

Arcillas como sólidos adsorbentes de sustancias en medios líquidos y gaseosos

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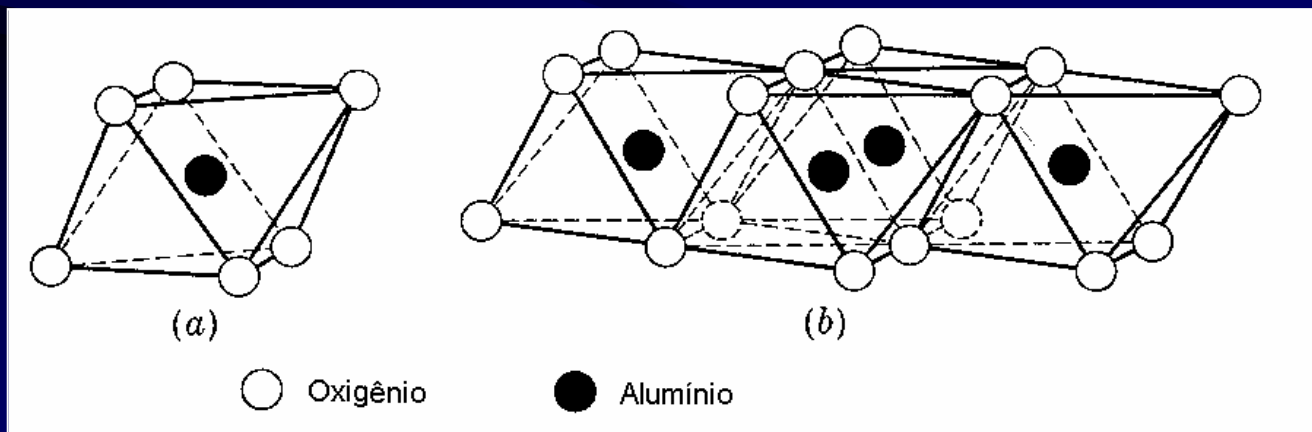
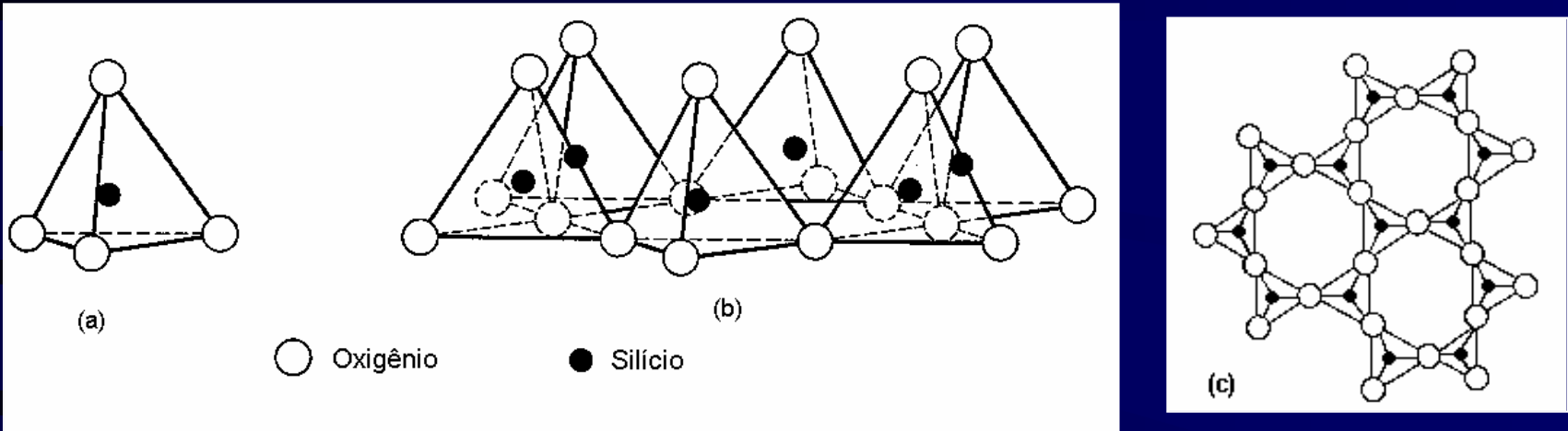
Simposio sobre Adsorción, Adsorbentes y sus Aplicaciones
San Luis, 24-27 de febrero, 2009

La palabra *arcilla* se refiere al material "natural" compuesto fundamentalmente por "mineral de grano fino", el cual es generalmente "plástico" con apropiada cantidad de agua, que endurece cuando se lo seca al aire o calcina.

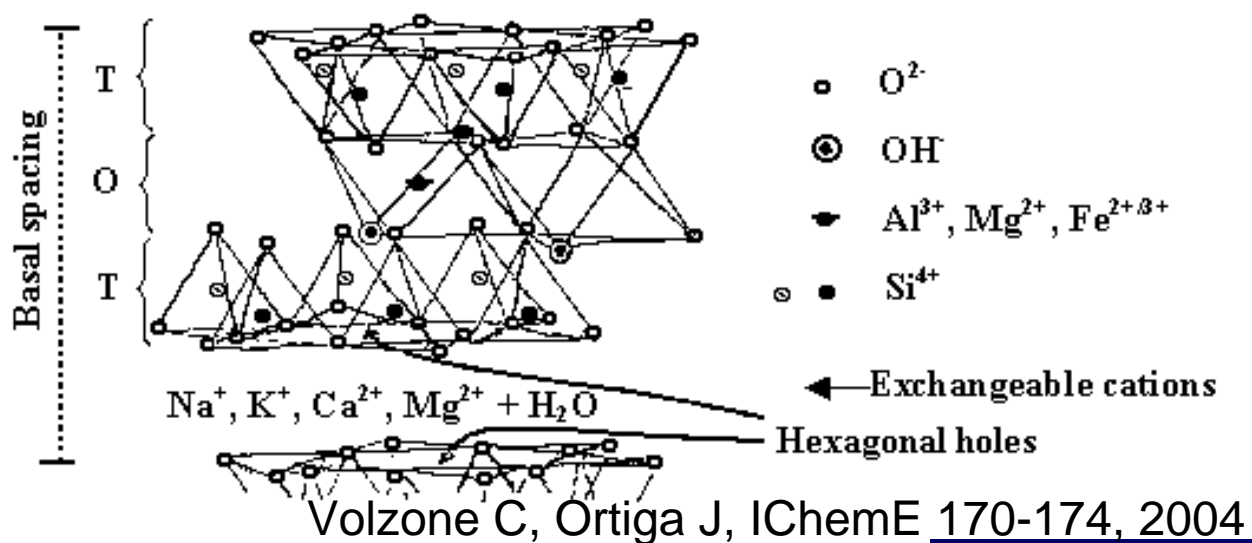
Las arcillas se han formado a partir de:

- transformaciones o alteraciones de rocas ricas en aluminosilicatos,
- por transformaciones de vidrios volcánicos.

Estrutura de arcilla



Clay structure



Si⁴⁺ (Al³⁺).....



Al³⁺(Mg²⁺Fe^{3/2+}Ti⁴⁺)

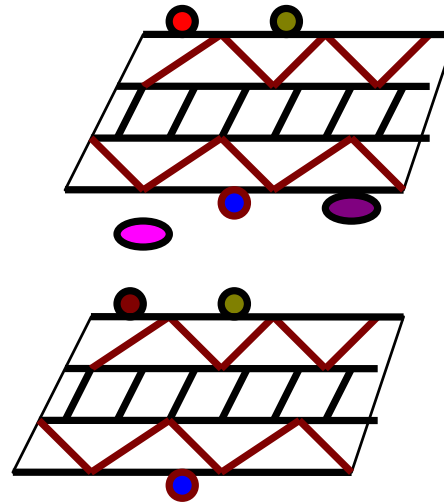
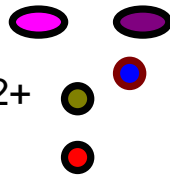


Si⁴⁺ (Al³⁺).....



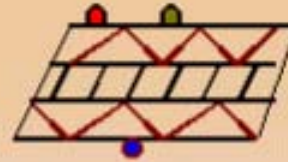
Cation exchange

Ca²⁺, Na⁺, K⁺, Mg²⁺



Activation of clays

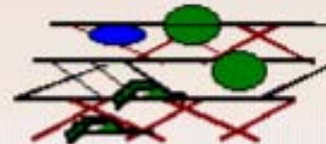
Clay



Treatment



Activated clay



CVolzone

How do you obtain Activated Clays?

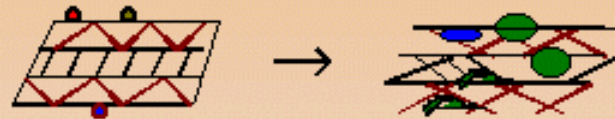
- ⇒ ionic exchange

- ⇒ inorganic substances
 - ⇒ acid
 - ⇒ hydroxy-cations

- ⇒ organic substances
(organo-clays)

