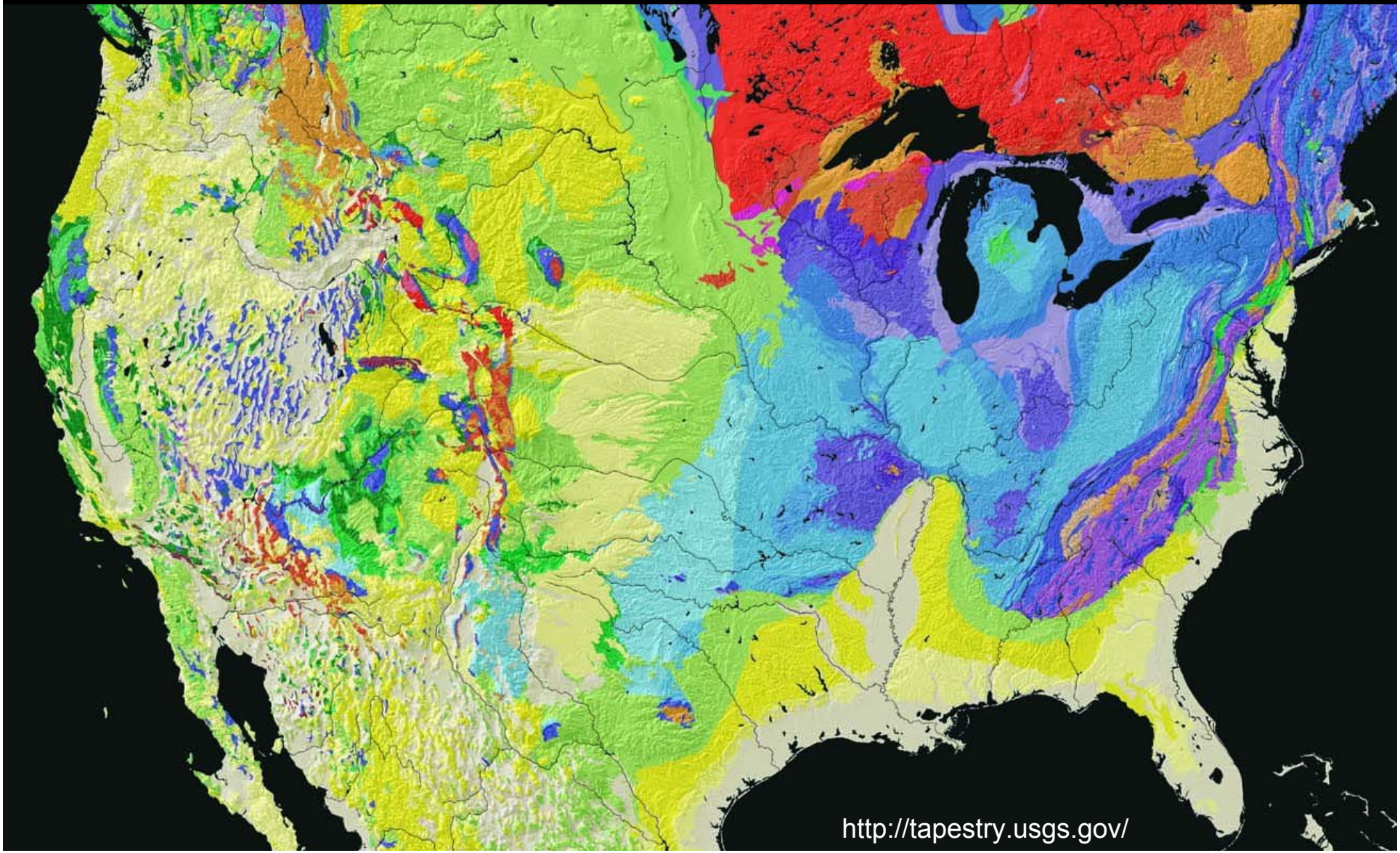
GeoFrame: An Integrated Geologic Framework for EarthScope's USArray



Overview

What is **GeoFrame**?

