Sample Transect at Domeland: A Possible Newly-found Impact Structure in California

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Abstract

The Domeland structure possibly exhibits geological and geophysical traits consistent with an impact origin. To investigate this further, in-situ surficial rock samples were collected along a transect walked from outside the hypothetical structure's northeast quadrant into its central highland realm. The transect and samples were analyzed for macro- and microscopic evidence of shock. Nothing definitive was found. Further research is planned.

Introduction

The Domeland structure is an unusual geomorphologic feature exposed in the southern Sierra Nevada centered on 35.93 N, 118.23 W with an apparent diameter of ~16.4 km (Figs. 1, 2).

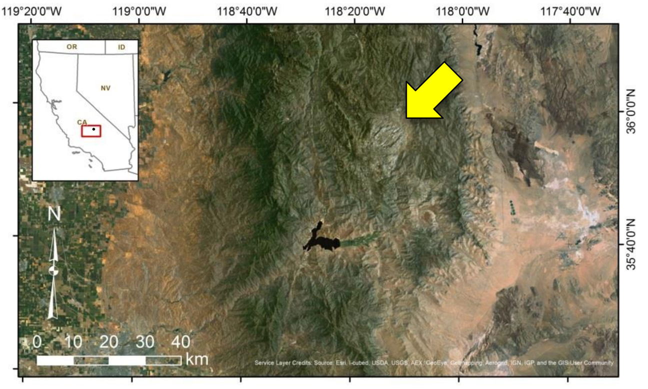

Figure 1 – Visible-light satellite image of southern Sierra Nevada with outermost edge of Domeland structure indicated by arrow.

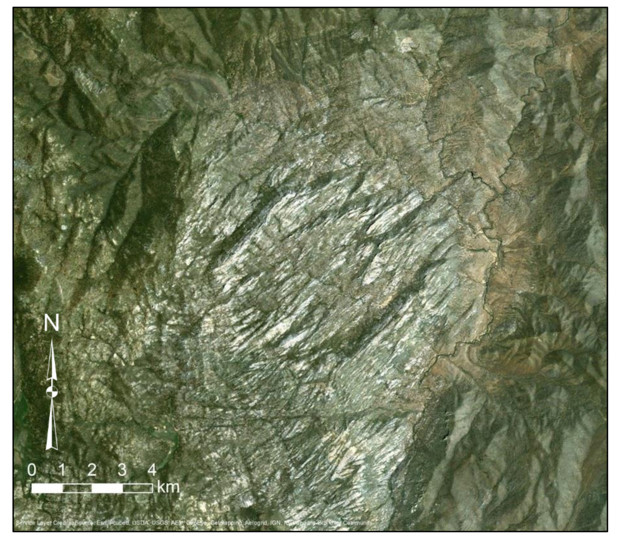

Figure 2 – Detail view of the Domeland structure.

Regional Overview

When observed in visible-light satellite imagery the Domeland structure (Fig. 2) appears superficially similar to the Clearwater West impact structure (not shown) [1]. When directly observed from an elevation of 2860 m above sea level, the Domeland exhibits superficial morphologic features consistent with an impact origin [2] (Figs. 3, 4).

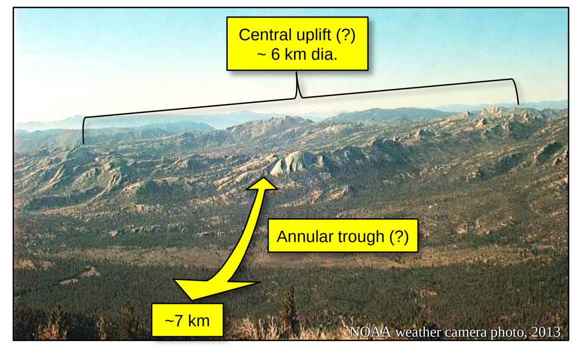

Figure 3 – Central uplift as seen looking south from atop Bald Mtn.

