Assessing long-term change in forest soils fertility by mean of stable Sr isotope dendrochemistry

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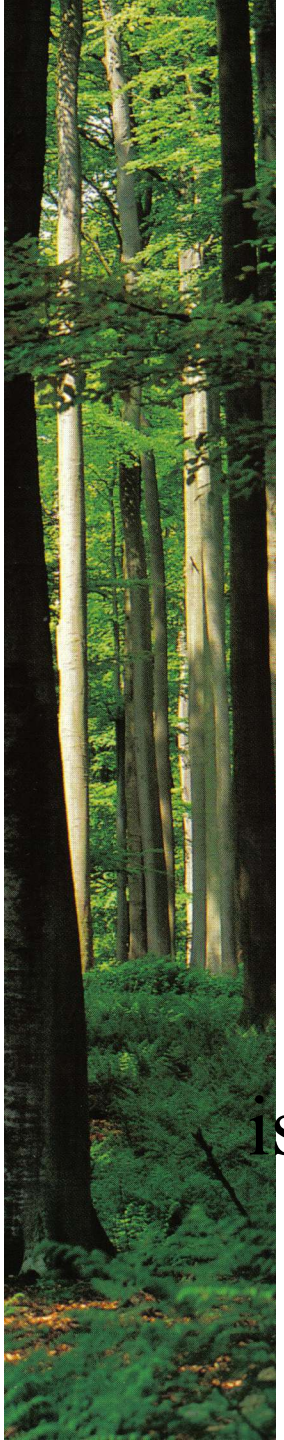


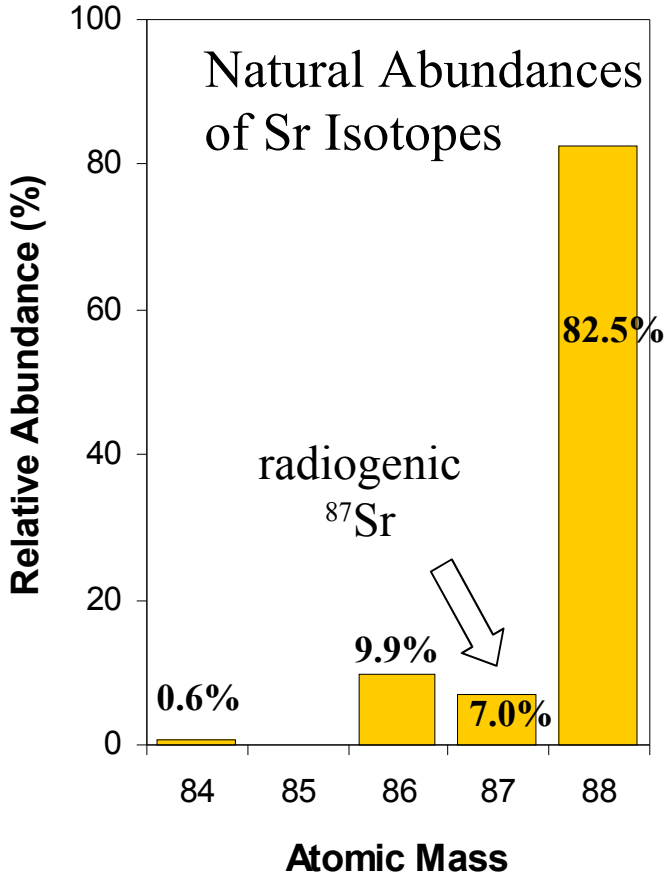
Objectives

- Quantify the proportion of weathering and atmospheric sources of Ca in tree nutrition by the Sr isotope method

- Study the evolution of stand nutrition by Sr isotope tree-ring analysis of Sr isotopes

Method

- Ca and Sr have a similar geochemical behaviour
- Similar ionic radius : Ca = 1.00 Å ; Sr = 1.13 Å
- Identical charge (+2)



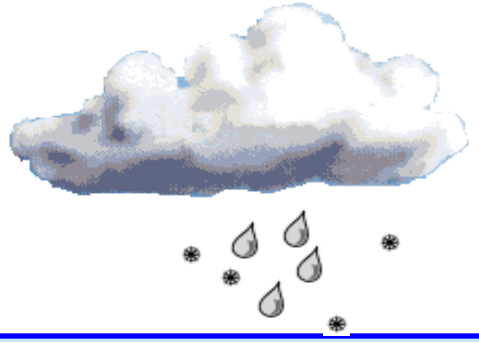
$^{87}Rb \rightarrow {}^{87}Sr + \beta^-$

