



DUE TUES

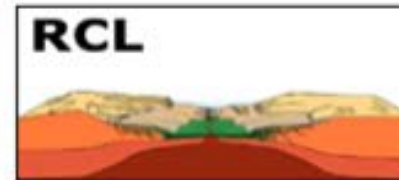
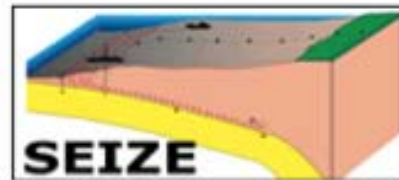
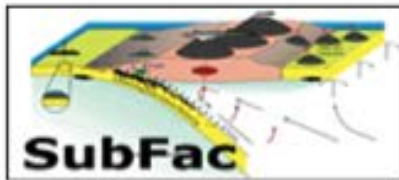
OCE & EAR



*Geodynamic Processes
at Rifting and
Subducting
Margins*

Incorporating Cutting Edge Scientific Results from the MARGINS-GeoPRISMS Program into the Undergraduate Curriculum: An Overview

*Julia Morgan, August Costa, Andrew Goodliffe, Jeff Marshall,
Ellen Iverson & MARGINS Mini-Lesson Development Team*



Website: <http://serc.carleton.edu/margins>

E-mail: morganj@rice.edu

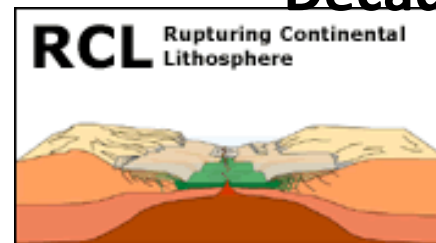
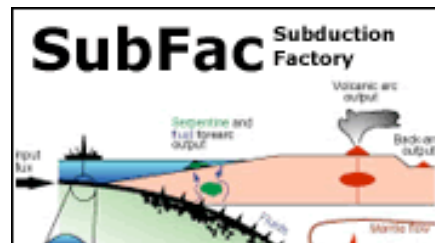
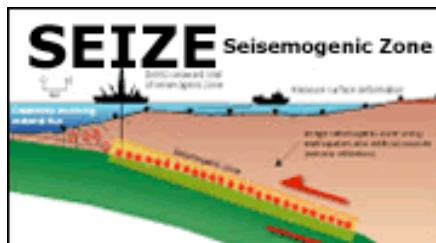
NSF MARGINS Program (<2000-2010)

- *"to understand the complex interplay of processes that govern continental margin evolution globally"*
- **Main Principles**
 - *Focus on rifts and subduction zones*
 - *Cross the shoreline (& NSF divisions)*
 - *Explore active processes & margins*
 - *Interdisciplinary investigations*
 - *Integrate field lab, theory & modeling*
 - *Concentrate resources at Focus Sites*

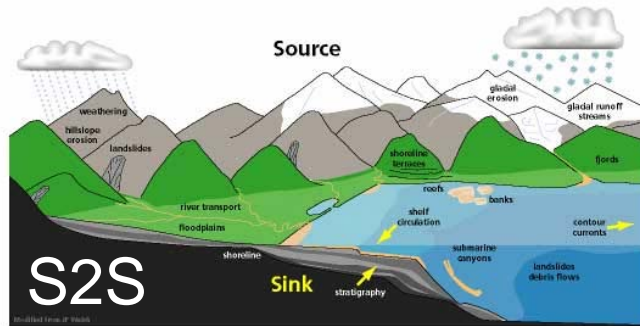


www.nsf-margins.org

- **Four interdisciplinary initiatives.**
- **Science questions based on community workshops.**
- **MARGINS Science Plan**
- **Decadal Review (2009)**



