Reducing Misconceptions through Lecture Tutorials and ConcepTests

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Early Career Geoscience Faculty Workshop
Monday, June 11, 2012
Teaching Strategies 2:20-3:10

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Why do we care about misconceptions?

[The frog] told the fish about the birds, who had wings, and two legs, and many, many colors.

From
Fish is Fish
by Leo Lionni

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Why do we care about misconceptions?

From
Fish is Fish
by Leo Lionni

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Why do we care about misconceptions?

"… in 15 years… it had never occurred to me that students believe that pebbles grow."

(Kusnick, 2002)

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Why do we care about misconceptions?

"The lava comes up through hotspots and it forms basalt when it cools…"

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Why do we care about misconceptions?

"The lava comes up through hotspots and it forms basalt when it cools…

Upon further questioning…

… Basalt is made from sediments. Sediments form in the core, are brought to the surface by hotspots, then mold together to form the rock basalt."

Kortz & Murray (2009)

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What are misconceptions you've encountered with your students?

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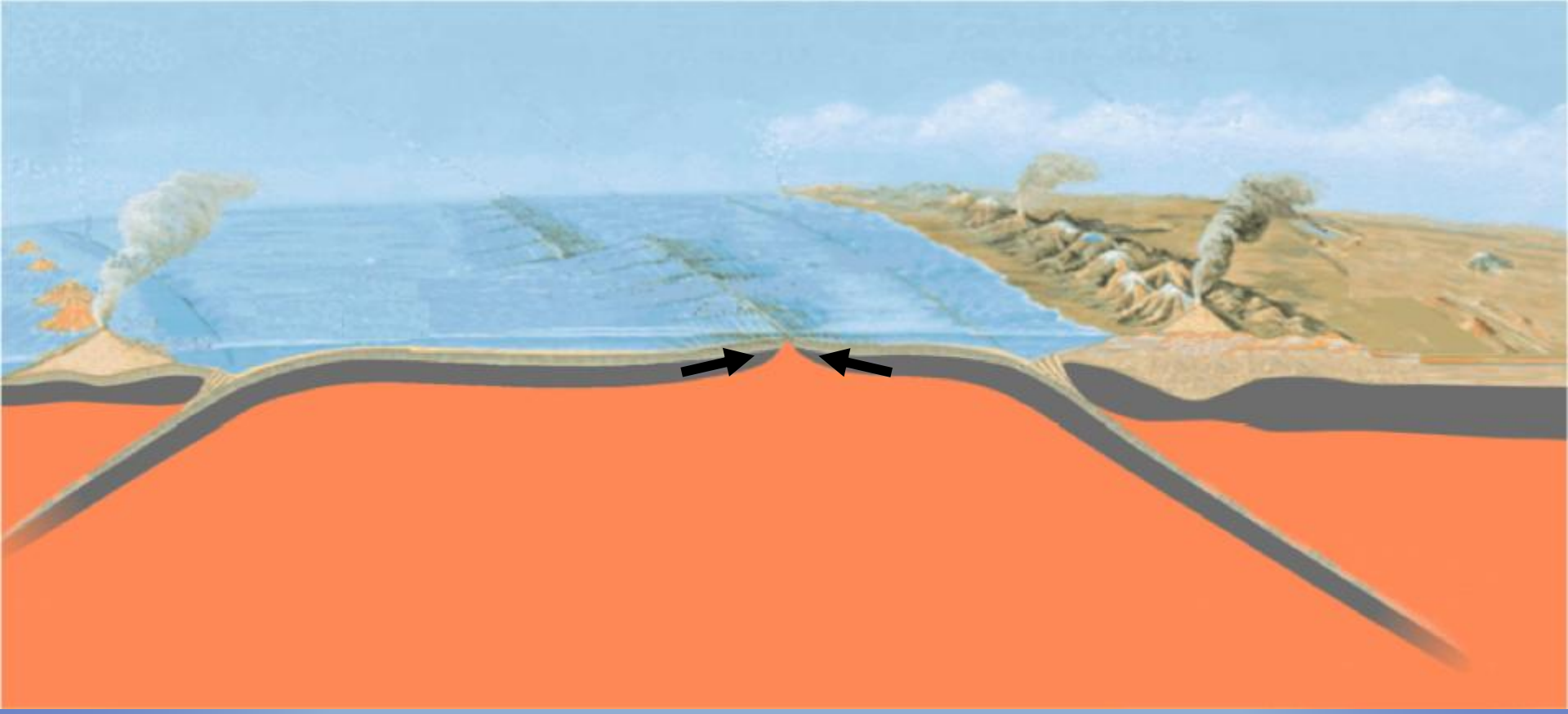

