Volcanoes in Context: Island Arcs and Hot Spots

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Volcanoes are totally cool

Teaching about volcanoes can be awful

- Nomenclature of igneous features, landforms
- Nomenclature of igneous rocks
- Chemical classification of volcanic rocks
- Diverse array of eruption hazards

Can lead to non-ideal pedagogic strategies

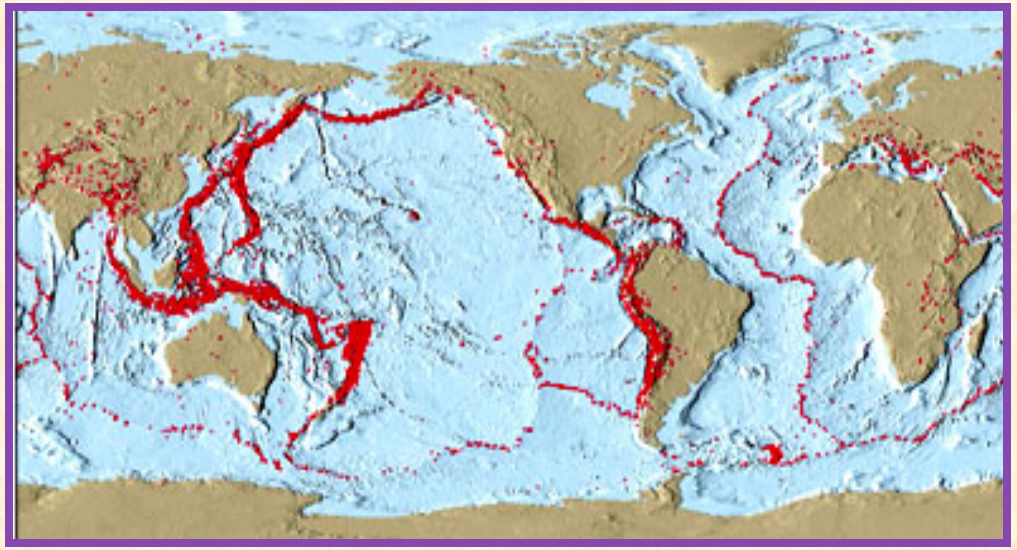
- Memorize lots of words
- Baking soda and vinegar models

Misconceptions About Volcanoes

- Volcano shape, lava type, rock names are unrelated and unpredictable
- Volcanoes are not related to plate motions
  - Hot spots are part of the vocabulary
  - Divergent / convergent boundary (not familiar)
  - Ocean floor entirely made of lava (not familiar)
- All volcanoes are like Hawai'i
  - Volcanoes occur randomly around the globe
  - Volcanoes need to be islands / water is important

Plate tectonics **is** the governing paradigm

- Volcanoes
- Earthquakes
- Rocks and minerals
- Natural resources
- Paleoclimate
- Landforms and mountain-building



Integrated curriculum is based on tectonics

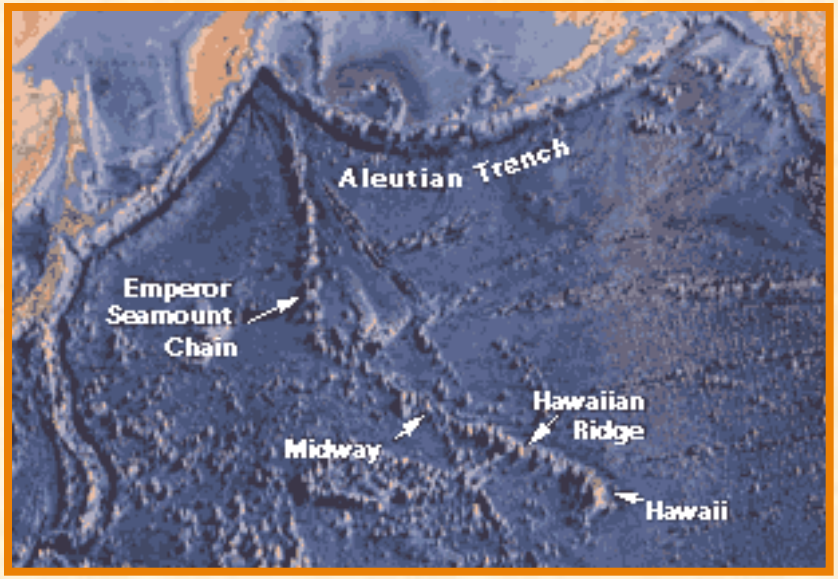
Textbooks do not present material in this way

