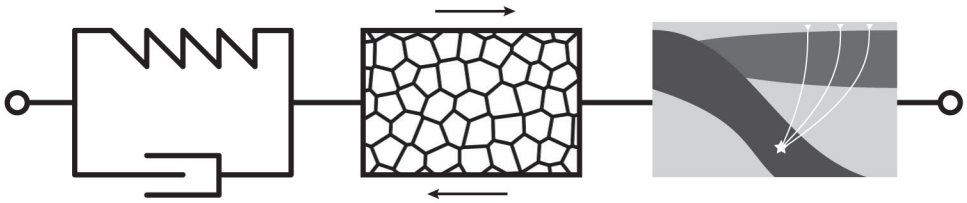


PPEM

Physical Properties
of Earth Materials
sites.agu.org/ppem/

Annual Newsletter

December 2017

A Note From The Chair

~ Chris Marone ~
Penn State University
PPEM Chair

Dear friends and Colleagues, I hope this note finds you in good health and ready for 2018. I wasn't able to get to New Orleans but I heard many great things about the AGU meeting, and New Orleans as a venue, so good for all of you who were there. I also had great reports about the PPEM dinner. Kudos and hats off to the team who pulled things together, despite unfamiliar territory: Christine McCarthy, David Goldsby, and Tom Mitchell.

This year's PPEM AGU special session was The Rheology and Processes of Transient and Steady State Rock Deformation. Thanks to Christine McCarthy, Margaret Boettcher and Jessica Warren for organizing that. It's not too early to start thinking about the 2018 meeting. Please get in touch with one of us on the steering committee if you have ideas.

It is with a heavy heart that I acknowledge the passing of two luminaries in Earth Materials research. We lost Harry Green and Joe Walsh in 2017. There are special sessions in the works that will in honor both Harry and Joe. We will miss both of them and our thoughts go out to their families.

This year promises many important opportunities to gather at workshops and seminars relevant to what we do in PPEM. In July, the Enrico Fermi School will host a workshop on the mechanics of earthquake faulting at Varenna, Lake Como, Italy. Later in the summer, The Gordon Conference on Rock Deformation will take place at the Proctor Academy in Andover NH, USA (Aug. 19-24, 2018). This year's theme is Integrated Approaches to Rock Deformation: Observations, Experiments, and Models and the meeting will be Chaired by Julia Morgan and Daniel Faulkner. These are always exciting meetings with cutting-edge research and important opportunities for students and early career professionals so make sure to apply early.

Please keep thinking about how PPEM can be relevant to what we all do, and reach out to one of us on the Steering Committee if you have ideas or suggestions (sites.agu.org/ppem).

I look forward to seeing you soon!

best regards,
Chris

Physical Properties of Earth Materials Annual Newsletter

The oldest continuously published annual newsletter on experimental rock mechanics and San Francisco fine dining.

Brought to you by your PPEM steering committee:

Chris Marone	Penn State University	Chair
Brian Bonner	Fine Dining Search Team	
Melodie French	Rice University	
Christine McCarthy	Lamont-Doherty Earth Observatory	
Tom Mitchell	University College London	
Andy Rathbun	Chevron	
Lars Hansen	University of Oxford	

12th Eurocon-ference on Rock Physics and Geomechanics

~Eyal Shalev~
Geological Survey of Israel

The 12th EURO-Conference on Rock Physics and Geomechanics was held in Ma'ale HaHamisha, Israel, on November 5th 2017 and attended by some 55 attendees. The relatively small group created an intimate atmosphere that allowed for in depth discussions. The program included 35 talks and 15 posters covering fundamental processes in fault mechanics, static and dynamic deformation, fault healing/sealing, time dependent deformation, and induced seismicity.

The theme for this conference was "Bridging between Rock Physics and Structural Geology" and in conjunction there was a one day field trip to deformation zones along the Dead Sea transform that included soft sediment deformation, a salt diapir, sinkholes, and an active fault zone. The Desert's spectacular outcrops and beautiful November weather triggered many good discussions. The conference was concluded by a tour to the Zedekiah's Cave and the old city of Jerusalem.

Consider a Donation to PPEM

Over the years, PPEM has maintained a small endowment that has been used to support activities at the Gordon Conference on Rock Deformation and other scientific venues.

