PROPAGATION OF A TRANSTENSIONAL MIDCONTINENT FAULT ZONE: ALLEGHANIAN REACTIVATION OF THE STE. GENEVIEVE FAULT, ILLINOIS

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1. Abstract

Geologic mapping of a 45 km^2 area, along with analyses of shallow drill cores, reveals that a complex array of subsidiary faults occurs at the southeastern end of the Ste. Genevieve Fault System (SGFS) in southern Illinois. The array, here called the Wolf Creek Fault Zone (WCFZ), lies on the northeastern (downthrown) side of the SGFS, and is bounded to the north by the Pomona fault. In the zone, normal faulting has broken uppermost Mississippian strata (Menard, Palestine, Clore, Degonia, and Kinkaid Formations) into a set of fault blocks that have tilted by 16° to 20°. Earliest Pennsylvanian sediments are also faulted, but to a much lesser degree, so an angular unconformity delineates the boundary between Mississippian and Pennsylvanian strata. This stratigraphic constraint indicates that the WCFZ formed at the time of the Alleghanian Orogeny. We suggest that the WCFZ consists of splays that propagated in an incipient pull-apart basin as the SGFS grew and propagated to the southeast, in response to stresses transmitted into the continental interior from the Alleghanian collision. In this regard, the WCFZ is a Midcontinent manifestation of the "Ancestral Rockies" event.

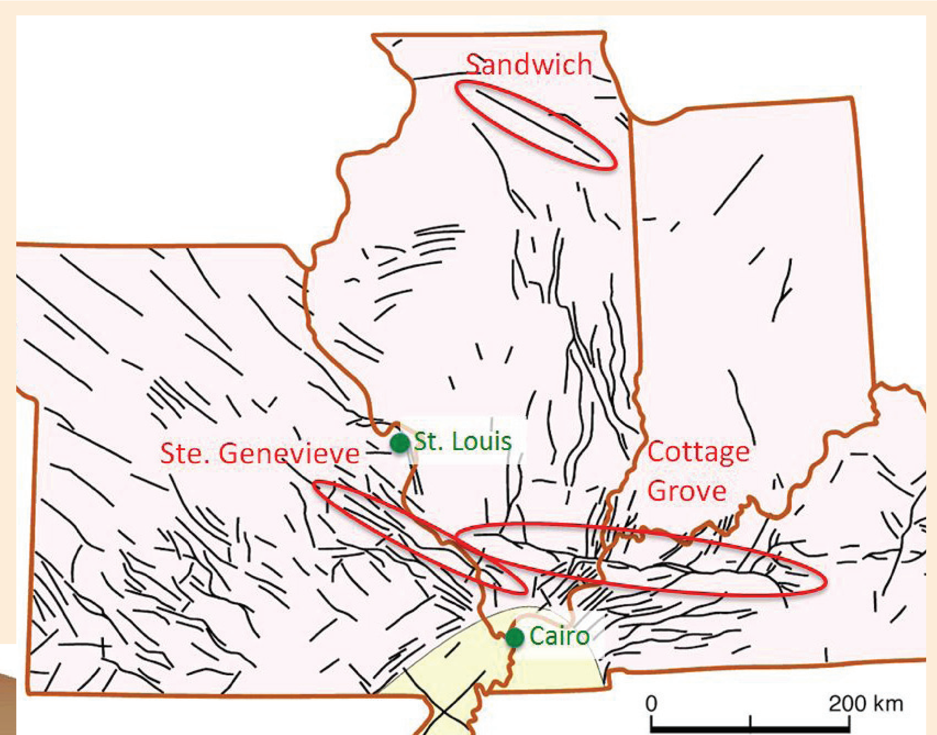

Figure 1

Ste. Genevieve fault system in southern Illinois.

