Biogeochemistry of Beryllium in a Forested Landscape Czech Republic

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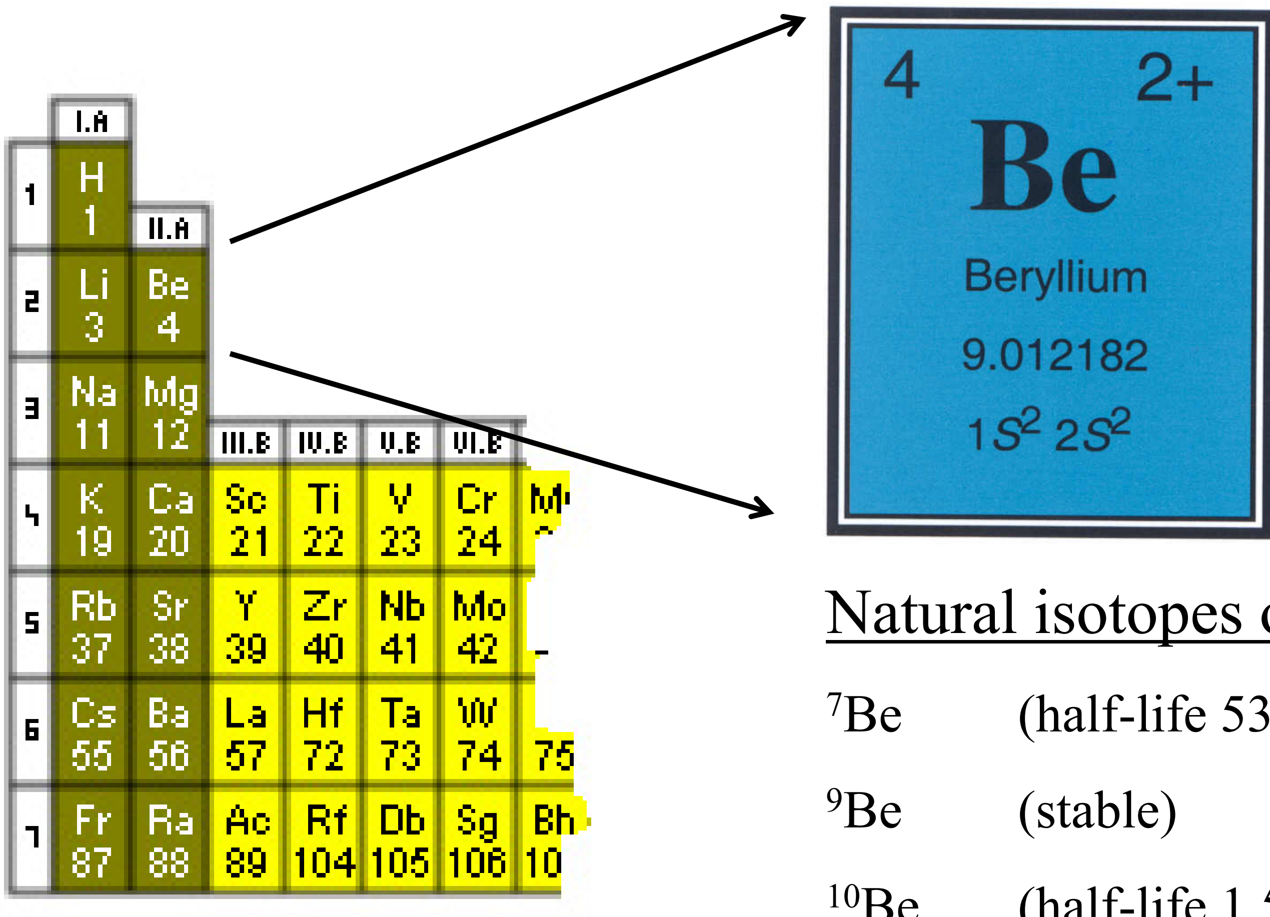
Beryllium