MARGINS Initiatives & Focus Sites

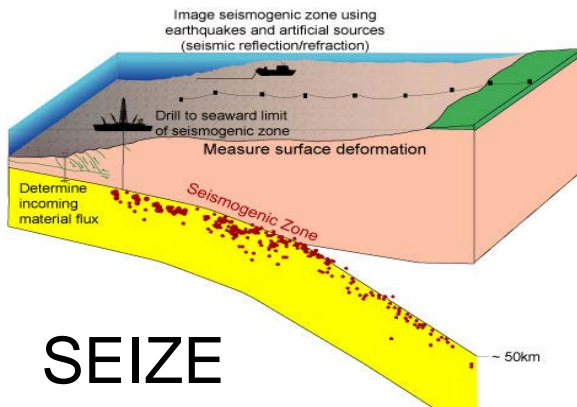


Sediment Source-to-Sink

- Production, transport & storage of sediments & solutes from source to sink

Gulf of Papua

Waipaoa, N.Z.



Seismogenic Zone

- Nature and genesis of large subduction-zone thrust earthquakes and the faults that make them

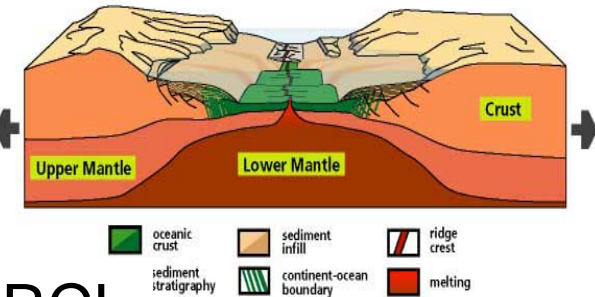
Nankai

Central America

MARGINS Initiatives & Focus Sites

Rupturing Continental Lithosphere

- Driving forces for rift initiation, propagation and evolution, from continent to ocean basin



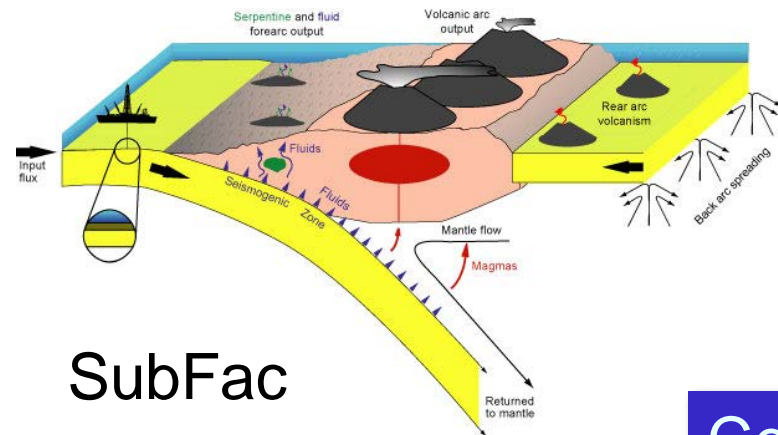
RCL

Gulf of California/Salton Trough

Allied: Red Sea

Subduction Factory

- The cycling of material, fluids, and energy from trench to arc and deep earth; growth of continents



SubFac

Central America

Izu-Bonin-Mariana

Allied: Cascadia, Aleutians

Pre-Existing MARGINS Mini-Lessons

(<http://serc.carleton.edu/margins/collection.html>)

2006 NSF CCLI (Abers)

- Train undergraduates using cutting edge scientific results.
- Yielded ~30 ready-to-use mini-lessons spanning MARGINS science.
- **Issues:**
 - *Levels of completion, review, testing, etc.*
 - *Gaps in content.*

2012 NSF TUES (Morgan)

- Opportunity to expand the collection & synthesize MARGINS results.



MARGINS Data in the Classroom > Mini-Lesson Collection

Margins Mini-lesson Collection

What are Mini-Lessons?

Mini-Lesson Collection

Submit a Mini-Lesson

Provide Feedback on Mini-Lessons

Education Planning Meeting 2009

Summer 2009 Webinar

2009 Workshop

2007 Workshop

MARGINS Project Home

Results 1 - 10 of 32 matches

Testing plate tectonics in the Gulf of California
Paul Umhoefer Northern Arizona University
This is a simple exercise to use real-world data from recent large earthquakes so that students can "test" for themselves if plate tectonics "works" in the Gulf of California.

