HafniumPlotter

Sundell et al. (2019)

HafniumPlotter is a program designed for visualizing paired U-Pb geochronology – Lu-Hf geochemistry data as bivariate kernel density estimates (KDEs). The program constructs bivariate KDEs following the same basic method of a standard one-dimensional (1D) KDE (Silverman et al., 1986), but over a two-dimensional (2D) grid with density values on the z-axis. Bivariate KDEs facilitate visualizing complex 2D data as density plots which allow for identification of robust data clusters and non-arbitrary contouring of those clusters.

To construct a bivariate KDE, each data point on a 2D scatter plot is converted into a 2D Gaussian with separate kernel bandwidths for the x-axis (U-Pb age) and y-axis (εHf(t)) values determined by optimization (using Botev et al., 2010) or arbitrary selection (as appropriate to see details in the data density). Bivariate KDEs in HafniumPlotter are generated over a 512 x 512 grid and normalized such that the volume area integrates to 1. Contours are calculated as a percentage from peak density.

For a detailed description of the methods implemented in HafniumPlotter, and for proper citation, please reference the following paper:

Sundell, K.E., Saylor, J.E., Pecha, M., (2019), Sediment provenance and recycling of detrital zircons from Cenozoic Altiplano strata in southern Peru and implications for the crustal evolution of west-central South America, Book: Andean Tectonics, Journal of South American Earth Sciences.

Note that this program requires the MATLAB Runtime. The Runtime is free and only needs to be installed once. Following installation and upon running HafniumPlotter, the Runtime will automatically be accessed; there is no need to open the Runtime directly. If you have comments/questions about any of the files, please contact Kurt Sundell (kurtsundell@gmail.com).

Following are links to the latest version of HafniumPlotter, example data sets, user manual, and a PDF of Sundell et al. (2019), and MATLAB Runtime:

**HafniumPlotter for Windows and macOS, example data, user manual, publication**

MATLAB Runtime Compiler for Windows (free, and required to run HafniumPlotter)

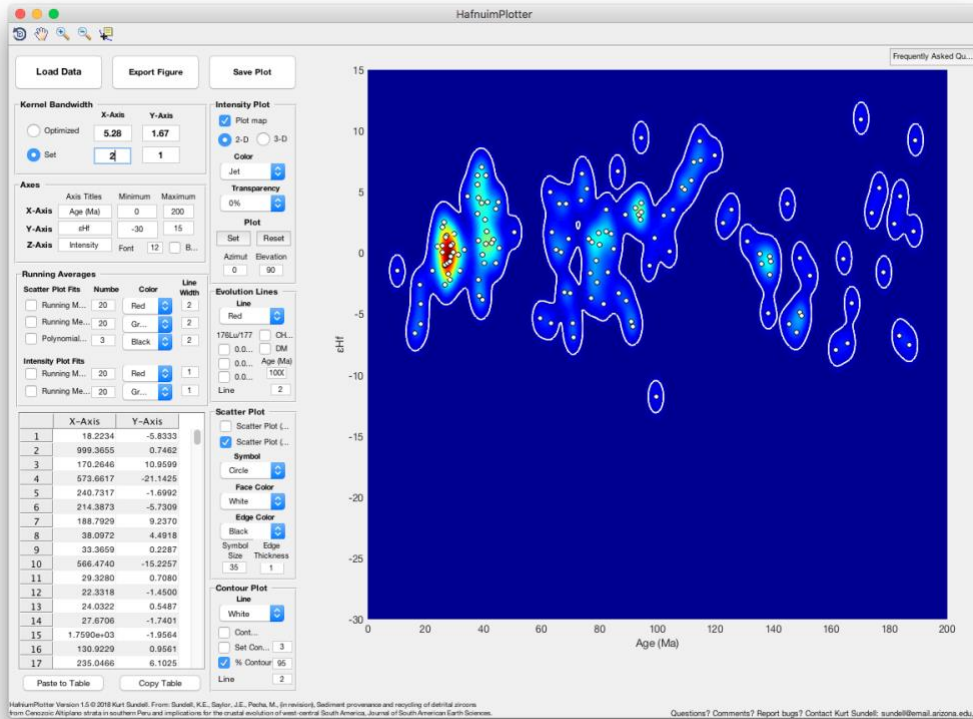**MATLAB Runtime Compiler for macOS (free, and required to run HafniumPlotter)**

