H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

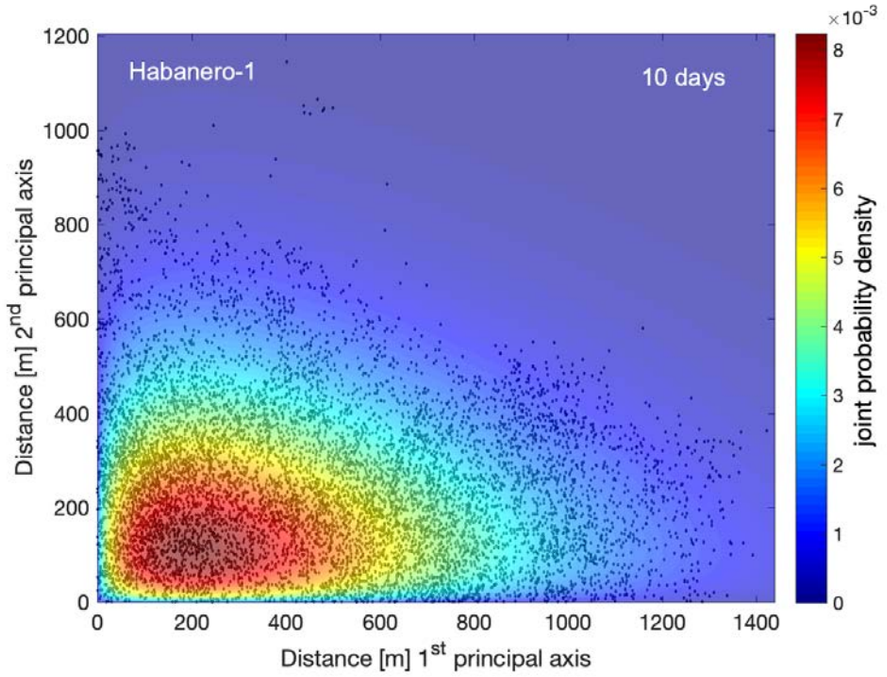
2nd Call for H.F.R.I. Research Projects to Support Post-Doctoral Researchers

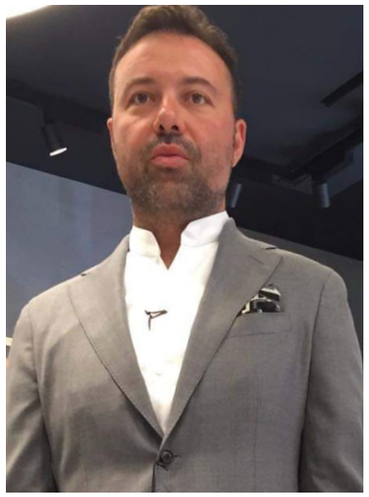
Title of the research project: **Fluid-Induced Seismicity mechanisms: Stochastic modelling, seismic anisotropy and beyond**

Principal Investigator: ***Dr. Georgios Michas***

Reader-friendly title: ***The mechanisms of Induced Seismicity***

Scientific Area: ***Physical Sciences***





Institution and Country: ***National and Kapodistrian University of Athens, Greece***

Host Institution: ***National and Kapodistrian University of Athens***

Collaborating Institution(s): ***The University of Kansas (USA), Institute of Methodologies for Environmental Analysis (Italy), National Observatory of Athens (Greece)***

Project webpage (if applicable):

Budget: **164,000.00 €**

Duration: **36 months**

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Research Project Synopsis

In modern world and high-populated societies and in the spectrum of an increasing global economy, there is increasing demand for estimating natural hazards more efficiently in order to increase resilience for the society and infrastructures. A crucial issue to this challenging task is the mitigation of earthquake risk and the causal secondary effects, such as tsunamis, landslides and technological disasters that impose a direct threat for our environment, lives and social cohesion. Recently, earthquakes induced by high pore-fluid pressures in the Earth's crust, related either to natural processes or to man-made activities and industrial projects, have drawn the intense scientific attention worldwide due to the increased number of the reported induced events. Fluid-induced earthquakes are usually not included in seismic hazard assessment studies, posing higher seismic risk for both society and infrastructures. To effectively mitigate the associated hazard, a detailed understanding of the physical processes involved is required, along with the development of appropriate models that can describe the nucleation and evolution of the phenomenon. The proposed project is dedicated to serve such an endeavor. In particular, the research project will integrate seismicity analysis (relocation, seismic anisotropy, statistical analysis) of numerous earthquake sequences in Greece, Italy, Australia, USA and elsewhere related with high pore-fluid pressures in the subsurface, either due to industrial activities (fluid injections in oil and gas fields and geothermal reservoirs, impoundment of water reservoirs) or due to natural processes (earthquake swarms), with statistical physics and stochastic modelling to provide novel insights in fundamental challenges that concern fluid-induced seismicity, such as the discrimination between tectonic and fluid-induced earthquakes, monitoring increased pore-fluid pressure regions and forecasting the evolution of the phenomenon.

Project originality

The innovative nature and originality of the proposed research project stems from the integration of independent research techniques to provide a holistic approach to cutting-edge topics of Seismology and Geophysics, leading to high-impact research. The long-term objective is to achieve a better understanding of the physical processes that control the nucleation and evolution of fluid-induced seismicity and to incorporate the insights gained from the analysis into seismic hazard assessments. The integration of the proposed methodologies with additional data, such as numerical simulations of injection data, pore-pressure increases inside injection-wells and water-level oscillations and reservoir modelling in water reservoirs, is expected to provide novel insights into the mechanisms of fluid-induced seismicity, improving our perception on the physical processes that take place and on the associated hazard and risk.

Expected results & Research Project Impact

Earthquakes induced by the circulation of fluids in the subsurface, have nowadays become a societal concern and have raised scientific and political discussion, particularly wherever injections of large volumes of fluids at depth are involved. Understanding why seismicity increases due to overpressurized fluids and what are the factors that in such cases control the evolution of seismicity and the associated hazard has become a priority for the earthquake-research community. The research project will implement and integrate innovative research techniques to provide novel insights in these fundamental challenges. In particular, the scientific outcomes of the research project are expected to provide novel insights into the physical mechanisms of fluid-induced seismicity and into some of the critical parameters that ultimately control seismic hazard and risk. Furthermore, the project will seek to develop novel techniques for discriminating, monitoring and forecasting the evolution of the phenomenon. The derived models and techniques will have the potential to be used in hazard models, in order to mitigate seismic risk more efficiently at sites prone to fluid-induced seismicity and potentially to provide useful guidelines for injection strategies in the field, adding a great scientific value to the project. The effective mitigation of the associated risk will assure the viability of such projects, will further contribute to economic growth and will assist in developing alternative green-energy sources. In addition, fluid-induced earthquakes have raised public concern at sites where such earthquakes occur. The effective mitigation of the associated risk will contribute to the well-being, the prosperity and the financial development of the associated communities.

The importance of this funding

The H.F.R.I. funding of my research project provides me the opportunity to further engage in cutting-edge topics of Geophysics and Seismology and contributes to my commitment to deliver high-impact research in those fields. In addition, it provides me the opportunity to form my own research team and to enhance my coordination and managerial skills. The professional occupation of the research team's members in the research project is expected to greatly enhance their research experience and prospects on their current and future academic career, to gain international exposure and to form novel national and international collaborations. Finally, the research project will contribute to the restriction of brain drain, by ensuring that young highly qualified scientists in the fields of Seismology and Geophysics will continue to deliver high-impact research products in their home country that lies in one of the most seismically active areas in the world.

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