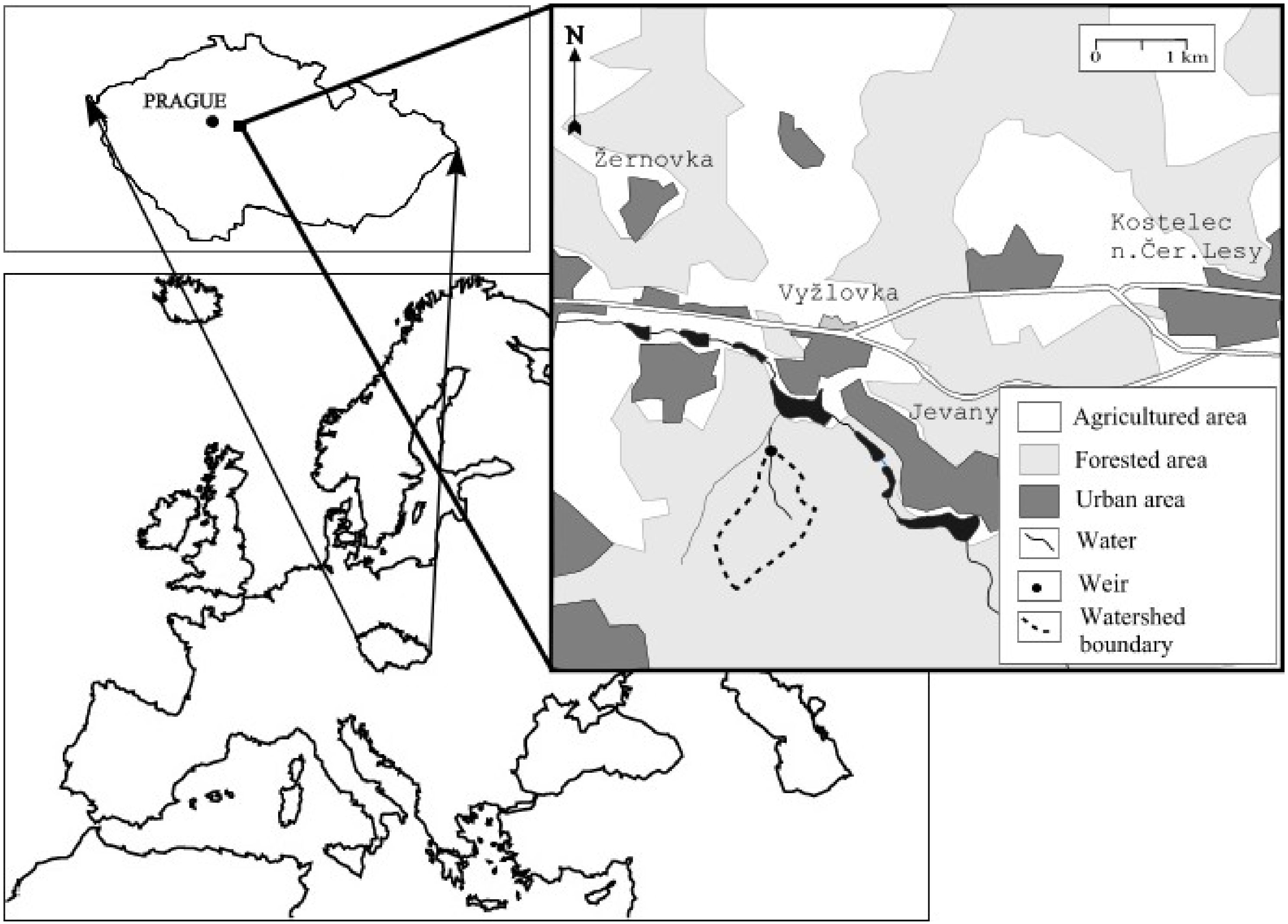
<u>Natural isotopes of Be</u>

^{7}Be	(half-life 53 days)
^{9}Be	(stable)
^{10}Be	(half-life 1.5 mil.years)

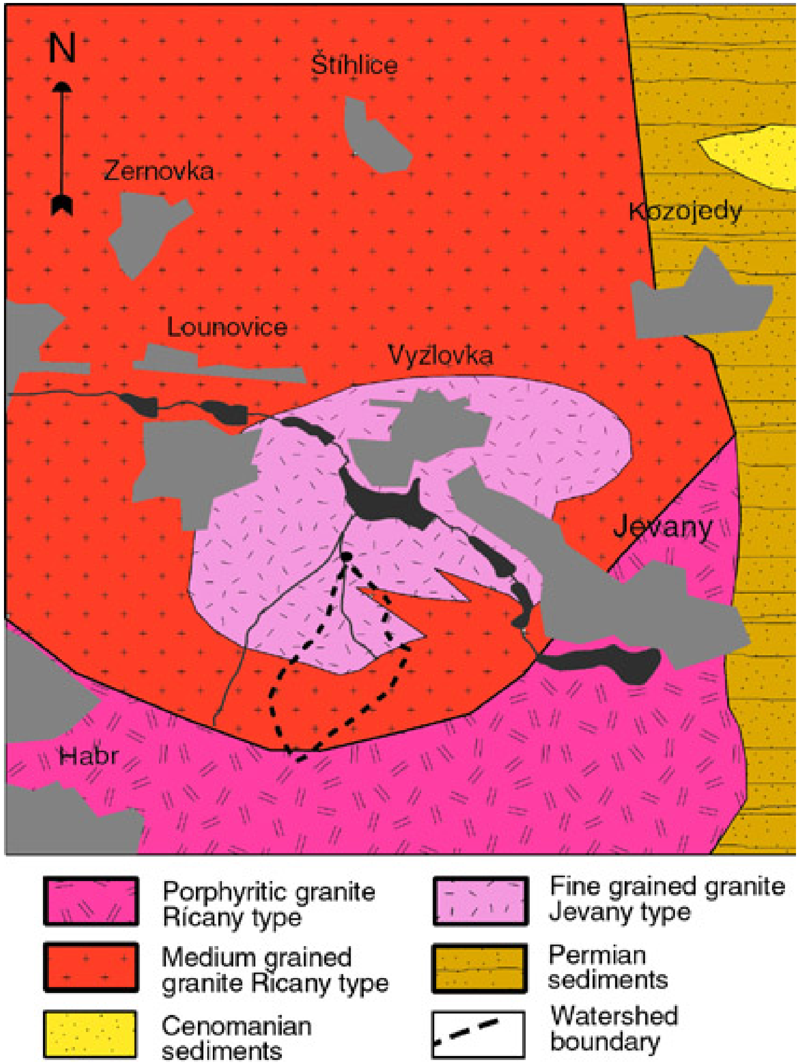
Why is it important to keep track of beryllium in the environment?

- Dating of geological a environmental processes
- Toxicity
- Anthropogenic effects on the element cycling

