Limitations of acidity testing in acid mine drainage prediction

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The determination of the pH of mine waste material is a fundamental property in determining the likelihood of sulphide oxidation and potential for the generation of acid mine drainage (AMD). Rinse and paste pH tests are fundamental tools used in static testing procedures to characterise the leach chemistry of mine waste rock. Rinse and paste pH tests are conducted on slurries of crushed or fine-grained samples in deionised (DI) water. However, a wide variety of experimental protocols exist within the field of AMD prediction; which vary in experimental layout and sample requirements. The objectives of this study were to establish: (1) which variables control the pH values measured on different types of sulphidic waste rock; and (2) which existing or modified pH tests provide the best indication of the propensity of a sample to produce AMD. In this project, one unweathered and two weathered sulphidic waste rocks were subjected to nine different pH tests based on rinse and paste pH protocols as well as standard soil pH testing methods (i.e. AS4969.2-2008, ISO 10390:2005(E), ASTM D4972-01 (2007)). In addition, the samples were characterised for trace element geochemistry, bulk mineralogy, particle surface area and their acid generating potential was determined using conventional Acid Base Accounting methods. Our research demonstrates that standard rinse and paste pH protocols used by research and commercial laboratories using DI water, can vary by as much as 1.9 pH-units for a given sample. Major factors that influenced the measured pH include grain size, soil:solution ratio, the use of electrolytes ($CaCl_2$, KCl), equilibration time, and stirring during pH measurement. Overall, changes in the the ionic strength of the slurry appears to exert the greatest control over the pH measurement. The use of DI water and 1M KCl in pH tests was associated with unstable or highly variable pH readings, respectively. In contrast, the use of 0.01M $CaCl_2$ solution led to more stable and precise pH measurements. Therefore, the preferred pH testing method for predicting first flush leachates arising from weathered sulphidic wastes is the ASTM D4972-01(2007) ($CaCl_2$) protocol, because the use of electrolytes stabilizes pH readings in low ionic strength solutions. This study highlights the need to use buffered pH testing protocols to accurately assess the first flush drainage properties of sulphidic waste rocks.

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