

Paul Niggli Medal 2015 awarded to Marcel Frehner

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The Paul Niggli Medal is Switzerland's most prestigious award for young earth scientist who made outstanding contributions in the research fields of mineralogy, geochemistry, petrology, resource geology or solid-earth geophysics. The Paul Niggli Medal honours and supports young ambassadors of Swiss geoscience, who are either Swiss citizens or have obtained at least two of their academic degrees in the Swiss university system (B.Sc. or M.Sc. and usually their Ph.D.).

The Board of the Paul Niggli Foundation has decided in their annual meeting of 22 April 2015, to award the Paul Niggli Medal for the year 2015 to Dr. Marcel Frehner, currently senior scientist at ETH Zürich, in recognition of his research contributions combining rock physics, tectonics and numerical modelling of geological processes. The award has been presented at the Swiss Geoscience Meeting in Basel on 20 November 2015.

Christoph Heinrich, on behalf of the Foundation Council of the *Paul Niggli Stiftung*.

1 Citation

I met Marcel the first time in 2004 at the airport in Zurich when we left for an exploratory excursion to the southeast of Iran as Jean-Pierre wanted to evaluate the feasibility of starting Ph.D. projects in this region. Marcel was then a Diploma student and Jean-Pierre offered him the

possibility to join the excursion because Marcel was a very motivated student and simply asked whether he could come along. In the Makran we could observe spectacular multilayer folds in turbiditic sequences. I worked myself on folding mechanics and during many discussions in the evenings, while drinking tea and eating onions with saffron rice, Marcel decided (or maybe I persuaded him) to do a Diploma thesis on the numerical modelling of multilayer folding with a focus on finite strain evolution and the formation of parasitic folds (S-, Z- and M-type folds). Marcel showed a great talent and motivation for numerical modelling, he developed all the numerical and visualization algorithms by himself and his Diploma thesis resulted in an article that was published in the *Journal of Structural Geology*.

After his Master thesis I was fortunate that Marcel decided (or maybe I persuaded him again) to continue working with me on a Doctoral thesis. The topic of his Ph.D. thesis was multiscale wave propagation phenomena in fluid-rock systems and the thesis was part of a larger KTI research project with the aim of evaluating innovative passive seismic methods for hydrocarbon exploration. Seismic wave propagation in fluid-rock systems is a mathematically challenging subject, especially for someone with a geological background. However, Marcel easily dived deep into the mathematics of wave scattering phenomena, wave propagation in fluid-filled rock fractures and wave propagation in fluids with gas bubbles. To the best of my knowledge, he was first to apply the finite element method with an unstructured mesh to study propagation, reflection and scattering of waves in order to accurately resolve the wave propagation along a thinning fracture around fracture tips. Marcel showed enormous skills in

learning and understanding new and complicated analytical solutions and confronting them with numerical simulations for more complicated and realistic configurations.

Marcel then successfully defended his Ph.D. thesis in 2009. He was immediately offered a position as Assistant in the Geodynamics research group of Bernhard Grasmann at the University of Vienna, which is another testimony of his excellence as a researcher and also as a teacher. In Vienna Marcel rapidly integrated his new working environment and was involved in several research projects focusing on, for example, the tectonic reconstruction of the Zagros High Folded Zone, the mechanics of pebble breakage in gravel or the analysis of tectonic anti-forms using differential geometry.

Marcel was then offered the position he still fulfils as Oberassistent at the ETH Zurich. Marcel became an outstanding young scientist with an expertise in both computational structural geology and computational rock physics. He has shown that he can accomplish independently significant research in two different fields of the Earth Sciences: In structural geology, combining field and modelling studies on the mechanics of rock folding (he additionally investigated folding in glaciers); in rock physics by his combined modelling and laboratory studies on wave propagation and attenuation in fluid-filled fractured rock. The broadness of his frontier scientific research and remarkable contributions make Marcel an exceptional young scientist. In addition to performing fundamental research on geological and geophysical processes, Marcel is very interested in applying his research to industrial and to particular geological problems. Marcel combines two important skills: He has a thorough education as field geologist and considerable knowledge in continuum mechanics and numerical modelling. Such a combination is rare but essential to do leading-edge quantitative and physics-based research in Earth sciences. It is comforting to see that Marcel now supervises and educates Bachelor, Master and Ph.D. students to form the next generation of quantitative geologists for academia and industry who will be able to address the pressing needs of infrastructure in mountain regions, natural resources, alternative energies (water power and geothermal energy) or radioactive waste management.

Since I have been acquainted with Marcel, he always was a man of action, called in German "ein Macher". While others lengthily discuss, Marcel simply does it, and he does it well. In Zurich he was one of the founders of the *erfa* (student association for Earth scientists), of the ETH Alumni group and of the competence center for rock physics research gravitating around the ETH Zurich (*ROCKETH*). In addition to his academic activities, Marcel was and is engaged in several social activities. He was, for example, organising for many years the *rockamweier* open

air rock festival and he is leading a yearly week camp for children with congenital heart disease.

I really hope that Marcel finds an academic position to continue his scientific career in research and teaching. I wish Marcel all the very best for his future, continuing joy with regard to his research and I congratulate him cordially for his well-deserved Paul Niggli Medal award.