Lesní Potok (brook) - Catchment



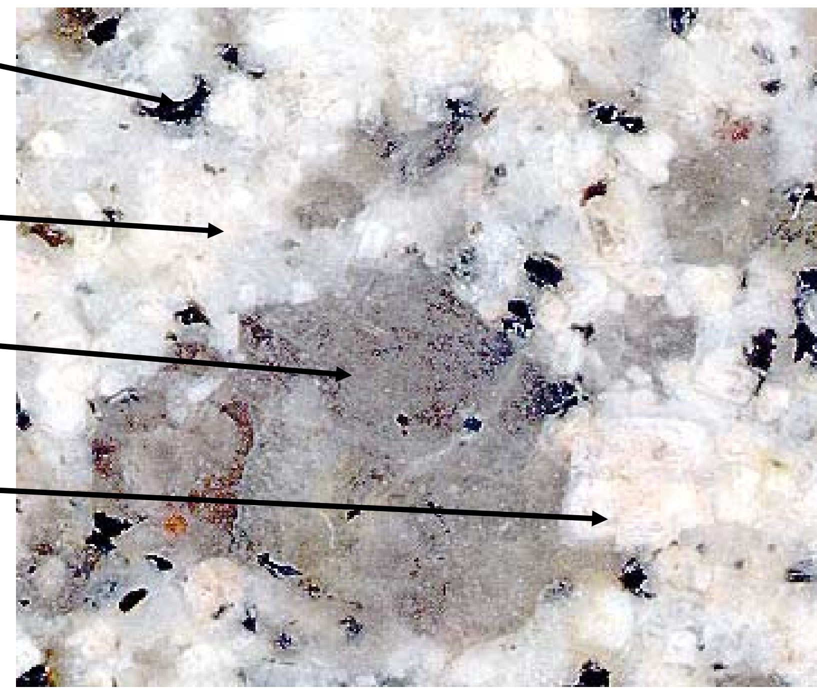
Lesni Potok Catchment…



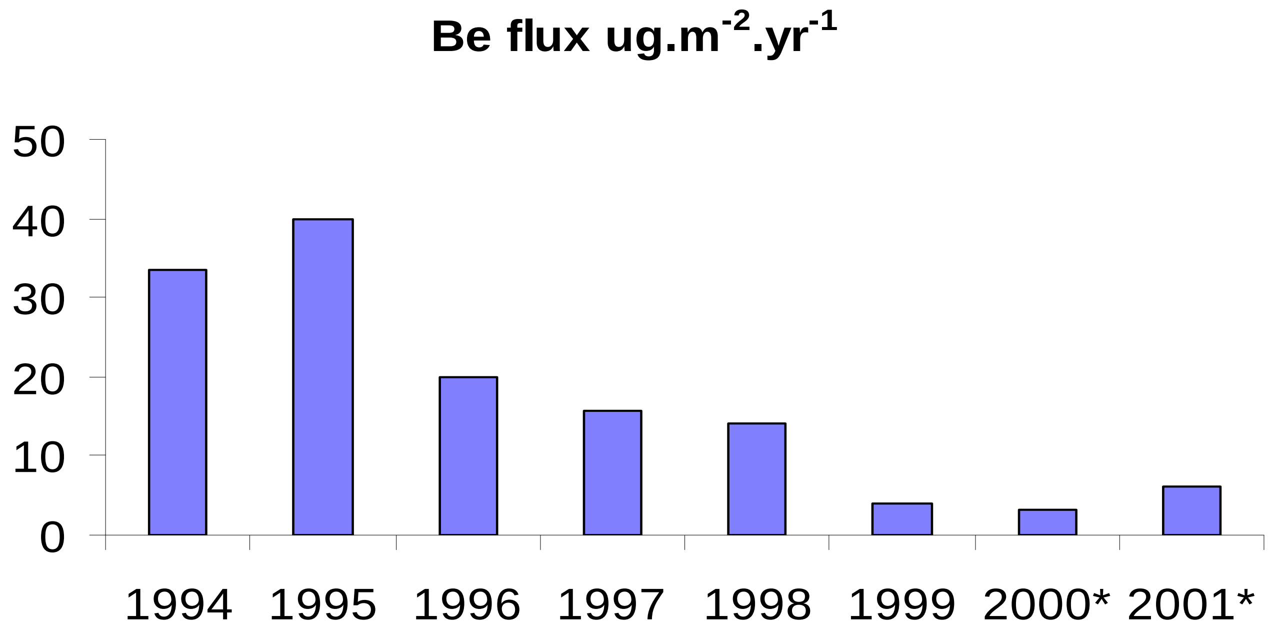
Beryllium in Bedrock - Granite

- whole rock Be in range 12 - 20 mg.kg^{-1}
- world average for granites low in Ca 5 mg.kg^{-1}

Biotite (8%)	7.1 mg.kg^{-1}
Plagioclase (28%)	18.1 mg.kg^{-1}
Quartz (27%)	<0.3 mg.kg^{-1}
Orthoclase (35%)	0.8 mg.kg^{-1}



Atmospheric Be Inputs

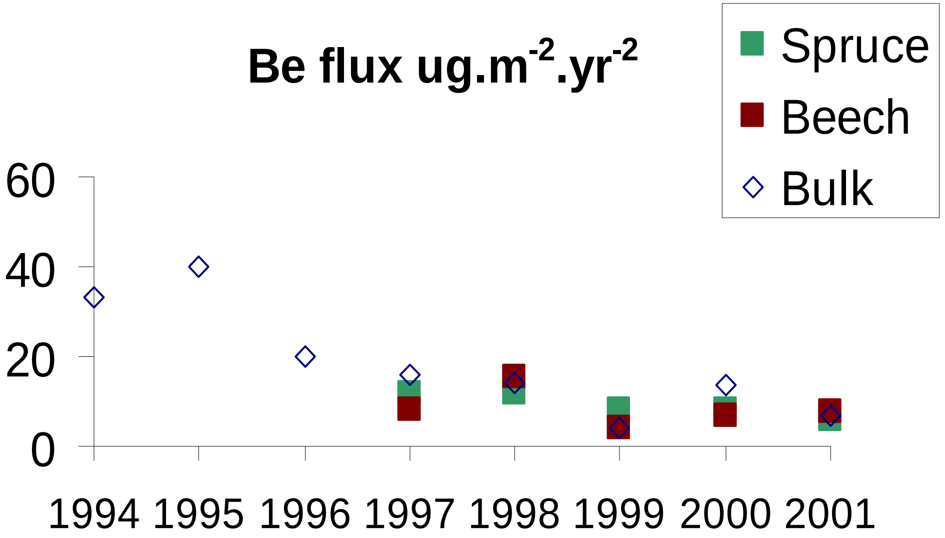


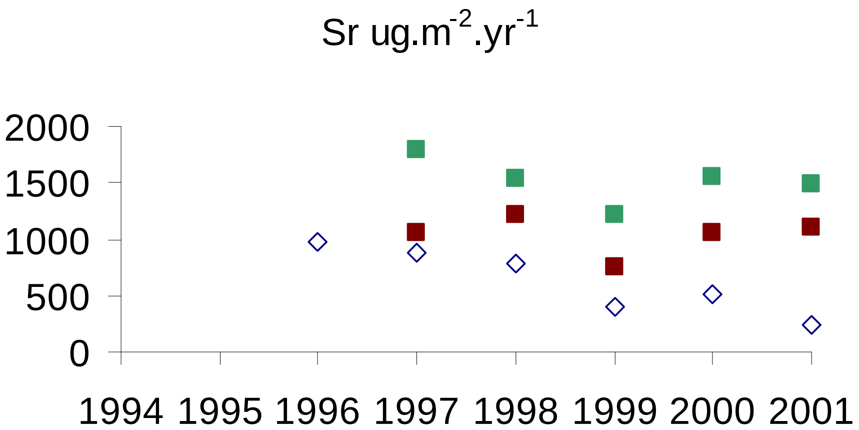
- concentrations and fluxes of Be in precipitation = LOW
- main sources of Be in precipitation
    - fossil fuel burning !!!!!! (CR lignite up to 63 $mg.kg^{-1}$)
    - eolic dust particles
    - local sources

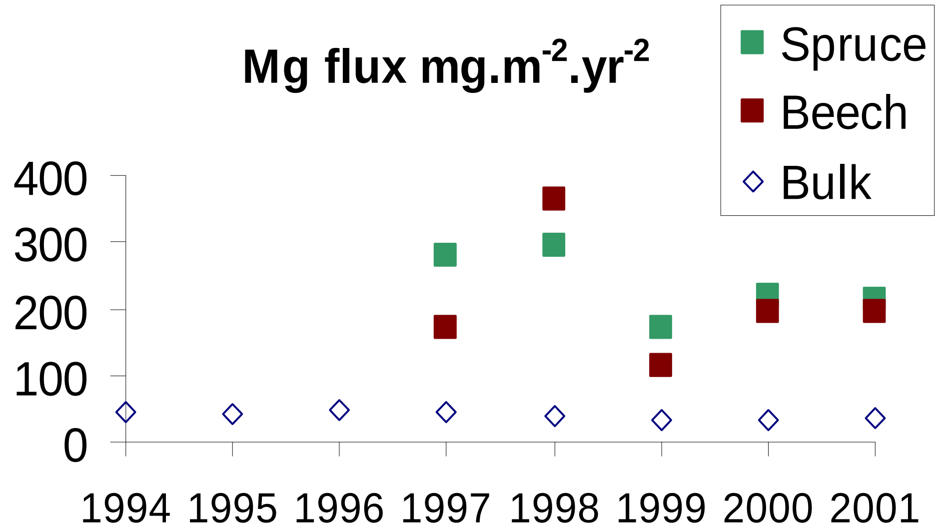
- sample pre-concentration (2000, 2001)

