An IAFI Puget Lobe Chapter Newsreel:

Introduction to the Milankovitch Theory, Ch 2, p. 1)

This chapter looks at the parameters that Milankovitch spent so many years calculating and studying. Those parameters are:

a, Eccentricity: The orbit of the earth around the sun over time.

b. Obliquity: The tilt of the earth over time.

c. Precession: The "wobble" of the earth over time.

We will look at each parameter individually, then put them together on a chart and reflects a curve called "ETP" (or Eccentricity, Tilt, and Precession. Remember this curve, for Milankovitch used this curve to identify when continental ice sheets could have occurred. And, very important are other curves, such as, CO^2 and O^{18} that show similar characteristics.

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Insolation was computed at the top of the atmosphere, not at ground level.

Milankovitch calculations are only made at the top of the atmosphere.

Any attempt to calculate insolation at ground level would have been counter productive and would have to take into account ablation, cloud cover, atmospheric water vapor, bare ground, ground cover, ground elevation, etc. Computers hadn't been invented yet.

Subsequently researchers have refined these calculations, I,e., computers.

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The Milankovitch Theory concerns itself with the “amount of insolation” the earth receives:

1. Where earth receives it:
    a. A circular orbit has no effect on isolation - its all the same from any point in earths orbit
    b. An eccentric orbit does – isolation may be 1-2% greater or lesser
    c. Obliquity favors the northern latitudes
    d. Precession favors the mid-latitudes
2. During what season of the year is insolation received:
    a. Where earth is in its orbit around the sun (when insolation was received)
    b. What latitude receives it, and,
    c. How was earth “tilted” and “wobbled” in it’s the orbit when insolation was received

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(the below is taken from Williams, Ch 1-5, 1998)

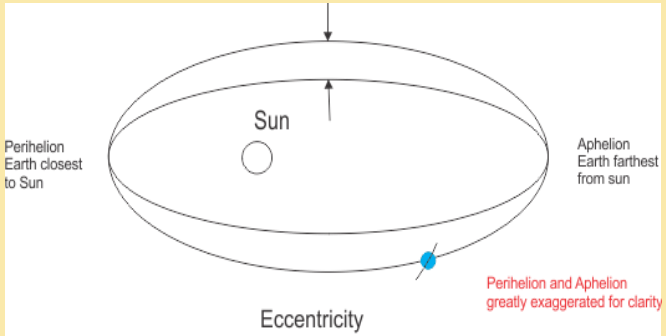
Eccentricity – *elliptical orbit of the earth around the sun (periodicity 100,000 yrs)*

Elliptical to circular orbit and back to elliptical orbit takes 100K years

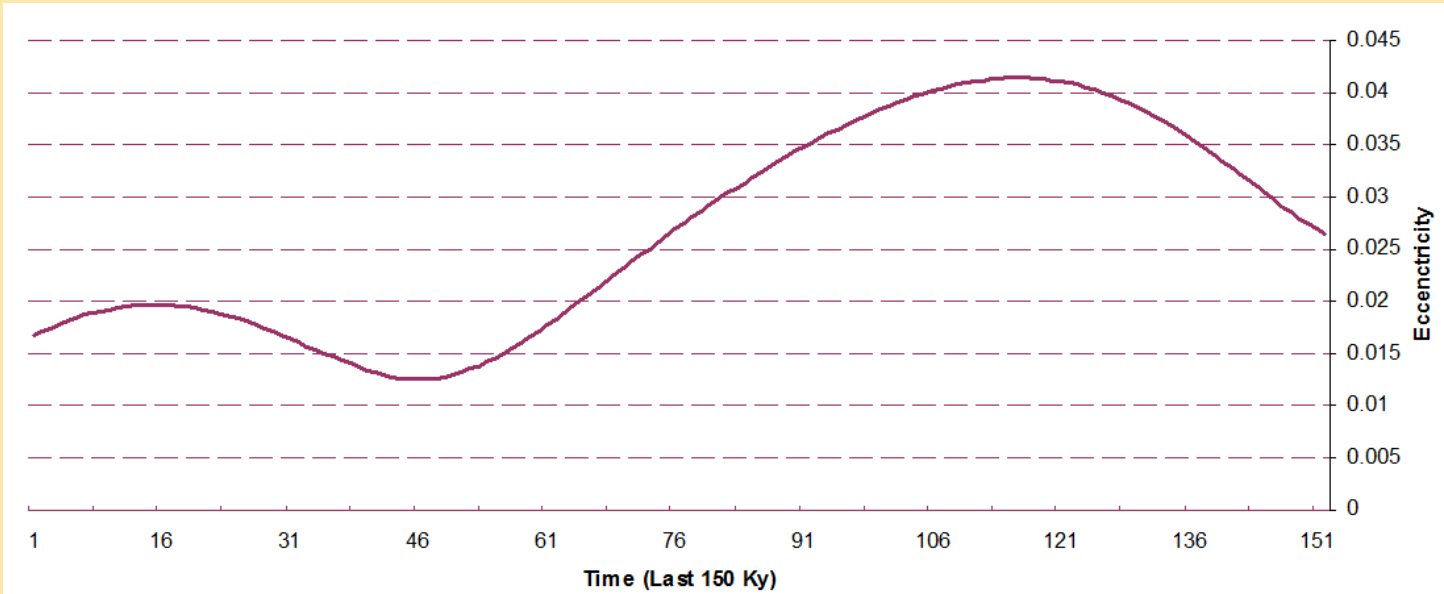
A circular orbit would not impart isolation *differences over time.*

