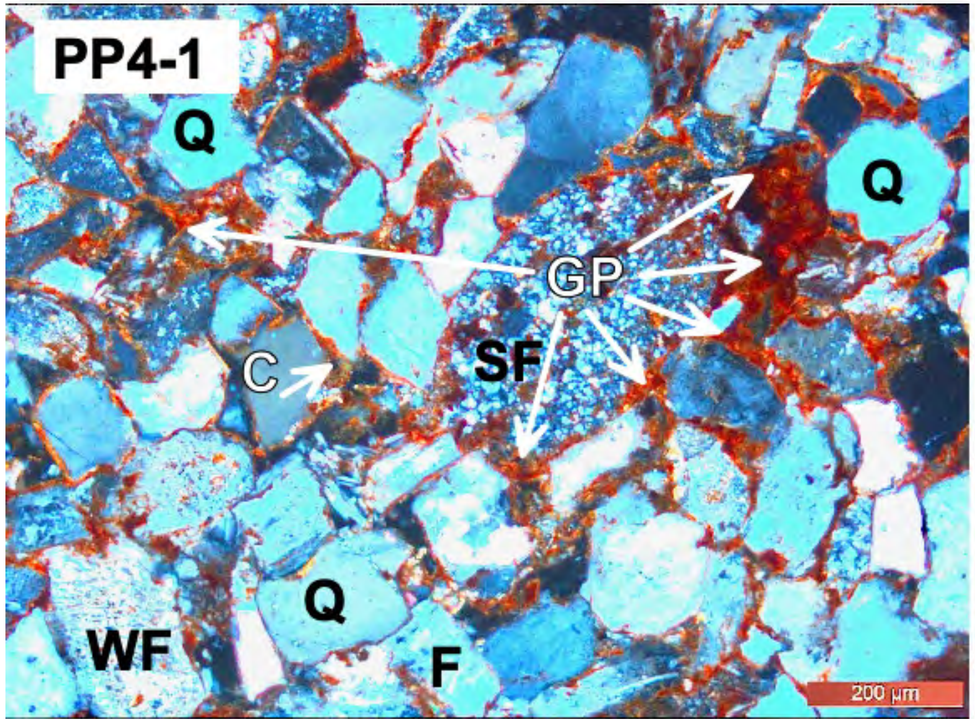
(Na,K,Ca)-(ferro-sialate)-based geopolymer cement