One-quarter of students show plate coming together at divergent boundaries

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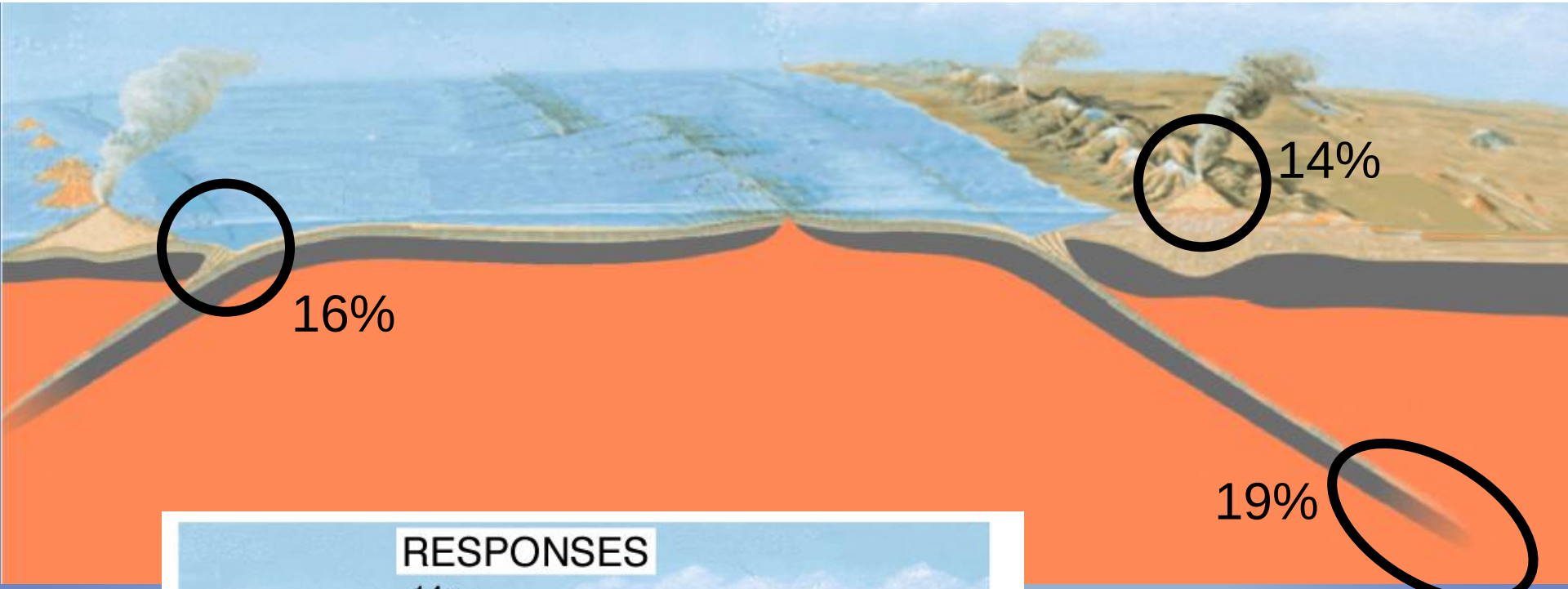
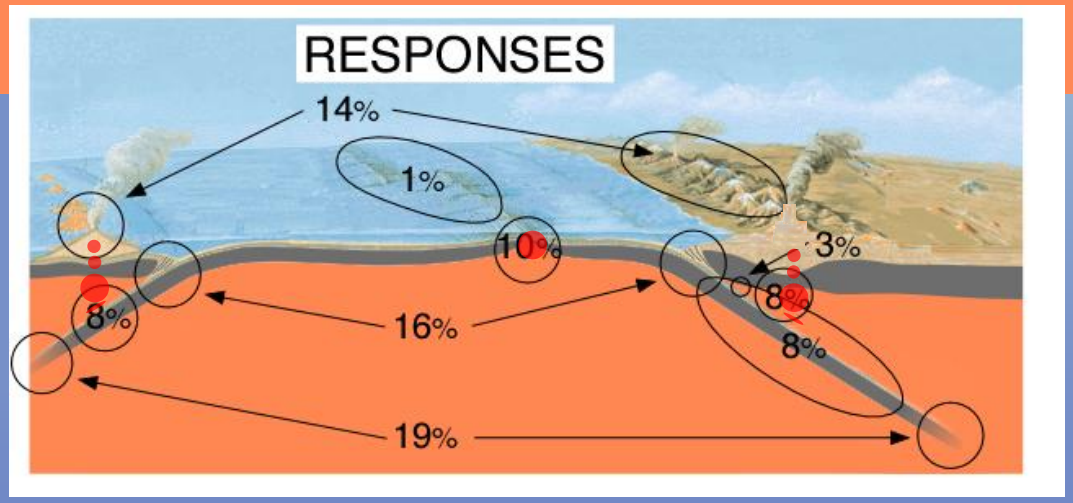
The 3 most common locations students circled to indicate where rock melts to become magma that feeds volcanism.