The time it takes the earth to orbit the sun is 365.25 day; hence, the leap year

Eccentricity will vary the length of the season from 82.5 to 100 days



Eccentricity is the elliptical orbit of the earth around the sun. Earths orbit goes an elliptical and circular (and back) in a cycle that takes approximately 100,000 years to complete.



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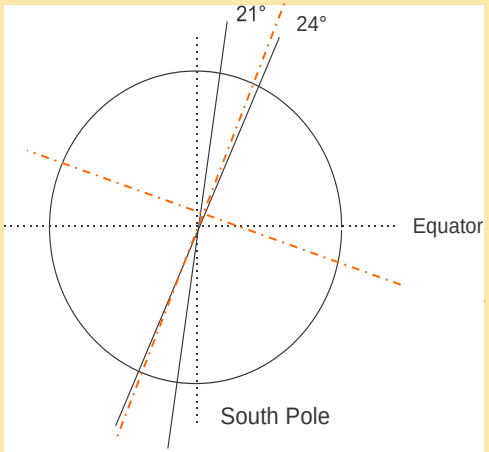
(the below is taken from Williams, Ch 1-5, 1998)

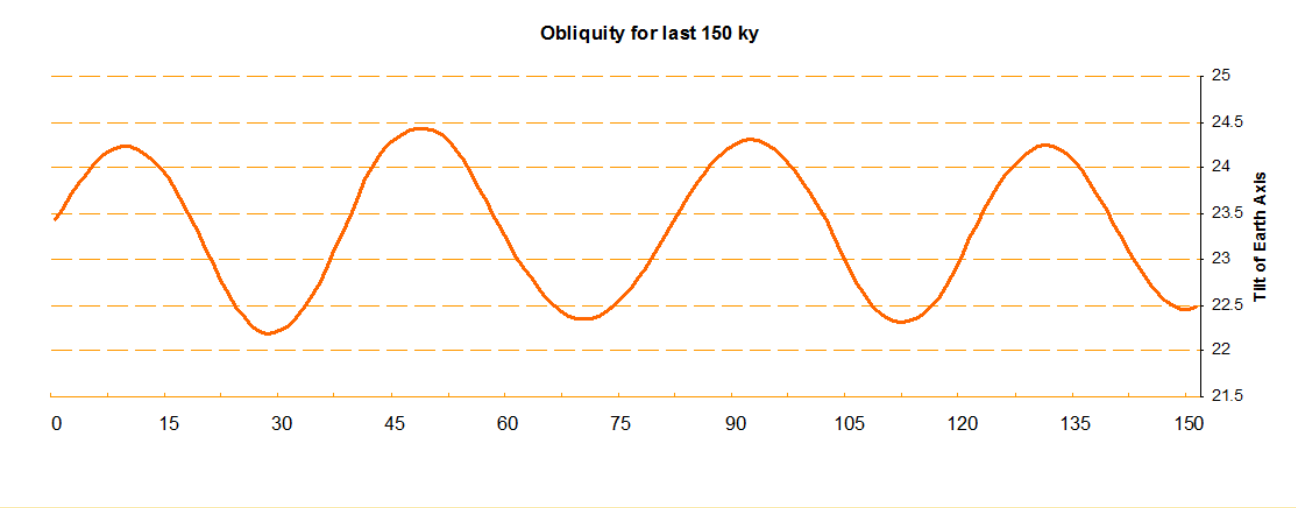
Obliquity *– the tilt of the earth over time (24.28 ° to 21.5° as calculated by Milankovitch over the last 1my) (periodicity 41,000 yrs with a range of 45ka to 38ka)*

