Università di Roma
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DIPARTIMENTO DI INGEGNERIA CIVILE E INGEGNERIA INFORMATICA
LABORATORIO DI INGEGNERIA AMBIENTALE
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Avviso di Seminari

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AULA ARCHIMEDE – CENTRO CONGRESSI MACROAREA di INGEGNERIA

Innovative technologies for in situ remediation: application to sites contaminated with Dense Non-Aqueous Phase Liquid

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Unconventional characterization methods for NAPL-contaminated sites: the Radon-deficit technique

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Abstract (Prof. Aurora Santos Lopez)

There are many sites contaminated with organic compounds that may constitute dense non-aqueous phase liquids (DNAPL). The presence of this contamination is often due to direct discharges (illegal in many cases) or leakages (from poorly sealed storage tanks) of solvents commonly employed in many industries and activities. Many of these pollutants are chlorinated compounds, highly toxic, persistent in the environment, bioaccumulative and, in some cases, carcinogenic. Sites may remain contaminated for decades after the initial discharge because of the extreme persistence of these pollutants. In addition, due to its high density, they can migrate through the subsurface and remain as highly residual saturation areas, at depths of several tens of meters below the ground level, acting as sources of secondary contamination of groundwater In this sense, in situ remediation treatments entail lower environmental and economic impact on solving these problems.

Sabiñánigo, a small town located in the province of Huesca (Spain) can be considered a megasite contaminated by HexachloroCycloHexane wastes, illegally disposed of by the company INQUINOSA (1975-1992), resulting in massive pollution of the groundwater with risk of contamination of the Gállego River. An estimated 150,000 tons of waste with high content of HCH and other organochlorine compounds were produced by INQUINOSA. Among the lindane wastes, a dense non aqueous phase liquid (DNAPL) composed of HCH isomers, benzene and chlorobenzenes was detected in the landfill subsurface with an associated polluted groundwater plume.

Since the time it was detected, the free DNAPL is being pumped in from wells, and the volume extracted is becoming lower and lower. Currently the free phase is practically exhausted, and remaining DNAPL can be encountered adhered to fractures and at the cul-de-sac. Although this remaining DNAPL can be considered as immobile, the multicomponent character of the DNAPL favours the incorporation of a large amount of contaminats to the dissolved phase, reaching conditions of HCH saturation due to the presence of co-solvents at the dense phase. Innovative technologies as the combination of SEAR (surfactant enhanced aquifer remediation) and S-ISCO (surfactant-enhanced in situ chemical oxidation) techniques are proposed to abate the residual DNAPL with the challenge of to completely remove of the DNAPL in the aquifer. The application of these techniques should ensure that the pollution is not mobilized but extracted (SEAR) or oxidated (S-ISCO). Besides, the reusability of the surfactant employed in SEAR could be a key point in the economy of the remediation process.

Given the complexity of these problems the solutions requires a multidisciplinar approach. Coordination with experts in chemical technologies and non-invasive technologies for subsoil characterization is required. Pilot tests in Sabiñanigo are carried out by researchers of the Spanish Network CARESOIL (CHARACTERIZATION, REMEDIATION, MODELLING AND RISK ASSESSMENT OF CONTAMINATED SITES) in cooperation with the Government of Aragon.

Speaker Bio:

Prof. Aurora Santos Lopez is Professor at the Chemical Engineering Department of the Universidad Complutense of Madrid (since 2006). She got the degree in Industrial Chemistry, Universidad Complutense of Madrid, July 1987 and the pH. D in Industrial Chemistry (cum Laude) at the Universidad Complutense of Madrid, September 1992. She was awarded best pHD in Industrial Chemistry 1991-1992. She was Assistant Lecture at Chemical Engineering Department, UCM between 1988-1993, Associate at Chemical Engineering Department, UCM between1994-1996 and Lecture at Chemical Engineering Department, UCM 1996-2006. International Stays (more than 3 months): Predoctoral: Chemical Engineering Department, Universidad de Leeds, 20 weeks (1989); Postdoctoral: Dipartimento di Ingegneria Chimica e Scienza dei Materiali. Politécnico de Torino. Fellowship Grant from EU. 12 months (1993). Her research interest include: Applied catalysis, chemical reactors and treatments of industrial effluents. In the last seventeen years, she has been working in advanced oxidation technologies applied to wastewater treatment and soil remediation, taking part in a Spanish network on soil characterization and remediation, "CARESOIL".

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Abstract (Prof. Eduardo De Miguel)

Contamination of sub-surface soil and groundwater by non-aqueous phase liquids (NAPL) has become a global concern since it poses a serious risk to human health and the environment. The delineation of the surface trace of the plume of contaminants is essential in planning remediation strategies and in monitoring the evolution and effectiveness of decontamination works. However, field investigations have faced significant challenges to date. Conventionally, these operations have been carried out by drilling and establishing a network of monitoring wells in order to take samples of soil, groundwater and NAPL. In the absence of preliminary site assessment studies, intrusive sampling campaigns are high-cost and could be unsuccessful or, even worse, misleading for their designed purpose. In order to optimize conventional drilling, sampling and analytical operations, screening methods have been developed to provide semiquantitative information about the extent of the plume and the location of hot spots, mainly soil air analysis, geophysical methods and Rn activity measurements.

The technique based on instantaneous Rn measurements, also known as emanometry, takes advantage of the ubiquitous presence of natural tracers - U and Ra, which decay into Rn - to detect the presence of organic compounds and delineate the extent of subsurface hydrocarbon accumulations. The applicability of Rn emanometry in contaminated sites is based on the predicted reduction of the concentration of radon (222Rn) in soil air directly above accumulations of NAPL in the subsoil due to its preferential partition in the NAPL phase relative to water and air.

The results of several field-studies in Spain and Portugal will be used to illustrate the advantages of the Rn deficit technique and its limitations. Examples of failure and success at several industrial sites contaminated with light and dense NAPLs and in widely different geological contexts will lead us to conclude that in the absence of unidentified lithological discontinuities and/or fracture systems the Rn deficit technique is a competitive and effective tool for the preliminary assessment of LNAPL-contaminated sites. Lastly, the uncertainties regarding the applicability of this tool to detect accumulations of dense mixtures and plumes of dissolved contaminants will be discussed in light of recent findings within the CARESOIL (Madrid Regional Government) and DENSOIL (Spanish Ministry of Economy and Competitiveness) research projects.

Speaker Bio:

Prof. Eduardo De Miguel is Professor at the Department of Energy and Fuels of the Universidad Politecnica de Madrid. He got the M.Sc. in Mining Engineering Chemistry at the Madrid School of Mines in 1990 and the pH. D in Environmental Geochemistry (t the Universidad Politecnica de Madrid in 1995.

He was Assistant Professor at the Madrid School of Mines of the Universidad Politecnica de Madrid between 1990-1998, Associate Professor at the Madrid School of Mines of the Universidad Politecnica de Madrid between 1998-2016. He was visiting professor at the Jonkoping University (Sweden) between 2004-2010 and St. Louis University (Madrid) between 1999-2001- He is technical director of the Environmental Geochemistry research and engineering laboratory (LI2GA). He ublished 28 peer review articles, 6 books and 8 book chapters, 53 contributions to conferences/congress and got 15 competitive research grants and 24 research contracts with companies and government agencies.

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