Classroom Application, and Assessing Educationals Impacts of Geoscience Video Animations

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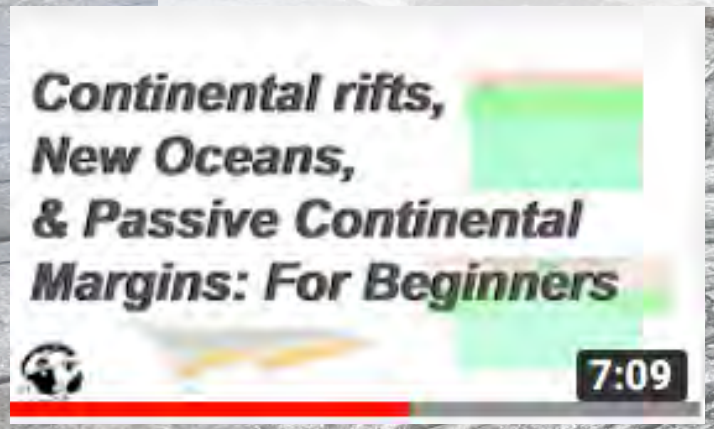
About Using Videos/Animations in the Classroom:

Showing them is good. But using them (and assessing your students' learning outcomes) is better

Frequent, low-stakes assessments foster student learning…

- **"Just in time…" assignments**
  - **have students watch them and answer questions ahead of class, toward addressing misconceptions/ challenges during class time**
- **Combine with "clicker question" classroom prompts (e.g Crouch and Mazur 2001)**
  - **Show video, ask a "meaty" question, have students vote on the answer, and brainstorm on correct response**
  - **"Think-pair-share" strategies can work here...**

Using Videos/Animations in the Classroom:



Videos in lieu of textbook reading(?!?)

- One can work from the videos re: content, with supplemental readings as student supports.
  - Why? Students will watch a video, but may/may not read a chapter
    - Combine with written or "sketch" assessments
      - *[Students want to do image captures. I make them write or sketch something to demonstrate their understanding…]*
- **The big need for doing this** – a rich supply of engaging, scientifically accurate videos/animations on varied geoscience topics!

Some sources for high-quality geoscience videos/animations for the classroom:

UTD GEOSCIENCE STUDIO
565 subscribers
Subscribe!

Upper-level and intro content; Animations, GeoNews, Texas-focused topics

NASA
5.18M subscribers

USGS
73.3K subscribers

GeoScience Videos
12.4K subscribers

(Largely introductory level content)

noaa
20.6K subscribers

Earth Rocks!
22.1K subscribers

Intro geology and intro oceanography

UNAVCO, Inc.
1.1K subscribers

IRIS Earthquake Science
19.4K subscribers

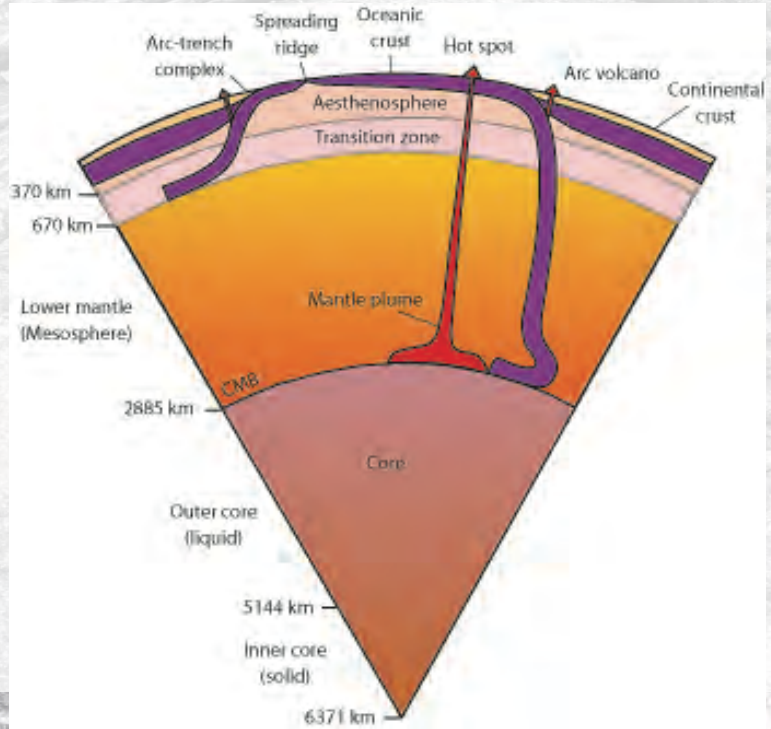
Good content on seismology and earthquake hazards

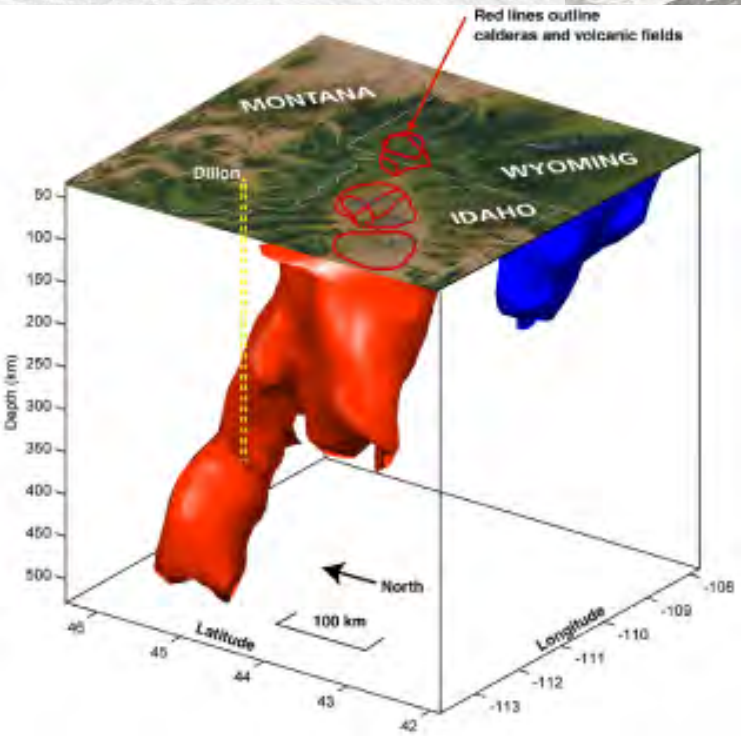
Varied content, some geoscience relevant, target audience may or may not be students

Assessing educational effectiveness of video animations.:

First – what are they?

