

*The Rock of Ages is more important than the age of rocks*

- William Jennings Bryan, three time candidate for US President, prosecutor and witness in the Scopes “monkey” trial

*If we are going to teach creation science as an alternative to evolution, then we should also teach the stork theory as an alternative to biological reproduction.*

- Judith Hayes, atheist, aka “The Happy Heretic”

Caveat: My view of faith vs. science

(Caveat)<sup>2</sup>: I am not a philosopher!

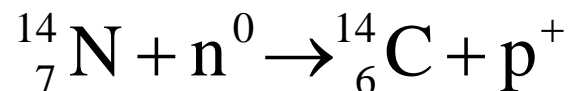
Bottom line: no real conflict, different realms

Limits of scientific truth

Why faith should be excluded from science education

## Radio-carbon dating

Basic idea:  $^{14}_6\text{C}$  formed from  $^{14}_7\text{N}$  by neutrons from cosmic rays in atmosphere.



$^{14}_6\text{C}$  is radioactive with half-life 5715 years.



$^{14}_6\text{C}$  is incorporated into  $\text{CO}_2$  and is metabolized into plants and animals throughout their life.

Relative abundances of carbon isotopes found on Earth are:

$^{12}_6\text{C}$  - 98.89%

$^{13}_6\text{C}$  - 1.11%

$^{14}_6\text{C}$  - 0.00000000010%

Williard F. Libby Nobel Prize in Chemistry (1960)

After a living thing dies, relative abundances of carbon isotopes begins to change, since  $^{14}\text{C}$  begins to decay, while other isotopes are stable.

In theory, carbonize sample by heating to high heat (*c.f.*, self-cleaning ovens), carefully weigh sample, then measure activity of sample.

In practice, three techniques (gas proportional counting, liquid scintillation counting, and accelerator mass spectrometry) All driven by extremely small amounts of carbon-14

Gas proportional counting: convert sample to  $\text{CO}_2$ , purify, and insert into modified Geiger counter.

Liquid scintillation counting: convert sample to  $\text{CO}_2$ , purify, convert to (usually) benzene, add scintillator, and measure light output.

Accelerator mass spectrometry: carbonize, purify, ionize, use magnetic separation of isotopes. Advantage: counts *all* carbon-14 nuclei, not just those decaying during measurement

Weakness and limitations of method:

Amount of carbon-14 is very small, so very sensitive measurement.

Not good for very recent samples, since isotope ratio would be little changed; not very good for very old samples ( $> 10$  half-lives, about 50,000 years) since too little carbon-14 left to measure.

Bigger sample is better to reduce statistical errors.

Care must be taken not to allow contamination of sample with more recently formed carbon-14.

Rate of formation of carbon-14 is not constant in time. Cosmic ray fluxes vary, Earth's magnetic field varies, atmospheric nuclear tests nearly doubled carbon-14 concentrations in atmosphere (now coming back down), burning of fossil fuels reduces concentration of carbon-14 in atmosphere. Need to cross calibrate dating methods, e.g., tree rings, written record, geologic strata. Radiocarbon years (before present, 1950) vs. calibrated date.



The island of Santorini

Eruption of Thera volcano:  
1630-1600 BC radiocarbon  
1550 BC archeology

Fall of Minoan civilization?

Famine in China? Change of  
dynasties?

Atlantis?

The 10 plagues on Egypt  
from the Exodus?

# The Shroud of Turin



Radiocarbon dating of shroud gives 1260-1390, but were samples taken from later patches? Dates skewed by process of image formation? Bacteria from handling? Off by factor of two? Permission to get new samples denied.

Some datings showing the existence of modern man older than 5000 years:

Stonehenge (7700 years)

Kennewick Man (9200 years)

Debert, Nova Scotia (10,600 years)

Conflicts with some literal interpretations of the Bible

(Uranium decay chain activity)