(Half-life 48 Gyr)

$^{87}Sr/^{86}Sr$ ratio

Method

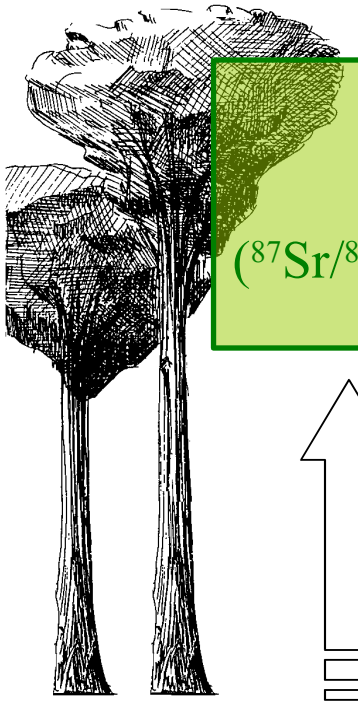
The use of du strontium isotope ratio



Atmospheric precipitation (source 2)

$(^{87}Sr/^{86}Sr)_{Prec} = 0.709$ (low)

Sr/Ca = ~0.0030



Vegetation (mixing)

$(^{87}Sr/^{86}Sr)_{Mix}$ = intermediate

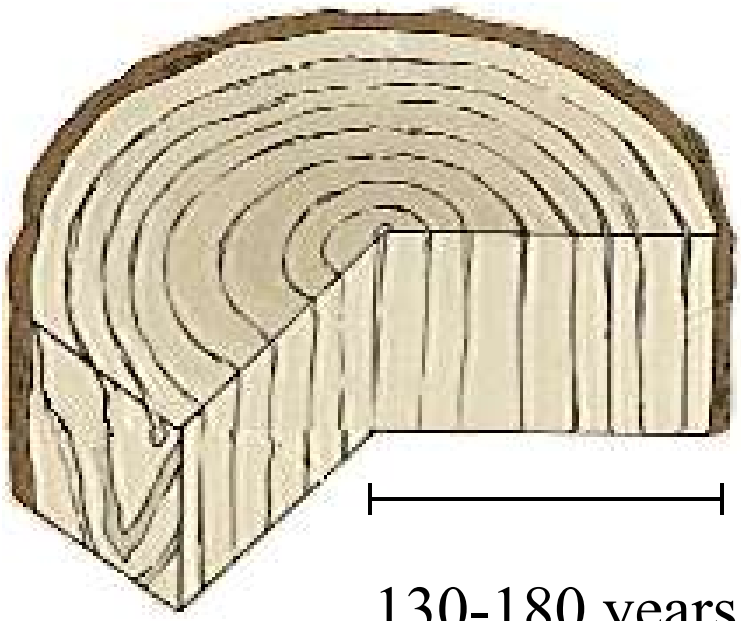
Weathering (source 1)

$(^{87}Sr/^{86}Sr)_{Wea}$ = high

Sr/Ca = ~0.0060

$$\%(Ca)_{Prec} = \frac{[(^{87}Sr/^{86}Sr)_{Mix} - (^{87}Sr/^{86}Sr)_{Wea}](Sr/Ca)_{Wea}}{[(^{87}Sr/^{86}Sr)_{Mix} - (^{87}Sr/^{86}Sr)_{Wea}](Sr/Ca)_{Wea} - [(^{87}Sr/^{86}Sr)_{Prec} - (^{87}Sr/^{86}Sr)_{Mix}](Sr/Ca)_{Préc}} \times 100$$

