# Sierra Nevada Time Series

J. Beem-Miller

21 Oct 2020

## Data preparation script for Sierra Nevada time series analysis

*Merge templates with 14C, C, and N data*

Radiocarbon analyses for the 2001 samples were not run originally, but were completed on archived samples in 2020.

### 2001 mean radiocarbon profiles

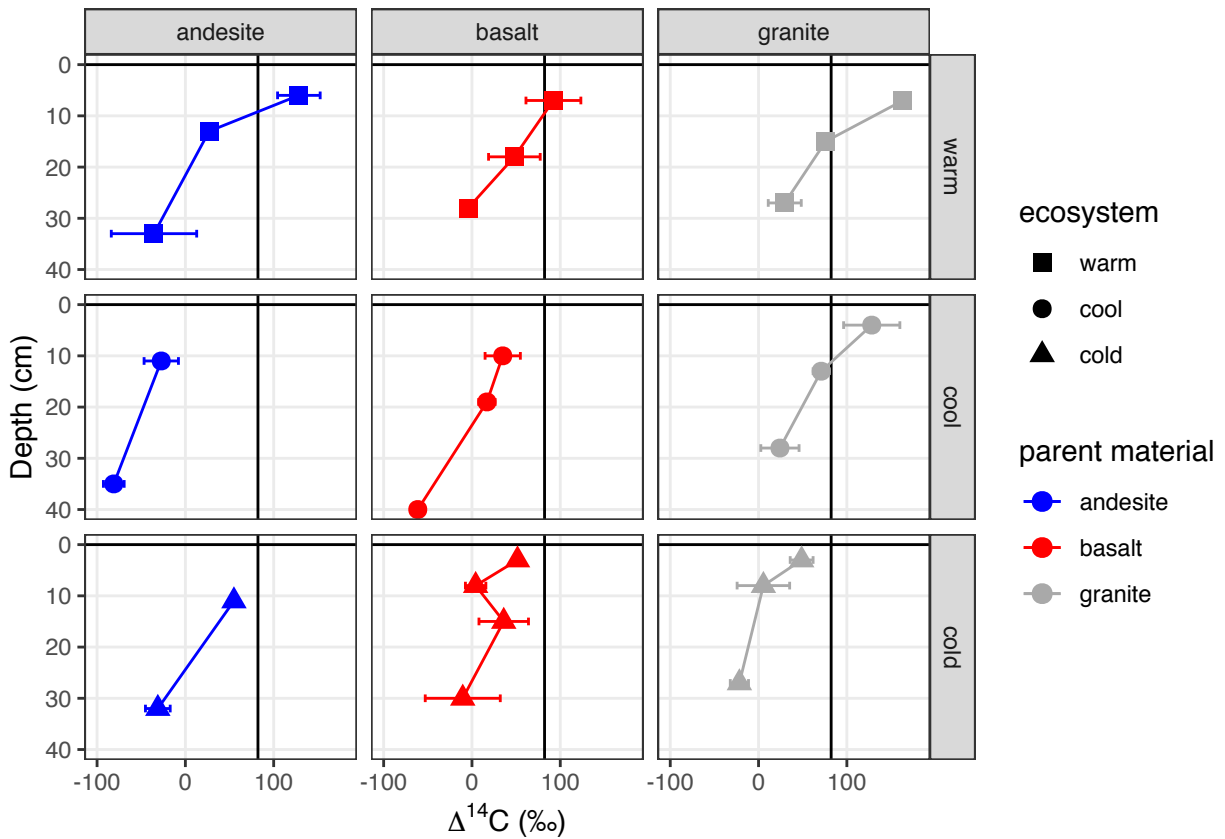Mean profiles are shown below for the 2001 samples, error bars show ±1 standard deviation.



**Fig. . Mean profile $\Delta^{14}$C for 2001 samples**

*Caption:* Mean $\Delta^{14}$C by depth for each site in 2001. Error bars show ±1 standard deviation.

