Deep Dust: A Proposed Drilling Project to Probe Continental Climate of the Late Paleozoic Icehouse-Greenhouse Transition

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EGU 2020: Sharing Geoscience Online
Session SSP2.1 – Phanerozoic Stratigraphy, Paleoenvironments, Eustasy and Paleoclimate
Live chat on Thursday, 07 May 2020, 08:30-10:15.

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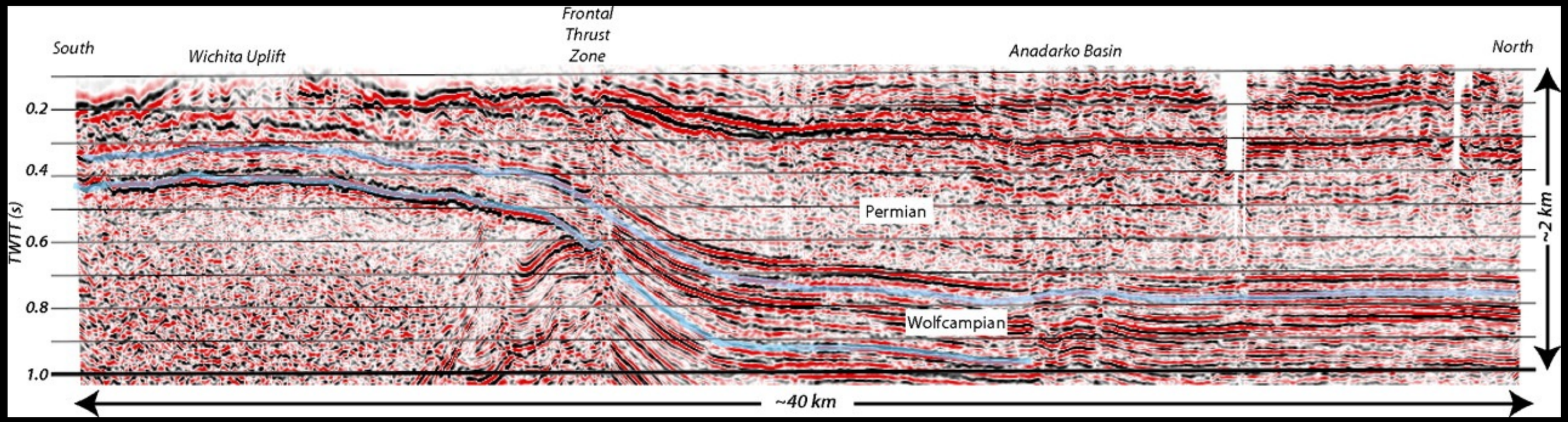
Deep Dust: Ultimate Goal

- Continuously core the Permian section of western and eastern equatorial Pangea (and possibly lowlands-uplands) with a primary goal of recovering records of continental paleoclimate.
- No cores currently exist that could enable this.