Sr isotope dendrochemistry

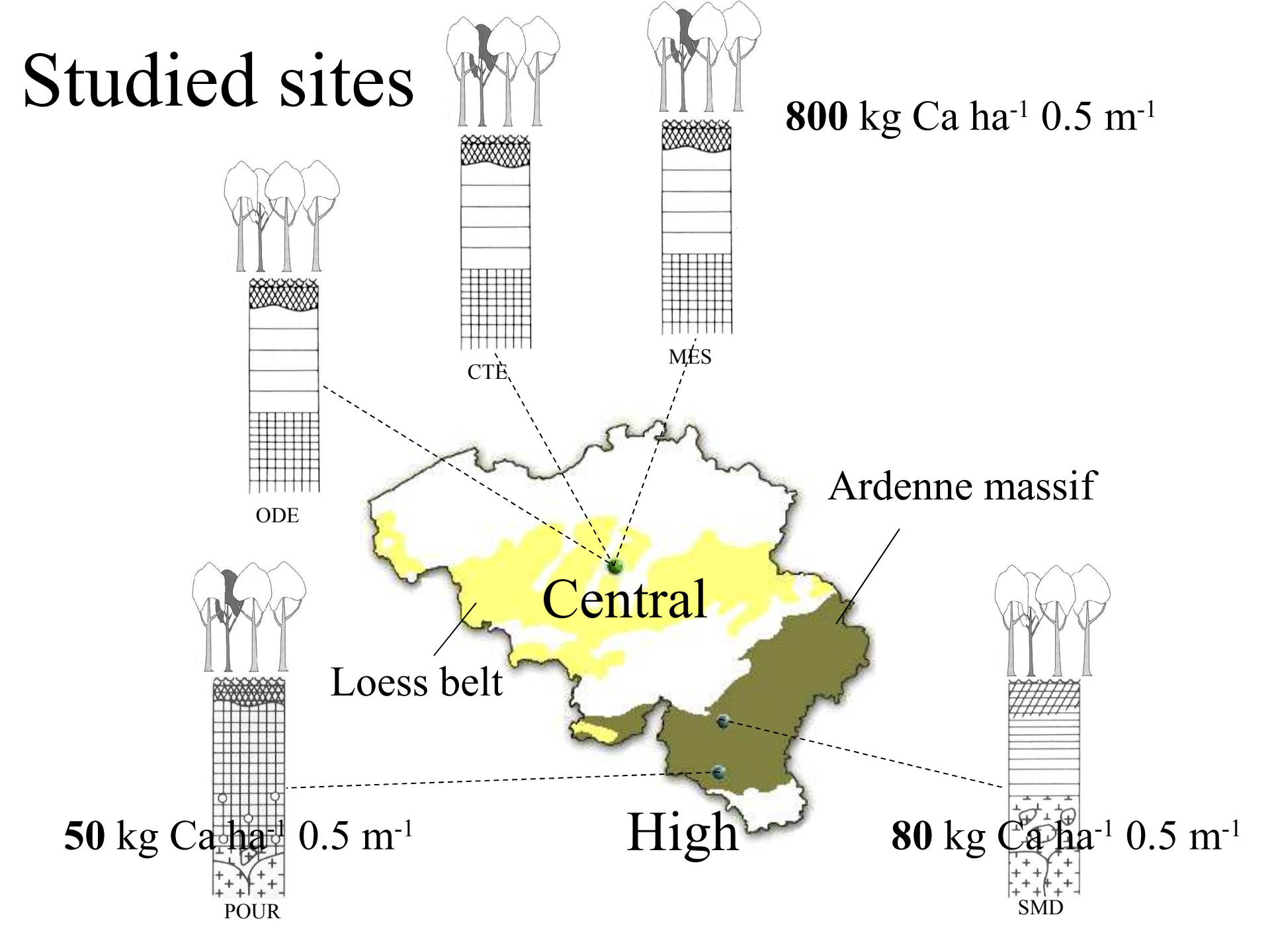


130-180 years