Beryllium in Throughfall

- throughfall Be fluxes comparable to bulk
- low exchange of Be with canopy in contrast to e.g. Mg
- low Be in scavenged aerosol particles

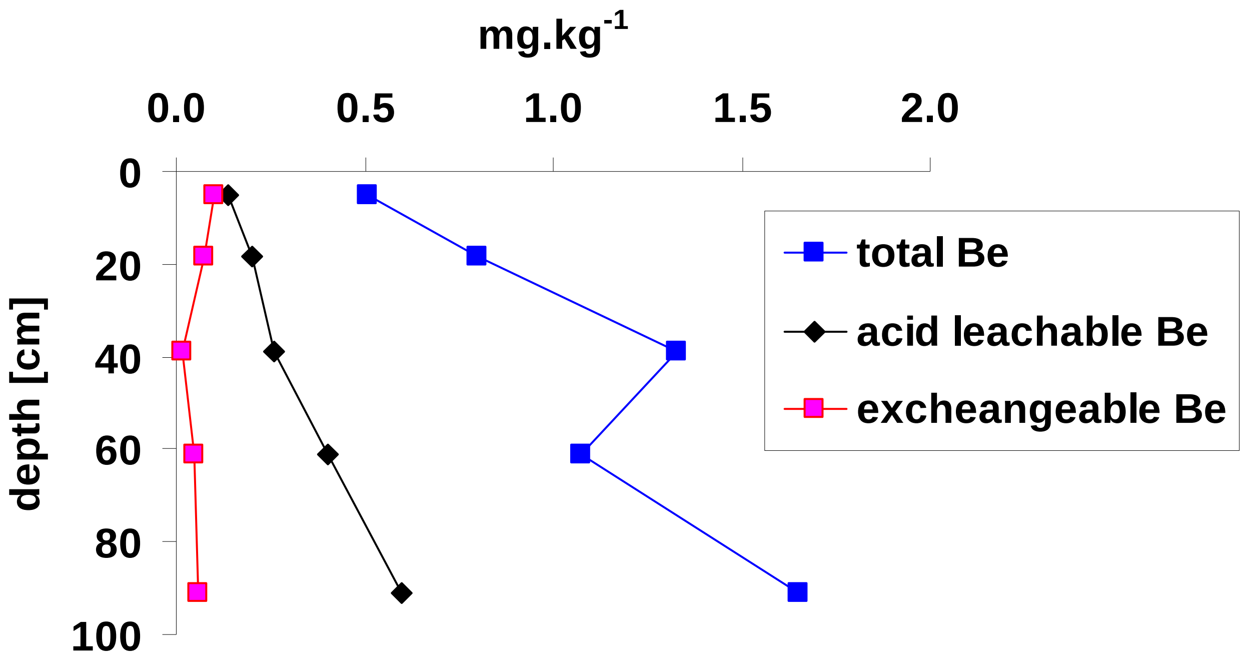




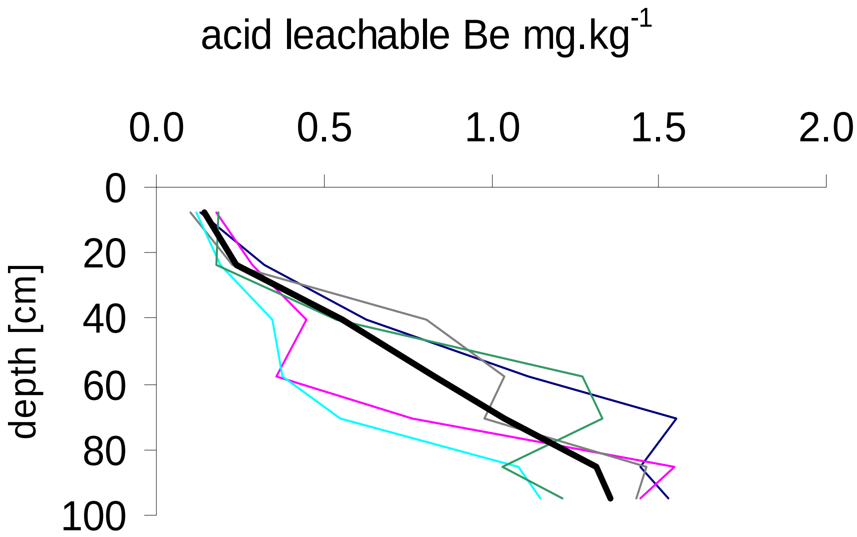


Beryllium in Soils

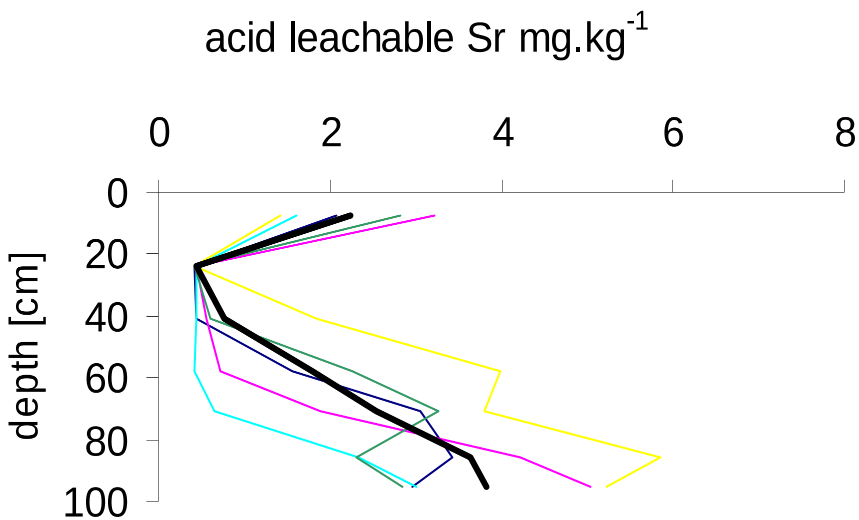
- total Be = depends before all on content of un-weathered particles
- acid leachable = decreased with depth due to mobilization from top layers
- exchangeable = very low portion of total Be, increased in top layers



