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SolSorb
CO_2 Capture & Storage
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STUDY OF ASH REMOVAL FROM ACTIVATED CARBON AND ITS RESULT ON CO_2 SORPTION CAPACITY

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PRESENTATION OUTLINE

Presentation structure:	Introduction
	Materials and methods
	Experimental
	Results
	Conclusions
	Acknowledgements
	Supporting data

Greenhouse effect

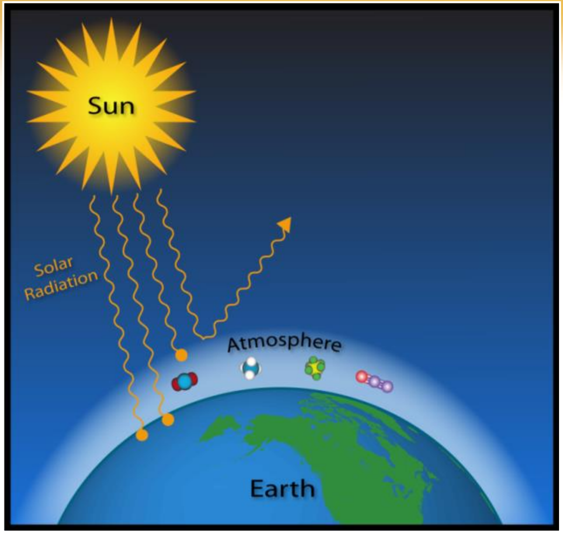


Fig. 1. Solar radiation - primary radiation.

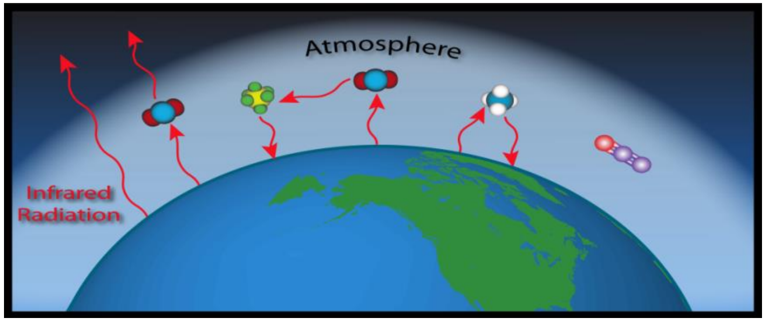


Fig. 2. IR radiation - secondary radiation.

Tab.1. Temperature on Earth with and without greenhouse effect.

	Temperature [°C]
Earth without greenhouse effect	-18
Earth with greenhouse effect	15

http://www.esrl.noaa.gov/gmd/outreach/carbon_toolkit/basics.html

CO_2 and temperature

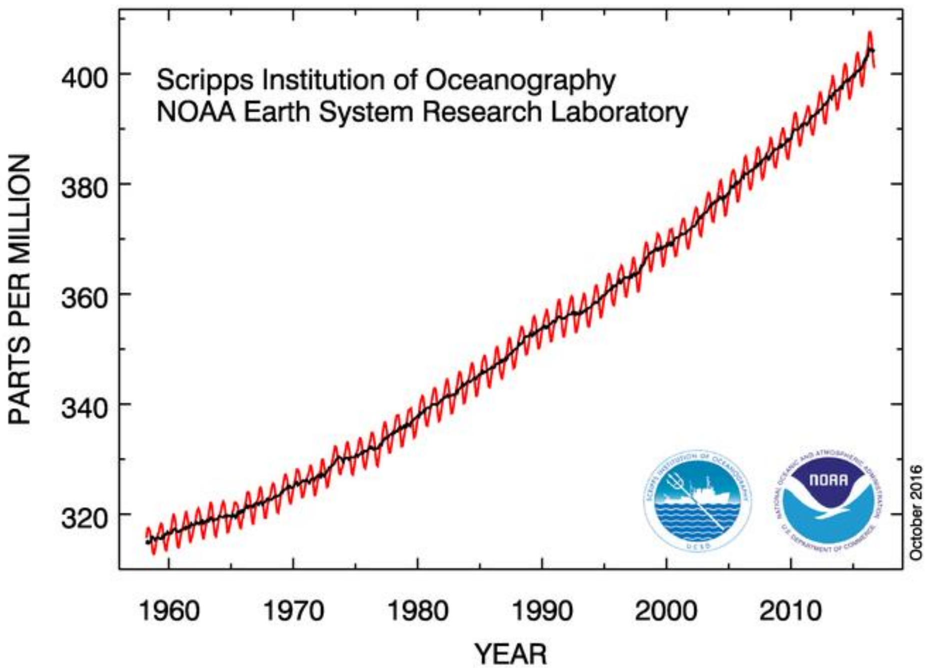


Fig. 3. Changes of carbon dioxide concentration.