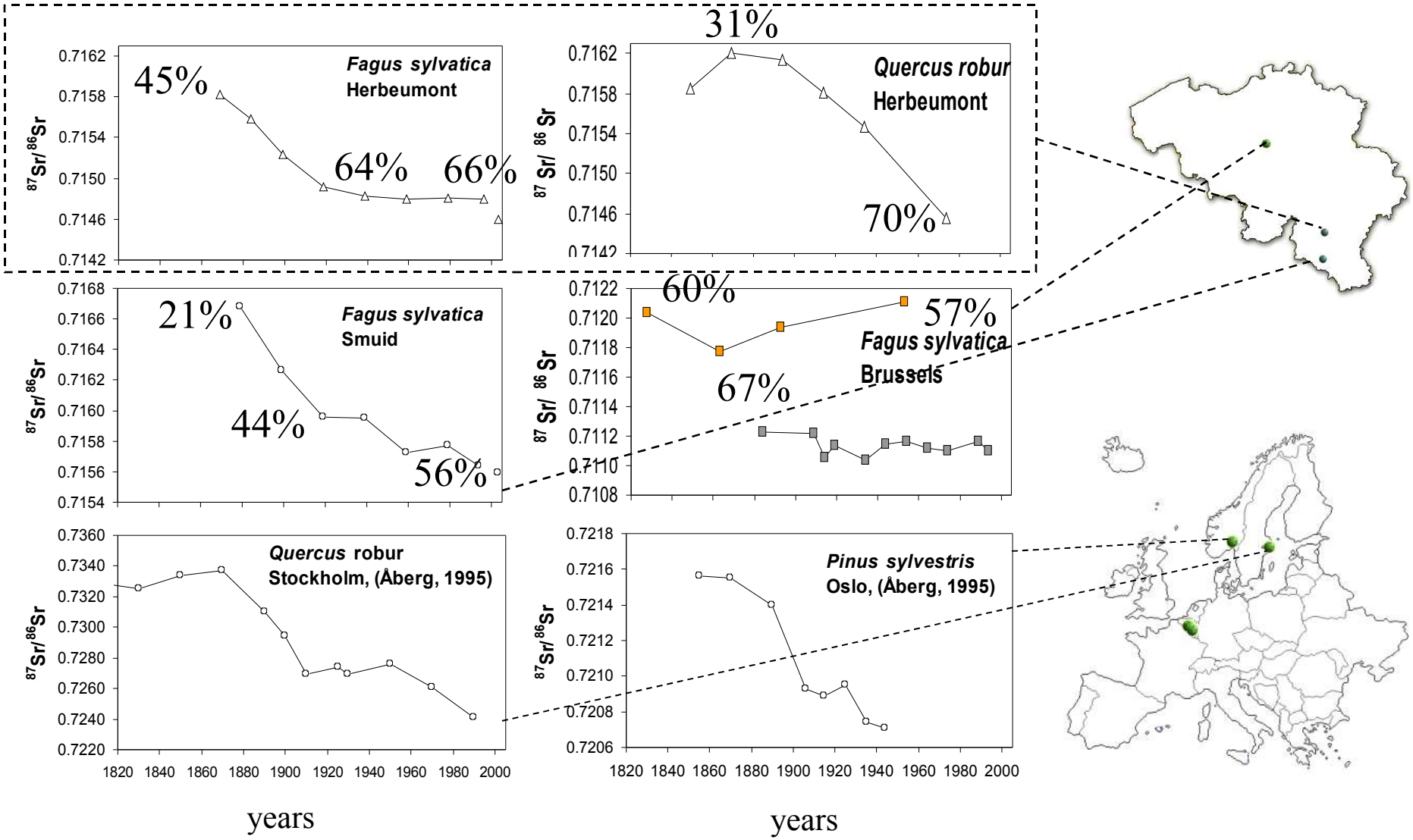
Fagus sylvatica L.

Quercus robur L.

