



Research Highlight

Coupling mantle convection (ASPECT) to lithosphere and surface processes to understand North American tectonics

Dramatic topographic extension, an unparalleled suite of data from field observations and EarthScope, and well-constrained plate boundary evolution make the western United States a world-class natural laboratory for studying the thermomechanical processes of extensional collapse. The present-day Basin and Range province of Southwestern North America (SWNA) is the product of this complete period of extension. The extensional period is generally recognized to consist of an early phase in latest Eocene-Oligocene, in which metamorphic core complexes formed through evolution of low-angle normal faults that eventually exhumed highly sheared middle-crustal rocks (Bahadori and Holt, 2019).

In a pair of studies we model mantle flow using ASPECT (Advanced Solver for Problems in Earth's Convection) (see Figure 1a,b) and couple output stress field to a lithosphere model using UWG (Underworld Geodynamics) (Beucher et al., 2019) (see Figure 1c,e). The modeling incorporates non-linear visco-plastic behavior of the lithosphere, and it accounts for the weakening effects of crustal partial melting, and mantle flow related dynamic topography (see Figure 1c). Implementation of external forcings like upper crustal velocities, paleoclimate, and sea-level fluctuation drive landscape evolution in the Badlands code (Salles, 2016) including sedimentation and erosion, which feed back into the lithosphere model.

Our simulations for the SWNA result... [\[full article\]](#)

contributed by

Alireza Bahadori and Jackie Austermann, *Columbia University*

From HQ

Dear Community,

The fourth phase of CIG began on February 1, 2023, with support from the NSF Geoinformatics and Geophysics Programs. The new funding will enable CIG to meet the growing needs of communities in computational geodynamics and seismology, although the reduced budget will entail a shift in our priorities (more on this below).

The renewal of CIG was the outcome of a long process. Input gathered from the virtual “all-hands” workshop in 2021 and from a more focused developers’ workshop was influential in shaping our vision. Extended meetings of the Executive and Science Steering Committee also provided valuable input on specific questions about the future scope of CIG. Ultimately, the hard work fell to the Proposal Writing Committee: Wolfgang Bangerth, Sylvain Barbot, Ebru Bozdogan, Bruce Buffett, Rene Gassmoeller, Lorraine Hwang, Laurent Montesi, Max Rudolph, Marc Spiegelman, and Jolante van Wijk. This group spent many long hours discussing the general goals and specific activities to include in the proposal.

One of the interesting points of discussion was the extent to which the computational landscape had changed since the inception of CIG in 2005. The organization was founded as an early and ardent advocate for open-source software with the goal of creating scientific software that would be shared and extended by the entire community. From the beginning CIG has been at the forefront of the open-source revolution. In many ways CIG has helped to prepare the geodynamics community for the remarkable changes that have occurred since 2005. Moving forward the Proposal Writing Committee wrestled with the goal of sustaining CIG’s vital role in computational geodynamics. As a group we wanted to ensure the future relevance of CIG in the face of rapid changes in scientific computing.

Many of the activities included in the funded project are familiar ones to the CIG community. Our emphasis on education and training of the research community at all levels remains a high priority. We will continue to run user workshops and hackathons to build the community and foster more effective use of CIG software. We will also continue to support key developers to oversee the training and to coordinate community contributions to the software. However, with the available funding, we can no longer continue to support development of specific new capabilities in CIG software. Instead, new capabilities for important research questions will be funded partly through the disciplinary programs.

This change should alter the way disciplinary research proposals are reviewed. Arguments against funding projects with a software development component can no longer be justified on the grounds that these activities are supported by CIG. See more on [Collaborating](#) with us.

The renewal places greater emphasis computational infrastructure that extends across disciplinary boundaries. One of the priorities in Year 1 of a 5-year plan is to modernize the installation and distribution of scientific software. The use of container systems has been shown to be a viable option for installing and running ASPECT on TACC XSEDE clusters. Users on these NSF computing systems will need only 3 lines of instructions (activate container system, download container, run container), requiring less than 10 minutes from login to submission of their first job. We plan to extend this capability to other CIG software as we build on the experiences with ASPECT.

CIG will also continue its role as an established leader in best practices for software and will build on its record by implementing [FAIR4RS](#). To meet FAIR4RS, geoscientists will need help from experts to make their code openly available. By providing support to researchers, CIG can make a vast collection of new software models and tools more broadly accessible. One practical limitation in fully realizing this goal is the reduced size of the CIG staff in response to the level of funding. While our goals do not change, the pace at which these goals are achieved will certainly be affected.

