



PUBLIC CUSTOMIZED TRAINING COURSE ON Stable isotope geochemistry and its application to mineral resource exploration

The **International School for Geoscience Resources** of KIGAM presents an intensive training course on **Stable isotope geochemistry and its application to mineral resource exploration**. The course will take place at the Mirinae room of International School for Geoscience Resources of KIGAM in Daejeon (Korea) in **May 11 to 15, 2015** and will include the following topics.

| Topics | Date | Instructor |
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| Day 1. Stable Isotope Geochemistry 1 | | |
| Topic 1. Introduction | | |
| Topic 2. History, Principles, standards..... | 5.11 | |
| Topic 3. O and H isotope systems | | |
| Topic 4. Exercises | | |
| Day 2. Stable Isotope Geochemistry 2 | | |
| Topic 1. S and C isotopic systems | 5.12 | Prof. Insung Lee (Seoul Nat' Univ., Korea) |
| Topic 2. Exercises on S and C systems | | |
| Day 3. Application to the study of mineral deposits | | |
| Topic 1. Magmatic mineral system | | |
| Topic 2. Hydrothermal mineral systems | 5.13 | |
| Topic 3. Porphyry Cu mineral system | | |
| Topic 4. Volcanogenic massive sulfide deposit | | |
| Topic 5. Non-magmatic mineral system | | |



Day 4. Magmatic Ni-Cu-PGE Deposits

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| Topic 1. Deposit types and key geochemical principles | | |
| Topic 2. Requirements for the generation of magmatic sulfide-rich Ni-Cu-PGE deposits | 5.14 | Prof. Edward M. Ripley (Indiana Univ., USA) |
| Topic 3. The application of S, O, and Re-Os isotopic measurements to the study of magmatic Ni-Cu-PGE deposits | | |

Day 5. Magmatic Ni-Cu-PGE Deposits(Continued)

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| Topic 4. Ni-Cu-PGE deposits associated with the Midcontinent Rift System, USA | | Prof. Edward M. Ripley (Indiana Univ., USA) |
| Topic 5. Conduit style deposits: Noril'sk, Voisey's Bay, and Eagle | 5.15 | |
| Topic 6. Deposits in convergent zone settings | | |
| Topic 7. Low-sulfide PGE deposits | | |



COURSE INFORMATION

- **Agenda**

- This course is designed to introduce the theory, applications, and mass spectroscopy for stable isotope analysis in environmental, earth and material science. Students will be introduced to the history of stable isotope analyses, principles of stable isotope fractionation, instrumental and sample preparation techniques, natural distribution of oxygen, hydrogen, carbon, sulfur, nitrogen isotopes, and will gain an understanding of analytical approach to problem solving. Stable isotope data in each genetic type of ore deposits will be given and will be discussed as tools for mineral exploration.

- **Course Covered**

- Principle of stable isotope geochemistry
- Application to the research of ore deposits
- Calculation exercise to evaluate the stable isotope systems

- **Course Requirements: Prerequisite**

- Knowledge of introductory Geology, mineralogy, petrology, and geochemistry
- Understanding of mathematical basics to solve the problems related to stable isotope fractionation in nature

- **Who should Attend?**

- This course is designed for scientists or engineers who work on ore deposits and mineral exploration.

- **Summary of topic contents and learning objectives**

Introduction of the theory, applications, and mass spectroscopy for stable isotope analysis in environmental, earth and material science. History of stable isotope analyses, principles of stable isotope fractionation, instrumental and sample preparation techniques, natural distribution of oxygen, hydrogen, carbon, sulfur, nitrogen isotopes, exercises on the calculation of the isotope systems will be covered. Stable isotope data in each genetic type of ore deposits will be given and will be discussed as tools for mineral exploration.

The course on Day 4 and 5 is designed to acquaint participants with magmatic Ni-Cu-PGE deposits and their genesis. Both sulfide-rich Ni-Cu-PGE and sulfide-poor PGE deposits will be discussed. Geochemical methods of investigation will be presented, with daily calculations done in the laboratory portion of the class to reinforce the lecture topics. No special prerequisites are necessary other than a background in geology and basic mathematics. Principal topics to be covered include:

- **Day 1. Stable Isotope Geochemistry 1 by Prof. Insung Lee(Seoul National University, Korea)**

Principles of isotope fractionation, sample preparation for the analysis, mass spectrometry, O and H isotope variation in nature, and calculation and evaluation of O and H isotope systems will be introduced.

- Introduction
- History, Principles, Standards, Analytical methods, and Mass spectroscopy
- Oxygen and hydrogen isotope system 1
- Oxygen and hydrogen isotope system 2
- Exercise on the O and H isotope systems

- **Day 2. Stable Isotope Geochemistry 2 by Prof. Insung Lee(Seoul National University, Korea)**

Principles of S and C isotope fractionation, sample preparation for the analysis, S and C isotope variation in nature, and calculation and evaluation of S and C isotope systems will be introduced.

- Sulfur and carbon isotope system 1
- Sulfur and carbon isotope system 2
- Exercise on the S and C isotope systems

- **Day 3. Application to the study of mineral deposits by Prof. Insung Lee(Seoul National University, Korea)**

Stable isotope data in different type of ore deposits will be introduced and discussed based on previous researches. Stable isotope as possible tools for the mineral exploration will be also examined. Evolution of isotope tracers will be reviewed and presented.