We encourage you to consider a contribution. You can contribute at the annual PPEM dinner or by sending a check directly to the PPEM Treasurer Nick Beeler (nbeeler@usgs.gov).

2018 Gordon Research Conference and Seminar on Rock Deformation

~ Julia Morgan ~
Rice Unversity

~ Dan Faulkner~
University of Liverpool

The 12th Gordon Research Conference (GRC) on Rock Deformation will take place from August 19-24, 2018, at Proctor Academy, Andover, New Hampshire. The theme for this meeting is "Integrated Approaches to Rock Deformation: Observations, Experiments, and Models", organized by Julia Morgan (Chair) and Daniel Faulkner (Vice-Chair).

Our first-order understanding of rock deformation is limited by our ability to observe and interpret natural phenomena or their relict signatures in the rocks. However, such observations allow us to define fundamental hypotheses that can be tested, in particular, by way of experiments and models, ultimately yielding deeper insights into rock deformation in nature. For example, both seismic and post-seismic deformation can be documented geodetically, but the remote nature of the data and their dramatic spatial and temporal variations, do not resolve the specific processes responsible. Deformation experiments under controlled conditions can narrow down the possibilities, while numerical modeling serves to extrapolate these results back to natural conditions. Thus, a fully integrated approach to rock deformation, one combining observation, interpretation, experimentation, and finally, physical or numerical modeling, is the key to furthering our understanding of the deformation behavior of complex Earth and planetary systems. The 2018 Gordon Research Conference on Rock Deformation will present cutting-edge research that spans a wide range of methodologies, materials, over a variety of spatial and temporal scales, with an eye on developing this integrated perspective on rock deformation. Presentations will cover brittle and ductile deformation, from microstructures to mantle rheology, with applications to earthquake mechanics, geodynamics, geohazards, geoengineering, and more. The conference will draw together international experts at the forefronts of their fields, both early-career and senior investigators, enabling the free exchange of ideas. The collegial and open atmosphere of the Gordon Research Conference, combining programmed sessions and discussions, as well as opportunities for informal gatherings in the afternoons, evenings and during meals, provides a forum for scientists from different disciplines to brainstorm together, while developing new cross-disciplinary collaborations in a range of research areas. A detailed program can be found at: https://www.grc.org/rock-deformation-conference/2018.

The 3rd Gordon Research Seminar will be held immediately before the Conference, August 18-19, 2018, with the theme: "Combined Approaches to Investigating Rock Deformation Across Vast Temporal and Spatial Scales." This meeting will provide a unique forum for graduate students, post-docs, and other scientists with comparable levels of experience and education to present and exchange new data and cutting edge ideas. Co-chaired by Johanna Nevitt and Katrina Sauer, the meeting will explore the many factors that control the mechanics of rock deformation, including stress state, temperature, pressure, loading rate, composition, and fluid content. Variations in these factors throughout the lithosphere account for the wide range of deformation processes that drive plate tectonics, with implications for natural hazards (e.g., earthquakes, volcanoes), economic resources (e.g., ore deposits, hydrocarbons), and the geomorphic signature of Earth's surface. Building a more unified understanding of rock deformation requires the synthesis of many disparate data sets and analysis techniques that can account for spatial and temporal scales spanning several orders of magnitude. See https://www.grc.org/rock-deformation-grs-conference/2018 for information.

Please note that those interested in attending both meetings must submit an application for the GRS in addition to an application for the GRC. The deadlines to apply for these meetings is July 21, 2018 for the GRS, and July 22, 2018 for the GRC.

DRT 2017 - 21st International Conference on Deformation Mechanisms, Rheology and Tectonics

Enrique Gomez-Rivas
University of Aberdeen

The 21st DRT meeting gathered 115 scientists from all around the world working on structural geology, tectonics and petrology. The meeting took place in Inverness from 30th April to 4th May 2017, and was organised by the University of Aberdeen. DRT is one of the main world forums for discussing research in the fields of rock deformation, structural geology, rheology, tectonics, microstructures, rock physics and interactions between deformation and metamorphic/diagenetic reactions.

