Dendrochronology and Geochemistry of Trees on Long Island, NY

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Abstract

Having a good understanding of the factors (e.g. atmospheric deposition) that affect a pristine ecosystem, such as the Peconic River System, can be vital in its conservation and management. Atmospheric deposition is the only source of dry precipitation (aerosols, dust etc.) and is also the main source of plant nutrients as well as the dominant source of strontium to this system. Measuring the quantity of dry precipitation and its effects to the system cannot be done directly(Xin 1993). Since trees are good indicators of the environment and produce a new growth ring every year, they provide a indirect method of investigating these changes with time.

Strontium isotopic and elemental analyses of growth rings of two oak trees on Long Island, suggest a definite variability of the strontium input with time.

Introduction

The dominant input of strontium to Long Island is through atmospheric deposition, and this deposition has constituents of both local and long distant sources. Locally deposited materials maybe redistributed on a regional scale whereas other materials may by transported several thousand miles by winds and/or storms (J. Proios 1994). The composition of the transported materials (dust, aerosol etc.) depend on the path of the storm/winds (fig 1).

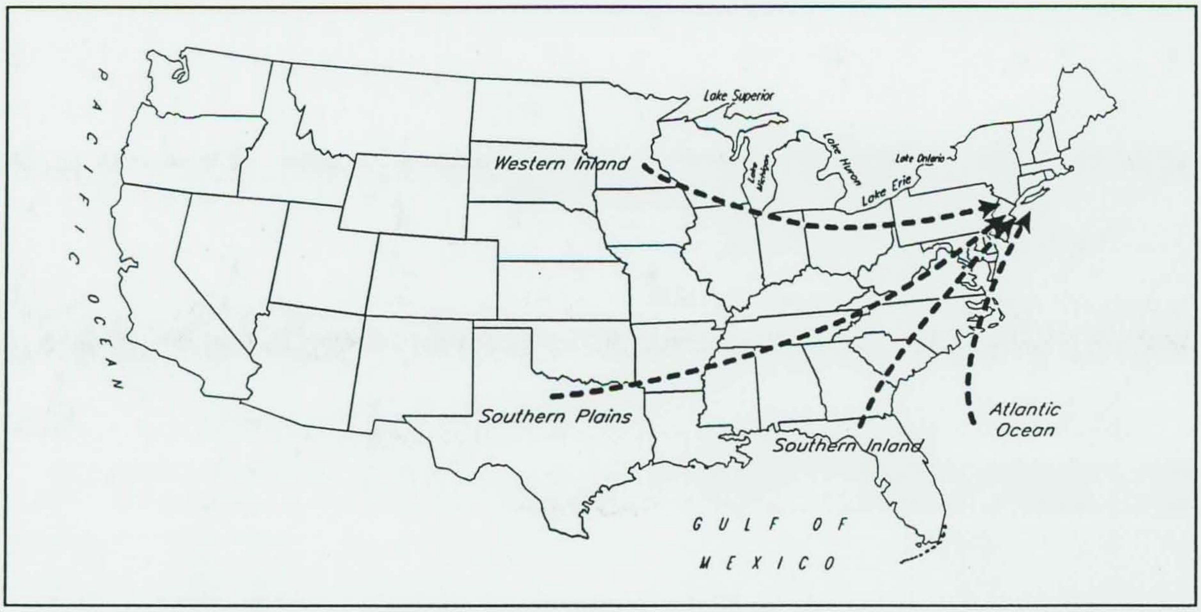

Fig 1 Map paths of major storms during the period Feb1992 - July 1992 (Xin1993)

The strontium signature of any particular source is unique (Faure 1973), so in this way the origins of this material can be determined. There are 2 major sources of atmosphericly inputted strontium: continental dust, aerosols etc. and sea spray. Aerosols and dust that are enriched with strontium of a continental origin(long distance source) have $^{87}Sr/^{86}Sr$ up to 0.720 whereas materials that are enriched with sea spray (local rain/aerosol) show $^{87}Sr/^{86}Sr$ of about 0.709 (Fig 2). One can hence deduce the dominant source of the atmospheric input and trees will offer information about the source variability with time.