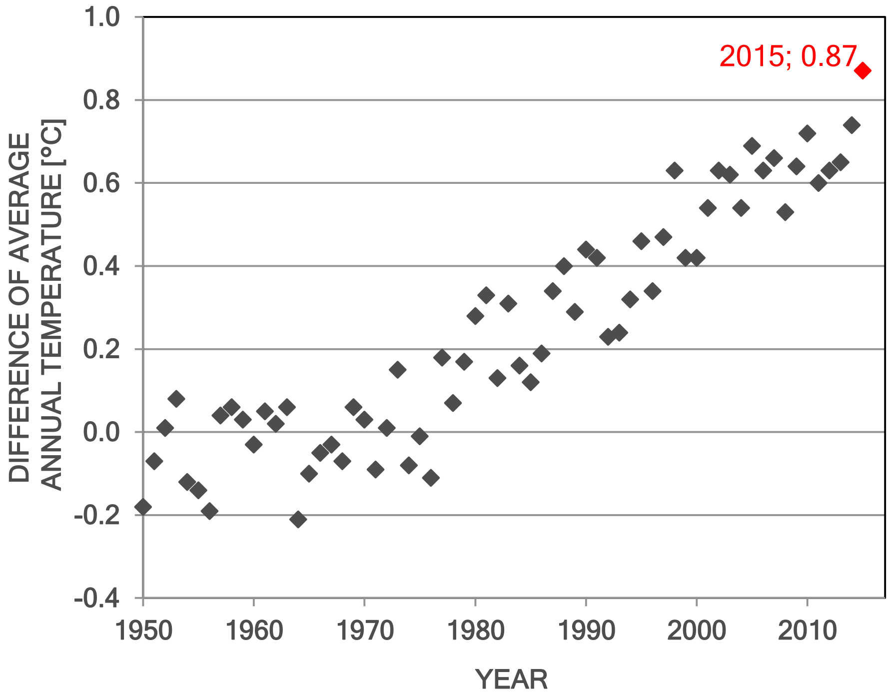


Fig. 4. Changes of average temperature.

http://www.esrl.noaa.gov/gmd/ccgg/trends/full.html

Carbon Capture and Storage

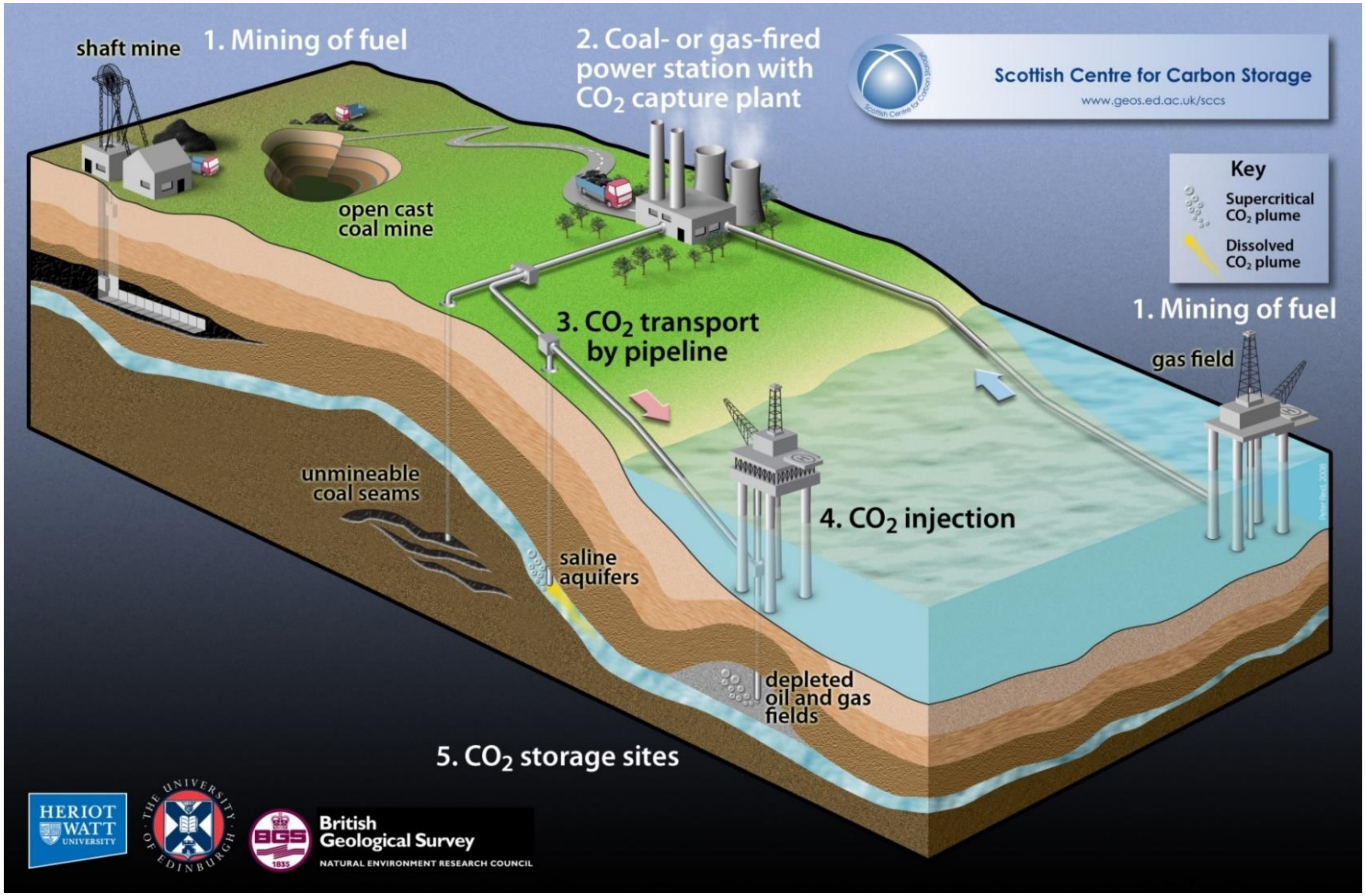


Fig. 5. Carbon Capture and Storage scheme.

