

CAROLYN BOULTON

AN INTERVIEW WITH A ROCKSTAR 'FAULT HUNTER'

Janis J Russell: Christchurch

Carolyn Boulton possesses an intense drive, one she has had since she was quite young, to seek out the answers to hard questions. Today, she applies that drive to good effect in the geosciences. In addition, she readily conveys warmth, passion, and infectious enthusiasm for both geoscience and life, in general, in equal measure. These qualities, combined with her unshakeable confidence, characterise her as a formidable Early Career Researcher who has already achieved huge things in her fledgling career, thus far.

Amongst towering tors, spectacular fault rocks are exposed on the Liebig Fault. Studying these rocks will yield insights into the processes that accommodate deformation in greywacke sandstone and argillite, New Zealand's most common rock types.



She has been the recent recipient of two prestigious international awards from both sides of the Atlantic—The American Geophysical Union and The European Geosciences Union—and is the first New Zealander to have received either of them.

Although she feels fortunate to have done so, Carolyn is characteristically modest and quick to emphasise the support of the geoscience community. Adamant that these accolades are a reflection of the strength of New Zealand geoscience, she waxes lyrical about it: "It's great for our community to be elevated on an international stage, to say hey, we are training amazing graduates...it is a testament to our research programmes and our institutions".

Carolyn proudly highlights the quality of teaching at the universities she has attended, here, and thrusts them into comparison with top-notch teaching establishments around the world. This home-grown research excellence approach is something she is particularly excited about. "We can compete with Caltech, Berkeley and ETH Zurich— we don't have to go overseas, we can stay here and do *outstanding* degrees".

This talented researcher's interest in geoscience began as a child, during visits to rivers and lakes, where she became fascinated by the appearance of rocks, replete with various colours and textures, in water. Such visual appeal led her to pick up rocks deemed "pretty" or to use as or skimming stones. Sometime later, after becoming besotted with our Alpine Fault, and New

Zealand tectonics, Carolyn came to New Zealand to do a semester abroad and became totally hooked on our geology. She graduated from University of Otago prior to enrolling for a PhD at the University of Canterbury.

At UC, her research focussed on creating experimental earthquakes in the laboratory. However, as there were no facilities in New Zealand, she headed offshore as a recipient of a Claude McCarthy fellowship. This award allows PhD researchers to conduct research towards their degree that they can't do here. The young researcher was only back a week from that overseas stint when the Darfield earthquake struck in 2010, triggering a series of aftershocks that lasted for two years. She admits that it was hard to be studying earthquakes at the same time as living through them. "Even though I understand them, as a research topic, it doesn't stop my heart pounding when they occur. It is so much better in the lab than in real life as we have all the control in the lab and none of the control in real life... We can only control our response and prepare for them..."

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Her eagerness, to prepare people for the impact of natural hazards, has spilled over into her enthusiasm for communicating



Happiest surrounded by rocks, Carolyn's most recent field season was partly spent researching the Liebig Fault in the Gamack Range.

geoscience through discussions, activities and social media. She'll talk about it for hours, to anyone who will listen, and enjoys using hands on demonstrations to explain difficult ideas to people, including geology students, of all ages. According to Carolyn, one of the most fun activities for everyone is using Playdoh to make a plate boundary. More recently, she has started a public Instagram account, showing photos of her in the field, and will soon be involved in making some podcasts on natural hazard preparedness. It is another area she feels strongly about. "Not seeing them as something scary but just having something that's there and we can take measures to mitigate their effects on us. They don't have to be disasters".

Out in the field, Carolyn sees her main role as a "fault hunter". Her observations focus on fault zones during, and after, an earthquake where she looks for evidence

such as the presence of fluids (influential in causing earthquakes and facilitating slip), or degree of melt in the fault plane. She loves field work for that 'being there' feeling — Climbing hills or mountains to look out large expanses of landscape fuels her curiosity about how the landforms, in front of her, got to be that way as how they appear today isn't how they have always been.

In January, she was dropped in by helicopter to around 1500-1600m in the Southern Alps. There, perched on the edge of a cliff, at the point of greatest uplift from the tectonic collision of the Pacific and Australian plates, she is filled with awe and wonder at the interwoven processes which have created our landscape. "You can see the faults that have created the elevation, which is then interacting with the climate and glaciations, and depositing giant moraines, and scalloping out cirques. When you're up there, you get a real appreciation for the interaction of all these processes that shape our landscape. There is no danger of becoming complacent or being 'ho-hum' about the place that we live in".

And once the notion of landscape evolution through time captured her imagination there was no stopping Carolyn in her search for answers. "[It's] that time element of it, that what we see today used to be under the ocean and what we see in the high Southern Alps actually used to be in a subduction zone as part of the down-going plate off Gondwana. The deep, rich history of the rocks and the landscape in New Zealand is an endless source of fascination, curiosity and exploration. So just seeing the landscape and understanding its evolution means I'm always curious about it and will never stop wanting to know more about it". "That's the beauty of science", she insists. It is an iterative process whereby finding answers not only generates more questions but also invites learning to ask *better* questions.



Working in geology, there is no danger of having an awe deficit!



Yet, although she enjoys the field work, Carolyn is adamant that field observations and lab measurements go hand in hand. The two are married together and then combined with other datasets including geophysical and seismological data. She believes that integrating disparate datasets allows us to gain a better big-picture understanding of how and why earthquakes happen.