Topography

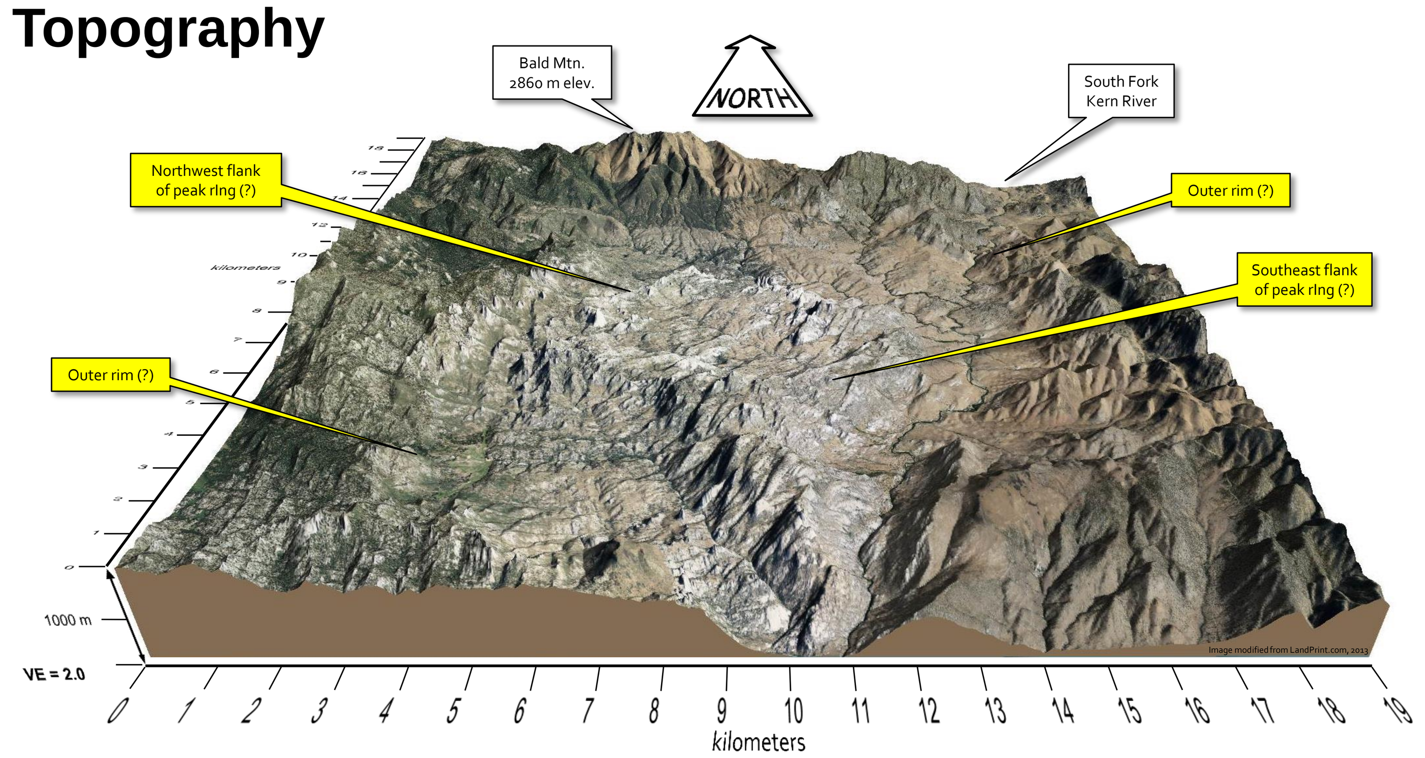

Figure 4 – Computer-generated topographic surface model of Domeland structure with draped visible-light satellite imagery.