Default three-dimensional (3D) plot of detrital zircon U-Pb–εHf(t) data from the Cenozoic Altiplano published in Sundell et al. (2019)
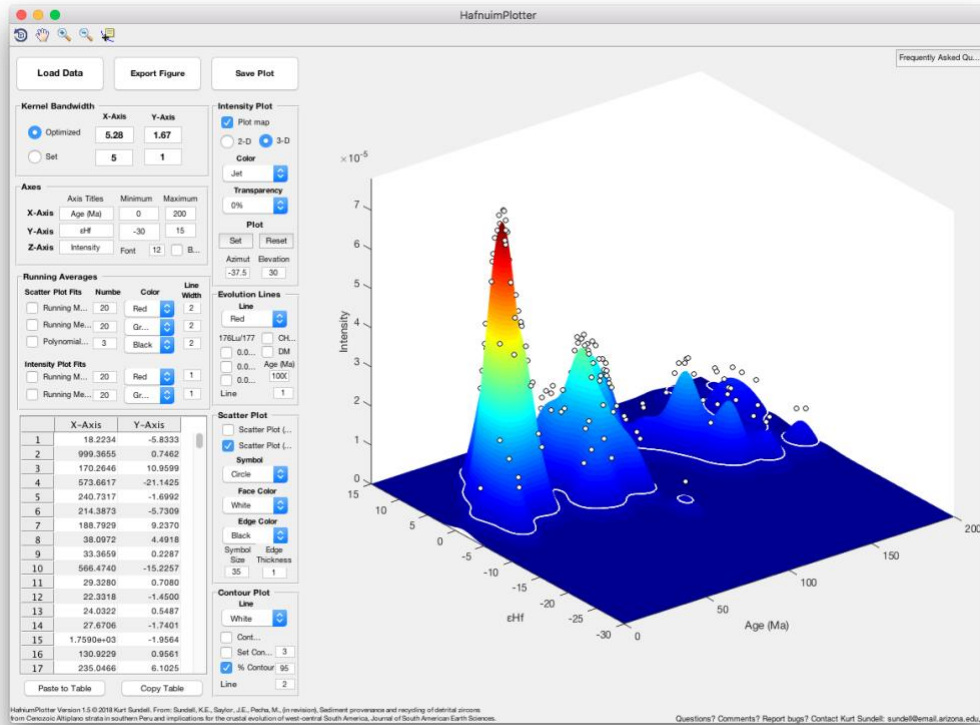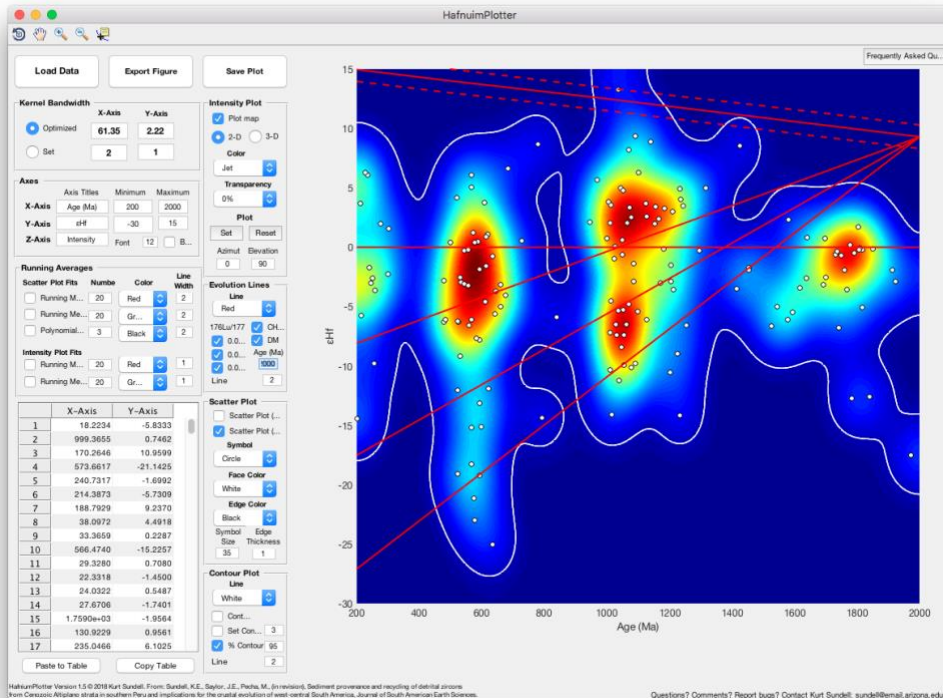