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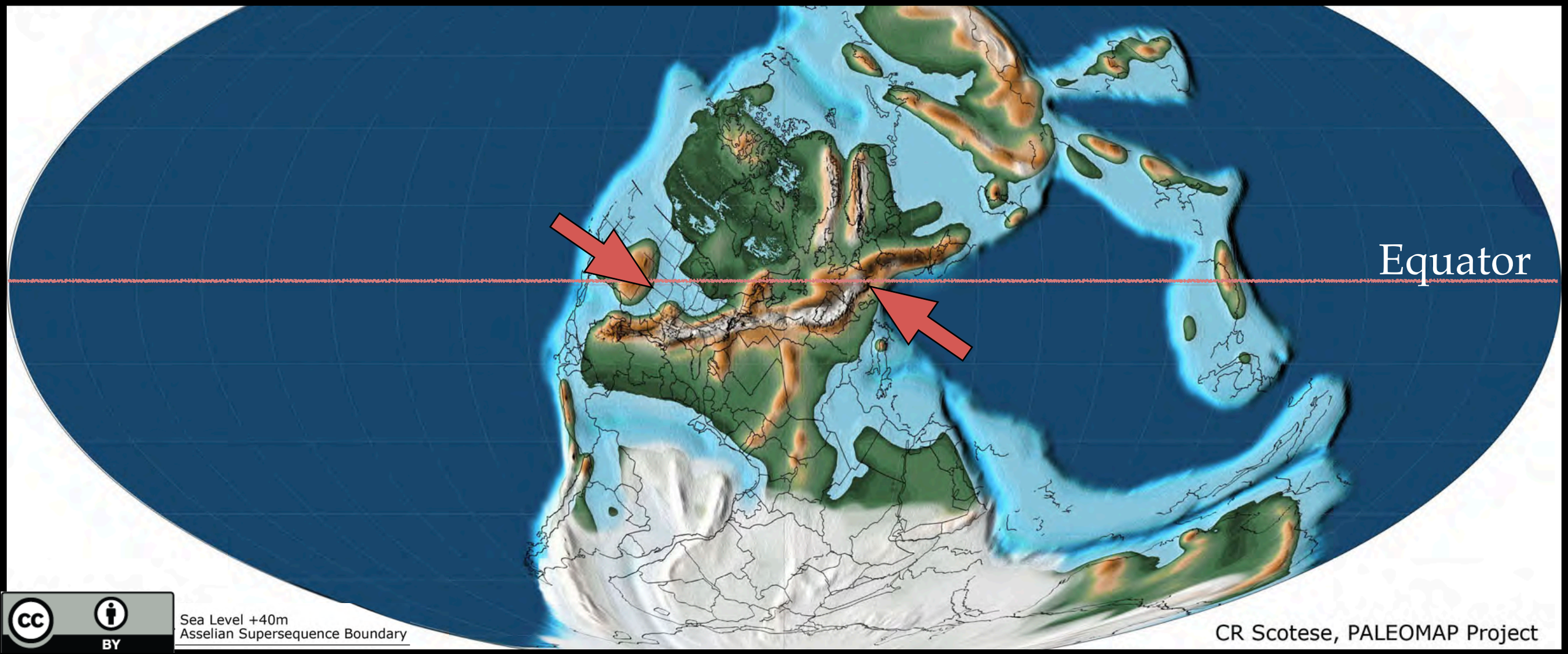
Why the Permian? Why the Equator?

- Permian captures penultimate transition from icehouse to greenhouse conditions on an Earth with a well-developed terrestrial biosphere.
- Equatorial sensitivity to climate forcings, and a focus on paleoclimate and linked Earth systems motivate recovery of continental records.
- Targeting high-resolution continental successions sensitive to environmental conditions (lacustrine, eolian, paleosol)