Surface Geology

As interpreted in ArcMap using DEM, satellite imagery, and geologic map overlays [3, 4, 5], three realms define the structure (Figs. 5-8):

At center, a possible central uplift ring is defined by a series of irregularly-raised granitic fins and exfoliation domes collectively forming a roughly circular rim ~6 km in diameter standing an average of 300 m above a shallow central basin within a broad region composed entirely of Upper Cretaceous granitoids [3, 4] (Figs. 1-6). Ring dimensions are similar to complex impact structures [6, 7] (Figs. 7, 8).

Beyond the north, east, and southwest flanks of the granitic rim sits what may be a **partial annular trough** composed of the same Upper Cretaceous granitoids [3, 4] extending out to a radius of ~8.2 km from the geographic center (Fig. 5). This flat-bottomed trough hosts a ~13-km run of the South Fork Kern River, but the river has failed to carve a V-shaped channel until exiting the trough through its southeast quadrant, just beyond which the river has cut a steep-walled valley up to 900 m deep into the Upper Cretaceous granitoids [3] (Figs. 5, 6).

Outlying units consist of Mesozoic and/or Paleozoic metasedimentary and metaigneous roof pendants as well as an Upper Jurassic diorite complex and sparsely distributed remnants of Neogene basalts and rare andesites [3, 4]. Together, the outlying units form a highland realm, which may define the outer limits of the possible annular trough (Figs. 5-8).

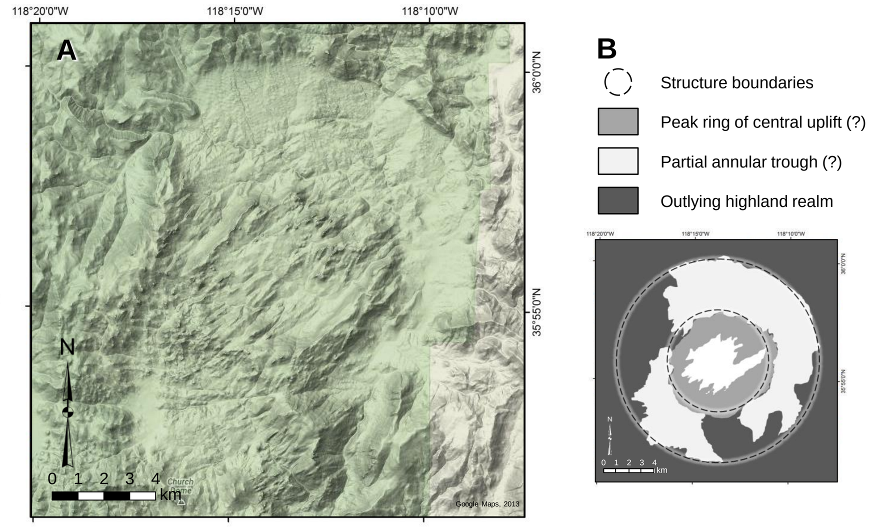

Figure 5 – A: Shaded relief map and B: simplified map of three realms that collectively define the Domeland structure.