**The same plot as above but in 2D; contour is 95% from the peak density**
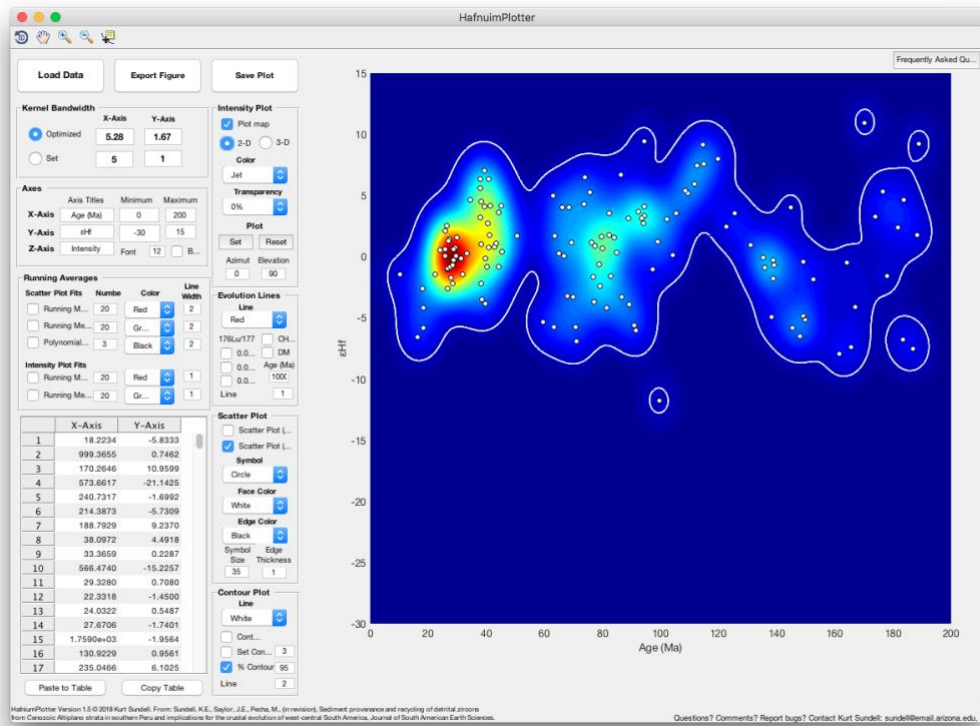
**Same data as above, but with set kernels to 2 Myr and 1 epsilon unit**

Same data as above, but with an adjusted age scale (200–2000 Ma), optimized kernels, crustal evolution lines, depleted mantle, and CHUR

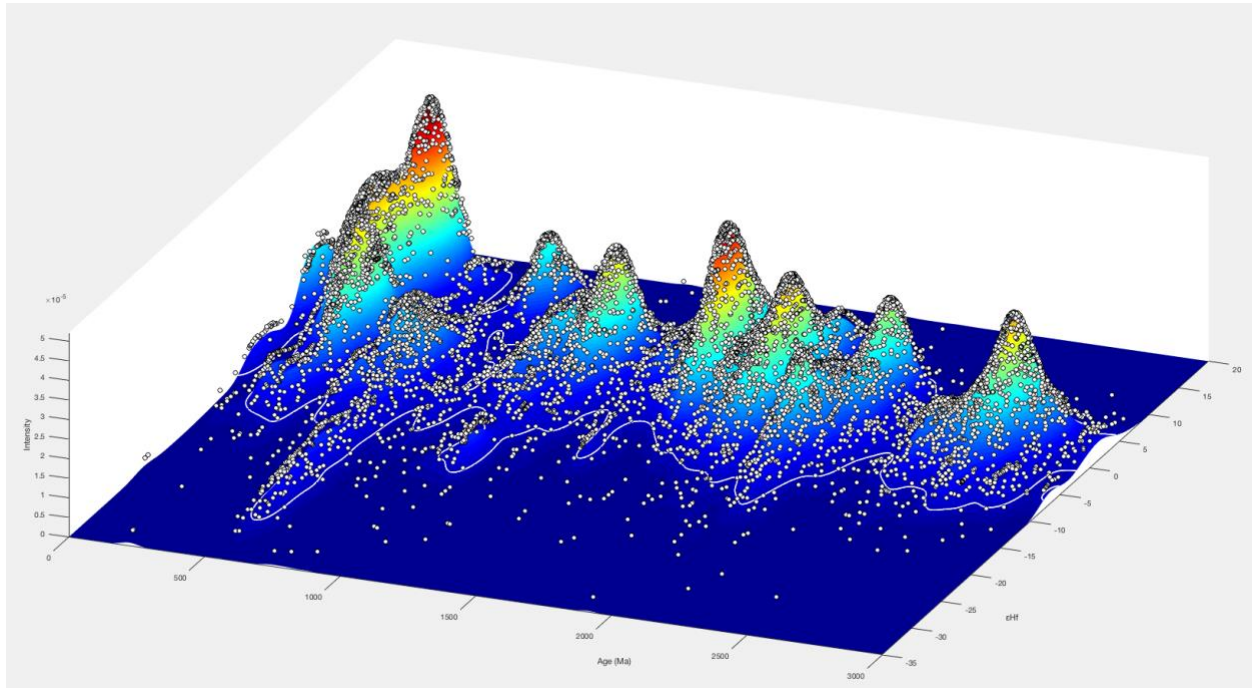HafniumPlotter (*Sundell et al., 2019*)

