Sense of shear and thermal evolution of the schist of Sierra de Salinas, California

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Abstract

Improved knowledge of kinematic and geochronologic relationships is important for understanding the late Cretaceous demise of the Salinia-Mojave continental arc, its effect on crustal composition, and the processes of sediment subduction, tectonic erosion, ridge collision and exhumation. The demise of the arc coincided with structural juxtaposition of forearc-type assemblages (the POR schists) and Eastern-zone plutonic rocks along the Salinas shear zone. We investigate this late Cretaceous episode using microstructural techniques, 2D modeling and Ar-Ar dating. Preliminary microstructural work indicates top-to-northeast ductile shear, similar to the sense of shear in lower-grade early Tertiary schists to the SE. Preliminary 2D modeling suggests that flat subduction may not be a feasible mechanism for schist emplacement as has previously been suggested.

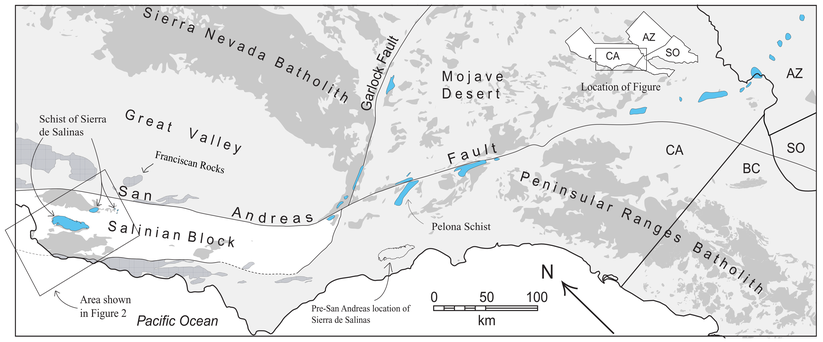

Figure 1. Map of parts of California, Arizona, Sonora, and Baja California showing some geologic features. The POR schists are shown in blue. Mesozoic granitic and related metamorphic rocks are shaded lightly. Fine-gridded areas are mainly Franciscan formation. Pre-San Andreas location of Sierra de Salinas from Powell (1993).

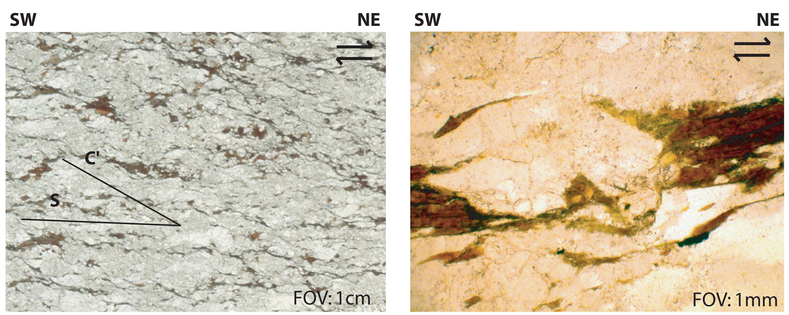

Figure 2. Micrographs of schist of Sierra de Salinas showing criteria used to determine sense of shear. The image at left shows typical C' fabric. The image at right shows two biotite "fish."

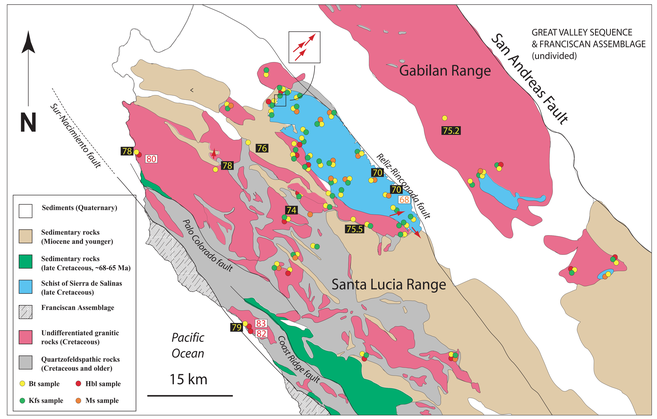

Figure 3. Geologic map of the Salinian central block (after Barbeau et al, 2005) showing sample locations for 40Ar/39Ar dating and sense-of-shear determinations. Boxed ages mark locations of samples previously dated by Barth et al. (2003) and Kistler and Champion (2001). Ar-work is in progress. See figure 1 for location. Red arrows indicate locations where a preliminary sense of shear is determined. Arrows indicate motion direction of upper plate.