Questionnaire responses from novices

Clark et al. (2011)

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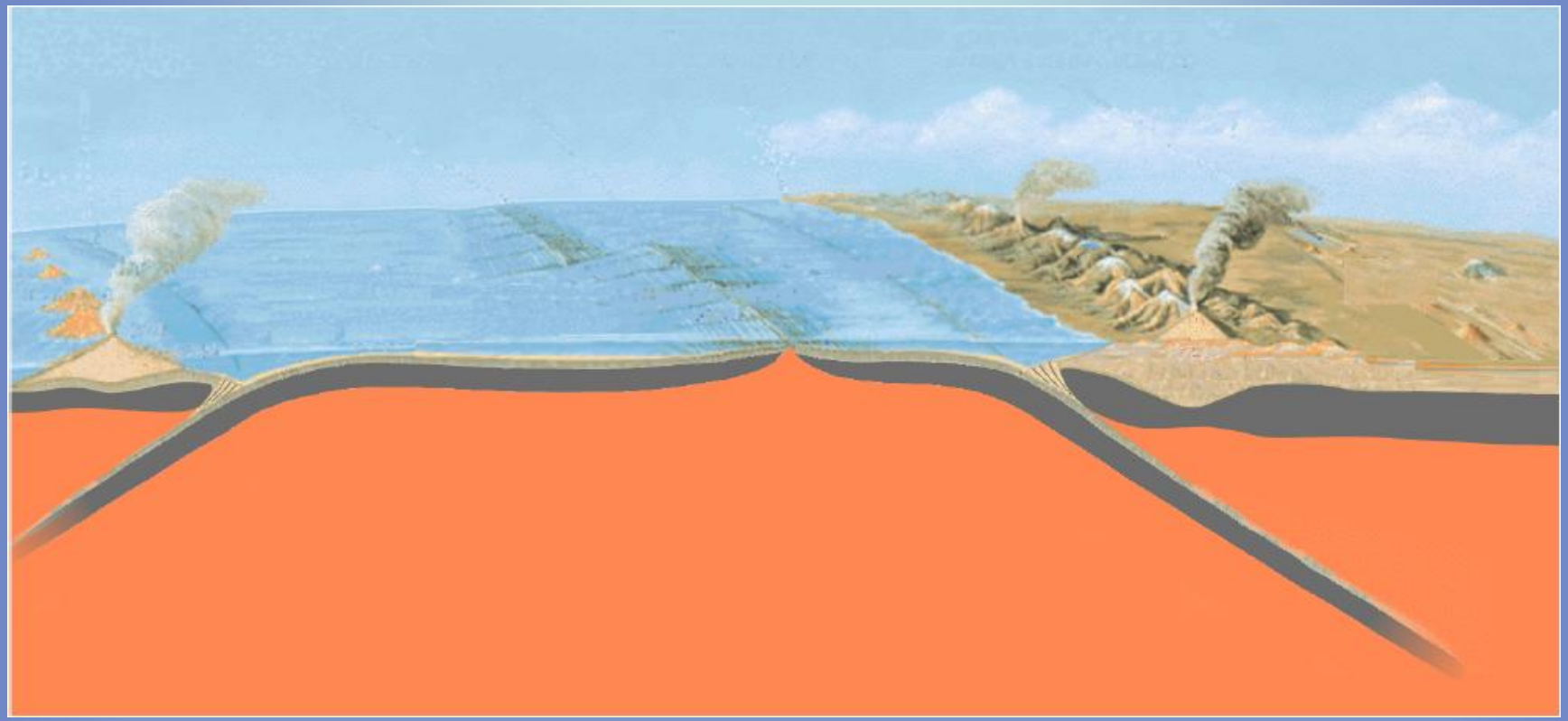
How Many Plates Are Present?



