

INTERNATIONAL SCHOOL FOR GEOSCIENCE RESOURCES  
KOREA INSTITUTE OF GEOSCIENCE AND MINERAL RESOURCES (KIGAM)

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## INTENSIVE TRAINING COURSE ON Groundwater Theory and Practice

The **International School for Geoscience Resources** of KIGAM presents an intensive training course on Groundwater. The course will take place at the Ara room of International School for Geoscience Resources of KIGAM in Daejeon (Korea) from July 5th through July 25th, 2011 and will include the following modules.

Module	Duration	Leading Instructor
<b>KIGAM LAB Tour</b>	7.5	KIGAM
<b>Module 1.</b> Introduction to Groundwater Basics	7.6 ~ 7.8	Schwartz/Lee
<b>Module 2.</b> Field Investigations on Hydrogeology	7.11~7.14	Schwartz/Lee
<b>Module 3.</b> Geochemistry, Isotopes, Karst hydrogeology, Age Dating	7.15, 7.18	Schwartz/Lee
<b>Module 4.</b> Contaminant Hydrology Field Excursion to Korea Water Resources Corporation	7.19~7.22	Schwartz/Lee
<b>Country Report Presentation</b>	7.25	KIGAM

※ Class time: 09:40~17:45

## Agenda

- To develop fundamental knowledge of basic concepts of groundwater flow, field investigation, and water chemistry
- To use illustrative problems and field exercises to foster a deep understanding of basic concepts
- To apply theory and concepts to problems of water supply development, water-resource assessments, contamination assessments, and water-source remediation

## Course Coverage

- Introduction into to the hydrologic cycle and water balance applied to water-resource assessments
- Fundamentals of groundwater flow through porous media, regional groundwater flow and well hydraulics
- Key technologies employed in the field assessment of groundwater resources, site investigation, measurements of hydraulic head and aquifer testing
- Introduction to groundwater geochemistry, isotope hydrology, and age dating
- Key contaminants and their fate and transport in groundwater and surface water system
- Addressing problems of contamination through remediation and policy

## Course Requirements

- Basic knowledge of geology obtained through B.S. programs in Geology, Environmental Science or Environmental Engineering
- Broad exposure to the basics of physics, chemistry
- Command of both spoken and written English
- Experience with personal computers and the Microsoft Office family of products
- Understanding of fundamental

## Module 1. Introduction to Groundwater Basics, July 6- 8 by Drs. Schwartz/Lee and Kim

This module will address the concept of a water cycle, water budgets from a hydrologic and groundwater perspective, the development of ideas of sustainability and basic concepts of flow through porous media and the controlling parameters. Another focus of this module is regional groundwater flow, the historical development of ideas and basic concepts. The exercises in this module will explore groundwater flow velocities and the construction of hydrogeologic cross-sections. The objectives of this module are to provide students with a clear understanding of fundamental concepts of the occurrence of water and the quantitative description of its flow, and the historical development of foundational ideas.

### Content of module

#### ○ Day 1. Groundwater Basics

- Water Cycle S
- Water budgets for lysimeters and a small watershed L
  - Exercise: Water budget calculation L-S
- Safe yield and sustainability – an evolution of ideas S
  - Exercise: Mississippi River Alluvial aquifer S-L

#### ○ Day 2. Theory of Groundwater Flow

- Groundwater basics L
  - Exercise: Application of Darcy's Law L-S
- Flownet theory and applications S
  - Exercise: Flownets S-L
- Regional groundwater flow S

#### ○ Day 3. Surficial Manifestation of Groundwater Flow

- The Prairie Profile S
- Groundwater surface-water interactions L
- Riparian zones S
  - Exercise: Preparation of hydrogeologic cross-section S-L
- *Field Exercise I: All afternoon ( with Dr. Yongcheol Kim, KIGAM)*
  - *Head measurement* K
  - *Downhole camera* Kyucheol Ha
  - *Groundwater sample collection by bailer and pump* K
  - *Filtering and water chemistry measurements* K