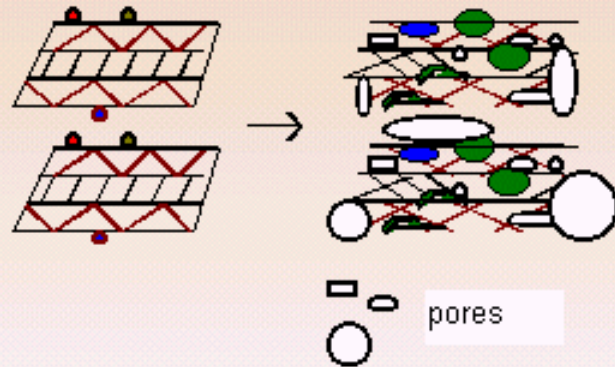
Modifications

⇒ **structural**: chemical composition



⇒ **textural**: porosity, surface area

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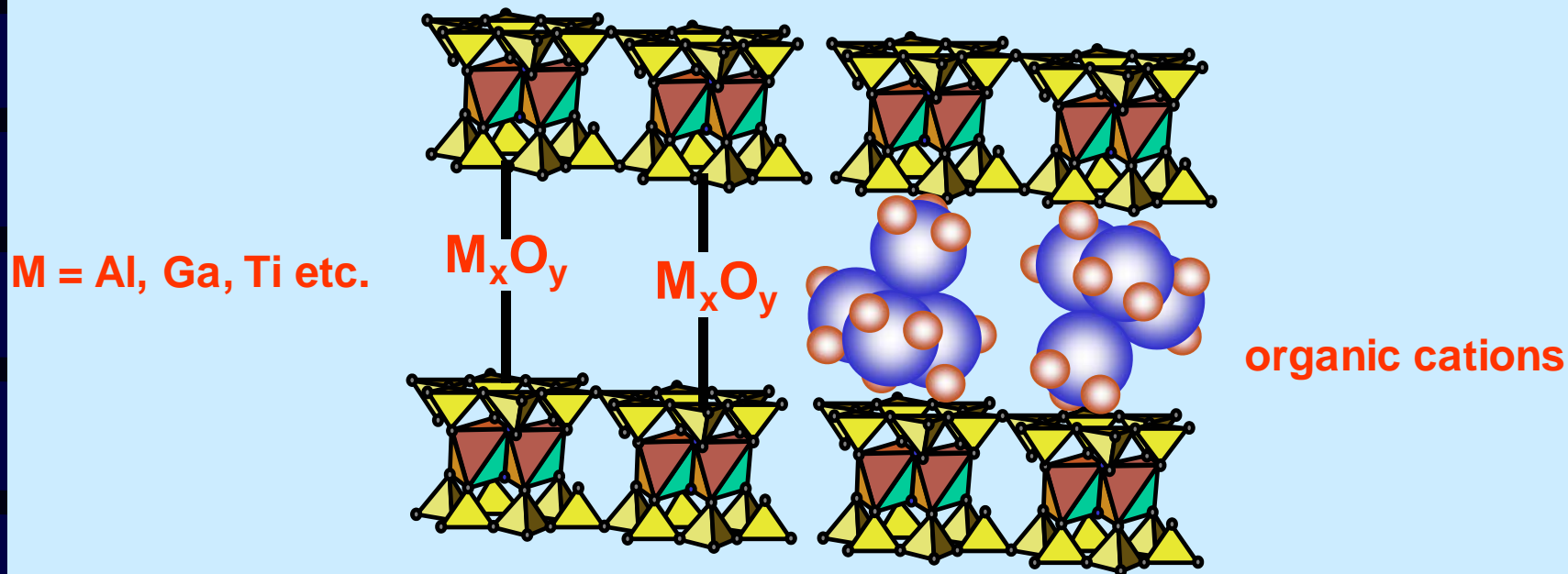
surface BET

raw clays

5 - 40 m²/g

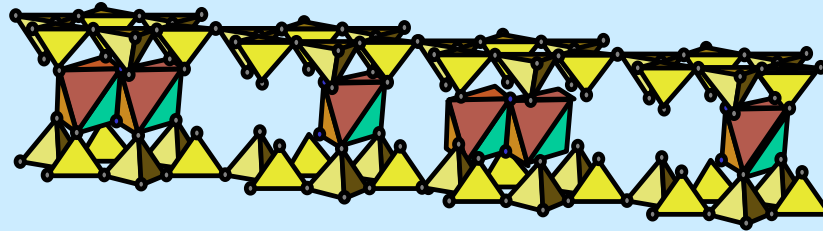
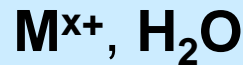
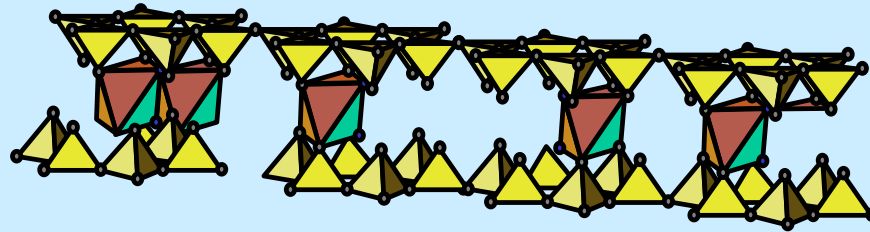
activated clays

200 - 500 m²/g



- Increased porosity, surface area
 - gas sorption
 - organic uptake

Churchman J, Volzone C. 12ICC 2001

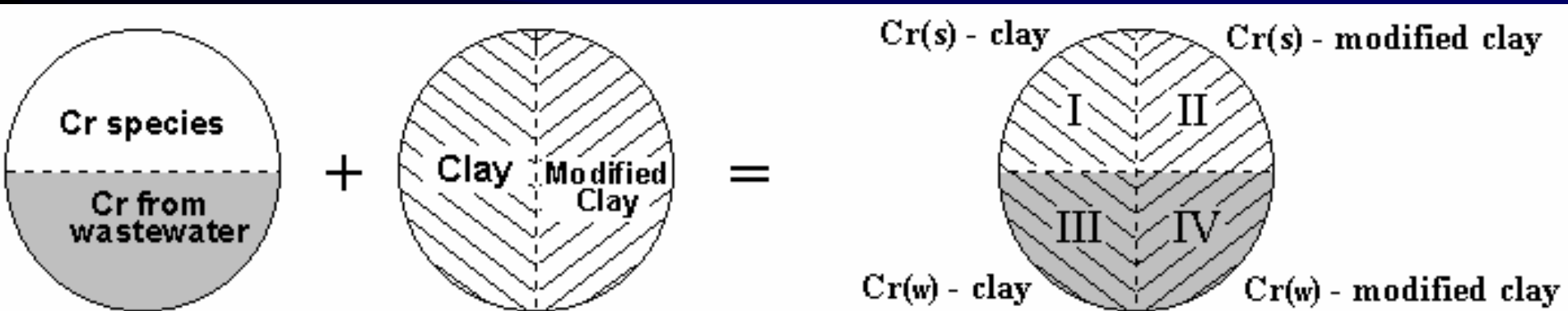


Acid activation: creating pores by subtraction

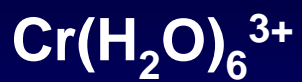
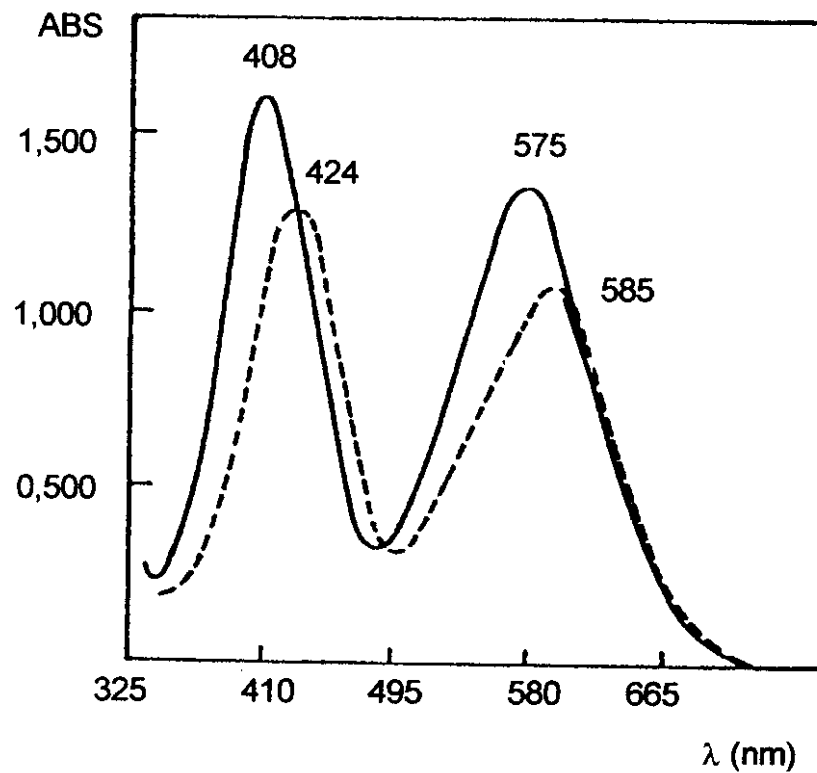
- Ability to remove large organic molecules (oil decolourising)
- Increased porosity, surface area
- gas sorption & selectivity

