

## Petra: Architectural Earth-Sun Alignments

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The relationship of architecture, urban morphology, and celestial pathways have been integrated since classical times (e.g., Newgrange, Chitzen Itza, Stonehenge). However, in Petra such relationships are only hinted by its earliest western explorers, such as Bachmann, and Libbey and Hoskins. Paradise (1999) first identified the possible relationship of solar pathways, structural alignment, and their horizon contacts in the Petra Theater. Through advanced spatial analysis, nutated celestial paths were analyzed across Petra (Figs. 1–3). Not only have several façades been found oriented to illumination on solar marker days (solstices, equinoxes), but interior elements have been identified as associated with seasonal sunlight, as well. Since 2000, to correlate earth-sun relationships to architecture, GPS, GIS, computer cartography, laser measuring, and remote sensing have been used to link architectural footprints, horizon diagrams, and nutated sun risings and settings on marker days—vital relationships used in cultural, social, agricultural, and religious rituals and in designs, reckonings, and feast days (Paradise and Angel 2015).

It was revealed that earth-sun relationships to architecture and urban form can be divided into two categories (exterior facades vs. interior chambers), with two sub-categories: specific orientations (e.g., equinox sunset only) or combined effects (e.g., equinox and solstice sunrise). Some sites had broader relationships to other special sites through lines of sight (e.g., Jebel Haroun) and/or those co-aligned within urban patterns. Of the thirty primary Nabataean-Roman structures addressed by Brünnow and Domaszewski, Bachmann, and Libbey and Hoskins, many structures (80 percent) exhibit some obvious and some tenuous earth-sun relationships (Paradise and Angel 2015). However, current research addresses solar pathways to additional structures.

Past research revealed *summer-solstice sunrise* alignments in five structures (17 percent), including the Tomb of the Roman Soldier in Wadi al-Farasa (midsummer's eve). Oddly, al-Khazneh (the Treasury) is aligned exactly with the solstice sunrise; however, that illumination is obscured by the naturally facing cliff face. *Summer-solstice sunset* alignments were found in ten structures (33 percent), including the Palace, Renaissance, Broken, and Pediment Tombs, in the triclinia in al-Farasa, High Place of Sacrifice, and Bab as-Siq, and in the Entrance Tomb in Siq al-Barid (Fig. 3). These alignments exhibited marker-day illumination on hewn chamber walls, niches, and/or glyptics. *Winter-solstice sunrises* were related to two structures (7 percent): the Columbarium and Turkmaniya Tombs. *Winter-solstice sunsets* illuminated nine structures (30 percent), including the Palace, Urn, and Corinthian Tombs, and alignments with



the Theater and the Garden Tomb. Accurate surveying of the southern plaza on al-Habis revealed accurate sandstone carving aligned with cardinal compass points as well, indicating an emphasis on east-west orientations (Fig. 3).

New findings revealed relationships where *winter-solstice sunsets* illuminate eleven structures (37 percent), including the Urn, Palace, Garden, Triclinium, Renaissance, Broken Pediment, and Obelisk Tombs, and the Bab as-Siq Triclinium. *Equinox sunrises* were found in four structures (13 percent), including the Unfinished and Roman Temple Tombs (Fig. 2). Some monuments and structures were also found to have defined, hewn east-west alignments, indicating equinoctial axes at the High Place on al-Habis and the hewn obelisks on Jebel al-Madhbah—exactly aligned east-west (090°N, 270°N) (Fig. 3). East-west alignments as solar markers have been noted from Newgrange, Chitzen Itza, and Stonehenge, to separate the year into the cool, dark half (e.g., Saturnalia, Haloa) and the warm, light half (e.g., Vestalia, Kronia), with the equinox beginning and ending each half.

Since many western festivals are still associated with solar marker days (e.g., Easter, Christmas), prior studies indicate that lunisolar calendars were fundamental to early communities and rituals, including those of the Nabateans. However, more research is needed to better understand whether these alignments were indeed engineered and not arbitrary or habitual. So, an inventory of Petra's architecture associated with earth-sun relationships might be essential to our understanding of Nabatean cosmology, urban planning, and theology and also as a central paradigm in its culture, society, agriculture, and even urban morphology.

