Crustal Deformation Modeling Tutorial

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Workshop Instructors

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Objectives of Tutorials

- Learn more about numerical modeling of crustal deformation
- Increase the productivity and quality of your numerical models
- Progress along the CUBIT/Trelis learning curve
- Progress along the PyLith learning curve
  - Make simple changes to examples
  - Create a simple model of your research problem of interest
- Progress along the ParaView learning curve

Overview of Tutorials

Agenda posted on geodynamics.org

Mon	Tue
Overview	Faults
PyLith 3.0	Tinker Time
Meshing I	Gravity
Group Exercise	
	Tinker Time
Mats & BCs	Troubleshooting II
Group Exercise	Tinker Time
Troubleshooting I	Meshing II

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Getting Started

PyLith v3.0.0beta1 contains the examples we will be discussing

Download v3.0.0beta1 from `https://github.com/geodynamics/pylith/releases`

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
  - 61 member institutions
  - 15 foreign affiliates

CIG Working Groups

Organized by sub-disciplines

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

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Short-Term Tectonics Working Group

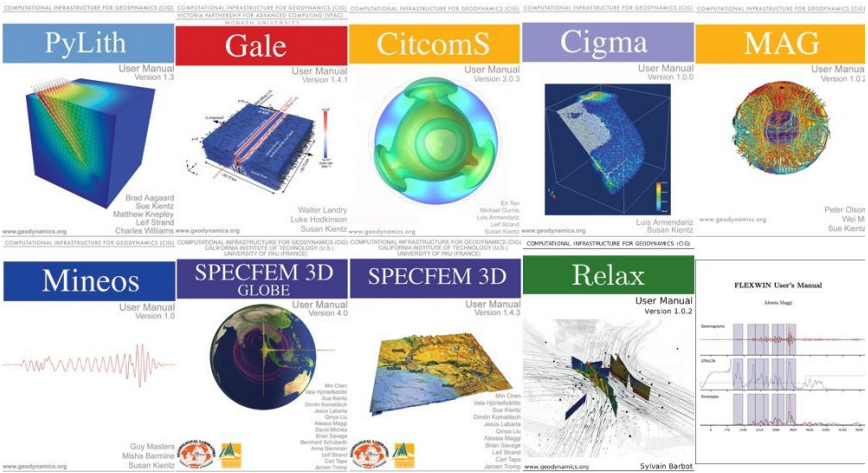
Objective: Simulate crustal deformation across spatial scales from 1 m to 10^3 km and temporal scales ranging from 0.01 s to 10^5 years.

- 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 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



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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 (obsolete) $\rightarrow$ Aspect
  - Solves problems in orogenesis, rifting, and subduction, including free surfaces with coupling to surface erosion models
  - Long-term tectonics where geometry changes significantly
- Virtual Quake
  - Boundary element code that simulates earthquakes on fault systems based on stress interactions

Logistics

Welcome to Golden!

- Meals
  - Breakfast and lunch are in Mines Market
  - Dinner is on your own
- All sessions are in this room
- Reimbursement: CIG and SCEC
- We are all visitors, please be respectful to our hosts!