Supplementary information for:

High-resolution reconstruction of infiltration in the Southern Cook Islands based on trace elements in speleothems

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***Table S 1**. Results of multi-collector ICP mass spectrometry U-Th analyses for Pu4.*

Sample	Lab Number	Depth(mm)	U(ngg^{-1})	[^{230}Th/^{238}U]^{a}	[^{234}U/^{238}U]^{a}	[^{232}Th/^{238}U]^{a}	[^{230}Th/^{232}Th]^{a}	Age(ka)^{b}	[^{234}U/^{238}U]$_{i}$^{c}
Pu4-3	UMD180228-518	11.0(1.0)	56	0.00180(67)	1.0359(89)	0.000216(48)	8.3	0.127(0.086)	1.0359(89)
Pu4-5	UMD180228-521	16.0(1.0)	57	0.00224(48)	1.0346(51)	0.000220(59)	10.2	0.168(0.070)	1.0346(51)
Pu4-8	UMD180228-522	23.0(1.0)	55	0.00204(45)	1.0291(73)	0.000147(54)	13.8	0.168(0.062)	1.0291(73)
Pu4-9	UMD180228-524	25.7(1.0)	51	0.00263(36)	1.0344(59)	0.000127(41)	20.7	0.236(0.050)	1.0344(59)

[a] Activity ratios determined at the University of Melbourne after Hellstrom (2003) and Drysdale et al. (2012).

[b] Age in kyr before year of measurement (2014), corrected for initial ^{230}Th using eqn. 1 of Hellstrom (2006), assumed initial [^{230}Th/^{232}Th] of 1.5 ± 1.5 and the decay constants of Cheng et al. (2013).

[c] Initial [^{234}U/^{238}U] activity calculated using corrected age.

2σ uncertainties in brackets are of the last two significant figures presented.