Acid Leachable Be



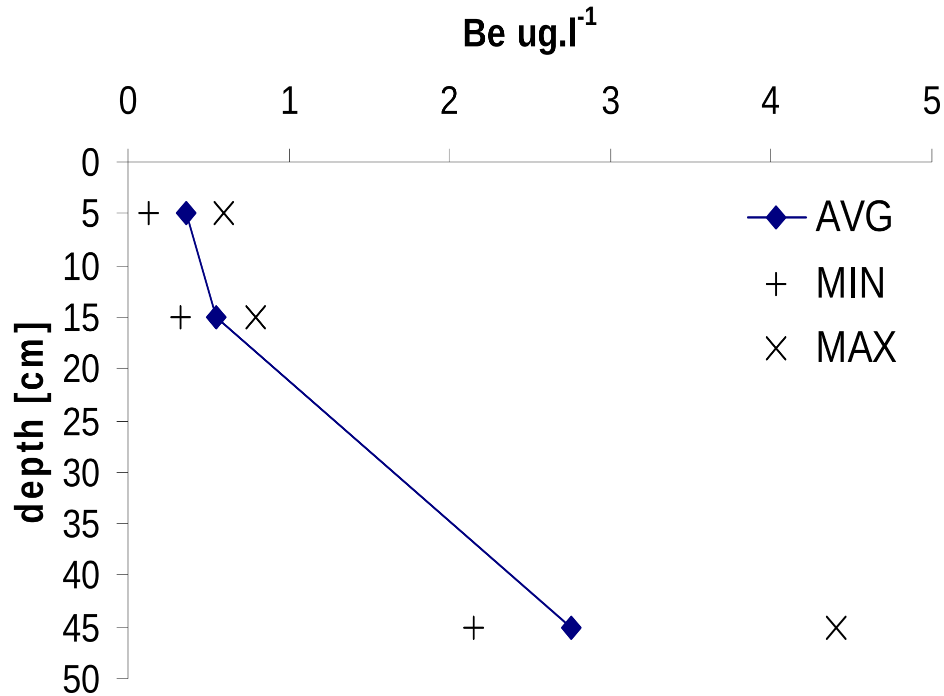
- acid used 0.1M HNO_3
- increasing Be with depth
- data from 20 soil pits



- contrasting trends of Be and Sr concentration in top layers

Beryllium in Soil Water

- zero tension lysimeters



- concentrations of Be in soilwater => acid leachable Be in soils

Beryllium Sources for Soil Water

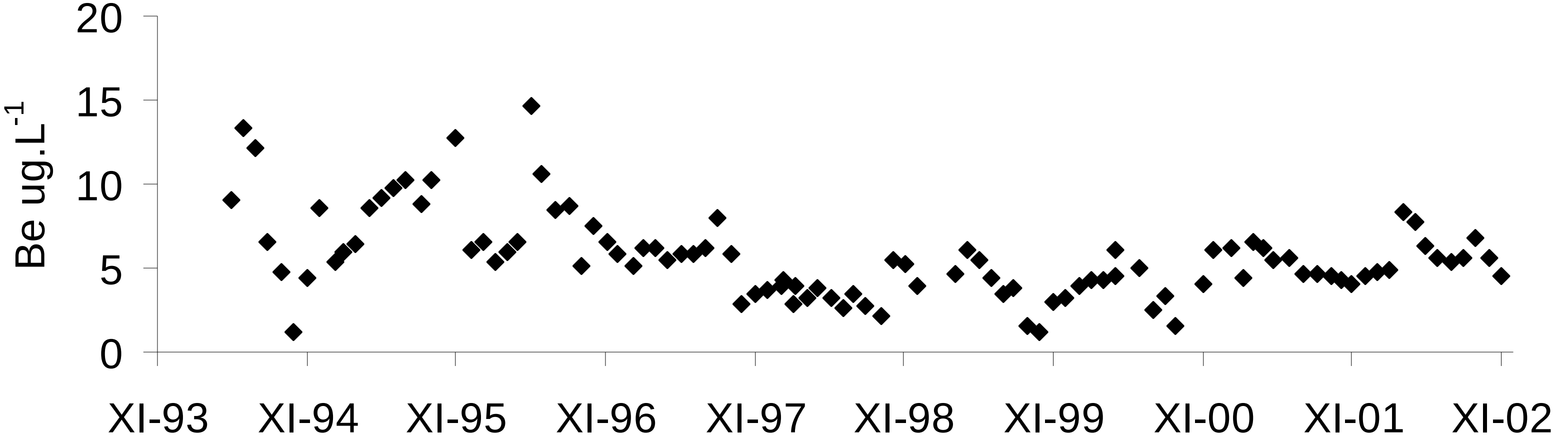
- table of enrichment of elements in soilwater passing the first 5 cm of soil in comparison to throughfall

	LP6			LP35
Parameter	5 cm		Parameter	5 cm
Mn	-62%		Mn	-76%
Mg	-17%		Mg	-28%
Ca	31%		Ca	11%
Na	110%		Na	250%
H	117%		Sr	300%
Sr	200%		H	467%
Ba	850%		Ba	800%
Be	**1900%**		**Be**	**900%**
Al	2233%		Al	2333%
Fe	3100%		Fe	3300%

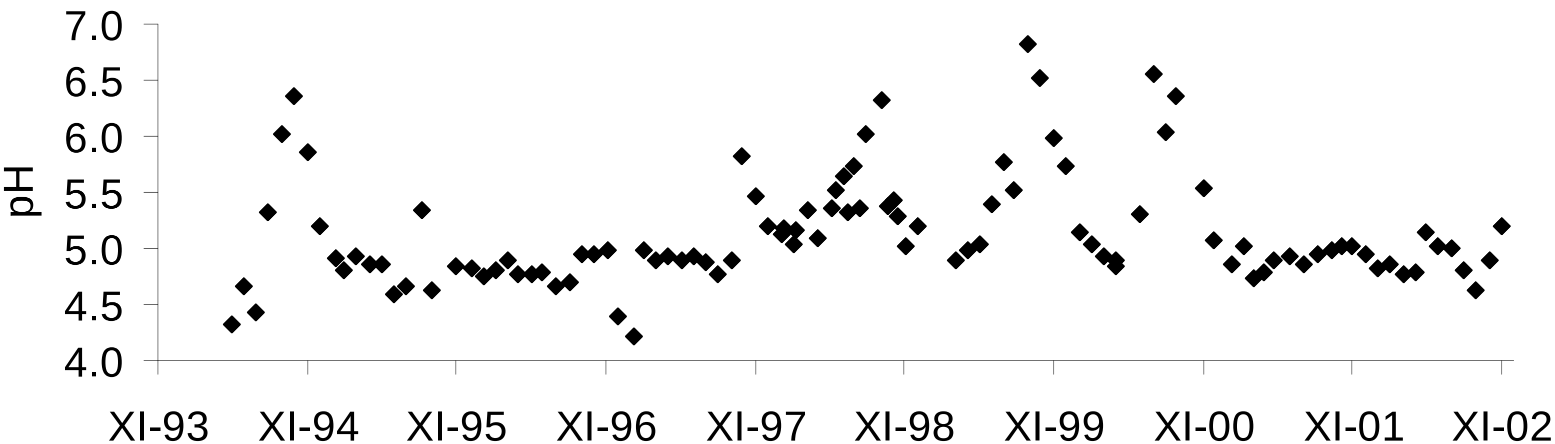
- Be becomes mobile after decomposition of organic material