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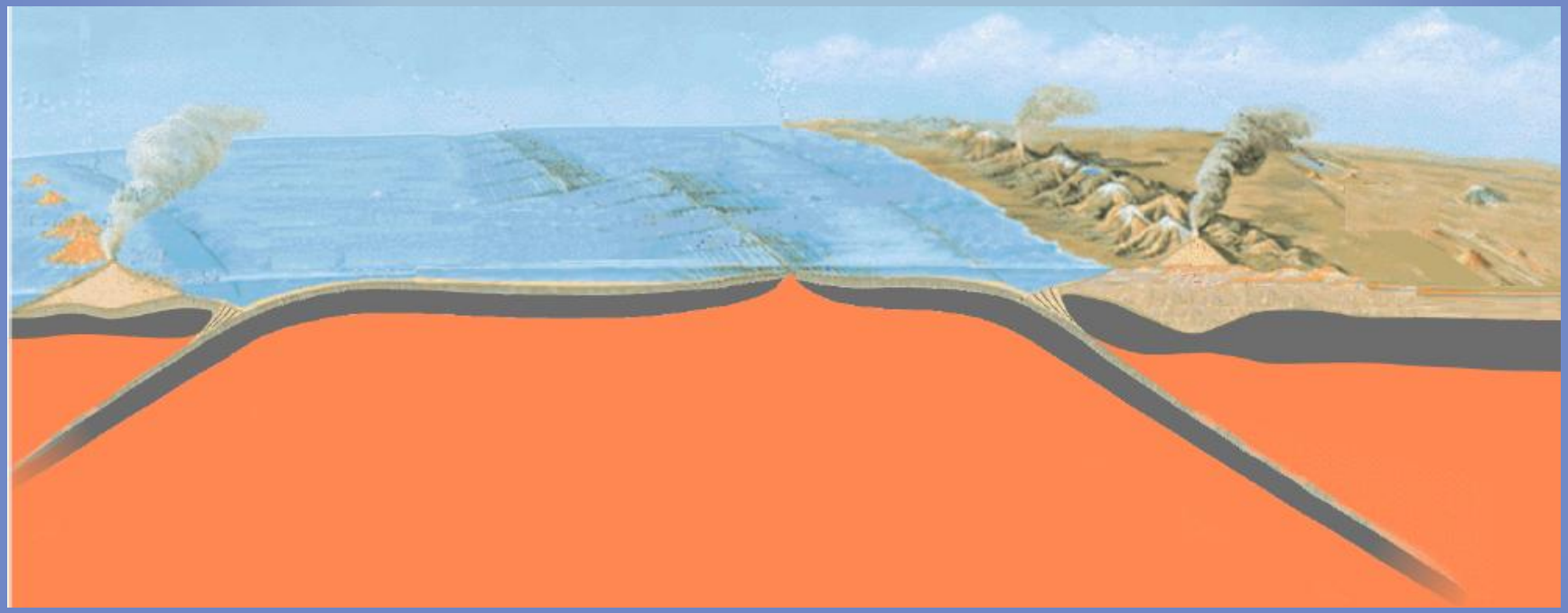
How Many Plates Are Present?

Student Responses:

2	3	**4**	5	6
13%	51%	**29%**	2%	1%



Kortz et al., 2011

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Example Misconceptions about Rocks

- Igneous rocks are not the result of magma crystallizing
- Sedimentary rocks form at or directly beneath Earth's surface
- Pieces purposely gather to form rocks
- Black rocks = igneous

Kortz and Murray 2009

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For More Info: Misconceptions

- How People Learn: Brain, Mind, Experience, and School, NRC, 2000
- Sept 2005 issue of the Journal of Geoscience Education (http://nagt.org/nagt/jge/issues.html)
- Clark S.K. et al. (2011) Alternative Conceptions of Plate Tectonics held by Non-Science Undergraduates. JGE, 59, p. 251–262.
- Kortz K.M. and D.P. Murray (2009) Barriers to college students learning how rocks form. JGE, 57, p. 300-315.

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Problem:

Students have misconceptions about basic geologic concepts, and lecture doesn't do a good job changing them.

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Solution:

Use research-informed, student-centered, interactive methods.

Such as…

Lecture Tutorials and ConcepTests

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Lecture Tutorials

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Lecture Tutorials

- Worksheet students complete in pairs after a short lecture
- Written to combat misconceptions and difficult topics
- Starts with basic questions and works towards more application-type questions

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Using Lecture Tutorials

- Professor lectures for a short time
- *Optional*: Students are posed a conceptually challenging question on the lecture material
- The class breaks into teams of two/three and work through the Lecture Tutorial worksheet
- Professor “debriefs” the activity highlighting the common problems
- *Optional*: Students are posed a similar question as before
- Professor returns to lecture mode

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Lecture Tutorial Example

- Form groups of 2 or 3.
- Complete the Lecture Tutorial titled “Movement at Convergent Boundaries”.
- *Ask questions and pretend you are a student…

