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Isotopes and Horses

EvyJo M. Compton
Parkland College

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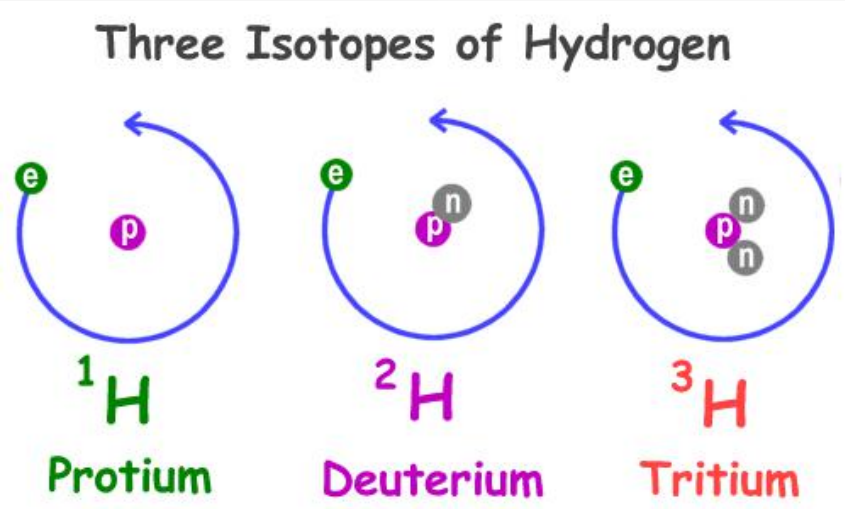
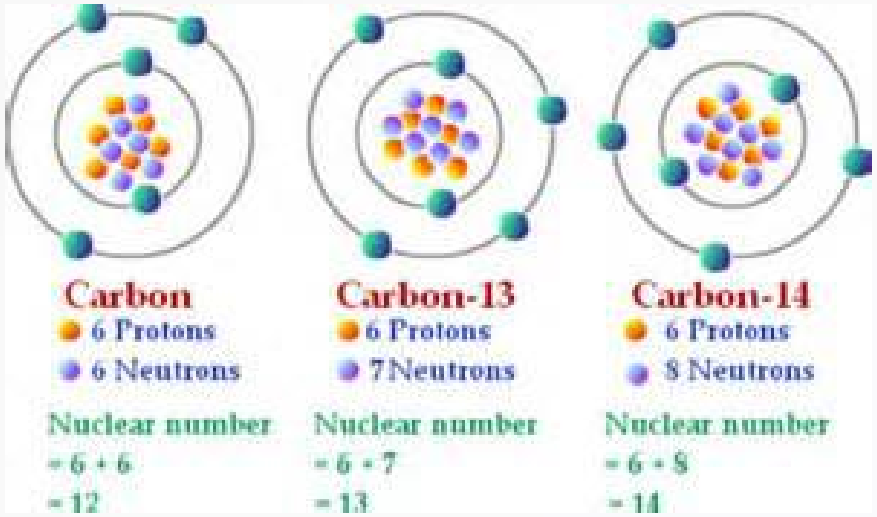
EvyJo Compton
Chemistry 102-004
Parkland College

What exactly is an isotope?

- Different species of atoms of an element.
  - Same atomic number and place on the periodic table
  - Same chemical, but different physical properties
  - Different atomic masses, and number of neutrons
  - All elements will have more than one isotope.



(http://www.ducksters.com/science/chemistry/isotopes.php)

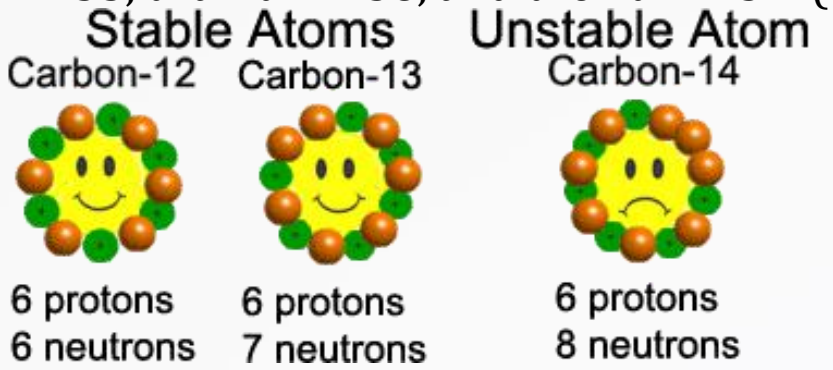


(http://chemistry.tutorcircle.com/inorganic-chemistry/isotopes.html)

(Herzog, n.p.)

Where do we find isotopes in nature?