What is the motivation for **GeoFrame**?

Moving forward with **GeoFrame**.

Discussion.

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An Integrated Geologic Framework for EarthScope's USArray

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The GeoFrame initiative is a new geologic venture that focuses on the construction, stabilization, and modification of the North American continent through time. The initiative's goals can be achieved through systematic integration of geologic knowledge—and particularly geologic time—with the unprecedented Earth imaging to be collected under the USArray program of EarthScope (http://www.earthscope.org/usarray). The GeoFrame initiative encourages a cooperative community approach to collecting and sharing data and will take a coast-to-coast perspective of the continent, focusing not only on the major geologic provinces, but also on the boundaries between these provinces. GeoFrame also offers a tangible, 'you can see it and touch it' basis for a national approach to education and outreach in the Earth sciences.

The EarthScope project is a massive undertaking to investigate the structure and evolution of the North American continent. Sponsored by the U.S. National Science Foundation (NSF), EarthScope uses modern observational, analytical, and telecommunications technologies to establish fundamental and applied research in the Earth's dynamics, contributing to natural resource exploration and development, the mitigation of geologic hazards and risk, and a greater public understanding of solid Earth systems. One part of this project is USArray, a moving, continent-scale network of seismic stations designed to provide a foundation for the study of the lithosphere and deep Earth.

Eight Focus Regions for Studying North America

The EarthScope project has the potential to be a transformative activity for the geosciences and to take the solid Earth sciences a step beyond plate tectonics, but only if structural geology, sedimentology, petrology, geochronology, geochemistry, and geophysics are combined in an integrated manner. The goal of the GeoFrame project is to help accomplish this task. This approach requires the contribution of large segments of the U.S. geosciences community, particularly those who provide the crucial information about Earth history across both space and time.

On 3–5 February 2006, a diverse group of about 60 geoscientists attended the GeoFrame workshop in St. Louis, Mo., to discuss an integrated geologic framework for the USArray component of EarthScope. This was the first national workshop that leveraged the results of multiple regional workshops. At the workshop, there was general consensus about the intellectual merit, scientific necessity, and role of GeoFrame in EarthScope science. Further, participants agreed that this type of national planning is necessary for organizing targeted geographic regions across the United States for integrative study.

The task and challenge of the workshop was clear: to integrate the spatial detail and time portrayed by the U.S. geologic map [*Schruben et al.*, 1994] with EarthScope studies of whole Earth and lithospheric processes. Participants agreed that a broad, integrated geologic framework was needed to understand how continents are built, specifically formation and growth of the North American continent through time and its modification by deformation, accretion, magmatism, and rifting.

To give these concepts a more concrete foundation, the workshop participants outlined seven focus regions across the conterminous United States and an eighth focus topic. These areas were identified to address fundamental aspects of the growth, evolution, and modification of the North American continent through time (Figure 1) with further focus on some of the major continent-scale transitions between geological provinces. Recognizing that many interesting areas of the conterminous United States will be overlooked in any selection, the choice of regions reflects a compromise between field areas, research topics, and spatial connections among regions.

The boxes shown in Figure 1 are approximate placeholders that broadly encompass the areas that address many outstanding scientific questions about the fundamental processes that form, stabilize, and modify continental crust. While some geological areas are omitted by this selection, focus areas linked by

