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Investigation of sintering reactions in the anhydrite-quartz system using *in situ* hyperspectral Raman imaging

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During the combustion process of lignite, mineral deposits on the surfaces of the heat exchangers negatively impact the power station blocks. The sintering temperature of the material depends on its composition. Therefore, it is important to determine both elemental oxides and mineral phases before using lignite. There exist varieties of investigation opportunities to classify brown coals according to its combustion behavior. These are used to analyze mineral reactions associated with coals [1]. However, no experiments were processed to study sintering reactions *in situ* as a function of temperature and time. Modern confocal Raman spectrometer systems with integrated heating stages, allow the investigation of mineral distributions and textures even at high temperatures with a spatial resolution of a few micrometers. Therefore, it is an exceptional method to follow high-temperature phase transformations *in situ* [2]. The mineral phases anhydrite and quartz are typical components of Rhenish brown coal ash. Gehlenite, the Ca-endmember of the melilith series of mixed crystals, is also a mineral phase contained in brown coal ashes and part of various mineral transformations during the ash process [1]. Sintering reactions between these phases at high temperature lead to adherent soiling and poorly removable sintering inside the boiler of power stations. In the present study samples consisting of anhydrite, quartz and gehlenite, were fired to about 1100°C and analyzed *in situ* by hyperspectral Raman imaging. The sintering experiments revealed relevant insights to calcium silicate mineral reactions: (i) At about 830°C gehlenite recrystallized to wollastonite. (ii) From a temperature of ca. 920°C on, wollastonite was formed within the anhydrite-quartz system through the reaction between quartz and calcium oxide, which was gain by the decomposition of anhydrite. (iii) At 1100°C the crystallization of α-Ca_2SiO_4 was observed based on the main Raman band at 843cm^{-1} for the first time. During the cooling process β-Ca_2SiO_4 (larnite) crystallized and could remain metastable at room temperature. The reaction by dicalcium silicate with quartz to wollastonite was observed locally after cooling down. Summarized, three wollastonite-forming reactions within three different temperature ranges could be identified *in situ*, whereby the power of hyperspectral Raman imaging is highlighted. Such information about the mechanism of mineral transformations are essential for prognosis of sinter reactions in e.g. brown coal blocks.

References

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