

# Clusters of flowstone ages are not supported by statistical evidence

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Pickering et al.<sup>1</sup> identify six clusters of U–Pb dates among 29 flowstone deposits in the Cradle of Humankind to argue that the hominin record of South Africa is restricted to dry climate phases. The six clusters were identified as peaks in a kernel density estimate, which was created using software developed by one of us<sup>2</sup>: unfortunately, this software has not been used appropriately. Kernel density estimation is a descriptor of data and not a statistical tool—it has no parametric or distributional element, and the data are not ‘fitted’ in a statistical sense. Therefore, a kernel density estimate cannot be used as justification to subdivide the small dataset of 29 dispersed values into 6 even-smaller clusters. There is no statistical evidence that the data contain more than one age component, as was proposed by Pickering et al.<sup>1</sup>. For example, the flowstone data pass a standard Shapiro–Wilk test for normality ( $P = 0.4$ ). We do not claim that the data follow a normal distribution; here we use the hypothesis test to argue that if the dataset is too small to reject normality, then it is too small to prove multimodality. By manually selecting an inappropriately narrow kernel bandwidth (of 30,000 years instead of the default 320,000 years) and histogram bin width, the authors have created six ‘phantom peaks’ of questionable scientific value<sup>3</sup>.

1. Pickering, R. et al. U–Pb-dated flowstones restrict South African early hominin record to dry climate phases. *Nature* 565, 226–229 (2019).
2. Vermeesch, P. On the visualisation of detrital age distributions. *Chem. Geol.* 312–313, 190–194 (2012).
3. Stratford, D. et al. Comments on ‘U–Pb dated flowstones restrict South African early hominin record to dry climate phases’ (Pickering et al. *Nature* 2018;565:226–229). *S. Afr. J. Sci.* 116, 7094 (2020).

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**Additional information**

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