The Woodlark Basin as a Natural Laboratory for the Study of the Geological Sciences
Andrew M. Goodliffe, University of Alabama
This activity guides the students through a set of geological problems related to the Woodlark Basin, Papua New Guinea.

Chemical Inputs and Outputs at Subduction Zones
This page is authored by Karin Block, Lamont-Doherty Earth Observatory of Columbia University
Related Links
Provide feedback on this mini-lesson
In this exercise students utilize data from geochemistry databases to analyze inputs and outputs associated with arc volcanism.

What Can (and Cannot) Be Learned from Scientific Drilling Using Examples from Margins Initiatives
Rosemary Hickey-Vargas Florida International University using many Margins and ODP images and one animation from the Carleton SERC website
This is a lecture segment that could be introduced to an introductory geoscience class to help explain and demonstrate what can and cannot be found out by scientific drilling.

Narrow the View

Subject: Geology

- Geophysics [3 matches](#)
- Geochemistry [4 matches](#)
- Mineralogy [2 matches](#)
- Structural Geology [1 match](#)
- Igneous and Metamorphic Petrology [10 matches](#)
- Sedimentary Geology [6 matches](#)
- Geomorphology [7 matches](#)
- Tectonics [12 matches](#)

Resource Type: Activities

- [10 matches](#) General/Other
- Problem Set [3 matches](#)
- Classroom Activity [16 matches](#)
- Lab Activity [15 matches](#)

Grade Level

- Middle (6-8) [1 match](#)
- High School (9-12) [1 match](#)
- College Lower (13-14) [26 matches](#)
- College Upper (15-16) [13 matches](#)
- Graduate/Professional [1 match](#)

MARGINS Initiative

- RCL [8 matches](#)
- S2S [4 matches](#)
- Seize [8 matches](#)
- SubFac [17 matches](#)

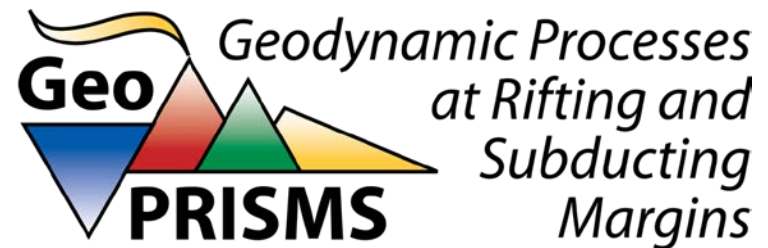
Motivation for this Project

- **Strong support from the **Decadal Review Committee****
 - *Enhance upper-level undergraduate education.*
- **Unique opportunity/obligation to synthesize and bring the landmark science of the last decade into the undergraduate curriculum using state of the art teaching practices.**
 - *Review highlights of a decade+ of MARGINS results in four initiatives; how they have **changed our understanding** of continental margins.*
 - *Enable **student encounters** with scientific data & research results.*
 - *Teach **critical thinking** and the **scientific process**.*
- **Combine the best science with the best educational practice**
 - *Scientific expertise of MARGINS (and GeoPRISMS).*
 - *Educational expertise of **On the Cutting Edge**.*
- **Team-based curriculum development process**
- **Explicit plan for field testing, refinement, and assessment**

MARGINS Mini-Lesson Project Leads

MARGINS Mini-Lesson Project Team

- *Julia Morgan, Former GeoPRISMS Chair & GEAC Member (Rice University)*
- *August Costa, GeoPRISMS Education & Outreach Coordinator (Rice University)*
- *Ellen Iverson [and Cathy Manduca, GEAC Member] (SERC, Carleton College)*
- *Andrew Goodliffe, Former GEAC Member (University of Alabama)*
- *Jeff Marshall, GEAC Member (Cal Poly Pomona)*
- *Jenn Beck (EvalArts Consulting)*



Science Team Leads

- *SubFac: Bob Stern (U. Texas Dallas)*
- *SEIZE: Casey Moore (UCSC)*
- *RCL: Becky Dorsey (U. Oregon) > Scott Bennett (USGS)*
- *S2S: Steve Kuehl (VIMS) & Lonnie Leithold (NCSU)*



