CIG Long Term Tectonics Working Group

Current and Future Computational Geoscience Directions: Successes & Failures

Dennis L. Harry (*Colorado State University), Co-Chair*
Mousumi Roy (*University of New Mexico), Co-Chair*
Thorsten Becker (University of Southern California)
Todd Ehlers (University of Michigan)
Noah Fay (University of Arizona)
Ritske Huismans (Bergen University)
Carolina Lithgow-Bertelloni (University College, London)
Dietmar Muller (University of Sidney)
Patrice Rey (University of Sidney)
Jolante van Wijke (Los Alamos National Laboratory)

Primary LTT-WG CIG Codes

GALE – 2D & 3D FEM ALE code for modeling viscoplastic deformation of the lithosphere.

- Developed in-house by CIG
- Focus is on orogeny, rifting, and subduction
- Large strain solutions
- St. Germain infrastructure

PLASTI – 2D FEM ALE code for modeling viscoplastic deformation of the lithosphere.

- Developed at Dalhousie
- Use has primarily been orogeny & subduction
- Large strain solutions

SNAC – 2D & 3D FEM code for modeling elasto-visco-plastic deformation of the lithosphere, widely used in modeling rifting.

- Developed by Choi, Lavier, and Gurnis
- Use has primarily been rifting
- Large strain solutions
- St. Germain infrastructure
- Not volume/area balanced?

CitCOM – Not really LTT-WG code, but has a user base in our community.

LTT-WG History

Formed at 2007 AGU Meeting

Discussions to date have focused primarily on:

GALE –
- How to use it
- What to do with it
- How to promote it

Education –
- Inform community of code existence
- How to train community to use the code?

Documentation –
- Making codes more “readable”
- Making I/O more “geological”

Integration – Connecting lithosphere-scale modeling codes with
- Magma Dynamics
- Mantle Convection?
- Short Tem Tectonics?

CIG LTT SUCCESSES

Gale

Result of LTT community ideas generated at NSF 2005 Breckenridge Geodynamics Workshop

Numerous tutorial workshops (focusing mainly on how to run the cookbook examples)

CIG rapid responses to (as yet limited) user requests for help

Plasti

User base?

SNAC

User base?

Other

CIG has gently prompted LTT modeling community to get better organized and consider technical issues re: codes, repeatability of results, and clarity of methods.

CIG LTT FAILURES

Gale

- Use is very limited
  - Some technical issues
    - pressure oscilations
    - Slow UZAWA convergence
    - Some non-functional rheologies (users need to be warned!)
  - Easiest to fall back on our individual "known" codes
  - Difficulty in translating geology to/from GALE (difficult I/O interface)
- Community engagement in development has not materialized
  - Opaque code
  - Limited time for PI's to invest in getting involved in development
  - Lack of understanding of the St. Germain infrastructure
- Numerous tutorial workshops (focusing mainly on how to run the cookbook examples)
- CIG rapid responses to (as yet limited) user requests for help

CIG LTT OPPORTUNITIES

Incremental

- Solve technical issues
  - pressure oscilations
  - Slow UZAWA convergence
- Develop I/O “wrapper” scripts to connect geology to GALE computations
- Flow chart (CIG staff) and published examples (community)
- Track P-T-t paths (melting & metamorphic histories)
- Implement surface processes (erosion/deposition: CHILD, CASCADE)

Transformative

- Flexible boundary conditions
  - Vary with depth and spatially
  - Mass flux in/out of domain
- Couple GALE with Magma Dynamics codes
- Dynamic remeshing (preserving subdomain boundaries)
- Elasticity
- Physical properties that are P-T-t-{z} dependant (already implemented?)

CIG LTT-WG RECOMMENDATIONS

Action Plan

Focus first on technical issues (priority 1 – CIG)

Engage community to add features (priority 2 – CIG & LTT community)

1 or 2 day training sessions (not "how to use GALE", but sessions where users set up the problems they are working on and start "production" modeling). Develop associated manual.

Establish a "visiting scientist" program, allowing LTT researchers to spend 2-4 weeks at CIG working with Walter to implement geodynamically interesting features

Training sessions designed for modelers who wish to "improve" the code – perhaps a Developers Manual.