Tropic of Cancer is at present located about **23.5°** N and heading south (decreasing) for another 9,300 yrs and is over 90 km from its position in 1908. Then it "starts" north again. *(Williams, p.82)*

Effects are most noticeable in the higher latitudes



Obliquity - tilt of the earth on its axis



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Precession – *"direction of the tilt of the Earth's axis relative to the fixed star*s.

The earths axis is obliquity plus precession: it is also "the direction in which the spin axis points in space" (Williams, p.79)

The sun, moon, and planetary gravitational forces cause a wobble to the earth's spin

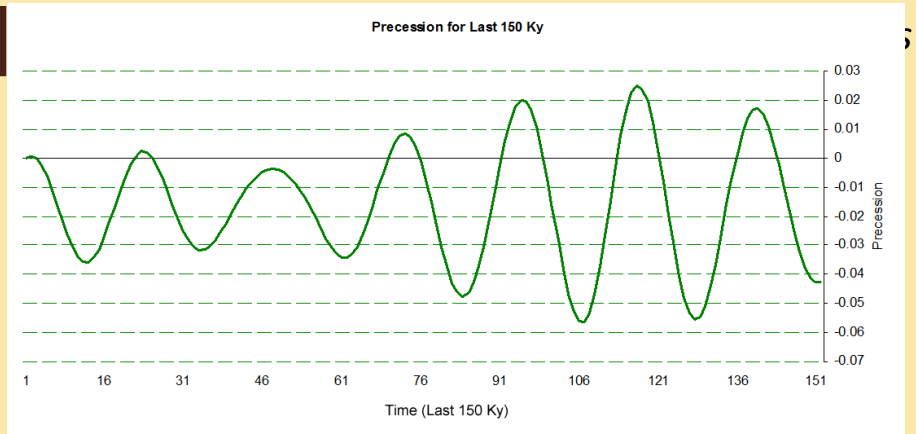
The wobble traces a retrograde movement of about +.05° to -.05 ° maximum to +.02° to -.02° currently (last 25Ka).

Smallest wobble about +.01° to -.01° about 750 Kyrs and 450Kyrs-350Kyrs

Every 70 years, the earth looses a day of distance in it's orbit (or 50" per year).

The equinoxes will rotate around the orbit at a rate of loss of 50 seconds of arc per year.

This rotation takes about 23 Kyrs; but, because of the retrograde rotation of the wobble, the spin takes about 19 Kyrs. Currently, Polaris is the north star; however, in 13,000 years it will be Vega



Imbrie, J. et al, 1990, SPECMAP Archive #1. IGBP PAGES/World Data Center-A for Paleoclimatology Data Contribution Series # 90-001. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA (file 17