Beryllium in Streamwater

- changes of Be concentrations in LP streamwater

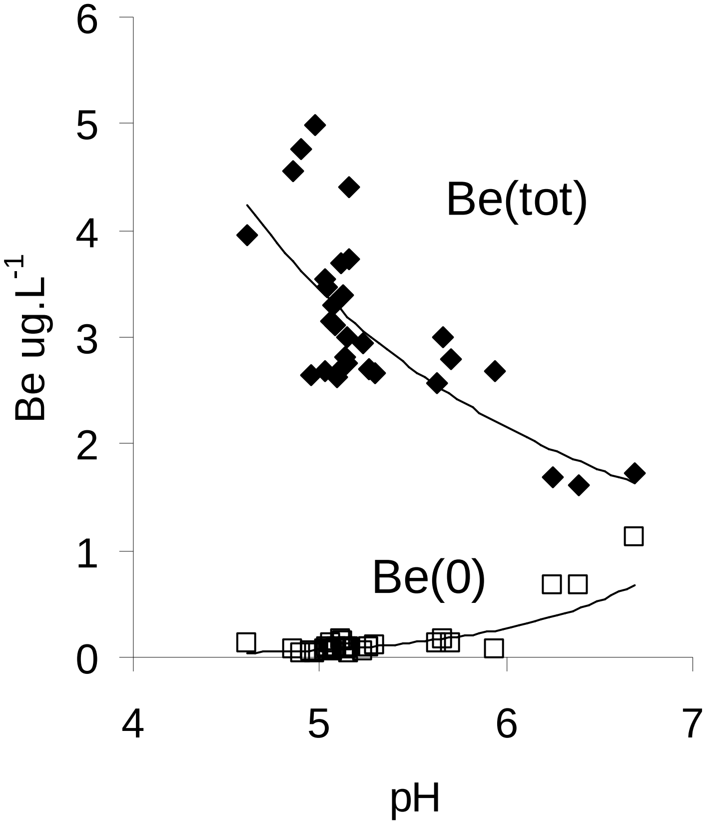


- increasing pH value => decreasing level of acidification



Speciation of Be in Streamwater

- usage of exchange column techniques with CATEX resins

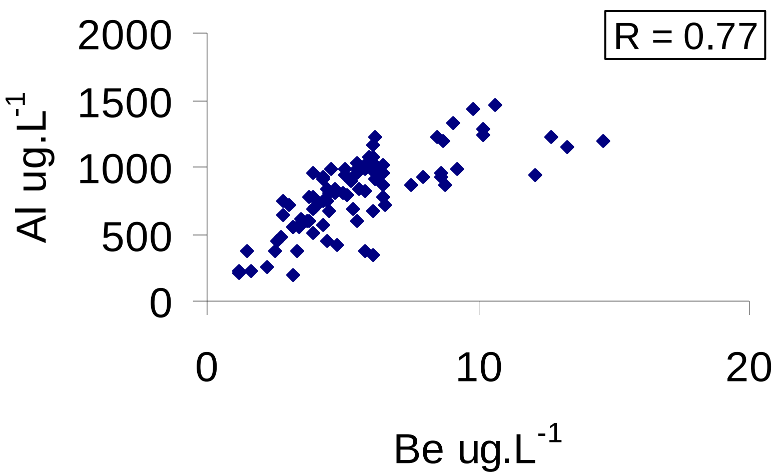


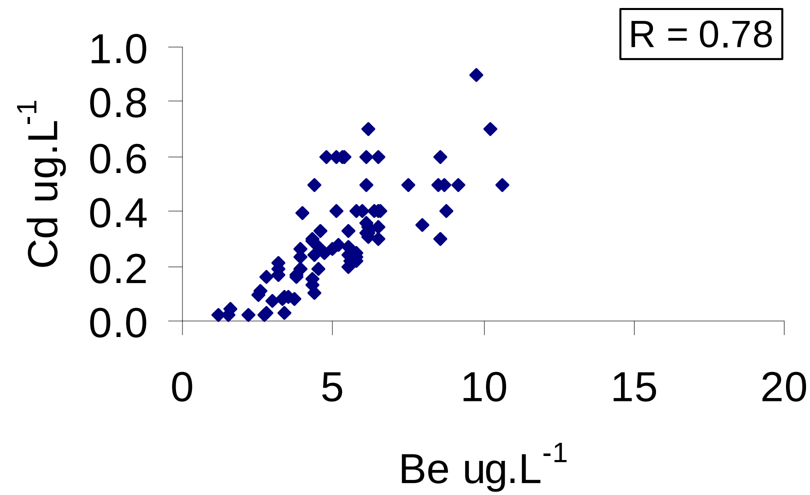
- Speciation modeling

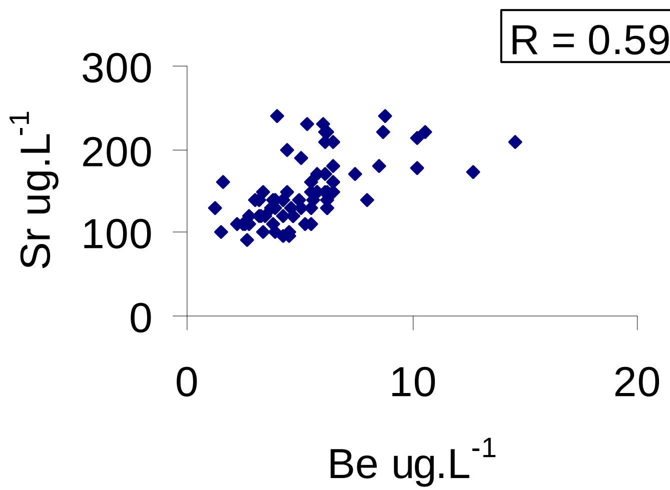
Software MINEQL+

pH 4 - 5.5	Be^{2+}
	BeF^{+}
