# Crustal Deformation Modeling Tutorial

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# Workshop Instructors

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# Overview of Workshop

Draft agenda posted on geodynamics.org

| Mon | Wed | Fri |
|---|---|---|
| Overview | Green's Fns: Overview | Fault Friction: Overview |
| CUBIT, PyLith, ParaView | Green's Fns: 2-D | Friction: Quasi-static |
| PyLith 2.0 & beyond | Green's Fns: 3-D | Friction: Dynamic |
| Q&A | Q&A | Q&A |
| Meshing 2-D | Solvers: Overview | Parallel: Desktop |
| Meshing 3-D | Linear Solvers | Parallel: Cluster |
| Cell Size | Nonlinear Solver | Troubleshooting |
| Q&A | Q&A | Q&A |

# Overview of Adobe Connect

## Sessions will be recorded and archived for on-demand playback

- Audio input/output
  - Participants microphones are muted by default
  - Type your questions in the Q&A panel and comments in the chat window.
  - We can unmute your microphone if necessary.
- Q & A Pod
  - Submit questions using this tool.
  - Adobe Connect tracks which ones have not been answered.
  - We will archive all of the questions and answers.
- Chat Pod
  - Useful for responding to instructors.

# Reliability of Adobe Connect

**WARNING**

We have had good experiences with Adobe Connect, but we do occasionally run into minor technical issues with audio due to variations in available bandwidth.

We will do our best to remedy any problems as quickly as possible.

# Getting Help

- Read the PyLith manual
- Try to work through the problem on your own
- Submit questions to `cig-short@geodynamics.org`
  - Describe the problem
  - Send complete error messages
  - Include the platform you are using, the PyLith version, and whether it is a binary package or you built PyLith from source
  - We will try to respond but may defer detailed responses to the next online session
- Subscribe to `cig-short@geodynamics.org`
  - Answers to most questions will be cc'ed to this email list
  - Short-term tectonics working group issues are posted here

# What is CIG?

## Computational Infrastructure for Geodynamics (`www.geodynamics.org`)

Objective: Develop, support, and disseminate software for the geodynamics community.

- Coordinated effort to develop reusable, well-documented, open-source geodynamics software
- Strategic partnerships with the larger world of computational science and geoinformatics
- Specialized training and workshops for both geodynamics and larger Earth-science communities

Underlying principle: Earth scientists need help from computational scientists to develop state-of-the-art modeling codes

# CIG: Institution-Based Organization

## Educational and not-for-profit organization

- **Open-organization**
  - Any institution seeking to collaborate on the development of open-source geodynamics software
  - No cost or size requirements
- Current members
  - 50 member institutions
  - 10 foreign affiliates
- NSF funding Jul 2010 – Jun 2015

# CIG Working Groups

## Organized by sub-disciplines

- Short-term tectonics
- Long-term tectonics
- Mantle convection
- Computational seismology
- Geodynamo
- Magma dynamics

# Short-Term Tectonics Working Group

**Objective**: Simulate crustal deformation across spatial scales from 1 m to $10^3$ km and temporal scales ranging from 0.01 s to $10^5$ years.

- Formed through efforts by Brad Hager and Mark Simons before CIG started
- Strong connection to SCEC Stress and Deformation through Time (SDOT) focus group
- Building connections with SCEC Fault and Rupture Mechanics (FARM) focus group