Same data as above, but with adjusted colormap (to 'hot') and running mean (green line) and median (blue line) with 20-point windows
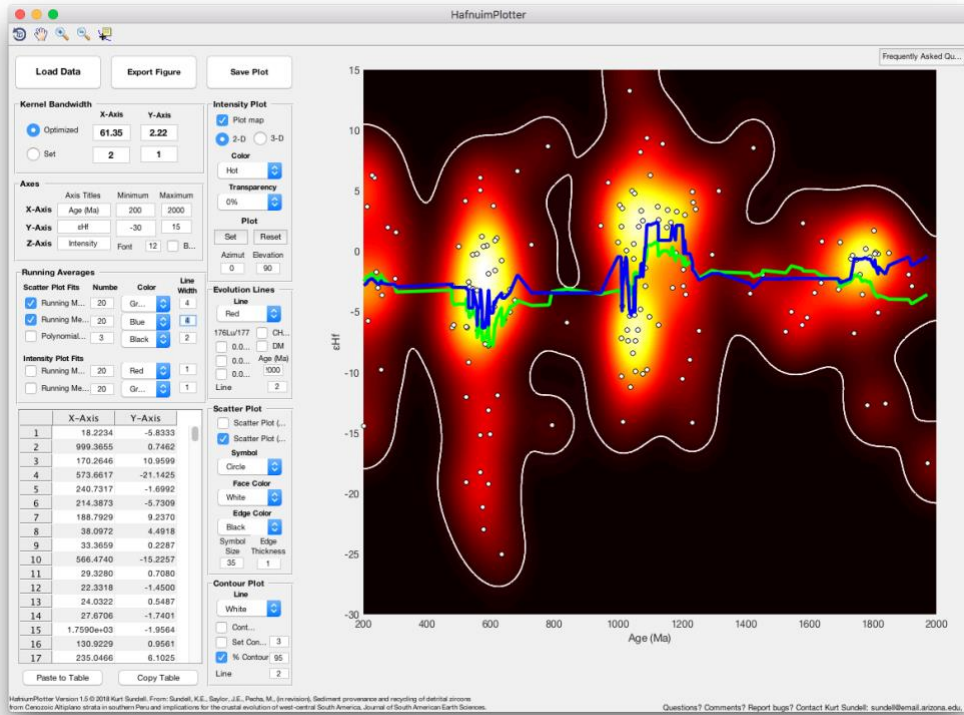
Running mean (in 3D) of peak density