Stefan Schmalholz (University of Lausanne)

2 Response

I am very delighted in this great honour to have received the 2015 Paul Niggli Medal and I want to first thank the Paul Niggli Foundation for awarding me with their prestigious medal. I want to take this opportunity to outline my young career path and thank the people along the way, who inspired and stimulated my work.

At the 2015 Swiss Geoscience Meeting, I was even more delighted to have received the laudation and the Paul Niggli Medal from Stefan Schmalholz, who certainly is the most significant tutor in my early career. As Stefan describes above, I met him for the first time in 2004 on a geological field trip to the Makran accretionary wedge in south-eastern Iran. As a Diploma student at the ETH Zurich, I had the unexpected opportunity to join Jean-Pierre Burg on this trip. He was exploring the area for future Ph.D. projects and took along his new employee Stefan. I still remember the beautiful landscapes, our hike to the top of a mud volcano, a social night smoking shisha in Chabahar, and our long discussions about the Makran fold structures. It was during this field trip that Stefan convinced me to do a Diploma thesis developing and applying numerical models to investigate asymmetric so-called parasitic folds. Hence my work on *Computational Structural Geology* has started.

Towards the end of my Diploma thesis, Stefan received a grant to conduct collaborative research with a start-up company. The project was largely about passive seismic methods, seismic wave propagation on different scales, and rock physics of porous and fractured rocks. Stefan told me that I am his desired candidate for one of the four Ph.D. positions. Feeling honoured, I accepted the offer and started developing and applying numerical models to study seismic wave propagation in strongly heterogeneous materials, in particular materials containing fractures. Hence my work on *Computational Rock Physics* has started. With my fellow Ph.D.-students Beatriz Quintal, Marc Lambert, and Brian Steiner I not only shared our tiny office, but also all the ups and downs of a Ph.D. student's life. We spent many days, evenings, and nights together in the office, in the bars of Zurich, or at conferences. I still

remember our very first conference in Dubai, where we spent the whole night on the balcony of Stefan's hotel room and went a bit sleepy to the Dubai Ski Hall. Our research team at the ETH Zurich was strengthened by Erik Saenger and we soon started collaborating with Holger Steeb of the Ruhr-University Bochum. They both strongly supported all of us where- and whenever they could.

The work environment during my Ph.D. was extremely stimulating. We had weekly meetings with Stefan and Erik, where we reported on our progress and the newest findings, tested and exercised presentations, and made plans for conferences and future work. We often had heavy scientific discussions trying to convince each other of this or that. I am very grateful to Stefan and the entire group for creating such an environment, in which we pushed each other to become better scientists. Thanks to that, I gained some skills, which turned out very important in my further career, such as scientific argumentation, visualization of data and concepts, or giving presentations.

After finishing my Ph.D., I was lucky not to get trapped in the (in-)famous Post-Doc-treadmill of short-term project-hopping. Quite on the contrary, I immediately got a faculty position with a more stable perspective at the Department for Geodynamics and Sedimentology at the University of Vienna, where I enjoyed a great deal of independence. I want to thank Bernhard Grasemann for all the support during my early career as an Assistant in Vienna. Since I was not bound to any project goals, I could focus on both my previous research interests, *Computational Structural Geology* and *Computational Rock Physics*. In Vienna, I also met Ulrike Exner, with whom I started collaborating on various geological projects and I continued working with Beatriz, Erik, Holger, and Stefan. From the beginning, I was also strongly involved in the teaching activities on all levels. My time at the University of Vienna really allowed me to develop quite a diverse set of expertise, both in terms of research and teaching.

In the meantime, Stefan left the ETH Zurich and Jean-Pierre was searching for a replacement. Of course, I

applied to this position and finally went back to the ETH Zurich replacing my former Diploma and Ph.D. supervisor. As a young researcher, I enjoyed and still enjoy the support and goodwill of Jean-Pierre. He always trusted in my research, teaching, and administrative capabilities and supported me when developing and leading my own scientific projects and lectures. Again, Jean-Pierre would not enforce any research directions but has always allowed me to follow my interests. Together with Beatriz and Erik, who were both still at the ETH Zurich, we formed *The Rock Physics Network at ETH Zurich* (short ROCKETH). At the same time, I continued my structural geology work and further broadened my research interests and expertise, for example working on cold region geomorphology in collaboration with Isabelle Gärtner-Roer of the University of Zurich.

My research output, which has now been acknowledged with the Paul Niggli Medal, would never have been possible without the collaboration with a large number of people. In particular, I thank Beatriz Quintal, Erik Saenger, Holger Steeb, and Stefan Schmalholz, who are all long-term scientific companions and also became very dear friends over the years. I also sincerely thank Ulrike Exner and Neil Mancktelow for being such great scientific and personal consultants and friends. Claudio Madonna and Nicola Tisato raised my awareness of how essential lab work is for rock physics research. Thanks for that.

One of the main sources of inspiration for my scientific work is the collaboration with and supervision of students. It is always a pleasure to be exposed to their critical questions and fresh ideas.

Of course, there are still a large number of other people that I did not, but should have acknowledged here. Thanks to all former and current members of the Structural Geology and Tectonics group at the ETH Zurich and of the Department for Geodynamics and Sedimentology at the University of Vienna, and to everybody I forgot.

Marcel Frehner (ETH Zurich)