



Utilization of asbestos waste in the syntheses of “historical” yellow cobblestones of Sofia

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The “yellow cobblestones” of Sofia are a historical clicker pavement, which in 1907-1908 was used to cover at about 60 decare of the central streets of the new Bulgarian capital.

<https://www.sofia.bg/web/tourism-in-sofia/yellow-pavement-symbolism>



Today the whole reserved space is two times smaller and many of yet existing “yellow bricks” are broken or cracked.

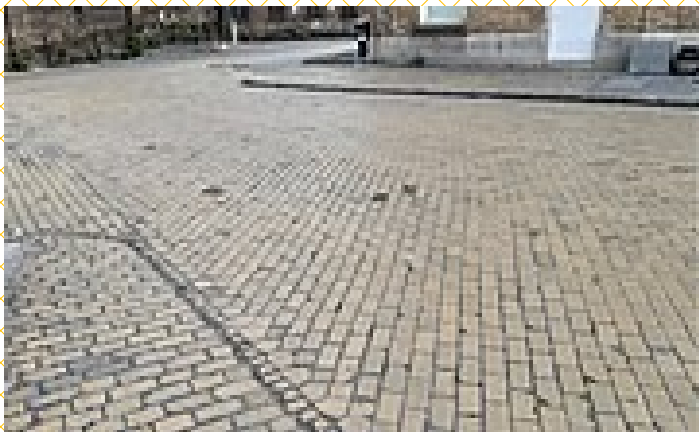
In 2013 by a decision of the Sofia Municipal Council this pavement was declared cultural heritage. However.....



KERAMIT – totally was produced at about 1 km²

<https://hu.wikipedia.org/wiki/Keramit>

Buda-Pest



Kecskemét

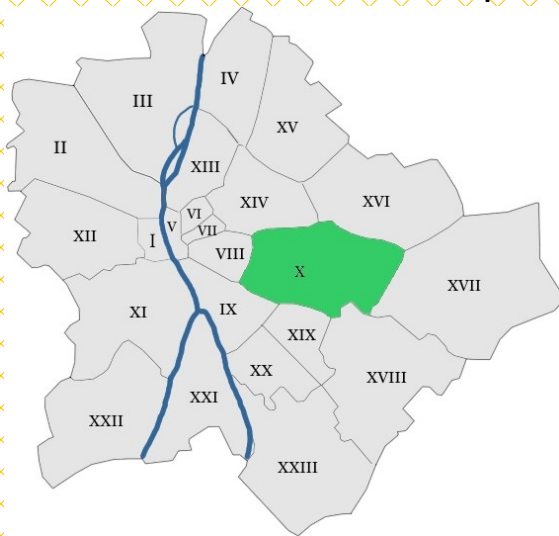


Kőbányai Gőztéglagyár Társulat Pesten téglagyára

Kőbánya Brickworks Association Brickworks in Pest – since 1869.



Europe's first brick museum, Wall II.



KERAMIT

Hungarian patent No 29749 - 1903



Diving in the Kőbánya Mine

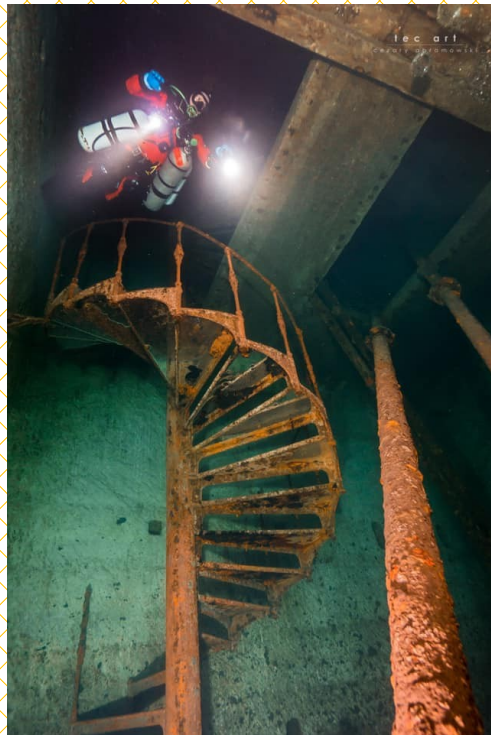
<https://mjcave.hu/en/diving/>

Diving prices (euro)

The new price list is valid from 01.01.2022. To see the detailed price list, please [click here](#)

Guided Cave Dives	1 dive	2-4 dives	5 + dives	Group
1 dive 50-70 min, max 40 meters;	60 euro/diver	55 euro/diver	50 euro/diver	Contact us!