pH 5.5 - 6	$BeOH^{+}$
	BeF_2

Relationships of Be with Other Solutes







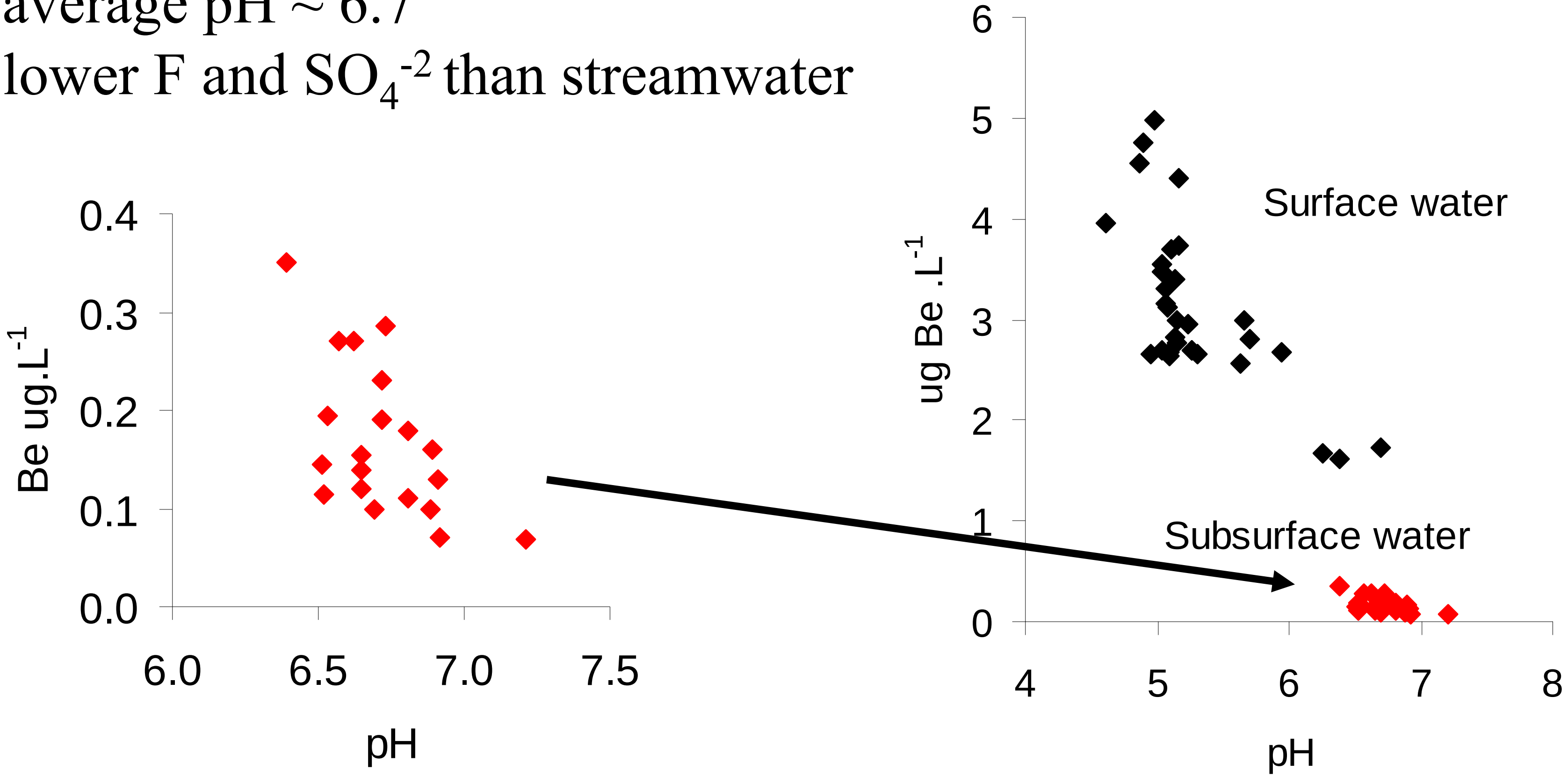
Beryllium in Streambed Material

- Fe-precipitates => 16.5 $mg.kg^{-1}$
- stream bed sediment => 12.7 $mg.kg^{-1}$

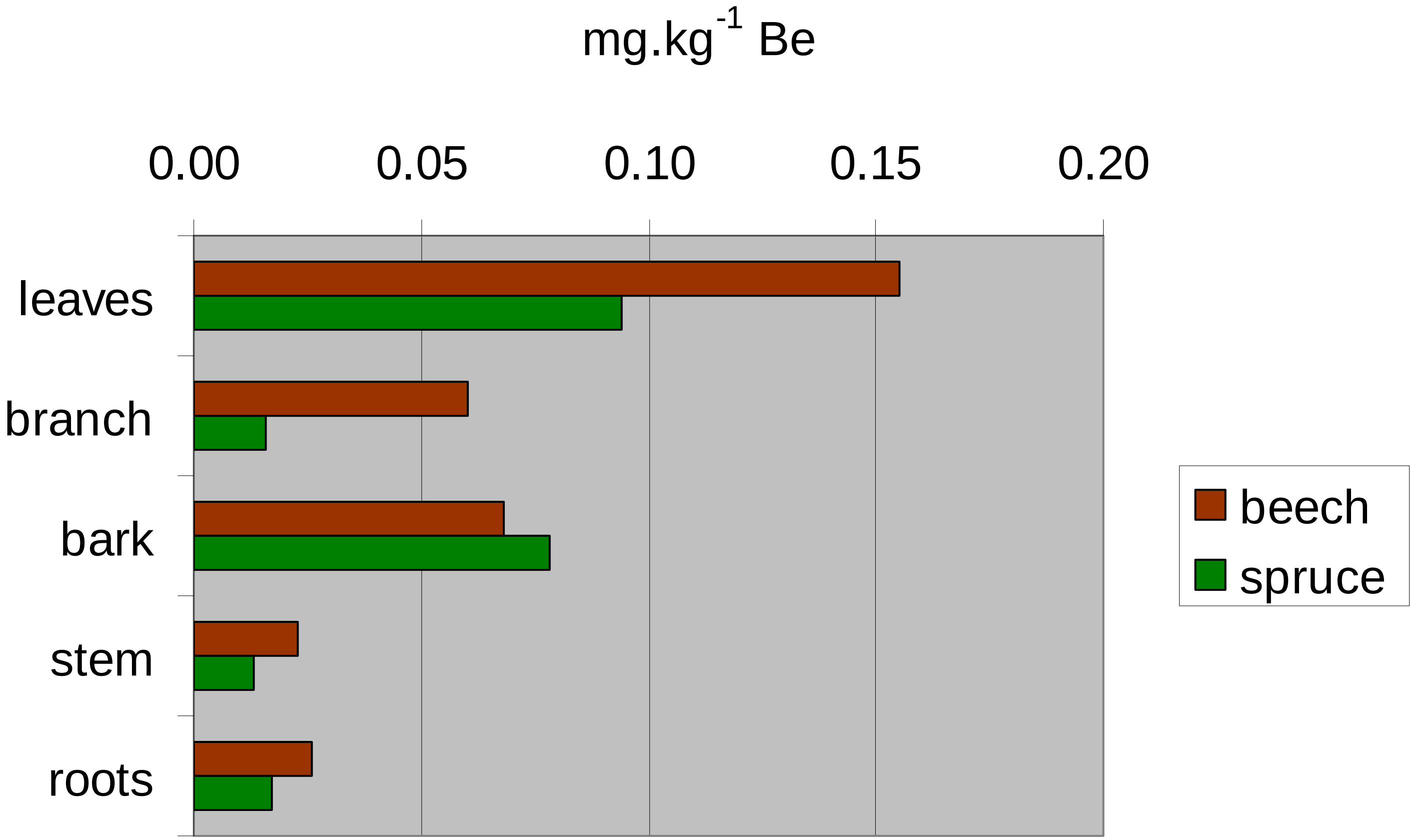
- acidification experiment
- beryllium => one of most mobilized metals
- stream bed material => an important Be source
- enhanced Be export => in acidified stream => further acidification