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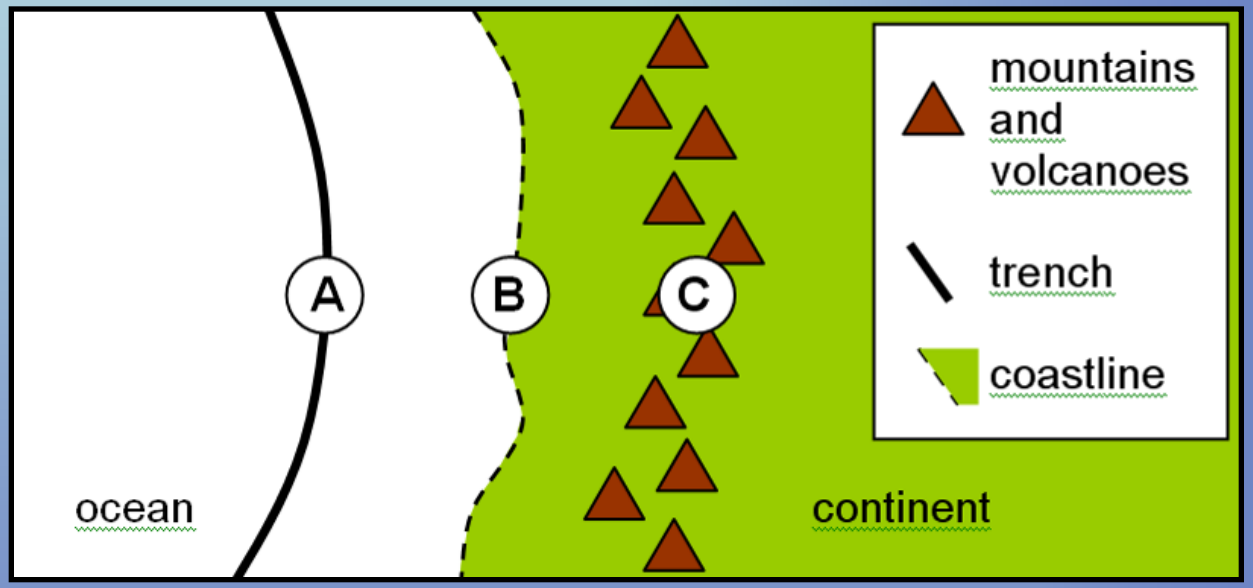
Movement at Convergent Boundaries

On the map, which two letters will eventually meet?

a. A and B
b. B and C
c. A and C
d. none of them will eventually meet



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Lecture Tutorial Research Results

- After completing the Lecture Tutorial, student scores increased 18% on multiple choice questions (from 58% to 76%)
- After an extended lecture (in lieu of Lecture Tutorial) student scores increased 5% on multiple choice questions

Kortz, Smay, and Murray, 2008

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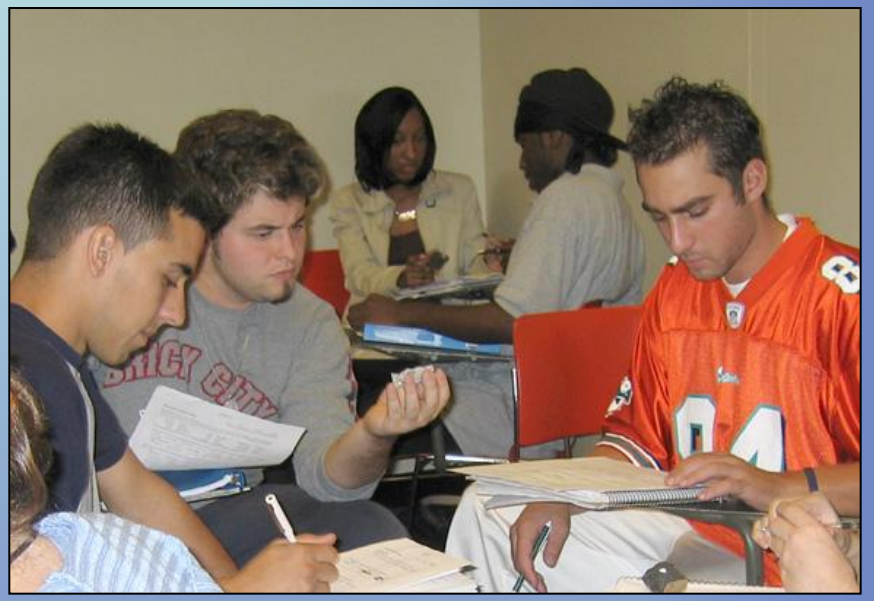
Lecture Tutorial Questionnaire Results

- 99% (n=209) of students agreed:

  “The worksheets helped with my understanding of the subject”



Kortz, Smay, and Murray, 2008

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For More Info: Lecture Tutorials

- Kortz and Smay (2012) Lecture Tutorials for Introductory Geoscience, 2e. W.H. Freeman.
- Kortz, Murray, and Smay (2008) Increasing Learning in Introductory Geoscience Courses Using Lecture Tutorials. JGE, v. 56, 280-290.
- Lecture Tutorial module: http://serc.carleton.edu/introgeo/index.html