http://www.sccs.org.uk/

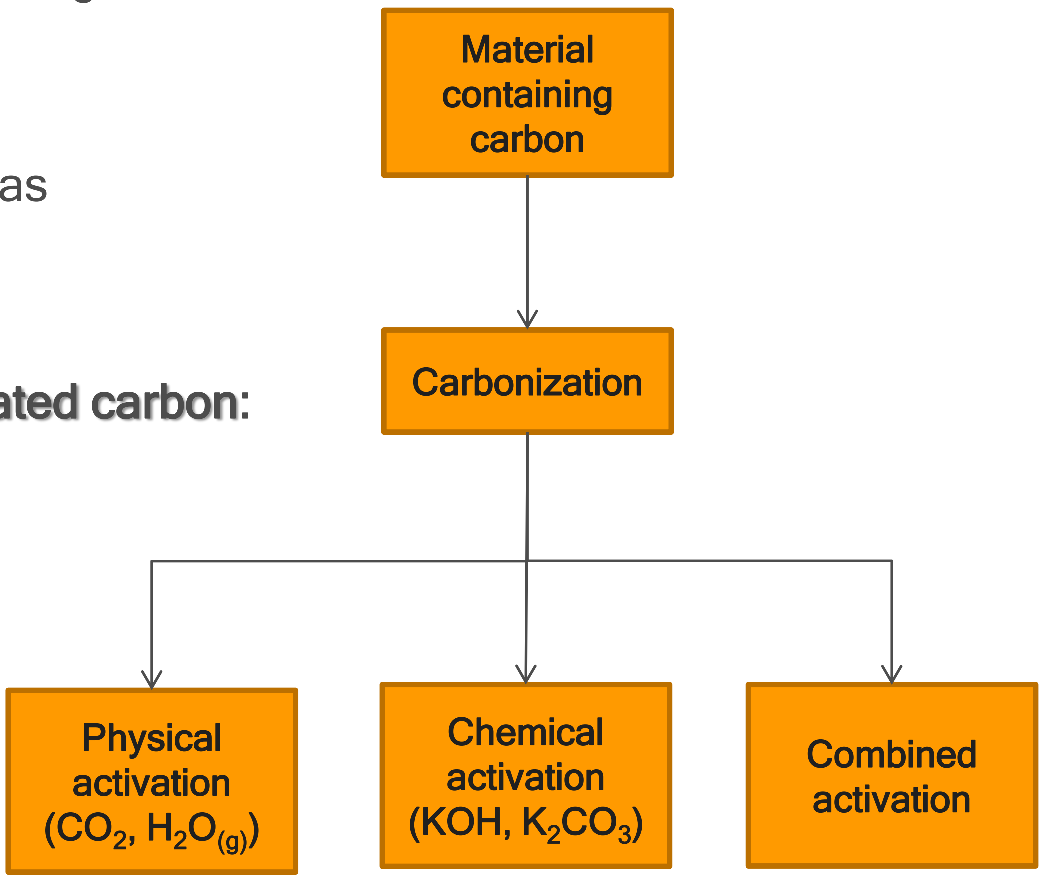
Introduction

Acivated carbons:

- microporous materials,
- specific surface area up to 2500 m^2/g,
- support for noble metals,
- cointain mineral matter,
- used in purification of water and as
- an adsorbent for SO_2 or CO_2.

Materials used for preparation activated carbon:

- cherry stones,
- wood,
- palm shell,
- coal,
- peat.



Scheme 1. Preparation of activated carbon.

Materials and methods

Materials:

- activated carbon BA11 (delivered by *Carbon, Poland*),

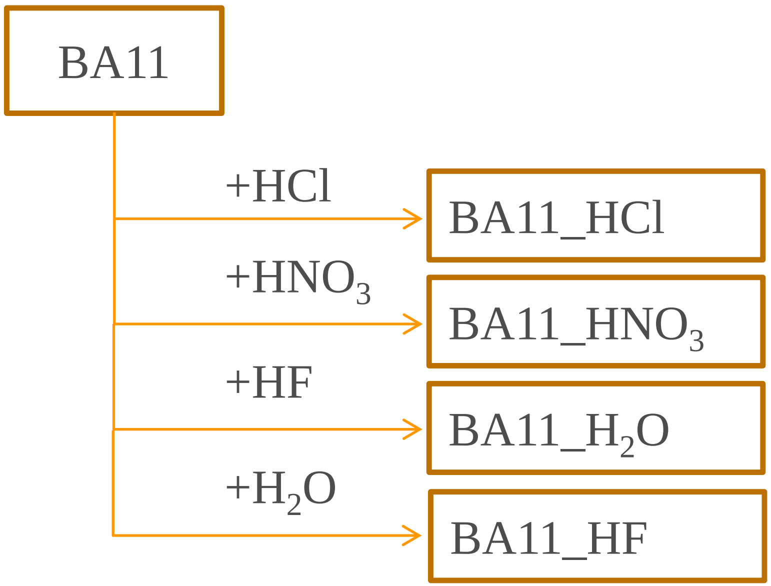
- 35-38% hydrochloric acid, 65% nitric acid, 40% fluoric acid (*Chempur, Poland*).

Methods:

- ❖ BET,
- ❖ CO_2 uptake,
- ❖ XPS,
- ❖ XRF,
- ❖ XRD.

Fig. 6. Activated carbon BA11.

Experimental



Scheme 2. Preparation of sorbents.

