

## More on Isotopic Analysis of Teeth and Bones

**C**harles Day's story "Isotopic Analysis of Teeth and Bones Solves a Mesoamerican Mystery" in the January 2004 issue of *PHYSICS TODAY* (page 20), in which he mentioned the work of Lori Wright of Texas A&M University, was a delight to read. However, the explanation given of the oxygen-18 and deuterium concentrations in the precipitation is erroneous. That variation is entirely due to isotopic fractionation during the molecular exchange between the seawater, atmospheric water vapor, and precipitation, and not to the increased weight of the rain droplets because of their higher isotopic content.<sup>1</sup>

A rain droplet's readiness to fall and its fall velocity are not controlled by the density of the droplet, but by its size. Also, the ratio of  $^{18}\text{O}$  to  $^{16}\text{O}$  in the water droplets is always less than, not the same as, that of the seawater where the water vapor originates. This is mostly because during evaporation, the isotopic fractionation occurs under nonequilibrium conditions in which relative humidity is less than 100%; the condensation of the water in clouds occurs under the equilibrium conditions, with relative humidity of 100%. Isotopic fractionation under nonequilibrium conditions, which prevail during evaporation, is significantly larger than the equilibrium fractionation that occurs during condensation. Over oceanic islands and coastal locations, average  $^{18}\text{O}$  to  $^{16}\text{O}$  ratios in precipitation are consistently lower than Standard Mean Ocean Water (SMOW), which approximates the mean isotopic composition of the world's oceans.<sup>2</sup>

The stable isotope variations in water in the area discussed in the story must be mainly due to the so-called altitude effect, since that region has significant altitude variations. The altitude effect is the result of continuous isotopic depletion of the atmospheric water vapor as it rises over the slopes of the mountains and heavy isotopes are preferentially removed by precipitation.

### References

1. W. Dansgaard, *Tellus* **16**, 436 (1964).
2. International Atomic Energy Agency, *Statistical Treatment of Environmental Isotope Data in Precipitation*, technical rep. no. 206, International Atomic Energy Agency, Vienna (1981).

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**Wright comments:** Many thanks to Turgut Dincer for his comments and corrections on Charles Day's article, which reported our work on strontium and oxygen isotopes in ancient Maya skeletons. Dincer is correct; the paragraph describing oxygen isotopes in rainfall was poorly stated. In communications with Day, I suspect that I described the changes in the oxygen isotope ratio of rain across the Maya area in exactly the same manner as Dincer did in his final sentence. The

patterns we see are a function of elevation, relative humidity, and the path of rainstorms across the landscape. Unfortunately, I did not catch this inaccuracy in a quick prepress reading of the article. Nonetheless, Dincer's correction does not change in any way our interpretations of the data nor the implications of our work for Maya prehistory.

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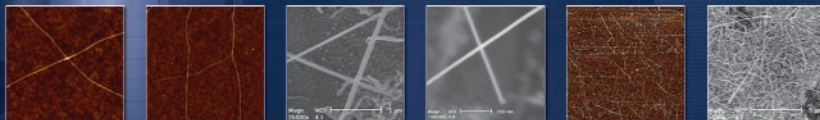
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