MARGINS Mini-Lesson Devpmt Teams

Applications solicited from MARGINS, GeoPRISMS, & On the Cutting Edge

- **Subduction Factory (SubFac): Chemical cycling in subduction zones**
 - *Robert Stern <rjstern@utdallas.edu> (U. Texas, Dallas) - Science Team Lead*
 - *Ben Edwards <edwardsb@dickinson.edu> (Dickinson College) - Curr. Specialist*
 - *Sarah Penniston-Dorland <sarahpd@mail.umd.edu> (U. Maryland) – GEAC & GSOC member*
 - *Chris Kincaid <kincaid@gso.uri.edu> (U. Rhode Island)*
- **Seismogenic Zone Experiment (SEIZE): Seismogenic zone processes at subd. zones**
 - *Casey Moore <casey@ucsc.edu> (UC Santa Cruz) - Science Team Lead*
 - *Jeff Marshall <marshall@csupomona.edu> (Cal Poly Pomona) - Curr. Specialist (and Project Team)*
 - *Eliza Richardson <eur10@psu.edu> (Penn State University)*
 - *David Pearson <peardavi@isu.edu> (Idaho State University)*
- **Rupturing continental lithosphere (RCL): Rifting processes and feedbacks**
 - *Rebecca Dorsey (U Oregon) > Scott Bennett (USGS) - Science Team Leads*
 - *Andrew Goodliffe <amg@ua.edu> (U. Alabama) - Curr. Specialist (and Project Team)*
 - *Jack Loveless <jloveles@smith.edu> (Smith College)*
 - *Lisa Lamb <malamb@stthomas.edu> (University of St. Thomas)*
- **Source to sink sediment cycling (S2S): Sediment erosion, transfer, and deposition**
 - *Steve Kuehl <kuehl@vims.edu> (Virginia Inst. Marine Science) - Co-Science Team Lead*
 - *Lonnie Leithold <elleitho@ncsu.edu> (N. Carolina State University) - Co-Science Team Lead*
 - *Kathleen Surples <ksurples@trinity.edu> (Trinity University) - Curr. Specialist*
 - *Adam Hoffman <AHoffman@dbq.edu> (University of Dubuque)*

MARGINS Mini-Lesson Devpmt Teams

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– Adam Hoffman <AHoffman@dbq.edu> (University of Dubuque)

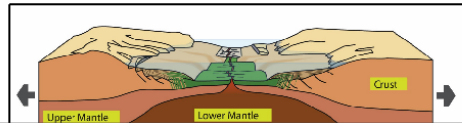
MARGINS Highlights Webinars

[\(<http://serc.carleton.edu/margins>\)](http://serc.carleton.edu/margins)

- February 28, 2013 - **Rebecca J. Dorsey** (University of Oregon), *A Decade of Research Findings about Rupturing Continental Lithosphere (RCL)*
- March 4, 2013 - **Lonnie Leithold** (North Carolina State University), *A Decade of Research Findings about Source to Sink Research (S2S)*
- March 5, 2013 - **J. Casey Moore** (University California, Santa Cruz), *A Decade of Research Findings about the Seismogenic Zone Experiment (SEIZE)*
- March 13, 2013 - **Robert J. Stern** (University of Texas at Dallas), *A Decade of Research Findings about Subduction Factory Studies (SubFac)*

Science Highlights of the RCL Initiative

Rupturing
Continental
Lithosphere



RCL

MARGINS Highlights Webinars

The overriding accomplishment

S2S

(Feb-Mar 2013)

Brought together expertise typically held in different communities of scientists to build unprecedented understanding
Broadcast a continental margin sediment

