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APPLICABILITY OF 'NEW TECHNOLOGY' SCINTILLATION COUNTERS (PACKARD 2000 CA/LL AND 2260 XL) for ^{14}C DATING

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ABSTRACT. The results of this study indicate that scintillation counters employing burst-counting circuitry are capable of producing accurate age measurements. Replicate analyses confirm the validity of the minimum error of 50-60 years quoted on routine age measurements carried out at this laboratory.

INTRODUCTION

We have conducted in this laboratory during the past two years a great deal of research into the use of the Packard range of counters employing burst-counting circuitry, with particular emphasis on their applicability to ^{14}C dating (Cook, Harkness & Anderson 1989; Cook *et al* 1989, 1990). The results of these studies have demonstrated how it is possible to maximize efficiency and stability of counting conditions by careful optimization of the scintillation cocktail. Nevertheless, the ultimate criterion for assessing the counters' applicability for ^{14}C dating must be the production of accurate and precise age measurements. To formally assess this, we undertook a number of replicate analyses on a large sample of oak known to have an age in excess of 5000 BP. This allowed us to assess the precision on replicate analyses and relate this to the quoted minimum error on routine measurements. We synthesized sufficient benzene to measure 4.5g in an 'old technology' counter (Packard 4530) and 2g in the Packard 2000 CA/LL and 2260 XL (new technology). Results of the recently completed International Collaborative Study (Scott *et al* 1990) demonstrated no systematic laboratory bias from measurements made on the Packard 4530. Thus, we could compare with a system of proven accuracy.

EXPERIMENTAL

A large section of oak constituting ca 100 years' growth was finely chopped and subjected to alternate acid and alkali extractions followed by bleaching with hypochlorite solution to produce cellulose. The cellulose was then further ground, thoroughly mixed and split into several sub-samples of sufficient size to synthesize ca 7g of benzene. We vialed 4.5g of the benzene into 20ml glass-sealable low-potassium borosilicate ampules, using butyl-PBD bis-MSB in toluene as the scintillation cocktail (Stenhouse & Baxter 1983). This technique is not used in either the 2000 CA/LL or 2260 XL. Instead, a cocktail consisting of butyl-PBD/bis-MSB dissolved in benzene is weighed into standard 7ml low-potassium screw-cap vials. The benzene is then removed by freeze drying. Sufficient cocktail is added to make the ultimate ratio of fluors/sample benzene 2.8mg butyl-PBD and 3.0mg bis-MSB/g of benzene. We made this modification to eliminate possible variations in dissolved oxygen in the samples from the sealing process on 7ml ampules, which could influence the pulse-shape analysis and lead to variations in counting efficiency (Cook *et al* 1989).

We synthesized seven replicate samples of the cellulose to benzene. We then counted the 4.5g samples solely in the Packard 4530 (2400 min) while the 2g samples were counted first in the Packard 2260 XL (2500 min) and then in the Packard 2000 CA/LL (2500 min).

RESULTS

The results in Table 1 indicate no significant differences between the weighted means of the seven age measurements ± 1 standard deviation (σ). Indeed, those of the Packard 2000CA/LL and 2260 XL are identical (5519 ± 23 BP) whereas that of the Packard 4530 is highly comparable (5507 ± 20 BP). Similarly, when one estimates a simple mean on the 7 measurements for each counter, only 6 years separate the 3 counters under study. Further, the standard deviations are quite consistent with the error on an individual measurement. For the Packard 4530, the standard deviation is slightly higher (56 years, *cf* ca 46); for the 2000 CA/LL, it is somewhat lower (37 *cf* ca 60) and for the 2260 XL, they are virtually identical (57 *cf* ca 60).

TABLE 1
Estimation of replicate error and intercomparison of old technology (Packard 4530) and new technology (Packard 2000 CA/LL and 2260 XL) scintillation counters

Replicate no.	Conventional ages BP Packard 4530	Packard 2000 CA/LL	Packard 2260 XL
1	5489 ± 48	5469 ± 67	5469 ± 67
2	5500 ± 49	5525 ± 62	5581 ± 59
3	5630 ± 52	5562 ± 58	5495 ± 59
4	5486 ± 47	5531 ± 52	5521 ± 61
5	5477 ± 46	5463 ± 60	5586 ± 62
6	5468 ± 39	5525 ± 60	5430 ± 60
7	5536 ± 43	5543 ± 64	5541 ± 55
Mean ± 1σ	5512 ± 56	5517 ± 37	5518 ± 57
Weighted mean ± 1σ	5507 ± 20	5519 ± 23	5519 ± 23

CONCLUSIONS

We conclude from the results presented here that the new Packard scintillation counters employing burst-counting circuitry are capable of producing accurate age measurements. The results were entirely consistent with those from a Packard 4530, which was successfully used in the recent International Collaborative Study (Scott *et al* 1990). Further, the results are consistent with a minimum error of 50-60 years generally quoted on routine age measurements.

We stress, however, that the performance of this type of new technology scintillation counter can vary according to the scintillation cocktail employed. The one used in this study was selected only after exhaustive research.

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