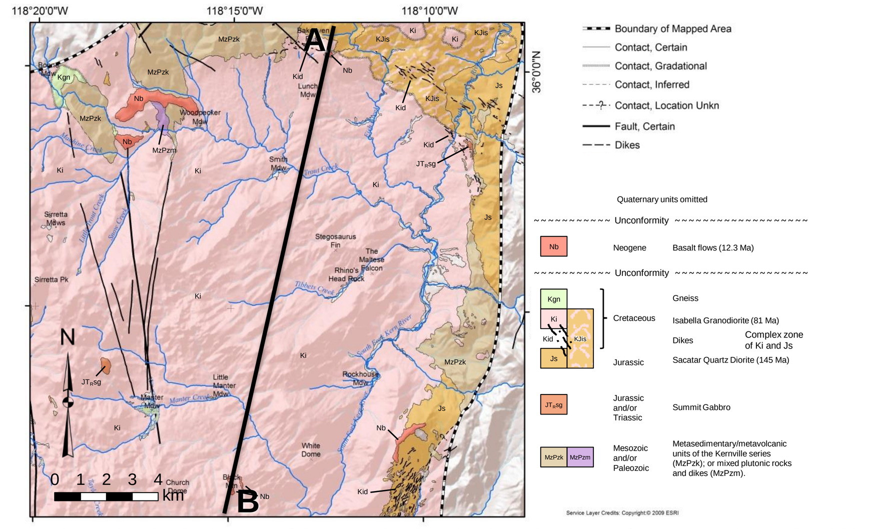

Figure 6 – Geologic map of the Domeland region based on maps from Bergquist et al., 1982 and Ross, 1995. See Fig. 8 for cross section A-B.

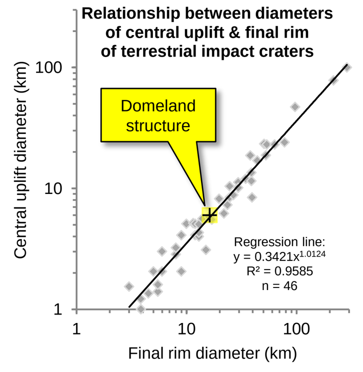

Figure 7 – Geometrics of accepted terrestrial complex craters [6] compared to geometrics of the Domeland structure.

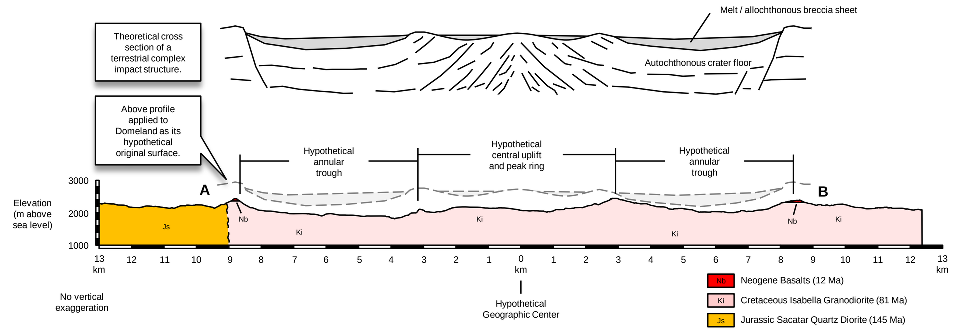

Figure 8 – Theoretical cross section of a complex impact structure having a central uplift, peak ring, and annular trough [7] compared to a geologic cross section of the Domeland structure. Neogene basalts are currently thought to be unrelated to the hypothetical impact event.

Geophysics

Aeromagnetic data indicate a ~200 nT anomaly in the ~51500-51700 nT range trending east-west through much of the possible central uplift and at four locations along the outer edge of the possible annular trough [8, 9] (Fig. 9). Bouguer gravity data indicate a low along the –160 mGal contour line coincident with hypothetical crater center [10] (Fig. 10), although this may be an extension of the Sierra batholith's stronger gravitational low to the north.

