Insights into the formation of the Cottonwood Canyon fault in the Catalina Schist

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Introduction

- Catalina Schist: subduction-related metamorphic rock complex on Santa Catalina Island, CA
- Cottonwood Canyon fault located in coherent amphibolite unit adjacent to mélange matrix
- Fault formation mechanisms may shed light on mélange matrix formation and relationship between coherent amphibolite unit and mélange matrix
- Catalina Schist: 7.5 - 11.5 kbar, 350-740 °C (Bebout and Barton, 2007)
- Amphibolite facies mélange: 8.5-11 kbar, 640-750 °C (Sorensen and Barton, 1987)
- 114.5 ± 0.6 Ma (Anczkiewicz et al., 2004)

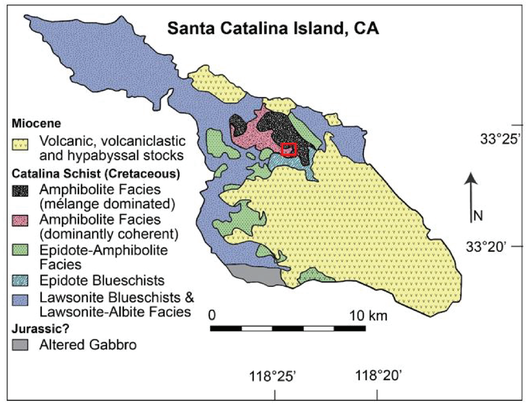

Fig. 1. The mélange dominated amphibolite facies rocks and dominantly coherent amphibolite facies (host) rock are the focus of this research. The red box indicates the location of the Cottonwood Canyon fault (adapted from Platt, 1975).

Hypothesis

The Cottonwood Canyon fault rock was in part derived from the mélange matrix in the Catalina Schist.

Results and Discussion

- Variable fault core thickness evidence for opening; slickensides evidence for shearing
- Hightended Ni, Cr, MgO, and highly siderophile elements (HSEs) in fault core and damage zone as well as geochemical heterogeneity in fault rock indicate mixing
- Pumpellyite does not have a shape preferred orientation in fault rock; chlorite and amphibolite show signs of deformation (kinks, folds, and fractures) in fault rock
- If water was added into the system, the following reaction from Brown (1977) may have taken place: Czo + Hbl + H_2O → Pmp + Chl + Qz

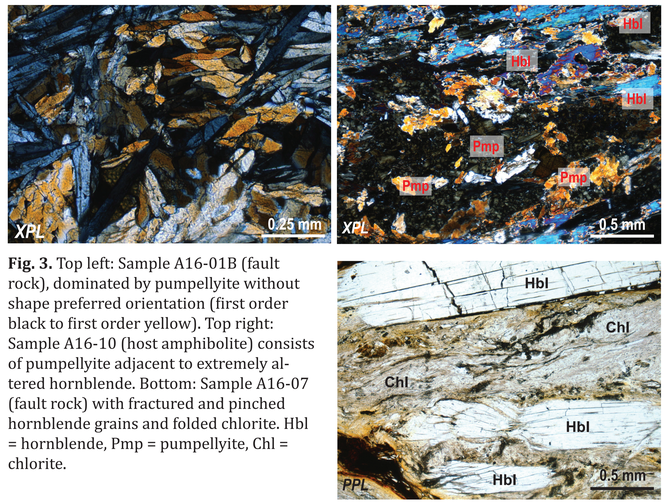

Fig. 3. Top left: Sample A16-01B (fault rock), dominated by pumpellyite without shape preferred orientation (first order black to first order yellow). Top right: Sample A16-10 (host amphibolite) consists of pumpellyite adjacent to extremely altered hornblende. Bottom: Sample A16-07 (fault rock) with fractured and pinched hornblende grains and folded chlorite. Hbl = hornblende, Pmp = pumpellyite, Chl = chlorite.