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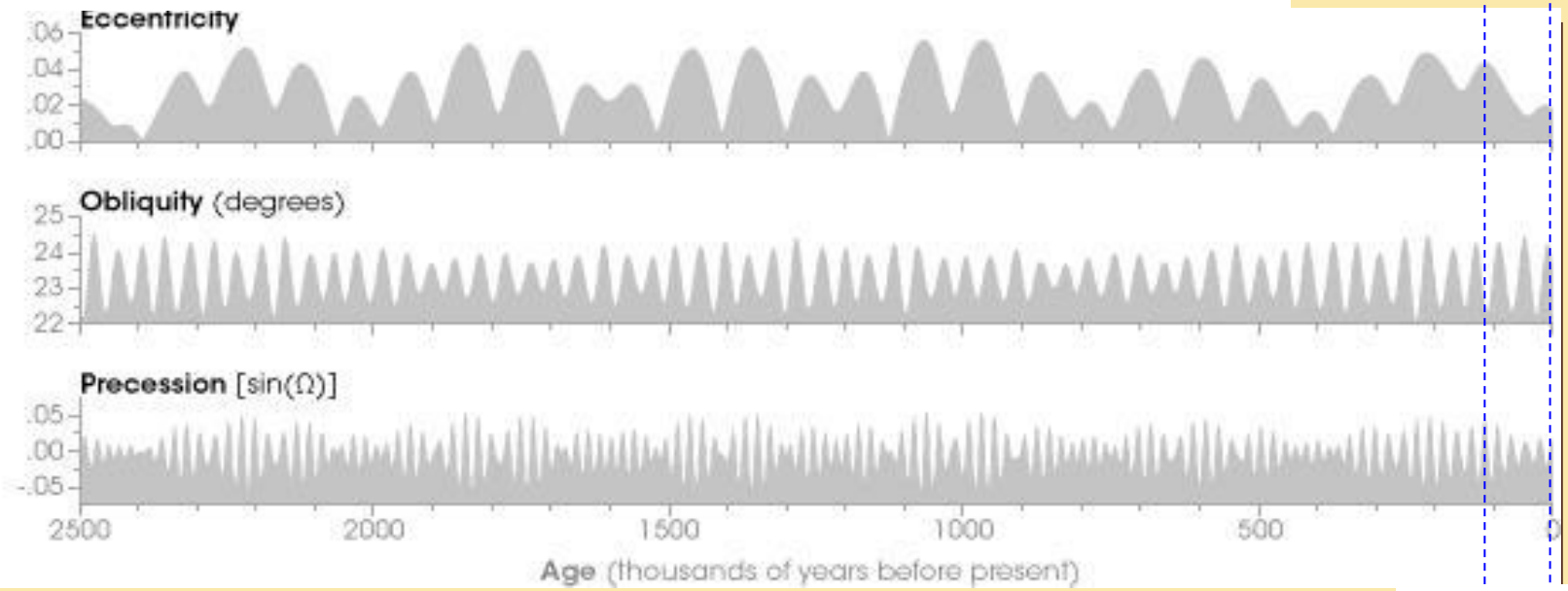
Timescale for Eccentricity, Obliquity, and Precession



USGS Fact Sheet 2018-3054 moved the border between Quaternary/Pleistocene and the Tertiary/Pliocene to 2.58 mya from 1.8 mya

Last 120K years

There is a rough ratio of 1:2:4 between eccentricity, obliquity, and precession. To the right, the dotted lines encompassing the last 120K years, takes you through one complete eccentricity cycle (the longest cycle) and shows the apparent ratio.

