BREAKING GROUND

THE PEOPLE AND PROJECTS BEHIND MALTESE SEISMOLOGY

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The University of Malta's (UM) Department of Geosciences and Malta's capacity to understand its seismic events are growing at an ever-faster rate. In this article, ***THINK's Jonathan Firbank*** *introduces some of the people and projects behind this most essential pursuit – our understanding of earthquakes.*

Dr Matthew Agius
Photo by James Moffett

Earthquakes are constantly transforming our planet, whether at an aeons' pace or with explosive speed. The forces that drive it are numerous and vast. Cooling sea floors compete with flowing magma. The incredible mass of tectonic plates clash and transform one another. Seismology is, necessarily, a broad tent. The movement beneath us is complex and on a scale that transcends national borders. To understand our planet and effectively mitigate natural disasters, the field must be multidisciplinary, multinational, and constantly expanding. This is exemplified by the University of Malta's Seismic Monitoring and Research Group (SMRG; Department of Geosciences).

MALTESE SEISMOLOGY, FROM VAULT TO SCHOOL – DR MATTHEW AGIUS

Dr Matthew Agius is a veteran member of the group, which he describes as 'growing and growing'. He elaborates: 'Founded as a means to monitor local and regional earthquakes, the seismic network has expanded from one station in 1995 to nine, and we are moving onto cutting-edge research.' His background in seismology began under Prof. Pauline Galea, who was instrumental in establishing the seismology group and the first head of UM's Department of Geosciences. 'At the time, with access to only one station, we began the process of cataloguing earthquakes, not just those which are felt but

Luke Said

Daniele Caruana

also weak earthquakes that are not felt locally, let alone abroad. This made us realise that seismic activity around us is far higher than previously thought. Discoveries like this are what motivate me.' Major tasks for Agius are the operation of the Malta Seismic Network, the real-time data exchange with international partners, especially important for earthquake warning, and also public outreach. For example, 'the upcoming Seismology in Schools programme, funded by the APS Bank, will involve providing small seismographs to local sixth form schools and inviting physics teachers to use them as educational tools. This is not just an opportunity to record earthquakes but also to describe how seismic waves propagate through the earth.'

THE MALTA EARTHQUAKE CATALOGUE – LUKE SAID

Luke Said, whilst always inclined to architecture, decided to venture into geoscience instead – a field that is underpinned by geography and physics. 'The fact that I could understand and disseminate the geology around me, whether around my home or while out hiking, was very intriguing.' From there, his interests led him to geophysics, seismology, and eventually a position as a Research Support Officer (RSO) for the Department of Geosciences. His work focuses on enhancing Malta's earthquake-detection tools, particularly for weak earthquakes. Malta and its surrounding sea are known for seismic events, but many are extremely hard to detect. He is combining his programming skills with physics to redevelop an old homegrown software called Local Earthquake Single-Station Location Analyser (LESSLA) into an open-source Python code with an interactive graphical user interface. This tool is crucial for maintaining a comprehensive Malta Earthquake Catalogue – a key resource for other fields such as structural engineering. The catalogue's importance is twofold: understanding the tectonics around us, and seeking to refine Malta's seismic hazard assessment. Such knowledge is important not just for buildings on land but also for marine infrastructure, such as cable and pipeline laying between countries in the region.

SENSEI – DANIELE CARUANA

Detecting underwater seismic activity is particularly challenging, as installing sea-floor instruments is incredibly demanding and resource-intensive. But for Malta, it's particularly crucial. One solution is to make use of existing infrastructure – the fibre-optic cables that connect us, digitally. RSO Daniele Caruana is working on the international project Smart European Networks for Sensing the Environment and Internet quality (SENSEI), funded by the European Union – a project in collaboration with the Department of Physics under Prof. André Xuereb's supervision. 'I come from more of a pure physics background, having previously worked on certain aspects of fibre optics. But rather than just working on theory, I wanted

Dr Oluwatimilehin Benjamin Balogun

to apply what I do to sectors such as geosciences. With fibre optics, one way of doing that is through seismology.' Seismic activity on the ocean floor, such as earthquakes or submarine landslides, can induce small strains on internet cables. These strains can be detected and measured using laser interferometry, which enables the cables to sense seismic activity. As Caruana points out, the advantage of this technique is its wide coverage, turning our vast global cable network into a system capable of detecting earthquakes, among other geophysical phenomena. The utility of this existing technology is not something to be taken for granted, however. 'It is important to stress the importance of research, which underpins all the technology and instruments we are making use of.' Fibre optic cables, for example, may not have been originally intended for seismology, but they themselves 'are the product of decades of scientific research.'

