Influence of Laramide Deformation on the Proterozoic Basement In the Southern Sangre de Cristo Mountains, New Mexico

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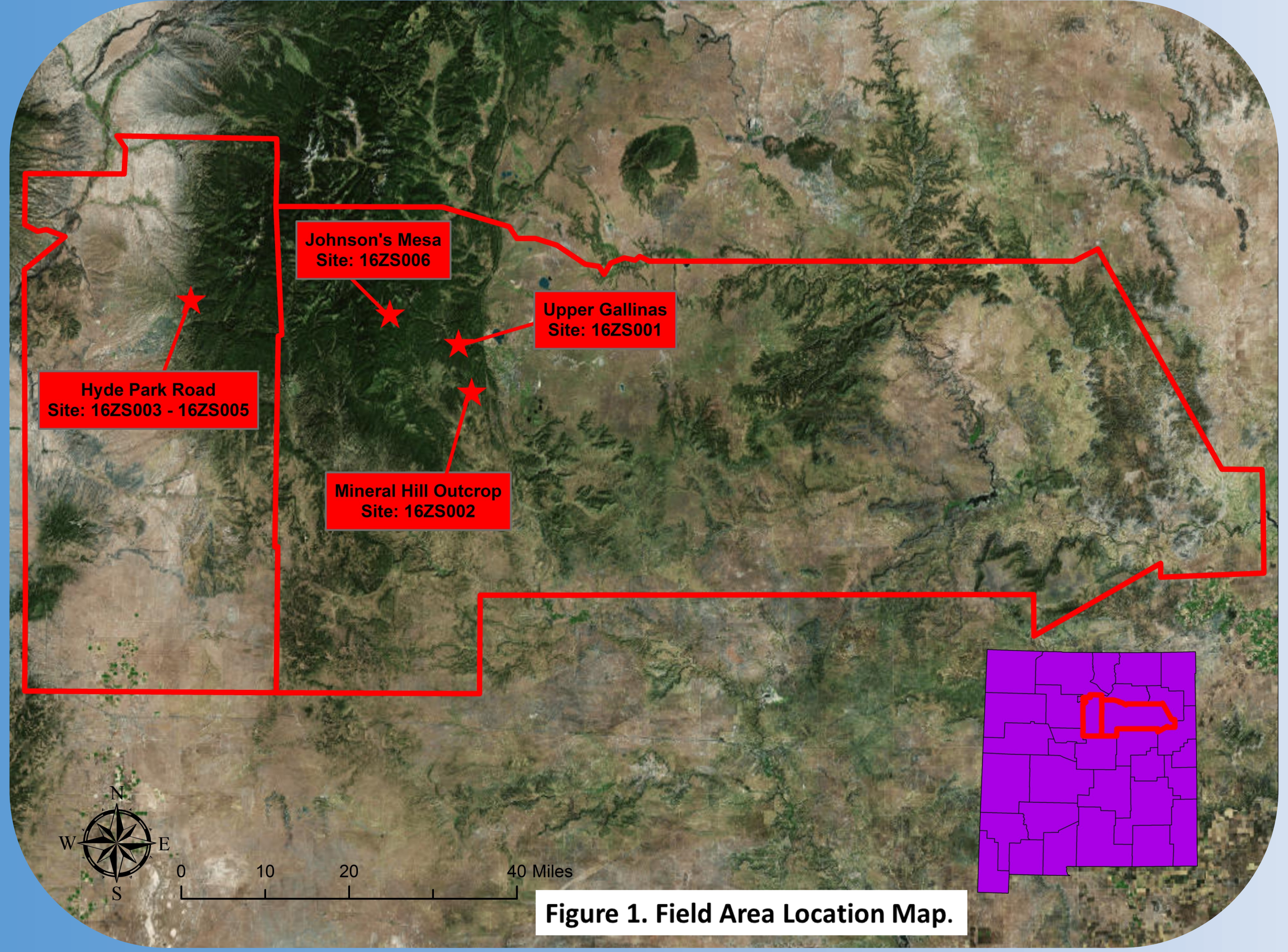

Figure 1. Field Area Location Map.