- Isotopes can have two forms- stable and unstable
  - Stable isotopes will last forever in nature, and can be found everywhere. (McCanty)
    - Some examples of stable isotopes include helium-3 and carbon-12 (University of Wyoming, “What are isotopes?”)
  - Unstable isotopes can be found in nature, but they are radioactive. (McCanty)
    - Unstable isotopes will decay. When unstable isotopes decay- they become a daughter nuclei. (University of Wyoming, “What are isotopes?”)
    - Unstable isotopes will eventually vanish from the Earth if not replenished artificially. Humans have helped replenish the population of unstable isotopes for years. (University of Wyoming “What are isotopes?')
    - Some examples of radioisotopes or unstable isotopes include potassium-40, rubidium-87, neodymium-144, uranium-235, uranium-238, and thorium-232. (University of Wyoming, What are isotopes?)



(https://www.radtrainonline.com/logon.asp?problem=BadID)

Why are isotopes important to us?

- Stable isotopes can be used to determine ecological processes.
  - These isotopes can show what ecological processes were occuring during the time that they were formed.
    - These can be found in the atmosphere, streams, lakes, rivers, etc.
- Stable isotopes can also be used to record biological responses to changes in the Earth's environment.
  - Key factors of life, like nutrients, can vary in isotopes. This means that one can trace how an organism survived.
    - These can be found in tree-rings, animal hair and ice-cores.

(University of Wyoming. “Application”)

How can we use isotopes to our advantage?

- There are quite a few ways that isotopes can be used by humans for our advantage.
  - Dating Objects
  - Radiopharmaceuticals used for medical imaging
  - Cancer treatment and similar therapy
  - Smoke detectors
  - NASA batteries for exploration sattelites
  - Forensic analysis
  - Calibrating shipping dock detectors
  - Nuclear Fission used for energy

("Why are isotopes important?")

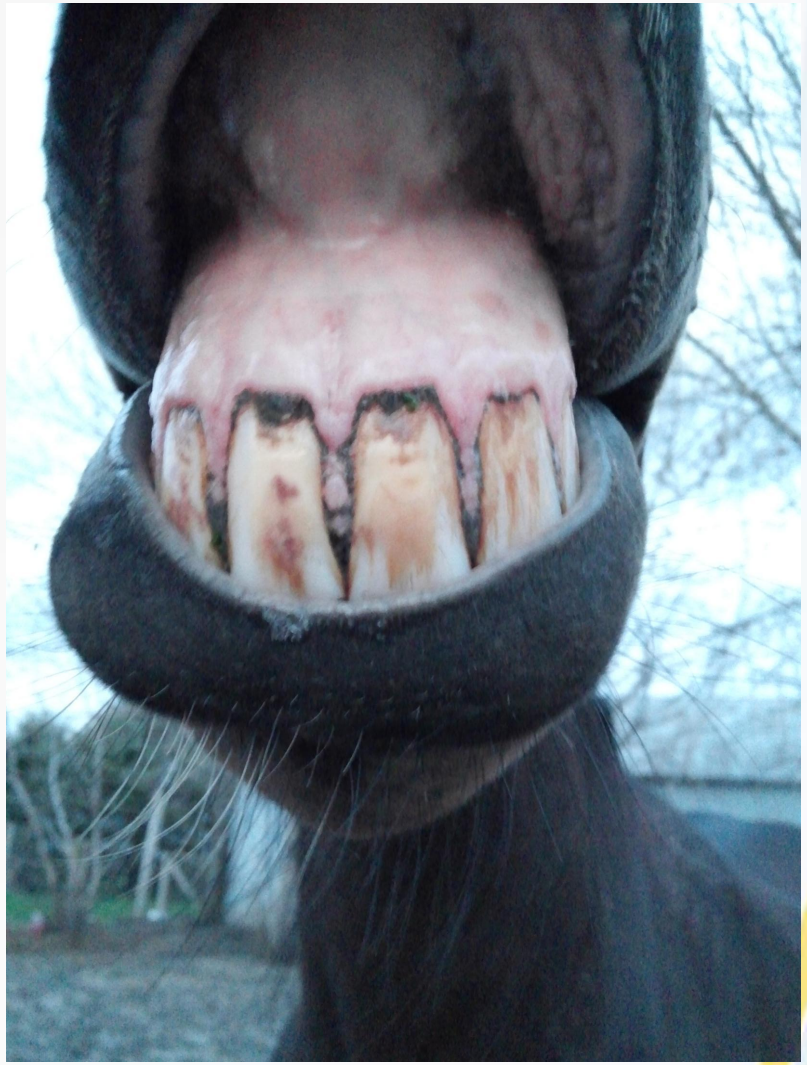
Isotopes and Horse Enamel: Introduction

- This experiment was based around bioapatite- a biomineral that is resistant to chemical alterations after being covered with dirt.
- Stable oxygen and carbon isotopes are tested for, and are used in this experiment.
  - paleo-seasonality is based on stable oxygen and carbon isotopes.
- A row of teeth from a modern horse is used as an environmental recorder to test the robustness of new paleo-seasonality proxies in tooth enamel.

