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Generation of Acidity and Alkalinity from Different Coal Measure Lithologies Under Saturated Conditions

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Acid mine drainage can result from the weathering of entire worked coal measures sequences. This contamination can be detrimental to the local subterranean and surface environment. Therefore, it is essential that we try to understand the development of these contaminated minewaters within various oxidising and reducing conditions. A series of batch reactor experiments have been undertaken to try and determine the possible origins of contaminants within a complete lithological sequence and to ascertain the chemical and physical weathering rates of these rock types under set laboratory conditions. Eight different lithologies were selected from an exposure at the former Rawdon Colliery. These samples comprised coals, mudstones, siltstones, ironstones and seatearths taken from a Carboniferous Middle Coal Measure Sequence. Prior to the experiment the solid samples were characterised in terms of physical properties, durability, total porosity, particle size, mineralogy and chemical composition. The samples were then submerged in a 1×10^{-2} mole sodium chloride solution and compressed air was pumped through each batch reactors at a constant rate. The pH and temperature levels were recorded at regular intervals and sub samples of the solid and liquid phases were extracted to monitor the progress of the chemical reactions within the two phases. After a two month experimental period the chemical and mineralogical composition of the solid samples was reassessed.

The pyritic coals and mudstones generally reacted rapidly under laboratory conditions generating a minimum solution pH of 1.93. In contrast, the ironstone and the non pyritic mudstones reacted at a slower rate and generated alkaline solution with a maximum pH value of 8.85 in the latter stages of the test. The reactivity of the different mudstones, siltstone and seatearth varied according to their position in the rock succession. Mudstones associated with the pyritic P39 Coal, such as the Maltby Marine Band and the underlying seatearth were found to be highly reactive generating a minimum solution pH of 1.27. Other mudstones in the succession were found to produce more alkaline conditions during the experiment.

It was found that the lithologies with a high sulphides content and a low carbonate and alumino-silicates content were more reactive during the batch reactor experiments, probably due to the low solution pH. The lithologies containing high levels of carbonate and alumino-silicates were less reactive perhaps due to the high buffering capacity which prevented the pH from falling much below neutral.