Number of divers in 1 group: max. 4 divers + dive leader



Chemical compositions of the CERAMIT and heat-treated Bulgarian marls

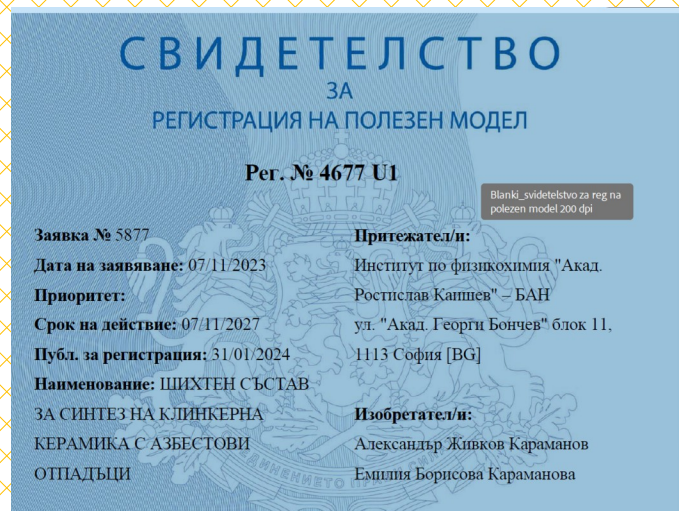
<i>Wt. %</i>	Original brick	Bulgarian marls
SiO ₂	<i>53.0-54.5</i>	<i>49.0-52.0</i>
Al ₂ O ₃	<i>14-14.5</i>	<i>15.5-17.0</i>
Fe ₂ O ₃	<i>5-5.5</i>	<i>4.5-6.0</i>
CaO	<i>16.5-17</i>	<i>17.5-20.5</i>
MgO	<i>5-5.2</i>	<i>2.0-2.5</i>
K ₂ O	<i>2.5-3</i>	<i>2.5-3.0</i>
Na ₂ O	<i>1.0-1.2</i>	<i>1.0-1.5</i>

Chemical compositions of the CERAMIT, heat-treated Bulgarian marls and heat-treated chrysotile asbestos

<i>Wt. %</i>	Original brick	Bulgarian marls	Asbestos waste
SiO ₂	53.0-54.5	49.0-52.0	47.3
Al ₂ O ₃	14-14.5	15.5-17.0	2.3
Fe ₂ O ₃	5-5.5	4.5-6.0	2.6
CaO	16.5-17	17.5-20.5	
MgO	5-5.2	2.0-2.5	
K ₂ O	2.5-3	2.5-3.0	46.7
Na ₂ O	1.0-1.2	1.0-1.5	

Chemical compositions of the CERAMIT, heat-treated Bulgarian marl and final „modified marl“

Wt. %	Original brick	Bulgarian marls	„modified marl“
SiO ₂	53.0-54.5	49.0-52.0	48.0-51.0
Al ₂ O ₃	14-14.5	15.5-17.0	15-16.5
CaO	16.5-17	17.5-20.5	17.0-18.5
Fe ₂ O ₃	5-5.5	4.5-6.0	5.5-6.0
K ₂ O	2.5-3	2.5-3.0	2.5-3.0
MgO	5-5.2	2.0-2.5	5.0-7.5
Na ₂ O	1.0-1.2	1.0-1.5	2.0-3.0