Chester et al.,
Nature, submitted

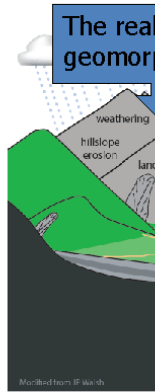
IODP Rapid
Response: JFAST
Exp. 343

SEIZE

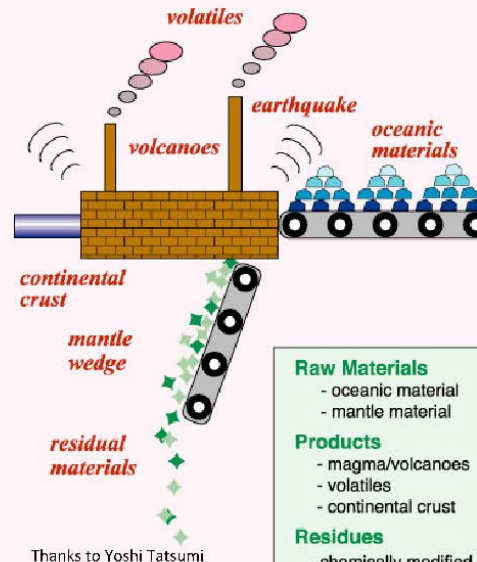
GAME CHANGERS

about continental

1. **Structural Evolution** (a) continental collision); (b) microcontinent collision
2. **Pre-Rift Magmatic Evolution** (a) magmatism. Less than expected (not localized). This is a new type of magmatism
3. **Role of Sediments** (a) control on rift process; (b) Includes critical link between crust and mantle
4. **New Type of Crust** (a) heavily sedimented; (b) Fundamentally different



The Subduction Factory



The MARGINS "Subduction Factory" experiment addressed 3 questions:

1. How do important variables (e.g., convergence rate, sediment thickness, age of subducted plate) control arc magma compositions?
2. How are volatiles (such as H₂O and CO₂) cycled through subduction zones?
3. What are the processes and rates by which subduction zones generate new continental crust?

SubFac

- Up to 45 attendees each
- Undergrad classes & International participants
- Now available as webcasts

<http://serc.carleton.edu/margins>

Very Large Slip

Virtual Workshop 1

*Jeff Ryan (USF, former MEAC, MSC, NSF) on
“Effective Mini-Lesson Design”*



A Successful Mini-Lesson built from NSF-MARGINS science results will:

- Address content that is both important scientifically, AND relevant in the context of an undergraduate geoscience curriculum.
- Be inquiry-based, supporting student investigations of data as a means to learning, and fostering the development of visualization/interpretive skills.
- Include clear and tractable methods for student learning assessment.
- Be self-contained and readily transportable and transferrable into different classrooms settings and constraints.

[Retrospectively: It should get used by more than those on its development team...!]

Attendees (18)

- Hosts (2)
 - Kristin O'Connell
 - Kristin O'Connell 2
- Presenters (2)
 - Jeffrey Ryan
 - Juli Morgan
- Participants (14)
 - Adam Hoffman
 - Andrew Goodliffe
 - Becky Dorzey
 - bob stern
 - Casey Moore
 - Dave Pearson
 - Eliza Richardson
 - Jack Loveless
 - Jeff Marshall
 - Jen Beck
 - Kathy Surpluss
 - Lisa Lamb
 - Sarah Penniston-Dorland
 - Steve Kuehl

Chat (Everyone)

Kristin O'Connell 2: To call in: 1-800-704-9804, access:397 5 354
Adam Hoffman: i'm here as well.
Lisa Lamb: i'll be in and out checking on my lab...my TA is down there now
Lisa Lamb: yes
bob stern: whats a rubric?
bob stern: ah! a scoresheet!

Jeff Marshall is typing...

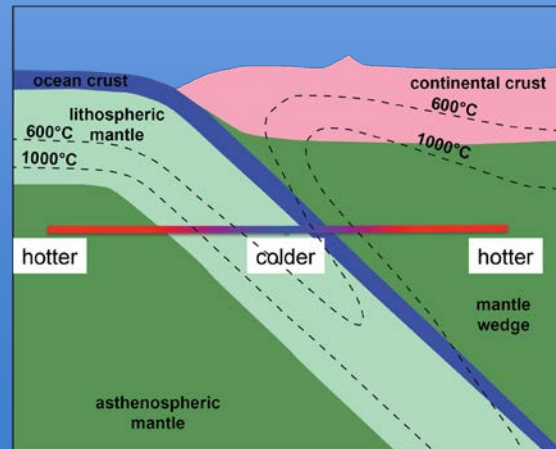
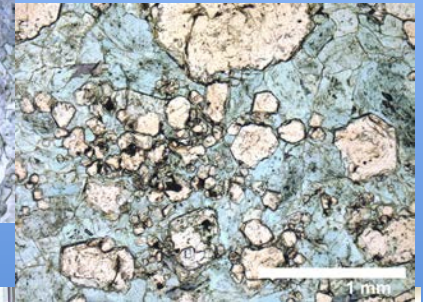
Everyone