## 2009 radiocarbon profiles

Mean profiles are shown below for the 2009 samples (error bars not shown as only a single replicate profile was analyzed).
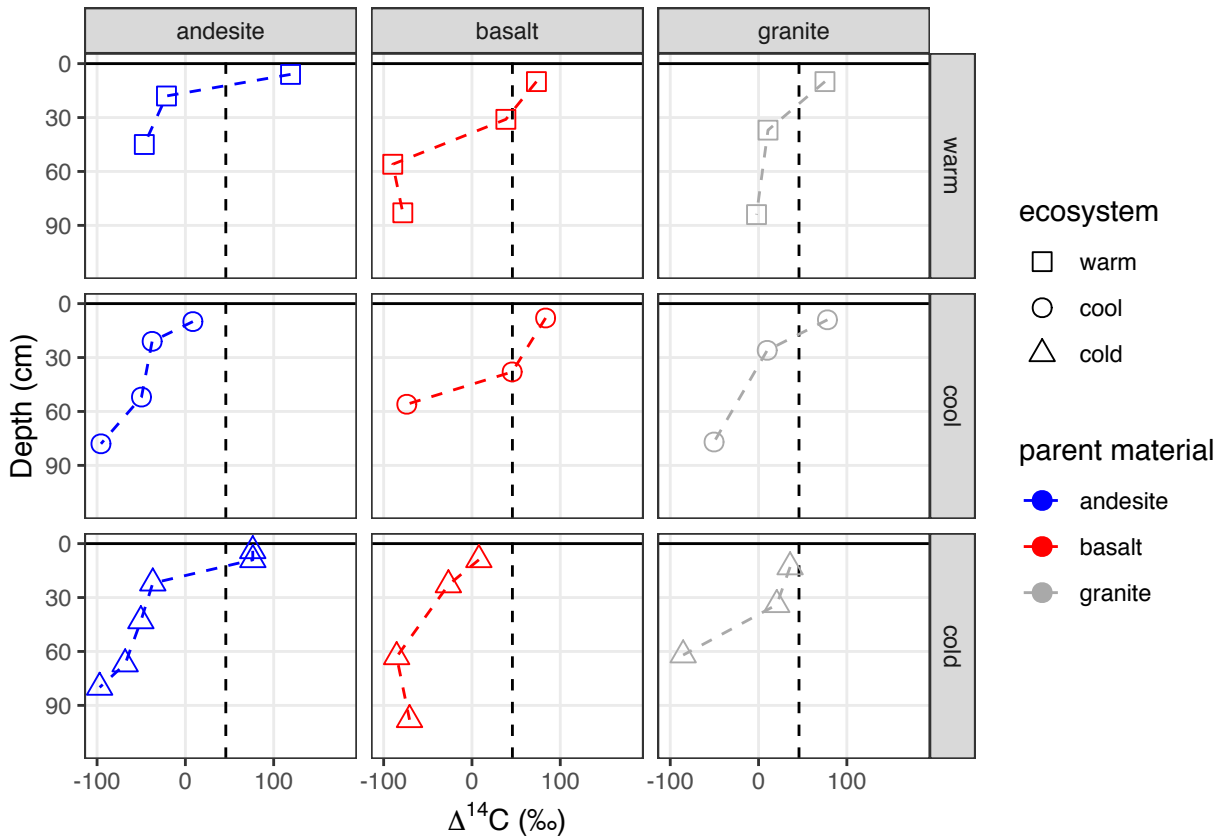


**Fig. 2. Profile $\Delta^{14}$C for 2009 samples**

*Caption:* Profile $\Delta^{14}$C by depth for each site in 2009. Error bars not shown as only a single replicate profile was analyzed per site.