Geologic Setting

- Proterozoic basement blocks are north trending and west tilting; bounded by northeast-trending, west dipping high angle Laramide reverse faults from the east and west.
- Main rock types in Mora-Rociada-Las Vegas Ranges: quartz-schist, Pecos Greenstone Complex, quartz-feldspar gneiss-basaltic amphibolite.
- Lithological changes occur due to tectonofacies changes from a back-arc basin to a magmatic arc.
- Proterozoic Rocks overlain by late Mississippian to Pennsylvanian age rocks – west dipping.
- **Ancestral Rocky Mountains (Late Mississippian – Early Permian)**
  - Series of intracratonic basement uplifts.
  - Structures trend north-northwest and are overprinted by Laramide Orogeny and Rio Grande Rift.
  - Basement uplifts show late Paleozoic age folding and faulting resulting from reverse and thrust faulting (Kues and Giles, 2004).
  - Proterozoic and Cambro-Ordivician weaknesses in the crust reactivated by ARM and later by the Laramide Orogeny.
- **Laramide Orogeny (Late Cretaceous - Eocene)**
  - Overturned Paleozoic and Mesozoic strata by basement uplift causing faulting, folding, and overturning.
  - Reverse faults strike north-south, parallel to mountain range; Structures localized to zones of weakness which were then reactivated (Figure 2).