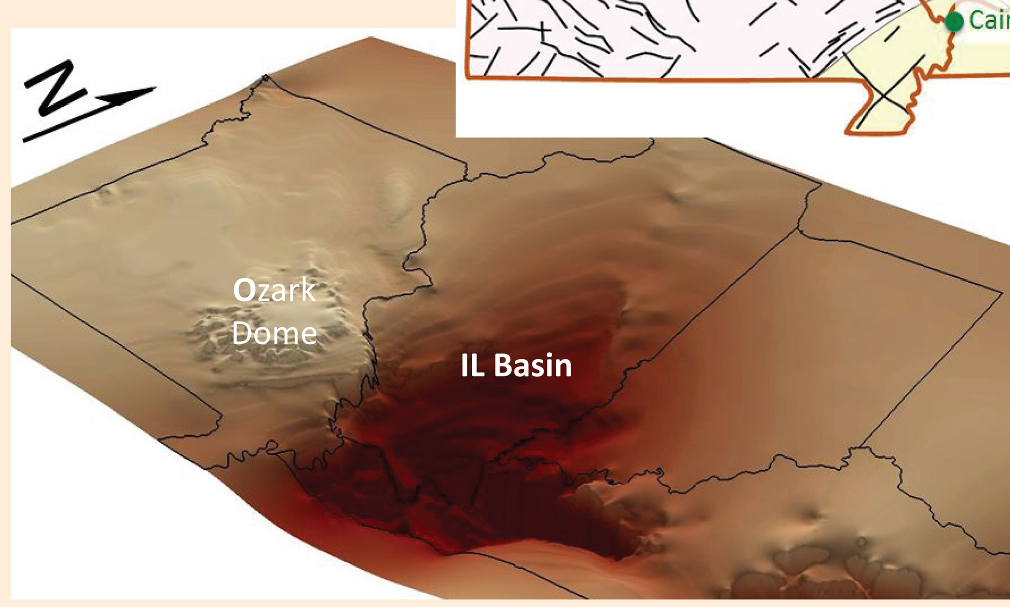

Figure 2

The SGFS is the major bounding fault separating the Ozark Dome and the Illinois Basin; surface of the top of Precambrian basement.

2. Introduction

The SGFS (Fig. 1) is the major bounding fault separating the Ozark Dome and the Illinois Basin (Fig. 2). It is one of a network of W- to NW-trending fault-and-fold zones that cut the cratonic platform of the Midwest. Other examples in the Illinois Basin include the Cottage Grove fault system and the Sandwich fault zone. Such faults penetrate basement at depth, and spread into a flower-like splay near the surface. Splays, in some cases, die out up-dip into monoclinal folds. Evidence from some examples suggests that the faults originated during Proterozoic rifting events, and have remained as crustal weak zones, susceptible to reactivation ever since.

Several midcontinent fault-and-fold zones were reactivated during the Paleozoic. The specific timing of reactivation events (Ordovician; Devonian; late Paleozoic) suggests that they are a cratonic response to continental collisions on the margins of North America.

The kinematics of movement varies substantially. The dip-slip component has been well documented, due to measureable stratigraphic offset. Strike-slip displacement is harder to characterize, but evidence for it does occur in the form of shallowly plunging slip lineations, arrays of en echelon subsidiary faults, and in a few cases, offset stream channels.

3. Statement of the Problem

- What is the geometry and kinematics of the Wolf Creek fault zone?
- How is the zone related to the Ste. Genevieve fault system?
- What does its existence imply about the manifestation of syn-Alleghanian deformation in the Midcontinent?

4. Results

Mapping elucidated that the WCFZ involves Carboniferous strata (Figs. 3 and 4), which have been cut by NNW- to NNE-trending normal faults. These faults are oriented obliquely to the main NW-SE trending SGFS. Most fault displacement occurred prior to the Pennsylvanian, since the base of the Pennsylvanian sequence is an angular unconformity.

