## Upper Elementary Through High School Student and Teacher Misconceptions of the Causes of the Breakup of Pangaea

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GSA Annual Meeting October 9, 2011



# Why teach the break-up of Pangaea?

 Entry point into the causal mechanisms of Plate Tectonics

### What we did...

Conducted professional development workshop for teachers of grades 4-12

Collected student (359) and teacher (17) responses If someone said that the Earth used to look like Picture A and that the Earth now looks like it does in Picture B, explain how you would get the Earth to look like Picture B from Picture A.



#### Student Responses

#### No responses

- Responses only based on physical differences of two images
- Misconception
- Terminology misuse
- Incomplete Conception

### Student Responses



# Student Responses by Grade Bands



Themes of Causal Misconceptions

- Land or continental movement (46%)
- Earthquakes (30%)
- Water/effects of water (13%)
- Rotation of Earth (5%)
- Erosion and deposition
   (4%)

- Ice age
- ✤ Meteor
- Volcanoes
- People
- Higher power (God)
- ✤ Gravity
- Tidal forces of the moon

### **Incomplete Conceptions**

- Incomplete statements using the words "plate tectonics" or tectonics
  - "because of plate tectonics", "because of tectonic plates", "due to tectonics"
- Incomplete statements about plates
  - "Earth' s plates move", "Earth' s plates shift"
- Incomplete statements about Pangaea
  - "Pangaea broke up"

#### **Teacher Responses**

Teachers' responses included temporal dimension

- Misconceptions:
  - Causal misconceptions related to the underlying mechanism of the break-up of Pangaea
  - Temporal misconception time scale incorrect
- Incomplete conceptions
- Terminology misuse key words associated with plate tectonics



### **Themes of Teacher Responses**

#### Causal misconceptions

- Movement of land masses/continents
- No causal mechanism identified
- Earthquakes and volcanic activity
- > Weathering
- Terminology misuse
  - Use of terms such as "convection cells", "divergent plates", or "plate tectonics"
- Temporal misconceptions
  - Use of vague time scale references such as "over long periods of time", "over millennia", "large amount of time", or "over time"

# Teacher and Student Response Comparison



Increasing Levels of Understanding

- "it would get like that by earth's plates shifting"
- \* "tectonic plates shift over time"
- \* "convections in the mantle causes slow movement of overlying lithosphere."
- \* "over millions of years convection in the mantle caused the tectonics plates of the earth to move."

## Findings

Student responses indicate limited conception of processes
Students familiar with terms (plate tectonics, tectonic plates)
Most students omit temporal component in their responses
Less than 10% of students mention time
Almost all state misconceptions/incomplete conceptions
Half of teachers include the temporal component (75% of those responses are misconceptions/incomplete conceptions)

#### **Implications for Instruction**

- Regrate causal process related to break-up of Pangaea.
- Reak-up of Pangaea is not a good entry point to plate tectonics.
- Reak-up of Pangaea can be used to demonstrate science practices (claim, evidence, reasoning; scientific argumentation)

## **Future Directions**

#### Refine question

Follow up written assessments with interviews in order to elicit deeper explanations of written answers.