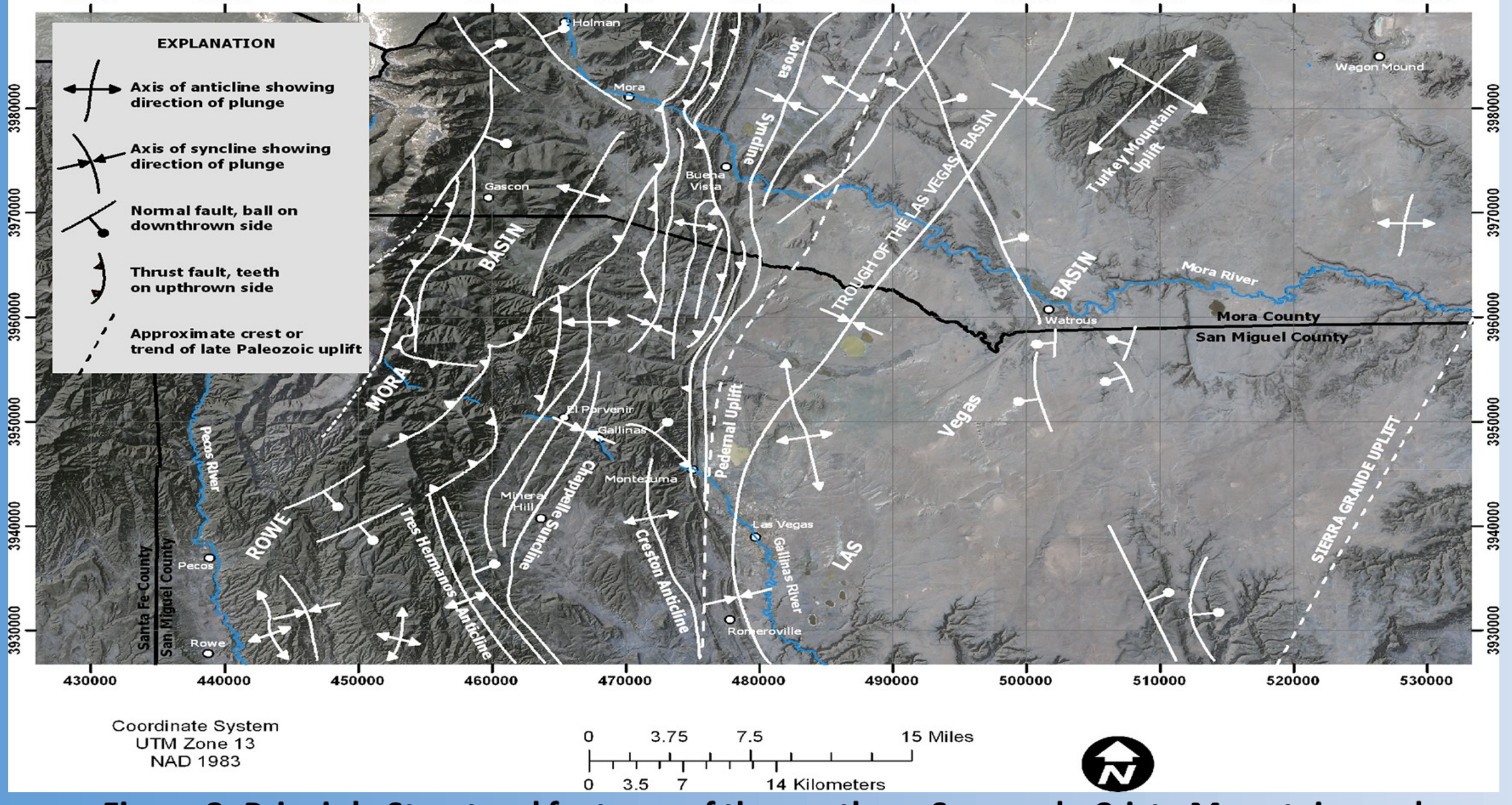

Figure 2. Principle Structrual features of the southern Sangre de Cristo Mountains and adjacent regions, adapted from Baltz and Bachman (1956) and Lindline et al., (2015).

Problem Statement

Baltz (1972) mapped numerous Laramide structures (map-scale folds and faults) throughout the Paleozoic and Mesozoic strata in Las Vegas, NM. He extends many of these structures into the Proterozoic basement, though it is unclear if the basement has been ductilely folded by younger deformation events. Studies have been conducted on Laramide deformation of the cover rocks but have not explored the extent of that deformation affecting the basement rocks beyond faulting. I hypothesize that basement structures (folds, foliations, and lineations) for the most part have not been reoriented by younger deformation. At the Proterozoic-Paleozoic contact, the development of cleavage and local slip planes have accommodated much of the Laramide compressive stress along with major reverse faults.

Abstract

The Las Vegas Range of the southern Sangre de Cristo Mountains is part of the southern-most subrange of the Rocky Mountains west of Las Vegas, New Mexico. Structures associated with the late Mississippian to early Permian (320-270 Ma) Ancestral Rocky Mountain orogenic event first deformed the Paleozoic cover strata that were deposited into a series of intracratonic basement uplifts. Evidence of Ancestral Rocky Mountain deformation are shown by the N-NW to S-SE striking structures throughout Colorado and New Mexico; however, many of these structures are overprinted by ones associated with the Late Cretaceous (80-55 Ma) Laramide Orogeny which resulted in broad folds, sedimentary basin development, and numerous range-frontal reverse faults. Uplift of these basement blocks and deformation of the Paleozoic-Mesozoic cover has implications for intraplate deformation, reactivation of older structures, and understanding the response of the continental lithosphere to compressive stress. The purpose of this study is to determine if, and how much, Laramide deformation affected the Proterozoic basement blocks. We hypothesize that the basement rocks were uplifted as largely intact and unrotated blocks. We further submit that Laramide deformation was accommodated in the basement by cleavage development and shearing at the Proterozoic contact - the Great Unconformity. The degree of cleavage development provides some evidence on the amount of strain the rocks have experienced. This can be seen by grain alignments discerned via the anisotropy of magnetic susceptibility (AMS) technique to find the preferred orientation of magnetic mineral phases. Paleomagnetic data will constrain the timing of deformation by determining the age of the magnetization (i.e. Late Paleozoic versus Late Cretaceous). AMS will map the preferred fabric orientation confirming any strain patterns observed in outcrops in the field. To accomplish this, macrostructures (fractures, foliations, and cleavages) have been measured in the field and compared to original basement structures. Preliminary results infer that the original undeformed basement regional structures trend NW - SE while at the Great Unconformity contact, fractures trend NE to SW which supports formation during Laramide deformation.

