University of Genova

Department of Earth, Environmental and Life Sciences

Doctorate Course in Earth and Environmental Science and Technology

Earth Science Curriculum

Università degli Studi di Genova

STAT

Dottorato in Scienze e Tecnologie per l'Ambiente e il Territorio

Research Theme n 3

Titolo: Studio geofisico del controllo tettonico-magmatico sullo sviluppo di sistemi idrotermali sottomarini e associata mineralizzazione nell'Arco di Kermadec (Oceano Pacifico Meridionale, Nuova Zelanda)

Title: Geophysical study of the tectono-magmatic control on the development of submarine hydrothermal systems and associated mineralization in the Kermadec Arc (South Pacific Ocean, New Zealand)

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Program description including the formation program abroad

The Kermadec intraoceanic arc northeast of New Zealand is characterized by a linear chain of ~30 major cone and caldera volcanoes, of which ~80% host active seafloor hydrothermal systems. Massive sulfide deposits are found on at least four of these volcanoes, providing a unique opportunity for in situ investigations of modern-day analogues of ancient onshore deposits. In particular, fundamental questions of global relevance revolve around how regional differences in structural and magmatic settings along the arc may influence the development of hydrothermal systems, and how regional and local tectonic structures control fluid circulation and mineralization. Answers to these questions will fill important knowledge gaps about the formation mechanisms of seafloor massive sulfide deposits and their ancient analogues, providing important information relative to the processes controlling critical mineral resources.

The candidate will focus the study on selected Kermadec volcanoes (e.g., Rumble III, Rumble IIW, and Hungaroa), which provide a representative set of the different morphologies (cones vs. caldera), as well as magmatic and hydrothermal settings observed along the Kermadec arc. The combined use of pre-existing geophysical data (including, but not limited to, multibeam bathymetry and backscatter, gravity, magnetics, heat-flow) from different platforms such as shipborne, Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs), will be integrated with new data acquired during the PhD project in the context of international research cruises. These data will be used to delineate the geometry of hydrothermal upflow zones and derive models of hydrothermal circulation, which will be constrained by in-situ sampling of rocks and fluids and ultimately correlated with the structural and morphological setting.

The project will benefit from the following network of National and International Collaboration and overseas experience:

1. Istituto Nazionale di Geofisica e Vulcanologia
2. GNS Science, New Zealand
3. Geomar, Germany
4. University of Bremen, Germany

The candidate will join at least one international research cruise in the Kermadec Arc during the PhD project. This trip will provide an important opportunity to visit GNS Science in Wellington, New Zealand, and collaborate with overseas partners. Collaborations with European partners can also be achieved under the umbrella of the Erasmus action.

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Tutor's publications of the last 3 years

1. **Caratori Tontini, F.**, (2025), *Seamount magnetism from Helbig's integrals: application to the Rano Rahi Seamount Field (East Pacific Rise 17°-19° S)*, Journal of Geophysical Research, 130, e2024JB030039, doi: 10.1029/2024JB030039.
2. Spain, E., Carey, R.J., Whittaker, J.M., Lucieer, V.L., Fox, J.M., Watson, S.J., **Caratori Tontini, F.** (2025), *Geomorphic time series reveals the constructive and destructive history of Havre caldera volcano*, *Kermadec arc*, Frontiers in Earth Science, Vol. 12, #1463257, doi:10.3389/feart.2024.1463257.
3. Ghirotto, A., Armadillo, E., Crispini, L., Zunino, A., **Caratori Tontini, F**., Ferraccioli, F. (2023), *The sub-ice structure of Mt. Melbourne Volcanic Field (Northern Victoria Land, Antarctica) uncovered by High-Resolution Aeromagnetic data*, Journal of Geophysical Research, 128, e2022JB025687, doi: 10.1029/2022JB025687.
4. **Caratori Tontini, F.**, Turner, G.M., Reyes, A.G., Speranza, F., Tivey, M.A., Massiot, C., de Ronde, C.E.J., Humphris, S.E. (2023), *Effects of hydrothermal alteration and mineralization on the paleomagnetic properties of rocks from IODP Expedition 376 at Brothers volcano*, Economic Geology, 118, 7, 1605-1627, doi: 10.5382/econgeo.5008.
5. **Caratori Tontini, F.**, de Ronde, C.E.J., Black, J., Stucker, V.K., Walker, S.L. (2023), *The geology and geophysics of Lake Tarawera, New Zealand: implications for sublacustrine geothermal activity*, Journal of Volcanology and Geothermal Research, 433, 107731, doi: 10.1016/j.jvolgeores.2022.107731.
6. Tankersley, M., Horgan, H.J., Siddoway, C.S., **Caratori Tontini, F.**, Tinto, K.J. (2022), *Basement topography and sediment thickness beneath Antarctica's Ross Ice Shelf*, Geophysical Research Letters, 49, e2021GL097371, doi: 10.1029/2021GL097371.
7. Miller, C.A., Barretto, J.A., Stagpoole, V., **Caratori Tontini, F**., Brakenrig, T., Bertrand, E. (2022), *The integrated history of repeated caldera formation and infill at the Okataina Volcanic Centre: Insights from 3D gravity and magnetic models*, Journal of Volcanology and Geothermal Research, 427, 107555, doi:10.1016/j.jvolgeores.2022.107555.
8. Massiot, C., McIntosh, I., Deans, J., Milicich, S.D., **Caratori Tontini, F.**, de Ronde, C.E.J., Adam, L., Kolandaivelu, K., Guerin, G. (2022), *Petrophysical Facies and Inferences on Permeability at Brothers Volcano, Kermadec Arc, Using Downhole Images and Petrophysical Data*, Economic Geology, doi:10.5382/econgeo.4897.