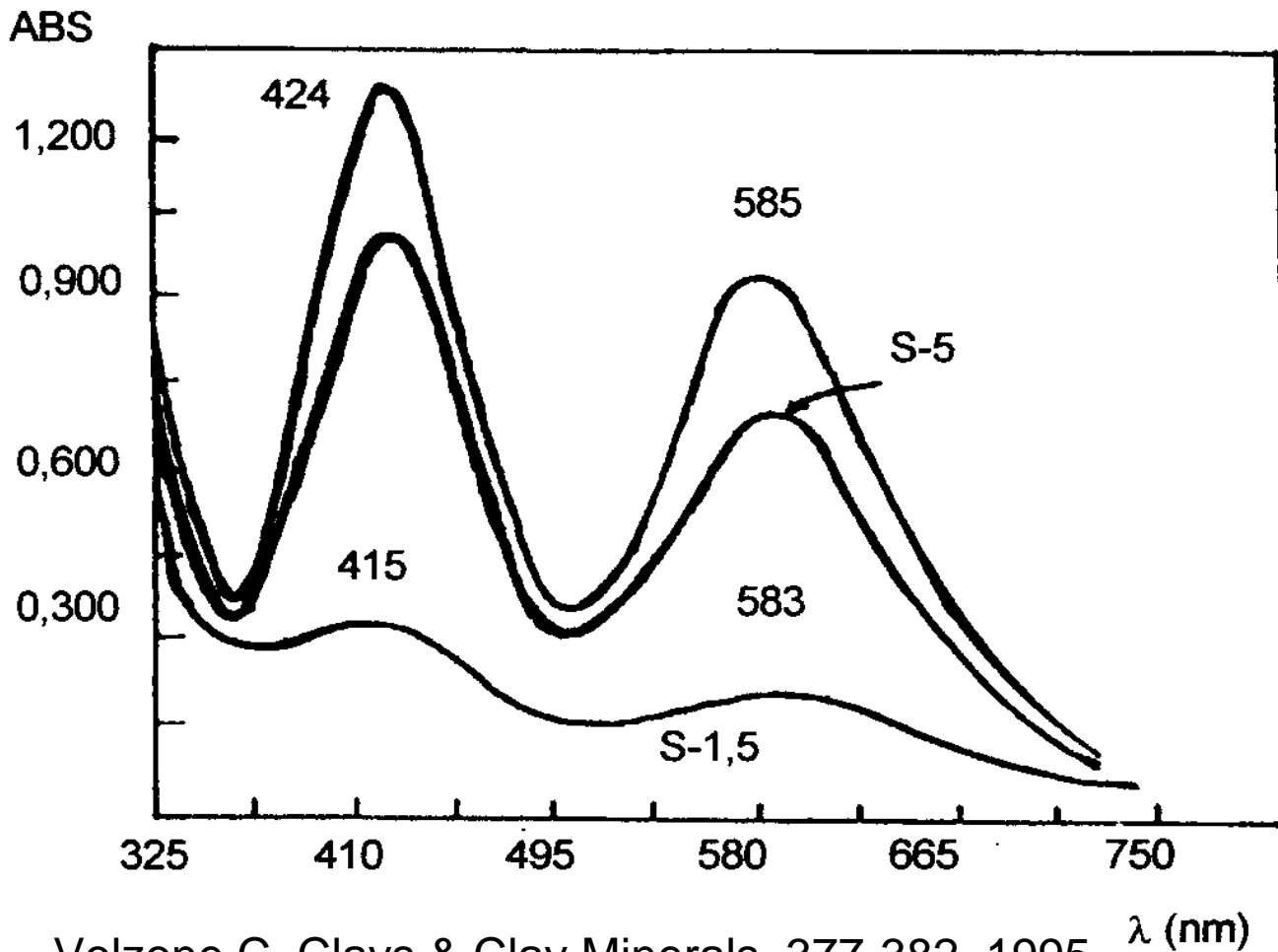
Churchman J, Volzone C. 12ICC 2001

Retención de sustancias metálicas en solución



C.Volzone, in Clay Surfaces: Fundamentals and Applications, Chapter 10,
Ed. F.Wypych and KGSatyanarayana, Academic Press, 2004

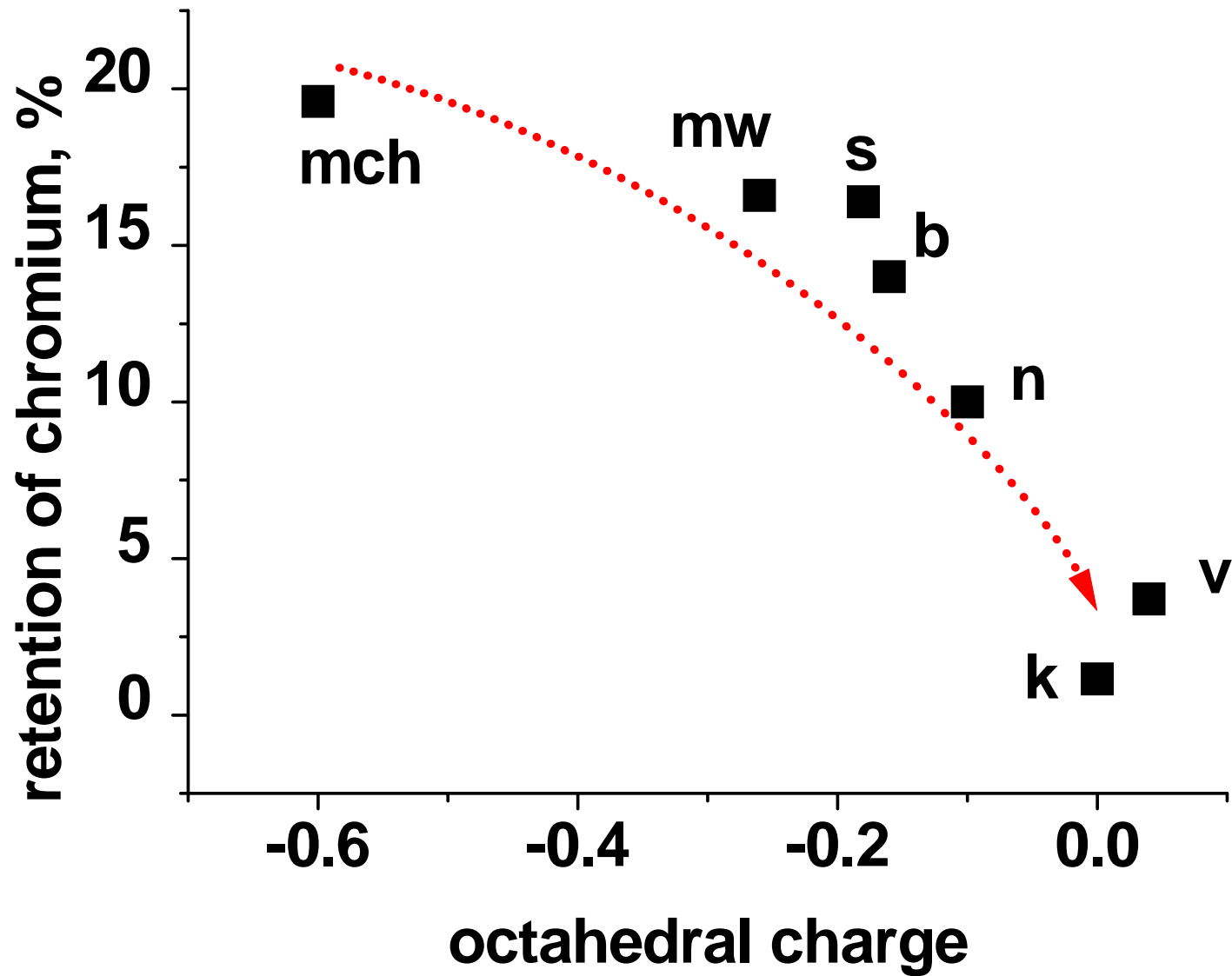




Volzone C, Clays & Clay Minerals, 377-382, 1995. λ (nm)

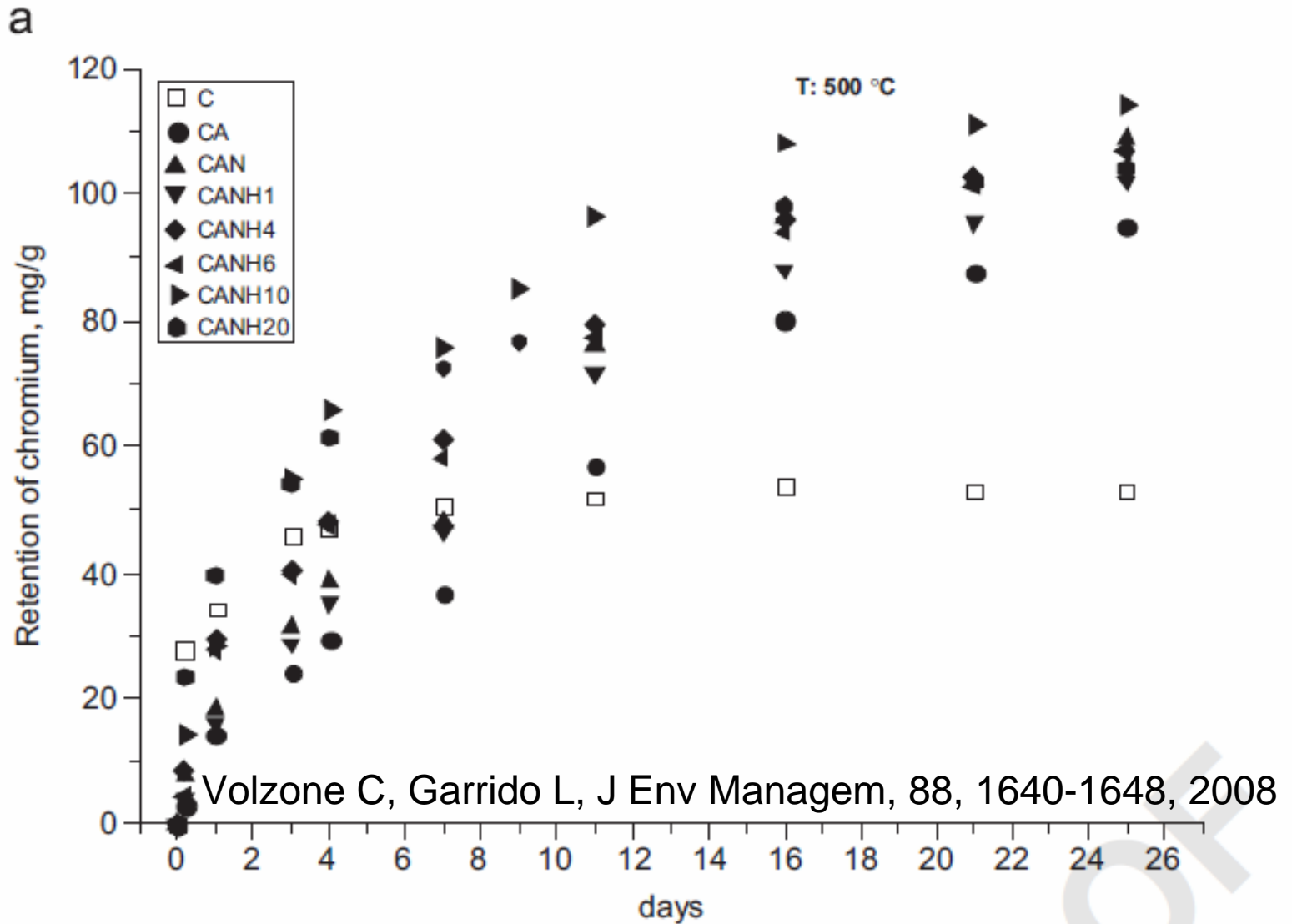
CLAYS	Monomeric - Cr	Polimeric - Cr
BENTONITES	1–2.5 CEC (100-250meq/100g)	3–8CEC (300-800meq/100g)
ACTIVATED – B	3.5 CEC (350meq/100g)	-----
KAOLINITES	1 CEC (10meq/100g)	7 CEC (10meq/100g)
ACTIVATED – K	12 CEC (120meq/100g)	-----
VERMICULITE	n.d.	1.12 CEC (146meq/100g)

