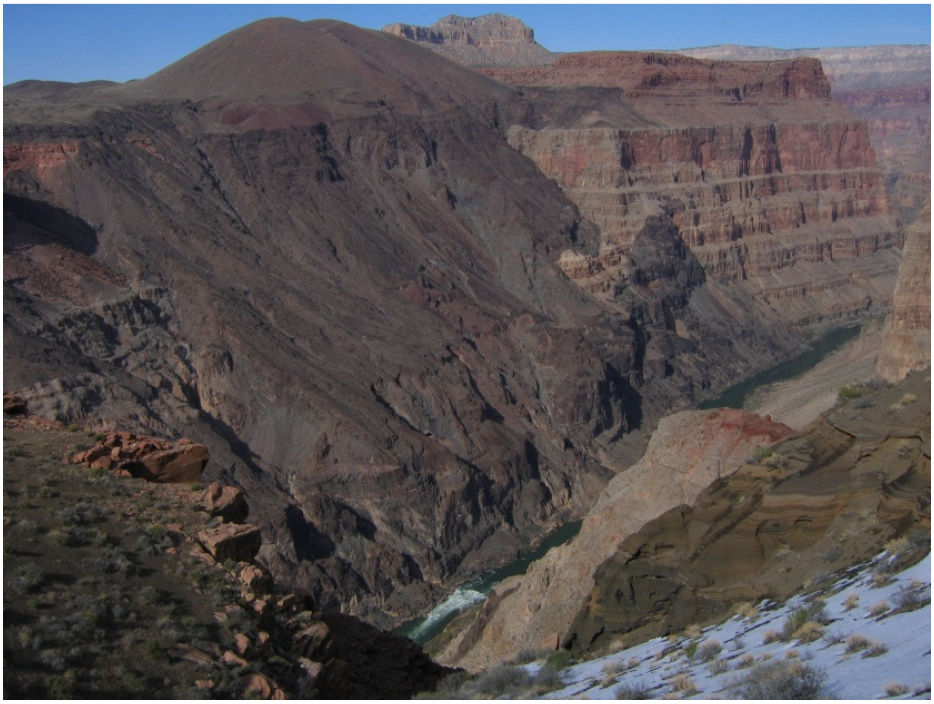
Grand Canyon's Lava Dams

Ryan S. Crow, Karl E. Karlstrom, William McIntosh, Lisa Peters



In western Grand Canyon, lavas that poured into and erupted in Grand Canyon provide an excellent record of the interplay between basaltic volcanism and a major river system. New dating and geochemical "fingerprinting" of basalt remnants allow for the identification of at least 17 individual intracanyon basalt flows that formed lava dams between 850,000 and 100,000 years ago. The best-constrained dams were 45 to 330 m (145 – 1083') above the river level and had lengths of 20 to over 135 km (12 – 84 miles); by comparison the modern Glen Canyon Dam is about 220 m (710') high. Lava dams varied in structure from massive dams formed by single basalt flows cascading into the canyon, to multi-flow dams where the Colorado River overtopped and partial eroded dams as additional flows were emplaced. Intracanyon eruptions and eruptions up local tributaries allowed for the accumulation of significant amounts of cinders under and within some dams. Although the longevity and failure mechanism of dams likely varied as a function of geometry and structure, many dams seem to have had a multi-staged evolution where: 1) The Colorado River was, at least initially, blocked quickly (within days to perhaps months), allowing the remainder of the lava to flow down a mostly dry river bed; 2) Because of heterogeneities in volcanic deposits, dams were leaky but generally overtopped within days to

years; 3) Failure of the upstream-most sections of the dam, where lava-water interactions were focused and incorporated cinders were abundant, occurred catastrophically soon after overtopping, depositing outburst-flood deposits on top of the still-stable distal ends of the dam; 4) The remaining dam sections, which were more stable due to a lack of quenching, were removed more slowly by abrasion, lateral disaggregation, and plucking of basalt columns. Based on a dearth of lake deposits, most dams failed prior to the resulting lakes being completely silted in. Only the longest Lower Black Ledge flow, which traveled over 135 km, shows strong evidence for being overtopped by a "normal" Colorado River which was transporting far-traveled sediment. This dam may have lasted for hundreds to thousands of years while most others likely failed tens to hundreds of years after formation. After dam failure, the river became choked with increased sediment supply but had sufficient stream power to re-establish its previous profile within hundreds to thousands of years after initial dam formation.

The new geochronology and dam reconstructions suggest the follow volcanic history for western Grand Canyon. From 850,000 to 400,000 years ago, at least 11 eruptions occurred resulting in intracanyon flows and lava dams. The plethora of large remnants and dikes of this age in the Lava Falls area indicate that most of these flows likely entered the canyon in that area as lava cascades or eruptions directly into the canyon. Vulcan's Anvil and the dikes south of Prospect Canyon mark the locations of volcanoes of this age that erupted within the canyon to produce the Upper Black Ledge and Upper Prospect flows.

Around 330,000 years ago the 177-mile flow was emplaced (this is one the first flows seen when floating the canyon low on river left). Although we don't know its exact source, dam reconstructions suggest it likely entered the canyon near the Lava Falls area and flowed to around Granite Park.

At about 250,000 and 200,000 years ago eruptions up Whitmore Wash sent a series of thin flows down that tributary creating what we call Upper and Lower Whitmore dams. North-rim cascades between Whitmore Wash and the Lava Falls area were also active at this time period producing at least two separate dams.

The last of Grand Canyon's lava dams, Upper Gray Ledge, formed about 100,000 years ago and is likely related to lava cascades south of Vulcan's Throne.