Mini-Lessons Suites

http://serc.carleton.edu/margins/lesson_descript.html

SubFac

- Subduction zone metamorphism
- Central American arc volcanoes: Petrology and geochemistry
- Slab temperature controls on melting in subduction zones
 - Part I. Conductive heat transfer
 - Part II. Advective heat transfer

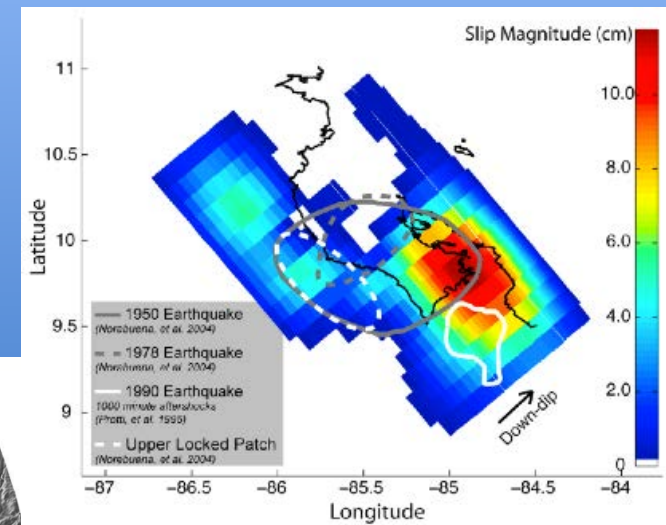
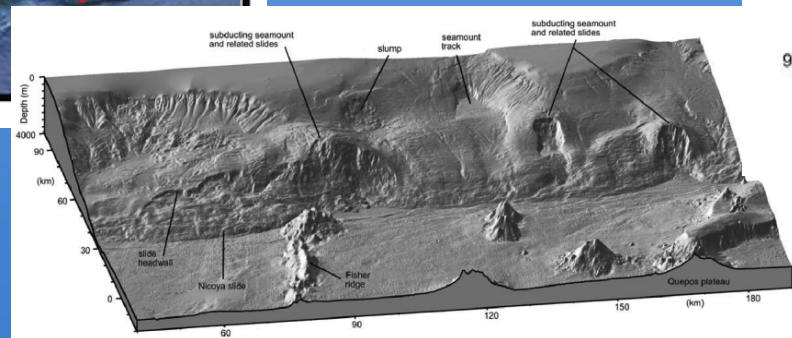
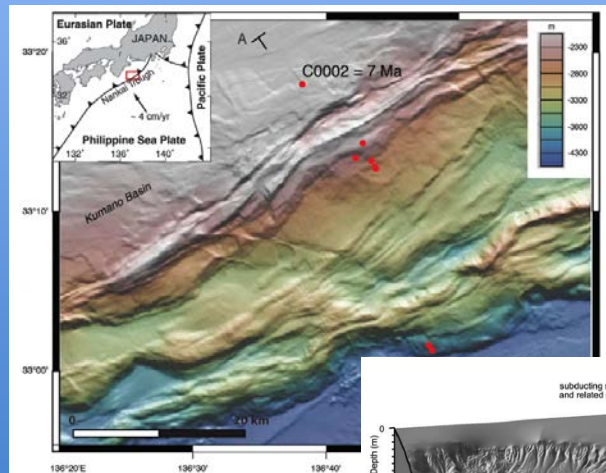