## References

- Paradise, T. R. 1999. "Analysis of Sandstone Weathering of the 'Roman Theater' in Petra, Jordan." *Annual of the Department of Antiquities of Jordan* 43: 353–368.
- Paradise T. R. and Angel, C. C. 2015. "Nabataean Architecture and the Sun: Landmark Discoveries Using GIS in Petra, Jordan." *ESRI ArcUser* (Winter 2015): [4 pp.].

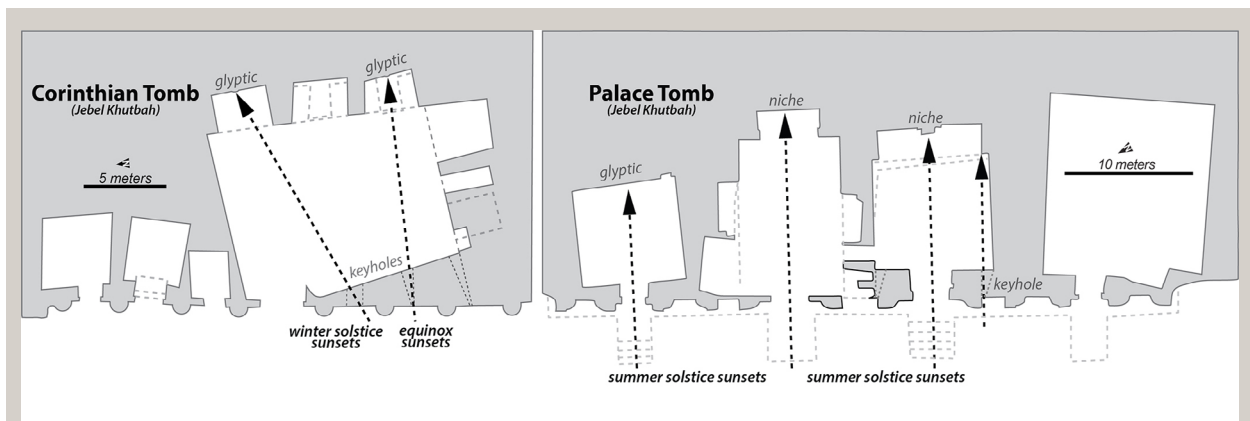


Fig. 1: The Corinthian and Palace Tombs are part of Petra's "Royal Tombs," and both revealed solar alignments on marker days illuminating the chamber interiors. The Royal Tombs, in general, face most sunsets, but it was the unique carving of "keyholes" in the façades that facilitated the sun's shining on the chamber walls of the tombs during the marker day sunsets. (Cartography by Tom Paradise.)

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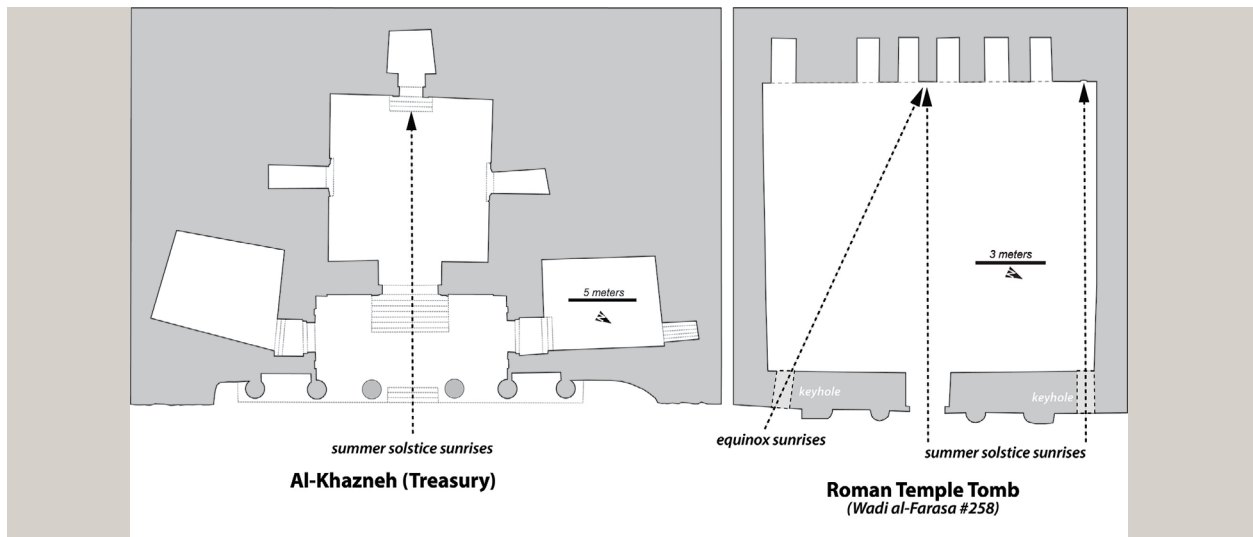