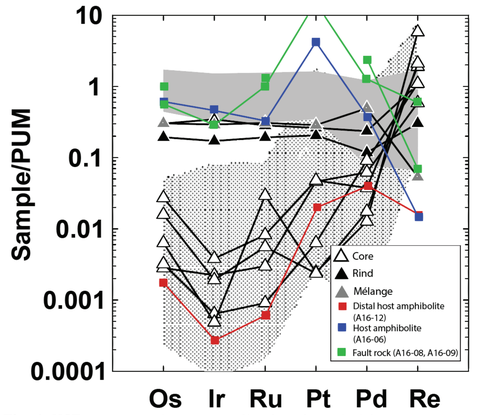

Fig. 4. HSE concentrations normalized to the primitive upper mantle (PUM) values determined by Becker et al. (2006) discriminate between ultramafic and mafic rocks. Triangles represent data from Penniston-Dorland et al. (2012). The crosshatched zone is the area where basalts plot; the solid grey zone is the area where peridotites plot.

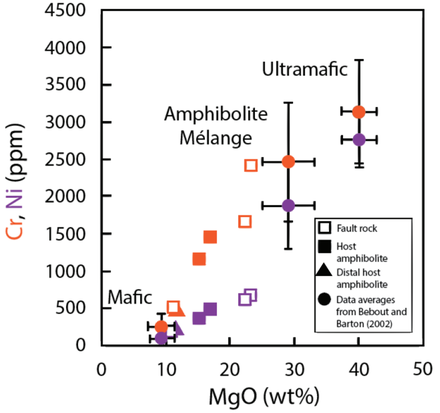

Fig. 5. MgO, Cr, and Ni concentrations in fault rock and host amphibolite as compared to mafic and ultramafic end-member averages as well as mélange matrix concentrations collected by Bebout and Barton (2002).

The Fault

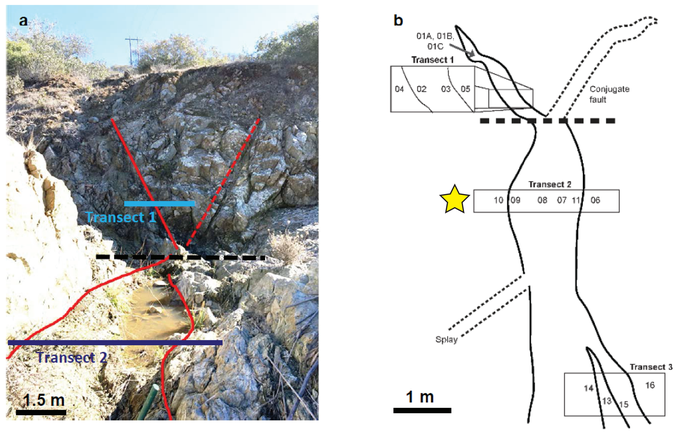

Fig. 2. a) Solid red line = main studied fault; dashed red line = possible conjugate fault. b) Star = transect of main geochemical and deformational interest; numbers = sample location, all begin with "A16-" followed by number/letter in figure; sample A16-12 not pictures, collected 64 m away from fault. Horizontal black dashed line in same location in both images.

Conclusions

- Both shearing and opening formed the fault
- Sheared host amphibolite + mélange matrix = fault rock
- Amphibolite crystallization → deformation + mélange matrix flow → pumpellyite crystallization
- Retrograde metamorphism took place
- Mélange matrix was once mobile and capable of flowing

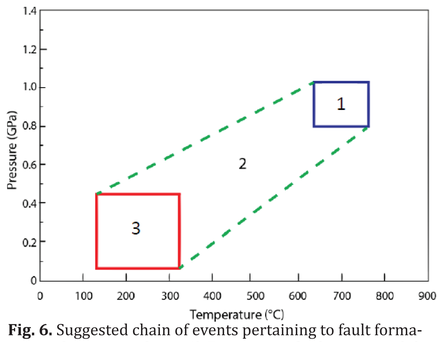

Fig. 6. Suggested chain of events pertaining to fault formation and metamorphism. 1) Formation of coherent amphibolite (Sorensen and Barton, 1987). 2) Shearing and opening of fault. 3) Pumpellyite crystallization.

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