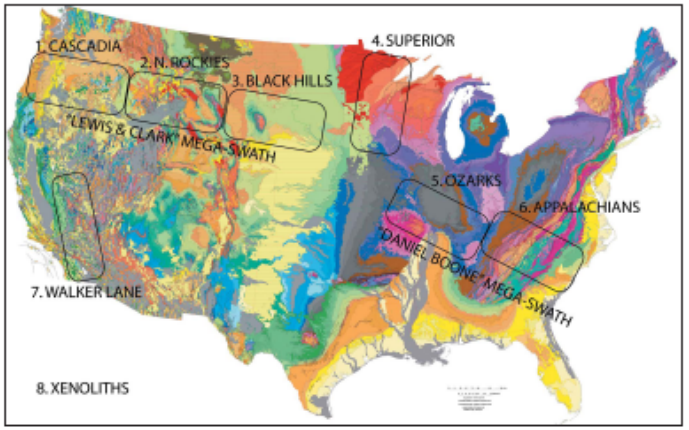


*Fig. 1. Seven of the GeoFrame focus areas placed on the 1974 King and Beikman geological map of the conterminous United States [*Schruben et al., *1994]. The areas collectively constitute a seamless continent-scale experiment, addressing many outstanding scientific questions about the fundamental processes that form, stabilize, and modify continental crust.*

By B. Tikoff, B. van der Pluijm, J. Hibbard, G. R. Keller, D. Mogk, J. Selverstone, J. Selverstone, and D. Walker

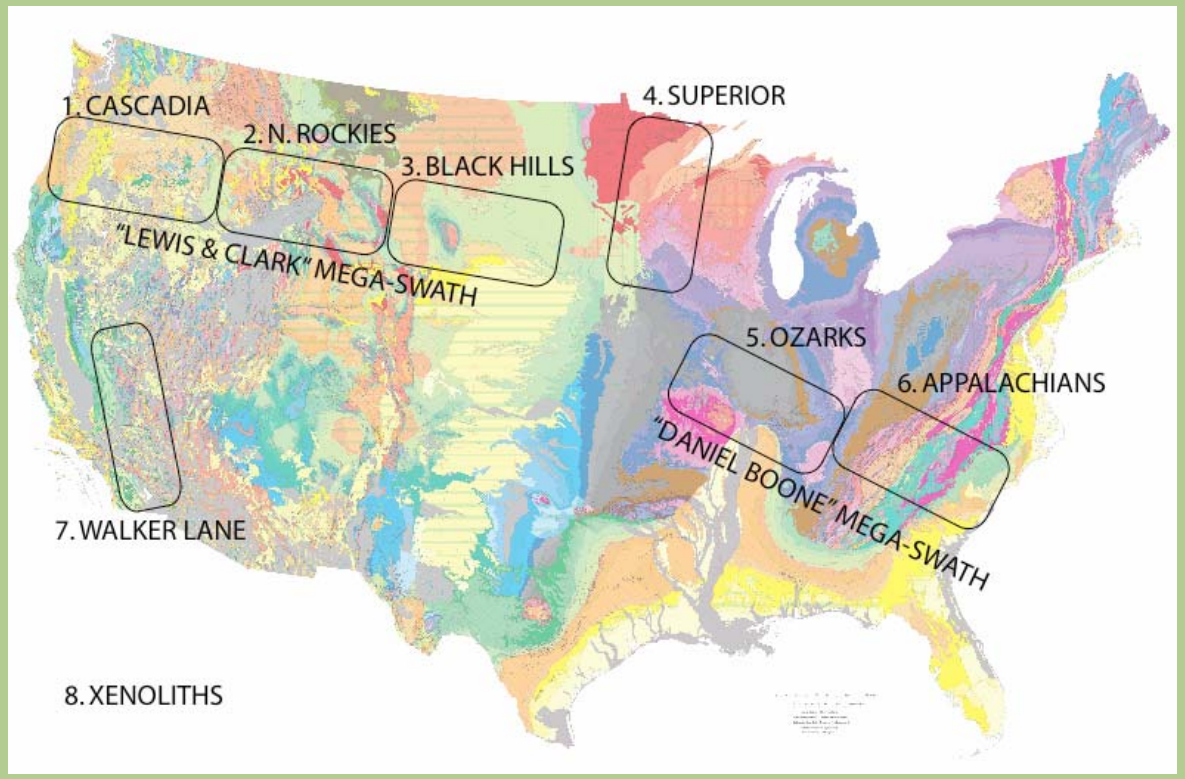
What is the **GeoFrame** concept?