(de Winter, Niels J., 1)

Isotopes and Horse Enamel: Background

- *Equus caballus,* or the modern day horse, have a hypsodont dentition which allows them to grow high-crowned cheek teeth.
  - These molars grow to be 8 to 9 cm. They can grow 3 to 4 cm every year.
- Bioapatite is made up of (Ca, Na, Mg, Ba, Fe, Sr, Zn, PO_4, HPO_4, CO_3, OH, F, Cl, O, and H_2O.
  - Bioapatite is a crystalline structure.
- Based on how much water and food the horse would drink/eat, one would be able to figure out the isotopes of oxygen (how much water) and carbon (their diet).



(EvyJo Compton)

(de Winter, Niels J., 2)

Isotopes and Horse Enamel: Materials and Methods

- Materials
  - 6 year old, adult male Belgian Draft Horse
    - Lived outdoors in grass pasture; grazed all year long
    - Horse's diet may have been supplemented with grain (oats, barely or corn)
  - Full upper right row of cheek teeth of horse were used
    - Cleaned for 72 hours using cold water maceration at 35 degrees Celcius
    - Abraded superficially with a mond-coated disc and let dry at 50 degrees Celcius
    - Cleaned by abrasion to rid of any varnish

(de Winter, Niels J.,5)

(http://www.suggest-keywords.com/YmVsZ2lhbiBob3JzZQ/)

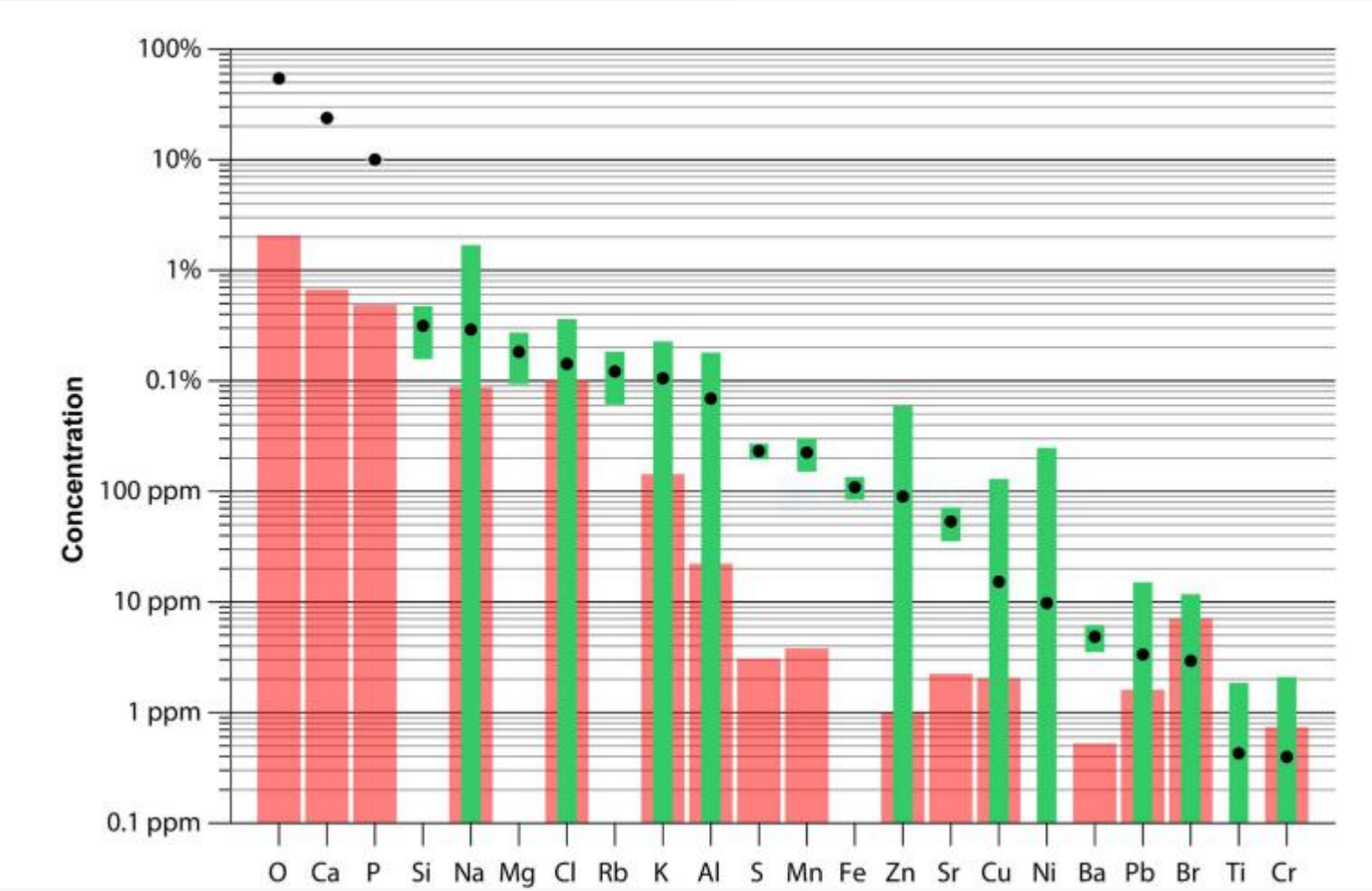
(http://www.allposters.co.uk/-sp/Belgian-Draft-Horses-Jim-Right-and-Jake-Graze-Posters_i3955444_.htm)