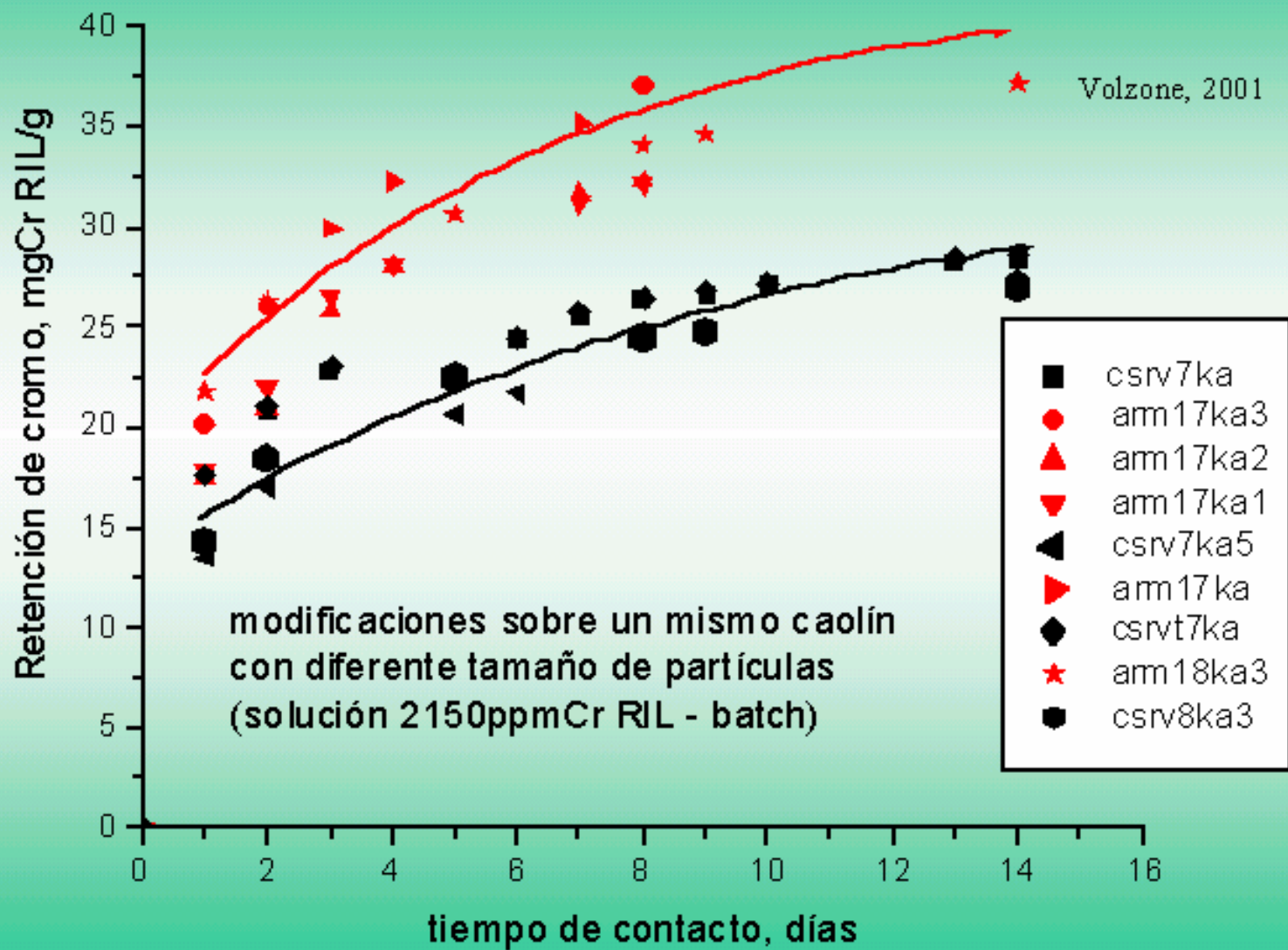


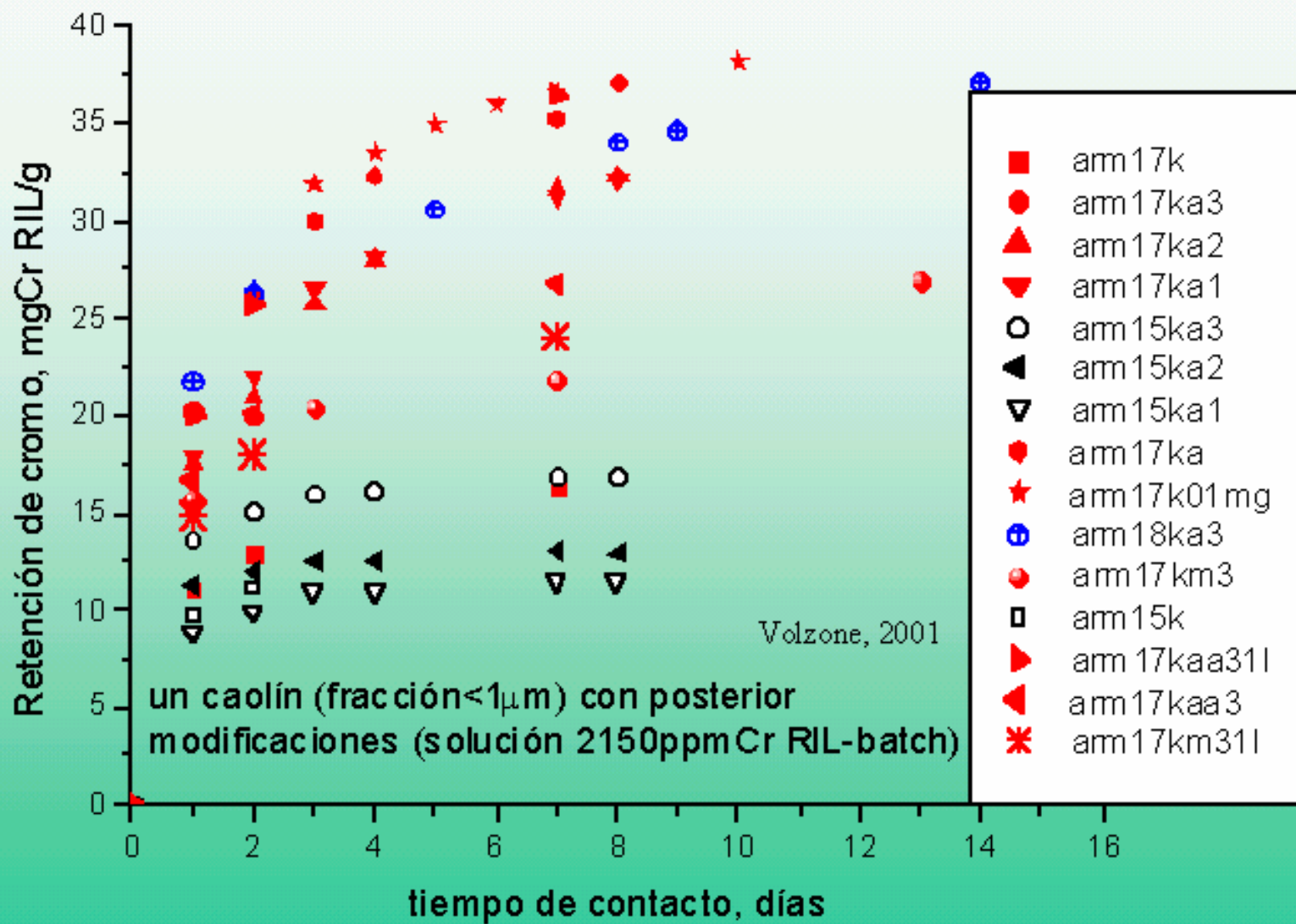


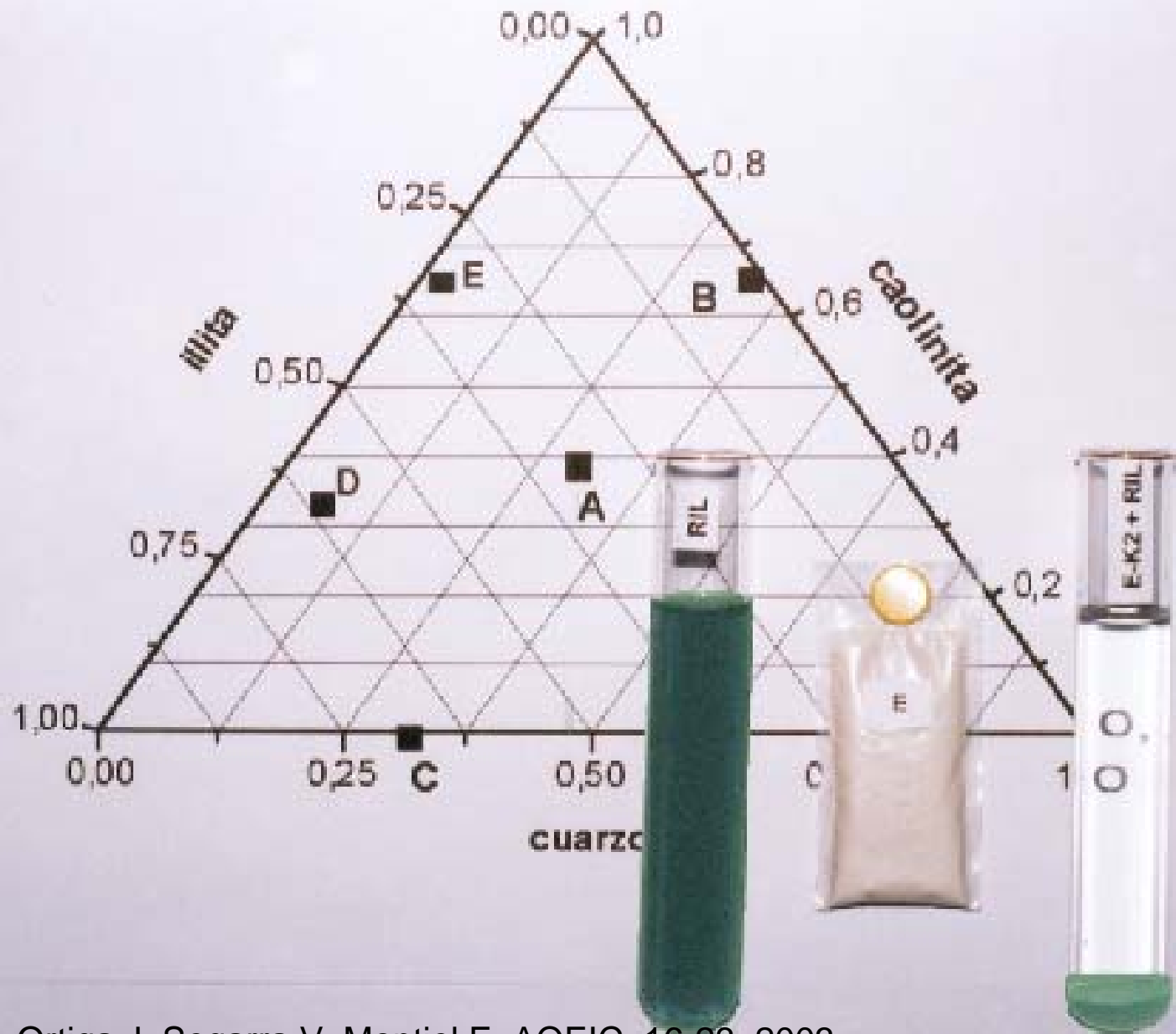
Volzone C, 2000

C : bentonita natural; CA: PILC-AI



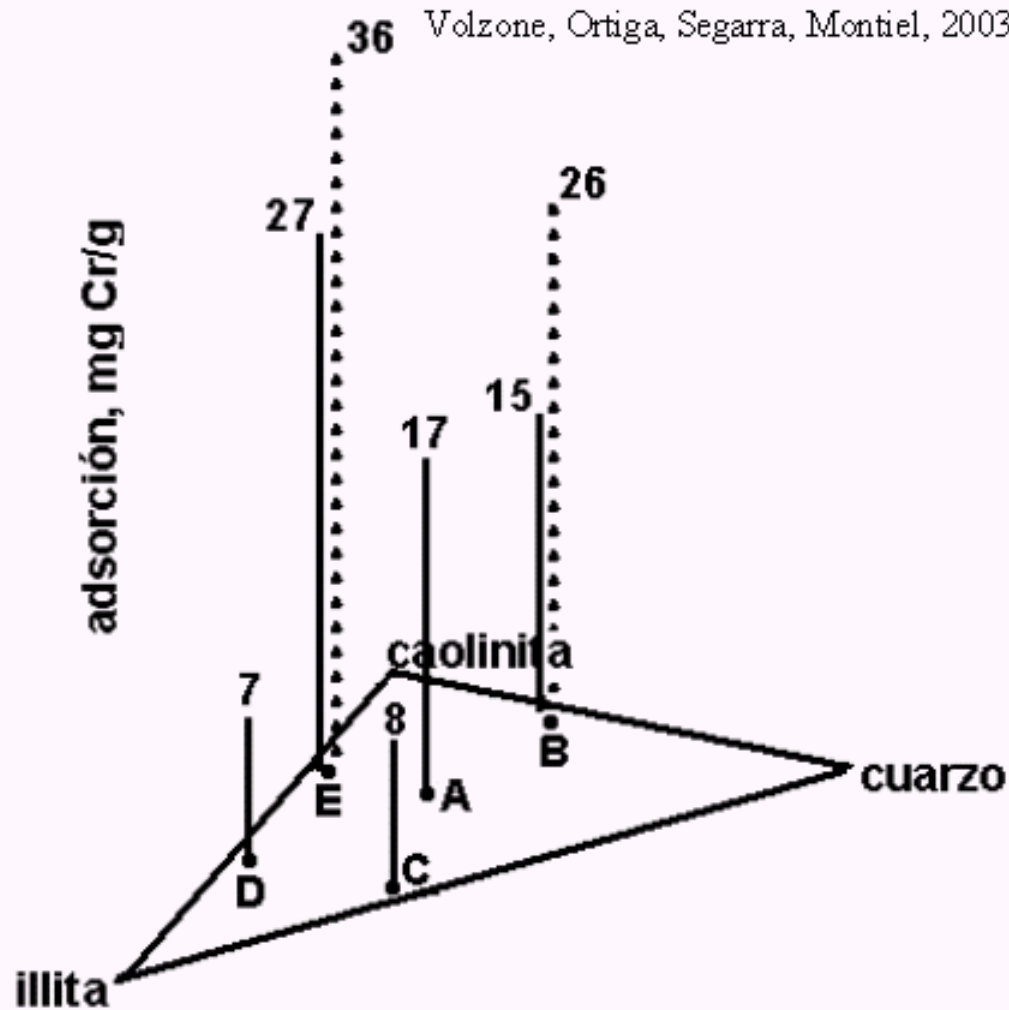