## Module 2. Field Investigations, July 11 – 14 by Drs. Schwartz/Lee and Kim

This module will cover key aspects related to the field practice of hydrogeology including, drilling and sampling, geophysical approaches, and the design and installation of piezometers and monitoring wells. It will provide a basic introduction of the theory of flow to wells and the application of this theory in aquifer testing, and regional water resource assessments. Exercises will provide instruction in correlation of lithologic data, and the interpretation of aquifer test results. Field demonstrations and exercises will let students observe aquifers in the field and common geophysical techniques. The objective of this module is to provide students with a basic understanding of basic field methods and their relationship to theoretical concepts .

- **Content of module**

- **Day 1. Drilling and sampling**

- Common drilling and sampling methods: S
- Geoprobe – revolution in shallow investigation S
  - Exercise: Geoprobe data analysis L-S
- Piezometer – design, theory and installation S
- Well development and hydraulic head measurements L
- Borehole logging S
  - Exercise: Lithologic and borehole log correlation S-L
- Geophysics for site investigation S
- *Field exercise II Geophysical exploration: All afternoon (with Dr. Changryol Kim, KIGAM)*
  - *Introduction to Environmental Geophysics for Site Investigations*
  - *Field Demonstration of Geophysical Explorations*
  - *Case Studies*

- **Day 2. Flow to Wells I**

- Aquifers
  - transmissivity and storativity L
  - Types of aquifers S
- Flow to wells L
  - Exercise: Forward problem – Theis calculation S-L
- Interpretation of aquifer test data:
  - Theis type-curve L
  - Cooper-Jacob L
  - Exercise: Theis type-curve method L-S
- Superposition and bounded aquifers S

○ **Day 3. Flow to Wells II and Water resource assessments**

- Interpretation of aquifer test data:
  - Hantush and Jacob method L
  - Neuman method L
- Slug test: Bouwer and Rice method L
- Climate, surface water, groundwater assessments S
- Introduction to groundwater modeling S
- Case study in application of groundwater model S
  - Exercise: Aquifer pumping simulation S-L

○ **Day 4. Field demonstrations**

- *Field Exercise III Aquifer test: Full day (with Dr. Kim, Yongcheol, KIGAM)*
  - *Introduction to aquifer test demonstration(Class)* K
  - *Data Collection: Head measurements, pressure head data logger installation* K
  - *Aquifer test: slug test, pumping test* K
  - *Data Interpretation(Class)* K

**Module 3. Geochemistry, Isotopes, Karst hydrogeology, Age Dating,**  
*July 15 and 18 by Profs. Schwartz/Lee*

This module provides an overview of basic concepts of aqueous geochemistry. It begins with an introduction of the variety of dissolved mass found in natural water, measures of concentration and types of water analyses. It includes a discussion of water standards and how they are used and how water evolves chemically in the subsurface. This module presents an overview of environmental isotopes and how they are used in water studies such as karst hydrogeology. It concludes with laboratory measurements and an overview of tritium and CFC methods in age determinations. Exercises focus on assessing the quality of water analyses and interpreting age dates. The objectives of this module are to provide students the basic tools to interpret geochemical and isotopic data in the context of groundwater and contaminant investigations.

• **Content of module**

○ **Day 1. Mass in natural water**

- Ions, measures of concentrations, cation/anion balance S
- Water analyses, drinking water standards L
- Plotting chemical data S
  - Exercise: Plotting chemical data S-L

- Carbonate equilibria and geochemical evolution of natural water L
- Introduction to isotope hydrology L
- **Day 2. Basic Laboratory Measurements, Isotopes, Age dating**
  - Karst Hydrogeology L
    - Exercise: Flow and geochemical evolution of water in karst terrain L
  - Treating water samples in the field and laboratory S
  - Age dating: Carbon-14, Tritium, CFC S
  - *Lab Exercise: Basic lab measurements, CFC dating (with Dr. Yoon Yeol Yoon, afternoon)*
    - *Principle of groundwater age dating*
    - *Age dating method*
    - *Sample treatment*