Source: NASA

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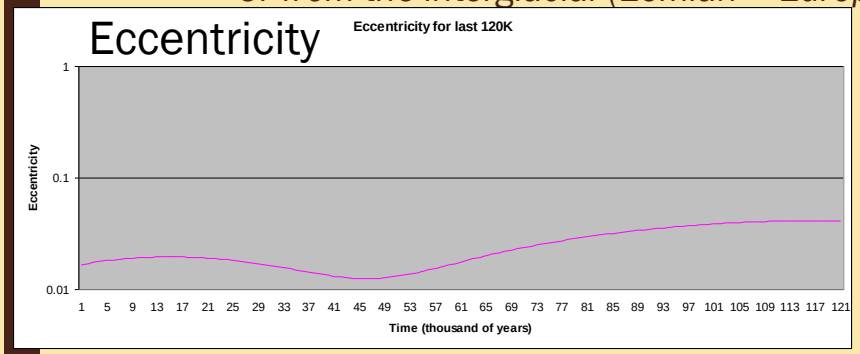
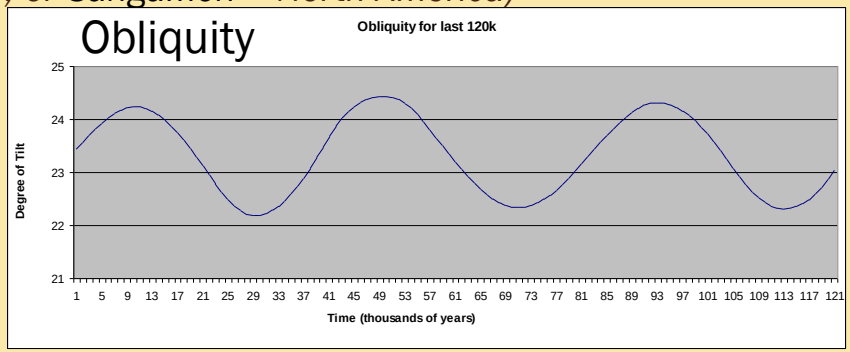
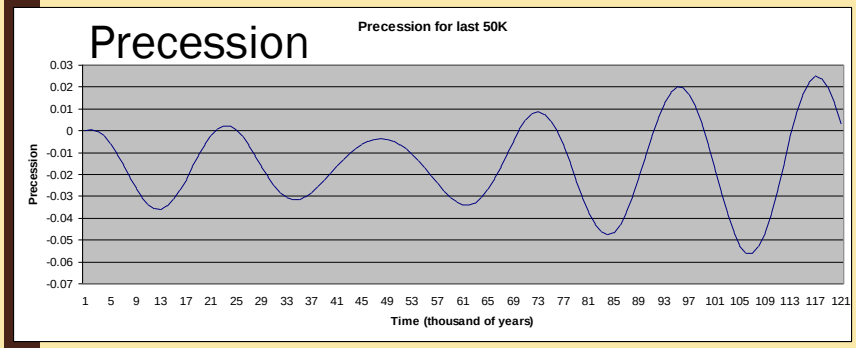
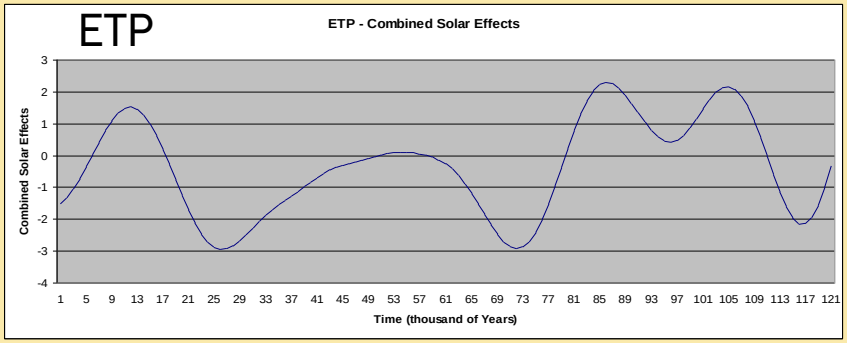
- Timeline for Eccentricity, Obliquity, and Precession 120K to Recent
  - *Or from the interglacial (Eemian – Europe, or Sangamon – North America)*









Data for orbital graphs supplied through:
Imbrie, J., et al, 1990 SPECMAP Archive#1. IGBP PAGES/ World Data Center-A for Paleoclimatology Data Contribution Series #90-001. NOAA/NGDC Paleoclimatology Program, Boulder CO, USA

Notice the curve in this chart (ETP), as you will see something similar in the marine sediment core charts. (See next slide)