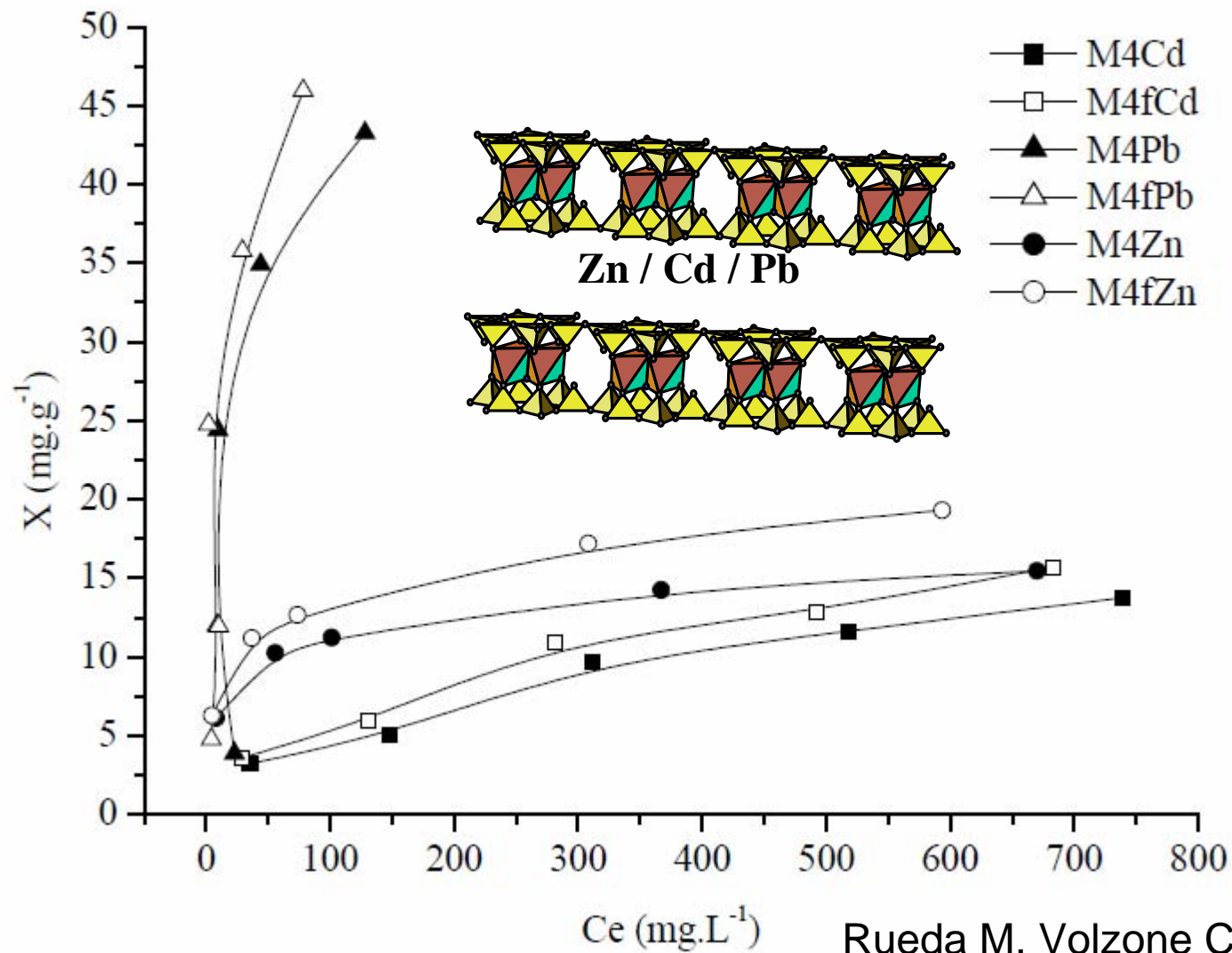




Volzone C, Ortiga J, Segarra V, Montiel E, AQEIC, 16-23, 2003

Volzone, Ortiga, Segarra, Montiel, 2003





Rueda M, Volzone C, 2007

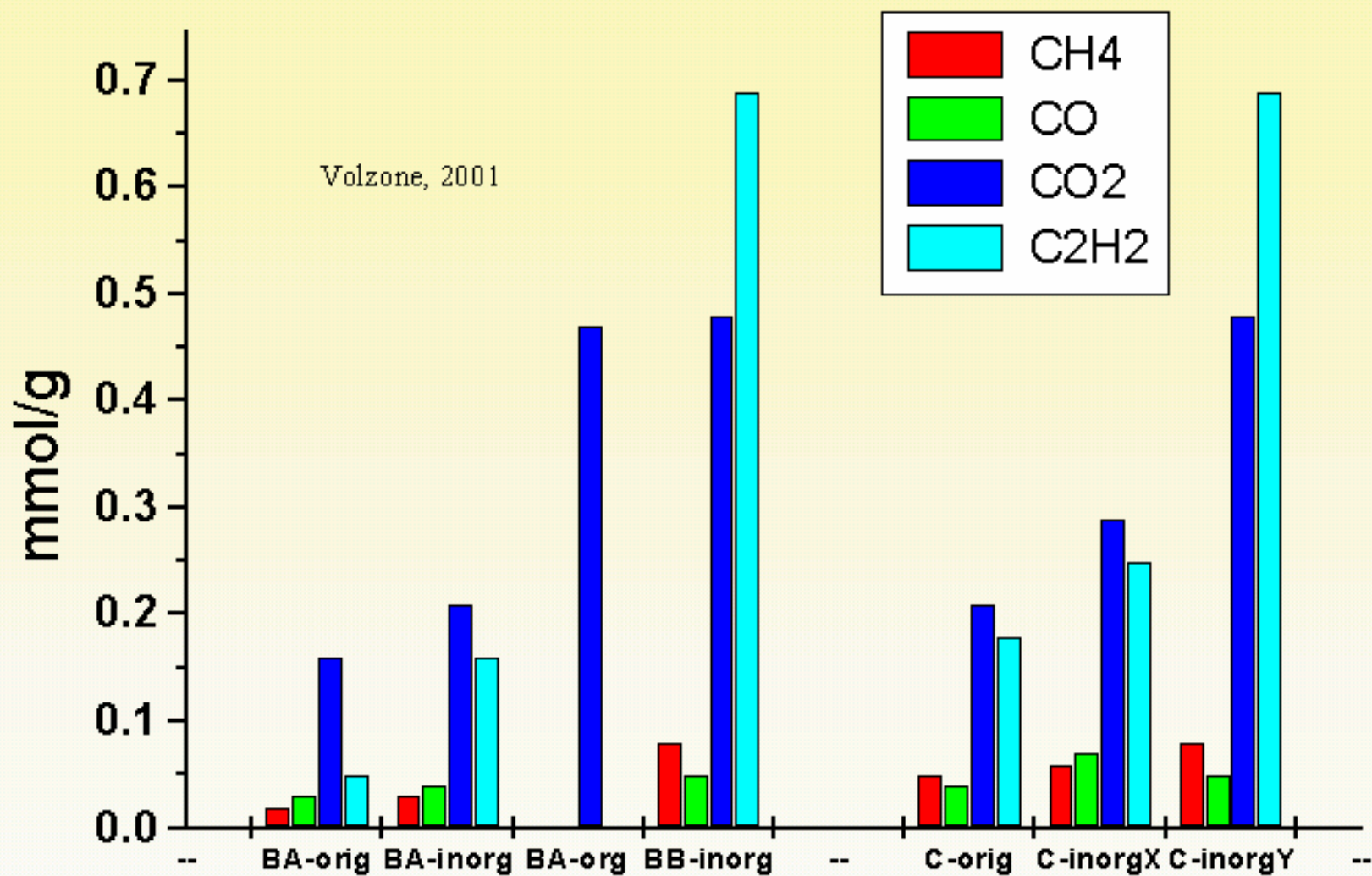
Tabla 2 – Parámetros de Langmuir.