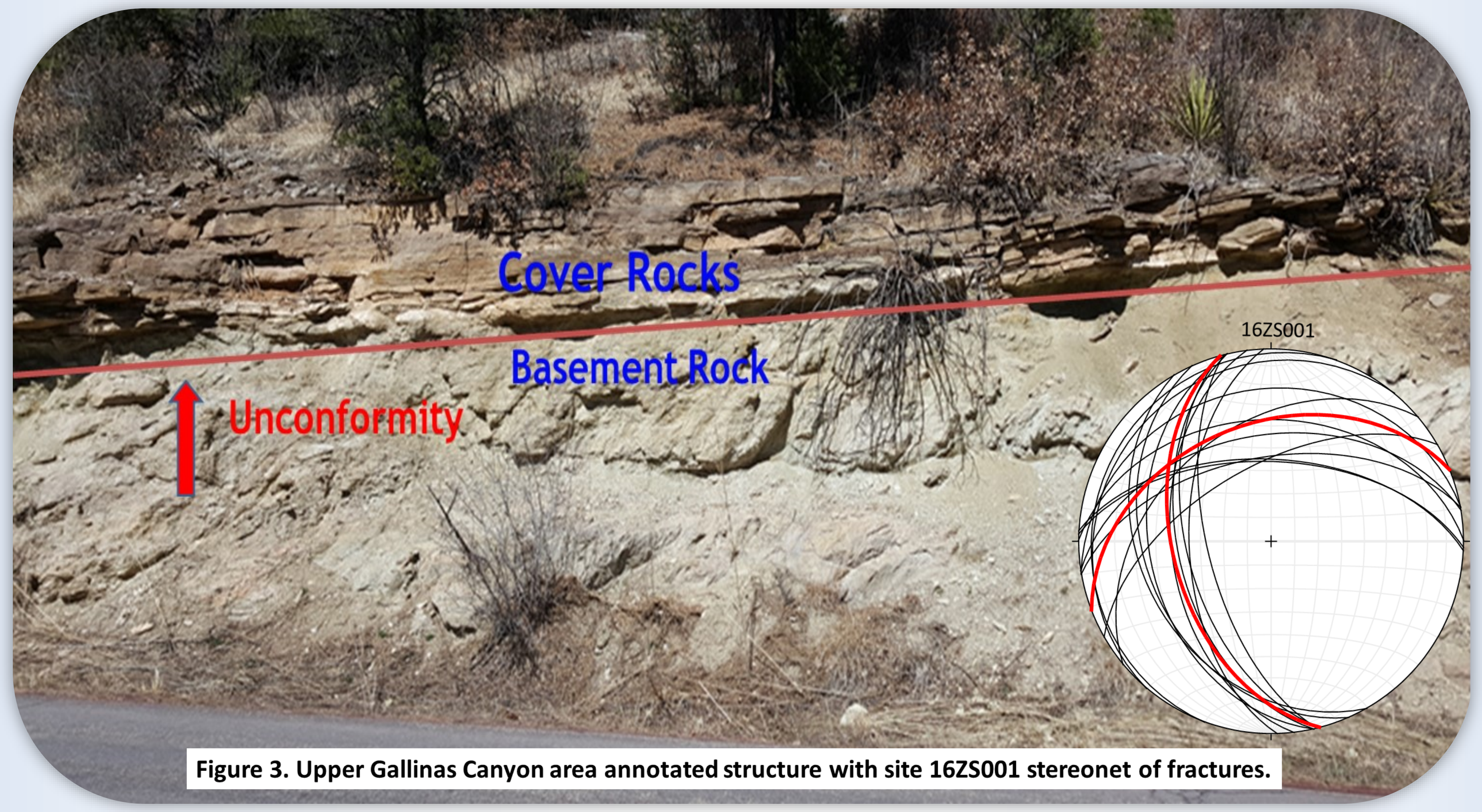

Figure 3. Upper Gallinas Canyon area annotated structure with site 16ZS001 stereonet of fractures.

Methods

- **Fieldwork**
  - Outcrop Observations
    - Types of rocks, thickness of lithologies, and general outcrop patterns.
  - Structural Measurements
    - Faults, folds, foliations, lineations, slickenlines.
  - Core Sample Collection
    - 8-10 Drill samples at each site for paleomagnetic testing.

- **Laboratory Work**
  - Paleomagnetic Testing
    - To determine age of magnetization to test age of magnetization related to deformation.

Figure 6. Hyde Park Road cover rock outcrop with site 16ZS004 & 16ZS005 stereonets of fractures.

