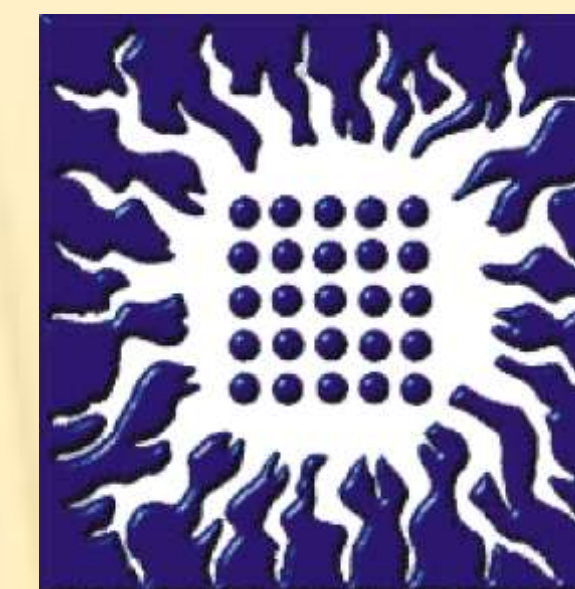


# PREPARATION AND CHARACTERIZATION OF CLAY AND DIATOMACEOUS EARTH BASED POROUS CERAMICS WITH BORIC ACID AS ADDITIVE



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**Abstract:** Porous silicon dioxide ceramics was obtained by using boric acid as an inexpensive additive and pore forming agent at low forming pressure and low sintering temperature. Starting raw materials, clay and diatomaceous earth from surface coal mine Kolubara, Serbia, were purified from organic and inorganic impurities by using heat and chemical treatment. Boric acid was used as binding and sintering aid in amount of 2 wt%. Powder was compacted by using different pressures (40 and 60 MPa). The pressed samples were sintered from 1000 to 1300 °C for 4 h in air. The phases and microstructure of the obtained ceramics were characterized. The relations between mechanical characteristics of samples (Young modulus and Poisson ratio) were studied.