REMCRUMR – DR OLUWATIMILEHIN BENJAMIN BALOGUN

Dr Oluwatimilehin Benjamin Balogun is a Marie Skłodowska-Curie Research Fellow, pursuing geosciences at UM. His project's title, REMCRUMR, stands for Real-time Monitoring of Deep Crustal Mass Redistribution for Timely Prediction of Earthquakes using Integrated Geodetic, Gravity and Seismic Data, funded by the European Union's Horizon Europe research and innovation programme. It seeks to replace the probabilistic method of earthquake prediction using, as its name suggests, a combination of highly contemporary techniques. 'I first became interested in the sciences because of the process. Once you have understood the basics, you can innovate, harmonising different forms of knowledge to achieve greater and greater outcomes.' That 'harmonising' is on full display with REMCRUMR. Its methodology relies on measuring changes in the Earth's gravitational field and in the velocity/strain of its tectonic plates. We are examining how minute but anomalous changes in these quantities define the onset of a seismic event, which in time could lead to a model that predicts earthquakes outright. Before an earthquake occurs, 'there has to be some sub-surface redistribution of masses and elasticity anomaly'. We are trying to monitor that in real time (from observable changes in the Earth's ambient gravity field, plate's motion, and strain) and predict when there will be a rupture in the Earth's crust.' This highly ambitious work could radically reduce the human cost of seismic natural disasters by predicting them far before the limits of current reactive detection methods, and with far greater accuracy than the aforementioned probabilism.

WAVEGUARD – PROF. SEBASTIANO D'AMICO

Seismology is an invaluable means of understanding our world as well as a vital pursuit for preserving human life. Malta has a history of seismic activity, and its central position in the Mediterranean means it has been affected by nearby areas of high seismic activity. Its worst natural disasters are gone from living memory, but the scars of earthquakes and tsunamis are still visible in its historic architecture, and have been recorded since the seventeenth

Prof. Sebastiano D'Amico
Photo by James Moffett

century. Conversely, Malta is ideally positioned to extend international monitoring networks. Prof. Sebastiano D'Amico, UM's Head of Geosciences, is coordinating the UM activities of the WAVEGUARD project – Enhanced monitoring and disaster response to mitigate impacts of extreme meteo-marine events (funded by the INTERREG Italia-Malta Programme). WAVEGUARD integrates an incredibly diverse range of data sources to raise awareness of, and thus create an opportunity to mitigate, natural hazards such as storms and high waves. The data ranges from the seismic to the barometric, from radar to video, and more besides. This incorporates work from UM's Oceanography Malta Research Group, which focuses on an equally impactful field of geosciences.

WAVEGUARD is a macrocosm of the ethos behind UM's seismology – an integration of diverse disciplines and heterogeneous data that pulls together for, in this instance, the simple goal of saving lives. It is just one example of how the Seismic Monitoring and Research Group and the Department of Geosciences are an evolving, dynamic combination of specialisations, which is then joined to equally fluid networks of study, safeguarding and response. Like the ground beneath our feet, it must constantly change.

Further Reading

Agius, M. R., & Galea, P. (2011). A single-station automated earthquake location system at Wied Dalam station, Malta. *Seismological Research Letters, 82*(4), 545–559. https://doi.org/10.1785/gssrl.82.4.545

Agius, M. R., Galea, P., Farrugia, D., & D'Amico, S. (2020). An instrumental earthquake catalogue for the offshore Maltese islands region, 1995–2014. *Annals of Geophysics, 63*(6), SE658. https://doi.org/10.4401/ag-8383

Borzì, A. M., Minio, V., De Plaen, R., Lecocq, T., Alparone, S., Aronica, S., Cannavò, F., Capodici, F., Ciraolo, G., D'Amico, S., Contrafatto, D., Di Grazi, G., Fontana, I., Giacalone, G., Larocca, G., Lo Re, C., Manno, G., Nardone, G., Orasi, A., Picone, M., Scicchitano, G., & Cannata, A. (2024). Integration of microseism, wavemeter buoy, HF radar and hindcast data to analyze the Mediterranean cyclone Helios. *Ocean Science, 20*, 1–20. https://doi.org/10.5194/os-20-1-2024

Galea, P., Agius, M. R., Bozionelos, G., D'Amico, S., & Farrugia, D. (2021). A first national seismic network for the Maltese islands – the Malta Seismic Network. *Seismological Research Letters, 92*(3), 1817–1831. https://doi.org/10.1785/0220200387

Marra, G., Clivati, C., Luckett, R., Tampellini, A., Kronjäger, J., Wright, L., Mura, A., Levi, F., Robinson, S., Xuereb, A., Baptie, B., & Calonico, D. (2018). Ultrastable laser interferometry for earthquake detection with terrestrial and submarine cables. *Science, 361*, 486–490. https://doi.org/10.1126/science.aat4458