#### **Module 4. Contaminant Hydrogeology, July 19 – 22 by Profs. Schwartz/Lee**

Contaminant hydrogeology brings together knowledge from other parts of the course and adds new ideas of physical and chemical transport. This module will explain how contaminants originate in groundwater and how they are organized for study. It will discuss the difference between problems of dissolved contaminants and those involving LNAPLs and DNAPLs. This section will explain the key processes involved in contaminant migration and develop conceptual models. Exercises and case studies will help focus learning on the most important lessons. The objective is to provide an introduction to the subject that will provide a good understanding of the topic and integrate theory and practice.

- **Content of module**

- **Day 1. Contaminants in groundwater, Theory of contaminant transport**
  - Contaminants and types of contamination S-L
    - Families of contaminants
    - Contaminant plumes in groundwater
    - Exercise: Cape Cod, MA case study
    - Exercise: Leon County, FL case study
  - Advection S
    - Theory
    - Exercise: Advection at Otis Air Base
  - Dispersion I L
    - Theory
    - Tracer tests
  - Dispersion II S



- Quantitative treatment of dispersion
- Exercise: Calculation of dispersivity

○ **Day 2. Theory of contaminant transport, NAPLs**

- Diffusion L
- Key chemical reactions – sorption and biodegradation S
- Retardation L
- NAPLs
  - Organic compounds L
  - Residual saturation and patterns of spreading L
  - vapor transport S
  - Petroleum hydrocarbons S
  - NAPL site investigations S
  - Exercise: DNAPL spreading S-L

○ **Day 3. NAPLs and Case Studies, Remediation**

- Exercise: Savage Well Superfund case study S-L
- Remediation
  - Containment S
  - Systems for recovering LNAPLs S
  - Designing injection/withdrawal systems S
  - In situ chemical oxidation L
  - Permeable reactive barriers and controlled-release system L
  - Bioremediation S
  - Case studies in contaminant cleanups S-L
- Culminating activity

○ **Day 4. Field Excursion to Korea Water Resources Corporation: All day by Dr. Kim, Yongcheol (KIGAM)**

- *To be distributed*

### About the presenter-Prof. Frank W. Schwartz



**Frank W. Schwartz** received B. Sc. M. Sc., and Ph.D. degrees in hydrology from University of Western Ontario, University of Manitoba, and University of Illinois, respectively. Professor Schwartz joined School of Earth Sciences of The Ohio State University in Columbus, OH in 1988 as the Ohio Eminent Scholar in Hydrogeology. He was formerly a Professor of Geology at the University of Alberta. Dr. Schwartz is the author of more than 160 publications and is known internationally for his work on field and

theoretical aspects of contaminant hydrogeology and remediation, mass transport, ground-water geochemistry, and watershed hydrology. He has co-authored two textbooks, *Physical and Chemical Hydrogeology* (John Wiley & Sons, Inc., New York, Domenico, P.A. and F.W. Schwartz, 1998), and *Fundamentals of Ground Water* (John Wiley & Sons, Inc., New York, F.W. Schwartz, and H. Zhang, 2003), which are widely used for teaching hydrogeology around the world. Professor Schwartz has received major awards recognizing his status as a scientific leader. He is a recipient of the O.E. Meinzer Award, the Excellence in Science and Engineering Award, the King Hubbert Science Award, and was elected as a Fellow of the American Geophysical Union and Geological Society of America. He served as the first Editor-in-Chief for the Journal of Contaminant Hydrology (1991-2003), and was recently named as the next Editor-in-Chief for the Groundwater. In addition, he has served on a variety of expert panels of the U.S. National Research Council, the U.S. Department of Energy, U.S. Geological Survey, the Lawrence Berkeley National Laboratory, and the US EPA. Dr. Schwartz has taught five educational programs that included 5-day courses in contaminant hydrogeology and remedial technologies (in Valencia, Spain, San Deigo, CA, Lima, OH, and Columbus, OH).