Leadership by CIG also extends to our community engagement. Community building has been one of the great successes of CIG, and nothing in the next phase of CIG changes this. However, the pace of our plan to extend this outreach to promote justice, equity, diversity, and inclusion is liable to be reduced by budgetary restrictions. On the other the vision laid out in the proposal will be set in motion over the coming years. Each of us will have a part to play in realizing our goals.

One of the conclusions to be drawn from our collective efforts to renew CIG is that we will need to broaden the sources of funding for this enterprise in the future. The good news is that CIG has been enormously successful in advancing the capabilities of researchers in computational geodynamics. This capability will put the community in a good position to compete successfully for funds in cyberinfrastructure across the National Science Foundation and beyond.

We look forward to working with you as we move forward along with Rene Gassmoeller, *Technical Lead*; Mohamed Gouiza, *Project Scientist*; in developing new capabilities in education, training and software.

Bruce Buffet & Lorraine Hwang, *coDirectors*

News

2023 The Year of Open Science

The Office of Science and Technology Policy (The White House) has declared 2023 the [Year of Open Science](#) to advance open and equitable research, including new grant funding, improvements in research infrastructure, broadened research participation for emerging scholars and expanded opportunities for public engagement. Federal agencies are participating through a variety of actions. This includes the NSF GEO funding opportunity *Geosciences Open Science Ecosystem* ([NSF GEO](#)), NASA *Transform to Open Science* ([TOPS](#)), and the upcoming USGS Community for Data Integration Workshop (CDI) [Open Data for Open Science](#). See the [CENDI resource](#) to stay informed on [funding opportunities](#) across federal agencies.

Speaker Series

Do you know someone who would be a great ambassador for CIG research? The CIG Speaker Series is looking for talented speakers who can promote computational modeling in geodynamics and related earth sciences to a broad scientific audience. Open a [ticket](#) and include on the first line, "SPEAKER NOMINATION". More information for speakers and institutions looking for speakers can be found on our website. Deadline is February 28, 2023. [\[info\]](#)

Governance

Elections

Please join us in welcoming Louis Moresi, Marc Spiegelman, and Phaedra Upton to the Executive Committee (EC) and Adam Holt, Elvira Mulyukova, and Emmanuel Njinju to our Science Steering Committee (SSC). Many thanks to outgoing EC members Claire Currie, Bruce Buffet and Carolina Lithgow-Bertelloni for their leadership on the EC and SSC members Julianne Dannberg, Scott King, and John Naliboff for their contributions to the community as well as everyone who participated by running and voting in this year's elections.

Working Groups

CIG seeks to engage its community and encourage new ideas by seeking members interested in participating as a member of a current working group or starting a new Focused Working Groups (FWG). New FWG's should address a specific topic and have a clearly defined scope e.g., workshop, white paper, benchmark, etc. A WG should define concrete outcome(s) achievable within a short time frame, < 2 years. Anyone can propose one! We look forward to your ideas in continuing the CIG community's dynamic leadership in the Earth sciences. [\[apply\]](#)

Events

Fault Mechanics for Numerical Modeling Webinar Series ***NEW***

This webinar series highlights the recent discoveries in rock and fault mechanics from field observations and laboratory experiments that may inform and improve numerical models of the seismic cycles and short-term crustal deformation. The presentations cover advanced topics related to the importance of lithology, texture, and temperature on fault mechanics, the role of fluids in fault zones, and new observations on dynamic ruptures, foreshocks, and aftershocks in the laboratory. Isolating these effects in the laboratory and in the field will help the formulation of new constitutive laws for fault friction and the behavior of the surrounding rocks, allowing more realistic models.

First webinar Friday February 17 @1P PST

Hydrothermal friction experiments on simulated basaltic fault gouge and implications for megathrust earthquakes, Tamara Jeppson, USGS.
[\[more info\]](#) [\[register\]](#)

See our [calendar](#) for details on all events and registration.

A full listing of all webinars can be viewed by navigating to [Outreach > Webinars](#)

CIG Monthly Webinars

February 9 *Genesis of the El Laco magnetite-apatite deposits by extrusion of iron-rich melt: a modelling perspective*, Tobias Keller, ETH
***10A PST [\[more info\]](#) [\[register\]](#)

March 9 Chase Million, Million Concepts

April 13 Adina Pusok, Oxford University

May 11 SZ4D

CIG Monthly Webinars are the second Thursday of the month at 2P PT unless otherwise noted.

Workshops

June 11-17 PyLith Hackathon Golden, Colorado

June 12-16 Rayleigh Hackathon Golden, Colorado

July 6-15 ASPECT Hackathon Lincoln City, Oregon

Registration for Workshops will be announced as they become available.

Remember to join our [forum](#) to receive announcements for these and other 2022-2023 events.
