



## **Past and present of analogue modelling, and its future trend**

Hemin Koyi

Hans Ramberg Tectonic Laboratory, Dept. of Earth Science, Uppsala University, Sweden

Since Hull (1815) published his article on modelling, analogue modelling has expanded to simulate both a wider range of tectonic regimes and target more challenging set-ups, and has become an integrated part of the fields of tectonics and structural geology. Establishment of new laboratories testifies for the increased attention the technique receives. The ties between modellers and field geoscientists have become stronger with the focus being on understanding the parameters that govern the evolution of a tectonic regime and the processes that dominate it. Since the first sand castle was built with damp sand on a beach, sand has proven to be an appropriate material analogue. Even though granular materials is the most widely used analogue material, new materials are also (re)introduced as rock analogues. Emphasis has been on more precise measurements of the mechanical properties of the materials and on minimizing the preparation effects, which have a great impact on scaling, interpretations and benchmarking.

The analytical technique used to quantify model results has also seen a great deal of improvement. In addition to X-ray tomography used to visualise internal structures of models, new techniques (e.g. PIV, high-resolution laser scanning, and interferometry) have enabled monitoring kinematics with a higher precision.

Benchmarking exercises have given modelling an additional checking tool by outlining, in addition to the rheology of the modelling materials, the impact of different preparation approaches, the effect of boundary conditions, and the human factor on model results. However, despite the different approaches and deformation rigs, results of models of different tectonic laboratories have shown a great deal of similarities.

Even with the introduction of more sophisticated numerical codes and usage of more powerful computers which enable the simulation of more challenging material properties and combinations of those, and 3D model set-up, analogue modelling can still play a significant role both as a physical checking tool and a complementary technique. Additional fine-tuning takes enables the technique to take on more challenging tasks. However, the foundation of the technique is in its link to natural prototypes and that model results can only give some hints about a geologic process or structure. Sixty years ago, Ernest Cloos stated that "...Many interpretations would never have been published if the author had only once tried his suggested mechanism of folding or faulting in an experiment". He has also said that "... experimenting is a good deal of fun". Both statements do still hold!