Studied sites

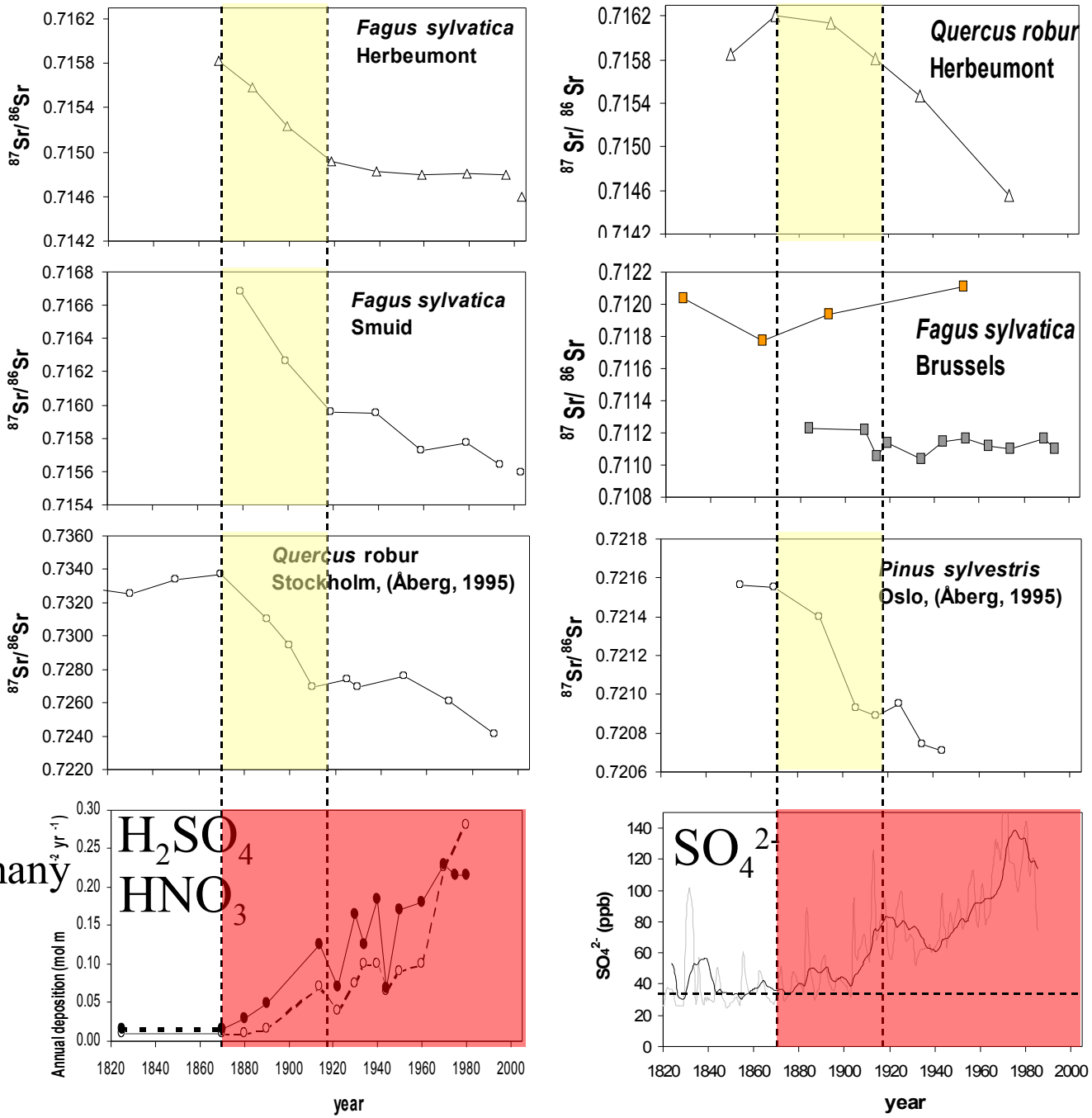


Evolution of the atmospheric source contribution to tree Ca nutrition



Mean increase of the atmospheric Ca of 20-30%

Evolution of the $^{87}Sr/^{86}Sr$ ratio



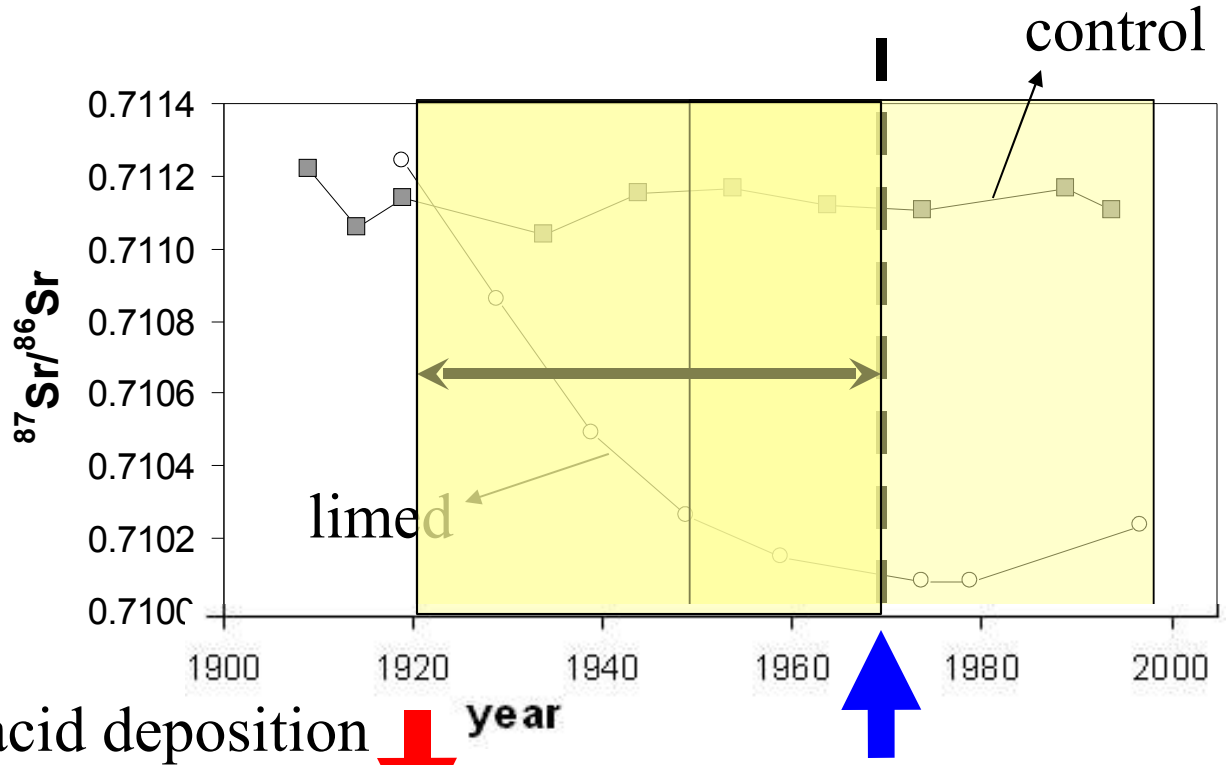
Acid deposition, Germany
