New Constrains on the Timing, Rate, and Style of Exhumation of the Wood Hills and Pequop Mountains, Elko County, Nevada

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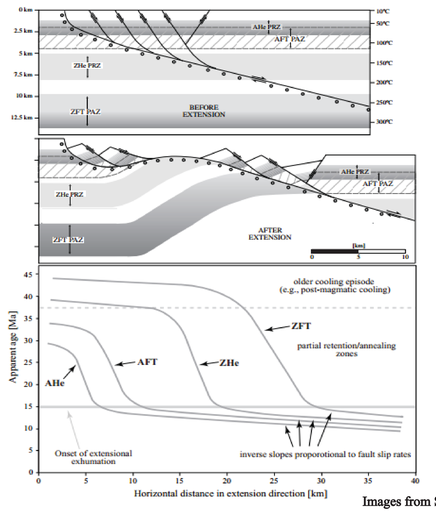
Abstract

The Ruby Mountain Detachment Fault (RMDF) is a regionally significant structure responsible for exhumation of the Ruby Mountains-East Humboldt Range (RM-EHR) metamorphic core complex (MCC). Despite numerous thermochronometric studies, many uncertainties remain concerning the rate, style and timing of the on-set of extension. The goal of this study is to use zircon (U-Th)/He thermochronometry to provide new constraints on the timing, rate, and style of exhumation of the Wood Hills and Pequop Mountains, which are part of the RM-EHR MCC. When did exhumation begin? Is the younging direction consistent with direction of tectonic transport? Can trends in effective radiation (eU) and age provide additional insight? Were the Pequop Mountains exhumed along the RMDF?

Outline

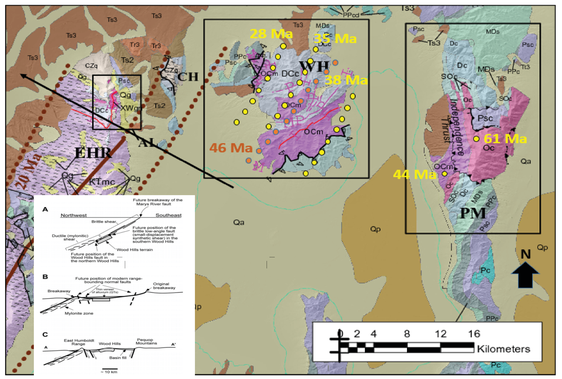
Purpose
- The timing of the onset of extension of the RM-EHR MCC is contested and debated.
- The Wood Hills and Pequop Mountains are the upper structural levels (above the EHR) of the MCC, which was later dissected by normal faults.
- Zircon (U-Th)/He analysis provides insight into the time since a sample has cooled past the 180-200 °C isotherm due to exhumation towards the surface, and thus provides and estimate for the onset of extension.

Sampling Strategy
- The SW to NW direction of tectonic transport is well-known from kinematic indicators preserved in the mylonitc shear zone along the western side of the EHR
- Samples in the Wood Hills were collected along a southeast to northwest transect in the direction of tectonic transport
- If the Wood Hills and Pequop Mountains were exhumed by the RMDF, zircon (U-Th)/He ages should young towards the NW, in the direction of tectonic transport.

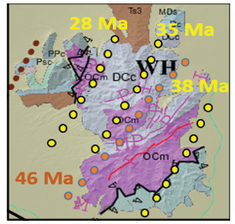


Images from Stockli (2005)

Summary Map for Proposed Chrontours

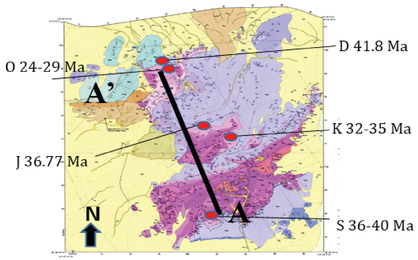


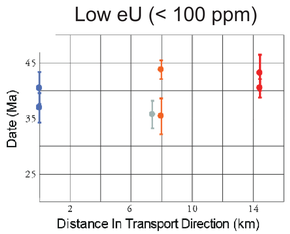
Camilleri and Chamberlin (1997); McGrew and Snee (1994); Stockli (2005)

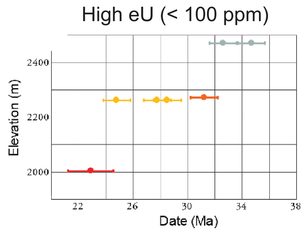


- Black arrow in direction of slip on RMDF
- Yellow chrontours proposed from this zircon (U-Th)/He study. Nominal Closure Temperature is ~200 °C.
- Red chrontours are $^{40}Ar/^{39}Ar$ biotite ages by McGrew and Snee (1994). Nominal Closure Temperature is ~300 °C.
- Orange chrontours are 40Ar/39Ar muscovite ages by Gifford et al. (2008). Nominal Closure Temperature is ~400 °C.

Wood Hills Cross Section of Ages



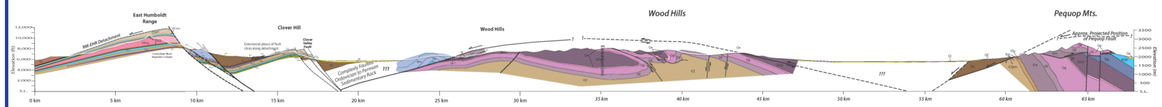




- Effective radiation damage (eU) is a control on the He diffusivity of the zircon grain and will affect its closure temperature. High eU grains will allow He leakage at lower temperatures, resulting in a lower closure temperature and a younger apparent age.
- For low eU values, Wood Hills samples young in the direction of tectonic transport.
- For high eU values, Wood Hills samples young with depth before burial (present day elevation).

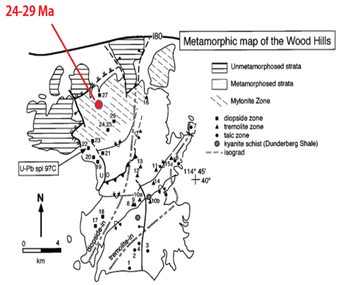
Camilleri and Chamberlin (1997); eU figured by Metcalf

Study Area Cross Section

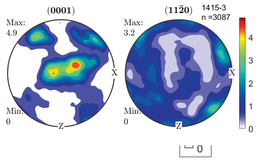


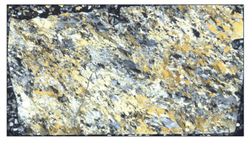
Cross Section by McGrew

Mylonites in the Wood Hills



Camilleri & Chamberlin (1997)





Jordan (Keck 2016)

Mylonites form at temperatures greater than the closure temperature for the (U-Th)/He sytem (>280 °C vs. 180-220 °C); therefore, slip on RMDF and mylonitization must have been active prior to 24-29 Ma, the date calculated for sample O here.

Conclusions

1. Slip on the RMDF began by at least the Oligocene, if not earlier (probably Eocene).
2. The SE-NW exhumation trend of Wood Hills is consistent with the trend suggested for the Ruby Mountain Detachment Fault in the broader area.
3. Wood Hills experienced relatively slow cooling (roughly 20 °C/Ma).
4. Wood Hills slip on RMDF was slow (roughly 1 km/Ma).
5. Low eU samples young in the direction of tectonic transport (SE to NW) across the Wood Hills. High eU samples young with higher elevations.

Acknowledgements

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