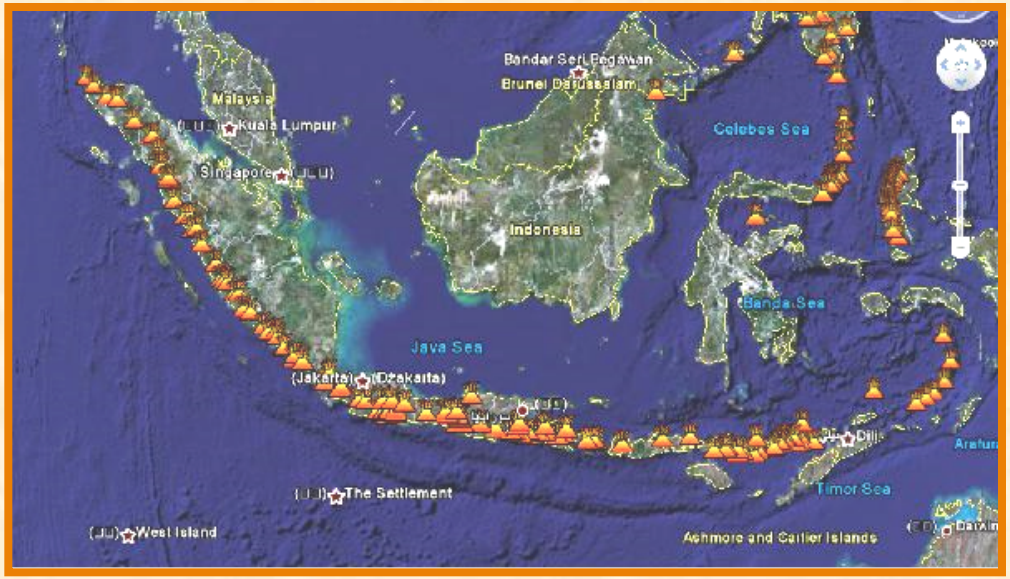
Use tectonics to establish context

- Context can reduce new misconceptions
- Make connections explicit across content
- Emphasize processes over memorization
- Establish framework, reinforce with activities