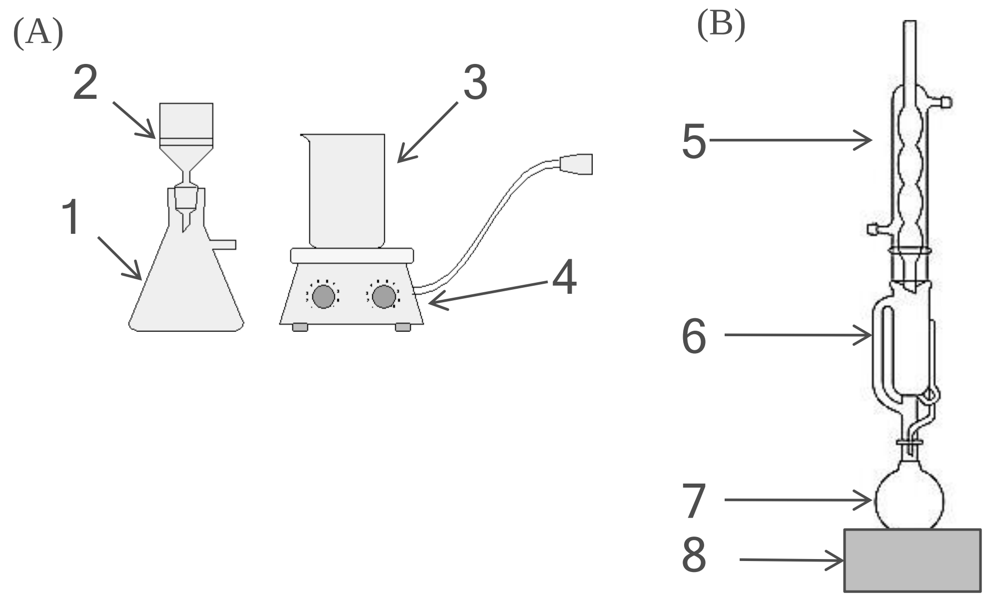


Fig. 7. Synthesis apparature: (A) for acid treatment, (B) for water treatment. 1 - filtering flask, 2 - Buchner funnel, 3 - beaker, 4 -magnetic stirrer, 5 - condenser, 6 - Soxhlet apparatus, 7 - round bottom flask, 8 - hot plate.

Results

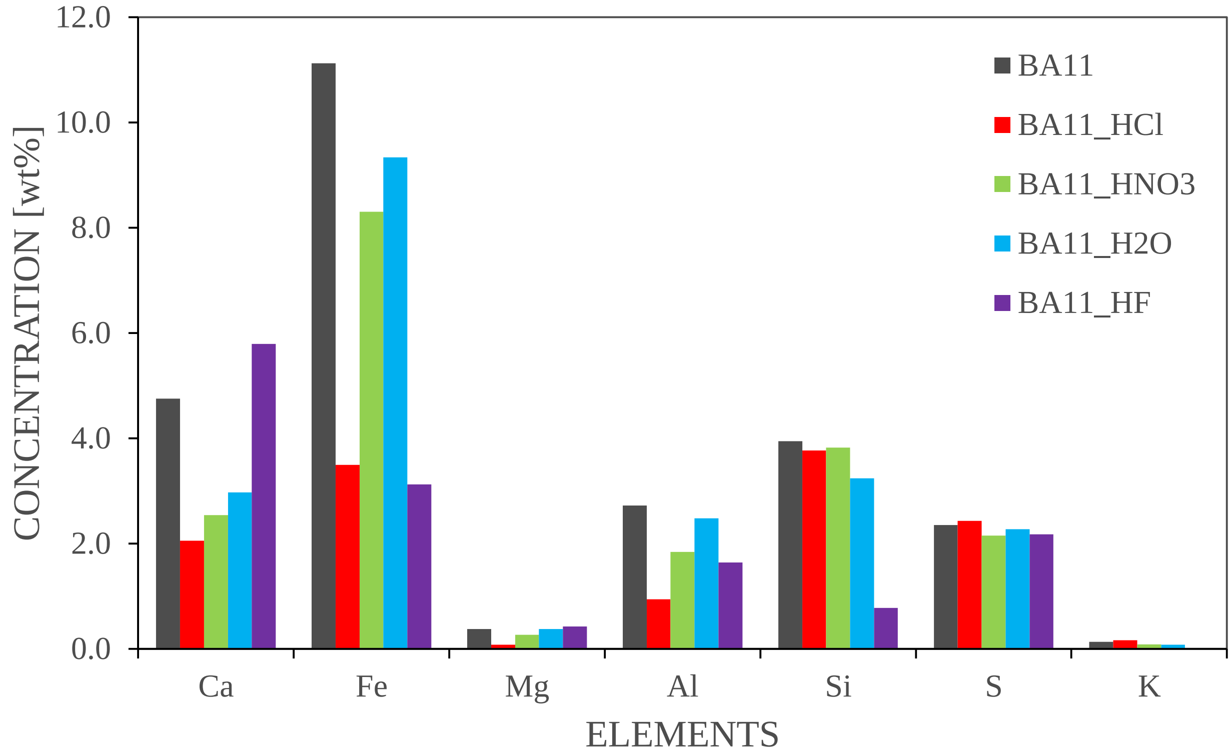


Fig. 8. XRF results of activated carbons.

Results

Fig 10. XRD results. Identified phases: A - anhydrite, Q - quartz, H - hematite, F - fluorite.