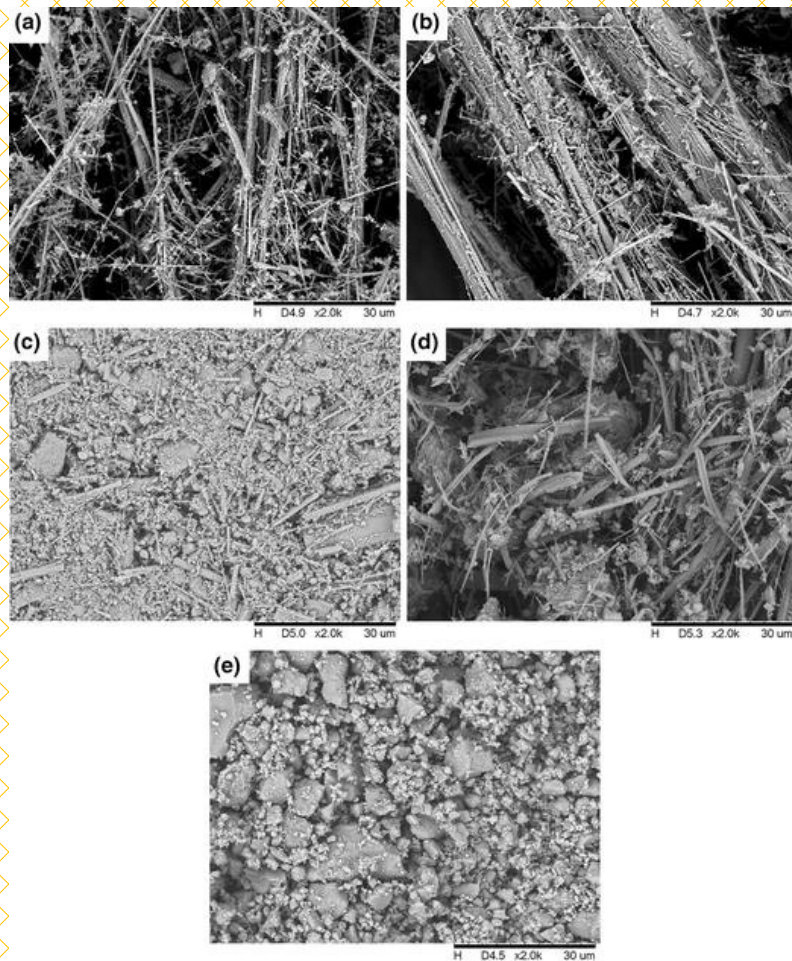
„modified marl“ was obtained by:

- mixing and preliminary heat-treatment and subsequent wet milling of ~ 40 % marl with ~10 % asbestos and Na₂CO₃.”
- mixing of the obtained product with ~ 50 % “fresh” marl, homogenization, pressing and sintering.

Asbestos was one of the “miracle” products, widely used in 20th century.

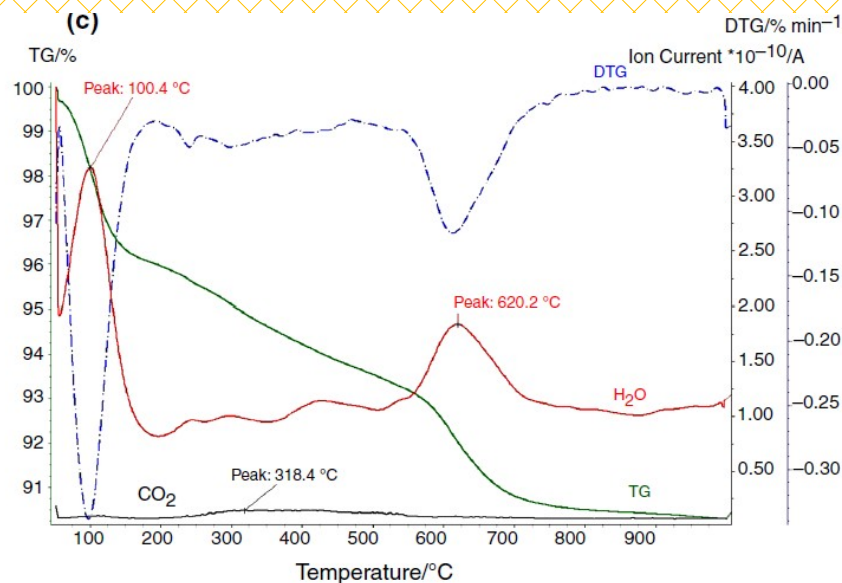
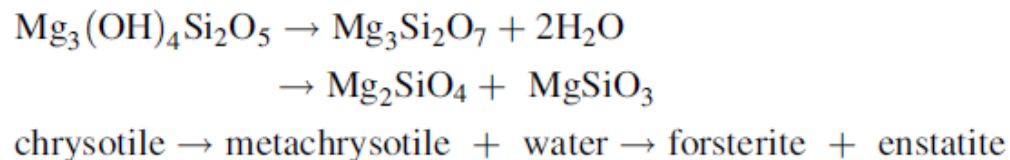
Today all types of asbestos fibers are known to cause serious health hazards in humans (as asbestosis and lung cancer).