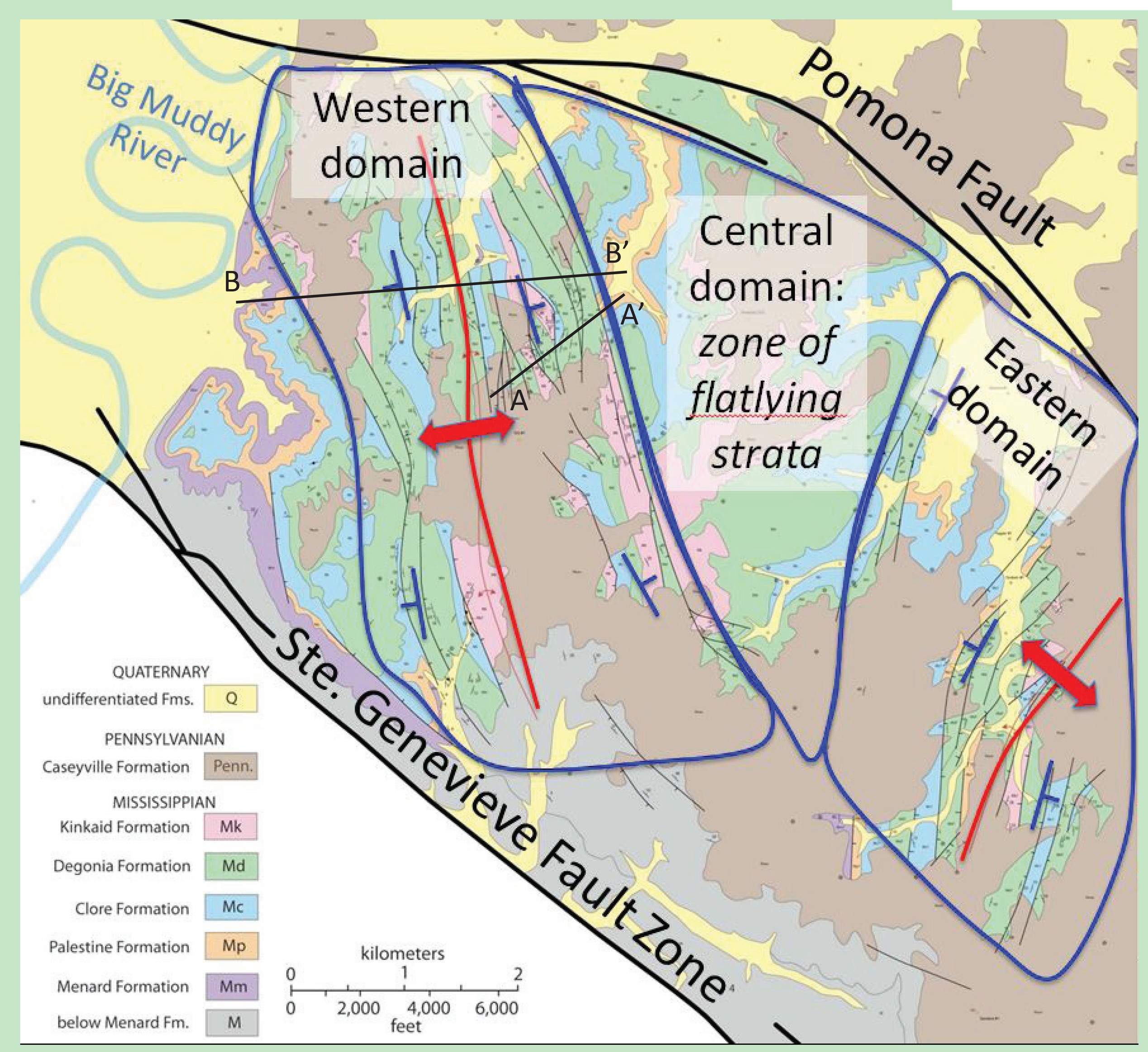

Figure 3 Geologic map of the WCFZ.

