Uva Wellassa University, Sri Lanka
Faculty of Science and Technology
Mineral Resources and Technology Degree Programme
1st Semester Examination – March/April 2013

MRT 452-3 Solute Transport Modelling Methods

Total number of questions: Five (05)
Answer **all** questions
Time allocation : Three (03) hours
Total marks : 100

1. a. Generally a groundwater system is very complicated. Briefly explain the different factors that cause this complexity.

(05 marks)

b. What are the limitations you may encounter in modelling a complex groundwater system?

(05 marks)

c. Describe in detail how you could use models for decision making in groundwater management.

(10 marks)

2. a. Assuming a homogeneous and an isotropic medium, give the mathematical expression for Darcy's Law in 2-D.

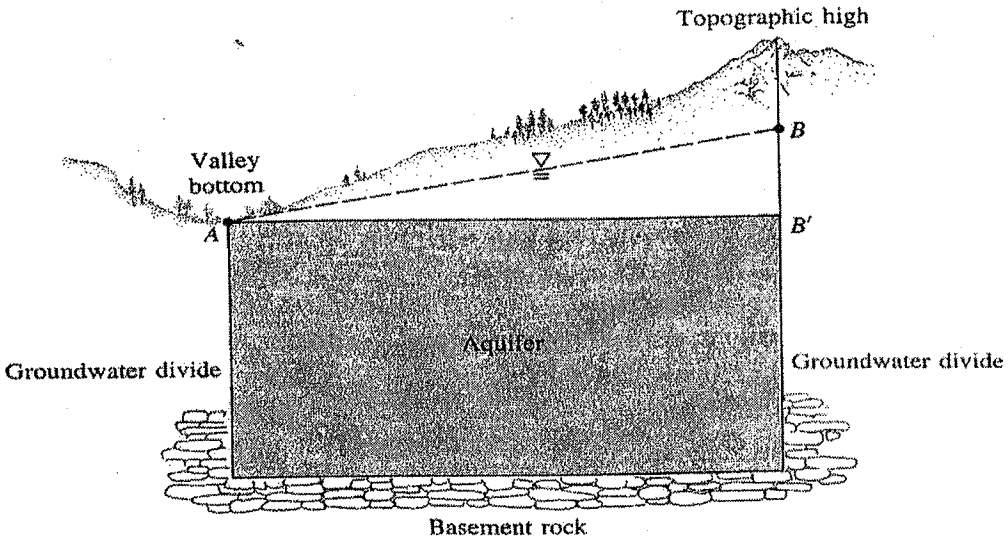
(05 marks)

b. Using the terms in 2.a, develop the continuity equation for steady-state flow in an aquifer.

(05 marks)

c. A simplified regional groundwater system is illustrated in Figure Q.2. The shaded area of the aquifer is the domain of interest for a particular problem.

Represent it using a simple mathematical model indicating appropriate boundary conditions and the hydraulic head distribution along the upper surface of the problem domain. State your assumptions. *[Hint: use terms from 2.b]*



Source: Wang and Anderson, 1982

Figure Q.2

(10 marks)

3. a. What are the advantages of numerical methods over analytical methods in solving a mathematical model of a groundwater system? Explain with appropriate examples.

(7.5 marks)

b. Give a simple mathematical expression for the transient flow in an aquifer. Derive the continuity equation in 2-D based on this relationship.

(12.5 marks)

4. a. Describe the basic features of the MODFLOW software package which is commonly used in groundwater modelling.

(2.5 marks)

b. Sketch the 3-D finite difference discretization of a hypothetical aquifer with block-centered approach.

(2.5 marks)

c. Figure Q.4 shows the neighbouring cells of the cell (i,j,k) in a 3-D finite difference grid.

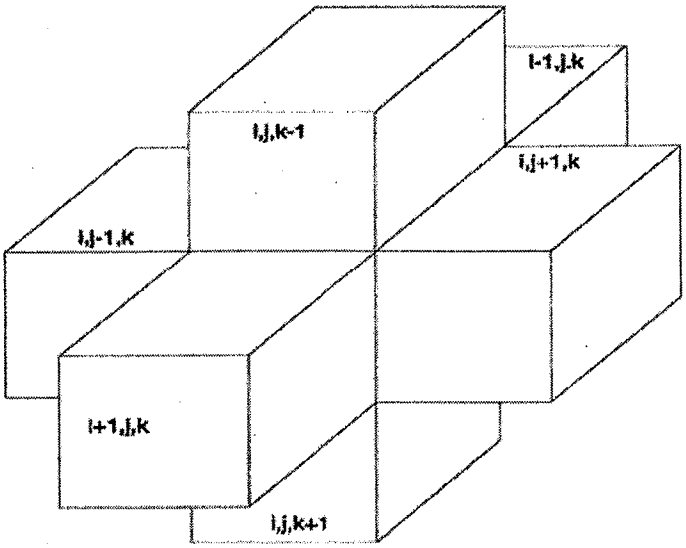


Figure Q.4

Develop the finite difference formulation considering the flow into cell (i,j,k) from all its six neighbours. Neglect external sources. *[Standard notations without definition are accepted]*.

(15 marks)

5. a. Briefly describe the processes of solute transport in groundwater systems.

(05 marks)

b. Describe the mass balance in solute transport considering all parameters involved.

(05 marks)

c. Explain how the movement of a solute is retarded in an aquifer. Defining all terms, write a mathematical expression that accounts for these processes.

(10 marks)

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