### About the presenter- Dr. Eung Seok Lee



**Eung Seok Lee** received B. Sc. and M. Sc. in geology from Yonsei University and Ph.D. in hydrogeology from Indiana University. Dr. Lee joined Department of Geological Sciences of Ohio University in Athens, OH in 2008 as an assistant professor in Hydrogeology. He was formerly a postdoctoral researcher at the University of Saskatchewan, Canada and a research scientist at The Ohio State University. An author of more than 20 publications, Professor Lee has performed sponsored research in the areas of karst hydrogeology, contaminant hydrogeology and remediation (US

DOE, DOD), isotope hydrology (NSERC, Canada), acid mine drainage (American Electric Power), and urban runoff management (Global Research Laboratory, MEST, Korea). Dr. Lee has received John Patton Award, Shell Scholarship, and served as an associate editor of journal *Groundwater*. He teaches hydrogeology courses at Ohio University.



**About the presenter- Dr. Changryol Kim**

**Changryol Kim** received B.Sc. in geology and M. Sc. in geophysics from Yonsei University, and Ph.D. in geophysics from Ohio State University. He formerly joined Environment Remediation Section of Korea Rural Community Corporation. Currently, he is a senior researcher of Exploration Geophysics and Mining Engineering Dept. of Korea Institute of Geoscience and Mineral Resources (KIGAM). He has served as a member of the board of directors for Korean Society of Earth and Exploration Geophysicists since 2008. He is an author of more than 25 publications, and is conducting researches in the areas of environmental and engineering applications of geophysical techniques, and mineral resource exploration using integrated geophysical techniques.

**About the presenter- Dr. Yongcheol Kim**

**Yongcheol Kim** received B. Sc. M. Sc., and Ph.D. degrees in hydrogeology from Seoul National University, South Korea. Dr. Kim researched at CESEP(Center for Experimental Study of Subsurface Environmental Processes) in Colorado School of Mines, Colorado, USA from 2003 to 2005 as a visiting scholar and post doctoral researcher. He joined Korea Institute of Geoscience and Mineral Resources in 2005 as a senior researcher. Dr. Kim has more than 20 publications, four patents registered and eleven patents reviewed. He has performed research in the area of artificial recharge for sustainable groundwater resources, flow and transport in saturated/unsaturated porous/fractured media, DNAPL problems, tracer test, hydraulic tests for site characterization, hydrogeological characterization of volcanic aquifer, karst aquifer, and groundwater contamination problem. Dr. Kim has received Young Geologist Award of Korea. In addition, he has served on expert panels of the Jeju Special Self-governing Province and Wonju Regional Environmental Office.

**About the presenter- Dr. Yoon Yeol Yoon**

**Yoon Yeol Yoon** received B. Sc. from Seoul National University and M. Sc., and Ph.D. degrees in chemistry from Chungnam National University, South Korea. Dr. Yoon researched at Washington State University, Washington, USA from 2002 to 2003 as a visiting scholar. He worked for Korea Institute of Geoscience and Mineral Resources from 1986 as a researcher and he has more than 40 publications. He has performed research in the area of groundwater age dating and hydrogeological application using environmental radionuclides.

## COURSE INFORMATION

- **STARTING/END DATE AND LOCATION**

- ✓ July 6 - July 22 (2 weeks and half) at KIGAM in Daejeon, Korea.

- **LANGUAGE OF STUDY**

- ✓ The language of instruction is English and all courseware is in English.

- **ASSESSMENT AND CERTIFICATION**

- ✓ Participants will receive certificates upon completion of the course.

- **APPLICATION**

- ✓ Participants should fill the application form and send to E-mail below before 3 days of module starting date..
- ✓ Or visit at <http://isgeo.kigam.re.kr>, IS-Geo Homepage for you to apply for this training course.

- **CONTACT**



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