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Editorial: Viscoplastic fluids: From theory to application

The seventh in a series of international workshops on *Viscoplastic fluids: From theory to application* was held Oct. 30–Nov. 3, 2017 in Rotorua, New Zealand. This Virtual Special Issue of the Journal of Non-Newtonian Fluid Mechanics presents 17 papers based on work presented at the workshop. The conference was attended by 32 researchers from eight countries (see Fig. 1). It featured 41 talks on a broad range of theoretical, numerical, experimental, and applied topics related to viscoplasticity. Formal and informal discussions took place throughout the week.

Viscoplasticity remains an active area of research, and publication data presented at the conference indicated that the number of papers published in the area has increased by a factor of two since this series of conferences began in 2005. The talks at the conference and the papers in this special issue exemplify the high quality and relevance of the research being done in the field.

The nature of yielding in real materials was an important theme in several of the talks. The meeting started with Daniel Bonn reassuring us that simple yield stress fluids do, in fact, exist. Nonetheless it was clear from many of the talks that yielding is a complex, gradual process in which elasticity plays an important role. We are only beginning to investigate yielding in situations other than simple shear flows.

While Carbopol remains a favorite model material for many experimentalists, yield-stress materials used in applications are often much more complex. Waxy crude oil is an important example that has properties that depend strongly on thermal and shear history. A wide range of materials were discussed at the meeting, including emulsions, thermal and athermal gels, semisolids, and geophysical materials such as sea ice, lava, and the earth's mantle. The influence of thermal, pressure, and surface tension effects on yielding are likely important in many applications, but have not yet been well studied. The yield stress of a viscoplastic material arises due to its internal microstructure, and the way in which this microstructure forms and breaks up is being studied both experimentally and through a variety of models.

The behavior of a single particle in a viscoplastic fluid has been studied experimentally and theoretically for some time. A notable trend that emerged at this meeting was the study of more complex systems involving two or more particles. Research on two particles in a sheared yield-stress fluid, viscoplastic flows through a field of obstacles, and a theoretical approach to studying suspensions of many particles in a viscoplastic fluid were presented at the meeting.

Real materials are not simply viscoplastic, but in general are also thixotropic (i.e., time-dependent) and elastic. Gareth McKinley discussed a thixotropic-elastoviscoplastic (T-EVP) framework for modeling real materials. Fast numerical methods that had been introduced at VPF6 have been further developed. The inevitable trade-off between speed and accuracy involved in numerical research was discussed in several talks, and Timm Treskatis emphasized the important distinction between precision (i.e., the degree to which a computation has converged to a solution) and accuracy (the degree to which that solution reproduces the "right" answer). There was an interesting discussion about whether computational effort should be directed towards more accurate simulations of simplified model systems, or towards modeling of more realistic, but more complicated, materials.

The papers in this Virtual Special Issue of JNNFM examine these and other important issues in the field. Andreas Alexandrou and co-workers discuss the problem of determining the "true" rheological properties of viscoplastic fluids from rheometrical measurements. Nicoló Sgreva and Anne Davaille study the contribution of thermoelastic stresses to the yielding of viscoplastic fluids in Rayleigh-Bénard convection. The stopping of a sphere falling into Carbopol is analyzed by Dominique Tarlet et al. Rodrigo Mitishita and co-workers report experiments on the propagation of an applied pressure through a viscoplastic fluid in a pipe. Riande Dekker et al. provide an explanation for differences observed in the scaling of flow curves determined experimentally and from simulations. Priscilla Varges and co-workers describe experiments on exchange flows of an elasto-viscoplastic fluid and a Newtonian fluid in a vertical tube. The construction of a phenomenological constitutive model that involves only measurable material functions and incorporates thixotropy, viscoelasticity, and yielding is explained by Paulo de Souza Mendes et al. Iasonas Ioannou and Georgios Georgiou discuss a theoretical study of the effect of pressure on the Poiseuille flow of a Bingham fluid. Yang Liu and co-workers study the flow of Carbopol confined to small microchannels. Roney Thompson et al. remind us that yield stress is a tensor quantity and present measurements of both shear stress and normal stress differences for several yield-stress materials. Abdulrahman Al-Behadili and others introduce a new rheological technique based on the Ellis model and applicable to free-surface flows. Paul Vigneault and co-workers report experimental and numerical studies of viscoplastic channel flow over a cavity. Gavin Donley et al. present a new method for identifying yielding from large-amplitude oscillatory shear measurements. The behavior of two particles in shear flows of yield-stress fluids is studied experimentally by Mohammadhossein Firouznia and others. Experiments on the start-up flow and yielding behavior of Carbopol in a vertical pipe are presented by Yang Liu and John de Bruyn.

Gareth McKinley's impression of our current Viscoplastic World View, originally sketched during the meeting, is shown in Fig. 2. It

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Fig. 1. Attendees at the 7th conference on Viscoplastic Fluids: From theory to application, held in Rotorua, New Zealand, Oct. 30–Nov. 3, 2017.