## 2019 mean radiocarbon profiles

Mean profiles are shown below for the 2019 samples, error bars show $\pm 1$ standard deviation.
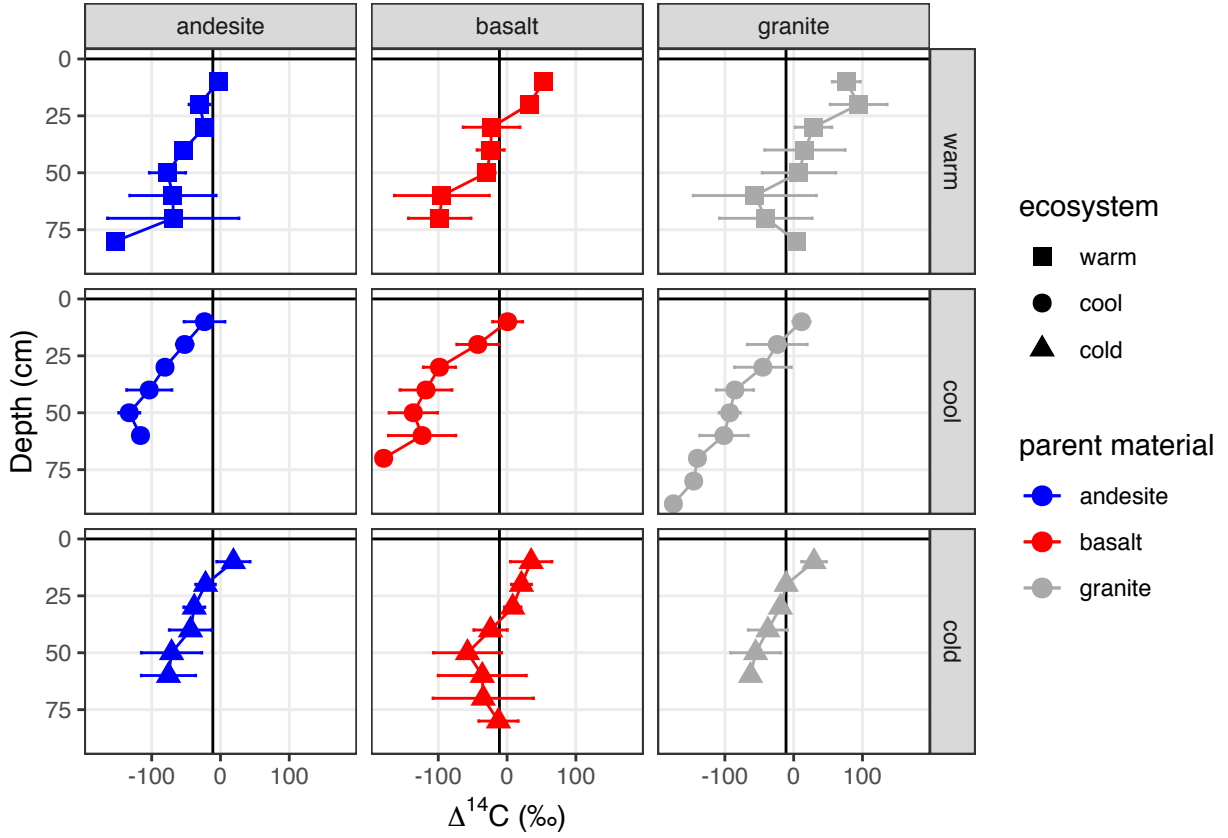
**Fig. 3. Mean profile $\Delta^{14}$C for 2019 samples**