Muestras	Adsorción de Pb			Adsorción de Cd			Adsorción de Zn		
	Xm (mg·g ⁻¹)	b (L·mg ⁻¹)	R ²	Xm (mg·g ⁻¹)	b (L·mg ⁻¹)	R ²	Xm (mg·g ⁻¹)	b (L·mg ⁻¹)	R ²
M4	47,619	8,750E-02	0,998	22,727	2,081E-03	0,978	15,873	3,326E-02	0,998
M4f	47,619	2,000E-01	0,988	24,390	2,576E-03	0,974	20,000	3,353E-02	0,996

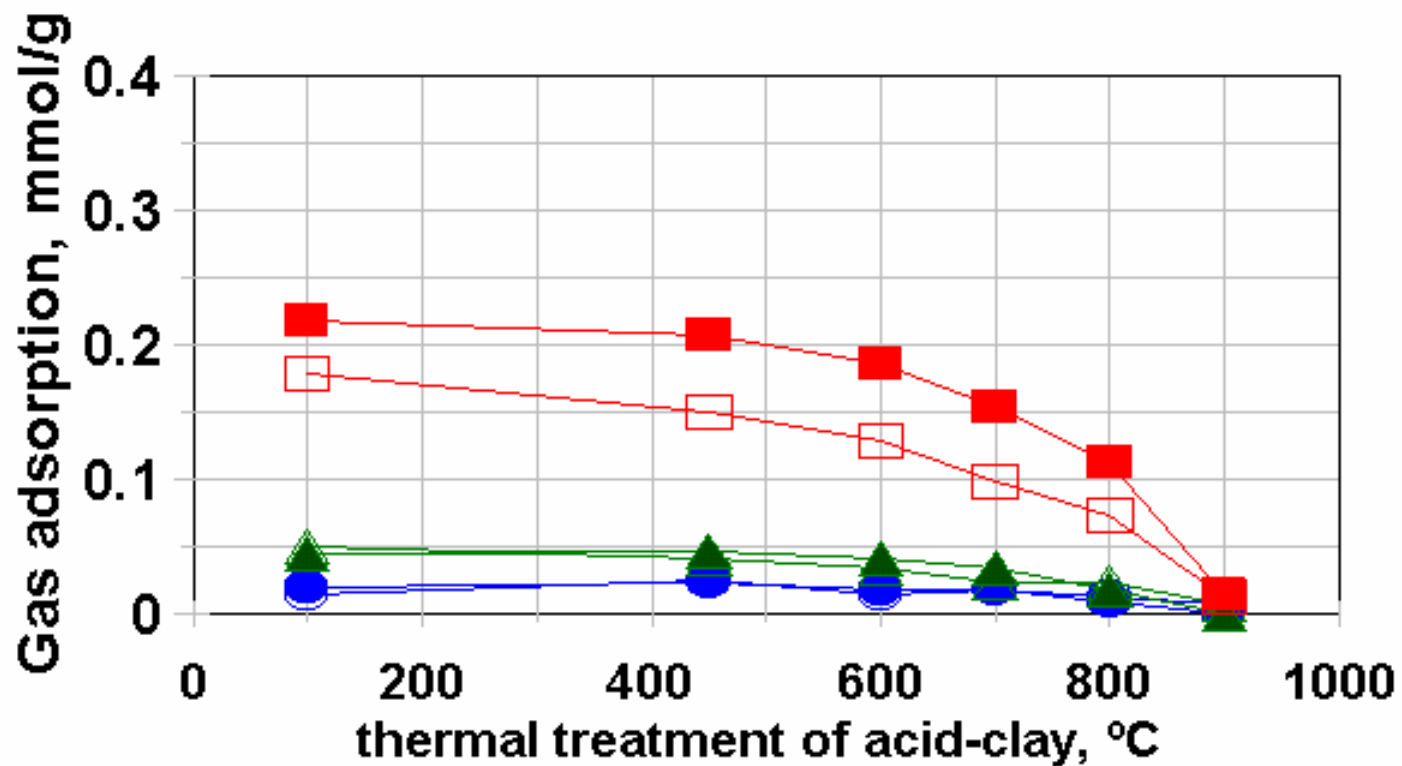
	Pb	Cd	Zn
M4	0,447 mmol /g	0,202 mmol/g	0,243mmol/g
M4f	0,447 mmol /g	0,217 mmol/g	0,306 mmol/g

Rueda M, Volzone C, 2007

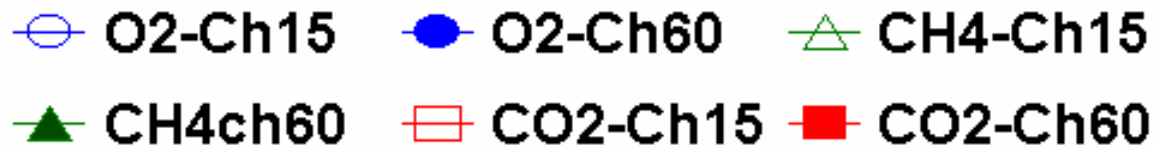
Retención de gases por arcillas naturales y modificadas

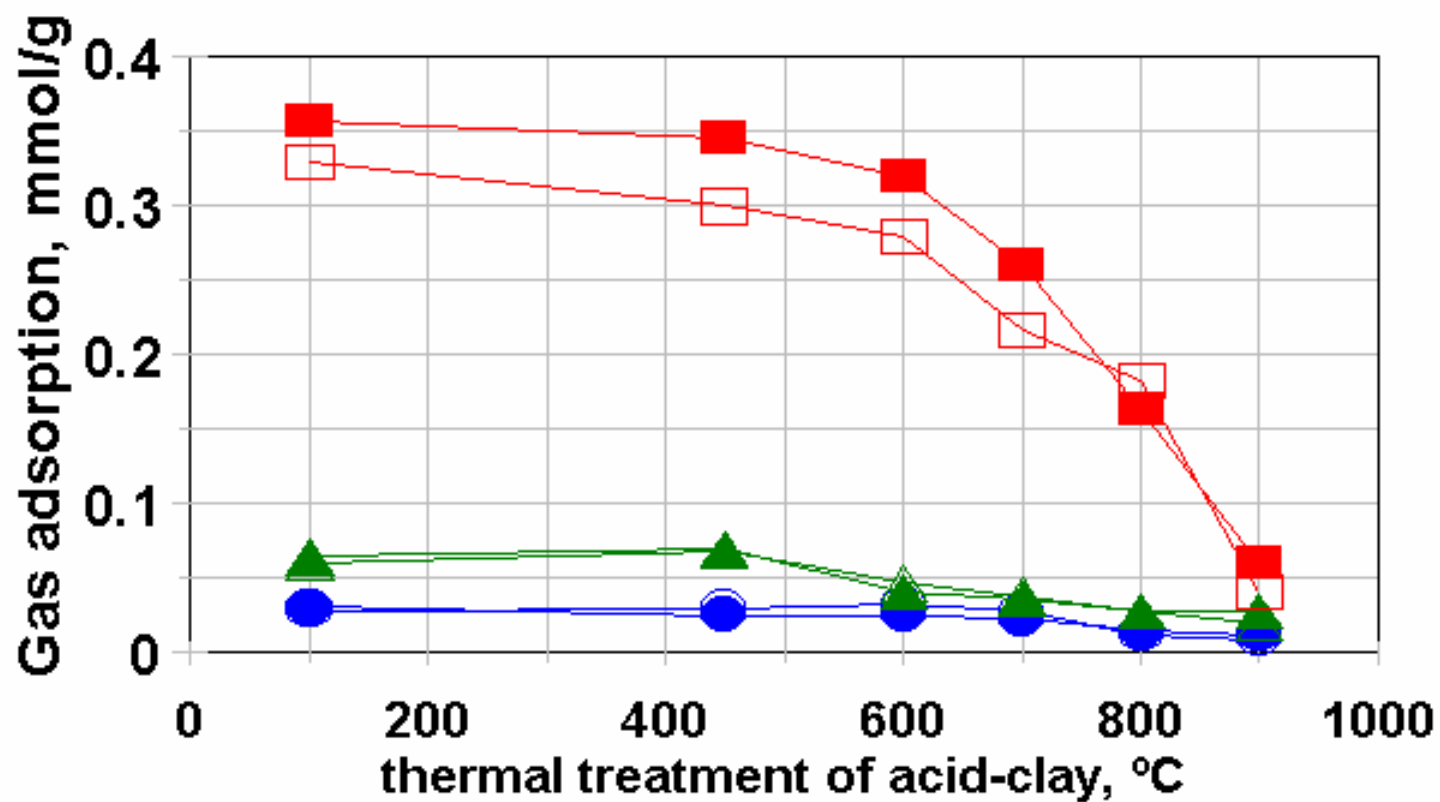


B: bentonite; C: kaolinite

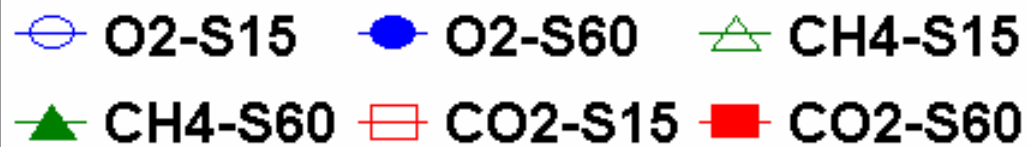


Volzone, Ortiga, 2000





Volzone, Ortiga, 2000



Sample	Total surface m²/g	Micropore surface m²/g	Si/oct.sheet
Ch	78	71	1.99
Ch15	276	222	2.55
Ch60	467	419	4.17
S	8	6	1.26
S15	322	288	8.30
S60	437	390	13.83