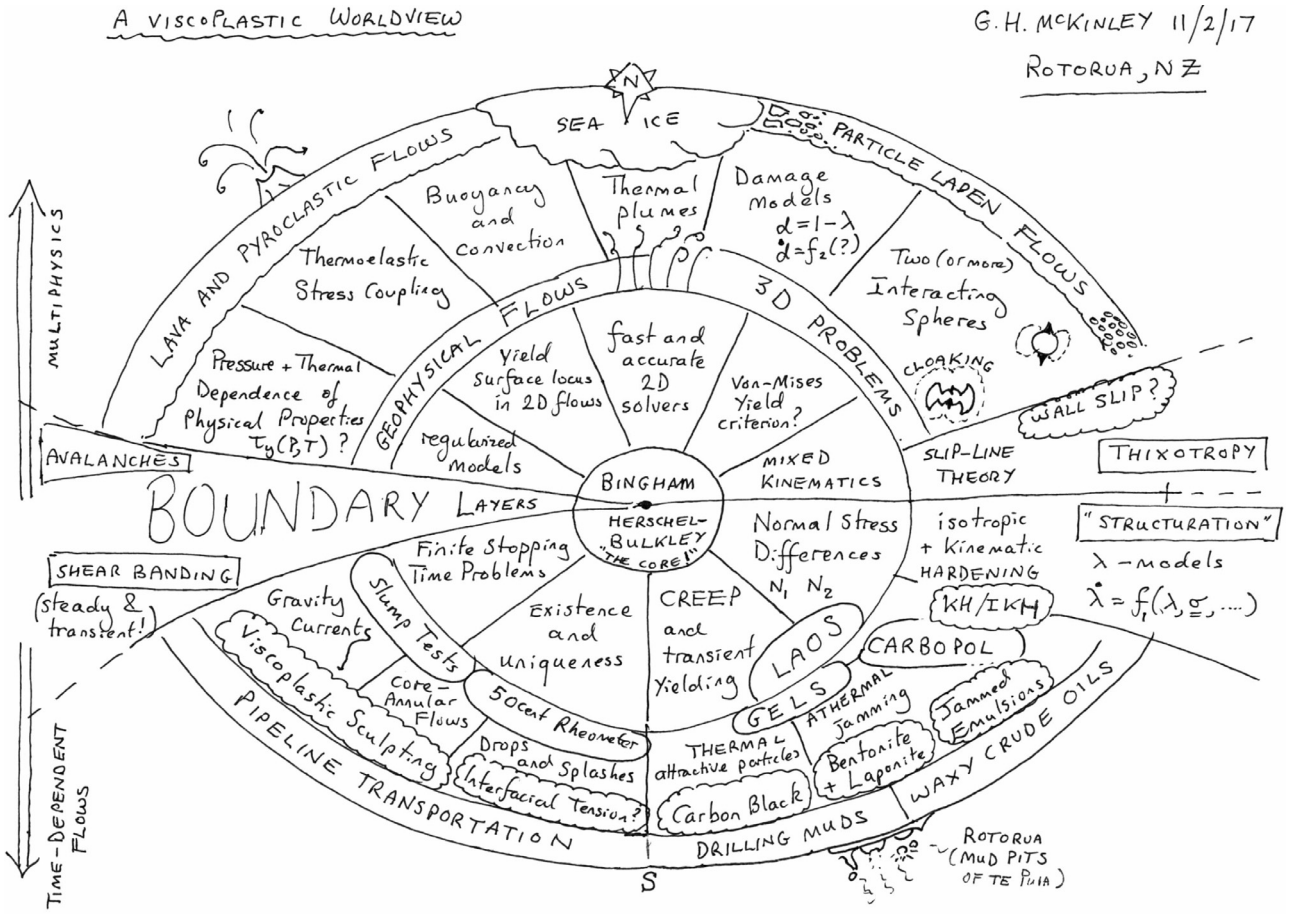

Fig. 2. A viscoplastic world view.

captures the important issues in the field and the relationship between them.

The faint (or sometimes not-so-faint) smell of sulfur reminded us that Rotorua is located in a geothermally-active region. One afternoon during the week was devoted to a tour of Te Puia, where we enjoyed Maori cultural exhibits and geothermal wonders, and observed both viscoplastic and Newtonian fluids in the wild (Fig. 3).

It has become a tradition at these meetings to present a few prizes. Timm Treskatis won the prize for the best talk by a “newcomer” for his provocative talk on fast numerical methods and the issue of accuracy vs.

Fig. 3. A viscoplastic fluid observed at Te Puia, New Zealand.

precision in numerical modeling of viscoplastic fluids. The "Bingham Plastic Prize" (not to be confused with another award with a similar name) was presented to Ian Frigaard in recognition of his many contributions to the field, including the founding of this series of conferences.

The Rotorua meeting was organized by Miguel Moyers-Gonzalez from the University of Canterbury in Christchurch, NZ. The conference gratefully acknowledges the sponsorship of the University of British Columbia and the University of Canterbury. We are also grateful to the editors-in-chief of the Journal of non-Newtonian Fluid Mechanics for agreeing to publish the proceedings of the workshop in this Virtual Special Issue. The eighth conference in this series will take place in Cambridge, England, in the fall of 2019.

Our community was deeply saddened to learn of the death of Andreas Alexandrou just a few months after he attended the Viscoplastic Fluids meeting in New Zealand. Andreas, who co-hosted VPF 2009 in Limassol, Cypus, was an excellent scientist, a strong academic leader, and a good friend to many of us. A full obituary appears elsewhere in this Virtual Special Issue.

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