Numerical simulation of critical mineral system geological processes

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The development of mineral systems involves the complex interaction between deformation, fluid flow, heat transport and chemical reactions. In order for geologists to test the influence of those processes and their interactions through "what if" scenarios, efficient simulation tools are particularly well suited. In particular, based on the Five Questions analysis for understanding mineral systems (Price and Stoker 2002), we know that understanding fluid flow is critical to the conceptual understanding of a system and advancing of our predictive capabilities. In this contribution we show how numerical simulation of hydrothermal ore-deposits provide an important tool for improving our understanding of fluid and other key processes which are active in mineral systems and for predicting the signatures of these deposits.

To do this we use numerical simulation at both ends of the hypothesis testing spectrum to cover: (1) the conceptual models to test singular fundamental physical behaviours of poorly-understood processes such as fluid flow through fault systems, or episodicity and periodicity related to deformation (Figure 1a) and (2) simulations incorporating multiple components (complex geometries, geological architecture, multi-physics, temperature and pressure dependent material properties, material property distributions) but with simplified underlying physics (Figure 1b). In this way we may account for a detailed understanding of a single phenomenon in some models or for more complex process interactions involving several phenomena but at a lower resolution.

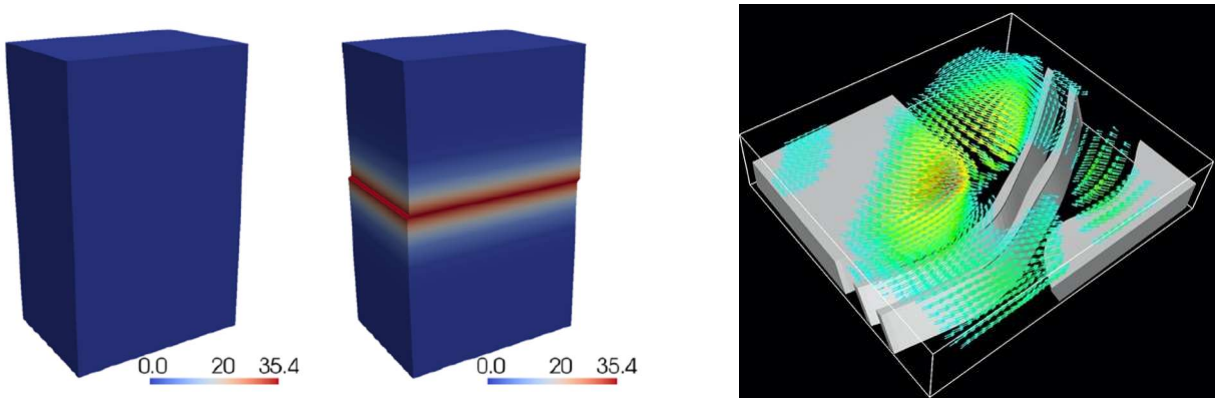

Figure 1. Examples of a) simple geometric simulations which focus on one detailed physical process and b) more complex geometrical models with coupling of a number of geologic processes

Currently we have the expertise to determine the necessary granularity and suitable inputs to the numerical models to capture the relevant driving process and test them with an adequate resolution (e.g. appropriate geometric complexity, number of geologic processes). To test tractable, identified hypotheses we welcome the opportunity to engage with industry to understand what geologic problems are critical for advancing their exploration efforts.

References

Price, G.P. and P. Stoker, 2002, Australian Geodynamics Cooperative Research Centre's integrated research program delivers a new minerals exploration strategy for industry. Australian Journal of Earth Science