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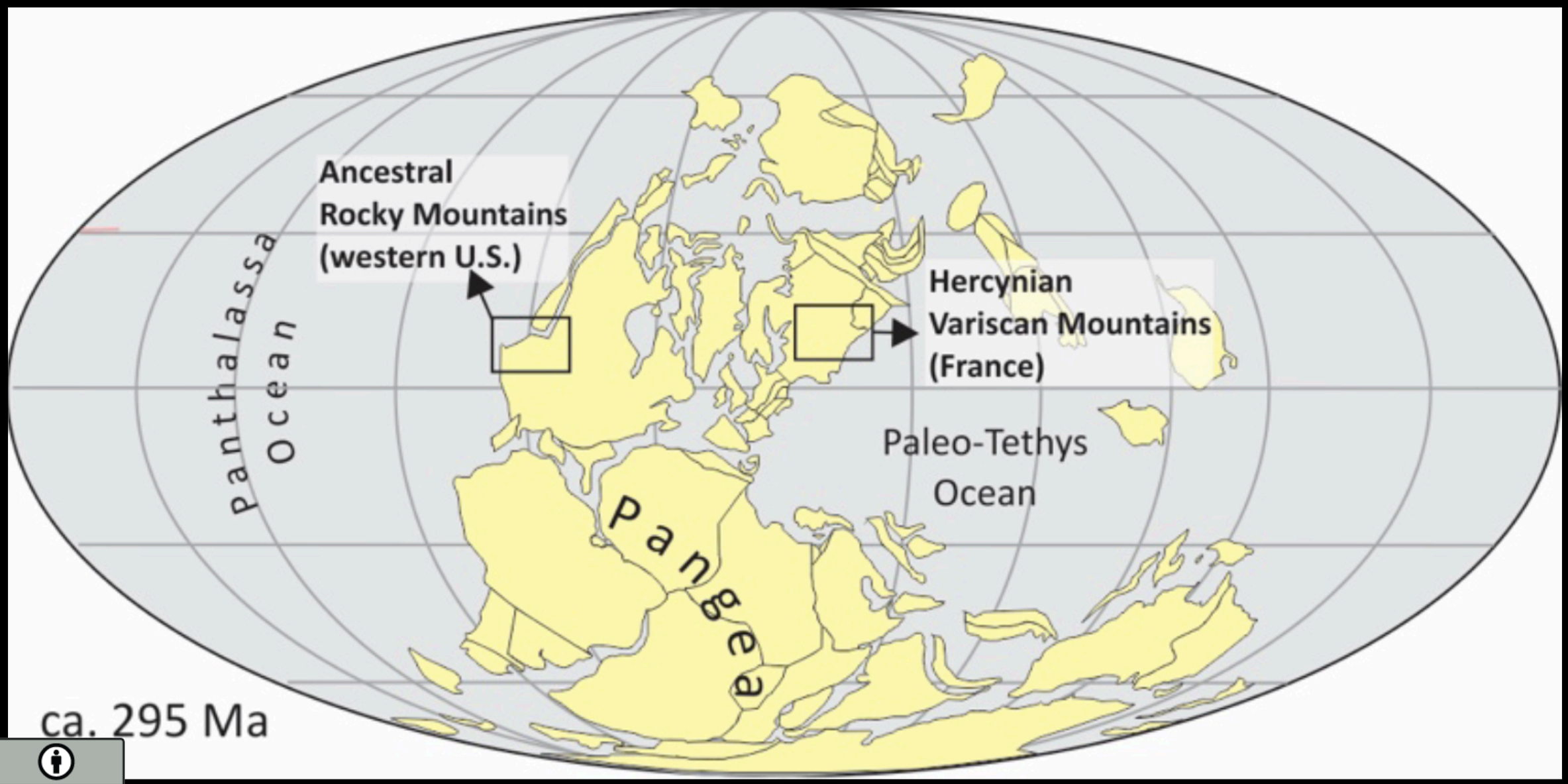
Target Sites

- Continental, W and E equatorial Pangea, lowlands-uplands
- Ideal sites proposed:
  - Anadarko Basin, Oklahoma, U.S. (western Pangea)
  - Paris Basin, France (eastern Pangea)



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DeepDust

Workshop 1.0
March 2019, Oklahoma

Objective: Discuss the compelling scientific questions to be answered through coring Permian continental strata of the Mid-Continent US and Western Europe, and develop analytical, drilling, outreach, and funding plans.

Workshop 2.0
January 2020, Paris

Objective: Define the target for coring Permian continental strata of Western Europe.

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Primary Science Objectives (ICDP Themes “Climate & Ecosystems” and “Sustainable Georesources”)

- Equatorial Pangaean climate— Icehouse to greenhouse
  - Character of peak icehouse (at equator); upland glaciation?
  - Icehouse collapse
- The Later Permian— Run-up to the Great Dying
  - Transition to extreme greenhouse
  - Extreme high continental temperatures? unusual chemistries?
- Atmospheric dust and the Pangaean megamonsoon
  - Dust as an archive of atmospheric circulation, hydroclimate
  - Mineral aerosols as a climate forcing

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Auxiliary Science Objectives

- Microbial Biosphere
  - Extent and nature of deep microbial biosphere
  - Ancient microbial biosphere (preserved in evaporites)
- Astrobiology
  - Redbed dust deposits and evaporites— Mars analogs?
  - Proxy development (e.g. labile minerals in evaporites?)
- Orogenic Processes
  - Targeted sites record orogenic collapse/upland subsidence
  - Widespread volcanism in eastern equator region
  - Exhumation rates in uplands (via thermochronology?)
- Microseismicity, Geothermal?

