



Michigan Basin Geological Society

May MBGS Membership Meeting

www.mbgs.org



WHEN **Tuesday May 12th, 2026 - FREE**
Social: 6:45PM
Presentation - 7:00 PM - 8:00 PM

WHERE **East Lansing Public Library**
950 Abbot Rd, East Lansing, Michigan 48823

WHO **Reece P. Elling, PhD**
Grand Valley State University
Affiliate Professor of Geology
Website: bit.ly/rececelling



Rift Evolution and Precambrian Tectonics: Insights from North America's Failed Midcontinent Rift

ABSTRACT: Failed continental rifts provide unique opportunities to study aspects of plate tectonic evolution frozen in time. North America contains three major failed rifts: The Midcontinent Rift (MCR), Southern Oklahoma Aulacogen (SOA), and the Reelfoot Rift (RR). To understand why some rifts fail while others succeed to seafloor spreading, this work explores details of these rifts and their interactions within the framework of Laurentia's tectonic history.

Although the ~1100 Ma MCR is exposed along Lake Superior, it is primarily delineated by gravity, magnetic, and seismic data through the central United States. Its structures and evolution, defined by gravity modeling, seismic, and geologic data, tell a story of a sequence of extension, volcanism, subsidence, sedimentation, and subsequent inversion. Near the MCR's eastern arm also lie orogenic facies related to the Grenville Orogeny, a series of discrete collisions between Laurentia and Amazonia that culminated in the assembly of the supercontinent of Rodinia. Examining the interaction of these juxtaposing tectonic events using their gravity signatures revealed that the lineated gravity highs in the eastern U.S. appear similar to those along the remainder of the MCR, and unlike those along any portion of the Grenville Front (GF) where it is exposed and identified by seismic and potential field data in Canada. However, thrust sheet structures, like those of the southern Canadian GF, are likely present along the MCR's east arm, as implied by recent seismic data.

Investigating the similarities and differences of North America's three major failed rifts – the MCR, SOA, and RR – provide insight into the rifting process. All three rifts formed in similar tectonic settings as part of Laurentia's interactions within Rodinia, and followed similar evolutionary paths of extension, magmatism, subsidence, and inversion by later compression, leading to similar widths and architecture. However, differences

between the rifts reflect the extent to which these processes occurred. Because no sea floor older than a few hundred million years exists, understanding the tectonics of the Precambrian requires the use of paleomagnetic data to constrain plate motions and model global tectonics. Part of this research involved compiling over 15,000 published paleomagnetic poles to support a 1.5 Ga global plate model that was used to investigate the correlation between cusps in apparent polar wander paths and major tectonic events (such as rifting). This approach can be useful in defining tectonic events in time periods during which paleomagnetic data may be the only constraints.

BIOGRAPHY: Since graduating from GVSU in 2016, Reece completed a PhD in Geophysics at Northwestern University where he researched failed continental rifting events to understand their possible evolution paths in succeeding, or failing to succeed, to volcanic passive margins. He primarily focused on North America's Midcontinent Rift, and interpreted gravity, magnetic, and seismic data from the surrounding region to build subsurface models to understand its formation. While wrapping up his dissertation, he interned with the geophysical applications group at ExxonMobil, but Reece kept being drawn back to his passion for teaching. After graduating, he taught for one year at Indiana University Northwest before returning to GVSU as an Affiliate Faculty in 2023, where he's had the opportunity to teach introductory geology courses alongside solid earth materials, structural geology, and geophysics. He is currently mentoring several undergraduate research projects investigating the youngest bedrock in the Michigan Basin - the red beds of Ionia. Outside of work, Reece lives in Spring Lake with his wife, Hayley, and daughter, Inez, where they spend as much time as possible hiking in the dunes along Lake Michigan.

RELATED RECENT PUBLICATONS:

Elling, R.P., Stein, S., Gefeke, K., Stein, C.A., 2022. North America's Three Rifts: Similarities and Differences. *GSA Today*, v. 32, 8 pp.

Stein, C.A., Stein, S., Gallahue, M., **Elling, R.P.**, 2021. Revisiting hotspots and continental breakup – Updating the classical three-arm model, *GSA Special Paper "In the Footsteps of Warren B. Hamilton: New Ideas in Earth Science"*, v. 553, p. 1-17.

Elling, R.P., Stein, S., Stein, C.A., Keller, G.R., 2019. Tectonic implications of the gravity signatures of the Midcontinent Rift and Grenville Front. *Tectonophysics*.

Stein, S., Stein, C.A., **Elling, R.P.**, Kley, J., Keller, R., Wysession, M., Rooney, T., Frederiksen, A., and Moucha, R., 2018. Insights from North America's failed Midcontinent Rift into the evolution of continental rifts and passive continental margins. *Tectonophysics*. v. 744, p. 403-421.

Stein, C.A., Stein, S., **Elling, R.P.**, Keller, G.R., and Kley, J., 2018. Is the "Grenville Front" in the central United States really the Midcontinent Rift? *GSA Today*, v. 28(5), p. 4-10.