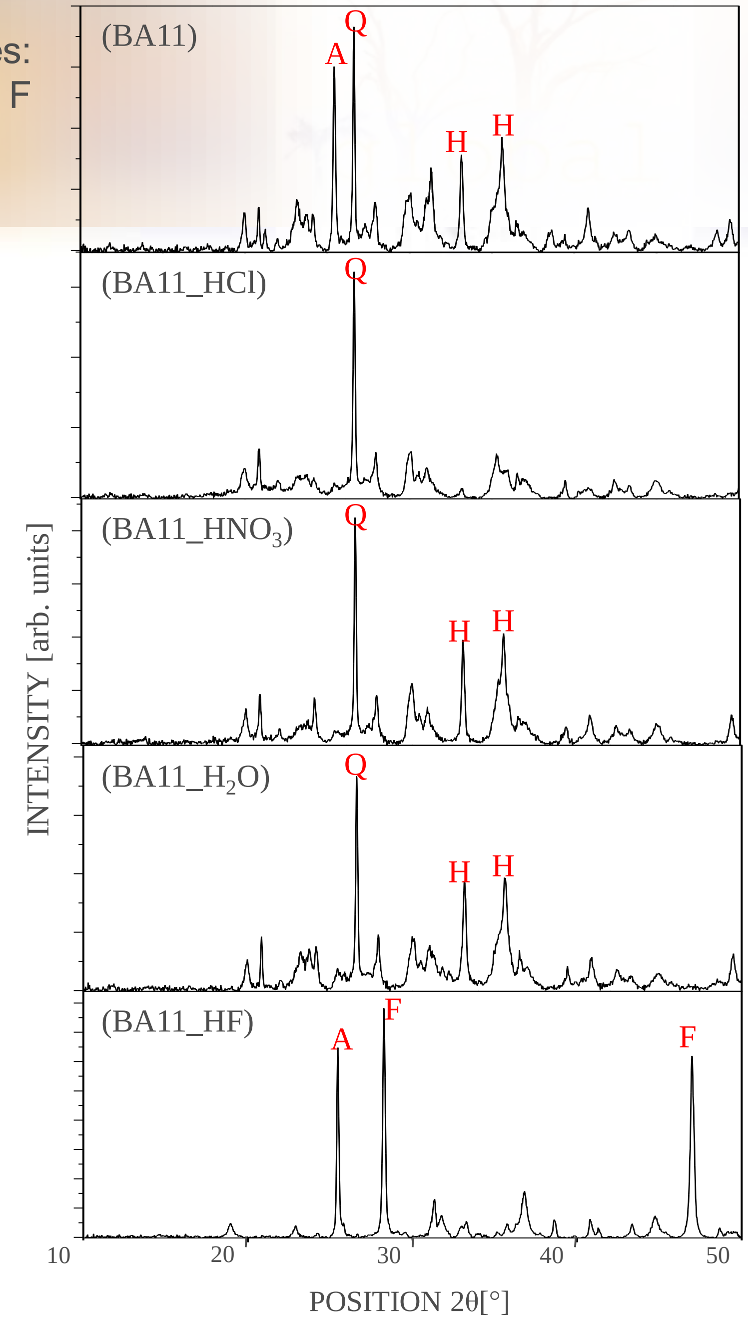
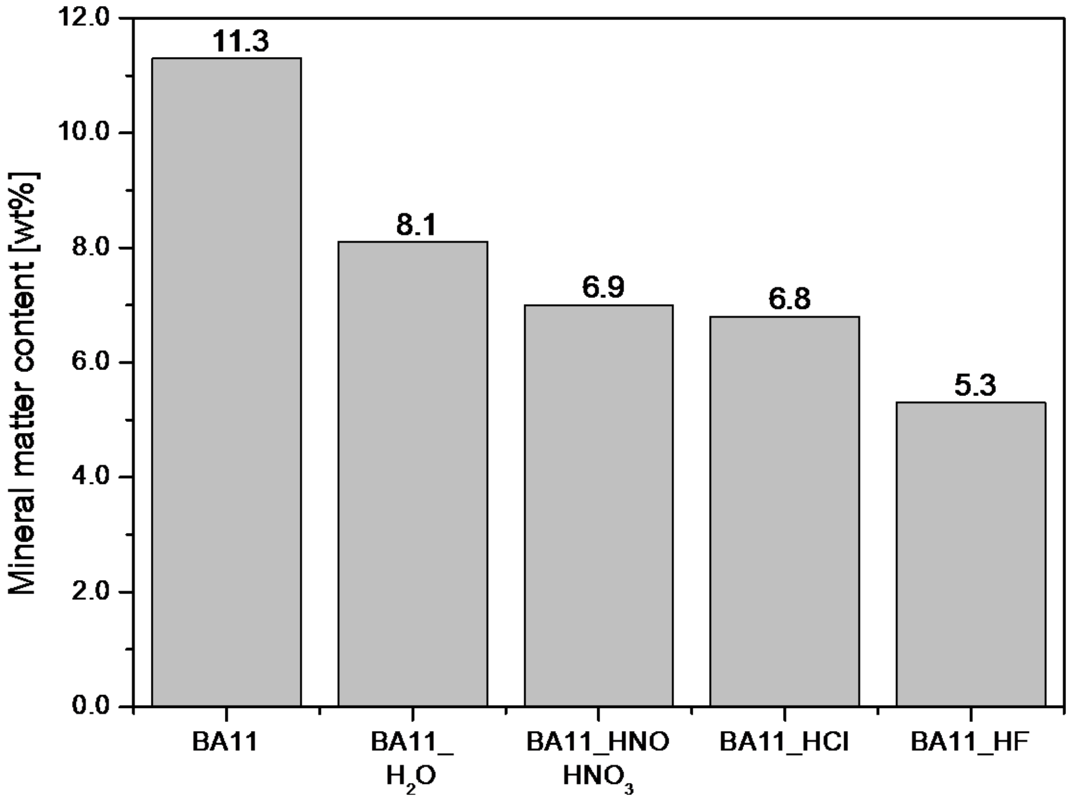


Fig 9. Mineral matter content.



