Theory of the stratigraphic filter

Andrew J. Moodie

July 17, 2019

Elevation and stratigraphy

Sedimentary rocks record the conditions of Earth's surface at various times in the past. Sediments are retained in the rock record only if they are *never* eroded at some later time. This theory, coupled with the observation that measured sedimentation rates decreases with increasing time span measured over (often called the Sadler effect (Sadler 1981)), lead researchers to try and understand why the stratigraphy records only a vanishingly small fraction of time—in other words, the stratigraphic record is remarkably incomplete. Tipper (1983) was the first to apply a random walk model to the problem of stratigraphic completeness, wherein he presented a model for how erosional events eliminate depositional elevation changes, and thus preclude large periods of time from the stratigraphic record.

Consider Figure 1, which depicts the elevation at a single location over time (black line), where the elevation is changed by a random amount (dz) each timestep (dt). The resulting timeseries of elevation is a *random walk* for elevation. The *stratigraphic filter* is the process by which periods of time when the elevation was increased are removed by erosive events that bring the elevation back to a lower point. Thus, the resulting stratigraphy is calculated by

"This process mathematically summarizes thegeological intuition that each stratum is a record of the mostrecent interval during which the surface occupied the corre-sponding stratigraphic position" (Schumer, Jerolmack, and McElroy 2011).

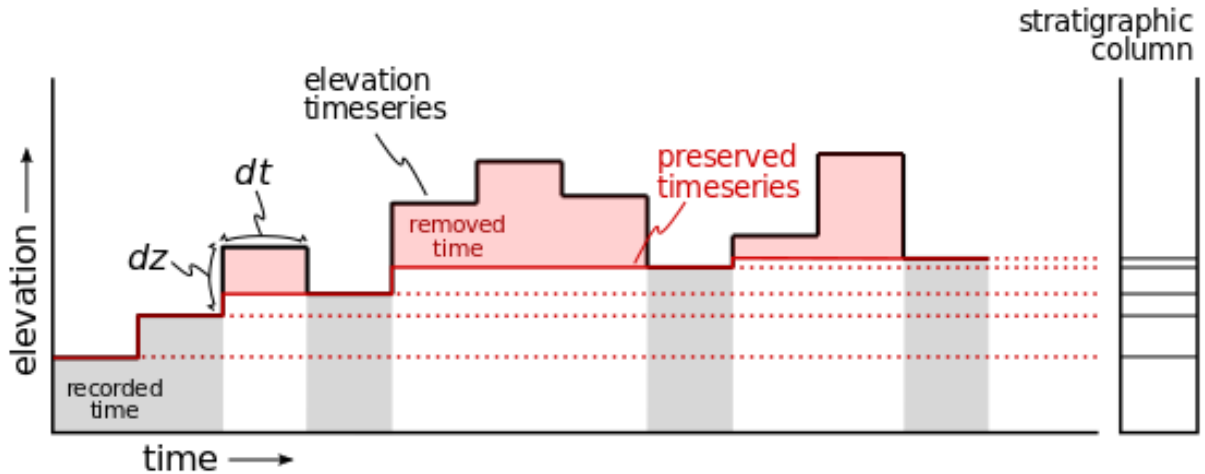Figure 1: Schematic drawing of a random walk model for stratigraphic development. Each timestep the elevation is changed by adding a randomly drawn Δz value from a probability distribution. The stratigraphy is calculated after the model run is completed, by the routine presented in the following section.

The numerical model

In this module, a simple random walk model is developed. Research into how random walks

A review of time, stratigraphy, and random walk models is given by (Paola et al. 2018).

Discussion questions

1.
2.

References

Paola, Chris, Vamsi Ganti, David Mohrig, Anthony C. Runkel, and Kyle M. Straub. 2018. "Time Not Our Time: Physical Controls on the Preservation and Measurement of Geologic Time." *Annual Review of Earth and Planetary Sciences* 46 (1): 409–38. doi:10.1146/annurev-earth-082517-010129.

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Schumer, Rina, Douglas Jerolmack, and Brandon McElroy. 2011. "The Stratigraphic Filter and Bias in Measurement of Geologic Rates." *Geophysical Research Letters* 38 (11). doi:10.1029/2011GL047118.

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