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Western Target: Anadarko Basin, Oklahoma

- Thickest sedimentary basin on N. American craton; Most complete record of Permian continental environments in the W. hemisphere (and possibly world).
- Pennsylvanian-Permian record houses continental climate of interior W. tropical Pangaea, at unique time— history of icehouse collapse, just prior to largest extinction known.
- Fundamental science with application (e.g. loess reservoirs, the impact of dust on source; structure of the front).
- Unique record of Permian paleomountains (including the structural/tectonic conditions that enabled them) that subsequently subsided— preservation of a paleo-landscape (next slide).

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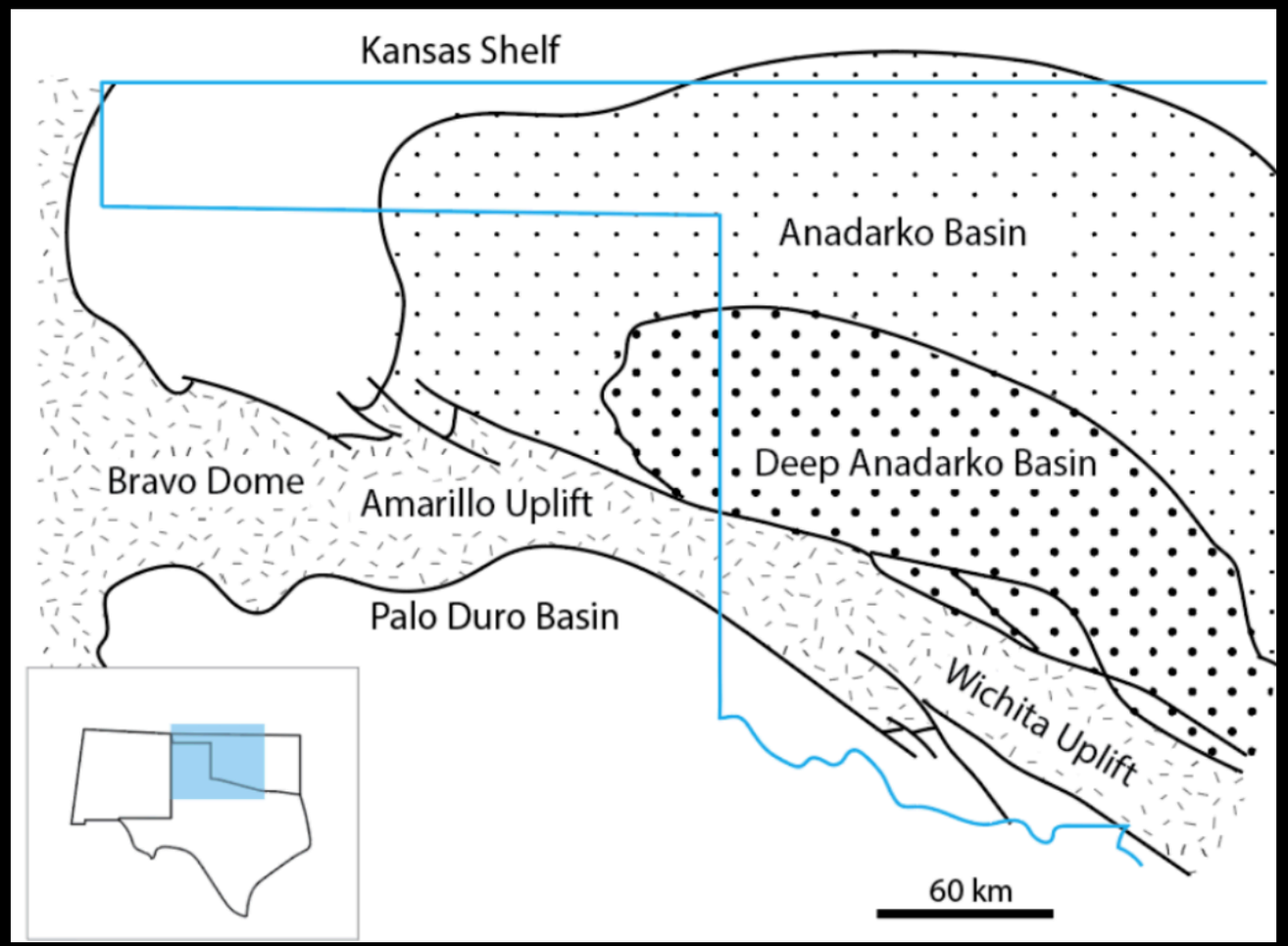
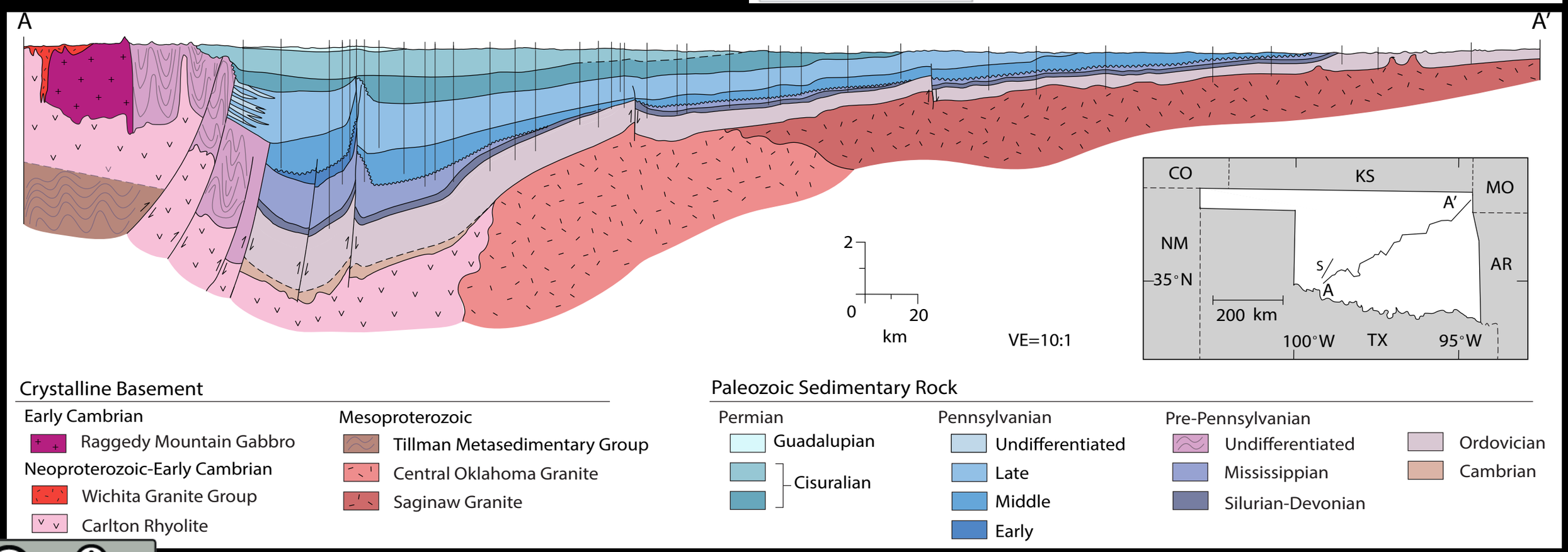
Western Target: Anadarko Basin, Oklahoma