*Caption:* Mean $\Delta^{14}$C by depth for each site in 2019. Error bars show $\pm 1$ standard deviation.
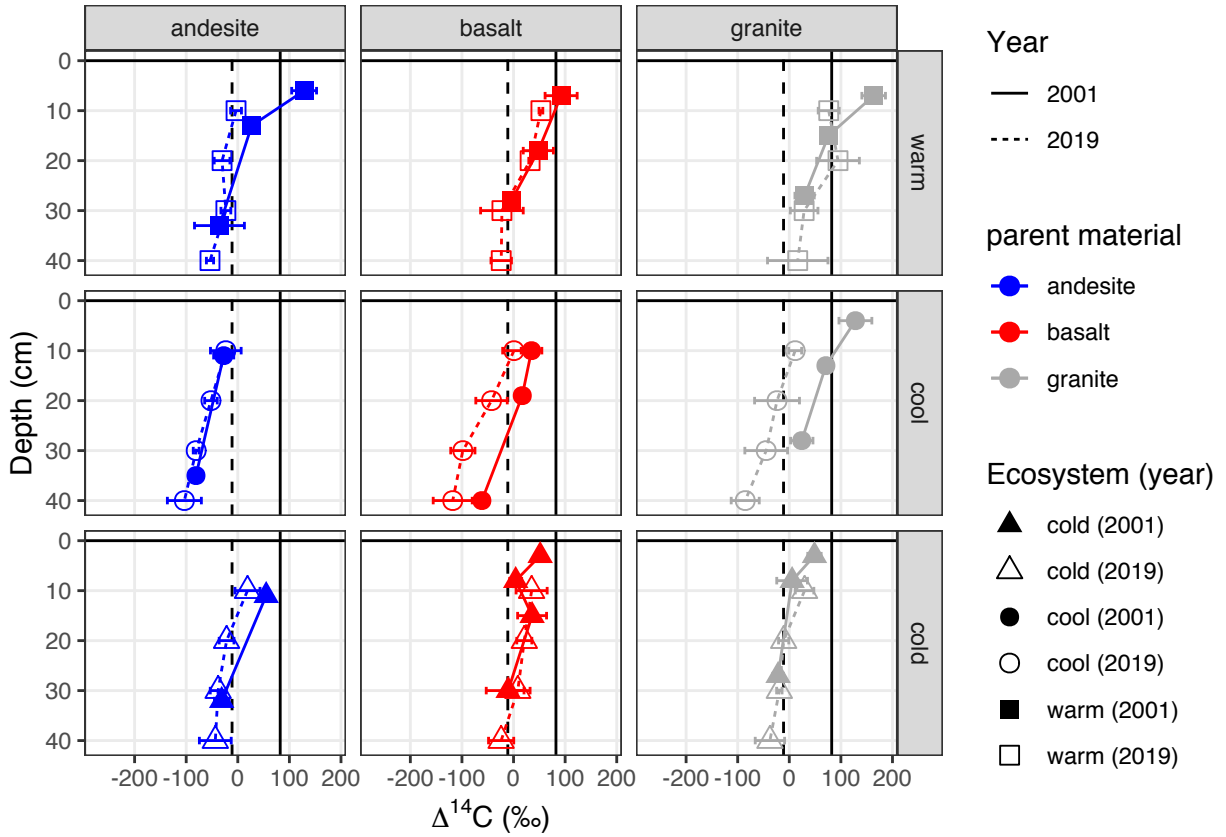
# Change in $\Delta^{14}$C over time between 2001 and 2019



**Fig. 4. Mean profile $\Delta^{14}$C for 2001 and 2019 samples**

*Caption:* Mean $\Delta^{14}$C by depth for each site in 2001 and 2019. Error bars show $\pm 1$ standard deviation.

# Incubation $\Delta^{14}$C-CO$_2$ for 2019 bulk soils



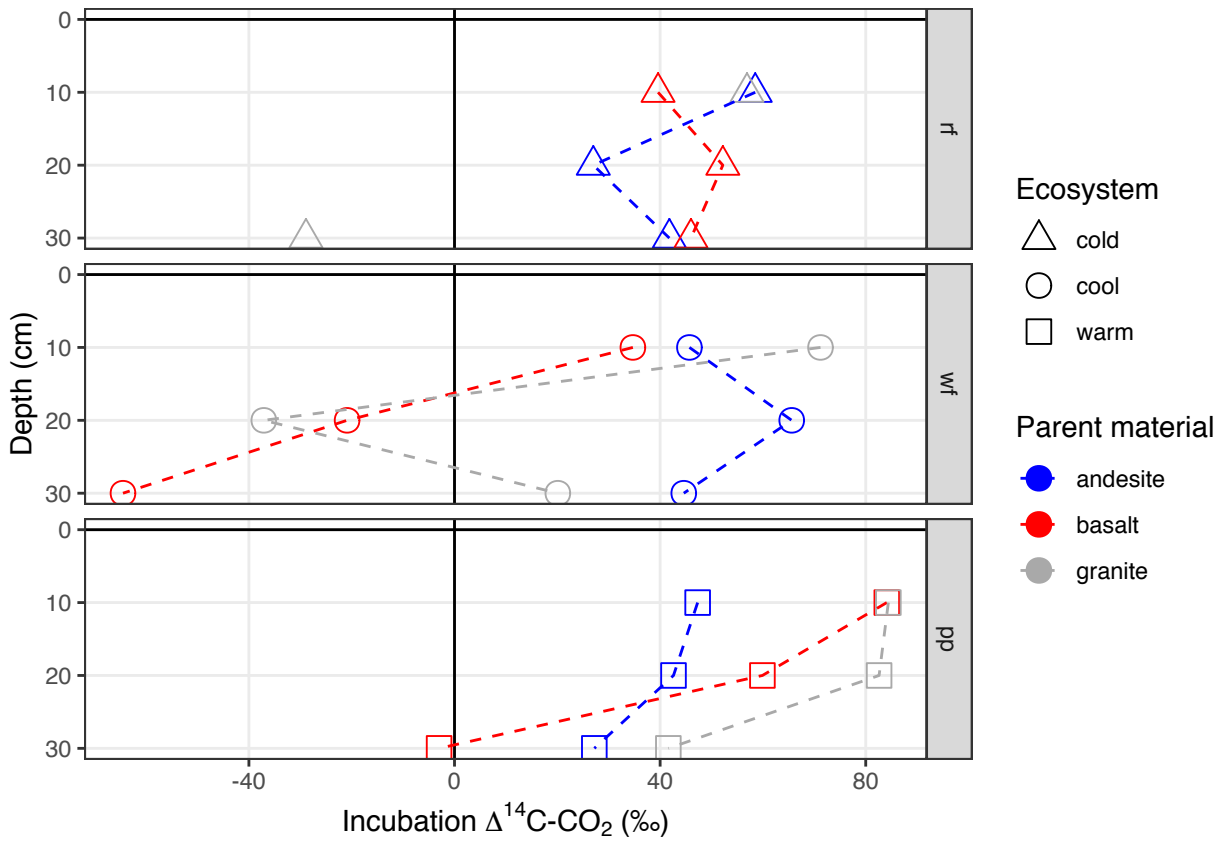**Fig. 5. Rep 1 $\Delta^{14}$C-CO$_2$ of 2019 bulk soil incubations**

