Division of Environmental Studies

Department of Environment Systems

Laboratory	Faculty	Introduction of research activities and laboratory	Key words	Projects or activities summer program students can participate
Energy and Environment Laboratory	Lecturer Masaatsu AICHI	Current approaches to energy supply and consumption face problems such as climate changes and dwindling resources. The development of key technologies for saving energy, switching to renewable energy resources, and appropriate waste disposal is required. Our goal is to perform research that will contribute to the development of these technologies, especially by taking advantages of the characteristics of subsurface formations. For example, we study ways of developing a sustainable energy system, especially through hydrogeological and thermo-poro-mechanical modeling of geothermal heat pumps, geothermal power plants, and the geological sequestration of carbon dioxide. On the other hand, we also start to study how to adapt to global warming. Combining mitigation and adaptation is an attractive choice but it is not simple because one countermeasure possibly causes another environmental effects. For example, though the groundwater becomes more important water resource under changing climate, the overexploitation of groundwater possibly causes another environmental problem such as land subsidence, sea water intrusion in coastal area, so on. We try to predict and prepare for this kind of domino-like propagation to other environmental problems in advance.	1) Water resource 2) Groundwater 3) Land subsidence 4) Modeling 5) Management	Land subsidence caused by groundwater abstraction has been one of the severe environmental problems in Asian coastal megacities. By strictly regulating the groundwater abstraction, the land subsidence in several cities in Japan ceased today. On the other hand, the groundwater becomes more important water resource under changing climate. In addition, the groundwater is considered to be an important water resource after an earthquake disaster. Furthermore, the high groundwater pressure is harmful for the subsurface infrastructures. Then, the possibility to restart groundwater abstraction is becoming a matter of debate. However, it is essential to avoid the restart of land subsidence problem. Theoretically, it can be achieved by controlling the groundwater level so that the effective stress does not exceed the preconsolidation stress of subsurface formations. However, it is very difficult to find practically because of the heterogeneity in subsurface formations and the history of hydraulic head change. In this program, we try to numerically simulate the evolution of the preconsolidation stress under the historical groundwater abstraction and find a critical groundwater level in the

				future groundwater usage. The schedule is roughly planned as follows: 1st-2nd week: Introduction to land subsidence simulation and excursion to the land subsidence monitoring system in Tokyo. 3rd -4th week: Simulation of the past land subsidence and proposal for the future.
Oshima Laboratory	Prof. Yoshito OSHIMA	"Supercritical fluid" refers to a fluid in which the material's critical points of temperature and pressure are being exceeded. Dramatic physical changes are possible depending on the operating conditions of the material. In particular, the ionic content and dielectric constant of supercritical water changes extensively based on temperature and/or pressure. As a result of this, it becomes possible to select a reaction based on one's objective: from an ionic atmosphere suitable for inorganic reactions, to one implementing the dissolving of organics, which is equivalent to a non-polar solvent. Taking advantage of these properties, it is expected that this new, inexpensive, environmentally-friendly reaction medium will replace conventional organic solvents. Our laboratory has many research goals, covering a broad range of topics: Degradation of harmful waste products using the oxidation reaction in supercritical water, organic synthesis using solid catalysts, and synthesis of inorganic materials such as nanoparticles and polymers. In regards to all of these fields, by designing, analyzing, and controlling reactions based on a study of chemical reaction rate and reaction engineering, we are advancing extensive research, from fundamental research related to the	1) Supercritical water 2) Reaction engineering 3) Organic synthesis 4) Tunable solvent 5) Catalysis	Organic synthesis using supercritical water as an environmental technology Supercritical water is a promising reaction medium for organic reactions because its solvent properties can be varied with the temperature and the pressure, and these properties affect reaction kinetics and mechanisms. The aim of this study is to propose a methodology which enables to control the reaction rate and the selectivity of organic synthesis reactions only with the change of temperature and pressure of supercritical water.

		chemical reaction of supercritical fluids, to the cultivation of new engineering application technologies.		
Environmental Chemical Energy Engineering Laboratory (Otomo Laboratory)	Assoc.Prof. Junichiro OTOMO	Development of environmental-benign energy devices and systems is a crucial issue in terms of energy saving and reduction of CO2 emission. The research in Otomo laboratory focuses on electrochemical reaction, catalytic reaction and ionic conduction in solid electrolytes with the objective of integrating the elemental technologies into new chemical energy conversion devices and systems such as fuel cells, hydrogen production and energy storage systems. The integration of physicochemical phenomena with different scales is necessary to construct novel energy devices and systems. Thus, we are investigating the physicochemical (or electrochemical) phenomena through the perspective in molecular-scale, mesoscopic scale and macroscopic scale to solve some energy problems.	1) Chemical looping 2) Eversible fuel cell 3) Hydrogen 4) Energy storage 5) Technology assessment	Hydrogen production and energy storage systems are key technologies in terms of future energy systems combined with renewable energy. Chemical-looping (CL) and reversible fuel cell (r-FC) technologies are efficient energy conversion systems, and they attract attention as next generation energy supply and storage systems. To advance the systems, their technology assessments are required as well as experimental studies. In this project, the assessment of environmental impact and relevant experiment for CL or r-FC system will be investigated based on physicochemical properties of component materials and reactions with relevant experiments of CL and r-FC.

Geosphere Environment Systems Laboratory	Prof. Tomochika TOKUNAGA	Underground geosphere environment has been extensively used to support highly developed human society; e.g., extraction of energy resources and groundwater, waste disposal, construction of tunnels and underground spaces. Because of these activities, environmental problems which affect the sustainability of our society have emerged. The target of our laboratory is to understand and predict the change of geosphere environment caused by human activities, and to develop necessary engineering measures to attain sustainable use of geosphere environment. Current research topics include, studying and evaluating geosphere environmental changes caused by energy resources development and proposing necessary technological measures for sustainable resources development, securing stable and safe freshwater resources and development of efficient management schemes, and modeling long-term fluid flow and material transport processes through geosphere and its application to waste disposal and energy resources exploration.	1) Geosphere environment 2) Coastal groundwater 3) Natural resources management	Research topic: Analyzing natural and anthropogenic impacts on coastal groundwater systems by combining laboratory experiments, field measurements, and numerical simulations: About 70% of world's population live in coastal areas where groundwater is usually the primary source of freshwater. However, the freshwater-saltwater interactions in a coastal groundwater system is highly sensitive to variety of natural processes (e.g., tsunami disasters, climate change, tidal fluctuation, long-term transgression and regression) and human activities (e.g., groundwater abstraction, land reclamation, subsurface utilization). Understating the effects of natural and anthropogenic forcing on the dynamics of coastal groundwater systems can provide necessary information for the urban design/planning, sustainable managements of coastal resources, and protection of the coastal ecosystems. In this project, students will select one or several of natural/anthropogenic factors as the research target. The impacts of the selected factor(s) on coastal groundwater systems will be studied by combining laboratory experiments, field measurements, and numerical modelling.　Students can obtain knowledge on the coastal hydrogeology, hands-on experience on building

				and operating experimental system, and skills on the numerical modeling approaches.