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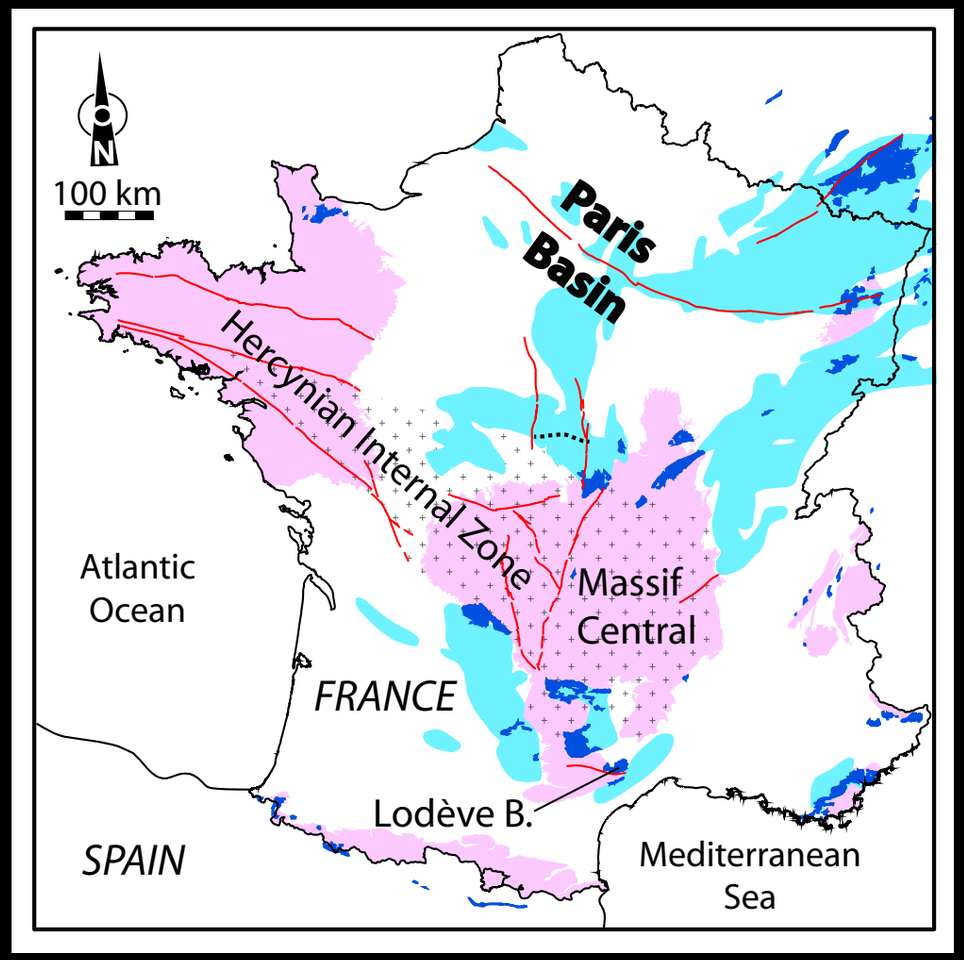
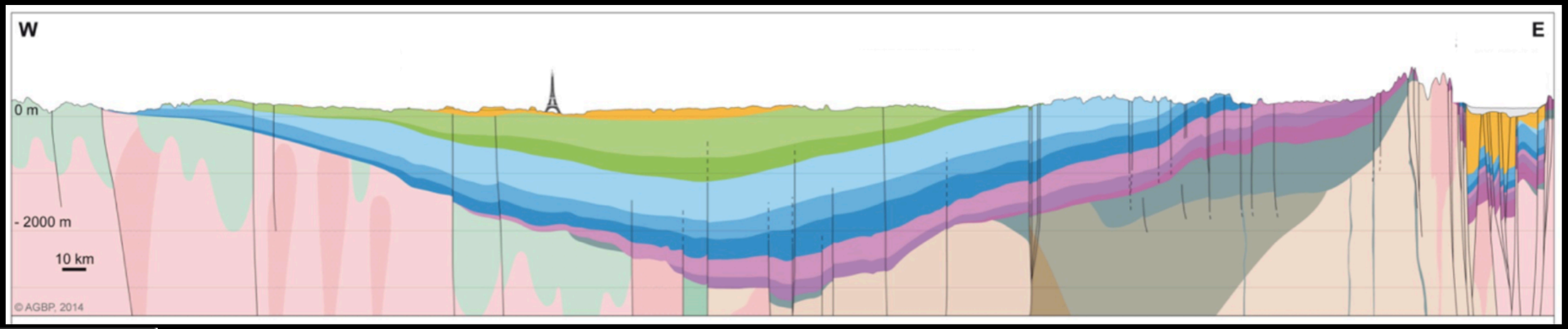
Eastern Target: Paris Basin