- **Geoscience Animations are Visualizations:**
  - **"Visualizations can present massive amounts of information to help scientists identify relevant patterns and processes in nature."**[Mackay, Starting Point collection, https://serc.carleton.edu/introgeo/visualizations/index.html]
    - **Animations**
    - **Profiles**
    - **Cross-sections**
    - **Imagery**
    - **Etc.**





What are video animations, such as we've been discussing here?

Teaching/Learning with Visualizations:

- Sibley, D. (2005) Visual abilities and misconceptions about plate tectonics. Journal of Geoscience Education, 53, 471-477
- Reynolds SJ, Piburn MD, Leedy DE, McAuliffe CM, Birk JP, Johnson JK (2006) The Hidden Earth—Interactive, computer-based modules for geoscience learning, In: Manduca CA, Mogk DW (eds) Earth and Mind: How Geologists Think and Learn About the Earth. Geological Society of America Special Paper 413, pp 157-170
- Dutrow, BL (2007) Visual Communication: Do You See What I See? Elements v3 pp119-126
- Whitmeyer, S., DePaor, D., Bailey J., Orndorf, T (eds) (2012) *Google Earth and Visualizations in Geoscience Education and Research.* Boulder, CO, GSA Special Paper 492.
- Stofer, KA (2016) When a Picture Isn't Worth 1000 Words: Learners Struggle to Find Meaning in Data Visualizations. J. Geoscience Education 64, 231-241

What are video animations, such as we've been discussing here?

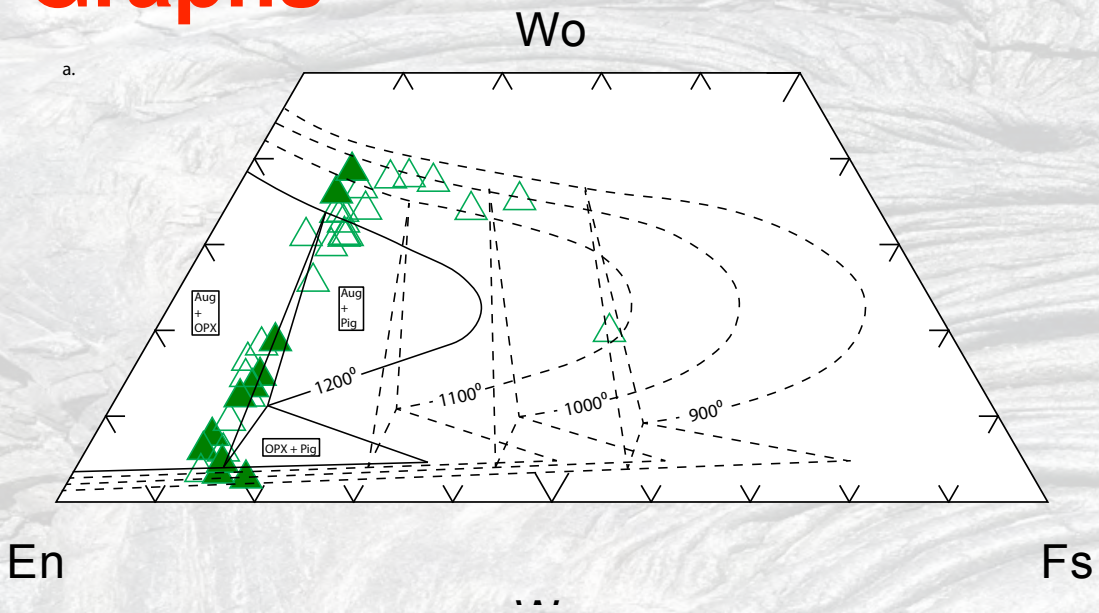
Geoscience Animations are Models:

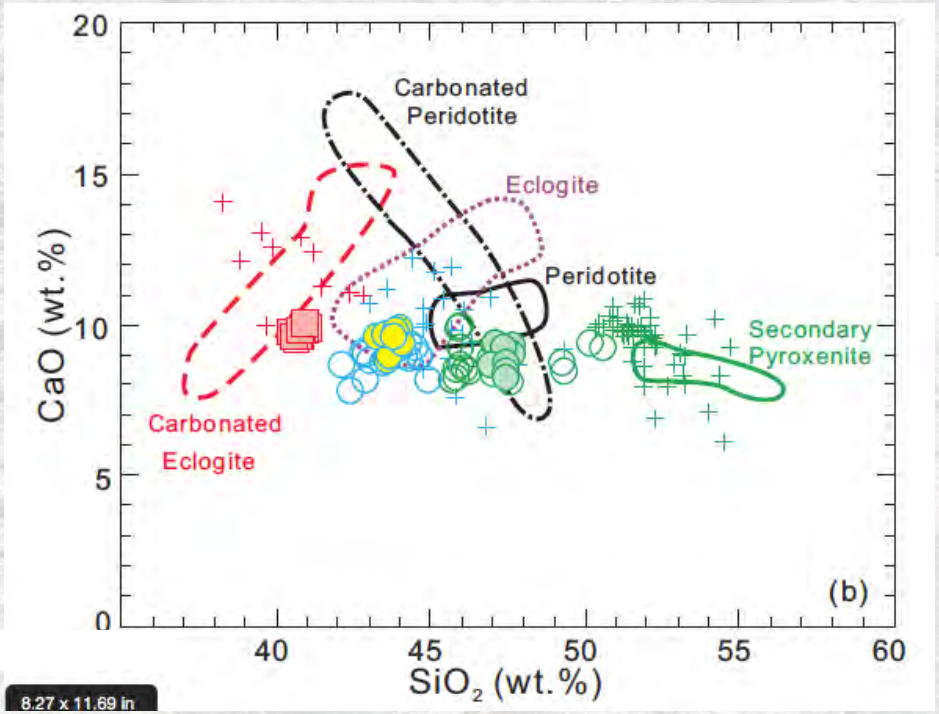
- "A **model** is a representation of structure in a physical system and/or its properties. It describes (or specifies) four types of structure:
  - **systemic structure** (composition (internal parts of the system),environment (external agents linked to the system), connections (external and internal causal links))
  - **geometric structure** (position with respect to a reference frame (external geometry), configuration (geometric relations among the parts)
  - **temporal structure** (changes in state variables or system properties, expressed w/r/t time or via mathematical relations)
  - **interaction structure** (interaction laws expressing interactions among causal links, usually as function of state variables)"
    - **[FROM: Modeling Methodology for Physics Teachers, 1997 http://modeling.asu.edu/modeling/ModMeth.html]**
- **Teaching/Learning with Models:**
  - **Gobert JD & Buckley BC (2000) Introduction to model-based teaching and learning in science education, International Journal of Science Education, 22:9, 891-894, DOI: 10.1080/095006900416839**
  - **Gobert, J.D (2005) The Effects of Different learning Tasks on Model-building in Plate Tectonics: Diagramming Versus Explaining. Journal of Geoscience Education, 53, 4; 444-455**

What are video animations, such as we've been discussing here?