## Results and discussion

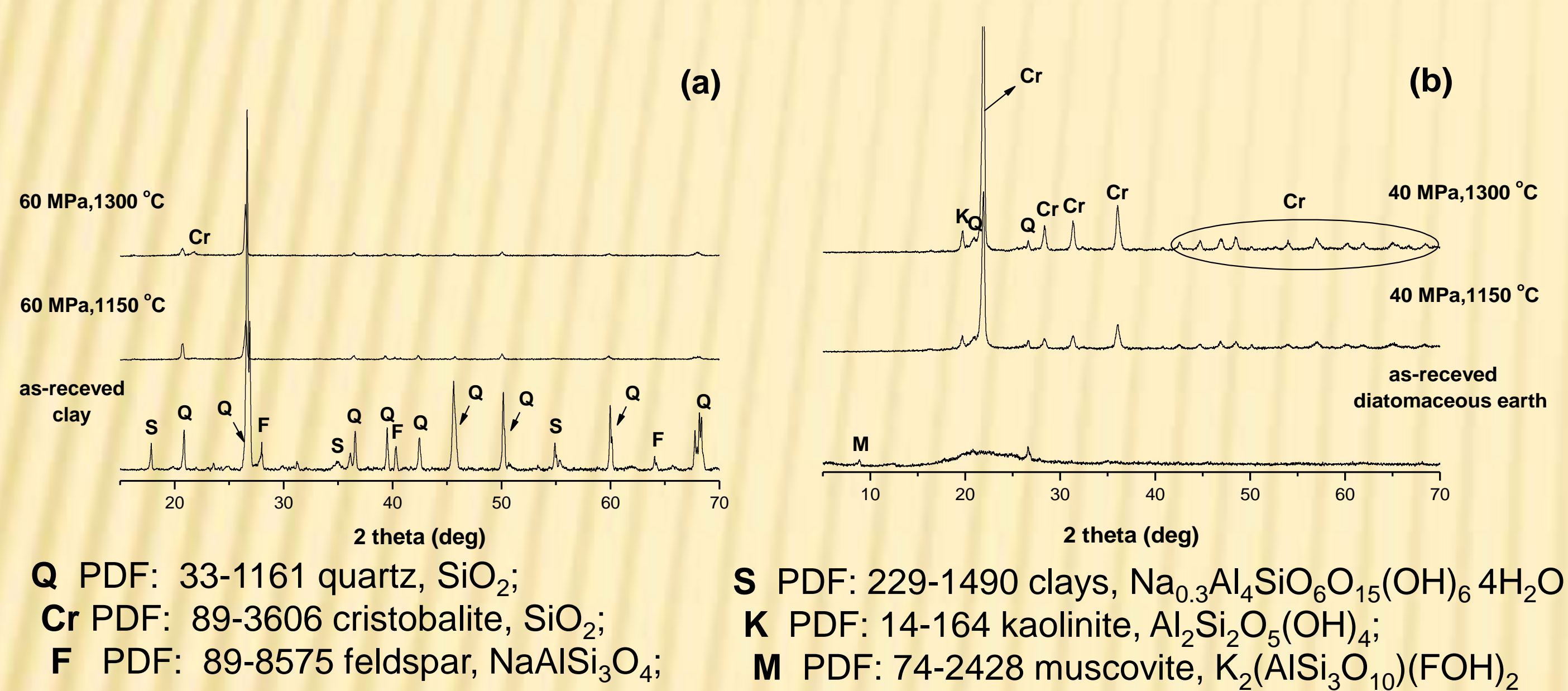


Fig. 1. XRD patterns: as-received clay, clay with 2 wt% of boric acid (a) and as-received diatomaceous earth, diatomaceous with 2 wt% of boric acid (b).