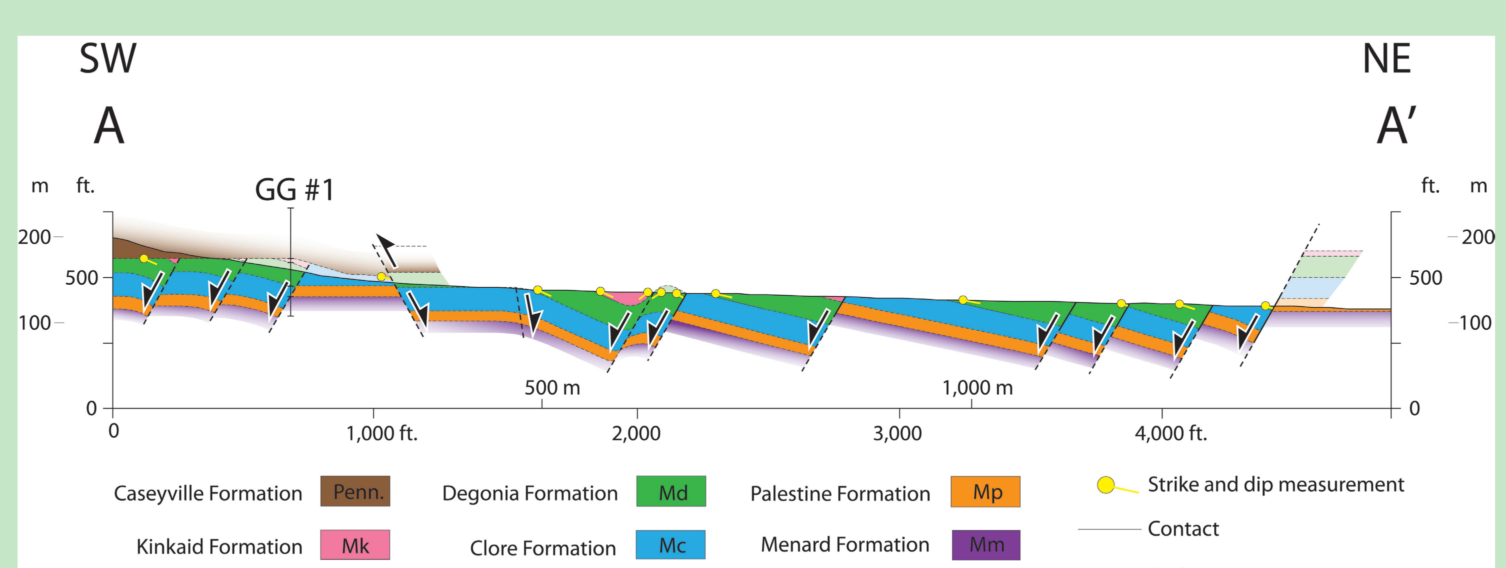

Figure 4 Cross-section of Wolf Creek.

5. Discussion

Two alternative working hypothesis to explain the faulting were tested. In the first, the faults ramp down to a shallow detachment (in the Menard Formation) due to near-surface slumping into a paleo-valley. In the second, the faults are the near-surface manifestation of a negative flower structure (Fig. 5) associated with transtension at the end of the SGFS. In this model, the zone is effectively an incipient pull-apart horsetail (Fig. 6).

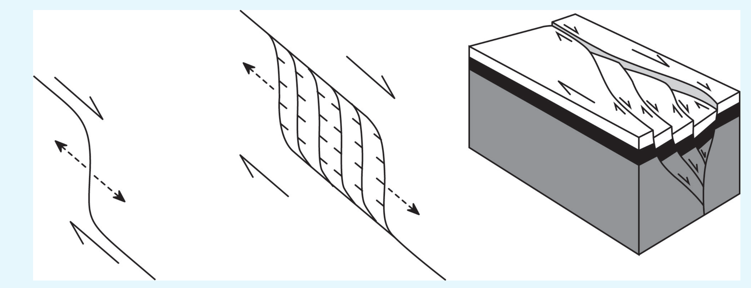

Figure 5

A negative-flower structure (from Woodcock and Fischer, 1986).