Geoscience Animations usually include

- **Graphs**

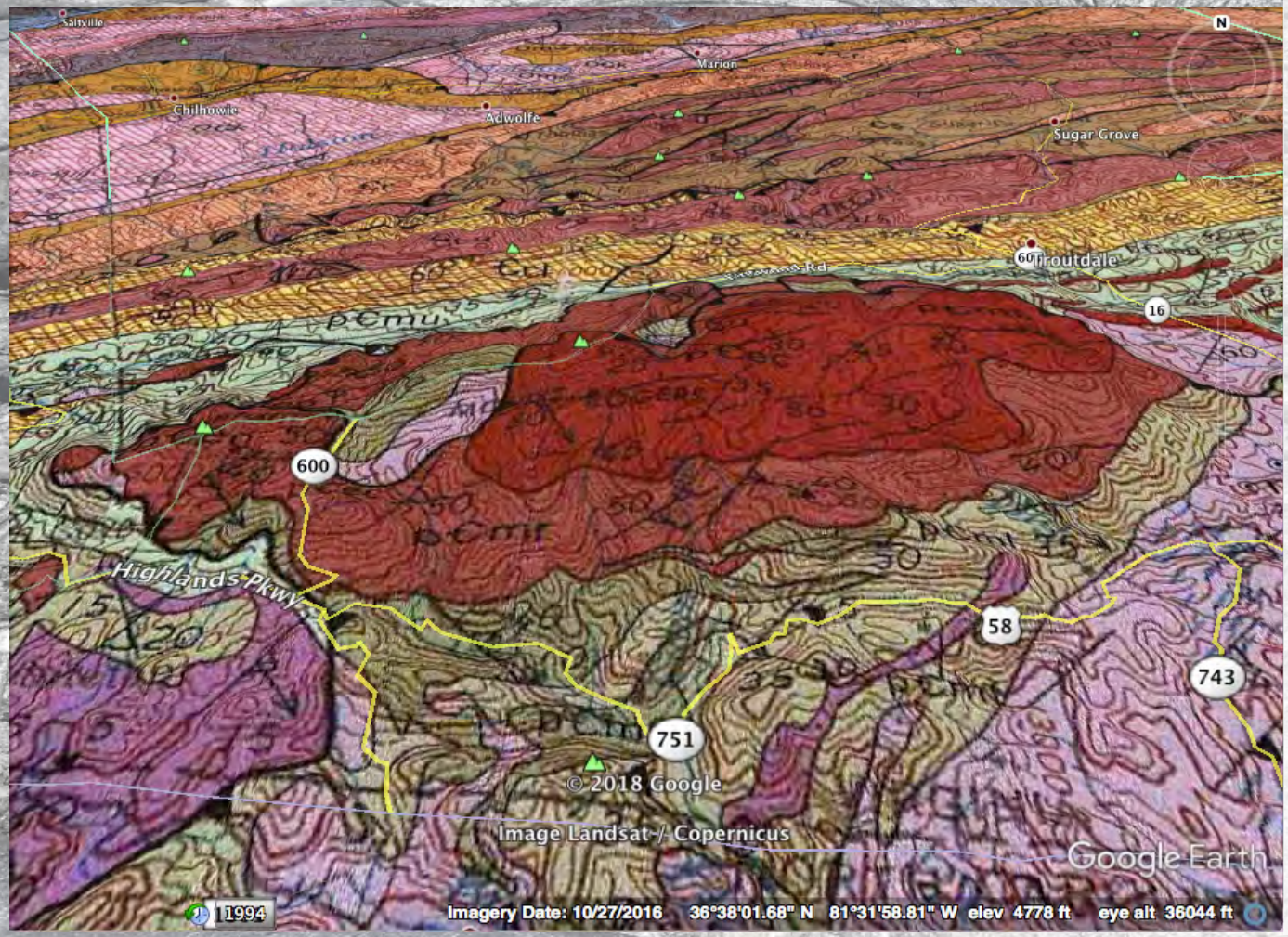




- **Teaching/Learning with Graphs**
  - Glazer, N (2011): Challenges with graph interpretation: a review of the literature, Studies in Science Education, 47:2, 183-210
  - Tversky B, Morrison JB, Betrancourt M (2002) Animation: can it facilitate? International Journal of Human-Computer Studies 57: 247-262

What are video animations, such as we've been discussing here?

- **Geoscience Animations usually include Maps**



Teaching/Learning with Maps

- Kastens KA, Kaplan D, Christie-Blick K (2001) Development and Evaluation of "Where are We?" Map-Skills Software and Curriculum, Journal of Geoscience Education, 49:3, 249-266, DOI: 10.5408/1089-9995-49.3.249
- Kastens KA, Ishikawa, T. (2006)Spatial Thinking in the Geosciences and Cognitive Sciences: A cross-disciplinary look at the intersection of the two fields. In (Manduca CA and Mogk DW, eds) Earth and Mind: How Geologists Think and Learn about the Earth GSA Special Paper 413
- Liben LS and Titus SJ (2012) The importance of spatial thinking for geoscience education: Insights from the crossroads of geoscience and cognitive science. In Manduca, C, and Kastens K (eds). Earth and Mind II: A Synthesis of Research on Thinking and Learning in the Geosciences. GSA Special Paper 486, 51-70

So: there's a lot of pertinent literature…

But what do we want to know re: using animations in our courses?

- Do they "work"?
  - Do students find them engaging?
  - Can students learn key concepts from them?
    - Do they in some way help or ameliorate the cognitive/ learning challenges identified in past work regarding visual information, maps, graphs, models or visualizations?
      - In other words: a very rich topic for research in geoscience education!!