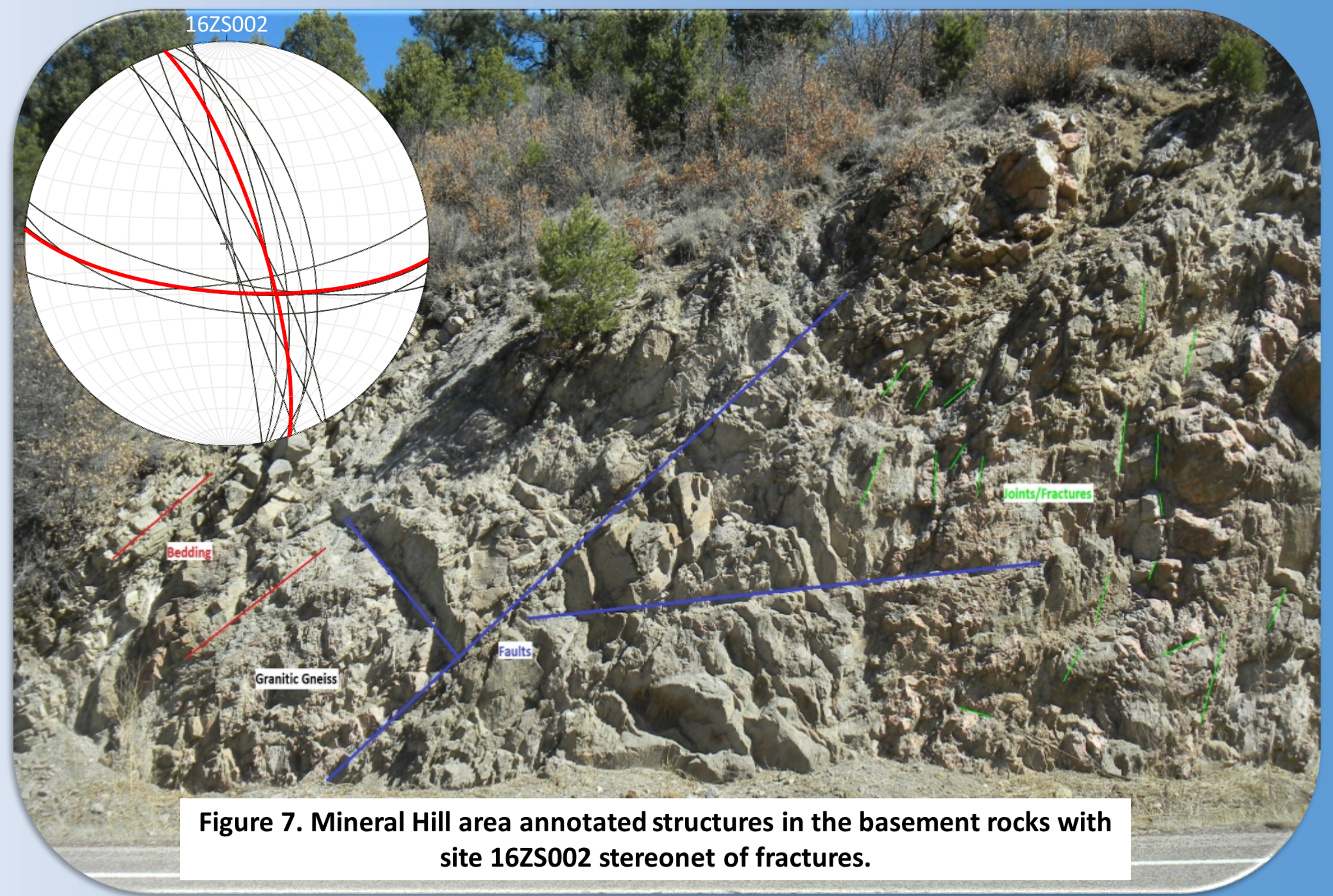

Figure 7. Mineral Hill area annotated structures in the basement rocks with site 16ZS002 stereonet of fractures.

Preliminary Results/Future Work

- **Results**
  - Site 16ZS001
    - Conjugate pair of fractures; 1) striking NS & dipping W, 2) striking EW & dipping N.
  - Site 16ZS002
    - Conjugate pair of fractures; 1) striking NS & dipping E, 2) striking EW & dipping S.
  - 16ZS003
    - Conjugate pair of fractures; 1) striking NS & dipping steeply, 2) striking EW & dipping S.
  - 16ZS004 & 16ZS005
    - Cover rock fractures are striking NE/SW and dipping NW & striking NW/SE and dipping SW.
- **Future Work**
  - Interpret data through stereonets and lab data.
  - Locate additional sites to expand dataset.
  - Collect core samples for paleomagnetic analysis.