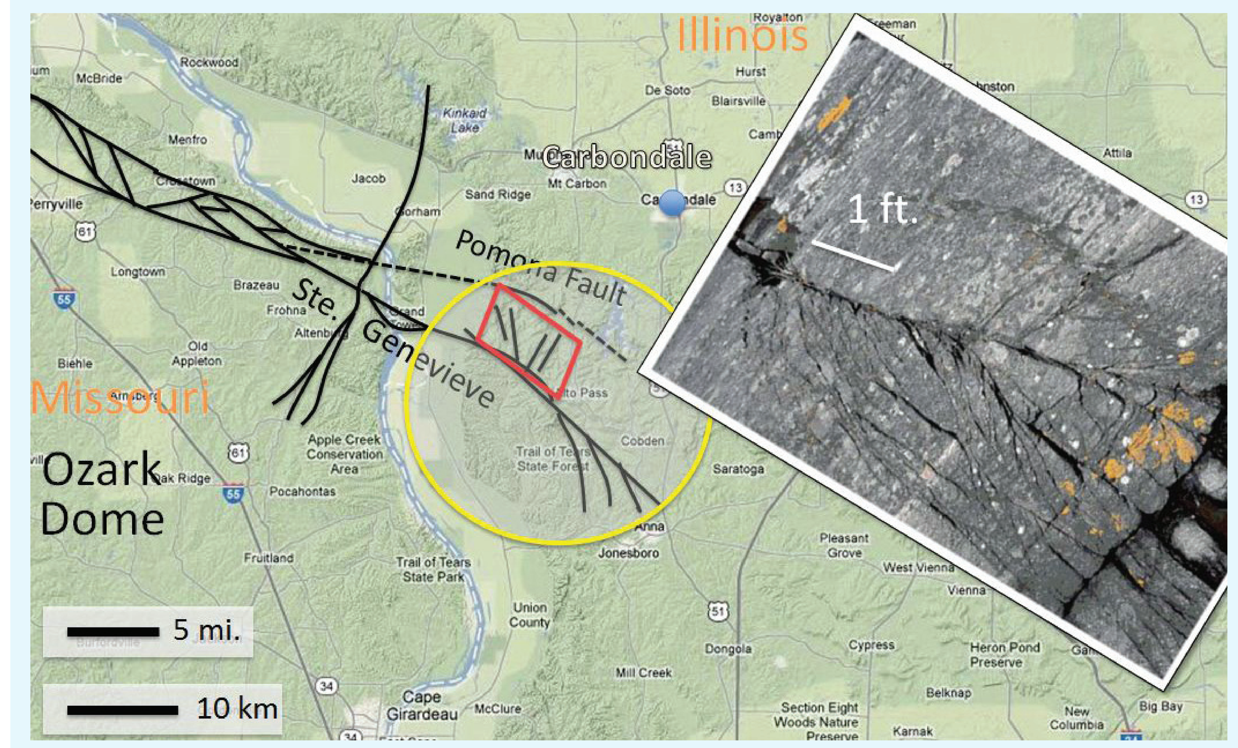

Figure 6 An incipient pull-apart horsetail at the SE tip of the SGFS.