Objectives in the UTD/USF Animations IUSE Project

- **To establish a sustainable model for developing and refining geoscience video animations**
  - (see previous presentations…)
- **To develop resources that are educationally effective**
  - **Accurate scientifically**
  - **Presented clearly and effectively**
  - **Supportive of student learning**
- **To develop resources that will get used**
  - **Engaging for Students**
  - **Engaging/effective enough to faculty that they'll make use of them in courses!**

USF role: data collection/analysis

Geoscience Animations: Evaluative Data collection - Objectives and ambitions

- **Are the animations and videos scientifically accurate?**
  - **Before public presentation: Reviewed by at least two (and generally more) content experts for scientific accuracy and clarity of presentation.**
  - **Formative evaluation: Feedback from viewers (at meetings, on Youtube, etc.)**
    - **Your part in this effort:**
      - **Please do send us your perspectives on the videos! We need your formative feedback!!**

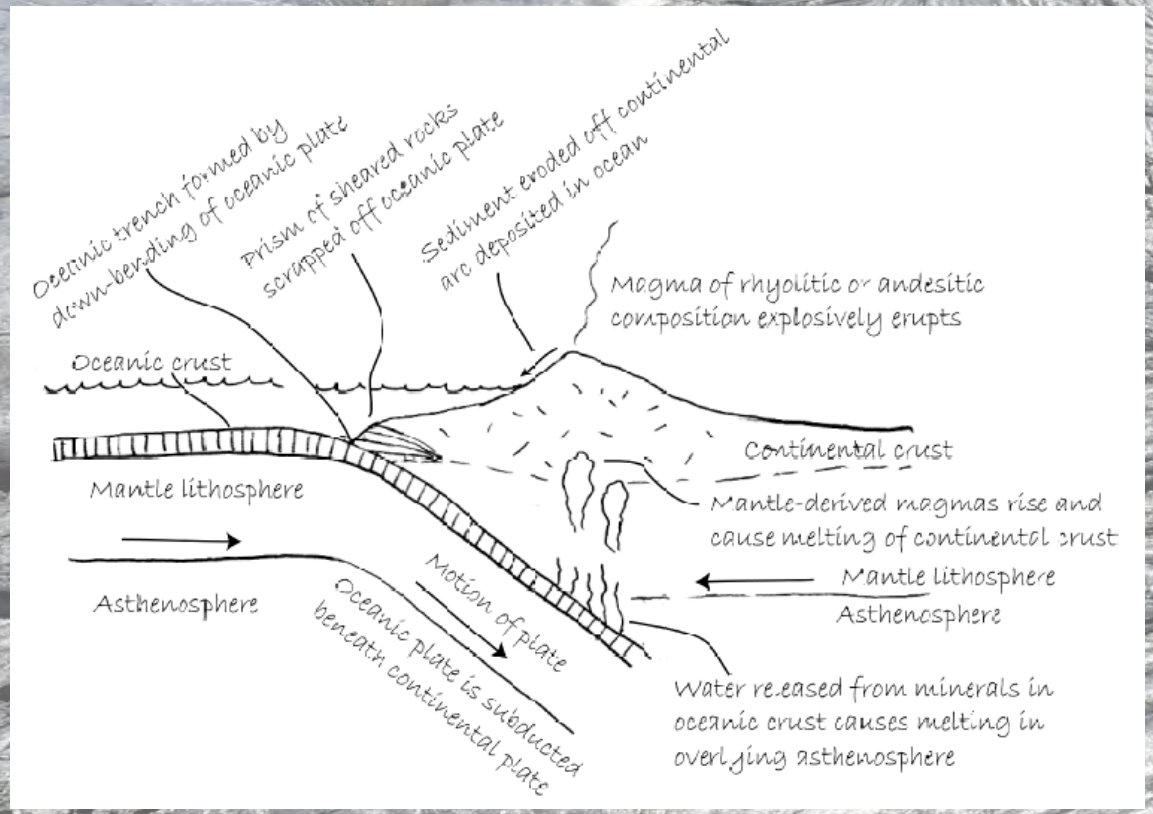
Geoscience Animations: Evaluative Data collection objectives/ ambitions

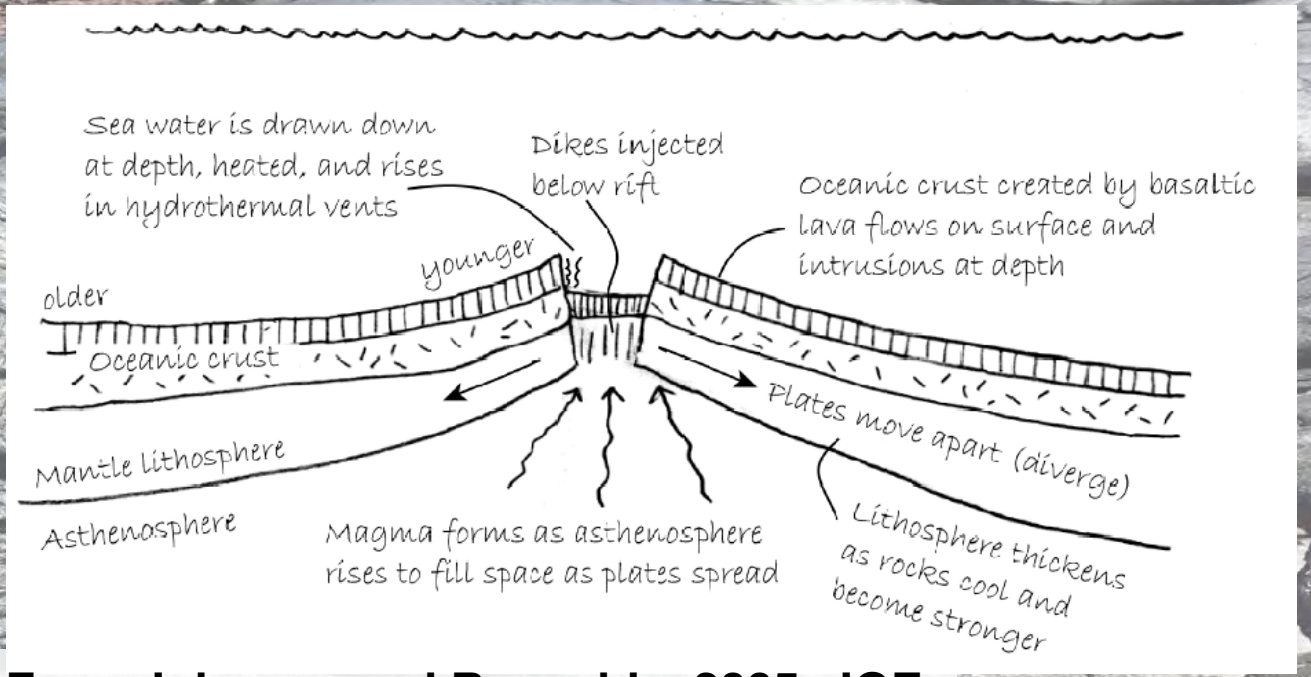
- **Are the videos and animations engaging/comfortable to use for the students? (And, did they feel like they learned from them?)**
- **Instrument: Semi-structured interviews (three questions, with open-ended follow-up…)**
  - "Think back to the computer animation on [*plate tectonics*] that you viewed in [*COURSE*]. Were those animations helpful to you in understanding the [*deep Earth*] processes they described? Please explain ."
  - "Did you have any difficulties with the animations? This can be something technical or conceptual. If so, please explain."
  - "How could the animations be improved [to help avoid misconceptions, confusion]"?