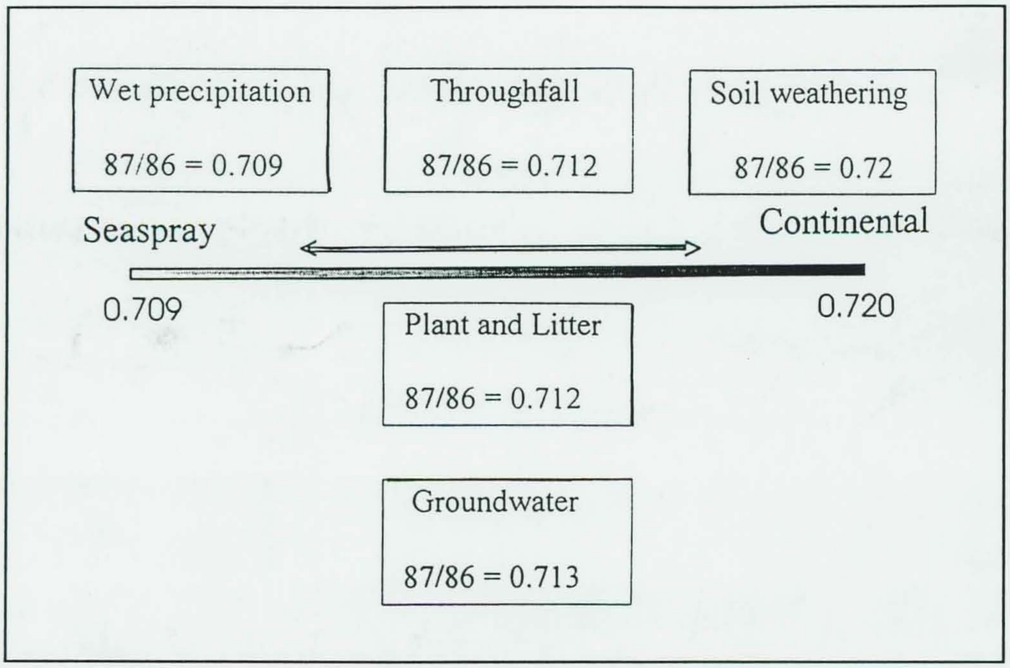

Fig 2 Strontium ratios from varying input sources and 2 reservoirs. It is assumed that weathering is not an input source on Long Island.

Recent studies have shown correlation between tree ring and soil chemistry (Guyette and Bruce(1994), Baes III (1984), Bondietti (1989). Dry precipitation directly affects the soil and soil solution chemistry because it adds new, foreign material to the soil. Hence if the chemistry of the soil has indeed changed over time due to dry precipitation, it should be reflected (by the change in strontium ratios) in the annual ring growths of native Long Island trees (white oak, pitch pine, yellow pine etc.).

One problem that has been noted in other studies is translocation (i.e. the movement either vertical or lateral in and out across growth ring boundaries of solutes within the tree). The amount of translocation varies with element and tree spices. To solve this problem one could simply investigate those spices of tree in which the element under examination does not translocate (Vroblesky 1990), or by normalizing the element in question to one that is immobile.

The objectives of this study is to identify the sources of atmospheric input, how it has changed over time and to what extent it has affected the soil and groundwater by using Mass Spectrometry and Di-Couple Plasma Spectroscopy.

Method

To investigate these factors cores, using a increment borer(diameter 0.4mm),were taken from native trees, with ages ranging from ~200 to ~50 years (fig 3).

