The South Virgin-White Hills detachment fault system of SE Nevada and NW Arizona: The application of apatite fission track thermochronology to constraining displacement gradient accommodation along a major detachment fault

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Low temperature thermochronologic techniques have been applied extensively to extended terranes, notably to constrain the timing of extension and slip rate along low-angle detachment faults. Typically samples are collected parallel to extension direction and the variation of age with paleodepth or horizontal distance used to constrain these parameters. Arguably, the archetypical example of a tilted crustal block where low temperature thermochronologic techniques have been applied is the Gold Butte Block (GBB) of SE Nevada. The controlling structure for top-to-the-west extension in the GBB is the Lakeside Mine fault that extends ~60 km to the south into the White Hills of NW Arizona to form the South Vrigin-White Hills Detachment (SVWHD). Displacement on the SVWHD decreases from ~17 km at the GBB to <6 km at its southern end in the White Hills. This along-strike decrease in displacement is accompanied by a change in fault and footwall rock type from mylonite, overprinted by cataclasite along the Lakeside Mine fault to chlorite cataclasite, and then unconsolidated fault breccia at the southern end. Thus, deformation progresses from ductile to progressively more brittle reflecting decreasing fault displacement and footwall exhumation.

We apply apatite fission track thermochronology along-strike and across-strike in the GBB and White Hills to explain this deplacement gradient. The thermal history reflects Laramide cooling, then slow cooling or establishment of a PAZ until rapid cooling due to tectonic denudation. While ages patterns reflect some complexity, extension along-strike appears synchronous, initated at ca. 17 Ma. Slip rate however is variable, being dramatically faster along the SVWHD in the GBB (ca. 8 km/my) compared to 1-2 km/my in the White Hills. While the displacment gradient can be envisaged geometrically by rotation about a pole south of the White Hills, transvese structural features are more likely responsible for linking different segments of the detachment that accommodate varying displacements.