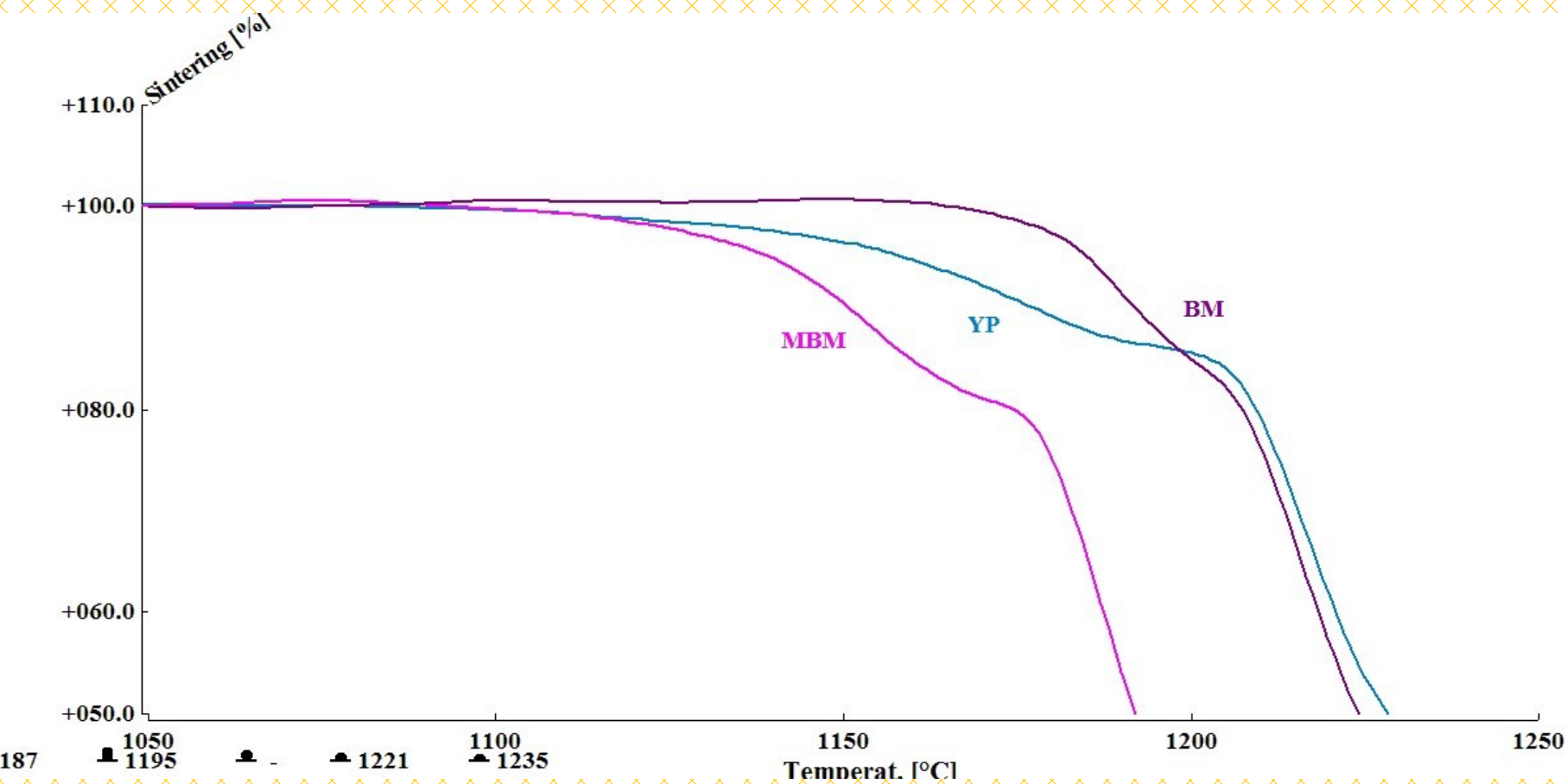


SEM images of the raw (K2) sample (a), after thermal treatment at 450 °C (b, c) and 700 °C (d, e); without (b, d) and with soft crush in a mortar (c, e).

