Basin Genesis Hub a new ARC - Industrial Transformation Research Hub

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The Basin Genesis Hub (BGH) is an ARC Industrial Transformation Research Hub dedicated to the understanding of the formation and evolution of sedimentary basins and continental margins. BGH research innovation is based on the new opportunities offered by HPC-based numerical modelling.

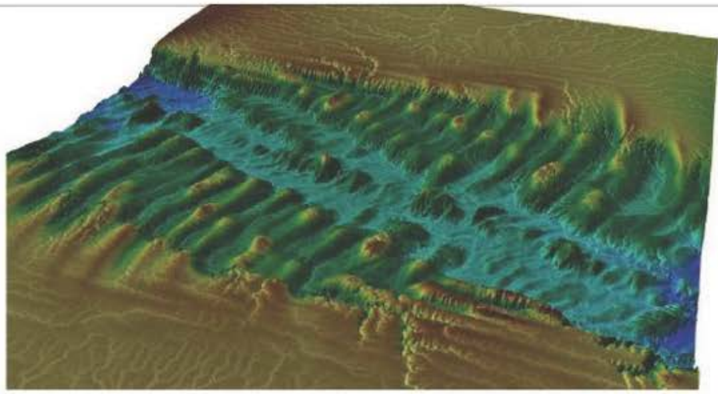
With supercomputers such as Magnus at the Pawsey Supercomputing Center in Perth, and Raijin at NCI (National Computational Infrastructure) in Canberra, 21th century high-performance computers have finally catch-up with 19th century physics, through the efficient implementation of mid-20 century numerical methods.

It is now possible to model the thermal and mechanical evolution of deforming lithosphere at a resolution high enough to capture the scale at which sedimentary basins form.

Written in the 1850's, the Navier-Stokes equations are the set of differential equations that describe the motion of fluid. They relate velocity gradients to pressure gradients and can be analytically solved only when considering simple, steady, laminar flow.

One hundred years later, with the advent of mainframe computers, the Navier-Stokes equations could be discretised and solved at the node of a numerical grid to explore the type of complex, time-dependent fluid flow we encounter in nature. As computers grew in power, so did the complexity of fluid flow problems that one can tackle.

In the late 1990's, computers become powerful enough to allow the implementation of a 1950's numerical method called the particle-in-cell (PIC) in which individual fluid elements



Example of digital landscape formed in a right-lateral pull-apart basin computed by coupling Underworld and Badlands.

carrying material properties and flow history are advected through a fixed computational grid.

For geologists, this progress meant that one could simulate the deformation of strongly mechanically layered systems such as the Earth's lithosphere; albeit in two dimensions.

Over the past decade, the growing availability of powerful high-performance computers has unleashed the power of computer-based modelling in all branches of Science. Geoscientists are now able to simulate in three-dimension, and using realistic coupled thermal and mechanical properties, lithospheric-scale deformation with surface processes evolving under various climatic regimes.

BGH is co-funded for 5-year by the Australian Research Council, Statoil, Chevron and Oil Search. It is lead by a group of Chief Investigators including Prof D. Müller, A.Prof P. Rey and Dr T. Salles at the The University of Sydney, Prof L. Moresi and A.Prof T. Rawlings at Melbourne University, Prof. C. Elders at Curtin University, and Prof. M. Gurnis at Caltech.

BGH research is powered by an innovative open source numerical infrastructure able to simulate the complex feedback between geodynamic, tectonic and surface processes involved in the formation and evolution of sedimentary basins. BGH digital workbench bridges a suite of open source codes, many developed through the NCRIS-Auscope program, including GPlates (for the interactive manipulation of plate-reconstruction and visualization of geodata through geological time), CitcomS (a spherical finite element code designed to solve compressible thermochemical global convection and its interaction with plate tectonic processes), Underworld (a Cartesian 3D-parallel coupled thermo-mechanical tectonic modelling framework, using a Lagrangian particle-in-cell finite element scheme), Badlands (BGH 3D finite element code to simulate surface processes and solve problems in relation to fluxes of sediments on an evolving landscape), and Obsidian (the NICTA toolbox to perform synthetic geophysics).

Working closely with its Industry Partners, BGH will deliver the next generation of predictive computer model of rift basins and continental margins. It will design innovative workflows to simulate and validate, via synthetic geophysics, the formation of sedimentary basins, and will deliver a 5D (space, time and uncertainty) Digital Atlas of adaptable models that can be fine-tuned to specific exploration targets.