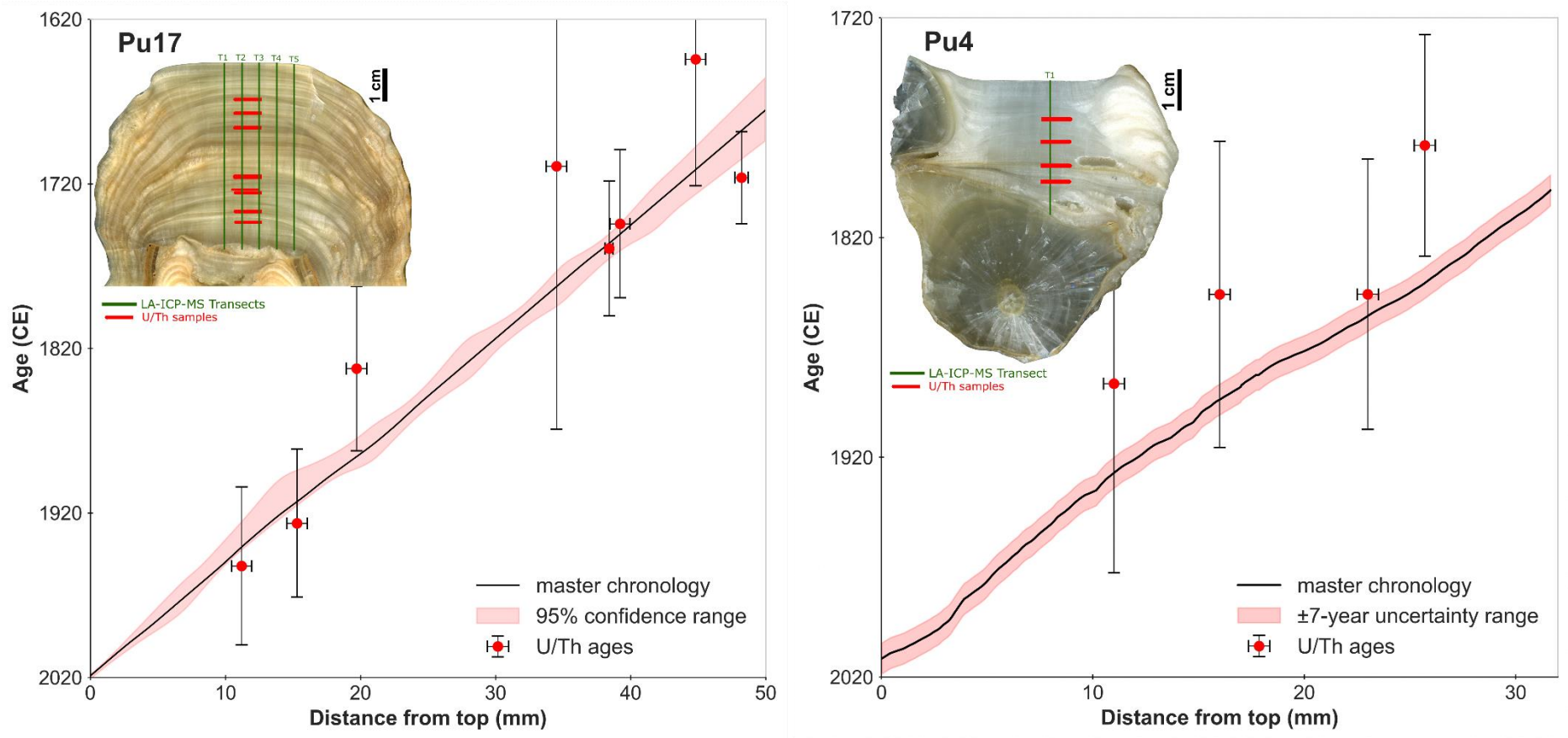

Fig. S 1. *Age models for Pu17 (left) and Pu4 (right) integrating lamina counting and U-Th analyses. The optical scans of the two stalagmites showing the location of U-Th dates, and LA-ICP-MS transects are also inserted. The scans of the stalagmites reveal that Pu17 was growing on a broken stalagmite, while Pu4 was growing on a broken stalactite. Chronology for Pu17 and Pu4 were determined by combining the U-Th dating with counted visible chemical laminae on synchrotron µXRF two-dimensional map of Sr and optically visible growth bands (Faraji et al., 2021). The Pu17 master chronology was further constrained via developing a chronology for modern portions of the stalagmite (top ~14 mm) using ^{14}C and the bomb pulse soil continuum method, and then combining it with laminae counting and radiocarbon age models as discussed in Faraji et al. (2023).*

