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I have always been fascinated by the growth of the front teeth of rabbits, largely because of their continuous growth … and the fact that I have "buck teeth".

Last summer two students came to me with an interesting challenge. They had collected rabbit teeth from a region somewhere in the USA and posed the following challenge. Can I tell them anything about the climate of the growing region where the rabbit was found and the diet of the rabbit, if all that they have is the carbon and oxygen isotope ratios of carbonates from enamel extracted from different positions along the tooth. I said "Sure, no problem", hoping for the best. The students then analyzed the isotope ratios of the carbonates embedded within the tooth enamel along the entire length of the tooth and came up with the observations in the table below

Position from the base of the tooth	$\delta^{13}C$ of carbonate (PDB, ‰)	$\delta^{18}O$ of carbonate (SMOW, ‰)
1	-0.1	32.0
2	-0.1	32.0
3	-0.9	31.0
4	-9.0	25.0
5	-14.0	22.0
6	-14.0	22.0
7	-9.0	25.0
8	-0.9	31.0
9	-0.1	32.0
10	-0.1	32.0

Well, I think it would be easiest if I could remember the fractionation factors for (a) oxygen between water and carbonate and (b) for carbon between carbon dioxide in the blood and carbonate. Perhaps I can get Professor Ehleringer to remind me of those fractionation factors.

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One of the best classes I ever took in college involved field studies where we looked at long-term recorders of climate in a region. On a field trip to southern Utah in Fall 1987, we sampled a Douglas fir tree that was dated as being born in 1949.We obtained this information by collecting a tree ring core. In talking to people from the region, they reported that the forest where the tree had been sampled had been thinned at some time in the past (but they did not recall the year). We measured the carbon isotope ratios in each individual tree rings from that tree. The data are shown below, where I also report the precipitation measured in the same year that the tree ring was produced. Both the utility of tree rings as a measure climate and of past thinning history were obvious in the tree rings.

Growth year	Tree ring $\delta^{13}C$, ‰	S. Utah precipitation, mm
1950	-29.5	730
1951	-29.6	640
1952	-29.5	600
1953	-29.4	560
1954	-29.3	500
1955	-29.5	450
1956	-29.4	420
1957	-29.5	429
1958	-29.3	468
1959	-25.2	400
1960	-25.3	430
1961	-25.4	480
1962	-25.5	500
1963	-25.1	350
1964	-25.1	370
1965	-25.2	390
1966	-25.3	420
1967	-25.5	500
1968	-25.5	506
1969	-26.0	660
1970	-26.1	690
1971	-26.2	730
1972	-25.9	640
1973	-25.8	600
1974	-25.7	560
1975	-25.5	500
1976	-25.4	450
1977	-25.3	420

1978	-25.3	429
1979	-26.0	680
1980	-26.3	750
1981	-26.3	767
1982	-26.1	700
1983	-26.0	680
1984	-25.9	630
1985	-25.8	600
1986	-25.3	420
1987	-25.2	410

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At the same time as we measured tree rings in southern Utah, we also analyzed the oxygen isotope ratios of waters from the Great Salt Lake (GSL) that had been collected at the marina near Saltair every September 1st. We also have the height and volume data for the Great Salt Lake from the readings collected by state officials at the marina. We know that the volume of the Great Salt Lake changes from year to year depending on the amount of precipitation that fell during the winter before. Of course, it is not the precipitation that fell on the lake that causes the elevation changes, but is the river inputs from rain and snow that fell in the Wasatch and Uinta Mountains (entering at the Bear, Weber, and Jordan Rivers).

year	GSL elevation (m)	GSL volume (km3)	Surface water $\delta^{18}O$, ‰	salinity ‰
1950	1279.74	21.685	-3.92	16.9
1951	1280.02	22.746	-4.26	16.4
1952	1280.35	24.105	-4.69	15.8
1953	1280.17	23.355	-4.45	16.1
1954	1279.68	21.455	-3.85	17.0
1955	1279.44	20.559	-3.57	17.4
1956	1279.27	19.963	-3.38	17.6
1957	1279.27	19.963	-3.38	17.6
1958	1279.12	19.436	-3.22	17.9
1959	1278.81	18.424	-2.90	18.3
1960	1278.46	17.329	-2.55	18.8
1961	1277.96	15.887	-2.10	19.5
1962	1278.09	16.266	-2.22	19.3
1963	1277.90	15.723	-2.05	19.6
1964	1278.23	16.655	-2.34	19.1
1965	1278.58	17.702	-2.67	18.7
1966	1278.48	17.375	-2.57	18.8
1967	1278.61	17.796	-2.70	18.6
1968	1278.75	18.228	-2.84	18.4
1969	1279.04	19.178	-3.14	18.0
1970	1278.93	18.822	-3.02	18.2
1971	1279.53	20.891	-3.67	17.2
1972	1279.85	22.092	-4.05	16.7
1973	1280.24	23.665	-4.55	16.0
1974	1280.26	23.728	-4.57	15.9
1975	1280.49	24.680	-4.87	15.5
1976	1280.61	25.201	-5.03	15.3
1977	1280.15	23.294	-4.43	16.1
1978	1280.05	22.867	-4.30	16.3
1979	1279.77	21.801	-3.96	16.8

1980	1280.21	23.541	-4.51	16.0
1981	1279.92	22.387	-4.15	16.5
1982	1280.50	24.745	-4.89	15.5
1983	1281.81	30.823	-6.80	12.7
1984	1282.80	36.101	-8.46	10.3
1985	1282.99	37.140	-8.79	9.8
1986	1283.69	41.308	-10.10	7.9
1987	1283.32	39.096	-9.40	8.9