- Magmatic mineral systems
- Hydrothermal mineral systems
- Porphyry Cu deposits
- Volcanogenic massive sulfide deposits
- Non-magmatic mineral deposits
- Future of isotopic tracers for the mineral exploration and conclusions

- **Day 4. Magmatic Ni-Cu-PGE Deposits by Prof. Edward M. Ripley (Indiana University Bloomington, USA)**

- Deposit types and key geochemical principles
: An overview of the rock types that host magmatic Ni-Cu-PGE deposits, and the geochemical methods that are employed in the study of their genesis. Includes element distribution, solubility, R-factors, crystallization of sulfide liquids, and sulfide saturation.
- Requirements for the generation of magmatic sulfide-rich Ni-Cu-PGE deposits
: A discussion of the key processes that are needed to produce an economic deposit, beginning with partial melting of the mantle source.
- The application of S, O, and Re-Os isotopic measurements to the study of magmatic Ni-Cu-PGE deposits
: A review of how these isotopic systems are utilized and cautions in interpreting isotopic data.



- **Day 5. Magmatic Ni-Cu-PGE Deposits(Continued) by Prof. Edward M. Ripley (Indiana University Bloomington, USA)**
 - Ni-Cu-PGE deposits associated with the Midcontinent Rift System, USA
 - Conduit style deposits: Noril'sk, Voisey's Bay, and Eagle
 - Deposits in convergent zone settings
 - : A discussion of the potential for Ni-Cu-PGE deposits in convergent zones, with applications from Ural-Alaskan intrusions in North America and elsewhere.
 - Low-sulfide PGE deposits
 - : A review of reef-style PGE deposits in large (Bushveld, Stillwater, Great Dyke) and small (Sonju Lake, Stella,) intrusions. Processes of PGE enrichment.
 - Labs:
 - Calculation of olivine Forsterite – nickel relationships
 - Estimation of R-factors
 - Sulfide saturation plots
 - Interpretation of isotopic data



About the instructor – *Prof. Edward M. Ripley*

Prof. Edward M. Ripley is a professor of Department of Geological Sciences, Indiana University, USA since 1988. He holds Ph. D. on geochemistry (The Pennsylvania State University, 1976), M.S. and B.S. on geology (University of Minnesota, 1973 and Illinois State University, 1971, respectively). He belongs to Society of Economic Geologists, Mineralogical Association of Canada, Phi Kappa Phi, Geological Society of America and Geochemical Society. He supervised 23 M.S. students and 17 Ph. D. students from 1976 to 2013.

He has been involved in the teaching of field geology at the Indiana University Field Station for the past 22 years. The station is located between Butte and Bozeman, in the Tobacco Root Mountains of Montana.

And also, he has been involved in the teaching of several short courses on the genesis of magmatic sulfide deposits and the utilization of isotopic methods in petrologic studies. The most recent were in Sudbury, Hong Kong, Beijing, Duluth, Minneapolis, Guiyang, Mysore, Toronto and Sudbury.

He was an associate Editor of *Geochimica et Cosmochimica Acta*, National Science Foundation Past Panel Member of Petrology and Geochemistry(2002-2004), National Science Foundation Panel Member of Petrology and Geochemistry(2013), Former Associate Editor of *Canadian Mineralogist*(3-year term), Panel member of United States Geological Survey Mineral Resources Research Program(2007) and Elected member of the University of Minnesota, Duluth, Swenson College Academy of Science.

About the instructor – *Prof. Insung Lee*



Prof. Insung Lee, Resource Geology Laboratory, is teaching and doing research in the School of Earth and Environmental Sciences, Seoul National University since 1997. He worked as a director of Earth system science program at SEES, SNU from 2003 to 2005. He served as director of Inter-university center for basic science, SNU, and also served as director of SEES, SNU from 2012 to 2014.

Prof. Lee was born in Busan in 1957, graduated the Dept. of Geology, SNU in 1979 (B.S.), received M.S. from the Dept. of Geology, SNU in 1981,



received M.S. from the Dept. of Geology, U. of Minnesota, Twin Cities in 1987, and received Ph.D. in the area of resource geology- isotope geochemistry, from the Dept. of Geology, Indiana University.

Prof. Lee worked as Senior scientist and group leader of Isotope research group of Korea Basic Science Center from 1994 to 1997, has been working as director in Natural History Division of University Museum, Seoul National University since 2002. He has been managing the Wednesday open Lectures about Natural History designed for public outside University, since 2002. He worked as consultant for the Korea Government, advising mineral exploration project abroad including KOICA project and KORES mineral exploration in foreign countries. He worked for several mining companies consulting in several project in Mongolia, Kazakhstan, Thailand, and Cameron.

Prof. Lee's main research interest include the study of the genesis of metallic and non-metallic ore deposits, stable isotope geochemistry, and its application to the study of Earth and environmental sciences.

His main research publications include "Researches on the genesis of Cu-Ni deposits in the Great Lakes", "Stable isotope and fluid inclusion research on the talc deposits in Chungju-Jecheon area", "Sulfur and lead isotope studies on the Fujian Pb-Zn deposits, China", "Gold mineralization in the Kyaukpahto, Northern Myanmar", "Fluid inclusion studies on the Au-Ag-bearing quartz veins in Phuoc Thanh, Vietnam", "Sulfur, strontium, lead isotope researches of hydrothermal precipitates from Manus basin, west Pacific", "Solid-NMR research on coal resources in Mongolia", "S, O, H isotope studies on the wet precipitates in Seoul area", etc.