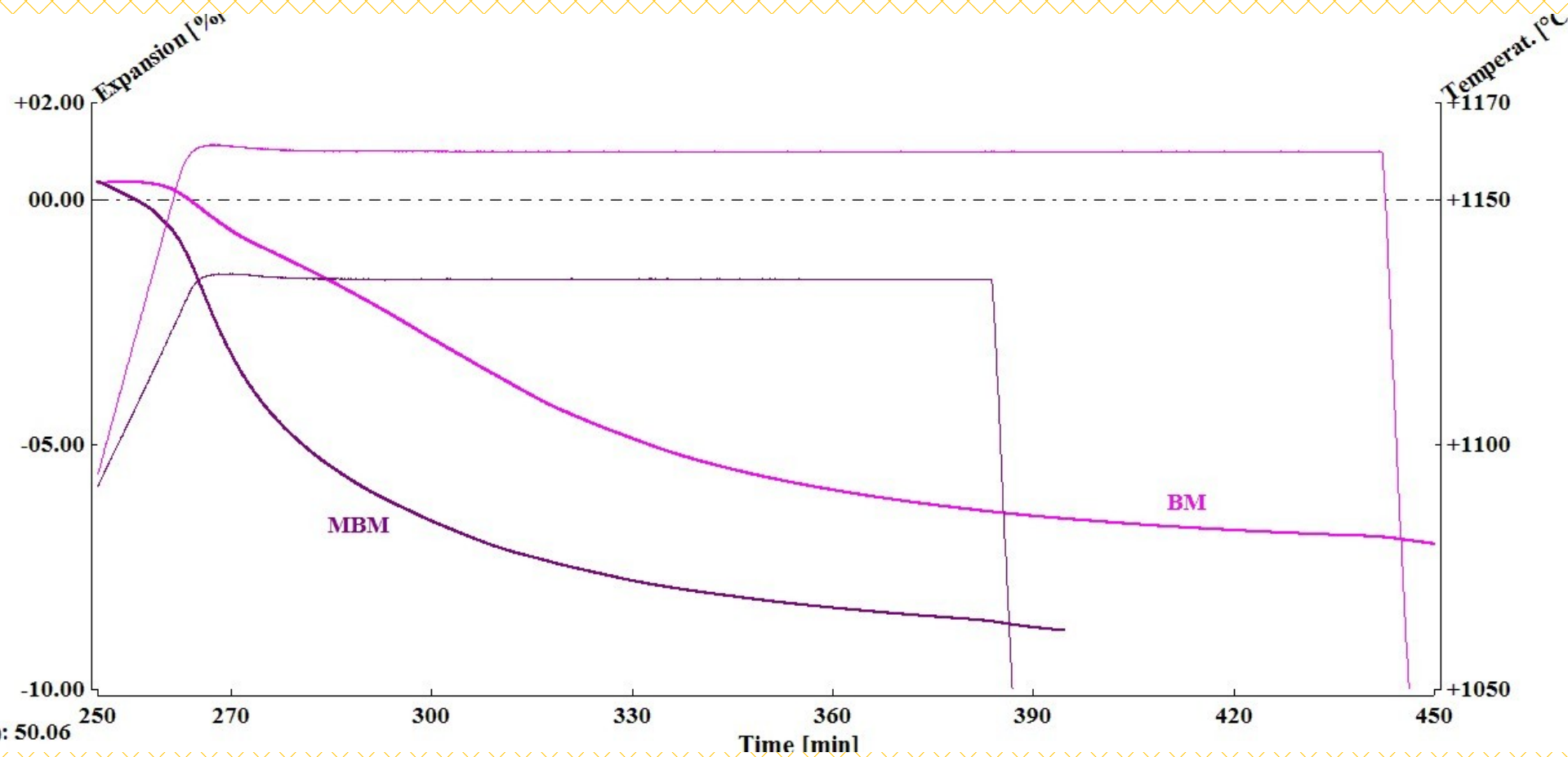
Kusiorowski, R., Zaremba, T., Gerle, A. et al.
Study on the thermal decomposition of
asbestos. J Therm Anal Calorim 120, 1585–1595
(2015).