Results

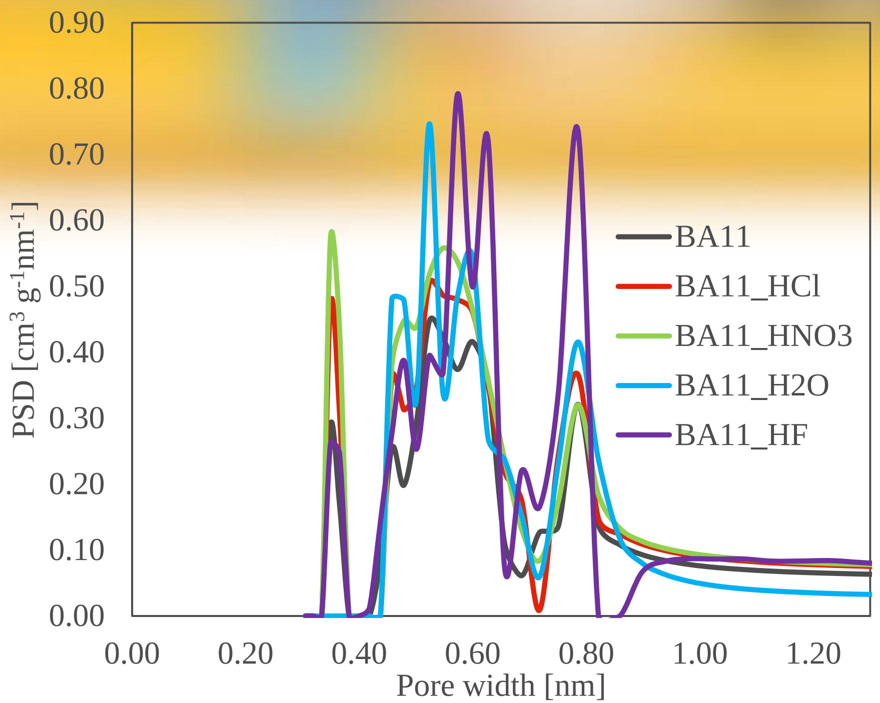


Fig. 11. Pore size distribution calculated from CO_2 adsorption/desorption isotherms at 0 °C.

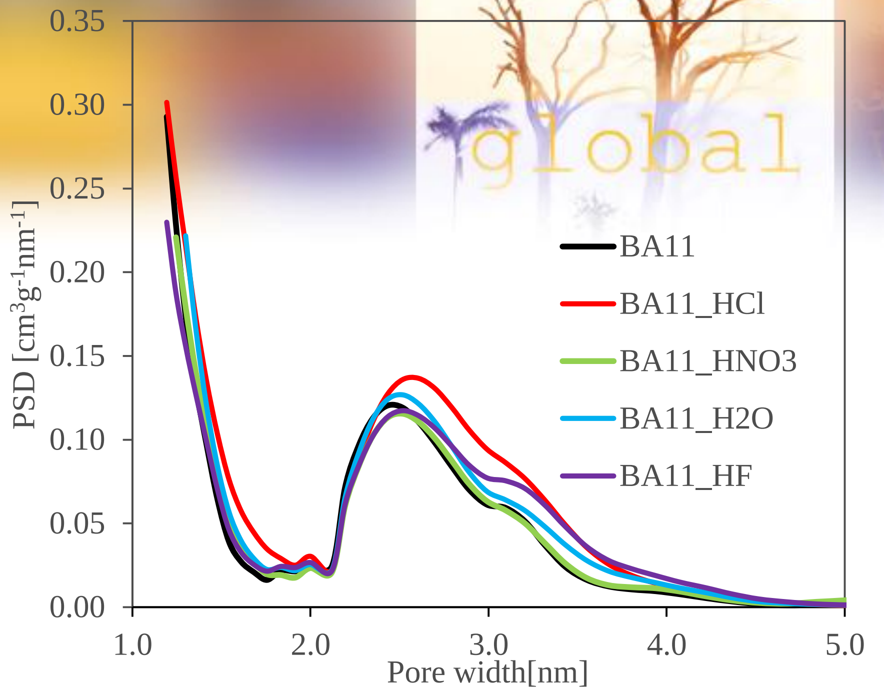


Fig. 12. Pore size distribution calculated from N_2 adsorption/desorption isotherms at -196 °C.

Tab. 2. Pore volumes of obtained samples.

Sample	V_{micro} [cm^3/g]	$V_{submicro}$ [cm^3/g] (<0.8 nm)
BA11	0.28	0.10
BA11_HCl	0.29	0.13
BA11_HNO_3	0.30	0.14
BA11_H_2O	0.30	0.14
BA11_HF	0.27	0.16