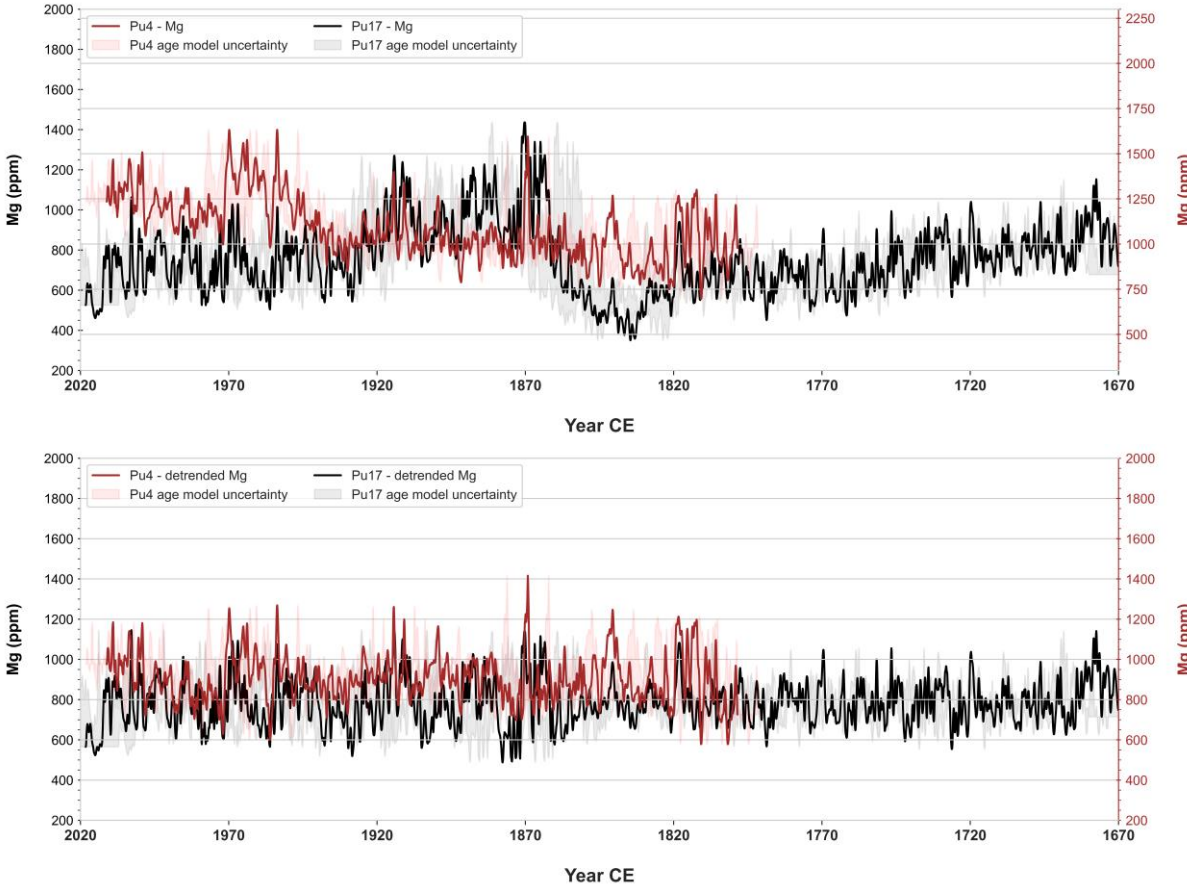

***Fig. S 2**. Time series of Mg in Pu4 and Pu17, showing that two stalagmites show different trends. The detrended time series correlate very well, which justifies the detrending exercise. This figure indicates that long-term trends in Mg are local and most likely related to aquifer responses to local events.*