***HSM of milled CERAMIT (YP), Bulgarian marl
(BM) and final „modified marl“ (MBM)***

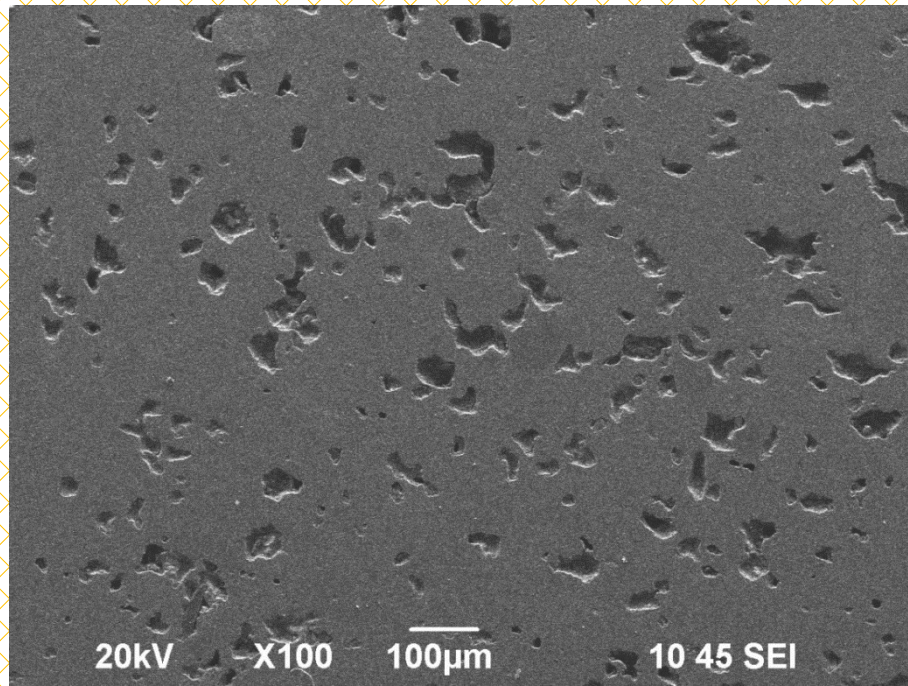


Sintering dilatometric curves of original marl at 1160 °C (brown sample) and “modified marl” at 1130 °C (yellow sample) by optical dilatometry

