

Changes of coal wastes mineralogy during self-heating processes simulated by hydrous and anhydrous pyrolysis

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The coal industry generates substantial amounts of gangue stored in waste dumps. These can undergo self-heating and self-ignition, causing serious environmental damages. In this study, hydrous pyrolysis (HP) and anhydrous pyrolysis (dry distillation, DD) were used to simulate natural self-heating processes of coal wastes with various contents of total organic carbon (TOC). All experiments were conducted isothermally for 72 hours in a 1-liter closed system, in presence of distilled water (HP), or without water (DD), at 250, 360 and 400°C.

The samples used in experiments were collected from fresh wastes of two coal mines and consist predominantly of quartz, kaolinite, muscovite and illite/illite-smectite. Less abundant minerals are K-feldspar, plagioclase, chlorite, carbonates in the form of dolomite/ankerite and siderite, pyrite, titanium oxides (rutile and anatase), and trioctahedral 2:1 and 1:1 minerals.

With the increase of temperature of pyrolysis, several trends in both series were observed:

- the content of carbonates were decreasing,
- iron ions from the decomposition of siderite lead to the magnetite formation,
- pyrite: is practically fully decomposed even in 250°C,
- illite-smectite of higher smectite content (20-30% S) is newly formed, especially at the highest temperatures of HP samples,
- the amount of K-feldspar decreases in HP samples,
- the content of kaolinite decreases, especially in 400°C of HP samples,
- other minerals, like quartz, muscovite, Ti-oxides, trioctahedral 2:1 and 1:1 minerals, are stable at temperatures of experiments.

Geochemical measurements showed no significant changes of major elements composition for samples with low content of TOC (a few percent). Samples having > 20% of TOC showed modification of proportions between major elements caused mainly by a decrease of loss on ignition and of TOC. These results indicate mineralogical transformations upon self-heating, with the parallel formation of amorphous phases.

Additionally, two samples collected in waste dumps that underwent self-heating were analysed. A significant decrease of kaolinite content and its transformation to an amorphous phase with similar chemical composition to kaolinite were identified.