*Caption:* $\Delta^{14}$CO$_2$ by depth for each site in 2019. (Still waiting on rep 2 data)

# Incubation vs. bulk soil $\Delta^{14}C$



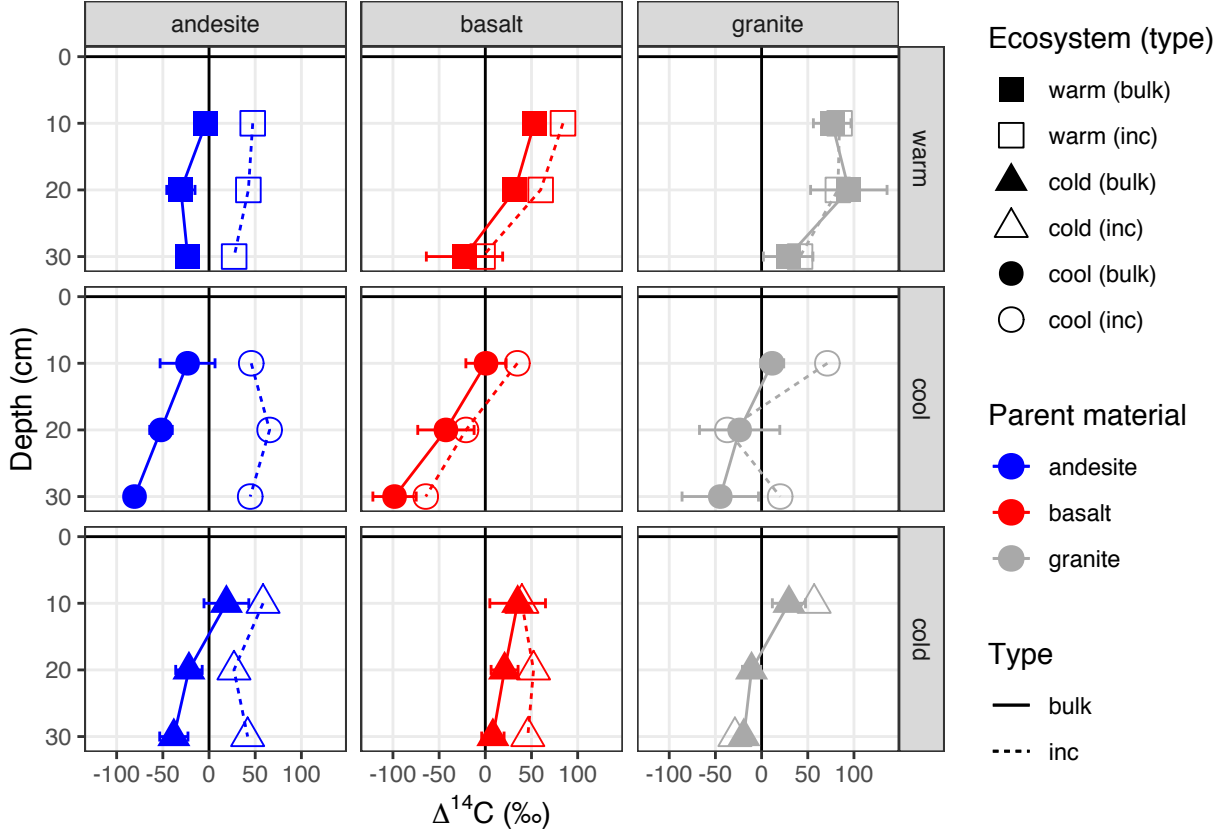**Fig. 6. $\Delta^{14}C$ of 2019 bulk soil incubations and corresponding bulk soil**