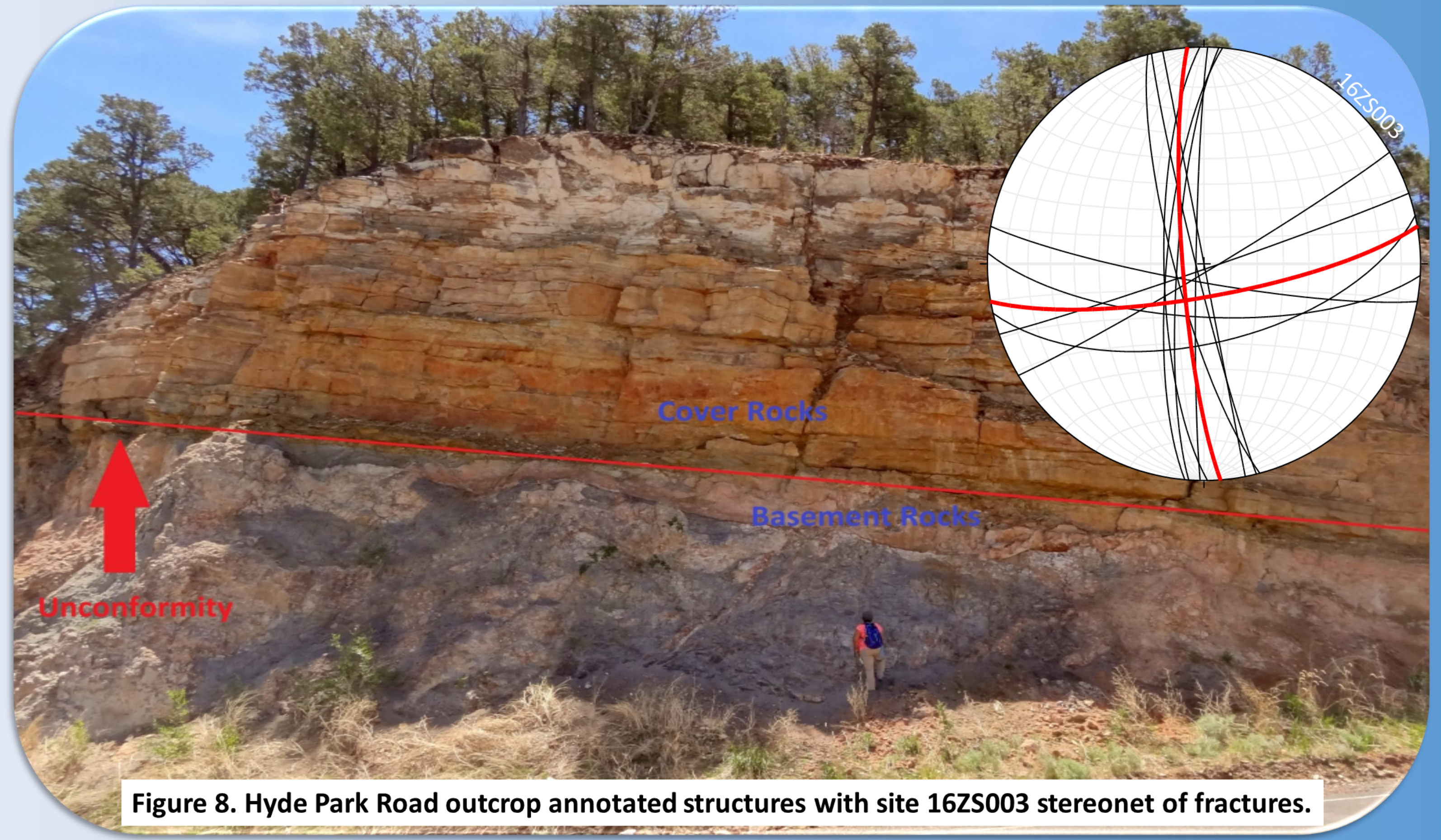

Figure 8. Hyde Park Road outcrop annotated structures with site 16ZS003 stereonet of fractures.

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