Rock varnish evidence for the early to mid Holocene African monsoon influence in the Dead Sea Basin and the Negev Desert

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Rock varnish from Holocene (11.6-0 ka) geomorphic and archaeological features in the Dead Sea Basin and the Negev Desert of the Middle East displays a regionally replicable layering sequence that is characterized by alternating Mn/Ba-rich dark layers and Mn/Ba-poor orange/yellow layers. Independent radiometric age constraints on the varnish-coated rocks, together with varnish thickness-based age interpolation, yield a numerical chronology for the Holocene varnish layering sequence. Six dark layers in the lower portion of the sequence deposited at ca. 11, 9.9, 8.8, 7.6, 6.2, 4.9 ka, are diagnostic of early to mid Holocene major wet phases in the region. Six light-dark layers in the upper portion formed at ca. 3.7, 2.8, 2.1, 1.5, 0.9, 0.3 ka, are the expression of a generally dry late Holocene with minor wet phases. All together thirteen orange/yellow layers represent relatively dry phases of the Holocene, including two pronounced orange/yellow layers deposited during two extremely dry events at ca. 8.2 and 4.2 ka in the region. Intriguingly, the early to mid Holocene wet phases inferred from the varnish record are generally not coeval with the reconstructed highstands of the Dead Sea. Rather, they appear to largely mimic the wetness variations in the varnish record from the Lake Turkana Basin of Kenya, as well as the high water levels of other African lakes during the African Humid Period (11-5.2 ka). We therefore infer that they reflect the African monsoon influence over the Dead Sea Basin and the Negev Desert. Moist air masses transported northward via the tropical plumes and/or eastward via the West African monsoon circulation are most likely responsible for the overall early to mid Holocene wet period in the region, though moisture fluxes from the northward expansion of the Red Sea Trough to the Southern Levant may also play a role.