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ConcepTests

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ConcepTests

- Conceptual multiple-choice questions
  - Focus on a single concept
  - Have good multiple-choice answers
  - Are clearly worded
  - Are of intermediate difficulty
  - Usually ask at the levels of comprehension, application, or analysis
  - Are not terminology-intensive

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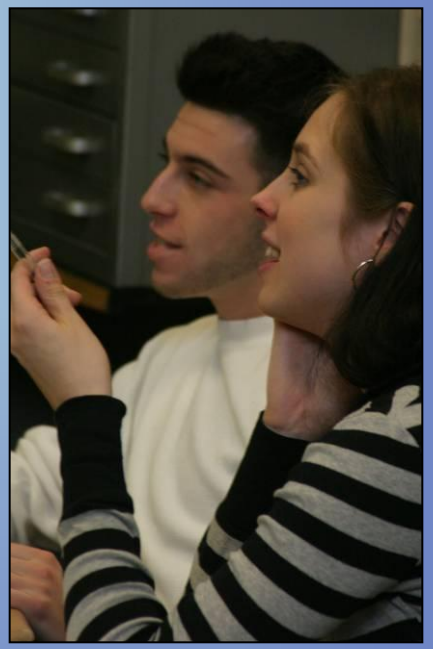
ConcepTests

- Ask a ConcepTest question
- Students think about it and vote
  - 30-70% should be correct
- Students pair up and discuss, if necessary
- Students vote again
- Can be used with personal response systems (“clickers”)



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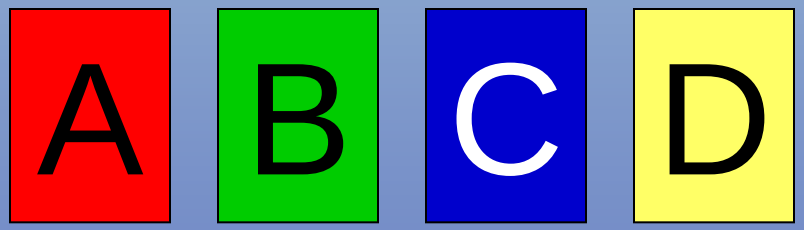
ConcepTest Voting

- Show of hands
- Show of fingers

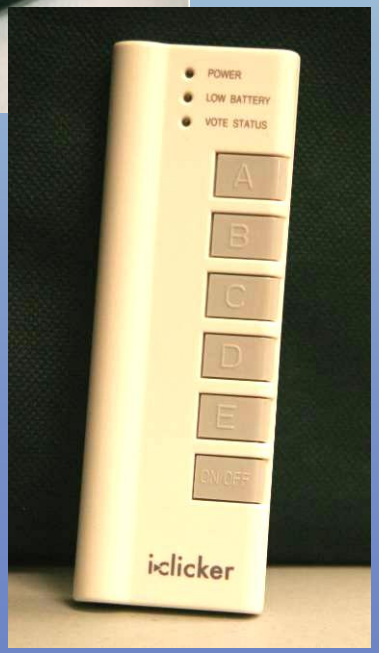
- Colored cards



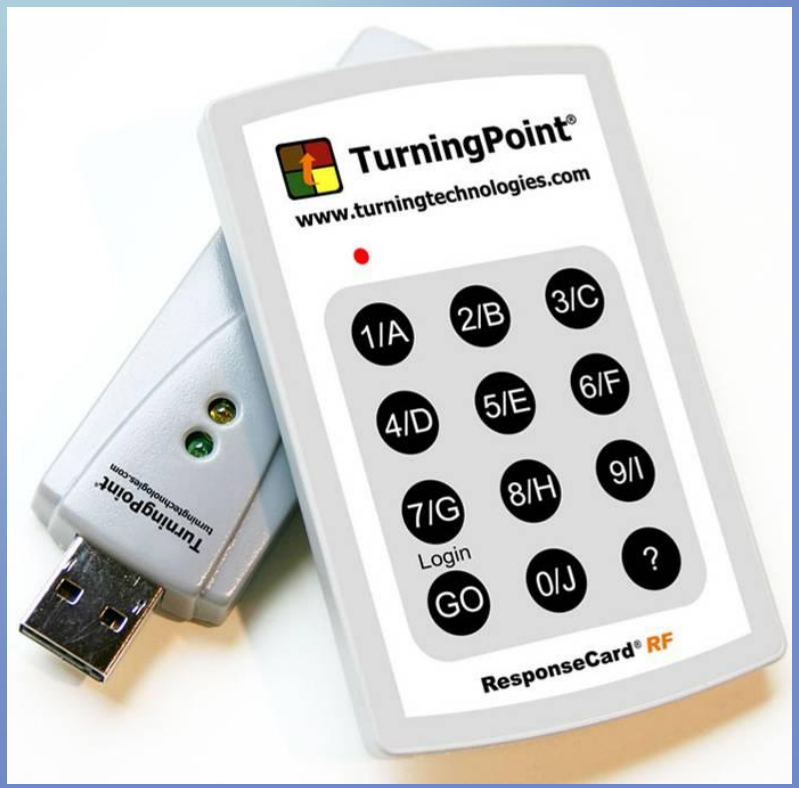
- Personal response systems (“clickers”)