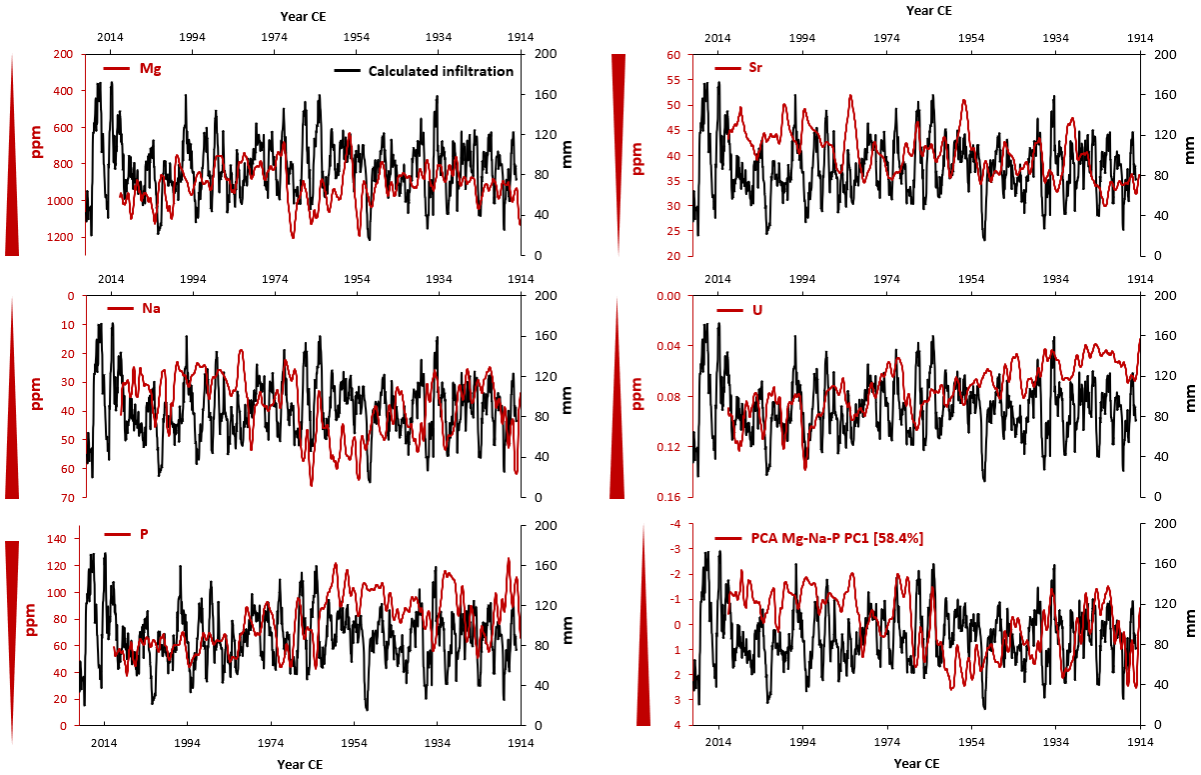

Fig. S 3*. Comparison of time series of trace elements (Mg, Sr, Na, U, P, and PC1 of Mg-Na-P PCA) in Pu4 with the 12-month moving average of the calculated infiltration (rainfall minus potential evapotranspiration) from 1914 to 2019.. Mg, Na, and P hold the best correlation with infiltration, with Mg and Na having a negative and P a positive relationship. Please note that the y-axis is in reversed order for Mg, Na, U and PC1. The red triangles next to the y-axes show the decreasing or increasing order of the y-axes.*

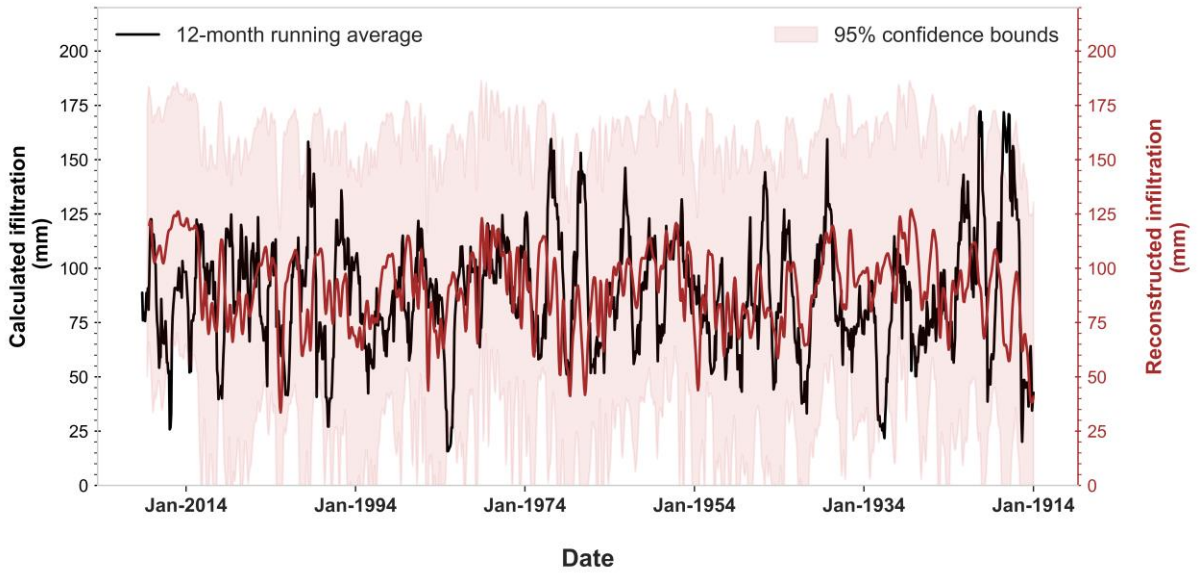

Fig. S 4*. Comparison between calculated infiltration with reconstructed infiltration for Pu17 based on the time series of Mg and by applying the Mg transfer function. The 95% confidence bounds of regression analysis are also shown in light red.*

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