Modeling the water flow in unsaturated waste rock pile: an important step in the overall closure planning of the first uranium mining site in Brazil.

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Release of acid drainage from mining-waste disposal areas is a problem found in many mine sites all around the world. Typically the generation of acid drainage may last for long periods of time and because of that permanent solutions need to be implement. However, the definition of the most effective strategy to be adopted can only be achieved if the knowledge of the characteristics of the acid generation process at the particular system are known. Some of the relevant processes regulating the acid generation are: oxygen transport into the waste rock pile, water flow inside the system, and the dissolution reactions of the main minerals. This paper presents the results obtained by the use of the numerical model HYDRUS-2D in the simulation of the water flow in one of the waste rock piles of the Pocos de Caldas Uranium Mining Site. Accurate modeling of the water flow in these systems entails considerable physical, mathematical and numerical challenges because they contain solids of different sizes, at different degrees of water saturation that in turn are subjected to reactive multicomponent transport,. The obtained results indicated that a steady state condition is achieved after 500 days of simulation. The average flow inside the pile was about 0.4 cm/d. The outflow estimated by the model was in good agreement with the measured values – a difference of 6.5% was observed and the error in the mass balance was only of 0.59%. It could be seen that most of the pile is under unsaturated conditions - saturated conditions prevailing up to 10 meters from the bottom. However, it must be emphasized that result only improved when the flux through the macropores was taken into account. The results support previous diagnostics that remedial actions to be applied to the system should focus manly in impeding oxygen diffusion into the pile.