Ulrich, 1987

GISP2, Greenland
Mayewski *et al.*, 1990

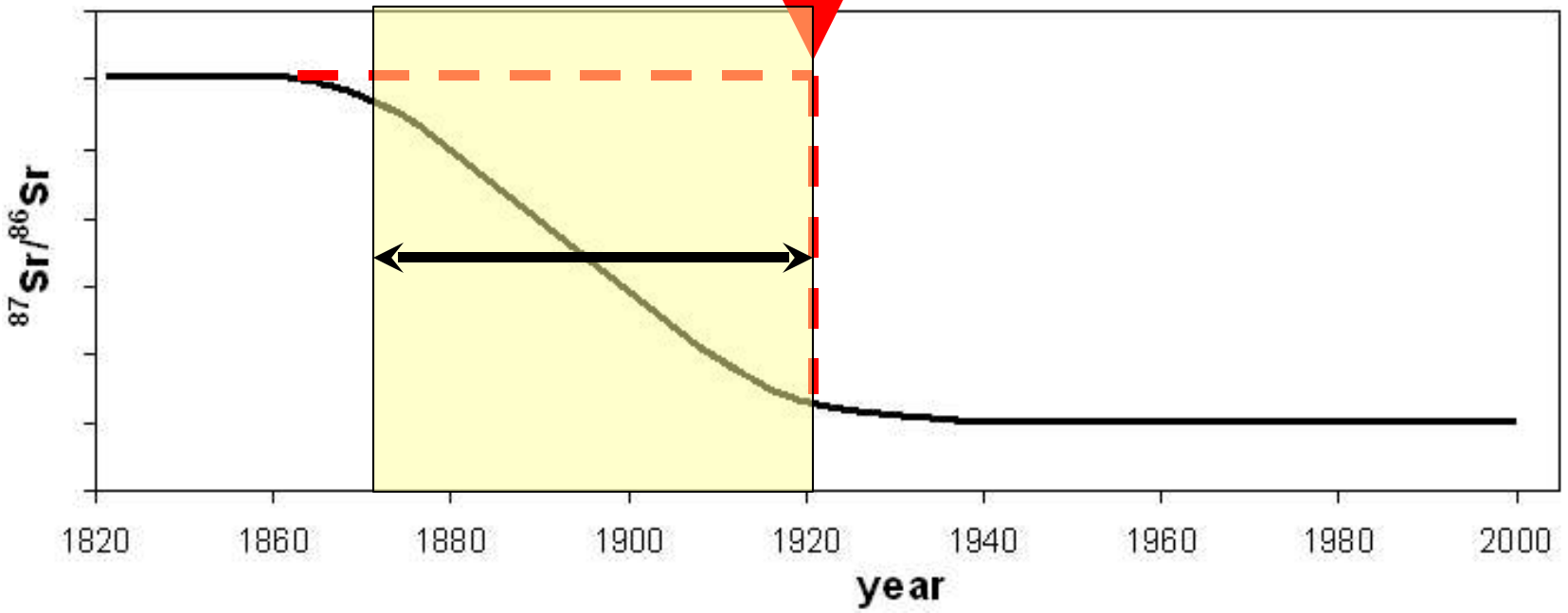
Limed stand

4 t of $CaCO_3$

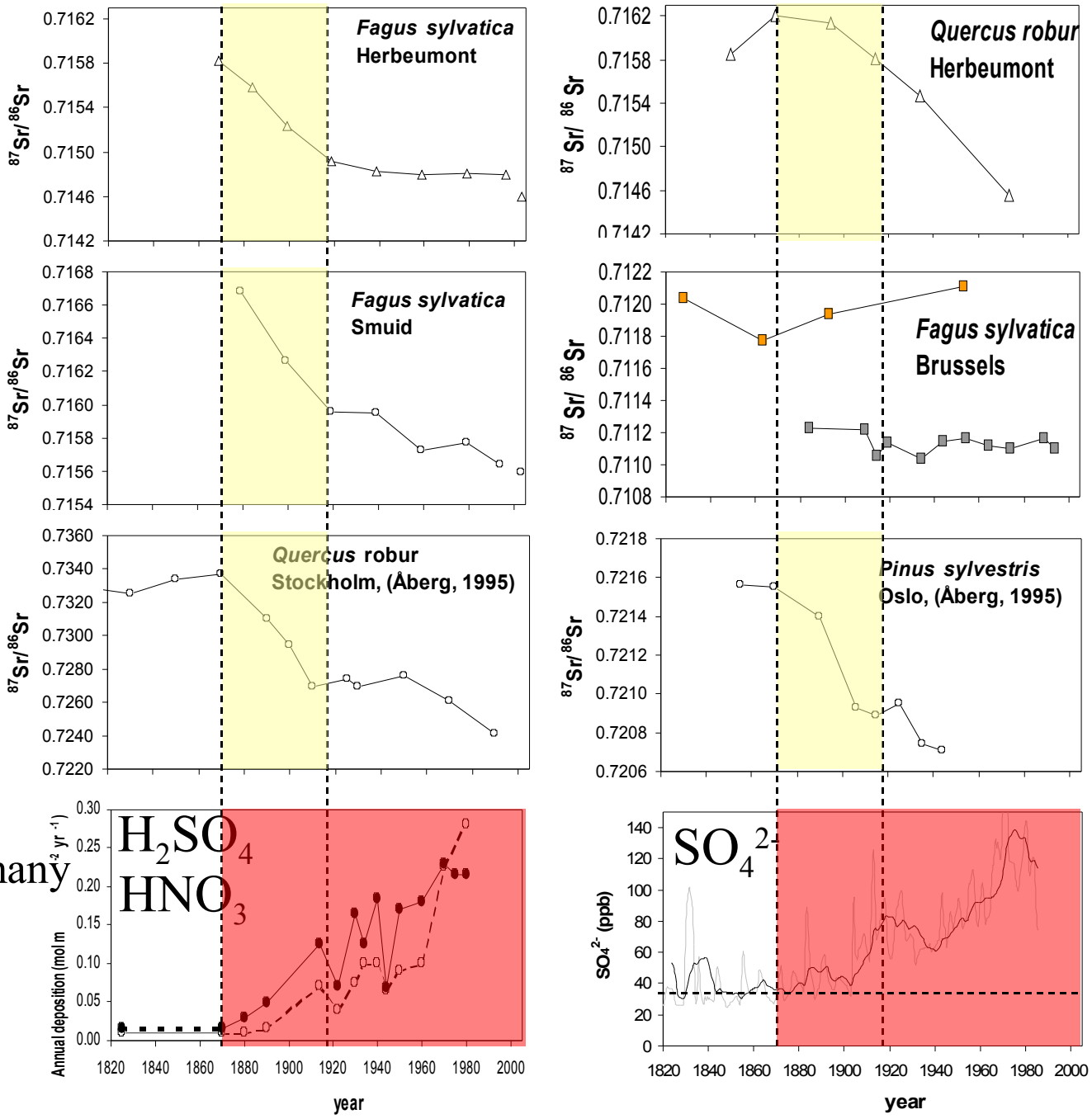
$^{87}Sr/^{86}Sr = 0.707857$



shematic curve
of stands depleted by acid deposition



Evolution of the $^{87}Sr/^{86}Sr$ ratio



