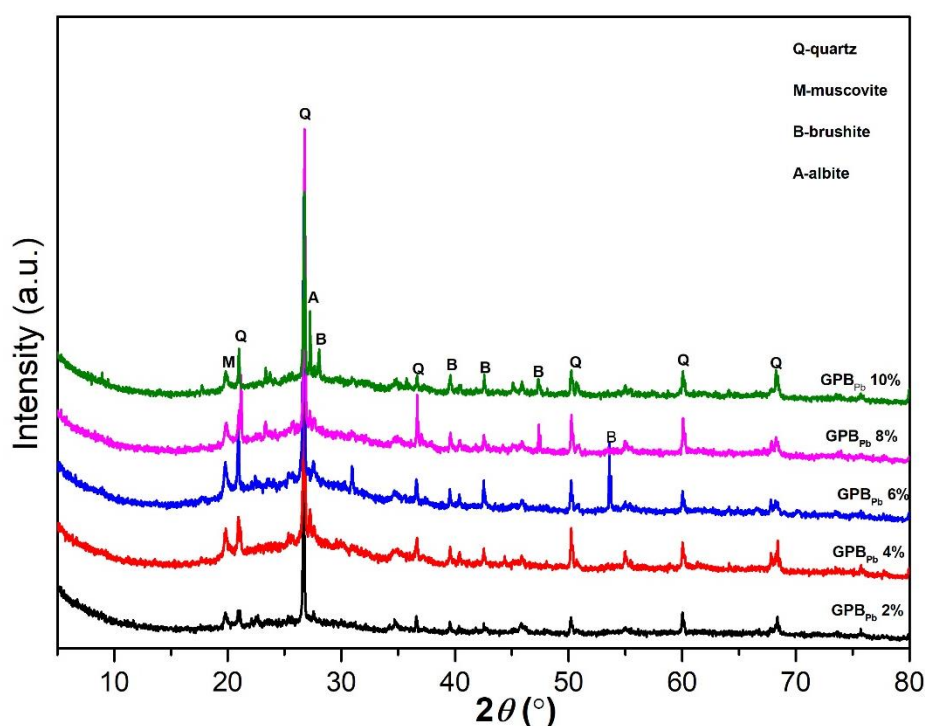


## Supplementary material: Brushite-metakaolin composite geopolymer material as an effective adsorbent for lead removal from aqueous solutions

After lead adsorption, the materials were dried and investigated by X-ray diffraction and FT-IR methods.

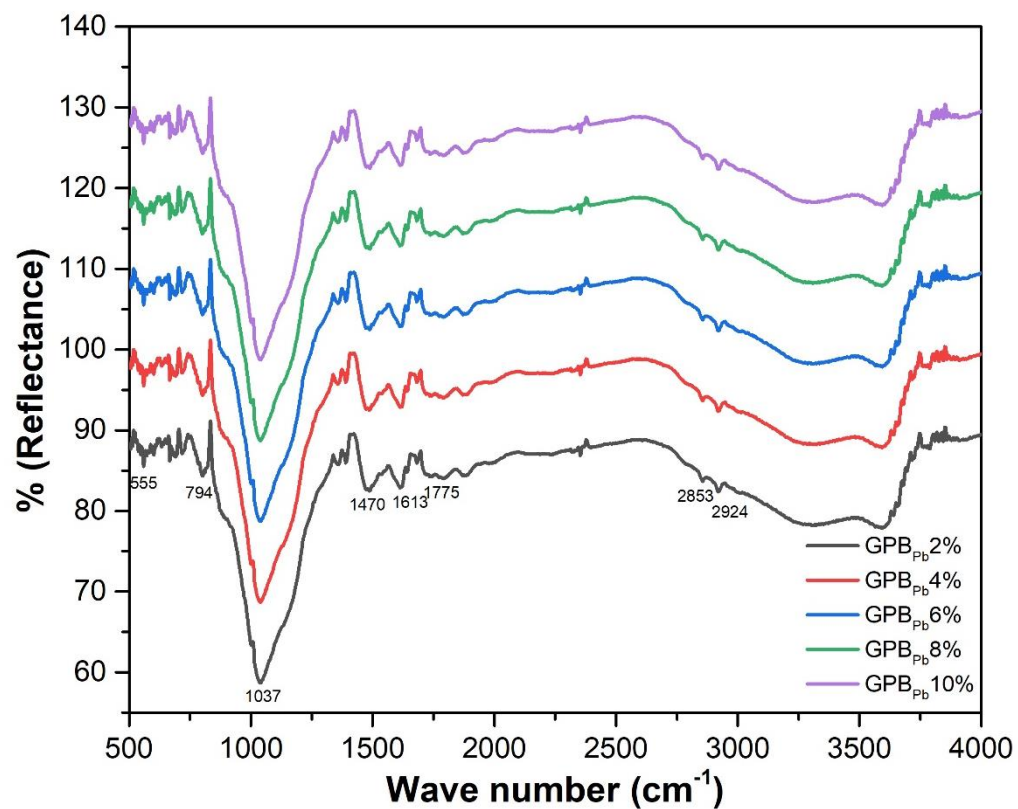
Based on the results obtained by X - ray diffraction, Figure S1, it was concluded that there were no significant changes in the structural properties of the investigated geopolymer materials after lead adsorption experiments. New phases were not identified. A slightly higher noise of the peaks was noticed. This may indicate that lead ions incorporated in the amorphous geopolymer matrix.



**Figure S1.** XRD results of GPB samples after lead adsorption experiments.

According to the obtained FT-IR spectra for GPBs, the band at about  $1440\text{ cm}^{-1}$  belongs to the formation of the non-centric carbonate group and  $\text{Na}^+$  from alkaline solution attached to  $\text{CO}_2$  from the air. The intensity of these bands is higher in the IR spectra of GPB 10%, GPB 8%, and GPB 6%. This higher intensity is related to the higher amount of Ca in the system which attracts  $\text{CO}_2$  from the atmosphere (Figure 2). After lead adsorption, the corresponding band is less intensive and moved to  $1470\text{ cm}^{-1}$ , Figure S2, due to the formation of lead carbonate. Furthermore, lead can easily replace either  $\text{Na}^+$  or  $\text{Ca}^{2+}$  due to the higher affinity for carbonate ions.

The wide stretched band at about  $1030\text{ cm}^{-1}$ , related to inclusions of  $\text{PO}_4$  tetrahedral units in geopolymer cement system, after the inclusion of lead into the system slightly changed. This may indicate that the adsorption of lead cations led to the incorporation of lead ions in the amorphous geopolymer matrix, irrespective of the brushite amount, Figure S2. This corresponds to the obtained XRD results for the materials after lead adsorption. However, there are still many preserved functional groups in the GPB after the adsorption process.



**Figure S2.** DRIFT spectra of GPB materials after lead adsorption experiments.

Finally, the XRD and FT-IR results for samples investigated after lead adsorption indicate that the chemisorption mechanism probably occurred on a structural level by incorporation of lead ions in GPB amorphous matrix.