- An intellectual framework that addresses the construction, stabilization, and modification of the North American continent through time ("4D Building a Continent").
- Combining process-oriented science with a coast-to-coast perspective of the continent, focusing not only on the major geologic provinces, but also on the boundaries between these provinces.
- A cooperative community approach to collecting and sharing data.
- A tangible, 'you can see it and touch it' basis for a national approach to education and outreach in the Earth sciences.

What is the **GeoFrame** concept?

Seven target areas (placeholders) across the conterminous U.S. and an eighth focus topic on xenoliths.

- Each target area addresses fundamental geological questions about the assembly and evolution of the continental lithosphere through time.
- The areas represent all types of tectonic boundaries (collisional, transpressional, strike-slip, transtensional, extensional).
- The areas preserve different times in Earth history (Archean, Proterozoic, Paleozoic, Mesozoic, Cenozoic, Active).



The path to **GeoFrame**

- A series of regional EarthScope and ISES meetings were held prior to the March 2006 EarthScope National Meeting.
- A mini-workshop on the GeoFrame concept (then called GeoTraverse) was help at 1st National EarthScope meeting in March 2006.
- An EarthScope-sponsored workshop on GeoFrame was held February 3-5, 2006, in St. Louis, Missouri.
  - Diverse group of about 60 geoscientists attended to discuss an integrated geologic framework for the USArray.
  - General consensus about the intellectual merit, scientific necessity, and role of GeoFrame in EarthScope science.
  - Agreement that this type of national planning is necessary for organizing targeted geographic regions across the United States for integrative study.
  - Choice of regions reflects a *compromise* between national coverage, field areas, research topics, and spatial connections among regions.
- The challenge of GeoFrame is clear: *to integrate the spatial detail and time portrayed by the U.S. geologic map with EarthScope studies of whole Earth and lithospheric processes*.

What is the motivation for **GeoFrame**?

- To build new partnerships in the EarthScope community (both geological and geophysical) in order to develop the integrated, multidisciplinary studies necessary to meet the stated EarthScope objective:
  "to investigate the structure and evolution of the North American continent ……..."

- To provide scientific cohesion and focus, by addressing national scientific problems for study in a connected approach.

- To encourage increased spatial resolution of the continental crust that is directly related to geological studies and thereby permit broader participation.

- A geologically based, problem-driven national approach that provide a new framework for educational and outreach opportunities.

Goals of this IRIS 2006 **SIG**

The geological community adds temporal, petrological, and kinematic constraints to the imaging dimensions of USArray. USArray needs to provide resolution on crustal scales that are important to geologic questions.

Moving forward:

- What is next for **GeoFrame**?
- What is needed for **GeoFrame**?

What made similar activities work?

- **Collaboration –** among geologists, geochemists, geochronologists and geophysicists.
- **Partnerships –** among all sectors: universities, governments and industry (where appropriate).
- **Integration –** all applicable subdisciplines of geology, geochemistry and geophysics.
- **Decentralized research –** local control for target areas; national coordination for overall project.

E.g., Lithoprobe, ECORS

Moving forward with **GeoFrame**

WE NEED A HAND-SHAKING PROTOCOL !

- Form a creative and constructive environment for geologists and geophysicists to learn from each other, mesh expertise and design investigations that optimize scientific return.
  - Note: This was just done successfully at the GeoFrame-inspired workshop on the Walker Lane region in Reno, Nevada (May 15–16, 2006).
- Provide a vehicle to build new partnerships between members of the EarthScope community.
  - Existing partnerships of geophysicists and geologists work, but new relations are needed for the scope and focus of the project.
  - Capitalize on growing EarthScope expertise, knowledge and interaction.
- Determine what specific areas and types of data are most important from a national geologic perspective, and coordinate regional working groups to achieve this.