Simplified geology of France. Dark blue regions are basins with Permian strata exposed (e.g. Lodève), whereas light blue regions denote Permian strata buried. The dotted line near the middle of the map is the location of the seismic line on the next slide (Modified from Beccaletto et al., 2015).

East-west transect through the Paris basin. The Permian is dark grey and Carboniferous is grey. The Early-Middle Triassic is violet, Late Triassic is pink, Jurassic is blue, and Cretaceous is green).



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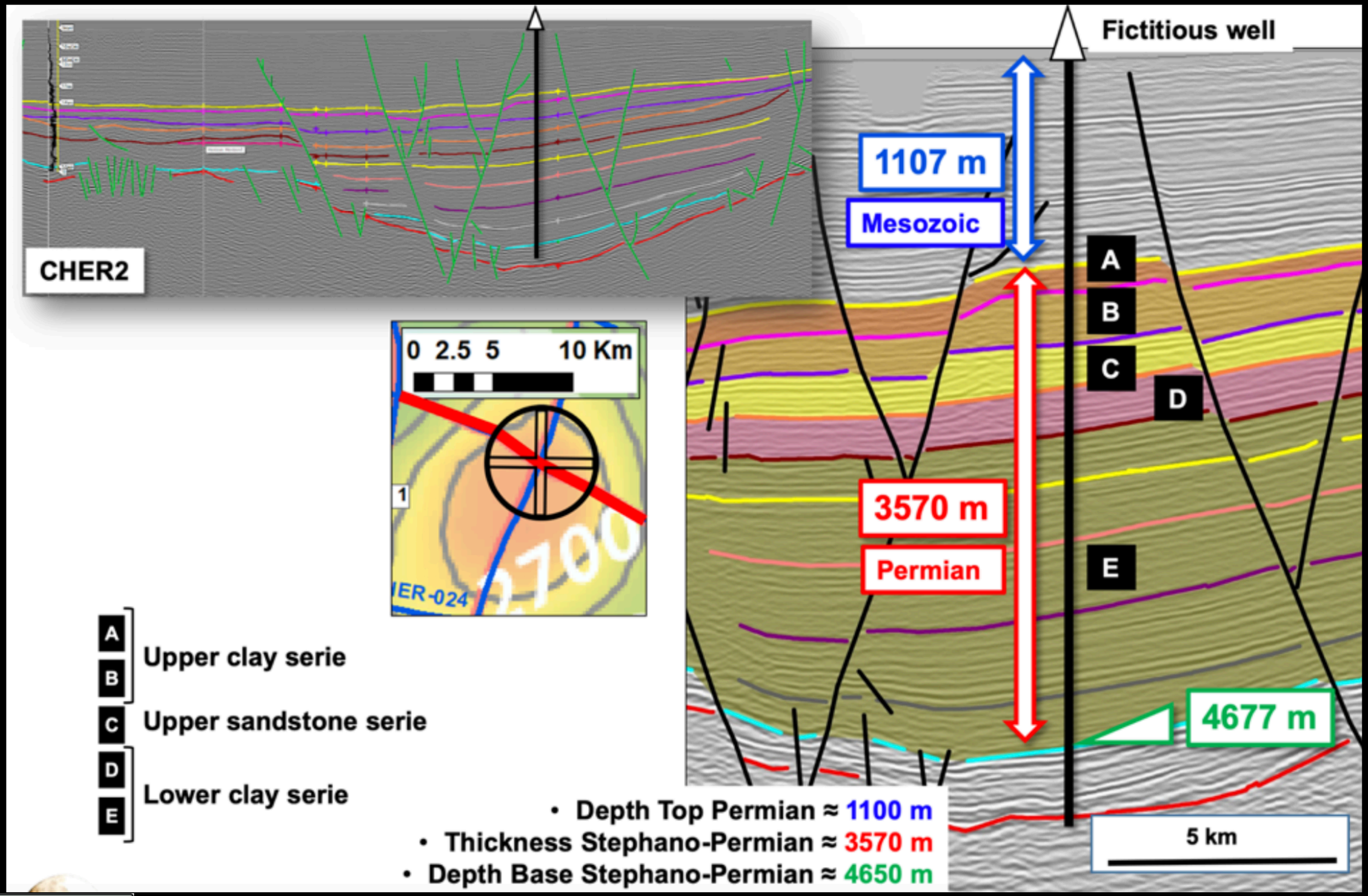

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Societal Relevance, Outreach

The climatic, tectonic, and biotic events of the Permian are among the most profound in Earth history. Rich fodder for investigating Earth system linkages, evolution of the carbon cycle, & auxiliary topics— all of strong interest for outreach and education.

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Thank you for taking the time to view this presentation. We are looking forward to receiving your comments and questions, but may not be able to monitor the live chat session due to the time difference (USA). Please leave your contact information with your comments so that we can respond as soon as possible. Thank you!

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