Inverness is the capital of the Scottish Highlands and lies astride the Great Glen Fault. Not far from this city crops out the Moine Thrust Belt, the front of the Caledonian orogenic belt on mainland Scotland and the outcrop edge of the Laurentian shield. In addition to presenting and discussing research during three days with sessions, the DRT-2017 delegates visited some of the key localities of Scottish geology in the NW Highlands Geopark in a one-day mid-conference excursion. Moreover, some of them also joined one of the four pre-conference excursions to the Lewisian Complex, Kinlochewe, Loch Monar and Clashach-Burghead, and a post-conference fieldtrip to the North coast of Scotland. Fieldtrips and excursions were led by Rob Butler, Rick Law, John Wheeler and Dave Healy, and were designed to promote discussions in the less formal setting of the field.

Participants had the opportunity to attended twelve oral presentation sessions spread over three days plus two poster sessions that lasted two days each. In the first keynote, Nick Timms presented new ways of quantifying and visualising the relationships between elastic anisotropy and plastic deformation of rock-forming minerals, using zircon as an example. In the second keynote, Mike Heap used results of triaxial rock deformation experiments to show how changes in pressure and temperature control the mechanical behaviour, failure

Two groups of DRT-2017 delegates during the mid-conference excursion to the NW Highlands, at Loch Glencoul and Laxford, respectively.

modes and strain localisation of volcanic rocks, and can thus affect the evolution of volcanic edifices. Antonio Teixell reviewed the characteristics of mountain belts derived from the inversion of rift basins, based on lessons learned from three well-documented examples in which he has intensively worked: the Pyrenees, the Atlas Mountains and the Eastern Cordillera of the Colombian Andes. In a session dedicated to polar ice deformation, Dave Prior discussed how crystal preferred orientations (CPOs), associated with ice deformation, change as a function of temperature, vorticity and differential stress and strain rate. He demonstrated the acquisition of proxy CPO data from seismic investigations and compared ultrasonic velocities measured from samples and those estimated from experimental and natural CPOs. Finally, in the last keynote, Jessica Warren showed that hydration can control fault rheology at variable depths, by examining peridotite mylonites from active transform faults and exhumed mantle shear zones.

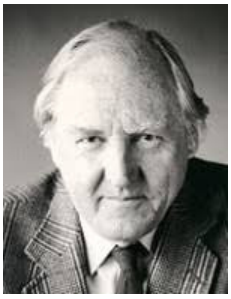
The sessions were filled by exciting oral and poster presentations by a large number of PhD students, postdocs and academics. Following the DRT tradition, the participants engaged in debates on different topics during plenary discussions at the end of each time block. Moreover, the mid-conference excursion provided a unique opportunity to discuss research in front of natural structures at famous outcrops. For more information on the meeting, you can visit the conference website (http://www.abdn.ac.uk/events/drt2017) and download the conference programme, excursion guides and abstract book.

TecTask, the Tectonics and Structural Geology commission of the International Union of Geological Sciences (IUGS, http://www.tectask.org), funded five travel grants that allowed five outstanding young researchers to attend the conference. The level of student presentations was extremely high, ensuring a bright future for DRT.

After the success of DRT 2017, the community is looking forward to the next edition that will be hosted by Paul Bons at the University of Tübingen (Germany), from 11th to 14th June 2019.

The Mervyn Paterson Archive

~ Mark Zimmerman ~
University of Minnesota



A major objective of the rock deformation community has been to build on the apparatus designs of outstanding early workers such as Griggs, Paterson, Brace, Heard, Handin and others. With that in mind, Mervyn Paterson has released all of his design drawings and extensive notes as an open resource for early career scientists and others who wish to advance experimental technology in our field. Links are provided below for you to share.

Upon his retirement from the Research School of Earth Sciences at the Australian National University, Prof. Mervyn Paterson made an important decision, one that greatly impacted the mineral and rock physics community. Mervyn, a superb engineer as well as an outstanding scientist, decided to build a commercial version of his rock deformation apparatuses that had established him as the leader in high-temperature, high-pressure studies of the rheology of crustal and mantle rocks. In 2004, Mervyn was awarded the Bucher Medal of the American Geophysical Union for his "major and lasting impact on the field of experimental rock deformation and on our understanding of the Earth's crust." In the words of Prof. Ian Jackson, of the Australian National University, from his nomination of Mervyn for the Bucher Medal (https://honors.agu.org/winners/mervyn-s-paterson/): "The study of rock deformation required the development of high-pressure techniques, initially at room temperature and, from the 1960s, at high temperature. The progressive enhancement of the capabilities of Mervyn's deformation machines has required solutions to several major technical challenges. Most significant among these have been internal heating and measurement within the pressure vessel of load and piston position, and arrangements for torsional deformation at both the micro-strains of seismic wave dispersion and attenuation and the very large strains sometimes encountered in natural rock deformation. It is no small testimony to the quality of Mervyn Paterson's designs that his high-temperature testing machine has become the instrument of choice for experimental rock deformation worldwide.