Instructional strategy for volcanoes

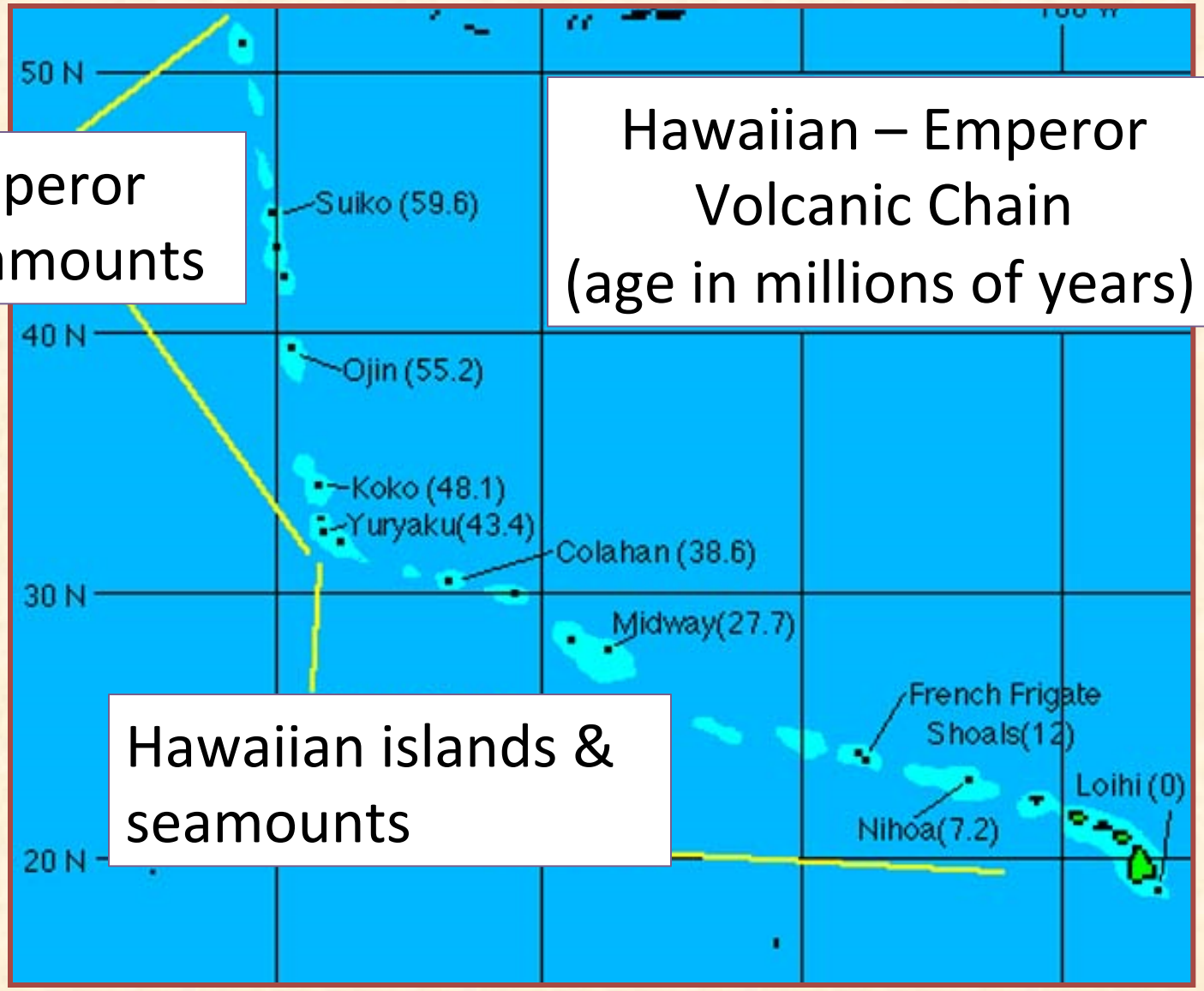
- Comparison of Hawai'i and Merapi
- Viscosity / gas / morphology comparison
- Age progression activity address misconceptions

