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Physics fills the gap for java man

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interrupting. Condon greeted him with "Join the fun, we're just shooting the breeze. What's on your mind?" The same article was bothering the senior. As Condon erased the board, he asked, "Are you taking advanced calculus?" The student said he was, and Condon explained the article in advanced calculus.

The next visitor was Fred Seitz, at the time an advanced graduate student, who was puzzled by the same article. Condon again went to the board and explained the article in math I didn't know. These three explanations spanned 45 minutes. I was privileged to study under many brilliant people, but Condon was the only one who could, without a shadow of a doubt, teach calculus to a six-year-old.

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Physics Fills the Gap for Java Man

Ervan Garrison wrote a very thoughtful article that brings the field of archaeology to the attention of physicists (PHYSICS TODAY, October 2001, page 32). Certainly both fields could benefit from more interactions. Garrison covered a lot of material in a short article, and so couldn't be thorough with every subject. I noticed some important omissions, and would like to point out that the field of radioisotopic dating is far more advanced than his article suggests.

Contrary to Garrison's suggestion, radiocarbon dating is not the only discovery to truly revolutionize archaeology or archaeological dating. Accelerator mass spectrometry,[1] which was covered in the Garrison article (see also the article by Richard A. Muller in PHYSICS TODAY, February 1979, page 23), increased the sensitivity of carbon-14 methods by a factor of 1000, enabling their use on much smaller samples. The invention of potassium-40/argon-40 dating (and its modern equivalent, $^{40}Ar/^{39}Ar$) was equally important for the field of archaeology and, as Garrison mentioned, has enabled us to date most hominid remains. The $^{40}Ar/^{39}Ar$ method has also been used to help determine the provenance of building stones, such as those in ancient Rome.[2]

Garrison suggests that there is an age "gap" from 0.05 Ma (million years ago) to 0.5 Ma between the effective age ranges covered by radiocarbon and ^{40}K-decay dating methods. This is false. While 0.05 Ma is the approximate range to which radiocarbon dating can be used, the $^{40}Ar/^{39}Ar$ method is being used all the way down to the historical realm, where it has been used to date the 79 AD (that is, 0.002 Ma) Mount Vesuvius eruption.[3] Thus, the lower limit of 0.5 Ma for $^{40}K/^{40}Ar$ dating mentioned by Garrison is incorrect, and the gap does not exist. Additionally, uranium-series decay methods are also ideally suited for dating materials of this gap age, including volcanic rocks, soil carbonate, and animal teeth.

Garrison points out that other dating methods have been used to date materials of the gap age. While it is true that other methods (thermoluminescence, optical-stimulated luminescence, and electron-spin resonance) are being used to date certain types of samples of that age (and, in many cases, samples that cannot be dated by radioisotopic means), the uncertainties associated with those methods (10% suggested by Garrison) are significantly larger than those associated with radioisotopic dating techniques (routinely 1–2%

error) when applied to materials of the same age. Thus, if given the choice, no one in the dating business would choose one of those other dating techniques over radioisotopes.

As a final note, Carl Swisher was not at the University of California. The $^{40}Ar/^{39}Ar$ laboratory where he worked on dating Java Man is the Berkeley Geochronology Center, a nonprofit research institute that is not a part of the University of California. The center and its benefactors deserve much of the credit for the dating of Java Man.

References

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GARRISON REPLIES: I hope I did not say there *is* a "gap" in our ability to date the late to mid-Pleistocene. I hoped to imply that there *was* a real gap, in the recent past, that I estimated to be about 500 ka—a singularly awkward time interval, since it is when the real evolution of anatomically modern humans (AMH) occurred. The present-day suite of dating techniques—uranium disequilibrium series; thermoluminescence (TL) and optical-stimulated luminescence; electron-spin resonance; and fission track—together with radiocarbon and argon/argon, now offer archaeologists a range of methods mostly unavailable or "unrecognized" before the last quarter of the 20th century.

I disagree with Karner on the revolutionary role of accelerator mass spectrometry–radiocarbon. AMS is sensitive to parts per quadrillion levels, but that still will not get us dates beyond the 50-ka limit, even with smaller samples. It is certainly a boon in limiting the destruction of rare and important archaeological specimens. AMS did give us the 24-ka age of the Neanderthal child found on the Iberian Peninsula, which raised issues of genetic mixing of AMH and Neanderthal.[1] New AMS dates for AMH and Neanderthal remains found at the Balkan sites of Hrvatsko Zajorje, Velika Pecina, and Vindija G1[2] raise the same issues in Europe proper for the same period.

As to uncertainties in TL ages, a recent study[3] has produced a remarkable correspondence between TL dates and tree-ring results—40% (6 of 15) from the same-site context. Likewise, three of the remaining samples were seen to be correspondent by use of bridging arguments for the dendrochronological data. Not bad.

As to Carl Swisher's professional attribution, I can only repeat what I read in the journals. Proper credit is due any benefactors responsible for dating, or redating, Java Man. No slight was intended.

References

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Correction

January 2002, page 67—The photograph identified as that of MacArthur Fellow Brooks Pate actually showed another MacArthur Fellow. ■