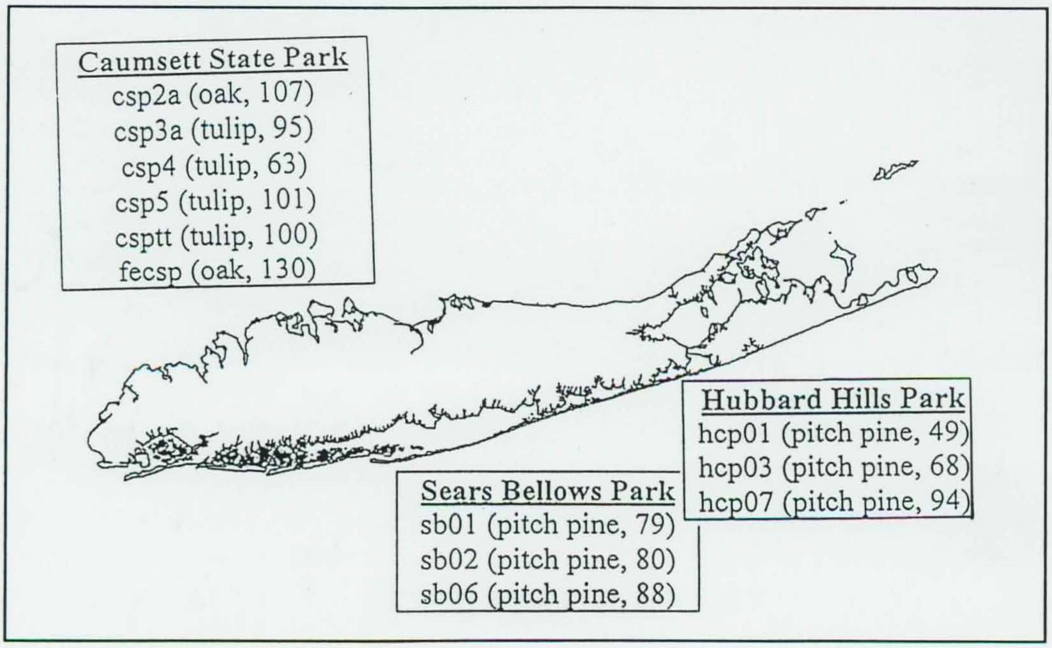

Fig 3 Map of Long Island showing locations of sampling as well as sample name, tree type and age

Cores samples were taken from within the Pine Barrens (pristine system) as well as from other areas outside of this system to provided some information on the differences between them. The number of growth rings were then counted and the width of each ring was measured for each sample core. The core samples were cut into 5 year segments which were then analyzed for both elemental concentrations, using the D.C.P. (Di-Couple Plasma Spectroscopy) and for $^{87}Sr/^{86}Sr$ isotopic composition (Mass Spectrometry).

Results

To date only one core sample have been analyzed, FECSP (oak, Caumsett State Park). Fig 4 shows that 87Sr/86Sr with and compared the raw growth ring with data and the Palmer's Drought Index (a measure of the relation between the measured rainfall with the expected/needed rainfall. There is an increase in the Sr ratio with time and at times of relatively elevated Sr ratios there is a marked decrease in the ring widths of that years. Further, the elevated Sr ratios seem to occur in times of drought when compared to the drought data. But not at times of average/normal rainfall.

Fig 5 show the 87Sr/86Sr ratio compared to the strontium concentration with time. There is an inverse relationship between the Sr ratio and its concentration. The strontium concentration however show no apparent relation to rainfall.

Elemental analyses seem to indicate no apparent trend.