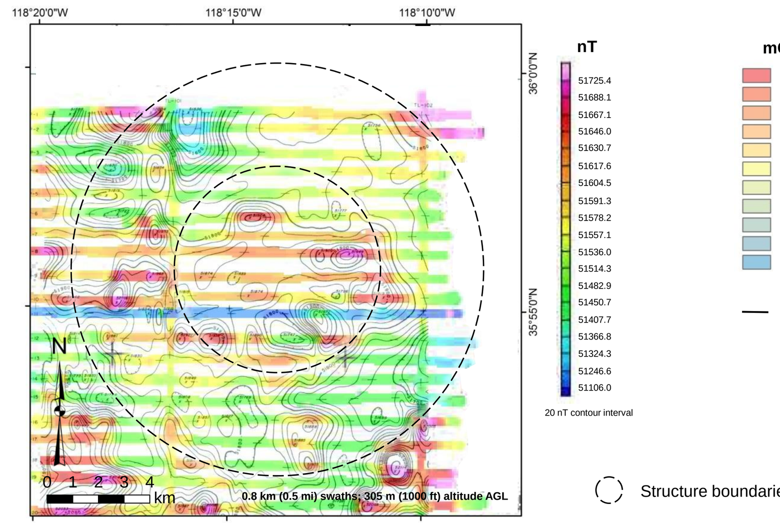

Figure 9 – Aeromagnetic flight-line map of the Domeland region compiled from [8, 9].

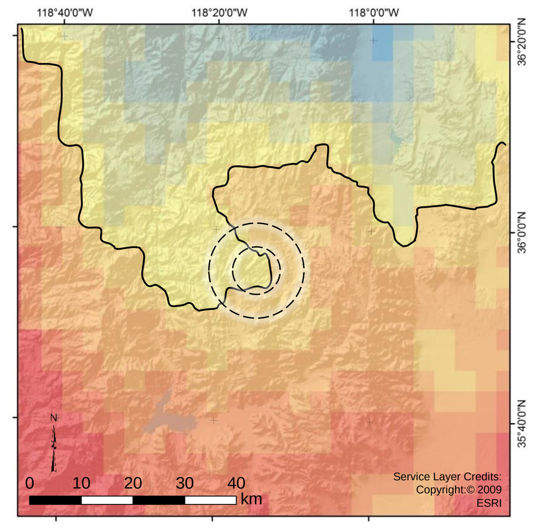

Figure 10 – Bouguer gravity map of the Domeland region derived from [10].

Sample Transect

In the early 1980s Bergquist et al. (1982) collected two samples from the outer flanks of our current study's hypothetical central uplift for purposes of petrographic modal analysis (blue points, Fig. 11). Over a decade later, Ross (1995) reported two samples collected from as close a distance as ~3 km outside our hypothetical central uplift (red points, Fig. 11).

In late June 2013, we backpacked a ~14 km transect into the Domeland Wilderness with the primary aim of collecting in-situ rock samples from *inside* the hypothetical central uplift (Fig. 12). This venture was successful and our literature review to date indicates we may possess the only lithologic samples ever collected from this specific realm.

Five other rock samples representative of the various lithologies found along the transect were collected on the ~14 km hike out.

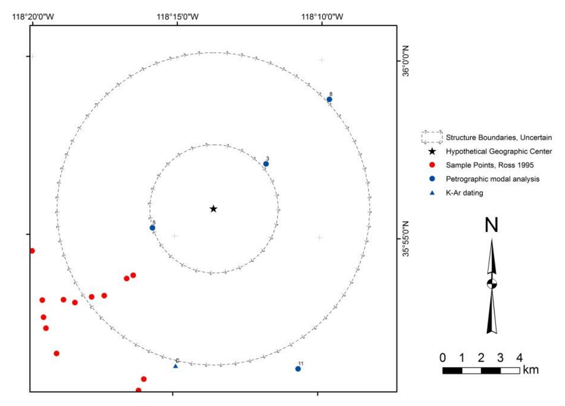

Figure 11 – Map of samples taken from the Domeland region by Bergquist et al. (1982) and Ross (1995). None are from within the hypothetical central uplift.