Results

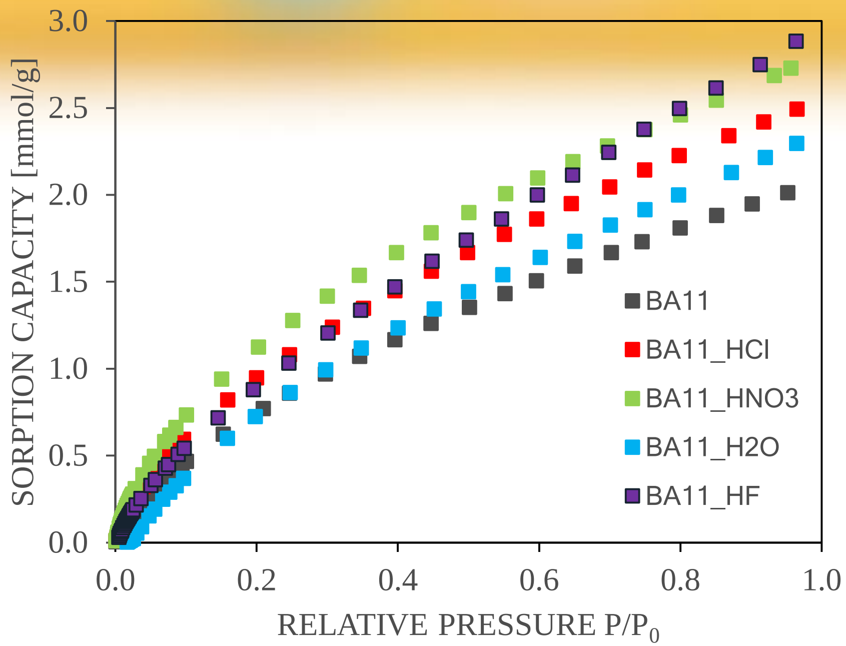


Fig. 13. CO_2 adsorption isotherms at 0 °C.

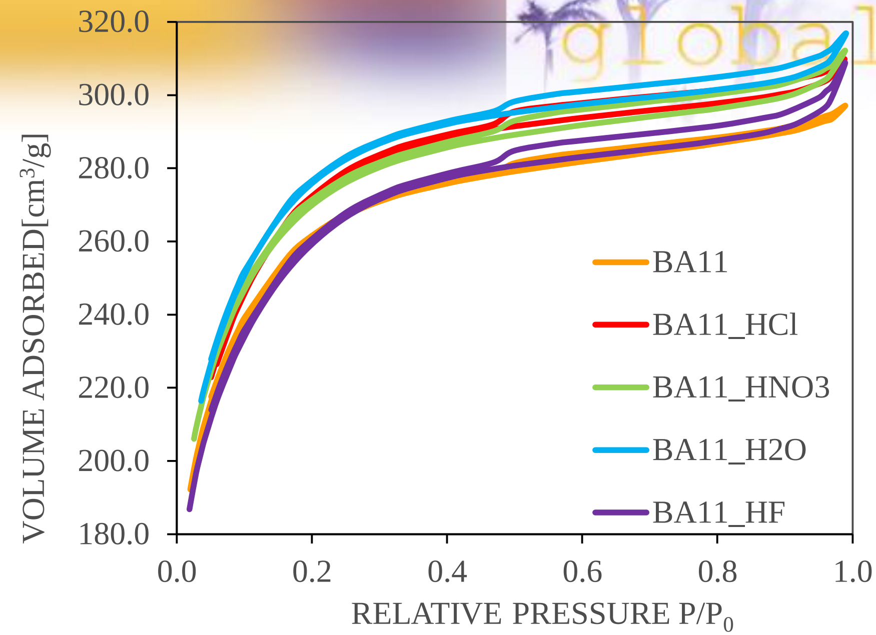


Fig. 12. N_2 adsorption/desorption isotherms at -196 °C.

Tab. 3. Results from volumetric methods for obtained samples.

Sample	S_{BET} [m^2/g]	Sorption capacity [mmol/g]	V_{micro} [cm^3/g]	$V_{submicro}$ [cm^3/g] (<0.8 nm)
BA11	967	2.01	0.28	0.10
BA11_HCl	997	2.50	0.29	0.13
BA11_HNO_3	1001	2.73	0.30	0.14
BA11_H_2O	1024	2.30	0.30	0.14
BA11_HF	960	2.88	0.27	0.16

Results

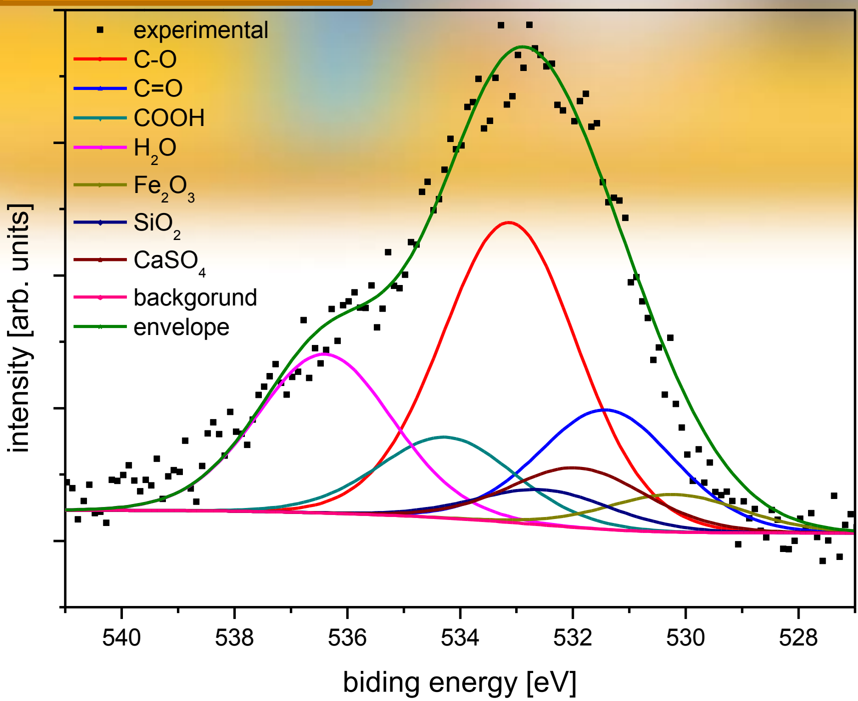


Fig. 15. XPS results. Deconvolution of O 1s signal from BA11 sample.