Fig. 2: Even Petra's most recognizable façade and chamber, al-Khazneh, divulged an unusual alignment directly with the rising sun on the summer solstice. However, the sun was/is unable to reach the chamber due to the high facing cliff wall. Was this a habitual orientation in Petra, or was the cliff face to be removed in part to permit sunlight to enter the chamber on this important annual marker day? Even in Wadi al-Farasa, the canyon adjacent to the Street of Façades, the Roman Temple Tomb (#258) revealed notable sun alignments on marker days directly through the main portal and through two additional keyholes carved directly through the façade. (Cartography by Tom Paradise.)

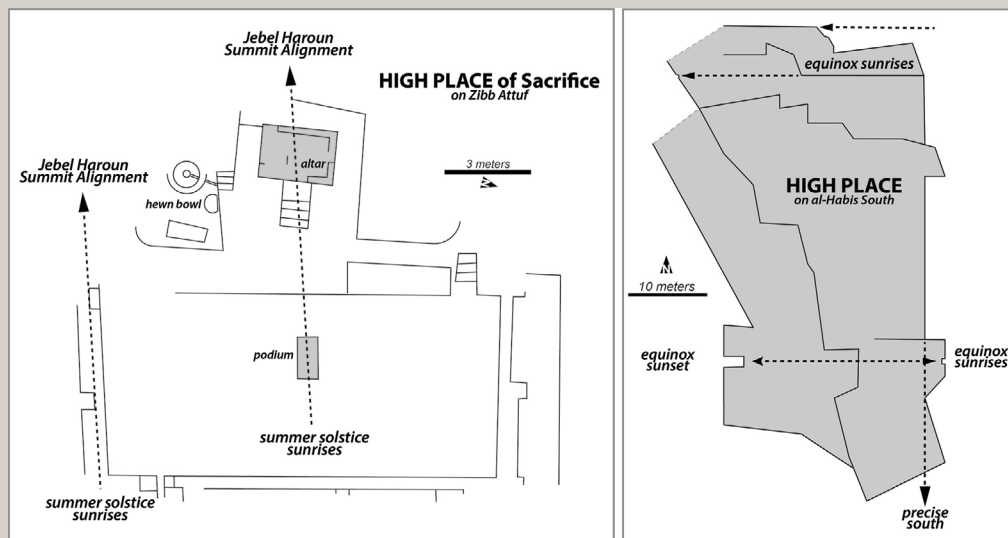


Fig. 3: Not only were marker days found to align with the rising and setting sun through doorways and "keyholes," but surrounding landscape elements were also found to align. It is known that ad-Deir (the Monastery) directly faces the peak and structure atop Jebel Haroun. However, the podium and altar on the "High Place of Sacrifice" atop Zibb 'Atuff are also in alignment with the peak of Jebel Haroun. This alignment is visible from the High Place plaza area. To a lesser degree, numerous areas across Petra—such as the southern "plaza" on al-Habis—have been found to have been designed, hewn, and/or oriented with direct (and often very accurate) positionings to cardinal compass points and/or marker-day orientation. (Cartography by Tom Paradise.)