

IMPROVE

European Training Network



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IMPROVE
Innovative Multi-disciplinary
European Research training network on
VolcanoEs

www.improve-etn.eu

IMPROVE Final Conference

The IMPROVE Final Conference will be held on July 16-17, 2025, at the INGV headquarters in Rome. During the conference, the Early Stage Researchers will present and discuss the results they have achieved in the framework of the IMPROVE project. The first day will be dedicated to the Krafla volcano (Iceland), and the second day to Mount Etna (Italy). Talks by IMPROVE industrial partners Landsvirkjun and West Systems will discuss the relevance and further opportunities in boosting academia-industry relationships. The meeting will be enriched by visits at the national seismic control room and the HP-HT laboratories, both hosted at INGV Rome.

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Photo credits: Andrew Mitchell

IMPROVE-EPOS-KMT workshop on science-industry cooperation



On November 21, 2024, the Dublin Institute for Advanced Studies hosted a joint workshop on magmatic geothermal systems in Dublin, Ireland, in collaboration with EPOS (European Plate Observing System, www.epos-eu.org), and KMT (Krafla Magma Testbed, <https://kmt.is>). The workshop brought together 33 participants, including experts from industry, academia, and IMPROVE Early Stage Researchers (ESRs), to discuss challenges and innovations in the emerging field of geothermal energy. In particular, the workshop focused on addressing the needs of the geothermal energy industry working with high-temperature and superhot geothermal systems, fostering collaboration and knowledge exchange between science and industry.

The workshop featured presentations from the three involved major initiatives KMT, EPOS, and IMPROVE. Keynote speakers included Bjarni Pálsson (Landsvirkjun, and President of the International Geothermal Association) on superhot geothermal energy opportunities, Yan Lavallée (Ludwig Maximilian University of Munich) on academic research driving industry solutions, and Helen Doran (Project Inner Space), who provided a global perspective on geothermal energy prospecting.

A panel discussion, chaired by Anne Obermann (ETH Zurich), explored industry challenges and innovations in magmatic geothermal systems, with contributions from experts representing KMT, ENEL (Enel Green Power), Orkuveitan, and RML. Additionally, IMPROVE ESRs presented brief elevator pitches and participated in a poster session, showcasing their ongoing research in the field.

The breakout sessions focused on the future of geothermal energy, collaboration between academia and

industry, and the tools and methodologies needed to advance geothermal research and development.

This workshop facilitated crucial dialogue between industry professionals, researchers, and infrastructure experts in the field of magmatic geothermal systems. By bringing together diverse perspectives, the event aimed to accelerate innovation and address key challenges in harnessing geothermal energy from magmatic sources.

The inclusion of both established experts and Early Stage Researchers (ESRs) highlighted the importance of bridging industry needs with emerging research and of cultivating new talent in the field.

The success of the workshop prompted the organizers to consider convening a second event, which will likely be organized within the framework of the EPOS-KMT collaboration. IMPROVE ESRs and other IMPROVE personnel will receive specific invitations.

Owen McCluskey

The IMPROVE-EPOS-KMT workshop provided us ESRs with a great opportunity to not only promote our research projects to a specialist audience but also to gain new perspectives on the current status of exciting, collaborative projects in the geoscience field. As with all IMPROVE events, the workshop encouraged stimulating scientific discussion, starting from presentations from world-leading geoscientists who covered a range of different aspects of geothermal research. My colleagues and I always enjoy networking with new people and this workshop allowed us to converse with established researchers and draw upon their experiences and gain expert recommendations. As a group, we were also able to explore and discuss potential avenues into careers within the industry. This proved to be an extremely worthwhile exercise as many of us begin to map out our futures after the completion of the project.

Dear Regina, congratulations for your recent publication in *Geophysical Journal International*. Can you tell us what the article is about?

Our article presents a detailed characterization of the seismic wavefields recorded at Krafla volcano. A central theme of the paper is the concept of coherency— the similarity between seismic waveforms at different stations. In simple geological settings, local earthquakes are expected to produce similar signals at stations only 30 m apart, but at Krafla we observed strong differences even between neighboring stations. Our study shows that this lack of coherency is due to the influence of highly heterogeneous near-surface layers. Resonances — reverberations of waves trapped within lava caves and flows — contribute to these site effects.

How did you address these issues?

To address this, we developed a filter that removes resonances with minimal distortion on the original waveforms. Combined with additional processing, our workflow improves coherency and enables the detection of possible reflections from the IDDP-1 magma pocket. If the reflections are from the pocket, then it extends over an area of at least 200×700 m around the IDDP-1 borehole, but uncertainties remain due to our earthquake–station geometry.