*Caption:* $\Delta^{14}C$ of bulk soil and respired $CO_2$ by depth for each site in 2019. Error bars show one standard deviation for bulk soil, points show mean of three replicate profiles for bulk soils and single observations for respired $CO_2$ (still waiting for data from laboratory duplicates).



**Fig. 7. Regression of 2019 bulk soil incubations and corresponding bulk soil $\Delta^{14}C$**

*Caption:* Regressions of $\Delta^{14}C$ of bulk soil and respired $CO_2$ by depth for each site in 2019. Error bars show one standard deviation for bulk soil, points show mean of three replicate profiles for bulk soils and single observations for respired $CO_2$ (still waiting for data from laboratory duplicates).
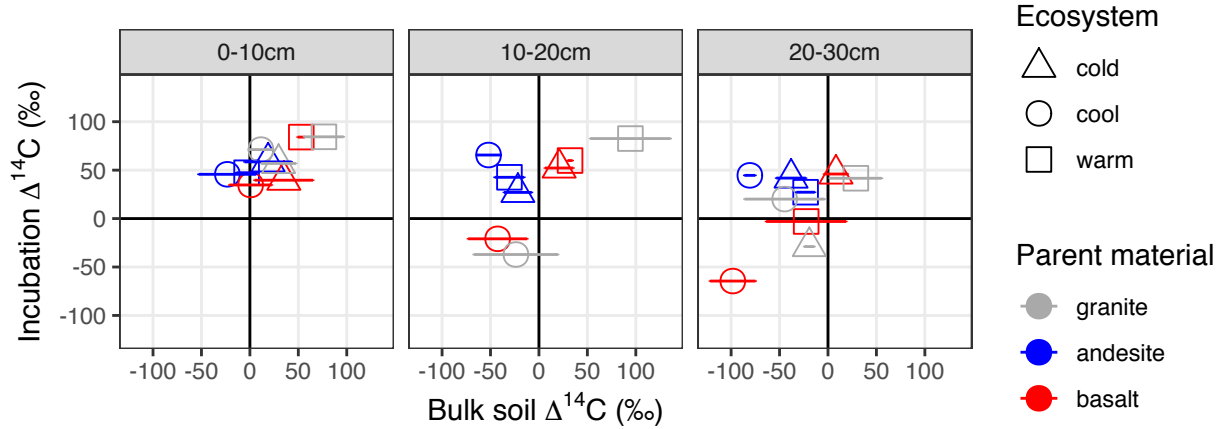
## Spline fitting

*Fit splines to 2009 data to predict at 2001 depths*

Soils collected in both the 2001 and 2009 sampling campaigns were sampled by horizon, but the depth intervals differed between the two sampling years. In 2009, full profiles were excavated for each site, as opposed to the shorter profiles collected in 2001 from the GR and AN sites. Radiocarbon was measured on all three replicate profiles at each site for the 2001 samples, but only for one of the replicate profiles at each site in 2009, e.g. ANpp rep2, etc.

In order to compare the radiocarbon profiles between 2001, 2009, and 2019 we interpolated both radiocarbon and carbon stock data at 1 cm intervals for each site in the 2009 and 2019 datasets, and then summed the carbon-stock-weighted radiocarbon values for each depth interval sampled in 2001. A monotonic cubic spline fit was used for the carbon stock interpolation (Wendt and Hauser 2013), and a mass-preserving spline was used to fit the radiocarbon data (Bishop, T.F.A., McBratney, A.B., Laslett, G.M., (1999) Modelling soil attribute depth functions with equal-area quadratic smoothing splines. Geoderma, 91(1-2): 27-45).