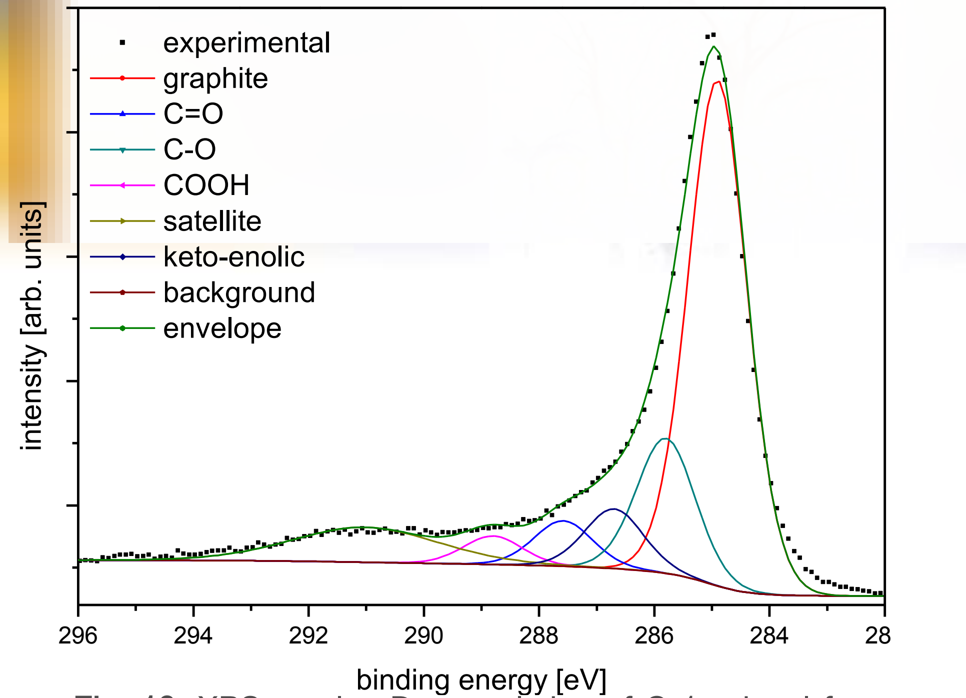
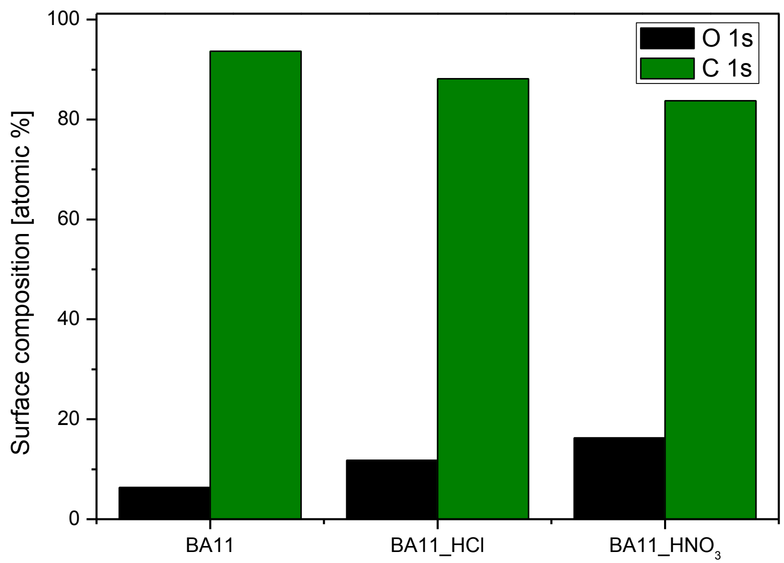


Fig. 16. XPS results. Deconvolution of C 1s signal from BA11 sample.

Fig. 17. XPS results. Composition of the surface for BA11, BA11_HCl, BA11_HNO_3.



CONCLUSIONS

1. Mineral matter behave like a ballast. Its removal leads to increased CO_2 sorption capacity.
2. Mineral matter may block access to pores. Its removal leads to increased specific surface area and may provide access to additional submicropores crucial for CO_2 adsorption.
3. The most effective compounds in removing mineral matter are:
   - HCl/HF for removing Fe_2O_3,
   - distilled water for removing $CaSO_4$,
   - HF for removing SiO_2.
4. CaSO4 should be removed prior to HF treatment due to formation of fluorite.
5. The highest sorption capacity was achieved for activated carbon after HF treatment (an increase of 44%).
6. Removing mineral matter reveals oxidized surface of the activated carbon.

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the Polish-Norwegian Research Programme operated by the National Centre for Research and Development under the Norwegian Financial Mechanism 2009-2014 in the frame of Project Contract No Pol-Nor/237761/98.

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SUPPORTING DATA

Improvement of CO_2 uptake of activated carbons by treatment with mineral acids

A. Gęsikiewicz-Puchalska, M. Zgrzebnicki, B. Michalkiewicz, U. Narkiewicz, A.W. Morawski, R.J. Wrobel, Chemical Engineering Journal, 309 (1 February 2017) p. 159-171

Thank you for your attention.