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# Fully coupled GoldSim-PHREEQC model using PhreeqPy for Mining Applications

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GoldSim is a software commonly used to model the quantity and movement of water and solutes in various types of environments. It is limited to managing concentrations of species at specific time points, without considering geochemical interactions and processes. However, when considering mine sites, it is critical to understand the geochemical processes and resulting solute loads within the site waters. USGS PHREEQC V3 allows the simulation of geochemical reactions such as mineral saturation, gas exchange, and adsorption as well as 1D advective transport calculations. Linking the capabilities of GoldSim with PHREEQC creates a dynamic model enabling chemical equilibration at every time point and different nodes within the model.

Methods have been developed which link GoldSim and PHREEQC using a Dynamic Link Library (DLL) with programming languages such as C++ or Python. Within consulting, the C++ method has been challenging to use due to its black-box approach, making PHREEQC elements of older models a challenge to update and errors hard to diagnose, with a higher level of programming expertise required to manipulate a C++ linked model. A new Python linked method was developed using PhreeqPy, providing the full capabilities of PHREEQC which include adsorption relevant for the fate and transport of constituents of potential concern which are essential at mining sites.

The study presents this method that has been benchmarked against an alternative Python-linked method, which does not include adsorption, and a case study for a mine site in Peru which used the C++ model. Almost identical results were generated with a shortened model run time. The model incorporates error checks between GoldSim and PHREEQC and presents a more user-friendly method, reducing the requirement for Python experience.

This method is being applied in the mining sphere across WSP globally for faster model development and to offer more comprehensive modelling capabilities. It has enabled a relationship between GoldSim and PHREEQC where site-specific flow data are combined with a comprehensive geochemical model to predict geochemical reactions likely to occur in dynamic, real-world water balance and mixing scenarios, reducing the time required for model development whilst enhancing the output to the end user.