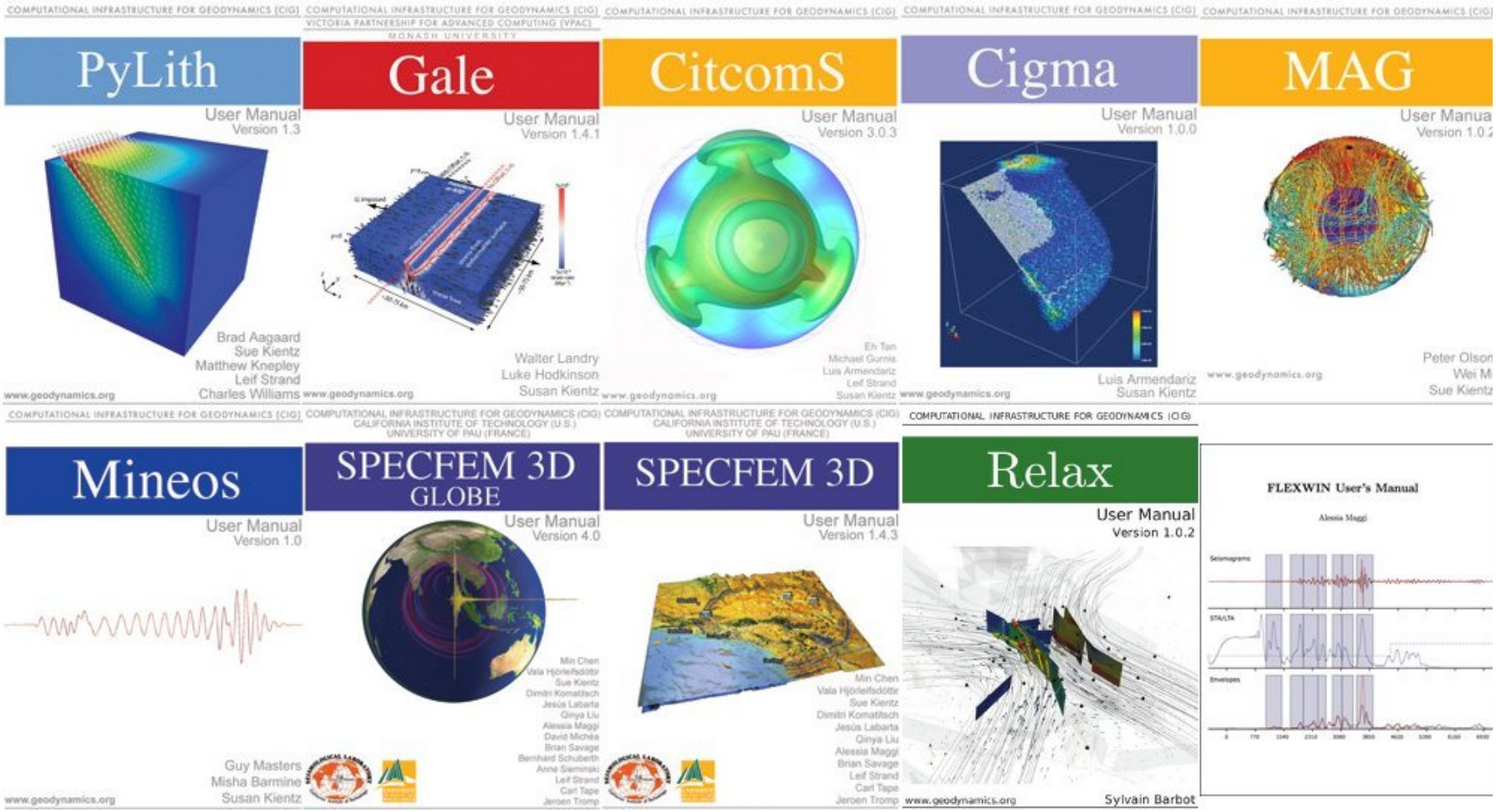
# CIG Organizational Structure

- Staff
  - Responsible for software development
  - Director handles day-to-day decisions
- Science Steering Committee
  - Voice of geophysics community
  - Prioritizes the competing needs of all sub-disciplines
- Executive Committee
  - Primary decision-making body
  - Approves SSC recommendations and contractual arrangements
- Member institution representatives
  - Vote on membership applications and bylaws
- Community members
  - Collaborate with staff to develop software

# CIG Activities

- Software development: primary activity
- Workshops
  - Sponsors workshops organized by one or more working groups
  - Holds workshops focusing on scientific computing and geodynamics
- Training in use of CIG software
  - Tutorials at workshops
  - Specialized training sessions (like this one)
- Web site: `geodynamics.org`
  - Distribution of software and documentation
  - Mailing lists for each working group
  - Wiki-like web pages for community involvement

# CIG Software



# CIG Software for Crustal Deformation

- Relax
  - Solves 3-D problems associated with earthquake faulting and quasi-static viscoelastic deformation
  - Short-term tectonics in a homogeneous half-space where geometry does not change significantly
- PyLith
  - Solves 2-D and 3-D problems associated with earthquake faulting and quasi-static and dynamic viscoelastic deformation
  - Short-term tectonics where geometry does not change significantly
- Gale
  - Solves problems in orogenesis, rifting, and subduction, including free surfaces with coupling to surface erosion models
  - Long-term tectonics where geometry changes significantly