Mini-Lessons Suites

http://serc.carleton.edu/margins/lesson_descript.html

SEIZE

- Overview and Context
- Accretionary vs. Erosive Subduction Margins
- The Spectrum of Fault Slip
- The Plate Boundary Fault of the 2011 Tohoku Earthquake: Oceanic Provenance and Earthquake Genesis

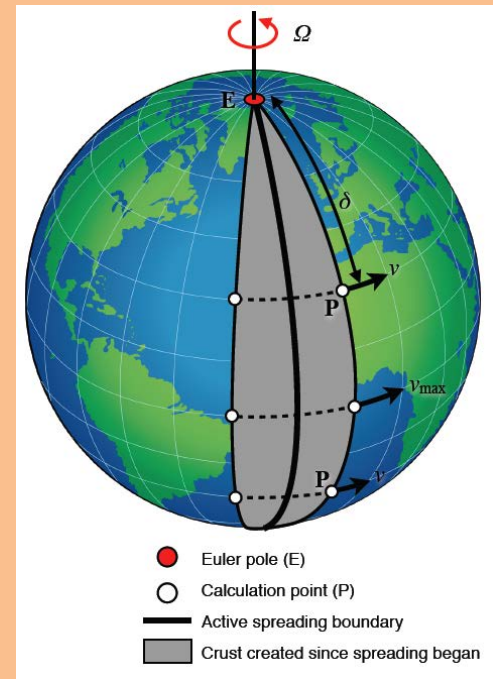
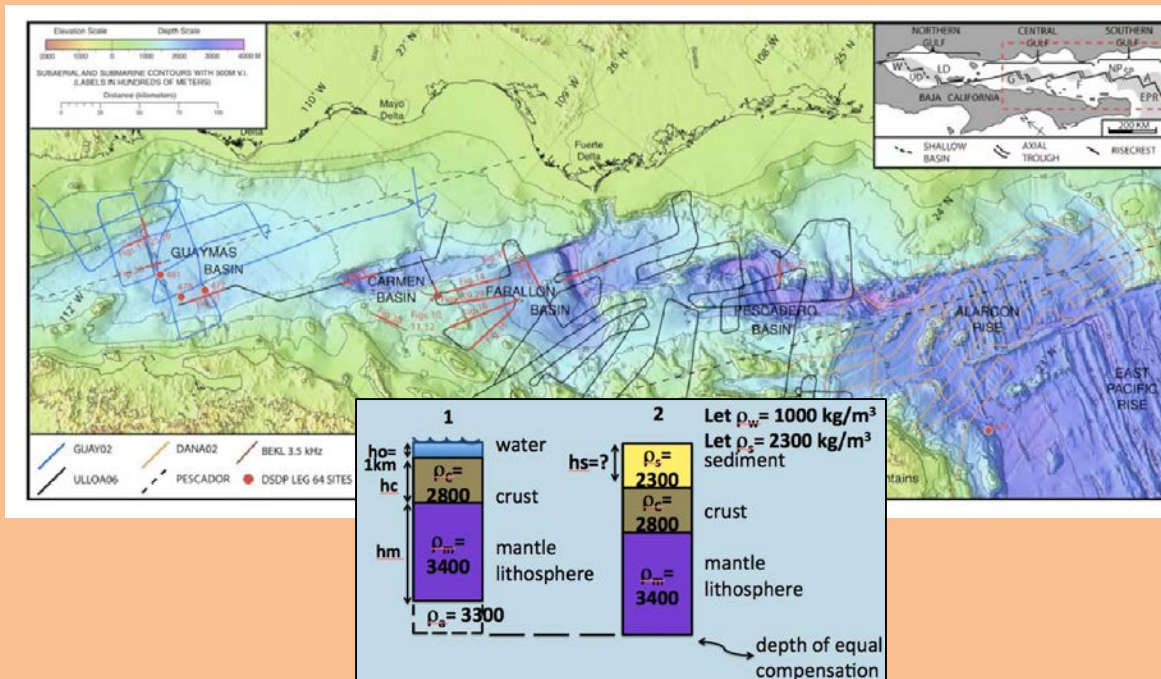


