Analyzing deformation within a normal fault transfer zone using Structure-from-Motion 3D Modeling

Sarah Landimes, Benjamin Stipesh, Curtis Segarra, Charley Hankla, and Madison Woodley

INTRODUCTION

Background

Jurassic Carmel Formation, which overlies the Navajo sandstone and consists of alternating siltstone and limeconglomerates, is exposed in a transect from the Mt. Carmel fault segment at Elkheart Cliffs, where a single fault accommodates extension (Fig. 2). Multiple fault segments of the steeply WNW-dipping Sevier fault zone have interacted to accommodate strain, intensity, and vertical variations within the fracture network.

Research Questions

1. Is there a significant difference in the fracture network developed within a normal fault transfer zone relative to an isolated normal fault segment?
2. How does fracture intensity, orientation, and spatial distribution vary in relation to axial ramps?
3. Is there significant vertical variation in fracture orientation and/or intensity within the exposed stratigraphy?

METHODS

Fracture Orientation

At Elkheart, M5, fracture orientations of each model scanlines are sub-pixel oriented to the host. The fault segment, dipping at the same orientation as the fault, was chosen to form the host for the normal fault transfer zone. A total of six fracture sets, called M1, M2, M3, M4, M5, and M6, were identified for orientation analysis. These fractures were observed from field and model scanlines. From field and model scanlines, the orientation of fracture sets relative to mapped faults was obtained. We photographed visually observed fractures (e.g., Kagan and Jackson, 2000) and plotted the orientation of fractures on fault maps to evaluate the orientation of fractures on fault maps.

Statistical Analysis

Using field and model scanlines, orientations of fracture sets relative to mapped faults were obtained. From field and model scanlines, the orientation of fracture sets relative to mapped faults was obtained. We photographed visually observed fractures (e.g., Kagan and Jackson, 2000) and plotted the orientation of fractures on fault maps to evaluate the orientation of fractures on fault maps.

Fracture Intensity and Clustering

In Red Hollow Canyon, the Carmel Formation is exposed with fractures (white) and bedding or changes in lithology (black) (Fig. 1). Although both localities display excellent bedrock exposure, the significant topography made documentation of field relationships impossible in many areas. Here and in the 3D model built for this location, the model displays fractures (white) and bedding or changes in lithology (black) (Fig. 1).

Fracture Intensity and Clustering

At both the transfer zone locality in Red Hollow Canyon (RHC) and at 31A, fracture intensities (FI) (m^-1) and the spatial distribution of fractures were determined from field and model scanlines. FI was determined from field and model scanlines. FI was determined from field and model scanlines. From field and model scanlines, the orientation of fracture sets relative to mapped faults was obtained. We photographed visually observed fractures (e.g., Kagan and Jackson, 2000) and plotted the orientation of fractures on fault maps to evaluate the orientation of fractures on fault maps.

DATA AND RESULTS

Lateral Fracture Intensity

In Red Hollow Canyon, our data from different stratigraphic positions suggests that average fracture intensity and the spatial distribution of fractures vary significantly in response to changes in stratigraphy. In our study area, fracture intensity can range from low values within the Navajo sandstone to high values within the Carmel Formation. Fracture intensity values range from low to high within the Navajo sandstone and Carmel Formation. These differences suggest that the fracture network is influenced by mechanical behavior (Fig. 9) and the spatial distribution of fractures is controlled by strain localization.

Fracture Intensity and Clustering

Fracture intensity and clustering vary with distance from the fault zone. Fractures in the Navajo sandstone display a significant increase in intensity with distance from the fault zone. Fractures in the Carmel Formation display a decrease in intensity with distance from the fault zone.

IMPLICATIONS

Fracture Intensity and Clustering

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REFERENCES


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