Revised geologic map of the Mineral King pendant, southern Sierra Nevada, California, indicates extreme structural imbrication of a Permian to mid-Cretaceous volcano-sedimentary sequence

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Introduction

The Mineral King pendant is an ~15-km long, NW -striking assemblage of Permian to mid-Cretaceous metavolcanic and metasedimentary rocks that form a steeply dipping wall rock screen between large mid-Cretaceous plutons of the Sierra Nevada batholith.

Pendant rocks are generally well-bedded, and characterized by NW-striking, steeply dipping, bedding-parallel cleavage and flattening foliation, and steeply NW-plunging stretching lineation.

NW-elongate lithologic units with well-developed parallel bedding and an absence of prominent faults or shear zones suggests a degree of stratigraphic continuity.

However, U/Pb zircon dating of rocks across the pendant indicates a complex pattern of structurally interleaved units with ages ranging from 276 Ma to 100 Ma.

Results

We utilize a compilation of 39 existing and new U/Pb zircon ages and 4 reported fossil localities to construct a revised geologic map of the Mineral King pendant that emphasizes age relationships rather than lithologic (e.g. Sisson and Moore, 2013) or stratigraphic (e.g. Busby-Spera, 1983) correlations.

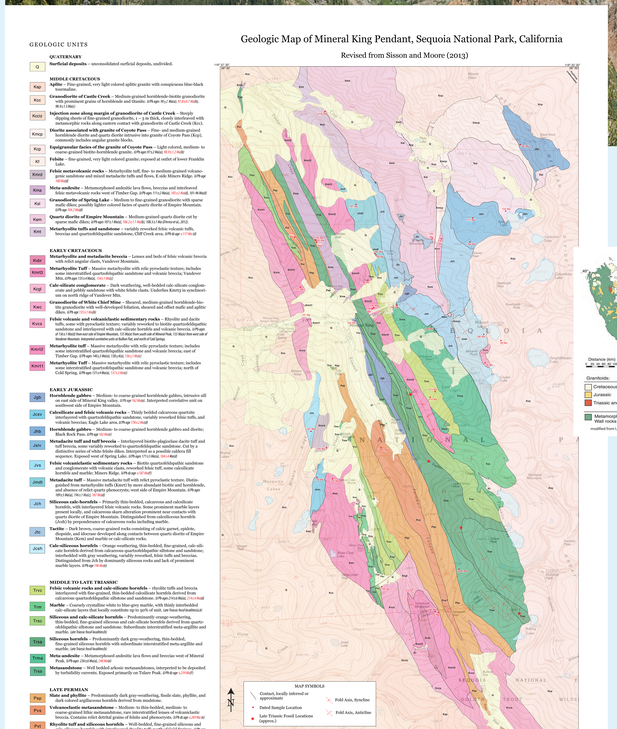
On the map at right, units of similar age based on our dating results are grouped by color, allowing structural assemblages to be more clearly identified.

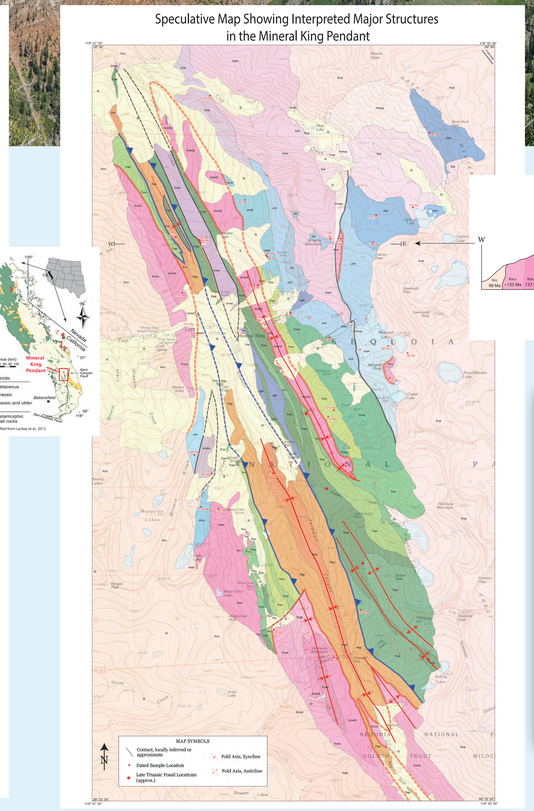
Three prominent structural/stratigraphic discontinuities are present:

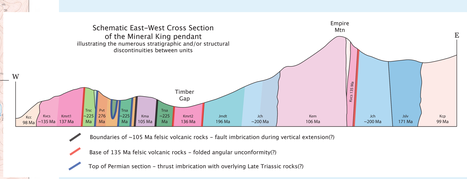
1. Between middle Permian strata and late Triassic units. This may represent a late Permian unconformity, complicated by repeated slices of Triassic rocks suggesting fault imbrication. Indicated in blue on the Speculative Major Structures map.

2. At the base of the 135 Ma felsic volcanic rocks. Contact with older rocks appears to be a tightly folded angular unconformity. Indicated in orange on the Speculative Major Structures map.

3. All contacts between the 105 to 100 Ma felsic volcanic units (Kma and Kmrd) and older strata. Discordant contacts may indicate fault imbrication into older units during vertical extension. Indicated in black on the Speculative Major Structures map.







Structural imbrication and stratigraphic discontinuities in the Mineral King pendant appear to result from some combination of:

1. At least one phase of contractional deformation post-late Triassic time, possibly resulting in folding and thrust imbrication of Permian and Triassic strata.

2. Major contractional deformation post-135 Ma, resulting in km-scale tight to isoclinal folding of early Cretaceous felsic volcanic strata (predominantly Kmrt and Kvcs) as well as the previously deformed Permo-Triassic and Jurassic sections.

3. Mid-Cretaceous ductile flattening and vertical stretching superimposed on all units during emplacement of the enclosing granite plutons.

Summary

We find that in the Mineral King pendant apparently coherent lithologic units are lensoidal and discontinuous, and cryptically interleaved at meter to km scales.

Along-strike facies changes and depositional unconformities combine with km-scale tight folding and structural imbrication to create a complex map pattern with numerous discordant units.

Discrete faults or major shear zones are not readily apparent in the exposed pendant rocks, although such structures would seem necessary to produce the structural complications revealed by our new mapping and U/Pb dating.

We interpret the Mineral King pendant to be structurally imbricated by a combination of km-scale tight to isoclinal folding and cryptic thrust(?) faulting, accentuated by, and eventually obscured by, pervasive flattening and vertical stretching that preceded and accompanied emplacement of the bounding mid-Cretaceous plutons.

Close juxtaposition of rhyolite tuffs deposited subaerially at ~100 Ma and large granitic plutons crystalized at ~11 km depth at 98 Ma (Klemetti et al., 2013) suggests that the final phase of deformation involved very rapid downward displacement of Mineral King pendant rocks during upward emplacement of granitic plutons.

We emphasize that much of the structural complexity in the Mineral King pendant is identifiable only through detailed dating. Other Sierran pendants may also prove to have much more complex structural histories than are presently documented.

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