Mini-Lessons Suites

http://serc.carleton.edu/margins/lesson_descript.html

RCL

- Introduction - Overview & context
- Bathymetry of rifted margins
- Exploring styles of extension in the Gulf of California
- Interactions between tectonics and sedimentation
- Oblique spreading and rift morphology

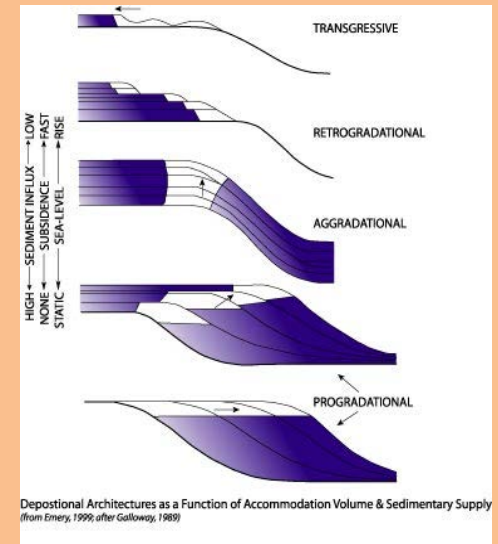
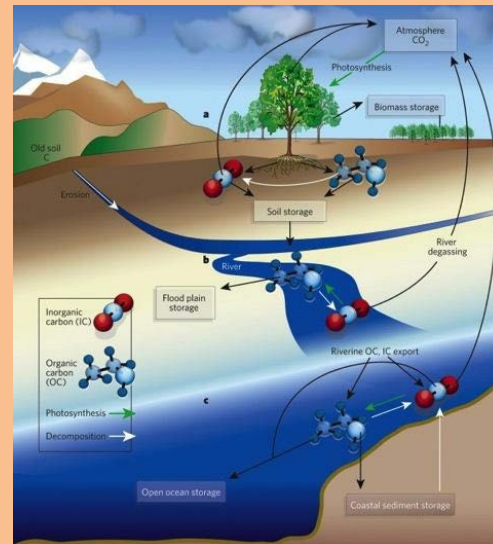


Mini-Lessons Suites

http://serc.carleton.edu/margins/lesson_descript.html

S2S

- Overview & Context: From source to sink: How sediment reflects the journey from the mountains to the sea
- Sediment dispersal and continental margin stratigraphy
- Contemporary climate oscillations: ENSO & case study of Huanghe River
- Holocene Optimum: A time of massively increased sediment discharge for Asian Rivers
- Sediments and carbon burial on the continental margins



Depositional Architectures as a Function of Accommodation Volume & Sedimentary Supply
(from Emery, 1999; after Galloway, 1989)

Finally

**Many, many heartfelt thanks to the entire
MARGINS Mini-Lesson Development Team!
As well as all users!**

**(Let us know what you
think, and if you want
to contribute to the
collection.)**



Process & Timeline (2013-2014)

- **Construct initiative-based development teams - 2 yr terms**
 - *Science team lead* and *curriculum expert* on each team.
 - Applications from MARGIN / GeoPRISMS & On the Cutting Edge.
 - **Breadth in expertise**, some overlapping interests among teams.
 - Balance of research and education roles.
 - Oversight by **project team** (PIs and SERC advisers).
- **Two year (and a bit) timeline**
 - *Introductory Webinar Series (Feb-Mar 2013)*
 - *Virtual Workshop for initial development phase (Mar-Apr 2013)*
 - *Outline & scope out potential mini-lessons; virtual check-in (Sum 2013)*
 - *Workshop to solidify mini-lessons, intro to pedagogy (Sept 2013)*
 - *Initial development of mini-lessons (Fall 2013)*
 - **Classroom testing & assessment (AY 2013-2014 and beyond)**
 - **Cross-team mini-lesson reviews**
 - *Refinement of mini-lessons (concurrent with field testing)*
 - *Workshop to complete mini-lessons, define steps forward (Sep 2014)*
 - *Mini-lesson finalization & dissemination (Oct-Dec 2014)*