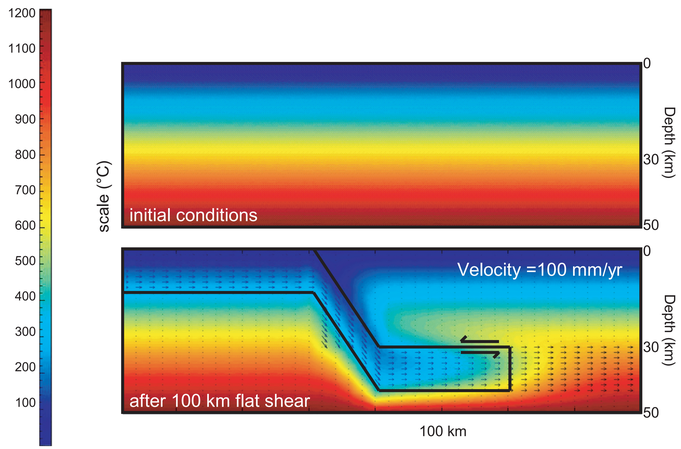

Figure 4. Thermal mechanical modeling can test the flat slab hypothesis (from East or West; e.g. Kidder et al, 2005; Grove et al, 2005). The key field observation is a convergence in upper and lower plate temperatures at initial upper plate conditions. Preliminary results shown above suggest insufficient heat is available with a flat slab scenario to reach observed temperatures in the schist.

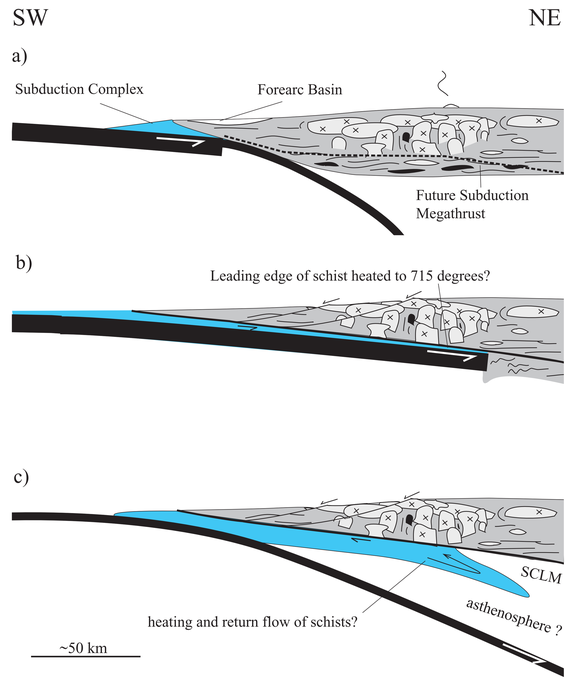

Figure 5. Cartoons depicting initial conditions and two possible scenarios for schist emplacement during the Late Cretaceous demise of the Salinia-Mojave continental arc. Schist shown in blue. No vertical exaggeration. (a) Initial conditions of arc just prior to collision with overthickened oceanic crust (e.g. Saleeby, 2003). The dashed line in panel a depicts the future location of the megathrust. (b) Flat slab hypothesis for heating the schist (after Kidder & Ducea, 2006). As lower portions of the arc were sheared off, the leading edge of the schist was carried beneath the now-extinct volcanic arc heating the schist to over 700°. This hypothesis predicts top-to-southwest shear. (c) Alternative hypothesis for heating the schist (after Saleeby, 2003). Schist is heated at depth and returned to shallower levels by some exhumation process, possibly return flow. This process overprints structures that may have developed in an earlier deformation phase of top-to-southwest shear (e.g. panel b). This hypothesis is more consistent with results of 2D modeling and preliminary evidence of top-to-northeast sense of shear observed in the schist of Sierra de Salinas.