Mervyn's development of versatile equipment for experimental rock deformation has been motivated by a desire to understand the mechanical behavior of the Earth's crust and a keen interest in material behavior more generally. His experimental studies of that distinctive class of materials known as rocks and minerals, supported by relevant theory, have provided insight into many naturally occurring phenomena. These range from folding and fabric development to dehydration embrittlement as a possible cause of earthquakes, from changes in porosity and permeability associated with dilatant behavior to the constitutive laws for high-temperature plastic deformation, from water weakening of quartz to geological applications of non-hydrostatic thermodynamics."

In the early 1990s, the first three Paterson apparatuses were delivered: one to Manchester, UK, another to Montpellier, France, and the third to Minneapolis, MN. Since, ten more rigs have been sent to labs in Switzerland, Germany, France, and most recently in 2012 China. These 'Cadillacs' of the rock deformation community have produced over 250 investigations of deformation of geological materials and numerous studies of other physical properties including seismic velocity, seismic attenuation, diffusion, and electrical conductivity. The impact has been enormous and continuous.

This year, Mervyn turned 92. A few years ago, members of the rock deformation community approached Mervyn about the future of Paterson apparatuses. Mervyn told us that he would no longer be involved in the manufacture of more rigs. He also said that he would give us the drawings and his detailed notebooks so that we could (1) maintain the current machines and (2) develop the capability of building new and possibly the next generation of Paterson apparatuses. Given this exciting possibility, the National Science Foundation through the Rapid program, agreed to fund an archival project with Mervyn's help to identify his key drawings and notebooks, and scan these documents (NSF Award # 1649412). The scanned materials are currently archived at the Australian National University and are accessible to interested scientists. ANU has now finished the documentation for Mervyn's HPT records. They've uploaded the PDFs of the drawings that were digitized and other records to the University's Open Research repository where they are available for public access. The drawings are grouped by number so while it appears that there are only 20 items altogether, there are many drawings in each item. These are separate links to:

1. Series and item descriptions:
http://archivescollection.anu.edu.au/index.php/mervynpatersons-papers-and-drawings-relating-to-hpt-machines

2. Authority record:
http://archivescollection.anu.edu.au/index.php/paterson-mervyn

3. Digitized copies:
https://openresearch-repository.anu.edu.au/handle/1885/117174

There is a hyperlink in the series description (and in the item descriptions where digitized copies exist) to the relevant part of the Open Research repository. The Archives database and the Open Research repository are also harvested by the National Library of Australia's Trove database, so they should be findable!

Since the introduction of the HPT rigs to the broader community by Mervyn Paterson in 1991, over 12,000 experiments have been conducted on these rigs involving the scientific training of over 140 people, including numerous graduate students, post-docs, and visiting scientists at 10 different laboratories world wide. This is a remarkable accomplishment and merits preservation of the development process by establishing an open access digital archive. The continued evolution of Mervyn's work will benefit the scientific communities in mineral and rock physics as well as material science. The opportunities for advancement of this technology are greatly enhanced by the preservation of the groundwork that Mervyn has established and those advancements will provide training for future generations of scientists in multiple research endeavors.

Memorial Symposium – Tribute to Harry W. Green II (1940-2017)

Harry W. Green II, Distinguished Professor of the Graduate Division at the University of California at Riverside, a Fellow of the Mineralogical Society of America, AGU, and the American Association for the Advancement of Science, the AGU Birch Lecture and Bowen Award, the MSA Roebling Medal and the EGU Louis Neel Medal recipient passed away at 22 September, 2017.

The Memorial Symposium took place at the University of California at Riverside,
November 3rd, 2017.