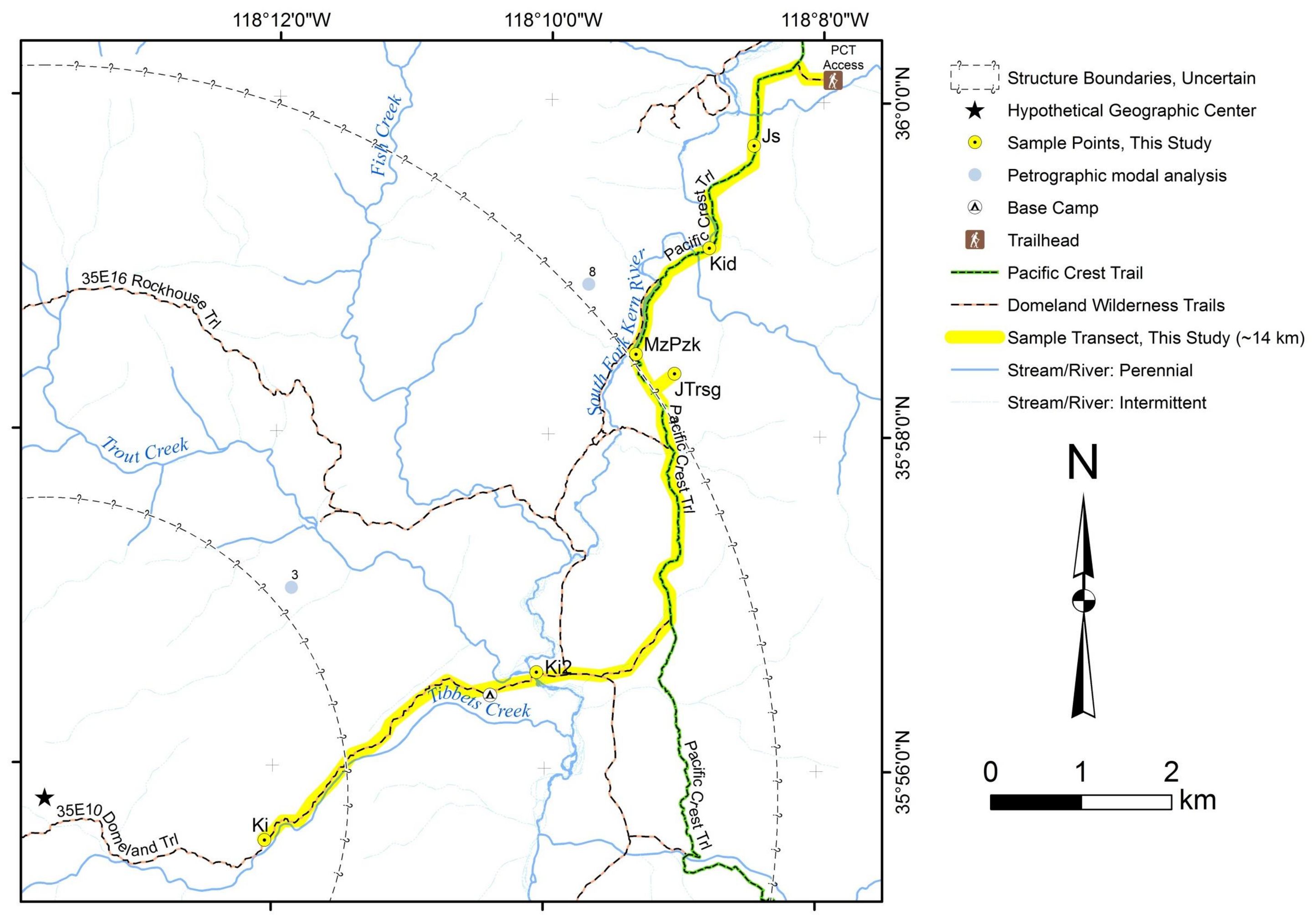

Figure 12 – Map of this study's sample transect (yellow path) and associated samples locations (six labeled points) from the Domeland region. Note the 'Ki' sample was collected ~1 km inside the hypothetical central uplift along the Domeland Trail.

Analysis and Results

Macroscopic Investigation

Our ~14 km transect was investigated for two full days, each having 14 hours of sunlight. While hiking the total distance of ~28 km, we searched many outcrops of various lithologies for impact-generated breccias, glass, and shatter cones. None were found.

