Geological Models for Exploration of Earth

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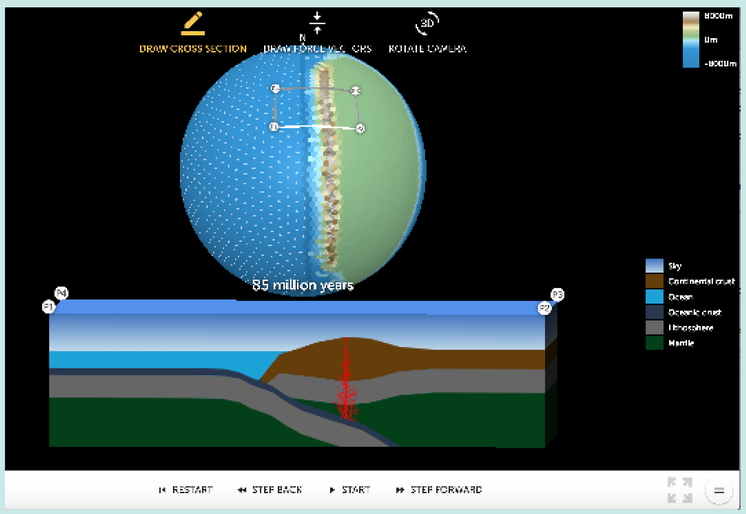
The GEODE models hold potential for transforming secondary plate tectonic education.

They make the invisible visible by providing ways of understanding the mechanisms and physical processes that shape Earth's surface.



Tectonic Explorer

An interactive dynamic plate tectonic model of an Earth-like planet.

This model allows users to observe interacting tectonic plates and the emergence of landforms that result. The 3D cross-section visualization helps users view structures and patterns at or near Earth's surface while seeing what is happening below the surface at the same time.

Students Mimic the Methodology of Earth Scientists

- Gather evidence through observations.
- Investigate causes that lie deep in the past and effects of which are observed only after very long and complex causal chains of intervening events.
- Compare current phenomena as an insight into what may have happened.

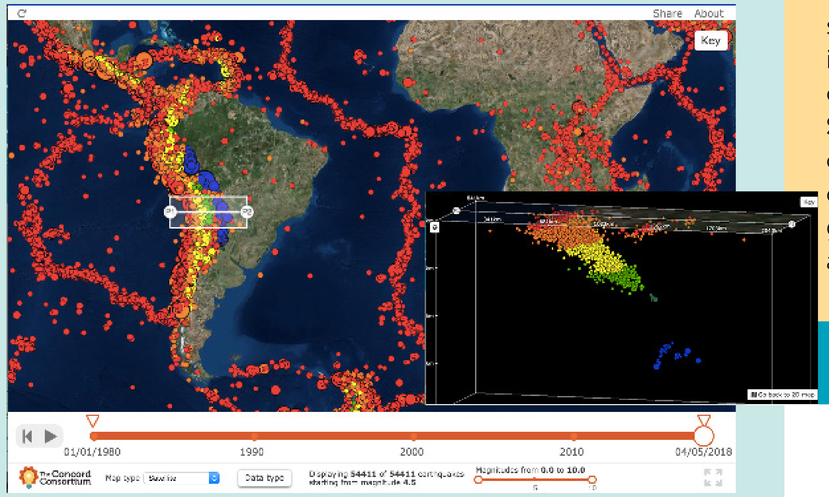
Research Questions

- How and to what extent does students' understanding of plate tectonics and Earth's processes develop?
- What patterns emerge from students' modeling practices? How do the modeling patterns relate to ways in which students describe and explain plate tectonics and associated geological processes that shape Earth's landforms?
- How do students use evidence generated from models in formulating arguments about geological phenomena? How do students frame uncertainty in accepting or refuting evidence from the models?
- What practices are productive in supporting students' use of dynamic computer models of complex phenomena?

Seismic Explorer

A data visualization model integrating earthquake, volcano, and plate motion data sets.

This model allows users to explore the locations of earthquakes (including magnitude and depth), volcanic eruptions, and plate boundaries, and correlate them with plate motion and Earth's topographic features as seen on relief maps.



Project Year 2 Research: The first design cycle of the GEODE module

We conducted design-based research with the first version of the GEODE module. 159 students taught by three middle school teachers and two high school teachers took the GEODE pre-test and post-test. Among them, 49% were male students; 95% spoke English as their first language; and 75% self-reported to have previously used computers in science learning.

Overall, students made significant gains in both content and argumentation tests.

	Total score	n	Pre-test mean	Post-test mean	Gain (Effect Size) Cohen's d
Content	26	138	11.37	13.66	0.62 SD***
Argumentation	43	133	19.59	23.89	0.89 SD***

Note: * p < .05., ** p < .01, *** p < .001

Based on analysis of pre-post tests, classroom observations, and teacher feedback, revisions focus on:
Content: Strengthening activities that address temporal scales of geological events, divergent boundary identification and mechanistic reasoning, and mantle convection as a cause for tectonic plate movement.
Scientific argumentation: Introducing uncertainty as part of scientific argumentation, articulating incompleteness of current plate tectonics theory to predict real-world geodynamic phenomena, and reinforcing scientific argumentation throughout the module.

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This material is based upon work supported by the National Science Foundation under Grant No. DRL-1621176. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.