Geoscience Animations: Evaluative Data collection objectives/ ambitions

- Do the videos/animations facilitate learning and retention of the concepts presented?
- Instruments:
  - Student perceptions: Interview responses (see previous slide…)
  - Learning Assessment: Concept Sketches (Johnson and Reynolds, 2005)

Concept Sketches:



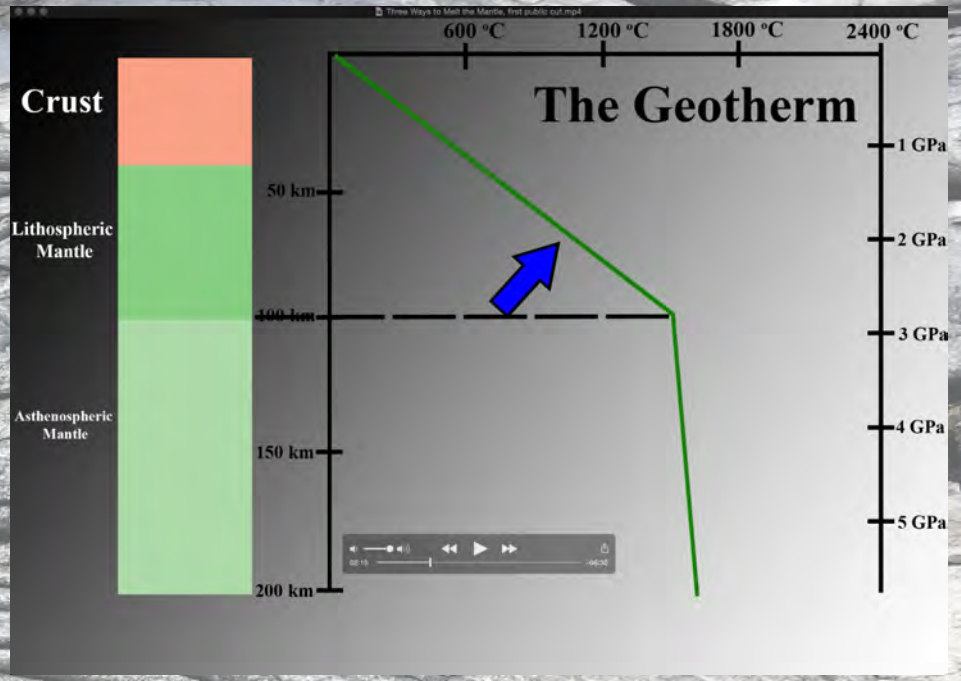


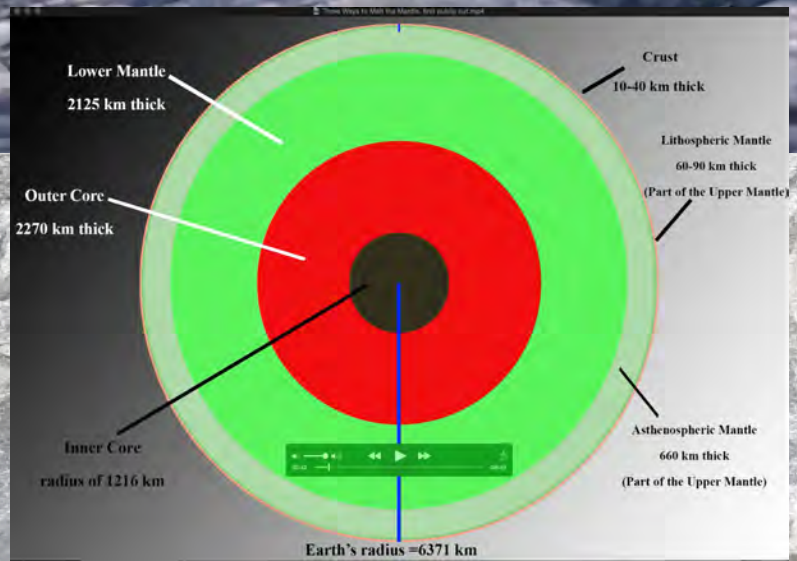
From Johnson and Reynolds, 2005, JGE

Annotated sketches of geologic phenomena, which can be instructor- or student generated.

- **A quick and integrated way to assay student understanding of visually complex geologic processes**
  - **As student work product, annotated sketches may provide insights into issues related to visual geoscience learning as well as to general conceptual understanding (e.g., Gobert et al 1999; Piburn et al 2005)**

Targeted video animation:



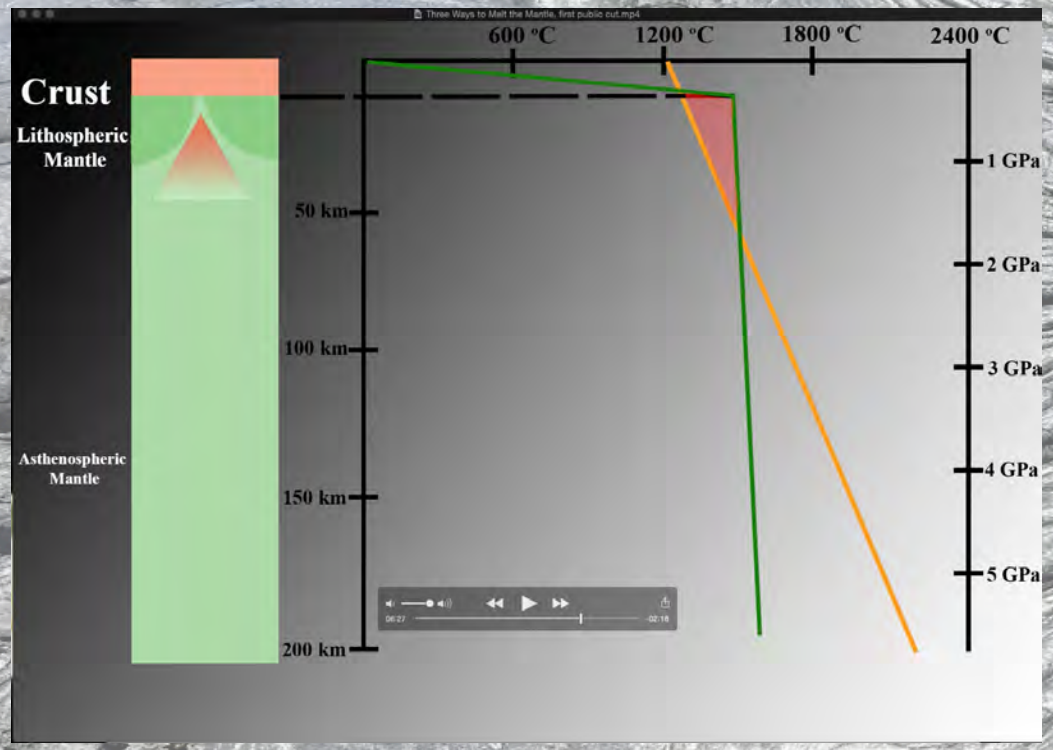


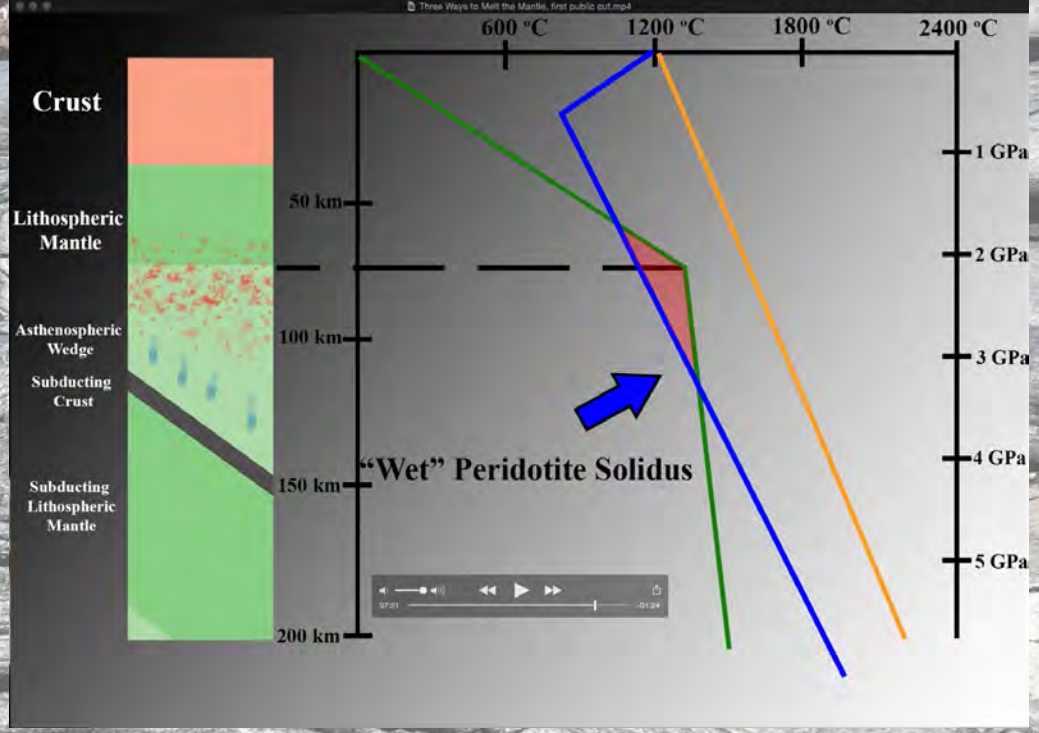
Video discussion of where and why and how the mantle melts in the Earth.

- **Target audience: Junior/Senior Geoscience majors**

- **Melting phenomena under three different conditions in three different tectonic settings**
- **Phenomena are visualized via animated P-T diagrams of the geotherm and mantle solidus**

An ongoing implementation…



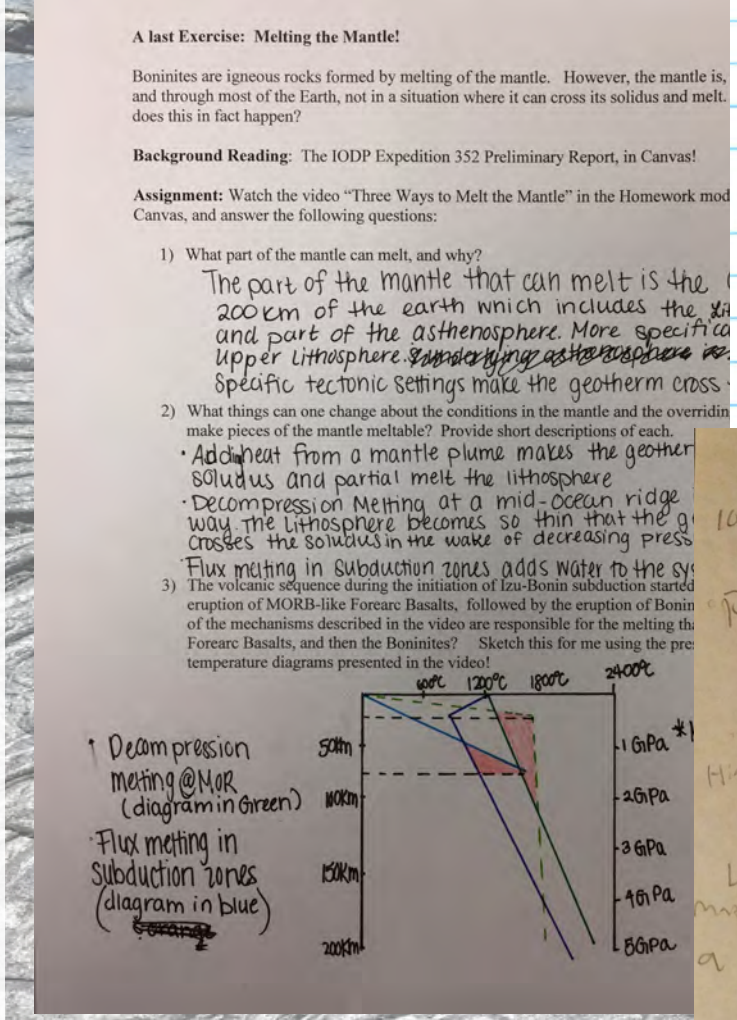


- Piloted at USF, in GLY 3311C (Mineralogy, Petrology, Geochemistry) over three years
- Of 80 students, ≈ 50% consented to participate (n = 40)