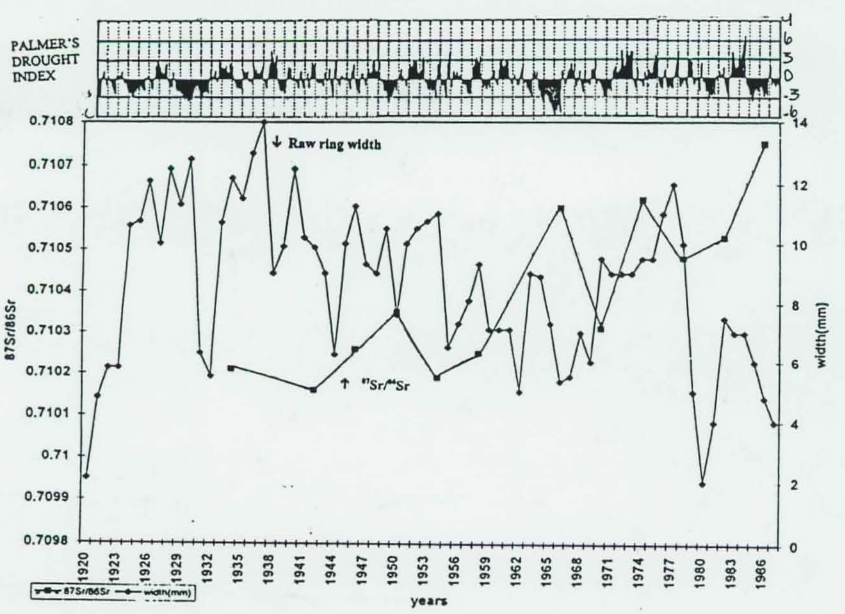

Fig 4 Raw ring width, Sr isotopic ratio and Palmer's Drought Index with time on core sample FECSP (oak from Caumsett State Park, Long Island, NY)

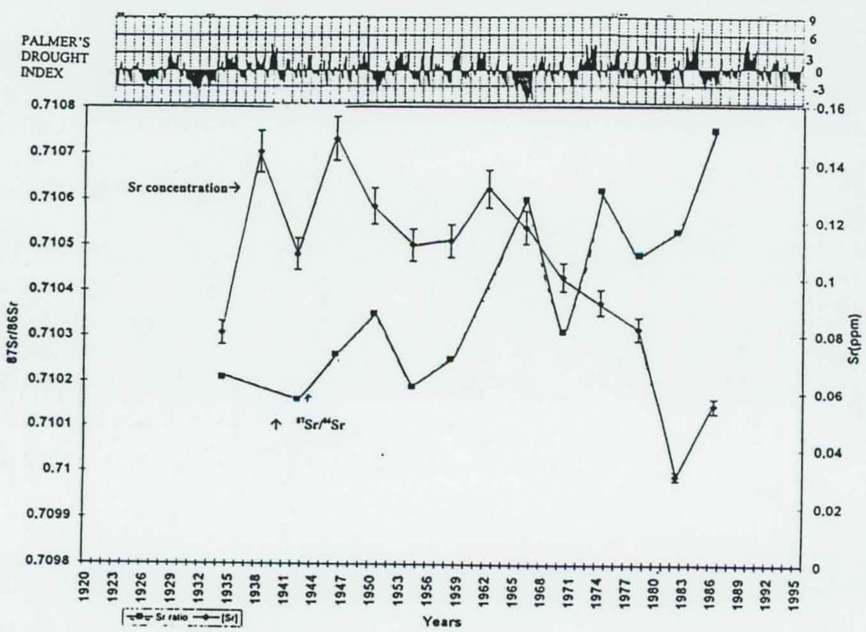

Fig 5 Sr concentration, isotopic ratio and Palmer's Drought Index with time of FECSP (oak form Caumsett State Park Long Island, NY)

Discussion

The relationship between the Sr ratios and the drought data indicated that wind, since drought suggest little rainfall, play the dominant role in the transport of materials with a continental signature. Whether this material is redistributed on a local scale or is a result of long distant transport is still unresolved.

The inverse relationship of the strontium concentration and its isotopic ratios seemingly indicates that the sea spray signature seem to out strip or overlay the effect of the continental source signature when there is a relatively large input of strontium to the system but when the input is significantly less the continental source signature can then be seen.

Other elements such as Mg, K, Fe, Al etc. show no obvious relationship with each other or to the Sr isotopic data or to the drought data. However, with the analysis different trees both form the same site as well as others, more information may be obtained and relationships between elements etc. may be observed.

Conclusion

It is clear form the strontium ratio and concentration, that variations exists from year to year in the growth rings of trees. This may suggest that there is also variability in the environment. With additional analyses, it is hoped that similar trends and further information will be obtained in order to ascertain the effects of dry precipitation on a pristine environment.

References

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