Clickers

- i>clicker



- TurningPoint



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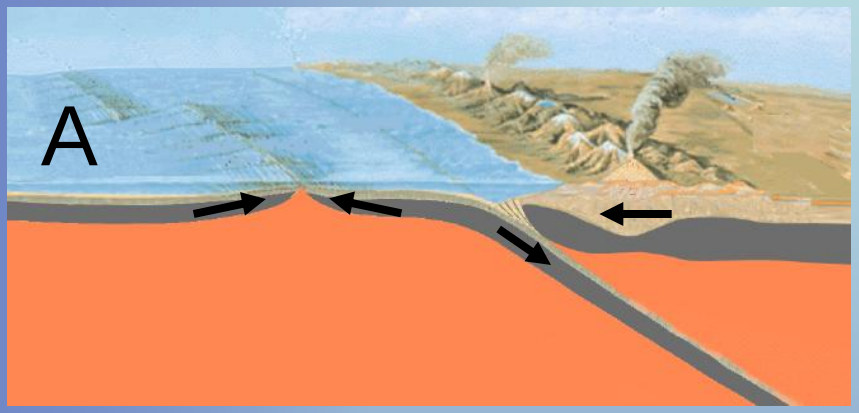
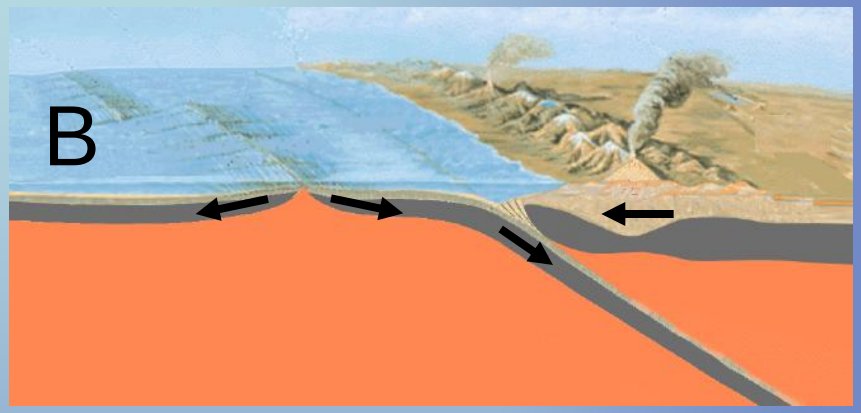
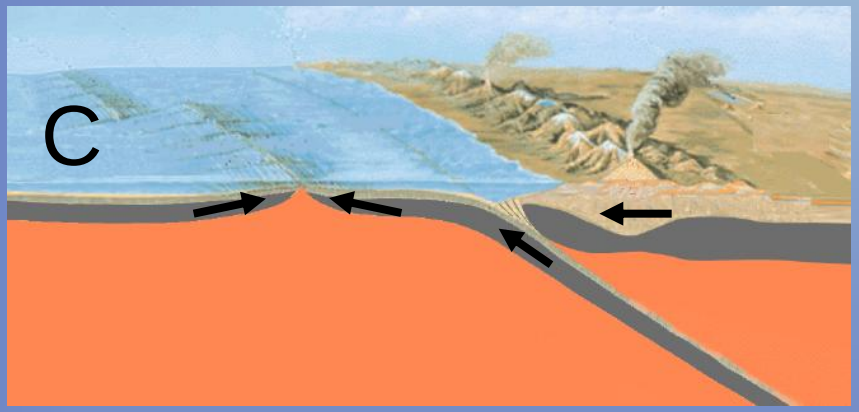
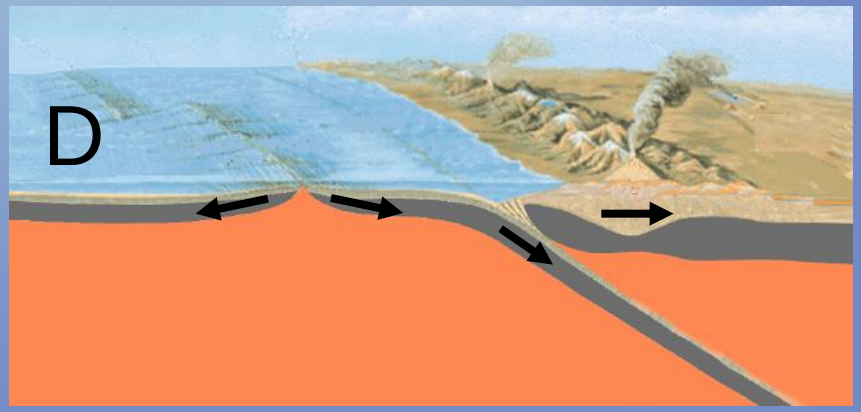
Which diagram BEST shows the directions of plate motions?