Harry Green was a giant in the field of the rheology of geological materials at mantle conditions, who always tried to connect rock deformation to phase transformations, mineralogy and petrology. Harry's work is an extraordinary example of the role of mineral physics in solving first-order dynamic Earth problems through detailed analytical and microstructural studies on natural rocks and in laboratory experiments. The accumulation of all his contributions has made a major impact on fundamental concepts and opened new avenues: one to earthquake physics and a second to deep subduction zone processes, both are major components of global plate tectonics. The Symposium assembled these components of Harry Green's seminal advances into two sessions: 1. Earthquakes and Faulting and 2. Everything about Subducted Slabs. The symposium brought together colleagues and friends from different corners of the USA, China, France and Australia. The speakers demonstrated how instrumental, diverse and profound Harry Green's scientific contributions were and how many collaborators and friends he made during his scientific carrier.

Session 1: Earthquakes and Faulting included the following presentations:

Jim Dietrich, University of California, Riverside - Earthquake Simulations Using Lab-based Constitutive Laws.
Shun-Ichiro Karato, Yale University - Recent Development of Experimental Studies on Plastic Deformation at High Pressures.
Carl Agee, University of New Mexico - Harry Green's Legacy to COMPRES.
Terry E. Tullis, Brown University - Harry Green and High Speed Rock Friction.
Junfeng Zhang, China University of Geosciences, Wuhan, China - Faulting and Earthquakes During Serpentine Dehydration: a Tribute to Harry Green.
David Lockner, United States Geological Survey - Acoustic Emissions During Asperity-Fault Interaction.
Yanbin Wang, University of Chicago – Labquakes and Nanoseismology: Continuing Harry's Ideas on Transformational Faulting.
Eric M. Riggs, Texas A&M University - The Early Days of Transformation Induced Faulting: Burnley and Riggs' adventures with Mg2GeO4.

Session #2: Everything about Subducted Slabs included the following presentations:

WangPing Chen, University of Illinois - The Quest for Entrained Continental Crust during Collision.
An Yin, University of California, Los Angeles - Viscoplastic Shear and the Origin of Intermediate-Depth Double Seismic Zones in Subducting Slabs.
Quentin Williams, University of California, Santa Cruz - Oxidized Mantle Carbon: HWG II's Early Perspectives and What has Followed...
Larissa Dobrzhinetskaya, University of California, Riverside - Mineralogy in Actions: from Mountains Building to Atomic Scales.
Zhenmin Jin, China University of Geosciences, Wuhan, China - Mineralogy of Stagnated Slab Beneath Eastern China and its Geodynamic Implications.

Earl O'Bannon, Lawrence Livermore National Laboratory - The High-Pressure Phase of Lawsonite: a Single-Crystal Study of a Key Subduction Zone Hydrous phase. A tribute to Harry W. Green II.

Asish Basu, University of Texas, Arlington - Minerals and Fluids from Mantle Transition Zone and Beyond: a Tribute to Harry W. Green II.

Krassimir Bozhilov, University of California, Riverside - Moissanite Polytypes in Amphibolite Grade Metamorphic Rocks from Southern Bulgaria.

Tom Sharp, Arizona State University - Olivine and Enstatite Phase Transitions in Subducting Slabs and their Possible Role in Deep Focus Earthquakes.

Liang Liu, Northwestern University, Xi'an, China -Discovery of Former Stishovite in Metamorphic Rocks of NW China: my Collaboration with Harry Green.

Feng Shi, University of Chicago - Eclogitization of Granulite Rocks Triggered Deep Crustal Seismicity in Southern Tibet.

Christopher Cline, Australian National University, Canberra, Australia - An Update on Laboratory Based Measurements of Seismic Properties: the Influence of Partial Melt and Water.

Howard Day, University of California, Davis - Early Jurassic Onset of Franciscan Subduction.

Thomas Ferrand, Laboratoire de Géologie de l'Ecole NormaleSupérieure. Paris, France - Intermediate-depth mantle earthquakes, from the lab to the field.

Harry was a great collaborator who conducted many projects with researchers across the world. He was a mentor to many students and post docs, and they all remember him as a fair and kind human being, with a deep sense of academic morals and integrity. Harry loved science; he repeatedly demonstrated how processes at the very finest scale contribute to our understanding of the Earth's system. Harry Green was an outstanding scientist whose mind was truly "open" to move our knowledge to the frontier of big science. We will miss him dearly.

Organizing Committee:

ZhenMin Jin, Larissa Dobrzhinetskaya, Junfeng Zhang, Krassimir Bozhilov, Pamela Burnley, Yanbin Wang