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Infrared detection of the mineralogical aspects that influence the processing of calcined kaolin

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Calcined kaolin is an industrial minerals product used in the production of paper, paint, rubber and other specialty applications. It is produced from kaolinite through a series of refinement steps and final calcination at temperatures of above 900°C, with the aim of generating a whiter and more abrasive material. The raw kaolin ore is a mixture of clay minerals, quartz and feldspars, where kaolinite is the main constituent. The optimal kaolin ores to feed the processing plant should ideally have high kaolinite abundance, be free in Fe-bearing mineralogy (to avoid influence in the colour of the product), and the kaolinite itself should be of high crystallinity (to ensure the correct abrasiveness after calcination).

This work presents a case study from the kaolin deposits in the St. Austell Granite (South-West England), which are known for their high quality and world-class size. In this area, the kaolin is of primary-hydrothermal origin, with mineral associations that are related to the genetic history. The eventual depletion of the high-quality reserves is bringing now the attention to the lower grade zones, where the amount of impurities increases. As a consequence, it is critical to developing strategies that ensure the supply of high-quality ore to the processing plant. For this, it is necessary to acquire a thorough knowledge of the ore, including relative abundance of the minerals and their textural relationships.

Hyperspectral images in the visible-near infrared (VNIR) and short-wave infrared (SWIR) ranges were collected from drill cores and run-off-mine (ROM) samples, obtained from one of the kaolin pits in the St. Austell area, where the kaolin quality is known to be lower than in the rest of the deposit. A series of mineral maps were generated to assess the distribution, texture and abundance of the Fe-bearing mineralogy and the other kaolin-associated minerals, as well as the variations in the crystallinity of kaolinite. The mineral maps enabled the identification of tourmaline, biotite and hematite as the Fe-bearing mineralogy. Tourmaline was found mainly in veins and sometimes as phenocrysts; biotite was rather scarce, which suggest the advanced alteration degree of the deposit; hematite was present as coating and concentrated along quartz veins. Most of the mineral associations were represented by kaolinite, halloysite, muscovite, illite and montmorillonite. The ground mass was mostly kaolinite, although transition zones from kaolinite to halloysite and kaolinite to mica and montmorillonite were detected. Regarding the kaolinite crystallinity, the pure kaolinite graded from high to very high crystallinity. For the mineral mixtures of kaolinite with montmorillonite or halloysite, the crystallinity could not be determined with confidence.

These findings raise the possibility of using hyperspectral imaging as a tool for assisting selective mining, by identifying the areas in the deposit with the highest kaolin quality, thus reducing the amount of waste. In scenarios where selective mining is not possible, the spectral characterisation might provide robust mineralogical information about the content of the ore that can support the decision-making process in higher levels of the kaolin value chain.