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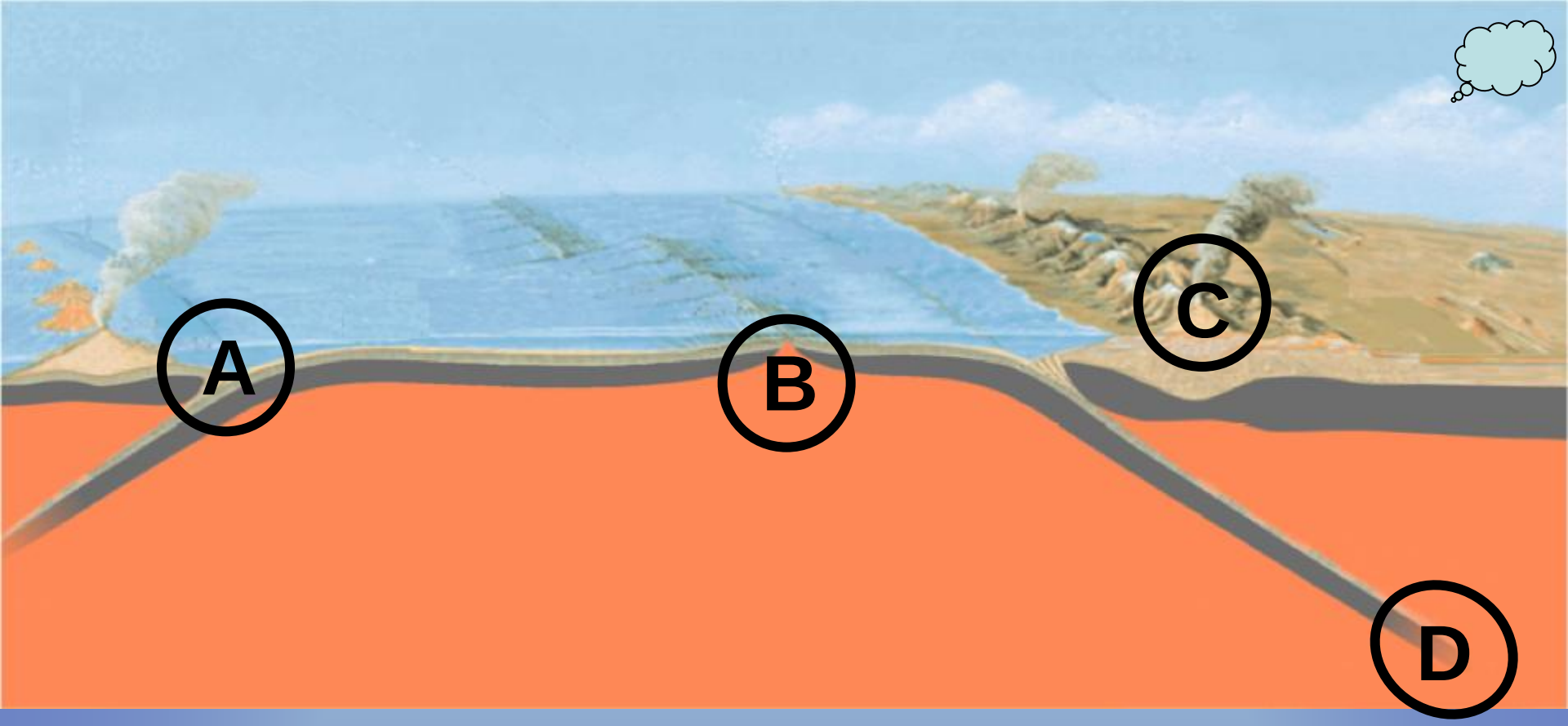

Which letter indicates a location where rock melts to become magma?

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For More Info: ConcepTests

- http://serc.carleton.edu/introgeo/interactive/conctest.html
- http://serc.carleton.edu/introgeo/conceptests/index.html
- McConnell et al. (2006) Using ConcepTests to Assess and Improve Student Conceptual Understanding in Intro Geoscience Courses. JGE, 54(1), p. 61-68.
- McConnell et al. (2003) Assessment and Active Learning Strategies for Introductory Geology Courses. JGE, 51(2), 205.
- http://derekbruff.com/site/classroom-response-systems

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