HafniumPlotter (*Sundell et al., 2019*)
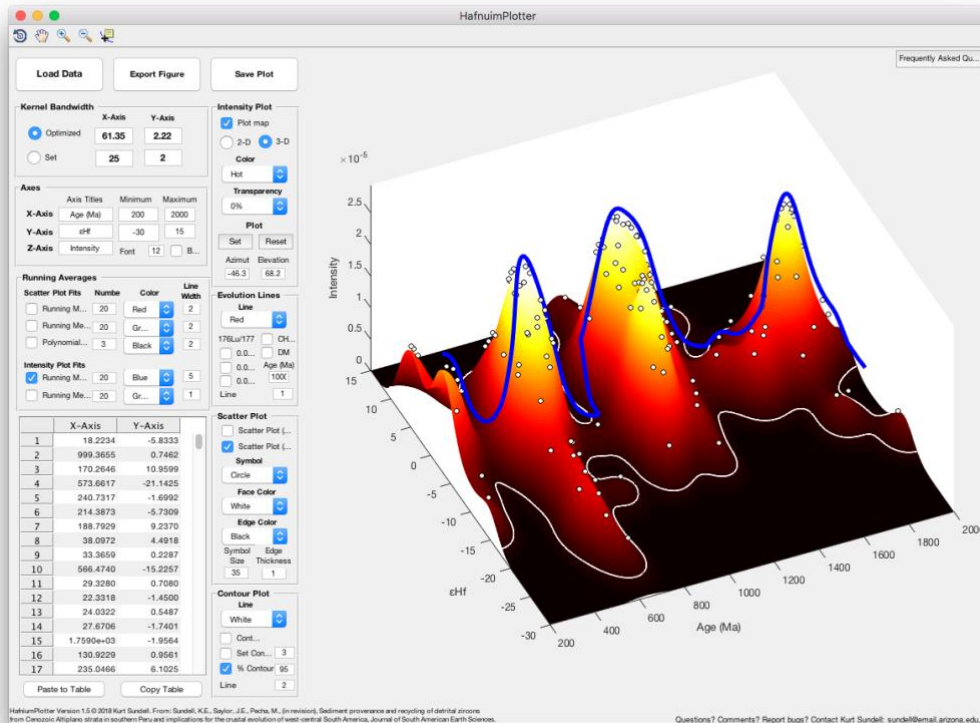
Global Hafnium database from Belousova et al. (2010)

Global Hafnium database from Belousova et al. (2010) plotted in 2D and with running median of 100-point window

HafniumPlotter (*Sundell et al., 2019*)
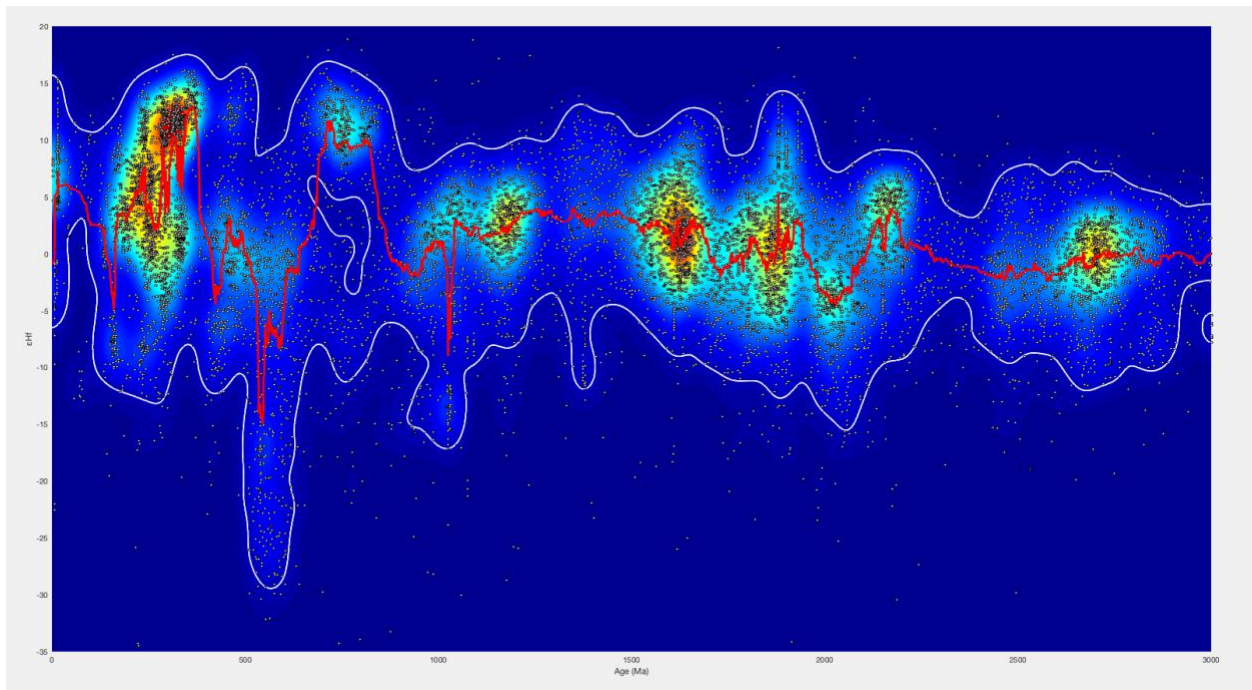
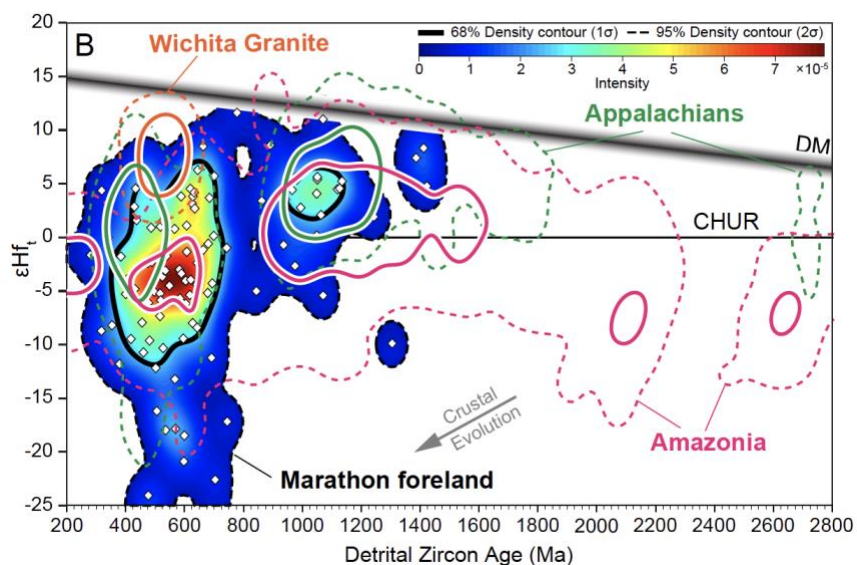# Example published figure and caption from Thomas et al. (2019)

