What date is it? Should there be an agreed datum for luminescence ages?

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Introduction

Wolfe (2007) recently highlighted the lack of an agreed common datum for most Quaternary chronological methods, and this was a topic also taken up by Grün (2008). The problem is that for many chronological methods, the value that is determined is the number of years that have passed between the event that is being dated and when the sample was collected, or when it was measured. Under such a system, an event in the past inevitably becomes further distant in time as time progresses. The eruption of Mt Pinatubo in the Philippines occurred in AD 1991, which today (AD 2011) means that it occurred 20 years ago. In the year AD2020 the event would have an age of 29 years ago.

At present only radiocarbon dating has an agreed system for quoting ages that is not affected by this. As agreed by the International Radiocarbon Conference all ages are quoted as ^{14}C years BP (before present), where the present is defined as AD 1950 (van der Plicht and Hogg 2006). The situation in radiocarbon dating is made more complex by the need to calibrate ages to overcome the effects of changes in the production of radiocarbon and its distribution between the different carbon reservoirs. However, this does not alter the situation that this method alone has defined a datum for its results, avoiding ambiguity when quoting ages.

Quaternary dating methods which do not have an agreed datum, including luminescence, normally solve the problem in one of two ways. The most common is that when ages are published, the year of measurement is quoted, and ages are given relative to that year. For instance Bristow et al. (2007) quoted ages (e.g. 34 ± 7 a) for recent samples from linear dunes in the Namib Sand Sea relative to AD 2004 when the ages were calculated. The second approach is to convert ages as given above to the Christian calendar and use AD (anno domini) and BC (before Christ). Thus the age of 34 ± 7 a measured in AD 2004 given above would equate to a date of AD1970 ± 7 a or AD1963 - 1977.

However, all of these alternatives have problems. Quoting ages relative to an age quoted in a table is scientifically accurate and leaves no uncertainty, but two issues arise. The first is that if the same event were dated at some different time, say 20 years earlier (in AD 1984) or 20 years later (in AD 2024) then different ages would be obtained (14 ± 7 a and 54 ± 7 a), yet in fact all these different age estimates are giving exactly the same estimate of when this event occurred. This is confusing, but not incorrect. The second issue can also be illustrated with this example. If at some stage all the ages for this event are collated then there is a risk that the person undertaking the summary will fail to take into account the different dates used for the datum of each analysis, or that in their summary table the year in which the ages were measured will not be included. The recent compilation of ages in the Namib Sand Sea digital database is such an example where ages have been compiled (Livingstone et al., 2010).

Quoting ages using AD or BC avoids this problem by using the datum of 1 BC / 1 AD. This solution enables ages to be quoted accurately and with no ambiguity. However, two potential difficulties arise here. The first is a simple numerical one. The construction of the timescale using AD and BC means that the numerical value arising increases both since the datum of 1 AD and prior to the datum. Thus one has both AD 100 and BC 100 (positive numerical values) even though one event is prior to the datum and one postdates it. The second is that geomorphologists and Quaternary scientists do not tend to work in AD and BC.

Luminescence is not unique among Quaternary geochronological methods in facing this problem. However, because of the age range now covered by luminescence, from hundreds of thousands of years to decades or even years (e.g. Madsen and Murray, 2009; Rink and Lopez, 2010; Rustomji and Pietsch, 2007; Wolf and Hugenholtz, 2009), the luminescence community is uniquely affected by the issue.

Additionally, with the growth of luminescence in recent decades, it is probably the second most widely used Quaternary radiometric method after radiocarbon.

Alternatives

I suggest that we have a number of alternatives when facing this issue:

1) The status quo.

Retain the practise of quoting luminescence ages along with the year in which they were measured, and thus leaving users to convert these into years AD or BC, or to compensate for differences between ages obtained in different years.

2) Adopt a datum of AD 1950 and use the term BP.

The use of the term BP (before present) has historically been specifically reserved for use with radiocarbon dates. Radiocarbon dates are often quoted in radiocarbon years before present (^{14}C yrs BP) and since the Libby half-life is used for such calculations, ^{14}C years are not equivalent to calendar years. Luminescence dates are calculated in calendar years and so adopting this term for luminescence would cause confusion.

3) Adopt a datum of AD 1950 and use an alternative term instead of BP.

Given the widespread use of 1950 as a datum by radiocarbon, this would provide a useful point of comparison. Once radiocarbon ages are calibrated into calendar years then ages from both methods should be directly comparable. An alternative term to BP would be required (for the reasons stated above).

4) Adopt a datum of AD 2000 and use the term b2k.

An alternative datum would be the year AD 2000. The use of a different datum and a different term (b2k instead of BP) would help to avoid confusion between uncalibrated radiocarbon dates and those from other methods which are not affected by the same issues of calibration due to changes in the production of radiocarbon. The term b2k (before 2000 AD) is one which is now being used increasingly by other dating methods (e.g. Walker et al., 2009).

I would strongly suggest that option 2 is not appropriate. The term BP has a very specific scientific meaning that is relevant to radiocarbon dating, but cannot be transferred to other methods. I would also suggest that option 3 would lead to confusion. One implication of adopting either option 3 or 4 above is that we will rapidly start to produce ages that are quoted as negative ages. For instance, if we were to adopt AD 2000 as the datum then an age of 7±2 a produced in AD 2010 would be presented as -3 ± 2 a b2k. At first sight this appears awkward since we are dating an event which is in the past, but it is quoted as a negative age because the event occurred after our datum. Such a situation is inevitable if we choose to adopt a datum.

What should happen next?

This is a decision that needs to be discussed by as wide a community as possible, and then an agreed decision made. A good venue for such an agreement would be at the International Luminescence and Electron Spin Resonance dating conference which is held once every three years. The next conference will be in Poland in July 2011, and I would suggest that this issue be discussed in open forum at that time for the community to come to a decision upon, and potentially to vote upon if the community felt that this was appropriate. For those colleagues who are unable to attend the meeting in Poland I would ask them to write to me, or to ask colleagues to present their views at that meeting.

Once a decision has been made then it should be disseminated as widely as possible amongst the luminescence community and the wider geomorphological, Quaternary and archaeological communities to ensure that it is used as widely as possible. This could be done through the special issues associated with the LED 2011 conference, and by writing to editors of key journals in the field.

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Reviewer
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