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Foreword

Invited contributions by 2016–2017 geoscience laureates of the French Academy of Sciences

Each year, the French Academy of Sciences awards a number of prizes and medals to recognize the contributions and achievements of outstanding colleagues in all fields of Science. Since 2013, laureates in the geoscience section are invited to make short presentations at the Academy, and to submit an invited paper to *Comptes rendus Geoscience* (see, e.g., Courtillot, 2014). The present issue brings together a 2016 and four 2017 laureates.

In the first paper, Bernard Marty (laureate of the 2016 Dolomieu Prize) and three colleagues analyse, by the extended argon–argon method, fluids trapped in inclusions in Archaean hydrothermal quartz crystals. Fluids are extracted by stepwise crushing of quartz samples from 3.5–3.0-Ga-old greenstone belts in NW Australia and South Africa. They find that these fluids are a mixture of a low-salinity end-member, regarded as the Archaean oceanic water, and of several hydrothermal end-members rich in Cl, K, N, and radiogenic parentless ^{40}Ar. The low value of the Cl–K end-member suggests that the salinity of the Archaean oceans was comparable to the modern one. That salinity of the oceans through time was constant has important implications for the stabilization of the continental crust and for the habitability of the ancient Earth.

In the second paper, Alexandre Chemenda (laureate of the 2017 Dolomieu Prize) and five colleagues investigate fracture processes using finite-difference simulations with a new constitutive model. They show that both geometry and fracture mechanism depend on the pre-existing heterogeneities that act as stress concentrators. In the brittle regime at low pressure, fractures propagate from the imposed weak zone normal to the least stress (mode I). At high pressure, shear deformation bands form oblique to the least stress. At intermediate pressure, the fracture mechanism involves both shear banding and tensile cracking, and results in the initiation and propagation of a pure dilation band. The fractures normal to the least stress are joints. Chemenda and colleagues conclude that there are two types of joints resulting from mode-I cracking and dilation banding.

In the third paper, Louis de Barros (laureate of the 2017 Michel Gouilloud Prize) and four colleagues focus on the seismicity induced by fluid perturbations; this has become an important societal concern since felt earthquakes (magnitude up to 6) are now known to have been caused by human activities. In order to mitigate the risks associated with undesired seismicity, and to be able to use the micro-seismicity as a probe for in-depth investigation of fluid-driven processes, the authors endeavour to understand the links between seismicity, fluid pressure, and flow. They have developed a series of in-situ experiments of fault zone reactivation by controlled fluid injection. The monitoring close to the injection allows one to cover the full frequency range of the fault responses. De Barros and colleagues focus on the micro-seismicity ($M_w \sim -4$ to -3) recorded during two fluid injection experiments in low-permeability shale and high-permeability limestone formations. In both experiments, they find that most of the deformation does not actually emit seismic signals. The induced deformation is mainly aseismic. Based on these observations, they propose a new model for injection-induced seismicity that is triggered by the stress perturbations transferred from the aseismic motion caused by the injection.

In the fourth paper, Charlie Morelle Angue Minto'O (laureate of the 2017 Louis Gentil – Jacques Bourcart Prize) and three colleagues apply a model obtained from depth modelling based on the distribution of 33 recent benthic foraminifer species to the fossil benthic foraminifers from a borehole drilled at a water depth of 491 m in the East-Corsica basin that encompasses the last 550,000 years. The variations of the palaeo-depths that they obtain show a moderate correlation with the oscillations of the relative sea level and also with the fluctuations of the oxygen isotopic ratio. The newly developed transfer function

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comes with an error margin of $\pm$ 86 m, which suggests to the authors that the model that is probably more suitable for a time scale of the order of a million years. The ''eustatic'' signal of the microfauna is accompanied by a ''trophic'' signal, which should not be neglected, especially at a millennial scale time resolution. Minto'O and colleagues conclude that the application of their method requires taking into account the bottom trophic effects that strongly control the distribution of benthic foraminifer assemblages.

In the last paper, Denis Savoie (laureate of the 2017 Paul Doistau – Émile Blutet Scientific Information Prize) reviews the astronomical uses of the gnomon throughout ages. This paper on a topic that belongs to the history of science is written in French. The gnomon is the most ancient instrument in astronomy. It has allowed scientists in many cultures since Antiquity to determine the fundamental Earth parameters, mainly its motion relative to the Sun. It has been improved constantly, attaining a precision of a few seconds of arc in the 17th century. But the most remarkable fact pointed out by Denis Savoie is that it is still used in space missions.

As in Courtillot (2014), I wish to congratulate the authors on winning the Academy's prestigious prizes and to thank them for submitting these very diverse papers that illustrate well the broad spectrum covered by geosciences; I hope they will be of interest to the readers of *Comptes Rendus Geoscience*. I wish also to thank the reviewers for assisting the associate editors and I in evaluating these invited papers. Let me conclude by recalling that *Comptes rendus Geoscience* welcomes not only highly innovative papers, but also sound and timely reviews of subjects that appear ripe for the exercise, and also proposals for thematic issues on topics that may be of interest to a wide readership.

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