Figure 7. (A) Plot of εHft data to compare results from Laurentia (Appalachians) (from sources listed in caption for Figure 3), Gondwana (Amazonia) (from Pepper et al., 2016), Southern Oklahoma igneous rocks (from Thomas et al., 2016), and Marathon foreland (from Figure 3, Supplemental Table S2). The Appalachian data exclude identified Gondwanan accreted terranes in the Appalachian internides but include detrital zircons from Gondwanan sources in the Appalachian foreland (from Thomas et al., 2017). The Amazonia data are from various primary sources in South America (from Pepper et al., 2016). Data from the Wichita granites show the distinctive positive εHft values for Iapetan synrift rocks (Thomas et al., 2016). (B) Age-εHft plotted as normalized bivariate kernel density estimates (KDEs) using HafniumPlotter version 1.4 (https://github.com/kurtsundell/HafniumPlotter). Construction of bivariate KDEs follows the same basic formulation as standard KDEs (Silverman, 1986). Each Age-εHft data point is converted into a three-dimensional Gaussian with kernel bandwidths of 50 Myr along the x-axis (U-Pb age) and 2 ε units along the y-axis (εHft value). All bivariate KDEs are mapped to a two-dimensional x-y grid of 512 x 512 cells, each with a single intensity value along the z-axis. When viewed parallel to the z-axis bivariate KDEs produce an intensity map that can be contoured to specified intervals, which facilitates comparison of data clusters through non-arbitrary contouring of those clusters. Contours are plotted at 68% and 95% (1σ and 2σ) of peak density. Note the similarity between the Amazonia 1σ contour (bold magenta line) and peak density of the Marathon foreland (dark red intensity values).

References

Belousova, E. A., Y. A. Kostitsyn, William L. Griffin, Graham C. Begg, Suzanne Y. O'Reilly, and Norman J. Pearson. "The growth of the continental crust: constraints from zircon Hf-isotope data." Lithos 119, no. 3-4 (2010): 457-466.

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Pepper, Martin, George Gehrels, Alex Pullen, Mauricio Ibanez-Mejia, Kevin M. Ward, and Paul Kapp. "Magmatic history and crustal genesis of western South America: Constraints from U-Pb ages and Hf isotopes of detrital zircons in modern rivers." Geosphere 12, no. 5 (2016): 1532-1555.

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Thomas, William A., George E. Gehrels, and Mariah C. Romero. "Detrital zircons from crystalline rocks along the Southern Oklahoma fault system, Wichita and Arbuckle Mountains, USA." Geosphere 12, no. 4 (2016): 1224-1234.

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