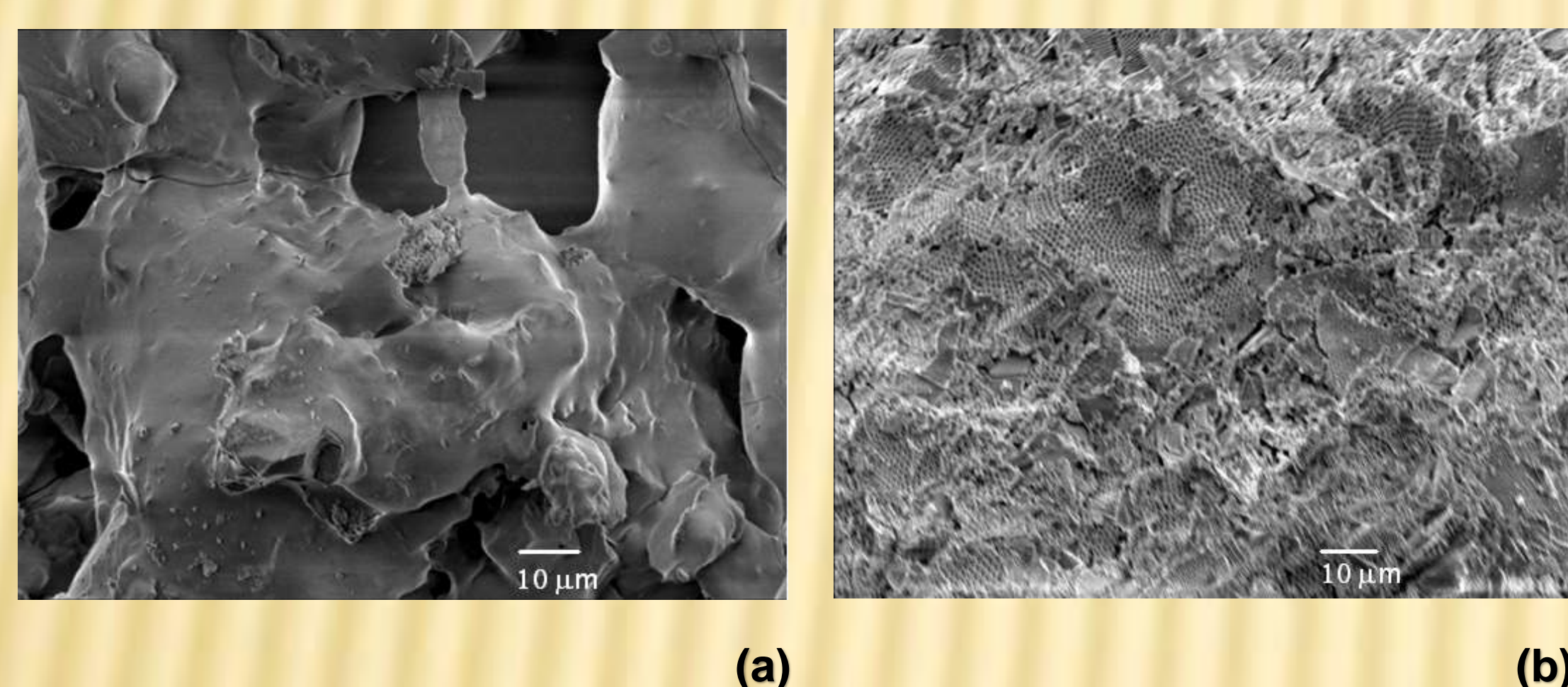


Fig. 2. SEM micrograph: of clay (a), and diatomaceous earth (b) with 2 wt% of boric acid, pressed at 60 MPa, and sintered at 1150°C.

Table 2

Intrusion data summary from mercury porosimetry: intrusion volume,  $V_p$ , specific surface area,  $S_s$ , median pore diameter,  $d_p$ , apparent density,  $\rho_p$ , and porosity versus,  $P$ , of the samples (clay and diatomaceous earth) with 2 wt% of boric acid.

SAMPLE WITH BORIC ACID	$P$ , MPa	$t$ , °C	$V_p$ , mm <sup>3</sup> /g	$S_s$ , m <sup>2</sup> /g	$d_p$ , nm	$\rho_p$ , g/cm <sup>3</sup>	$P$ , %
CLAY	60	1150	61	4.1	7232	2.12	13
		1300	113	1.3	446	1.95	22
DIATOMACEOUS EARTH	40	1150	624	7.9	1394	0.91	57
		1300	489	8.7	1950	1.05	51
	60	1150	518	7.0	1260	1.00	52
		1300	443	6.4	1674	1.10	49

## References

C.R. Hammond, Physical constants of inorganic compounds, in: D.R.Lide (Eds.), Handbook of Chemistry and Physics, 84<sup>th</sup> edition, CRC Press, 2003-2004, pp. 39-166.

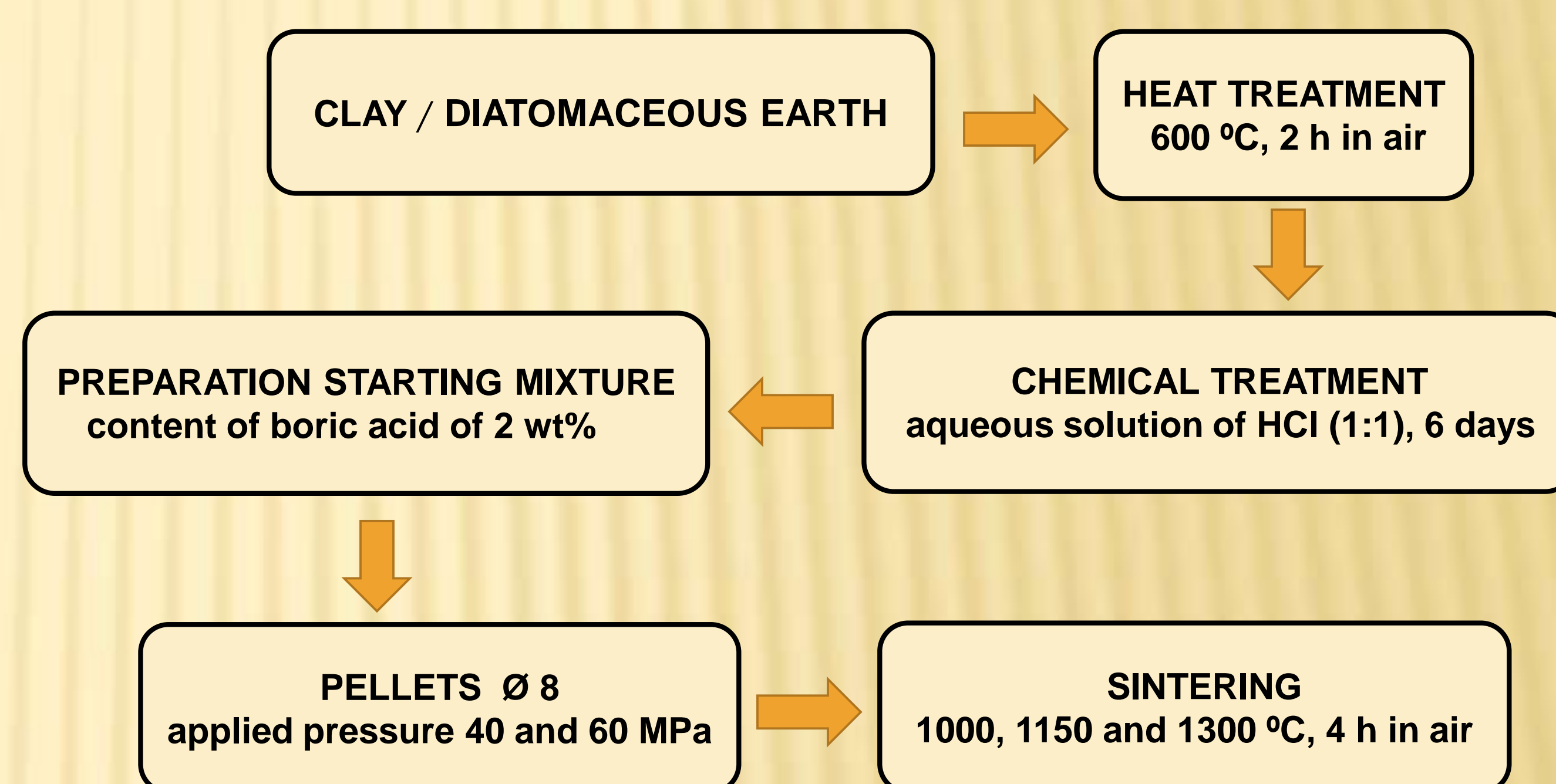
M. Kokunešoski, A. Šaponjić, V. Maksimović, M. Stanković, M. Pavlović, J. Pantić, J. Majstorović "Preparation and characterization of clay-based porous ceramics with boric acid as additive", Ceramics International 40 (2014) 14191–14196.