Acid deposition, Germany
Ulrich, 1987

GISP2, Greenland
Mayewski *et al.*, 1990

Mechanism

Pristine forest soil

H_2CO_3

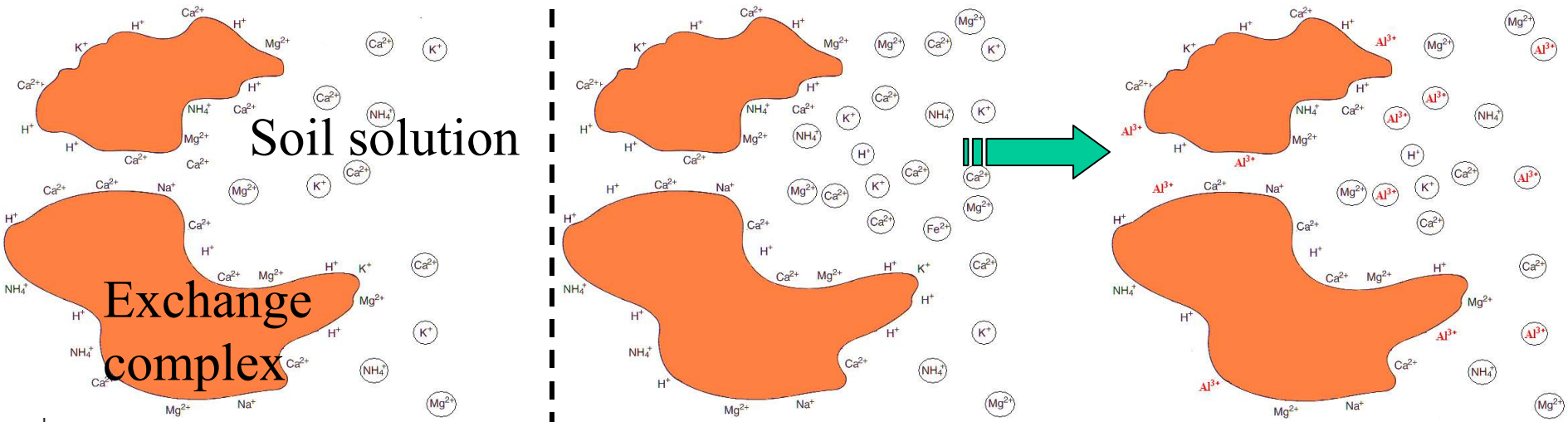
Weak acid

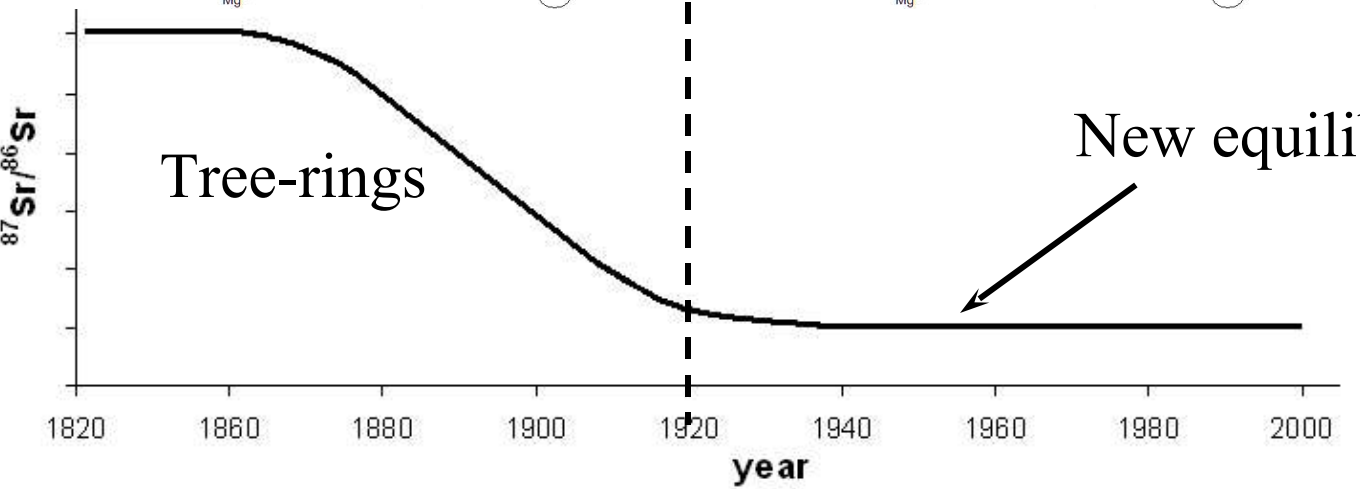
Post-industrial forest soil

H_2SO_4

Strong acid

Tomlinson, 2003





Conclusion

- Continuing atmospheric inputs of strong acids can change the source of Ca for tree nutrition

- Probably linked to a change in soil equilibrium reactions

- The sulphur pollution abatement measures are not sufficient to return to pristine soil functioning and tree nutrition.