

Centennial time scale effects of large incorporation of pyrogenic carbon in soils: carbon sequestration and soil fertility

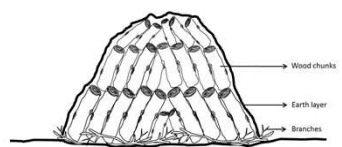
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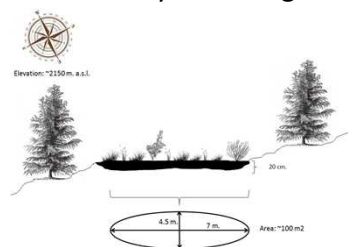
A long term experiment of 155 years...



1858: Larch charcoal production for iron foundries

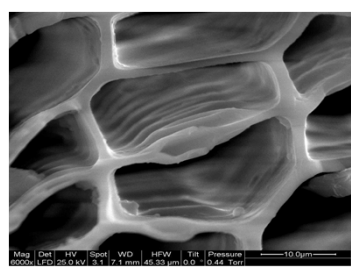


Today: 3 homogenous charcoal hearths undisturbed



Scientific questions

- How much Carbon?
- How much charcoal and other Soil Organic Carbon?
- How stable is charcoal?



Methodology

$$\text{Total C stock} = \text{Bd} * \text{Soil depth} * \%C \text{ soil} * \text{Hearth's surface}$$

$$\frac{C_{\text{CHAR}}}{C_{\text{TOT}}} = \frac{\delta^{13}\text{C}_{\text{TOT}} - \delta^{13}\text{C}_{\text{SOM}}}{\delta^{13}\text{C}_{\text{CHAR}} - \delta^{13}\text{C}_{\text{SOM}}}$$

$$\text{Char input in 1858} = \text{Forest wood stock} * \text{Carbonization efficiency} * \text{Char left on soil surface} * C_{\text{char}_0}$$

$$\text{Tot Char loss} = \frac{\text{Char input}_{1858} - \text{Char left}_0}{\text{Char left}_0}$$

$$\text{Char loss due to degradation} = \frac{C_{\text{char}_{1858}} - C_{\text{char}_0}}{C_{\text{char}_0}}$$

$$\text{Char loss due to runoff} = \text{Tot Char loss} - \text{Char loss due to degradation}$$

$$\text{Char}_{155} = \text{Char}_0 * e^{-k*155}$$

Soil chemical analyses

Plant growth experiment

Results

2.3 ± 1.2 tC hearth⁻¹ found today in the soil +300% control

89 ± 15% of Carbon is charcoal
2.04 ± 1.07 tC hearth⁻¹

2.7 ± 0.83 tC hearth⁻¹ of charcoal left on the soil in 1858

25.7 ± 4.5% of charcoal left in 1858 has been lost

21.3 ± 0.7% of charcoal has been lost because of degradation

4.4% of charcoal has been lost because of runoff

decay rate k=0.0015±0.00016 year⁻¹
mean residence time= 650±240 years

Compared to control
Ca available = + 270%
K available = +97%
Mg available = + 222%
P available = +72%

+ 107% of dry matter than control