Microscopic Investigation

A total of nine polished thin sections were made from the following three samples collected along our transect:

- **Ki -** Cretaceous Isabella Granodiorite from inside the hypothetical central uplift (Figs. 12, 13).
- **MzPzk -** Mesozoic/Paleozoic Kernville series (a metasedimentary complex) from near the outer edge of the hypothetical annular trough (Figs. 12, 14).
- **Kid -** Cretaceous Granodiorite Dikes from near the outer edge of the hypothetical annular trough (Figs. 12, 15).

Each of the polished slides exhibited surficial scratch marks from honing, and each mounted wafer displayed some grain crushing along its margins, but we consider this to be normal. To suppress the aforementioned blemishes in the surface polishing a tiny drop of pure glycerin (CVS brand) was applied to the surface of each slide.

All slides were examined several times using a petrographic microscope and we do not see any clear examples of PDFs, feathers, or any other definitive impact deformation features.

A brief description of each slide set follows:

Ki thin sections (Fig. 13) are very feldspar rich. Most of the closely spaced features in the feldspar grains are lamellae or twins. Many of the feldspars are cored and most are altered as well. Additionally, the feldspars were checked for any hint of maskelynite, but none was observed. All the quartz was clean with the exception of some undulose extinction and some curved planar fractures, but those attributes are likely tectonic. Some mica grains had internal features, but none rose to the level of kink bands as observed by other authors working elsewhere in the greater Domeland region.

MzPzk thin sections (Fig. 14) are much more finely crystalline and the quartz was smaller than the subordinate feldspar. Two grains near the center on one of these slides had some parallel straight planar fractures (one set/grain), but these planar fractures are very fresh (no decorations) so they most likely resulted from tectonic stresses.

Kid thin sections (Fig. 15) are free of PDFs, maskelynite, kinked mica, etc. Just a few planar fractures were observed in quartz.

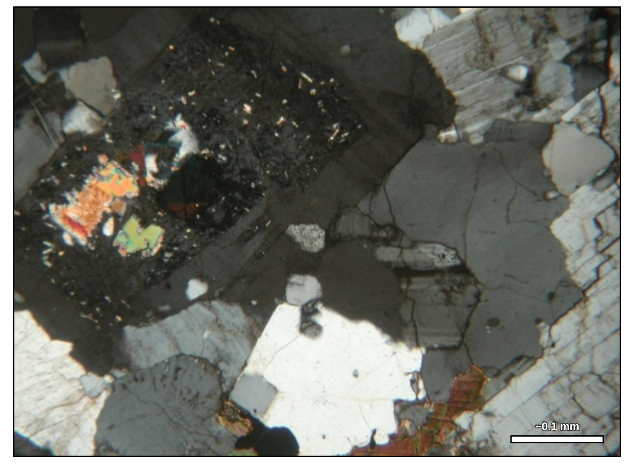

Figure 13 – Photomicrograph in cross polarized light of thin section from Ki sample collected inside the hypothetical central uplift.

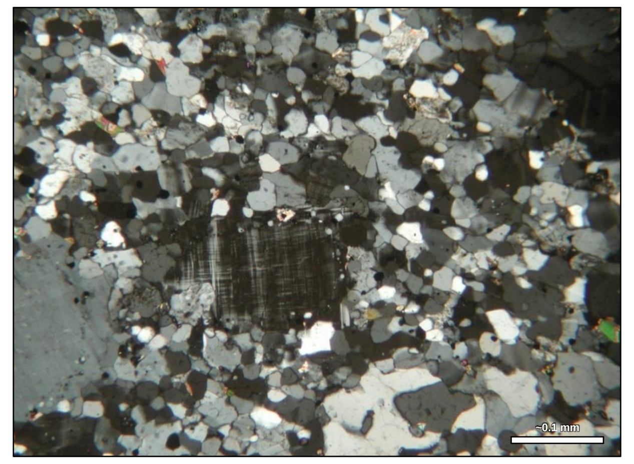

Figure 14 – Photomicrograph in cross polarized light of thin section from MzPzk sample collected from near the outer edge of the hypothetical annular trough.