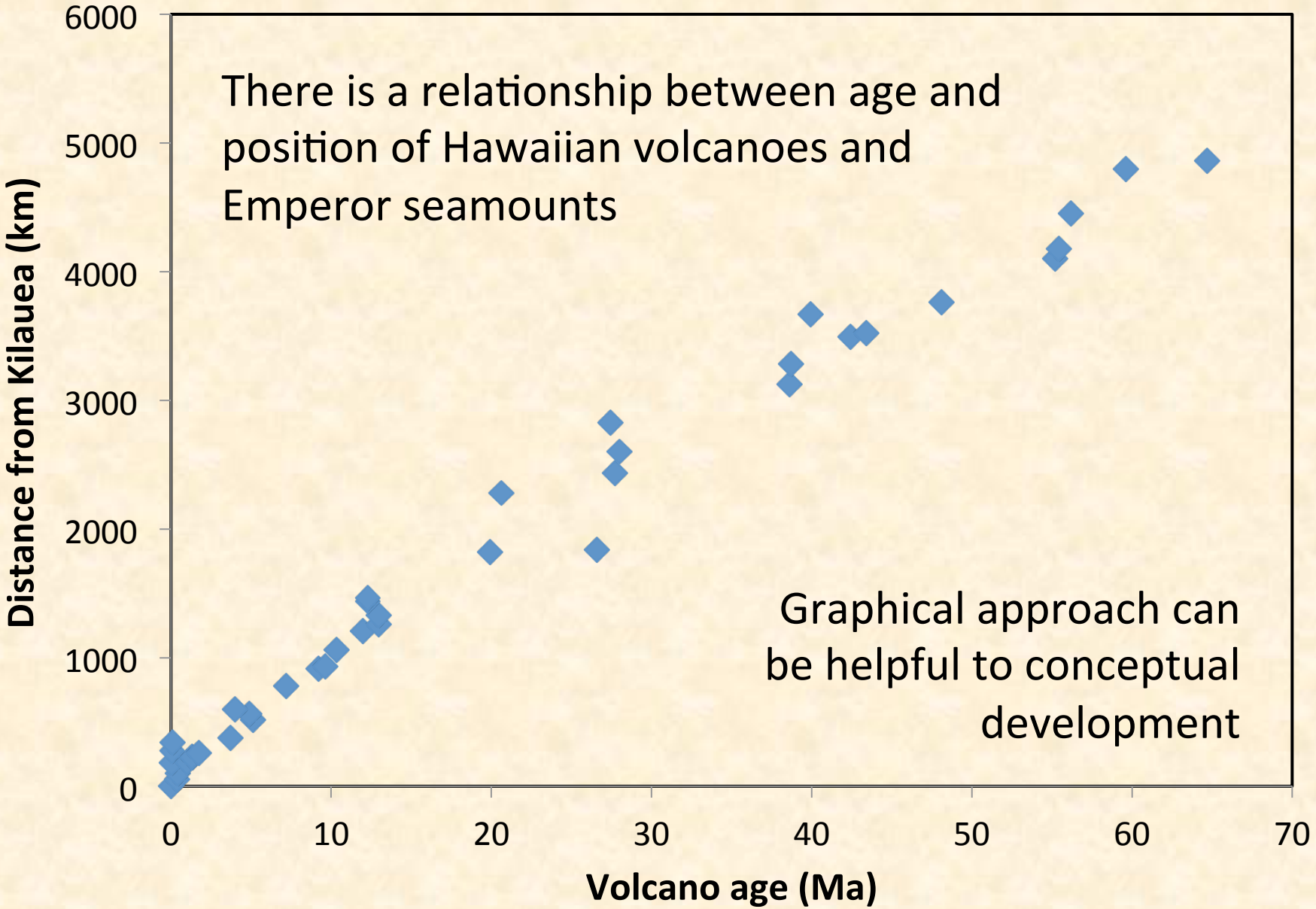


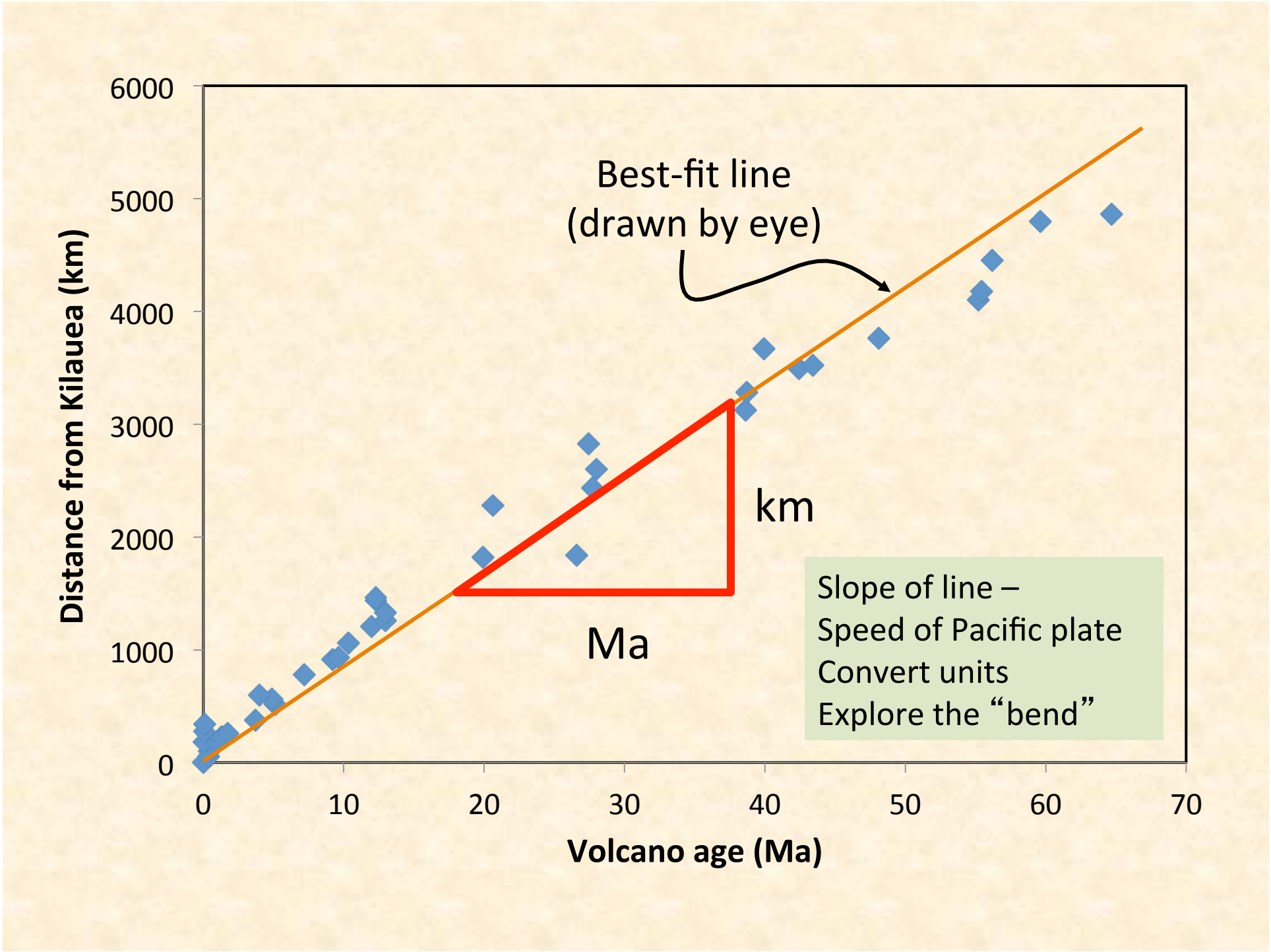


http://essp.psu.edu

Volcanoes get older NW of Hawai’i




There is a relationship between age and position of Hawaiian volcanoes and Emperor seamounts
Graphical approach can be helpful to conceptual development
Distance from Kilauea (km)
Volcano age (Ma)
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
70


Distance from Kilauea (km)
6000
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40
50
60
70
Volcano age (Ma)
Best-fit line
(drawn by eye)
km
Ma
Slope of line –
Speed of Pacific plate
Convert units
Explore the "bend"

Indonesia is different from Hawaii

No age progression in Indonesia

Contrast Hawai'i and Indonesia

- Graph is "simple" but meaningful for Hawai'i
- No analogous graph is possible for Indonesia
  - Graphing is always frustrating
  - Frustration important to uncovering meaning
- Origin of volcanic chains must be different
- Plate motions are meaningful in both cases
- Volcanoes can be "points" or boundary lines
- Discuss morphology, lava type, setting etc.

There are no Quick Fixes

- Geological phenomena are often abstract
- Temporal and spatial scales are challenging
- Learners' intuition / experiences not reliable
- Frame exploration with natural data
- Follow-up is most important
  - Requires deep understanding
  - Allows conceptions to develop and refresh
  - Builds coherent picture of discipline, content

Where are volcanoes located? Blurtit.com

Usually located near fault boundaries. Convergent subduction zones that is where most of our land volcanoes are located (and the most dangerous). Divergent plate boundary is where fissure, sea-mount, and shield volcanoes occur. There are some cases where there are hot-spots on Earth where volcanoes are randomly located, e.g. Hawaii. We believe it is a sort of heat flux from the Earth's core.