## Experimental

AS-RECEIVED MATERIA	CHEMICAL COMPOSITION, wt%							
	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	TiO <sub>2</sub>	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	SiO <sub>2</sub>
CLAY	6.05	2.06	0.48	0.35	0.18	1.05	1.76	88
DIATOMACEOUS EARTH	12.3	3.29	---	0.44	0.70	0.12	1.01	74

Table 1 Chemical composition (percentage weight: wt%) of as-received materials.

## Synthesis



## Conclusion

Porous SiO<sub>2</sub> ceramics based on clay / diatomaceous earth were synthesized with addition of 2 wt% boric acid as low-cost efficient additive and very powerful flux. A relatively high porosity of nearly 40 and 60 % were obtained for the samples of clay and diatomaceous earth respectively, pressed at 40 and 60 MPa and sintered at 1000 °C. Samples of clay / diatomaceous earth with median pore size diameters were in the range of macroporous up to 0.4 μm and 7.2 μm / 1.3 μm and 2 μm, sintered at 1150 and 1300 °C, respectively.

Table 3

Porosimetry data obtained by Archimedes method, bulk density,  $\rho$  and open porosity,  $\epsilon_o$  of the samples (clay and diatomaceous earth) with 2 wt% of boric acid.

CONDITION	SAMPLE WITH BORIC ACID					
	$P$ , MPa	$t$ , °C	CLAY		DIATOMACEOUS EARTH	
$\rho$ , g/cm <sup>3</sup>			$\epsilon_o$ , %	$\rho$ , g/cm <sup>3</sup>	$\epsilon_o$ , %	
40	1000	1.55	39.07	0.61	65.72	
	1150	1.76	32.30	0.84	57.44	
	1300	2.10	16.60	0.97	52.24	
60	1000	1.71	35.65	0.67	61.91	
	1150	1.80	30.21	0.93	52.98	
	1300	2.09	14.81	0.93	52.98	

Table 4

Mechanical properties, Young modulus,  $E$ , and Poisson ratio,  $\mu$  of the samples (clay and diatomaceous earth) with 2 wt% of boric acid.

CONDITION	SAMPLE WITH BORIC ACID					
	$P$ , MPa	$t$ , °C	CLAY		DIATOMACEOUS EARTH	
$E$ , GN/m <sup>2</sup>			$\mu$	$E$ , GN/m <sup>2</sup>	$\mu$	
40	1150	-	-	0.31	0.36	
	1300	-	-	0.51	0.36	
60	1150	1.24	0.37	0.30	0.36	
	1300	2.70	0.35	0.69	0.33	

## Acknowledgements

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