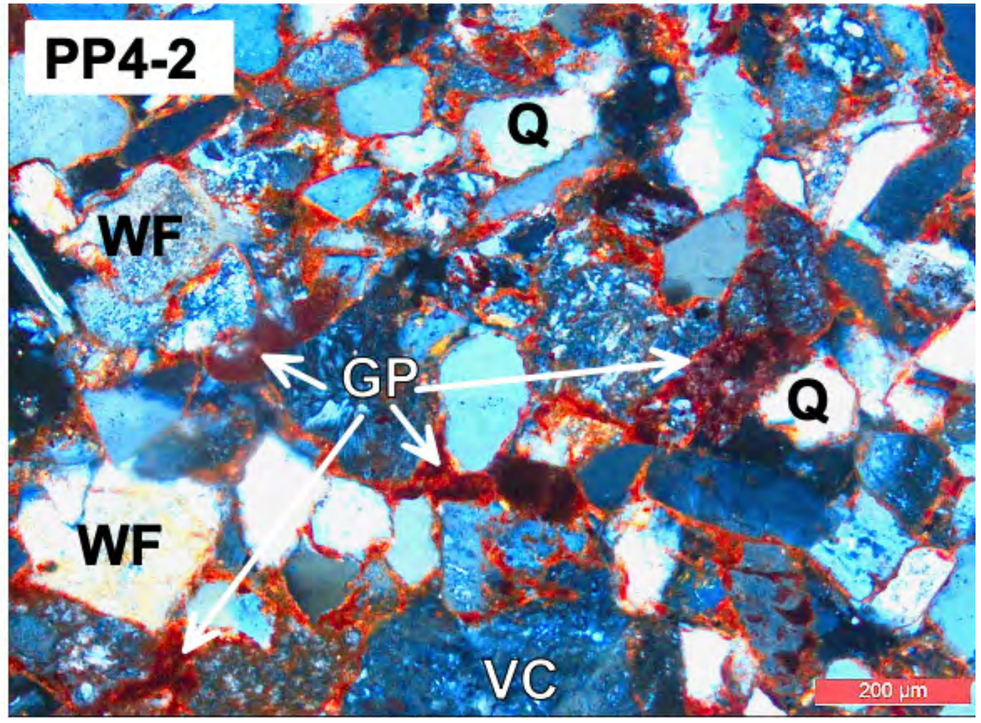
Geological site
Marka

Pumapunku
monument

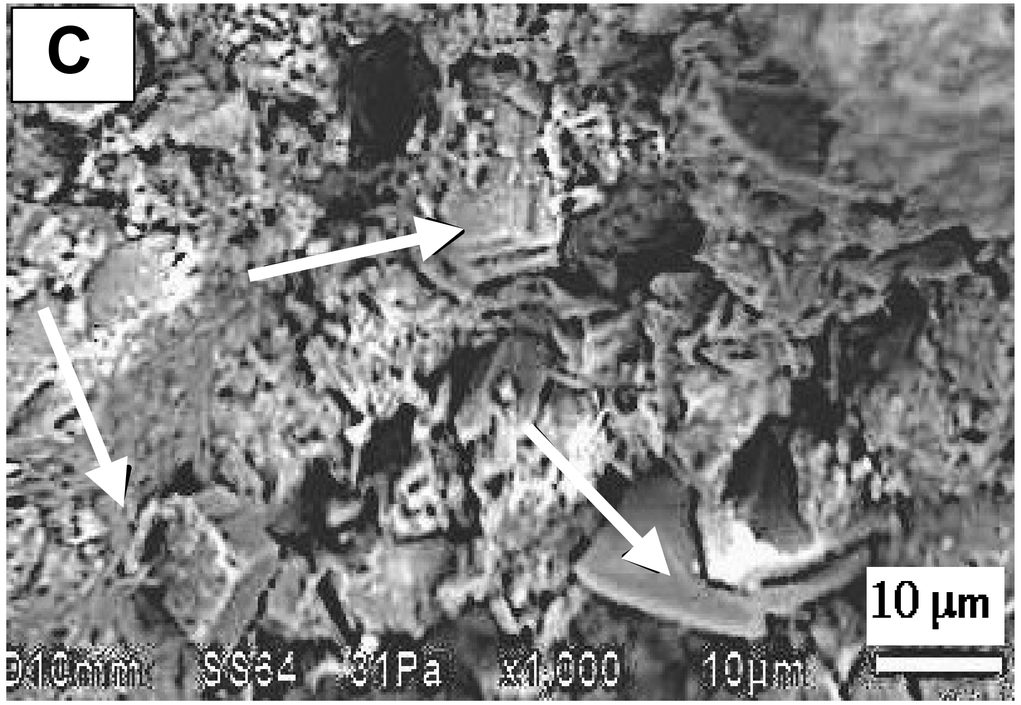


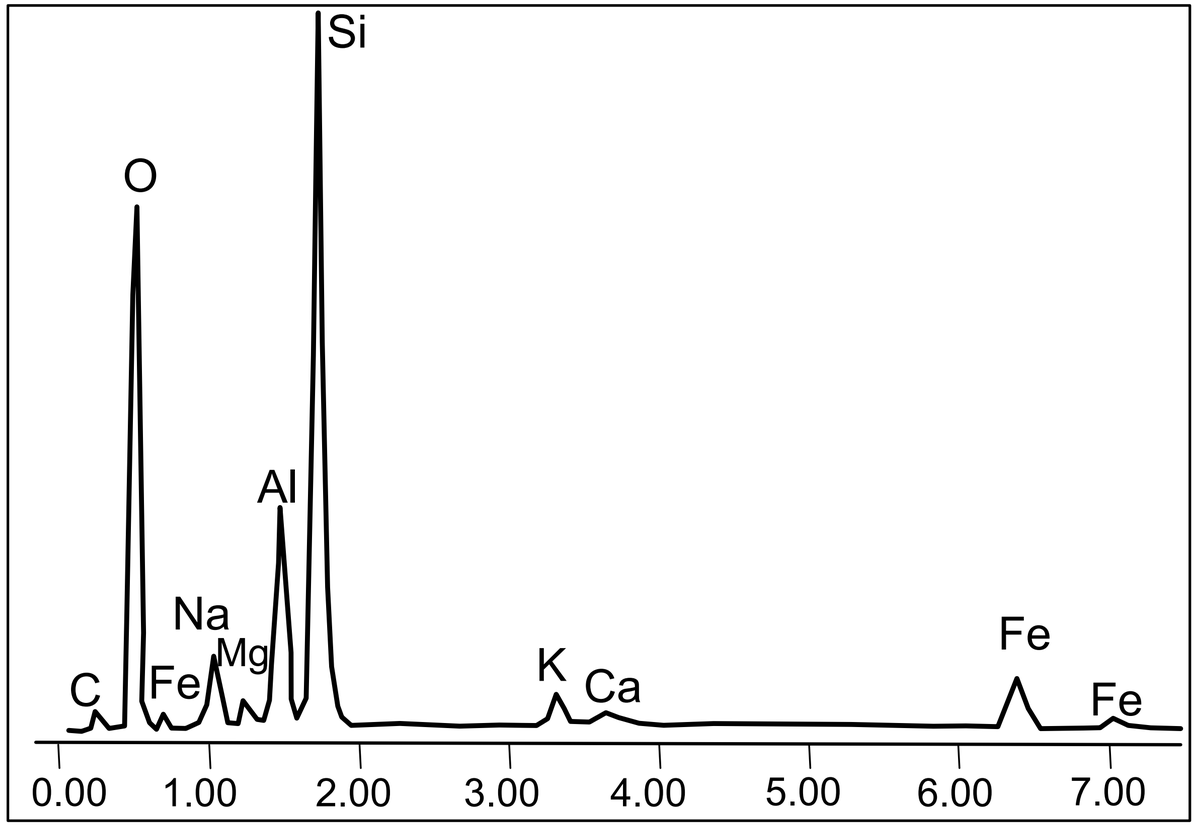






Pumapunku PP4 matrix





Pumapunku PP4 matrix

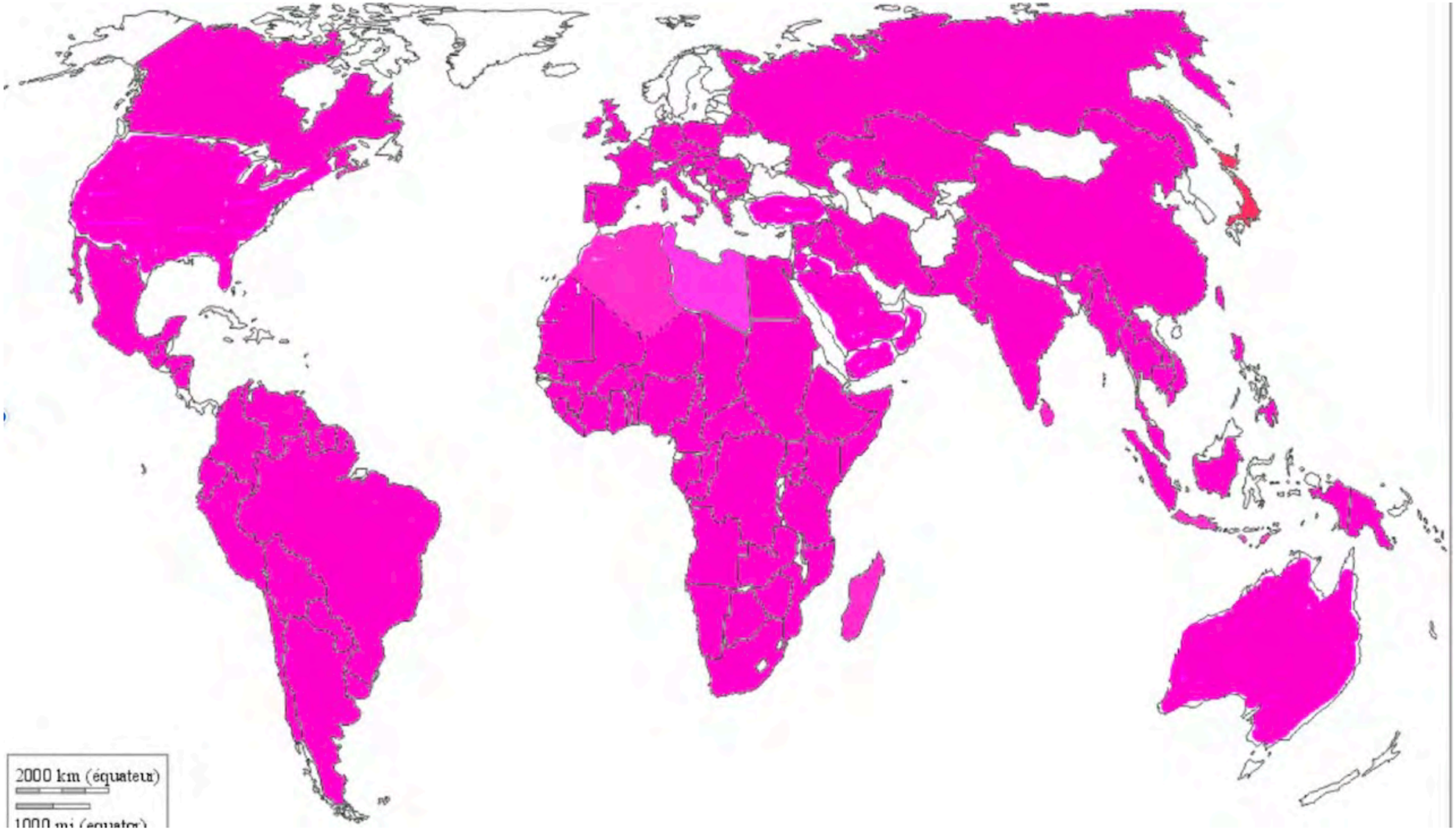
SEM/EDS	atom %	Oxide	Oxide %
Na	7.63	Na_2O	8.17
Mg	1.87	MgO	1.24
Al	15.43	Al_2O_3	23.16
Si	59.12	SiO_2	50.33
K	3.7	K_2O	3.54
Ca	0.6	CaO	0.33
Fe	11.65	Fe_2O_3	13.22
	100		100

substituted Fe at. % : 2.90 (max. 25% of Al)

in ferro-sialate geopolymer (-O-Fe-O-Si-O-Al-)

with Si/(Al,Fe) = 3.2 and rest Fe_2O_3 hematite as filler.

World-wide availability of raw material for ferro-sialate geopolymer cement



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