In terms of her career progression, it has always been less about mapping out a career path and more about finding opportunities that will assist her to follow a personal curiosity journey of unanswered questions and indulging in her passion for geology. [I'm thinking] "Will someone give me the opportunity to do that? and then I say 'Yes' when they do".

Her modus operandi has certainly been a successful one as she has been fortunate to find funding for ongoing research. Current projects include publishing work stemming from her research on the Alpine Fault and the Hikurangi Subduction Zone (the largest and least understood in New Zealand). She's now working to understand processes that contribute to earthquakes in greywacke fault zones. These have been somewhat neglected because they're often considered "ugly" but, in fact, many recent earthquakes (e.g. Kaikōura & Darfield) have occurred in the greywacke rock that forms the backbone of many of our ranges in New Zealand. So, even though Carolyn's career path was unplanned, one has been forged from her approach, having recently been appointed as a lecturer at Victoria University, Wellington.



Perched on fractured greywacke sandstone at the junction of the Esk Fault and Torlesse Fault, Carolyn looks for information about processes that occur during and after earthquakes.

Carolyn responded with a laugh, when questioned about what she'd like her legacy to be, as she has only just begun to settle into her new role as a lecturer with all its additional opportunities and responsibilities. Upon further reflection, she decided that having a network of supportive people is crucial for a sense of belonging to a dynamic research community. She suggested that fostering a welcoming atmosphere and culture for students and researchers at every stage of their careers, regardless of background and circumstances, is a key role for the GSNZ to embrace. In fact, a key component of her 'legacy' would be to ensure that there is a place for everyone within geoscience.

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I want there to be a place for everyone is geoscience regardless of their gender, nationality, ethnicity or background...[we need] a very diverse research culture in New Zealand and overseas because with diversity comes innovation and, I think, progress.

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Carolyn describes coming to NZ when she was 19 years old because she wanted to see the Alpine Fault, as a major highlight. Being a part of New Zealand geological research, and its community, was an important component of it. But the opportunity to be taught by pioneering researchers, like Richard Norris, Alan Cooper and Rick Sibson was the icing on the cake. They inspired her to carry on in that field, for her PhD, and form part of the team for the Deep Fault Drilling project at Gaunt Creek, near Whataroa.

Having attended Margaret Bradshaw's talk at the GSNZ 2020 conference, in Christchurch, Carolyn acknowledges the hardships of those pioneering women who have gone before. In

her view, there are still barriers in place today but they're primarily what she considers to be mental ones—an unconscious bias. She has encountered occasions where there is an uncomfortable dissonance between other people's perceptions of what a geologist could, or should, look like and herself. She clearly doesn't "look the part" by matching some outdated expectations of a geologist as a stereotypical six-foot-tall, deep-voiced, bearded man. It's the type of feedback that provides Carolyn with regular opportunities to confront and challenge this perception.

Furthermore, she reiterates the fact that women geoscientists are still under-represented in academia and Crown Research Institutes. She is keen to hold up examples, such as GNS's Laura Wallace, who have the ability to increase the visibility of women in the geosciences. She is keen to seek more change in this area. While the intellectual contribution of the aforementioned men to Carolyn's work was immense, looking back, she underscores the hugely supportive role that other women geoscientists, such as Daphne Lee at Otago and later Martha Savage at VUW, have played in her development as a young researcher. She recounts that she would have been lost if there had been *only* male professors in those early years. We should all feel somewhat indebted to these women, and others, who play such a pivotal role as advisors and mentors, in ensuring that young women are able to reach their full potential. The geoscience community in New Zealand is certainly stronger and richer because of it.

It may come as no surprise, that Carolyn's choice of geoscientist, from any time in history, to spend an evening with, would be an "amazing" woman. Tanya Atwater (b.1942) was "one of the first, most successful, female structural geologists in the world and was elected as a fellow of the AGU in 1978...within eight years of publishing her PhD". She wrote

seminal papers on the evolution of North America and the San Andreas Fault and was a leading plate tectonics theorist in a male dominated discipline. "One of the things that I love about her is that she said that at first she disguised her passion for science because she thought that a real scientist is very staid, very analytical and very logical. But later she realised that her passion for science was her 'superhero quality', that being passionate is a *good thing*".

During those times when she isn't working on difficult questions in geoscience, she delights in her home life and "just doing normal things". She loves spending time shopping with her daughter, walking around the streets of Christchurch admiring its recovery progress, gardening, or hugging her aging German short-haired pointer about whom she asserts: "Everyone says 'my dog is the best dog' but my dog IS the best dog!". Once Covid-19 travel restrictions are lifted she is looking forward to a break, "Someplace like

Rarotonga or New Caledonia and take my daughter swimming with sea turtles, and octopus, and all the diversity of life in and around a coral reef". She remains hopeful that we can get on top of climate change so that we don't lose those precious areas.

When asked how she fits everything in, Carolyn is all-at-once philosophical and pragmatic with a determination to find a work-life balance. Her brimming self-belief shines through at these times. "Being efficient and knowing when to stop...just saying hey, I have done a lot today, I have come up against a hard problem that I don't know how to solve. I'm going to go home and enjoy being with my family and I'm going to tackle this tomorrow. And tomorrow I'm going to be more awesome because I have done something I love, and given my brain a rest, and had a good night's sleep— future me is going to be way better". Her advice? "Don't neglect the other aspects of your life that make you happy". ■