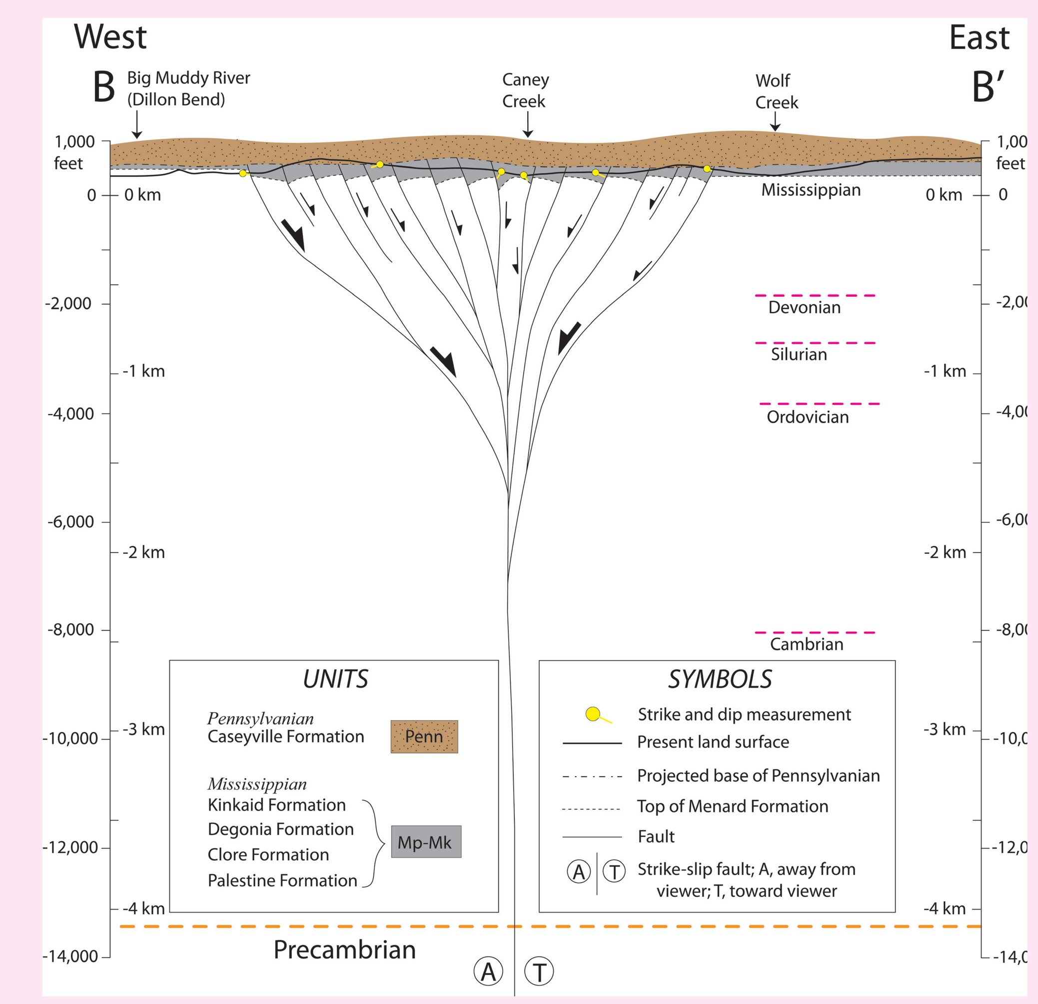

Figure 7 The negative flower structure forming the western domain.

Construction of cross sections requires that faulting penetrate more deeply than the Menard, so the first hypothesis does not work . The pattern of faulting is compatible with the second hypothesis, with the caveat that the WCFZ actually includes two negative-flower structures separated by an unfaulted block. The negative-flower structure forming the western domain is shown in B-B' (Fig. 7).

The WCFZ, therefore, resembles the Cottage Grove fault system and the Sandwich fault zone. The NNW and NNE trends of normal faults suggest localized WSW-ENE extension, which is consistent with a component of right-lateral strike-slip displacement on the SGFS (Fig. 8). This late-Mississippian to early-Pennsylvanian deformation event likely records a period of Alleghanian reactivation and associated propagation of a continental-interior fault-and-fold zone (Fig. 9).

