Petra: Colonnaded Street Flood Deposit Analysis

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Early explorers in Petra wrote vague accounts of flooding in the wadis of Musa, Mataha, and Abu ʻOlleqa. However, without documentation of historic flood(s), paleoflood reconstruction using empirical fieldwork is often used (Paradise 2011). Evidence from over 30 years of research in Petra indicates that Petra's city center was inundated by a ruinous flood that entered through al-Madras, the hewn tunnel at Bab as-Siq, Siq al-Muthlim, and Wadi Mataha (Fig. 1). It entered the valley at the confluence of Wadis Mataha and Musa, flooding the colonnaded street, and drained into the gorge of Wadi Siyagh. Geomorphic evidence includes (a) remnant sediments found suspended above current wadi channels; (b) excavated flood alluvium synchronous to the flooding; (c) distribution of missing pavers along the colonnaded road divulging the flood mega-meander patterns; and (d) channel configurations that exacerbate flood conditions—the thrust of this paper.

To ascertain flood stages and hydraulic power in Petra's wadis, channel profiles were measured and analyzed. Eight channel cross sections were measured from the confluence of Wadi Mudhlim with Wadi Mataha, along the reach of Mataha to its confluence with Wadi Musa (at the nymphaeum) in 2010 and 2018. Using GPS, surveying equipment, digital photography, and new remotely sensed imagery, wadi channels were measured to decimeter accuracy (±5 cm) (Figs. 1 and 2).

Manning's equations were used with channel dimensions to determine flood characteristics. Flood heights were determined using the heights of perched alluvial remnants along the wadi reach, and calculations were made to determine high-flow stages and velocities. Ideally, the ages of these sediments should have been determined; however, it would have been cost- and time-prohibitive to locate organic components for radiocarbon dating or for absolute dating procedures using optically stimulated luminescence (OSL) (Paradise 2011).

The greatest floodwater heights were determined from the remnant alluvia and/or fluvially eroded features. These heights were used in flood stage and velocity determination. Channel narrowing forced water to rise and increase in velocity as it neared Wadi Musa. To confirm this assessment, remnant alluvium was found high above the channel, corroborating calculations that flood levels exceeded 3–5 m at its confluence at the nymphaeum (Fig. 2).

Floodwaters were diverted upstream into Wadi Muthlim at the weir at Bab as-Siq (near the Roman tunnel). As the water flowed down Wadi Mataha, it would have risen dramatically and increased in velocity from channel narrowing (confirmed through Manning's calculations). Upper wadi velocities were estimated at 0.2 to 0.5 meters

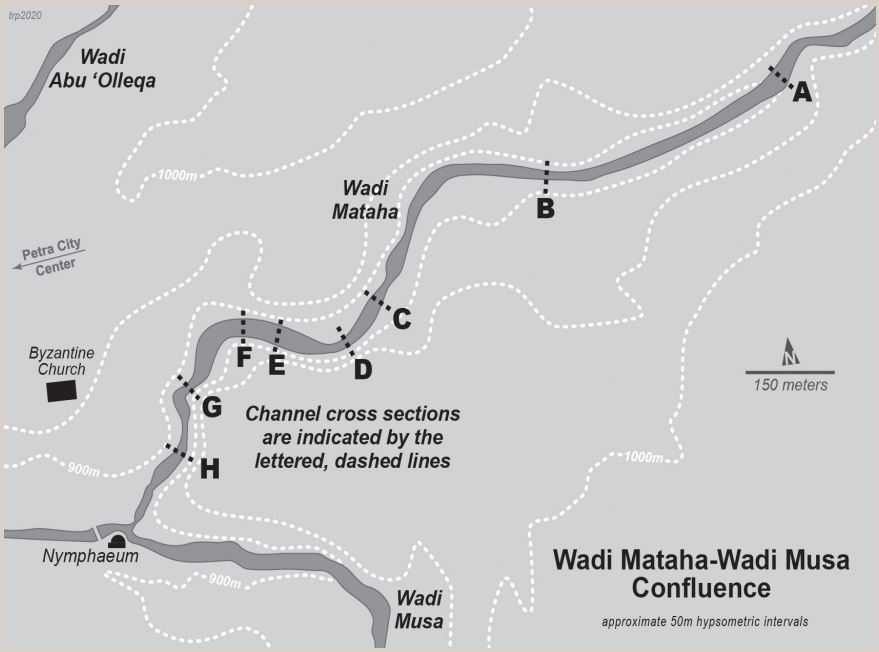

Fig. 1. Map representing the various channel cross-sections of Wadi Mataha, used in this paleo-flood research. For context note the Nymphaeum location along the colonnaded road in Petra's "Civic Center."