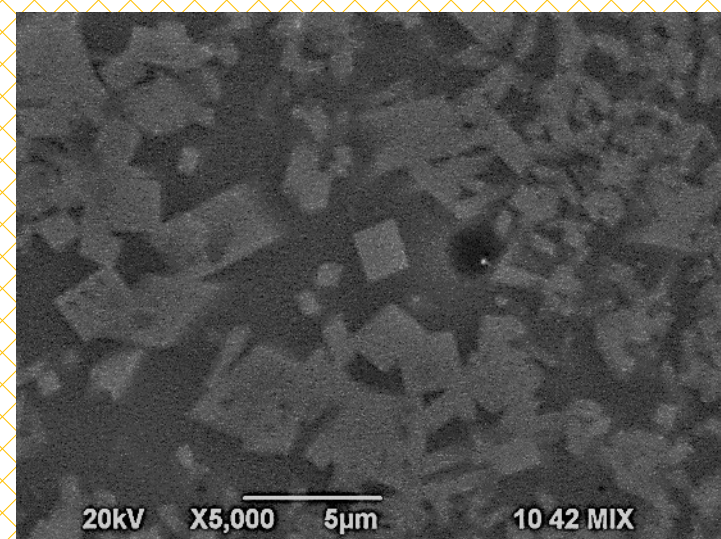
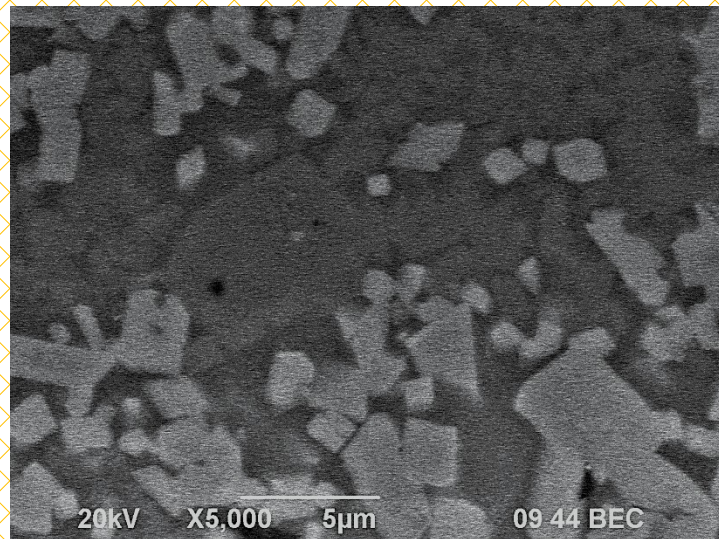
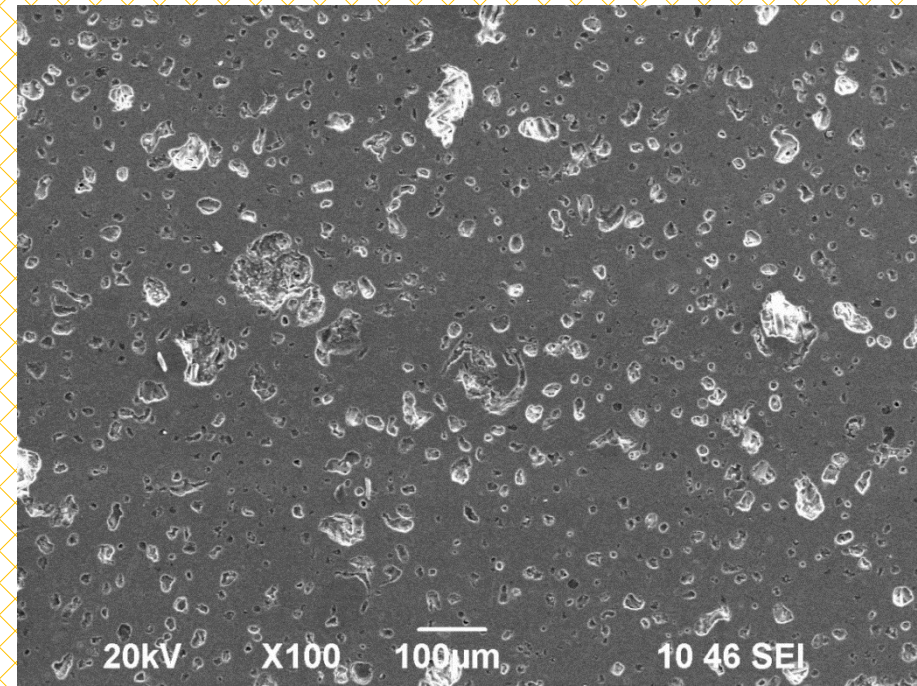


