Combining U-Th/He eruption age dating and ^{3}He cosmogenic dating to constrain landscape evolution.

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Earth analogues for Martian canyons

Steep-walled, amphitheater canyons on Mars have been invoked as evidence for underground water flow because of their similarities to seepage or sapping valleys/canyons on Earth. However, seepage canyon formation on Earth is speculative, particularly in basalt terrains, [1] and therefore analogies to Mars may be inappropriate.

One of these Earth analogues is Box Canyon, a spring fed tributary of the Snake River Canyon in southern Idaho cut into young basalt. Because of its amphitheater shape and absence of overland flow, it is a seepage canyon type locality. However, there is evidence for large scale flooding in the area (scour marks), which has been linked to the Bonneville flood (11 Kyr). One way to constrain the formation history is to determine a timescale over which the canyon forming processes occurred.

Eruption ages and cosmogenic exposure ages

We have measured the 3He cosmogenic exposure ages and U-Th/He eruption ages of a series of boulders and flows from Box Canyon. Combining the two methods allows us to evaluate the possible pre-exposure of the boulders within the canyon. Furthermore, we measured the U-Th/He eruption age of similar, nearby basalt dated by Ar-Ar to demonstrate the efficacy of our calculated eruption ages.

U-Th/He ages of 300 Kyr and 3 Ma for samples collected along the Snake River Canyon agree with previously published Ar-Ar ages. U-Th/He ages of the Box Canyon samples, indicate volcanism approximately 100 Kyr ago that lasted for ~20 Kyr. The exposure ages of boulders (20-50 Kyr) within the canyon and scoured bedrock at the canyon head (50 Kyr) indicate that the canyon was carved before the Bonneville Flood. A simple hypothesis that the canyon was incised rapidly as a result of damming of the Snake River by the erupted basalts cannot be fully accurate because of the lag between the eruption age of the basalt and exposure ages of the boulders and scour surface. The combined eruption-exposure history of the canyon would indicate a rate of formation that requires more than a single flood event. Mechanisms for formation, given the current flow volume of the spring, still need to be investigated.

References

[1] Lamb, M.P., Howard, A.D., Johnson, J., Whipple, K., Dietrich, W.E. and Perron, J.T. (2006) JGR **(in press)**