- The video was assigned as an in-class/homework activity
- Students answered questions based on video content
  - Questions were couched with respect to their term project, on Izu-Bonin forearc volcanic rocks, which form via adiabatic and fluid-addition melting processes)
  - Questions included a prompt to generate a concept sketch response.
- A similar concept sketch prompt was included as a question on the GLY 3311C final exam.
- Interviews were conducted with a subset of those who consented.

Concept sketch Scoring Rubric both for the activity and exam questions:

- 3 point scale.
  - Written responses correct =1
  - Correct diagram in sketch, with correct axes, etc. = 1
  - Correct annotation of the diagram = 1
    - ½ point for partly correct responses
  - 2 raters; good agreement



A last Exercise: Melting the Mantle!

Boninites are igneous rocks formed by melting of the mantle. However, the mantle is, and through most of the Earth, not in a situation where it can cross its solidus and melt. does this in fact happen?

Background Reading: The IODP Expedition 352 Preliminary Report, in Canvas!

Assignment: Watch the video "Three Ways to Melt the Mantle" in the Homework mod Canvas, and answer the following questions:

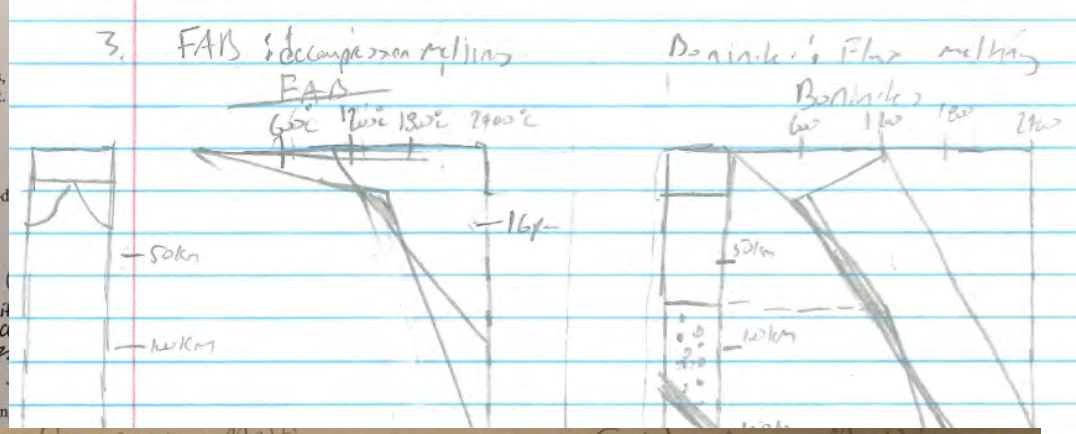
1) What part of the mantle can melt, and why?

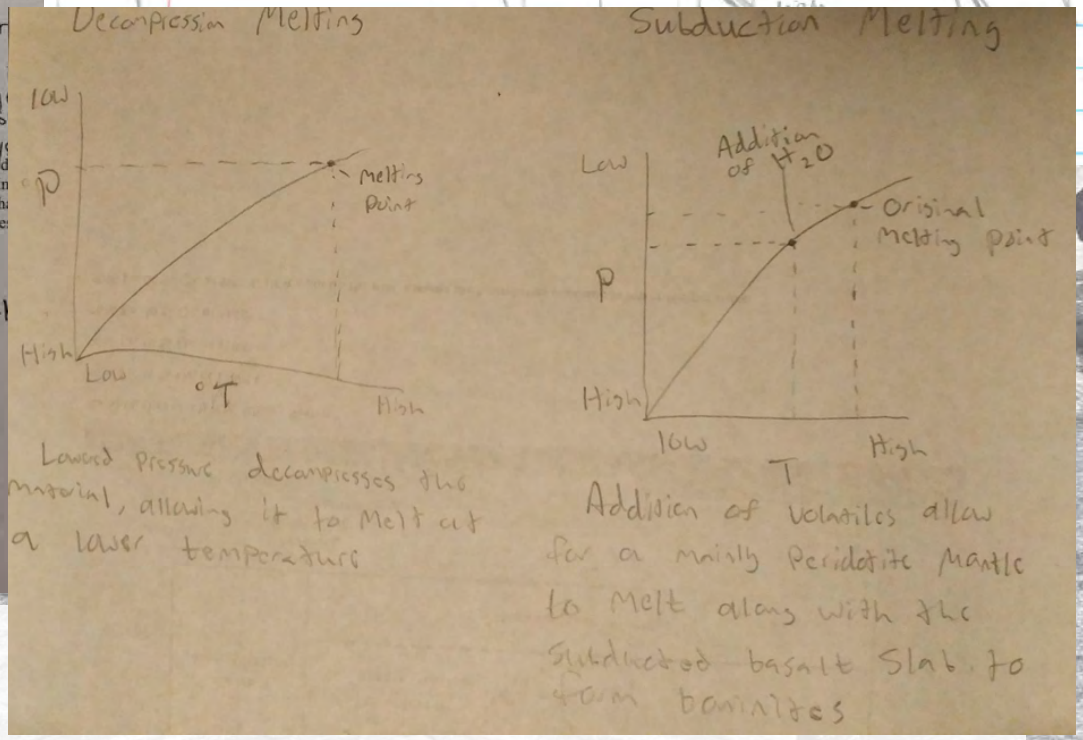
The part of the mantle that can melt is the 200 km of the earth which includes the and part of the asthenosphere. More specific Upper Lithosphere. Specific tectonic settings make the geotherm cross

2) What things can one change about the conditions in the mantle and the overridin make pieces of the mantle meltable? Provide short descriptions of each.