Isotopes and Horse Enamel: Materials and Methods

- Methods
  - All scans done on the teeth were done with a Bruker M_4 Tornado μ XRF scanner.
    - The scans were done with a Rh source tube at 50 kV and 600 μ A.
  - While scanning the teeth, the scanner would then plot the concentrations on a graph.
  - Each of the scans took 10 hours per tooth.
  - Once the scans were completed, those that fell under standard concentrations were rejected. Those that were above or at the standard concentrations were corrected, and then converted into molar percentages.

(de Winter, Niels J.6)

Isotopes and Horse Enamel: Results



(de Winter, Niels J., 9)

- Red bars are standard deviations of molar concentrations
- Green bars are the means and concentrations of the data taken from the Belgian's teeth
- Sodium (Na), Chlorine (Cl), Potassium(K), Aluminum (Al), Zinc (Zn), Nickel (Ni) were significantly above average in concentration.
- Oxygen (O), Calcium (Ca), Phosphorous (P) were below standard concentrations, and therefore were rejected.
- When the dots were placed into a linear regression equation, they found no correlation between the stable isotopes of Oxygen and Carbon.
- The horse's diet was very high in trace elements (which was expected)

(de Winter, Niels J.,10)

Isotopes and Horse Enamel: Conclusion

- When stable oxygen isotopes were tested for, it showed what was expected.
  - With the seasonal changes and temperatures, the amount of oxygen isotopes changed as well. More precipitation lead to more stable oxygen isotope.
- The high amount of trace elements was found to be normal in modern day horses.
  - These changed with the seasons- the amount of grass a horse ate, the amount of water it drank, or how much extra feed was added.
  - Another proposed reason was the amount of dust and that the horse would have ingested.
- When stable carbon isotopes were tested for, it mirrored the horse's diet during the seasons.

(de Winter, Niels J. 19, 20)

Works Cited Page

Sources:

de Winter, Niels J., et al. "Seasonal Cyclicity in Trace Elements and Stable Isotopes of Modern Horse Enamel." Plos ONE, vol. 11, no. 11, 22 Nov. 2016, pp. 1-29. EBSCOhost, doi:10.1371/journal.pone.0166678.

Herzog F. Gregory. Isotope: Chemistry. Enyclopædia Britannica, 12-12-16. Accessed: 4-03-17 https://www.britannica.com/science/isotope

McCanty Sean. Food Webs via Stable Isotopes. Experiment, 7-20-15. Accessed: 4-03-17. https://experiment.com/u/iA41fA

University of Wyoming. Application of Stable Isotope Measurements. University of Wyoming, N.D., Wyoming. Accessed: 4-06-17. http://www.uwyo.edu/sif/stable-isotopes/stable-isotope-measurement-applications.html

University of Wyoming. What are stable isotopes?. University of Wyoming, N.d., Wyoming. Accessed: 4-03-17 http://www.uwyo.edu/sif/stable-isotopes/what-are-stable-isotopes.html

Why are isotopes important? National Isotope Development Center, N.D. Accessed: 4-10-17. https://isotopes.gov/outreach/utilizations.html

Works Cited Continued

Pictures:

http://www.allposters.co.uk/-sp/Belgian-Draft-Horses-Jim-Right-and-Jake-Graze-Posters_i3955444_.html

http://chemistry.tutorcircle.com/inorganic-chemistry/isotopes.html

http://www.ducksters.com/science/chemistry/isotopes.php

https://www.radtrainonline.com/logon.asp?problem=BadID

http://www.suggest-keywords.com/YmVsZ2lhbiBob3JzZQ/