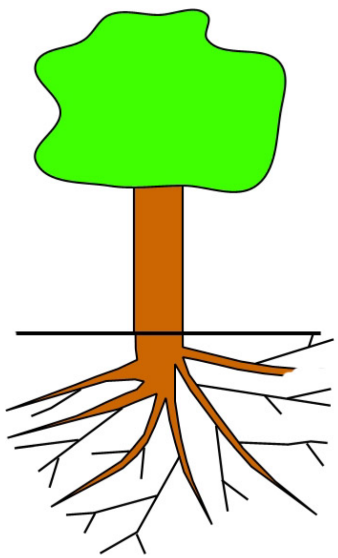
Beryllium in Shallow Groundwater

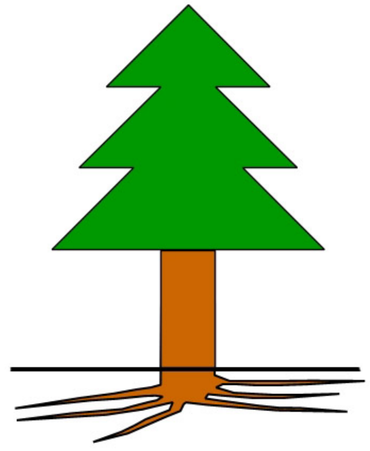
- average pH ~ 6.7
- lower F and SO_4^{-2} than streamwater



Beryllium in Vegetation



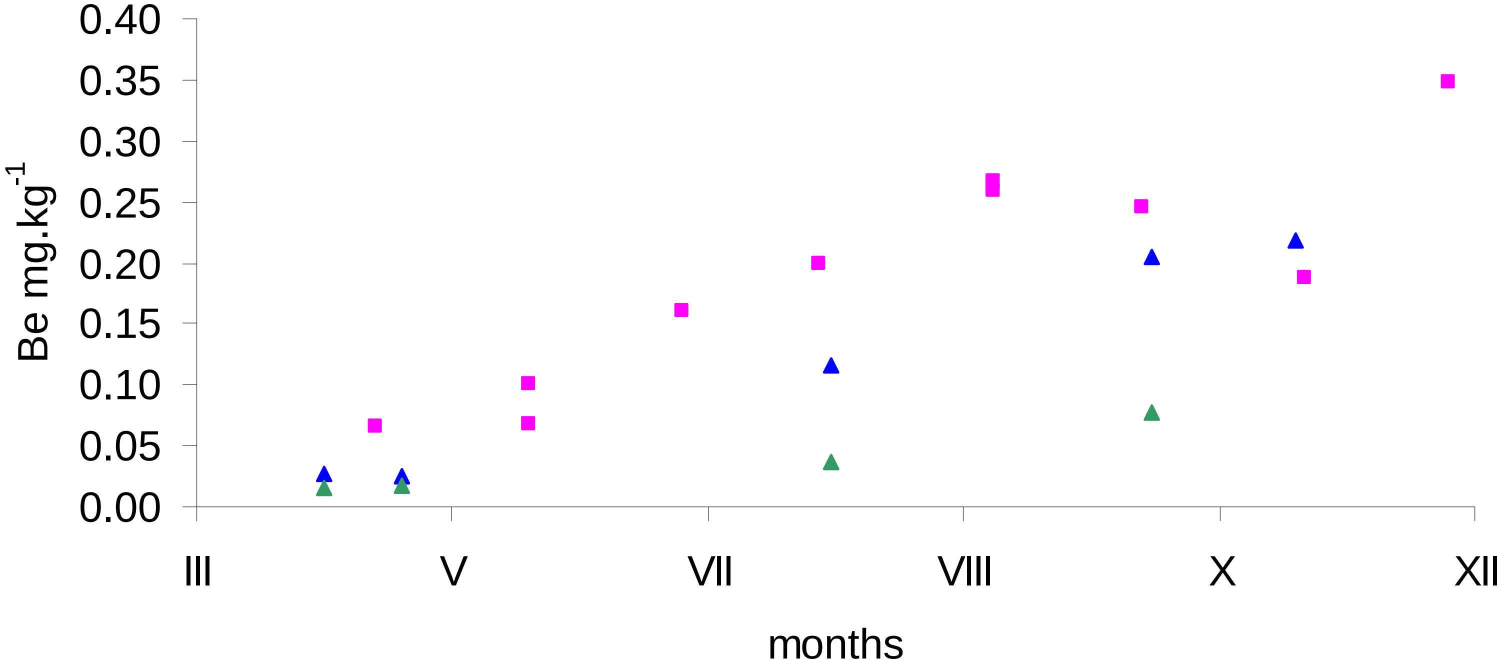




- linkage to soilwater – deeper rooting systém

= higher Be in assimilatory organs

Seasonal Changes of Be in Beech Leaves



- enrichment of Be in ass. organs similar to Ca, Sr, Ba etc.
- counter behavior = loss from ass. organs K, Mg, Cd

Conclusions

- bulk atmospheric inputs = negligible
  - 3 – 6 $ug.m^{-2}.yr^{-1}$
- canopy exchange and scavenging = negligible
  - 7 – 14 $ug.m^{-2}.yr^{-1}$
- most important input to forest floor = litterfall
  - 140 $ug.m^{-2}.yr^{-1}$
- export through streamwater discharge = the most significant flux
  - 300 - 1400 $ug.m^{-2}.yr^{-1}$

Conclusions cont.

- Be concentrations in soil and soilwater = increase with depth
- Be streamwater export = decreasing (due to increasing stream pH)
- important source of Be = streambed material
- low Be in shallow groundwater = circum-neutral pH value
- exported Be = mobilized from regolith and soils
- probable form of Be in assimilatory organs of vegetation could be oxalate due to similar behavior to Ca, Sr and Ba