SEM

original brick

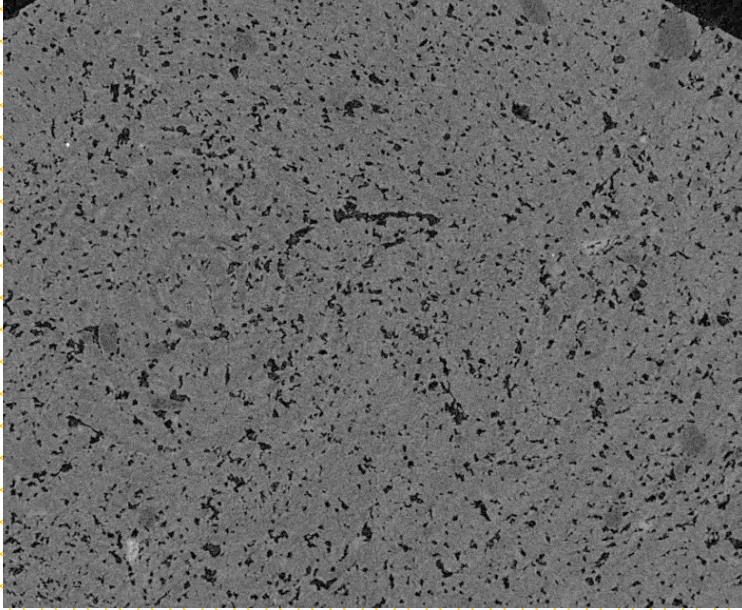


modified marl

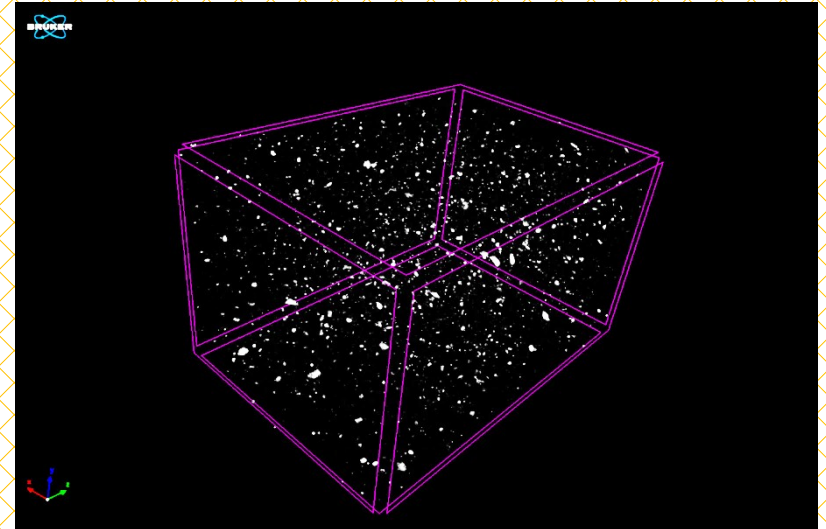
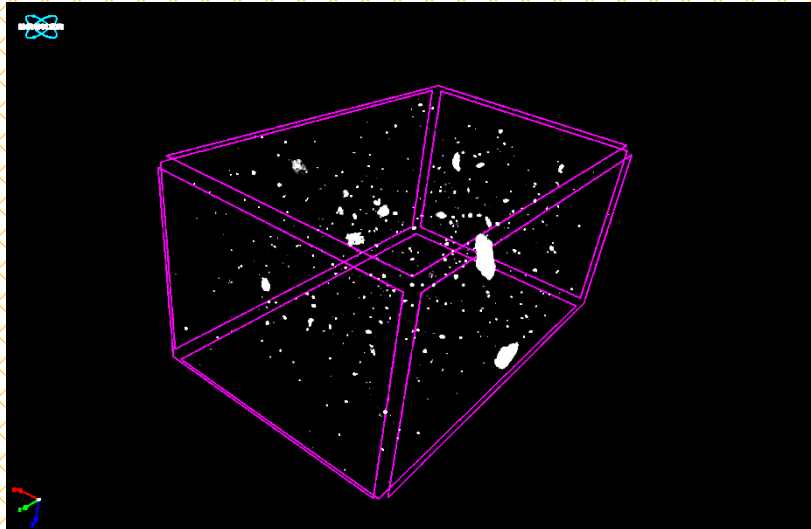
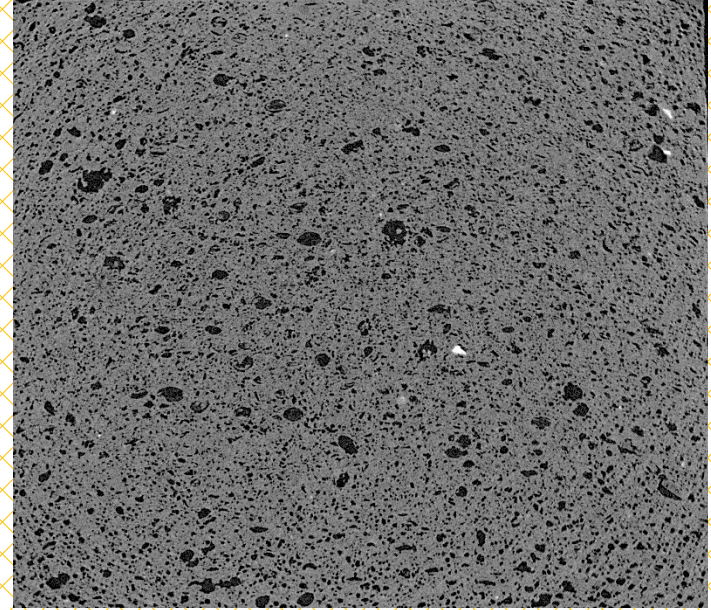


2D and 3D- XRD tomography

original brick



modified marl



Conclusions



***Are the yellow paving bricks of Sofia
an enigma?***

NO !

Thank you for the attention!