The Timing and Mechanism of Colorado Plateau Uplift

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INTRODUCTION

The history of how and when the Colorado Plateau (CP) uplifted to its current elevation of ~2 km has been a matter of contention among geologists for many years. Little evidence for crustal shortening or crustal deformation can be seen throughout the Colorado Plateau and cannot account for the current thickness (45 km) and elevation of the Colorado Plateau. A minimum age of around 80 Ma can be attributed to uplift due to the deposition of Paleozoic and Mesozoic marine rocks, suggesting uplift has occurred since the Mesozoic.

PROPOSED MECHANISMS FOR UPLIFT

80-40 Ma

Channel flow, McQuarrie and Chase, 2000
Crustal flow related to the Sevier orogeny thickens the crust. However, there is no evidence for eastward CP tilting, and crustal xenoliths show no suture between the upper and lower crust.

Chemical modification of the lithosphere by volatile addition from the Laramide flat-slab (Humphreys et al., 2003; Porter et al., 2017)

Hydration introduced by the Farallon flat-slab provides ~290 meters of isostatically supported uplift.

40-20 Ma

Phase changes and density decrease of lower crust (Porter et al., 2017)

Partial removal of plateau lithosphere and replacement with hot lithosphere (Spencer, 1996)

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Chemical modification through melt extraction along plateau margins (Roy et al., 2004; Sine et al., 2008)

Phase changes and density decrease of lower crust associated with warming and thinning of crust (Porter et al., 2017)

40-20 Ma

Regional extensional tectonism/mantle heating and other dynamic mantle processes (Sine et al., 2008; Van Wijk et al., 2010; Jones et al., 2015)

SUMMARY

100-80 Ma The CP is below sea level, and the Sevier-Laramide orogeny is ongoing. At the start of flat slab subduction of the Farallon plate to the west of the CP (~86 Ma), there is a period of subsidence across the CP preceding uplift and the intrusion of the Farallon plate beneath it. 80-40 Ma The CP begins to uplift due to hydration of the lower crust, decreasing density, increasing plate thickness, and subsequently uplifting the CP above sea level. 40-20 Ma The Farallon plate rolls back, and the upwelling of the asthenosphere along with the warming of the bottom of the crust encourages more uplift. 20-0 Ma Extensional tectonism along with small-scale convection at the Plateau edges encourages a final pulse of uplift, bringing it to its current elevation of ~2 km.

REFERENCES


