CIVIL AND ENVIRONMENTAL ENGINEERING

CNR IREA/DIATI - Advanced methodologies for investigating deformation induced by underground sources by exploiting and integrating DinSAR techniques

Funded By	C.N.R. - CONSIGLIO NAZIONALE DELLE RICERCHE [P.iva/CF:02118311006] Dipartimento DIATI
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Context of the research activity	The topic of the research activity will focus on the investigation of the use of surface deformation monitoring through satellite data as a diagnostic tool for the efficiency and safety of the geological fluid storage activities. The research will be based on the integration of Satellite Differential Radar Interferometry (DInSAR) time-series with fluid flow and mechanical models to provide a high-resolution characterization of the observed phenonena and reservoir properties.
Objectives	The global energy transition aims to significantly reduce greenhouse gas emissions while ensuring energy security. The subsurface plays a central role in achieving these objectives. Underground fluid storage provides the geological space required for permanent CO2 storage, seasonal storage of natural gas and future hydrogen systems, and the exploitation of geothermal energy as a stable and renewable source. These activities induce pressure and stress changes in the subsurface that may result in surface deformation, making effective monitoring essential to ensure efficiency, integrity, and long-term safety. Satellite-based surface deformation monitoring, particularly using Differential Radar Interferometry (DInSAR), offers a high resolution measurements over large areas with temporal continuity. These deformation signals can provide insights into reservoir behavior, fluid migration, and geomechanical properties. However, transforming surface observations into reliable subsurface information requires integration with physical models. The objective of this PhD research is to investigate the use of surface deformation monitoring through satellite data for assessing the efficiency and safety of geological fluid storage activities. The research is based on the development of methodologies for the integration of DInSAR time-series with fluid-flow and geomechanical models to achieve a high-resolution characterization of the involved phenomena. The study will combine numerical simulation, sensitivity analysis, and inverse modeling techniques to

	reduce uncertainty in subsurface characterization. The research will focus on the evaluation of existing modelling approaches applicable to subsurface stress/strain variations due to fluid storage operations. Forward reservoir models will be used inside a dedicated framework, calibrated via case studies, for integrating InSAR observations in order to estimate key deformation parameters. The results of this research will be directly applicable to underground gas storage and geothermal energy systems, two key components of a sustainable energy mix. In the long term, this work aims to contribute to the development of integrated numerical frameworks that enhance the reliability and safety of subsurface energy systems. The research will be developed in collaboration with IREA-CNR that will support the part related to satellite data analysis and itnerpretation.

Skills and competencies for the development of the activity	Given the strongly multidisciplinary nature of the research and the complexity of the problem to be addressed, the candidate should possess the required skill set that combines knowledge in reservoir geology, reservoir engineering and fluid mechanics in porous media. The candidate should have a sound understanding of scientific programming and 3D numerical simulation principles applied to geological, fluid-flow, and geomechanical processes. Professional experience in reservoir engineering would allow a deeper understaing of the involved phenomena.