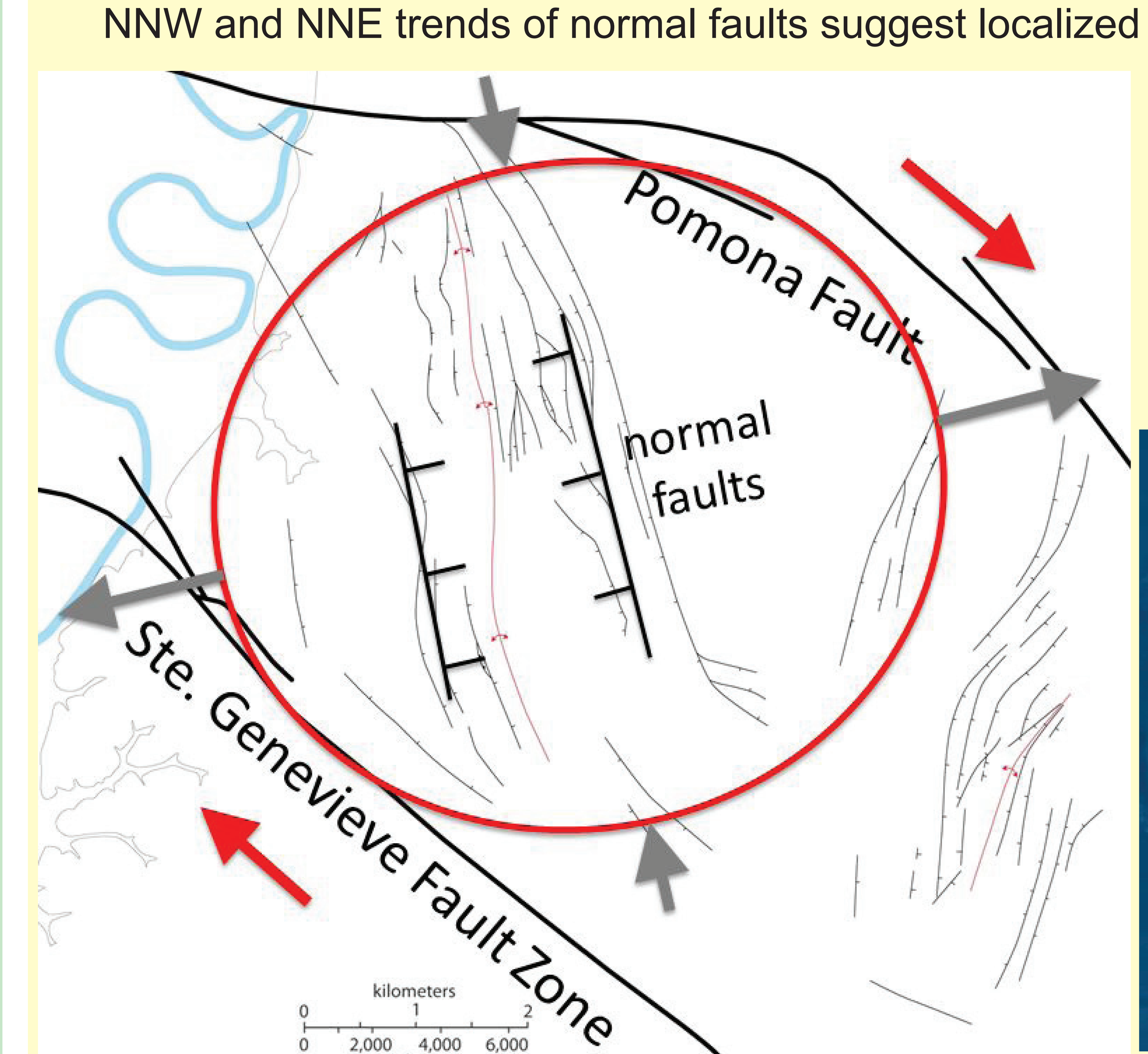

Figure 8 A component of right-lateral shear produces WSW-ENE extension.

Figure 9 Alleghanian Reactivation of the SGFS (modified from Blakey).

Acknowledgements

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