What is the main novel contribution of your work?

Our work presents a novel methodology for characterizing and reducing site effects in seismic data, with a focus on high-frequency resonances at volcanoes. Our methods are broadly applicable across different scales, geological environments, and datasets, advancing passive reflection imaging and providing new tools for seismic processing and interpretation in general. Geologically, our findings have implications for Landsvirkjun and the KMT drilling project, where precise structural knowledge is crucial for planning drilling operations and mitigating associated risks.

What was the role of IMPROVE in achieving these prestigious results?

IMPROVE played a huge part in shaping our publication. Thanks to the program, I had the opportunity to design and lead my own field experiment in Iceland—an unforgettable personal and academic experience. IMPROVE enabled me to conduct my PhD in Dublin - a city



Photo credits: Regina Maaß



Photo credits: Maurice Weber & Regina Maaß

with a very high cost of living - without major financial troubles. This stability allowed me to fully focus on my research and truly enjoy the rewarding experience of doing a PhD abroad. Through summer schools, courses and secondments, I expanded my knowledge within and beyond seismology, exchanged ideas with colleagues from around the world, and built a strong network of geoscientists and friends from both academia and industry—connections that will continue to support my academic and personal journey.

Thanks, Regina, and congratulations again for the significant results you've achieved.

The open access peer-reviewed article is available at: <https://www.improve-etn.eu/index.php/papers/>

Alejandra Vásquez Castillo: My IMPROVE Journey

Between the vibrant Mount Etna, geodetic time series and sand cones

Being part of IMPROVE has been one of the most enriching experiences of my academic journey so far. As a PhD candidate passionate about understanding how the solid Earth works and how ground movements reveal what happens beneath our feet, IMPROVE has offered me the ideal environment to develop both my technical expertise and my research identity.

From the very beginning, IMPROVE felt like a perfect fit, almost tailor-made for me. It gave me the chance to keep building on what I had started during my master: combining the geodesy I studied back home in Colombia with the volcanology that I learnt while studying in Germany. The position was exactly what I had been hoping for, the ideal next step in my academic journey. And what made it even more exciting was the opportunity to study a fascinating volcano like Etna, right there on site in Sicily.

The training activities not only boosted my academic confidence with useful research techniques but also helped me grow in essential soft skills, such as effective communication through public speaking. Additionally, these activities introduced me to a valuable, multidisciplinary network of researchers. Also my secondments at the University of Iceland and at the University of Lancaster were key moments: not only because I could deepen my understanding of analytical and analogue modelling, but I also had the chance to work with experts whose mentorship has had a lasting influence on my work, like Prof. Freysteinn Sigmundsson, Prof. Stephen Lane and Prof. Mike James. One of the highlights of my secondments has been the opportunity to not only study volcanic deformation through satellite observations such as InSAR and GNSS, but also to explore those same processes, like injection and withdrawal, through hands-on analogue modelling in the lab. It is something I never imagined

when I started my PhD, but being part of the IMPROVE framework encouraged me to explore creative approaches and interdisciplinary perspectives.

I have also been very fortunate to be mentored by an expert with decades of experience on Etna: Giuseppe Puglisi, whose deep knowledge and constant support have been invaluable throughout this journey. Working at INGV has also been very enriching; I had the chance to learn from other disciplines, like petrology, thanks to the generosity and expertise of outstanding scientists as Rosa Anna Corsaro, who has broadened my view of volcanic systems in different ways.

But what makes IMPROVE truly special is the human side of it. I still remember our first school in Laugar, Iceland: it was an energetic and inspiring start to this incredible journey. This is where I met my fellow ESR colleagues for the very first time, and I was truly excited to begin this path surrounded by such brilliant and motivated people. Adapting to new working cultures, and meeting other ESRs going through the same ups and downs has created a special sense of community. We've supported each other not only in research, but also in the day-to-day life of being young scientists living abroad. These fellow ESRs are now the people I will turn to if I have a question outside my area of volcanology expertise. We have become a real network, a community of young volcanologists!

There is no doubt that EU-funded programmes such as Horizon Europe play a crucial role in training researchers ready to tackle complex challenges. For me, IMPROVE is not just a project, but a launchpad for a career based on collaboration, curiosity, and scientific integrity. I am very proud to be a Marie Curie Alumna!



Photo credits: Alexander Bauer