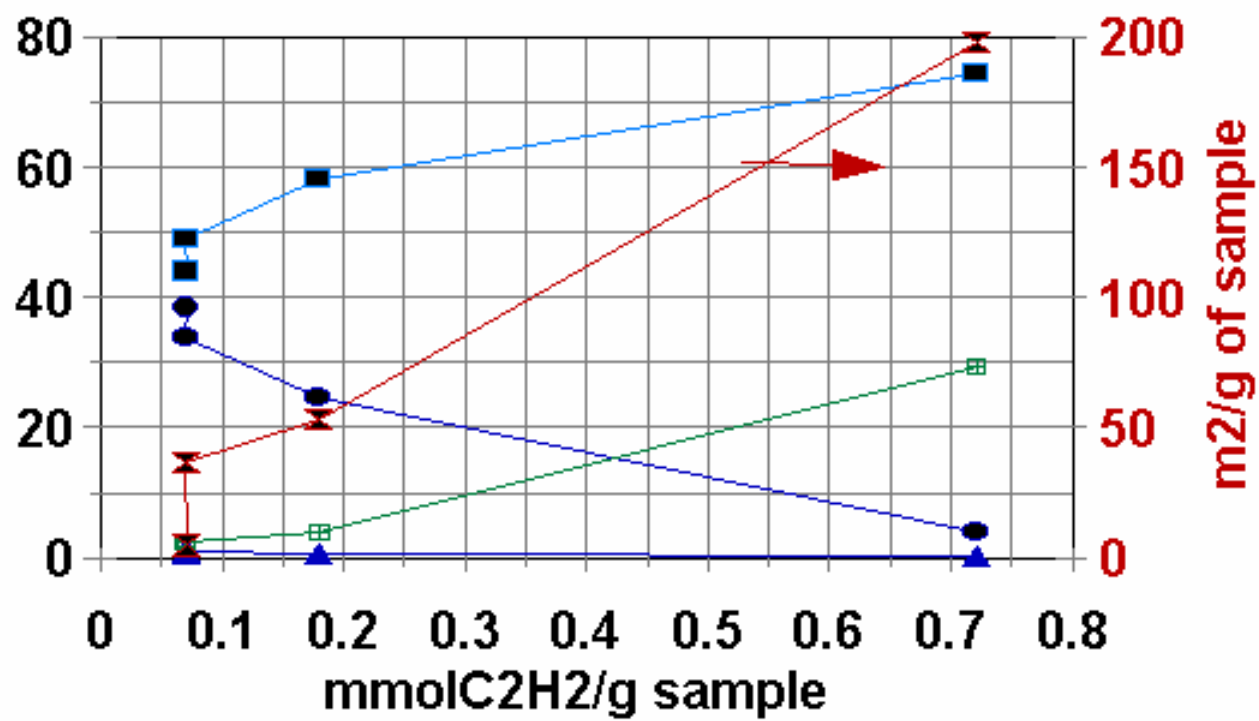
Volzone, Ortiga, 2000

Acid kaolinite	CO₂ mmol/g	CH₄ mmol/g	C₂H₂ mmol/g	CO₂/CH₄
K	0.044	0.016	0.071	2.9
K60	0.046	0.016	0.070	2.6
K180	0.140	0.014	0.180	3.1
K180M	0.602	0.066	0.721	9.2

Treatment: 5.0N sulphuric acid solution

*ratio > 3 commercially viable for gas separation

Volzone, Ortiga, 2000



Volzone, Ortiga, 2000

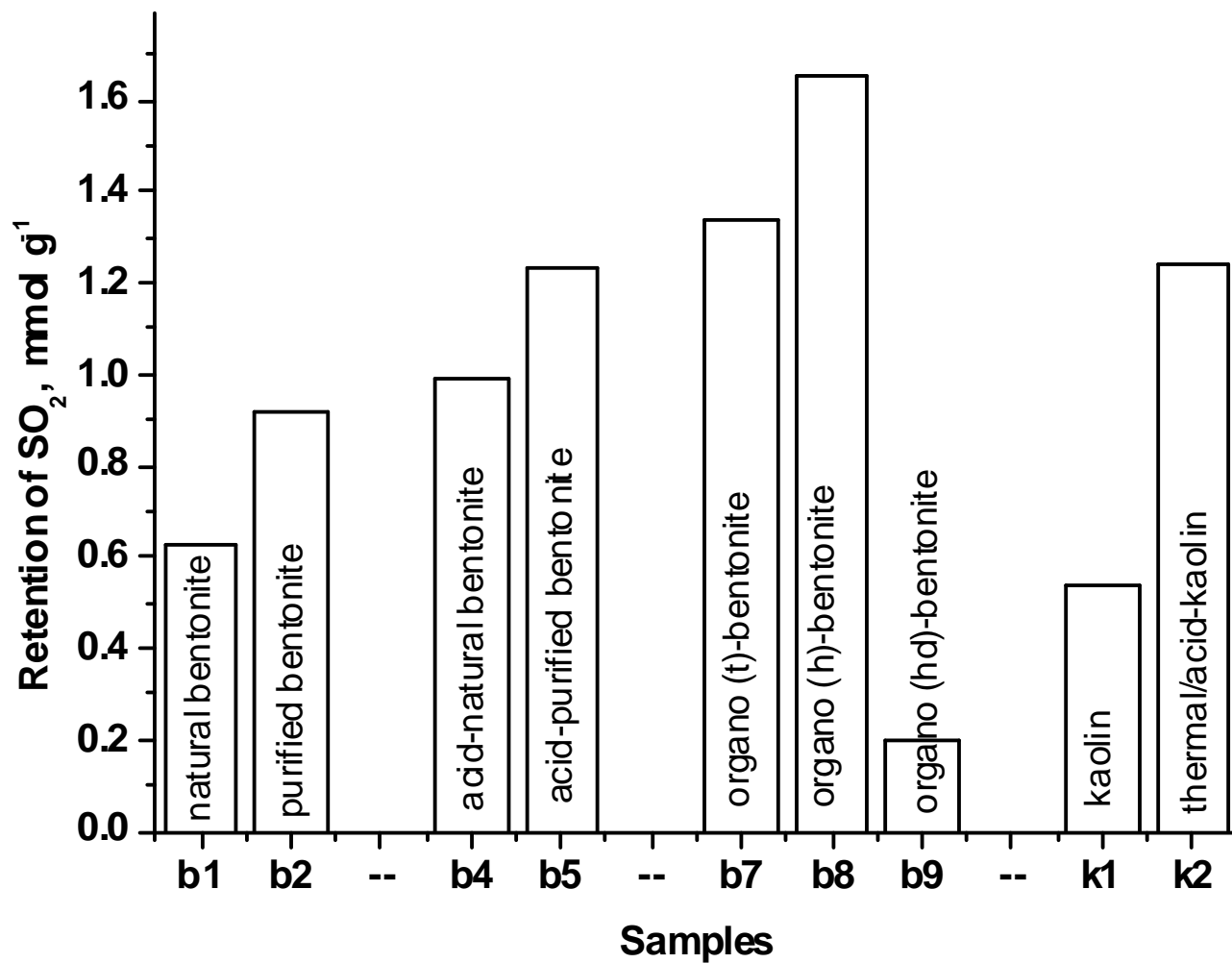
- SiO_2 , %
- Al_2O_3 , %
- ▲ Fe_2O_3 , %
- ▣ $\text{Si}/(\text{Al}+\text{Fe})$
- ✕ surface BET