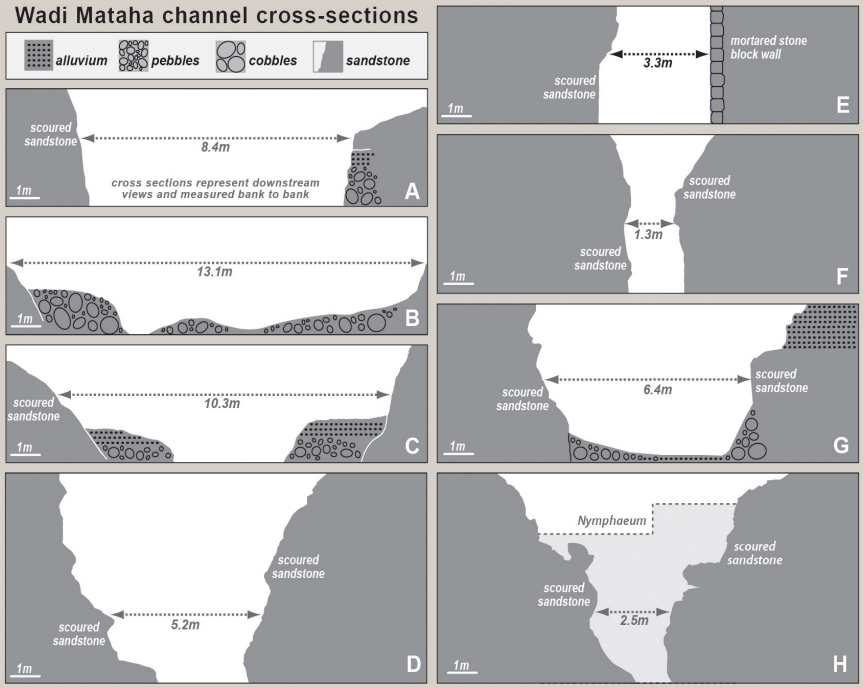

Fig. 2. These diagrams represent the Wadi Mataha channel cross-sections: "A" is farthest upstream near its confluence with Wadi al-Muthlim; "H" is farthest downstream near the confluence with Wadi Musa.

per second (mps) (0.7–1.5 kph) (cross sections A, B, and C), to 0.4 to 1.0 mps (1.4–3.6 kph) along the lower reaches as it neared Wadi Musa (cross sections F, G, and H). This speed increase was in tandem with an increase in flood height, raising water levels 1–3 m above the channel. With the channel width nearly four times wider at A (at Mudhlim) than at H (near the nymphaeum), it is verifiable that catastrophic flood stages would have breached the wadi wall at the nymphaeum.

Floodwaters would have inundated Petra's civic center, including the street shops, pool complex and Great Temple propylaea, temenos gate, and lower Qasr al-Bint. The flat area flanking lower Wadi Musa (today's restaurants) would have been submerged beneath 3–5 m of rushing water. These fast-moving currents would have created turbulence so great that it entrained and eroded pavement stones and removed road substrates, currently evidenced by the missing limestone pavers. Also, it would have redistributed extensive flood sediments from the upstream channel and sandbar sediment reservoirs into downstream channels and floodplains, creating lateral and distal sands, silts, and clays. These sediments have accumulated in the large stratified alluvial fan below Wadi Siyagh in the Wadi Araba—an ideal site for future research.

Reference

Paradise, T. R. 2011. "Petra's Great Flood: Evidence for a Catastrophic Flood in the 5th–6th Century." *Annual of the Department of Antiquities of Jordan* 56 (1): 143–158.