National University of Science and Technology

Think in Other Terms

FINAL YEAR PROJECT

MODELLING THE ATTENUATION OF IRON AND MANGANESE IN POROUS MEDIA

SIBONAKALISO CONSCIENCE MPALA

N004 1560D

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ABSTRACT

Iron and manganese bio-fouling is very common in boreholes in some groundwater systems. Iron(II) is rapidly converted to Iron(III) on exposure to atmospheric oxygen. Iron(III) always precipitates out of solution forming colloidal sized particles. The precipitates formed are very small and foul water-collection, water-storage, and water treatment systems. The study sought to model the transport and subsequent attenuation of iron and manganese in porous media. An in-depth study of redox processes and reaction kinetics was undertaken with the hope of understanding the factors that affect the oxidation or reduction of iron and manganese. It was revealed that the oxidation can be represented by a first order degradation component in the transport equation. In the study contaminant transport processes were taken into consideration and it was revealed that the advection-dispersion equation with the first order reaction component could be used to model this attenuation. It also emerged that to model the overall transport of each element, i.e. manganese or iron, a system of equations to show the sequential degradation of the element from one oxidation state to another had to be developed. A conceptual model was developed as well as a mathematical model. Processing MODFLOW for Windows (PMWIN) was then used to produce a numerical solution for a hypothetical system within the Matsheumhlope Aquifer. MODFLOW was applied to produce the steady state flow model. PMPATH was then applied to delineate the capture zones of boreholes within a 900 hectare portion of the aquifer. MT3DMS was then applied for the reactive solute transport. The simulation was affected by lack of critical data and typical hypothetical values were applied to simulate the transport of Iron(II) within the aquifer complex. Iron(III) transport simulation could not be performed because MT3DMS proved inadequate in handling sequential degradation of contaminants and a better alternative, RT3D could not be obtained. PMWIN, being shareware is still inadequate for modelling complex groundwater systems and robust but commercial versions of MODFLOW such as Visual MODFLOW and Groundwater Vistas will have to be sought.