ADSORPTION OF N₂ AND CO₂ GAS BY TETRAMETHYLAMMONIUM-MONTMORILLONITES

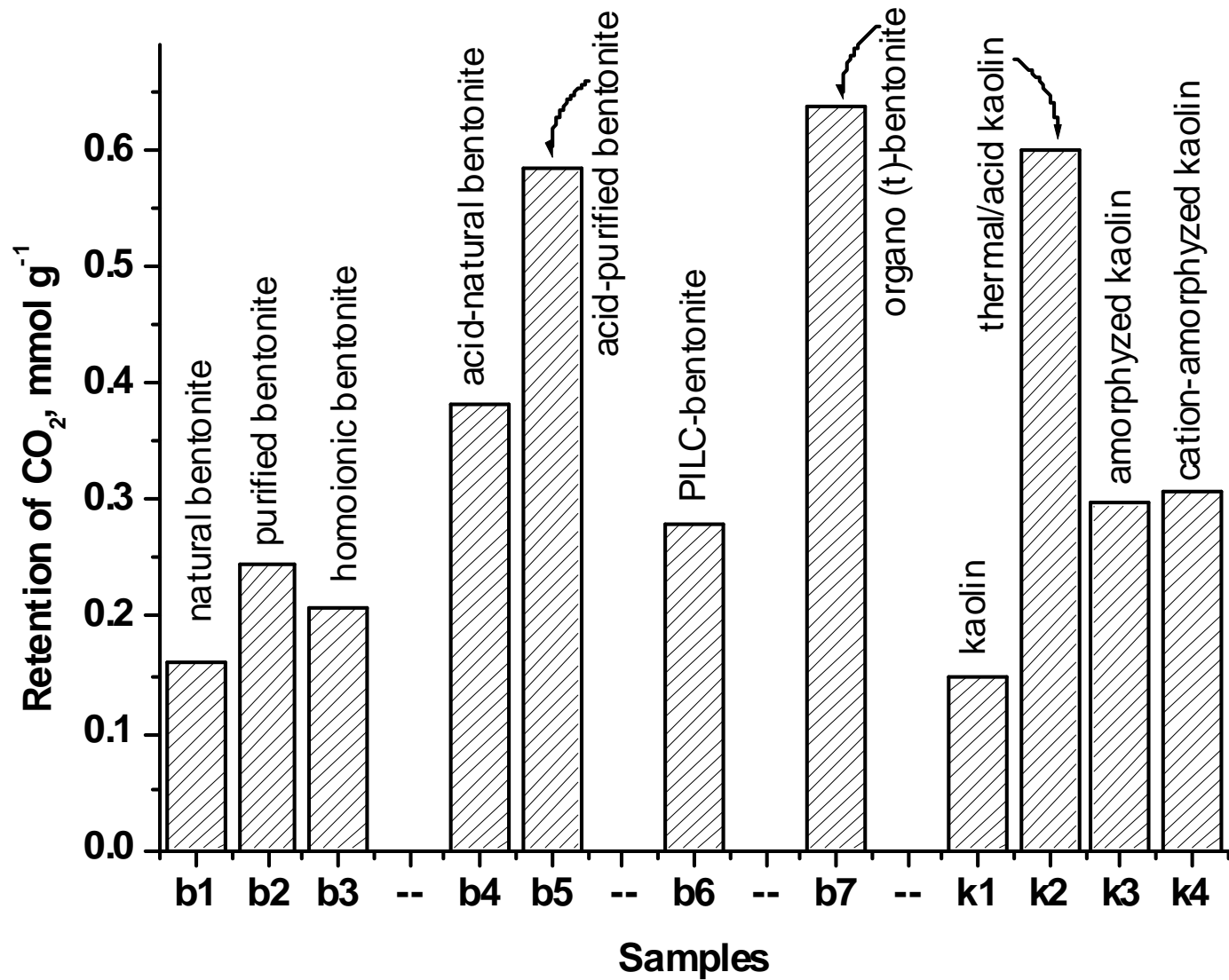
Volzone, Rinaldi, Ortiga, 2002

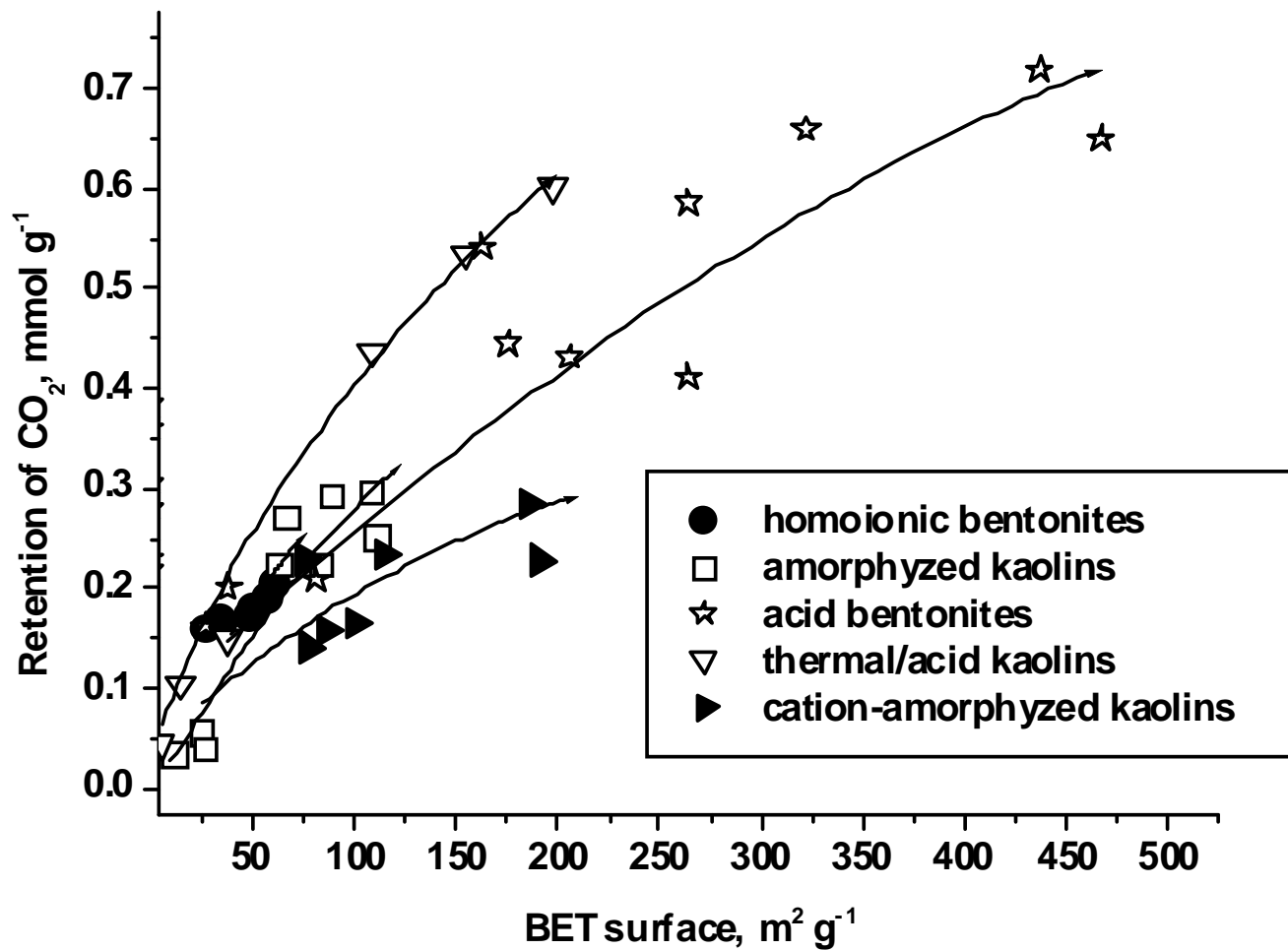
sample	N ₂ (mmol/g)	CO ₂ (mmol/g)
B1	0.017	0.210
B1(1-4)	0.055	0.439
B1(1-24)	0.044	0.445
B1(4-4)	0.038	0.353
B1(4-24)	0.049	0.423
B2	0.011	0.125
B2(1-4)	0.065	0.445
B2(1-24)	0.060	0.423
B2(4-4)	0.060	0.461
B2(4-24)	0.055	0.477

Gas adsorption at 25 °C and 1 kg/cm²

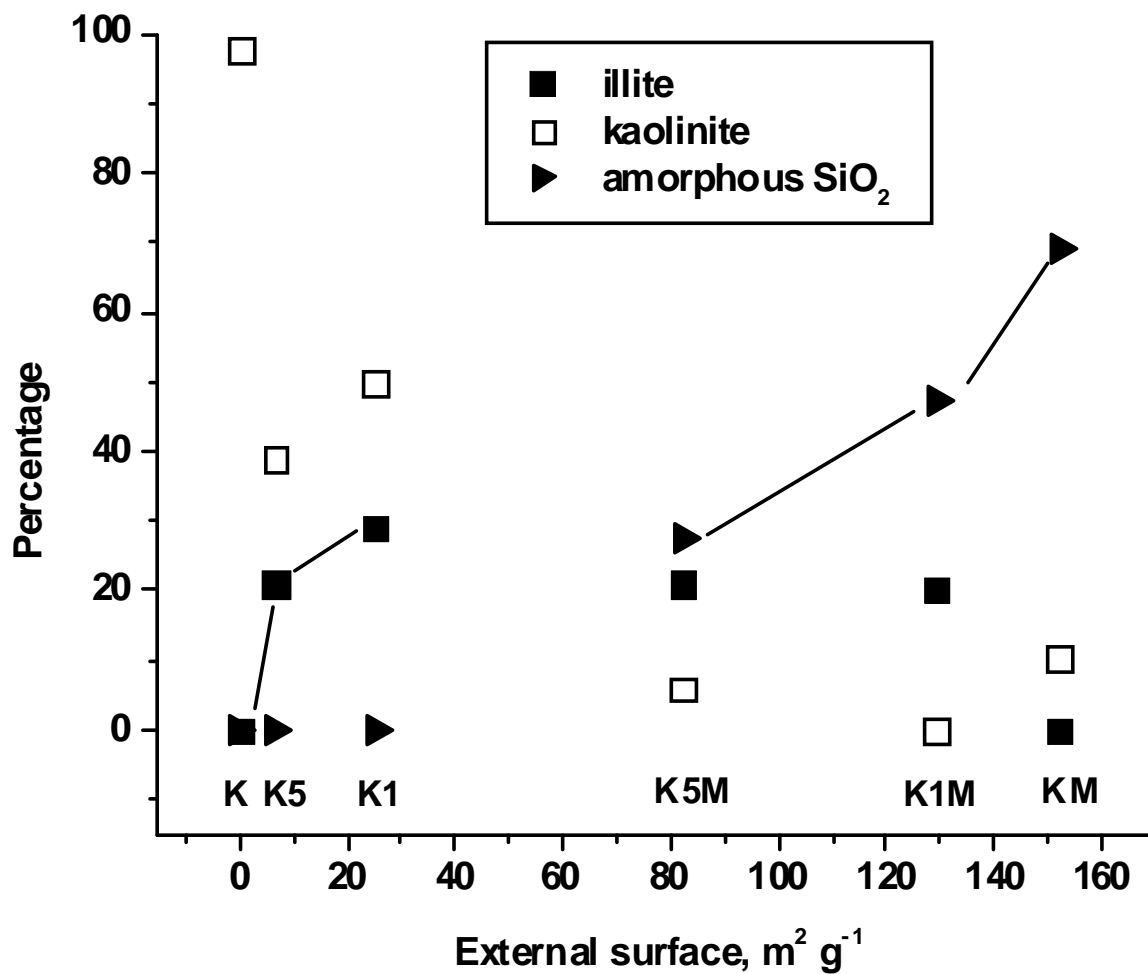


Volzone C, Appl.Clay Sci. 36, 191-196, 2007





Volzone C, Appl. Clay Sci. 36, 191-196, 2007



Volzone C, Ortiga J, Appl. Clay Sci. 32, 87-93, 2006



Retención de tolueno en agua

Muestras	Metilbenceno retenido (mg/g muestra) (Cl= 450mg /L)	Metilbenceno retenido (mg/g muestra) Cl= 650mg/L	Metilbenceno retenido (mg/g muestra) Cl= 990mg/L
Ja	0,9	2,1	2,8
Ja050H	13,2	18,0	41,4
Ja1H	14,7	23,0	45,0
Ja2H	17,1	25,0	45,0

Grupo de investigación

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Liliana Garrido

Ana Maria Cesio

José Ortiga

Jorge Rinaldi

Mónica Rueda

Nuria Vidal

Muchas gracias

Cristina