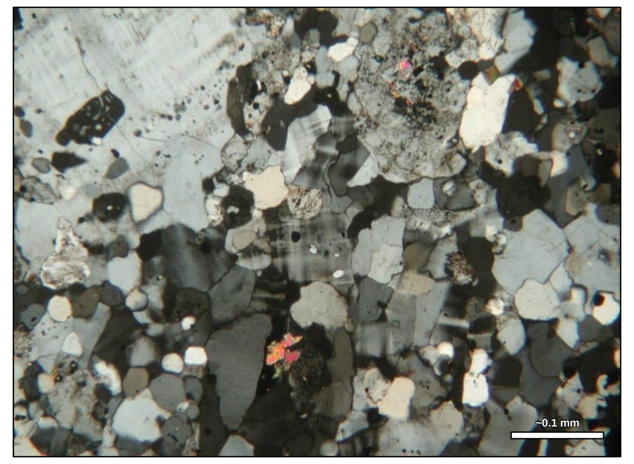

Figure 15 – Photomicrograph in cross polarized light of thin section from Kid sample collected from near the outer edge of the hypothetical annular trough.

Other Explanations?

Glacial – **Unsupported**. No evidence of glacial activity [3, 4]; the geomorphologies at Domeland do not accord with common glacially-derived landforms (Figs. 1, 4, 6).

Fluvial – **Unsupported**. Fluvial processes do not form peak rings and annular troughs, even when bedrock presents structural and/or lithologic heterogeneities (Figs. 1-8).

Orogenic – **Unsupported**. Taken as a whole, the structure is a unique geomorphology for the Sierras [11] (Fig. 1).

Seismic – **Unsupported**. Known fault and/or joint sets crosscut the structure in several directions at multiple locations throughout the structure [3] and cannot have formed the central uplift or annular trough (Figs. 2, 6, 8).

Tectonic – **Unsupported**. Although structural domes, basins, and folds commonly exhibit multi-ring landforms, we see no evidence of such anywhere in the region of interest (Figs. 2, 4, 5, 6, 8).

Volcanic – **Unsupported**. Granitoids are batholithic, there is no sub-volcanic plumbing [3, 4] (Figs. 6, 8), nor is there any resemblance to caldera-type volcanism as at Long Valley ~200 km to the north [12].

Plutonic – **The currently accepted explanation**. Assumes the structure is part of the Sierra batholith [1, 2], but does not account for geomorphologies that are similar to confirmed terrestrial impact structures (Figs. 2-8). Domeland is unlikely to be a discrete stock within the batholith as it lacks a metamorphic aureole, its lithology matches the surrounding granodiorite, and it is unlike two deeply dissected multi-ring granite/tonalite structures (stocks?) ~27 km NNW and ~18 km NNE of its geographic center (Fig. 1) which appear to have formed by sheeting and vertical ballooning during emplacement [13].

Conclusions

The Domeland structure exhibits a variety of geomorphic, geological, and geophysical features consistent with known terrestrial impact structures.

While walking our transect in the field, we were unable to locate any macroscopic features associated with impact.

Within the thin sections made from in situ surficial samples collected for this study, no microscopic evidence of shock was found.

We recognize that the structure is deeply eroded (regardless of its mode of formation) and any definitive evidence of shock may be exceedingly difficult to find.

Ongoing Work

In spite of not finding evidence for shock in the outcrops and surface samples examined thus far, we still believe the possibility of an impact origin is plausible, and our samples will next be examined for chemical signatures consistent with impact.

We are also continuing to work with the U.S. Forest Service, the Bureau of Land Management, and geology programs at surrounding colleges to crowdsource the hunt for macroscopic shock features (primarily shatter cones) in the hypothetical central uplift.

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