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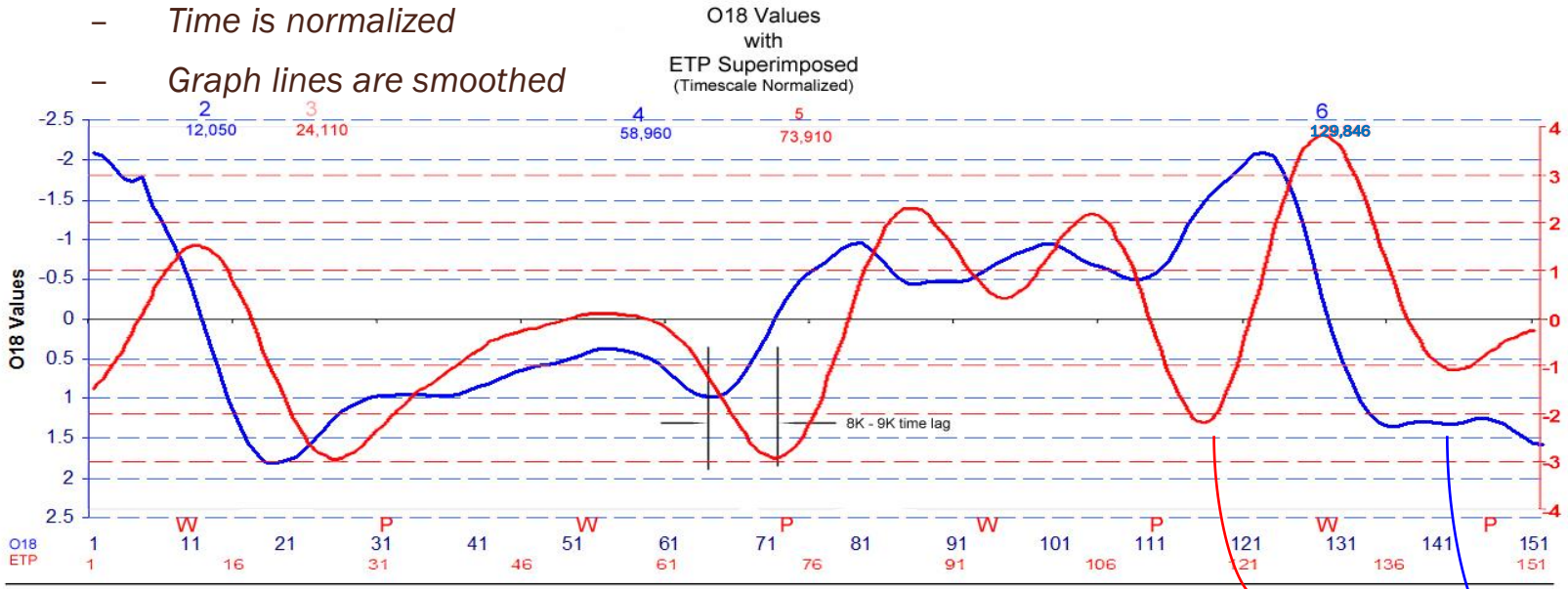
- ETP superimposed upon ‰^{18}Oxygen isotope graph.
  - *Time is normalized*
  - *Graph lines are smoothed*



Notes:

Heinrich, 1988, Quaternary Research 29: Dropstone record indicates ice rafting not only during stadial intervales by also more or less in the middle of interstades.

Ibmrie, 1979, p. 172: The 41K and 23K frequencies precede climatic changes by approximately 8K

Williams, 1997, p. 64: "The northern hemisphere high-latitude summer radiation values flucuate first, followed by a response in ice volumes that lags about 3Ka, and by a response in sea-surface temperature (SST) that lags by a further 6 Ka. This means that SSTs lagged behind insolation changes by an aggregate of 9,000 years.

W = II 270 deg winter minima
P = II 90 deg summer minima

ETP is red
O^{18} is Blue

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- ETP superimposed upon ‰^{18}Oxygen isotope graph comments:
  - *Time goes from right to left as you look at chart*
  - *On the -2.5 graph line, at the top you see the alternating blue and red figures. These figures represent marine glacial/nonglacial periods, or marine sequences. The figures shown are termination or recognized end points for the interstade/stade (glacial/nonglacial periods)*
    - Red or odd number represent warm –non-glacial periods such as our current epoch called the Holocene. There are no equivalent for termination dates for warm periods.
      - *Sagamon/Eems warm period between Double Bluff and Possession Glaciation*
      - *Olympic warm period between Possession and Fraser Glaciation*
      - *Holocene warm period after Fraser Glaciation – our current era*
    - Blue or even numbers represent cold periods – Glacial periods such as the Fraser or Possession glacial periods. Each cold period has a Termination date (Tn) with a "marked shift from isotopically heavy to lighter values". (Lowe, p. 325)
      - *T2 or the Double Bluff glaciation termination was ~ 126,846 kya*
      - *No Termination as Possession glaciation not considered full stadial event and has no marked shift in isotopic values. (However, it is considered to have ended by ~73,910 kya)*
      - *T1 or Frasier glaciation termination was ~12,050 kya*
      - *More about glacial Termination and oxygen isotopes in later chapters – it's a little complicated*

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In Ch 3 we will look at how we got to the Pleistocene. It wasn't time travel; rather, we took time, feedback mechanisms, geological happenings, etc. and looked at those records and deduced the past. It was a community effort with inputs from persons in the past, much like Adhëmar, Croll, Milankovitch, Köppen, Wegener, Penck, and Bückner – persons we have already introduced.

We continue on with our travel in time (not time travel) and introduce other players.