Non-trivial to match 2009 bulk density to 2019 depth increments. How to do this? Need a "closest match" function. Or predict from C content using regression? Regression approach fits poorly: best $R^2$ is 0.6117683. Actually, best approach is probably to use a spline function to predict bulk density for new intervals.
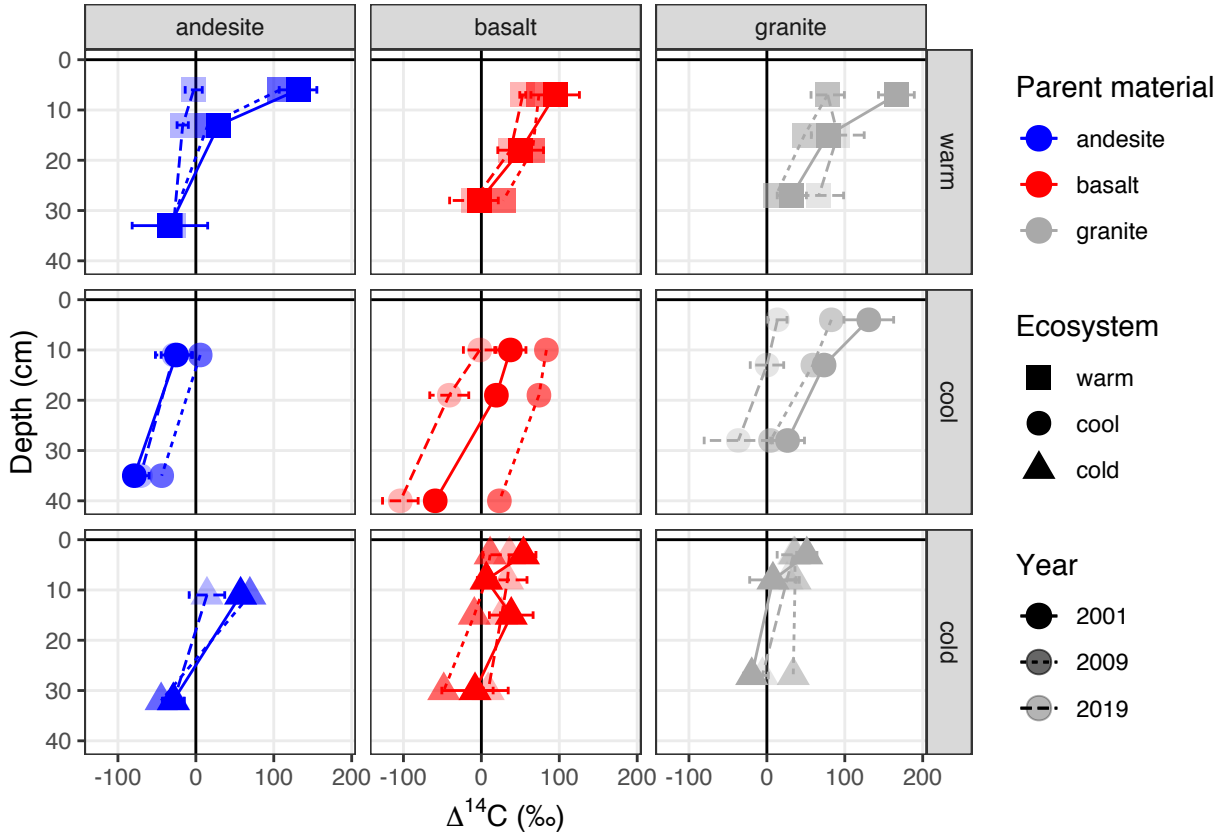


**Fig. 8. Mean profile fraction modern for all sites in 2001 and 2009**

*Caption:* Solid symbols connected by solid lines show fraction modern by depth for each site in 2001; error bars show ±1 standard deviation. Open symbols conneted by dashed lines show interpolated values of fraction modern measured in 2009. Solid and dashed vertical lines show the fraction modern of the atmosphere in 2001 and 2009, respectively, for reference.