- Add heat from a mantle plume makes the geother solidus and partial melt the lithosphere
- Decompression Melting at a mid-ocean ridge way the Lithosphere becomes so thin that the g crosses the solidus in the wake of decreasing press
- Flux melting in subduction zones adds water to the sy

3) The volcanic sequence during the initiation of Izu-Bonin subduction started eruption of MORB-like Forearc Basalts, followed by the eruption of Bonin of the mechanisms described in the video are responsible for the melting th Forearc Basalts, and then the Boninites? Sketch this for me using the pre temperature diagrams presented in the video!





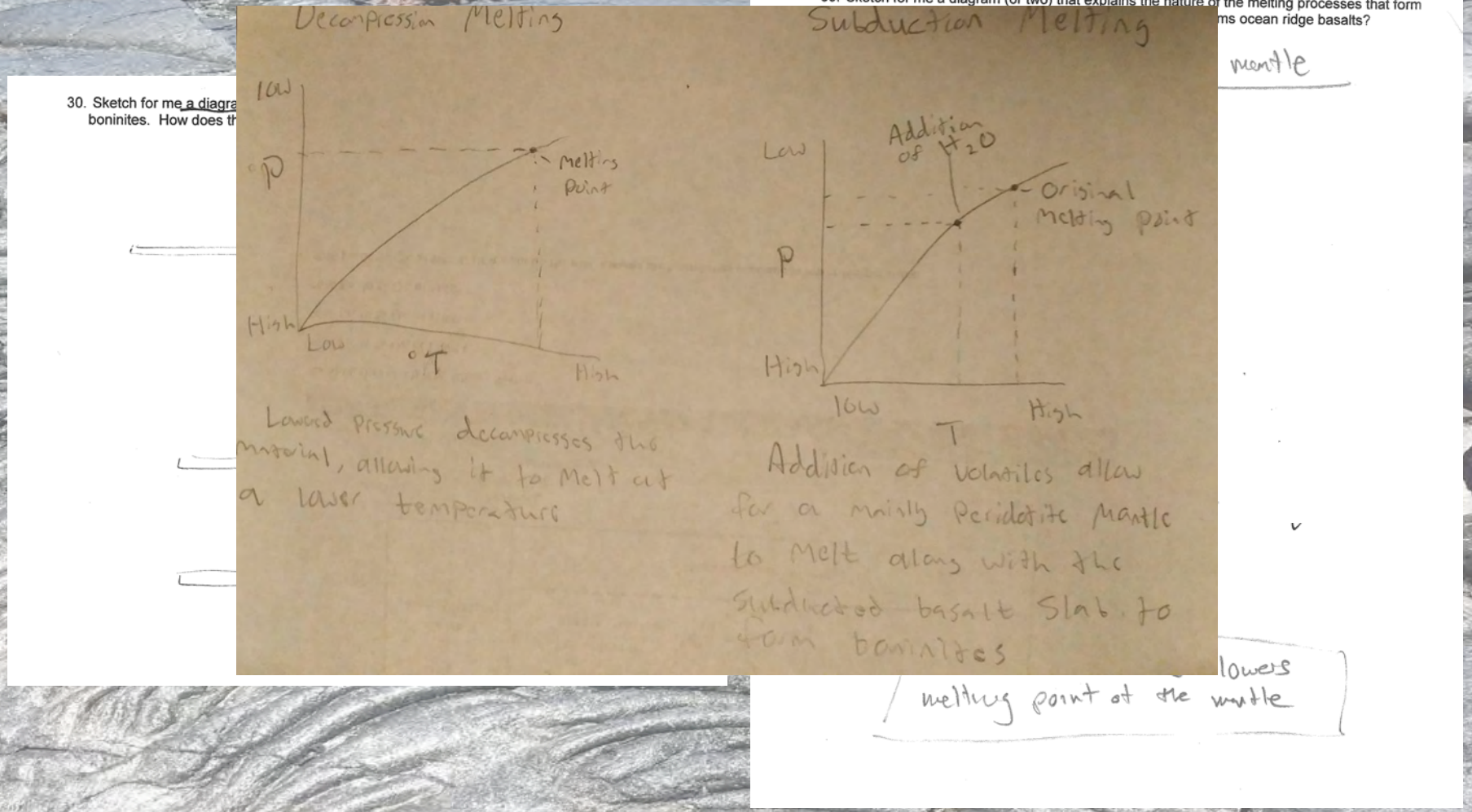
Classroom activity results:

- Overall Score: 1.7 of 3
- Students mostly generated the correct diagram, if not with correct annotation.
  - Some generated "anomalous" diagrams, seemingly from first principles
- Verbal responses scored better than sketch responses (~0.8 vs. 0.6; i.e., they could explain what was going on better than they could sketch it)

Exam question results (~6 weeks later…)

Mean score: 0.7

- Written responses still OK (~0.6)
- <10% generated the correct P-T sketch as an explanation!
  - Nearly all others sketched subduction zone profiles!
  - The "anomalous" sketched graphs persisted.



Interview results (post-course)

- Students liked the animation as a way to learn
  - They thought it helped their learning re: mantle melting
- They want the sound to be leveled out (earbud shock: not good!)

Inferences (from our current data):

- **Did students learn the concepts presented in the animation? Yes, apparently…**
  - Need pre-test results to confirm the video's impact…
  - And… more data! (small classes require multiple iterations…)
- **Visual content (like graphs, even animated ones) appears hard to ingest, cognitively speaking, and doesn't appear to persist readily.**
  - Students could explain that which they could not draw. (??)
  - What visual content does persist? That which they've seen repeatedly (like plate tectonic profiles, which are in introductory and upper level texts)

Our ongoing work, now on three different videos…

- Continued "triangulation" re: assaying learning (i.e., perception + written responses + concept sketches)
- Comparing results for "familiar" vs. "unfamiliar" visual content (i.e., graphs of melting vs. map and profile views of the crust and lithosphere)
- Some additional qualitative probing re: the issues above.

Looking to the future…

- If you would like to develop videos and/or pilot videos in your courses, let us know!
  - We'll share our assessments, and get our IRB to talk to yours so you and your students can fully participate.
  - We'll share our videos – and we'll test yours!
  - We'll use and credit your feedback on existing videos, and highlight your tested videos in the collection.
  - Trials in either upper-level or introductory courses are welcome, but we're very interested in how to adapt/edit existing upper-level videos for introductory audiences.

Please provide your feedback on our event!

https://www.surveymonkey.com/r/JV8K92K

Just five questions!

Thanks in advance for your responses!