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LUMINESCENCE DATING: ITS CONTRIBUTION TO THE CHRONOLOGY OF NEANDERTHAL EVOLUTION AND EXTINCTION

by

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Of the two techniques concerned thermoluminescence (TL) is now well-established but optically-stimulated luminescence (OSL) is still at the research stage, though with high potential for making an important contribution; alternatively the OSL technique is called Optical Dating following the terminology of its originators (HUNTLEY, GODFREY-SMITH and THEWALT, 1985).

The principal contribution so far made by TL in the palaeolithic has been through the dating of burnt flint. This has been the work of Joan Huxtable at Oxford, Hélène Valladas at Gif-sur-Yvette, and Sheridan Browman at the British Museum. The work of Valladas has been particularly important in the present context since she has concentrated on the Mousterian of SW France; in particular she has dated the various levels of Le Moustier obtaining ages ranging from 56 to 40 ka (VALLADAS *et al.*, 1986). At another site, Vigne Brun, she was able to make comparative dating of burnt flint and burnt quartz (VALLADAS and VALLADAS, 1987); since the latter is well-established as a reliable TL dating material the satisfactory agreement found is confirmation of the validity of flint dates, already predicted from that material's intrinsic properties. Bowman has reported dates for the Lower and Middle Palaeolithic levels of Combe Grenal (BOWMAN and SIEVEKING, 1983). The youngest is 44 ka and the oldest 113 ka. Huxtable has produced upward of a dozen dates spanning the range 10-300 ka as reported in AITKEN, HUXTABLE and DEBENHAM (1986).

These published dates represent only the beginning of a new era in the dating of the period concerned and many more are already in process. Along with electron spin resonance (ESR) and uranium-series dating they represent a new dimension because they are essentially a 'physicist's view' of palaeolithic chronology and quite independent of other interpretations of the sites. Hence the generally good agreement with expectations from chrono-stratigraphic studies enhances the confidence to be placed on either system.

Of course there are limitations. The principal one is the need to make a reliable evaluation of the gamma dose-rate from the burial soil. This requires that the burnt flint must have been surrounded by soil to a distance of 30 cm for the major part of the burial period; this is liable to rule out open air sites. Another serious limitation is that the flint must be well burnt; it must also be large enough – at least 10 mm thick and 30 mm across.

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There is the same dependence on gamma contribution in the case of stalagmitic calcite and in general the stratigraphic complexity in which stalagmitic material is found makes calcite dating rather difficult. An exception is calcite fragments which have fallen off the ceiling of a cave and become buried in a thick layer of occupation sediment (as at Abri Vaufrey – see AITKEN and BUSSELL, 1982). At the Oxford Laboratory we have also applied calcite dating to the cave sites of Pontnewydd and Tautavel, as reported by DEBENHAM and AITKEN (1984).

SEDIMENT DATING

The application by DEBENHAM (1985) of the fine-grain TL technique to loess deposits from NW Europe indicates a limitation to 100 ka, with growing uncertainty once 50 ka is exceeded (DEBENHAM, 1985). However there are growing indications from other workers that use of coarse grain feldspar and possibly also quartz, will relieve these limitations; hence it is to be expected that sediment dating whether by TL or OSL will be making a strong contribution to the chronology of the period in question. The advantage of OSL over TL is that the OSL signal is primarily from light-sensitive traps and hence the setting to zero of the signal at the time of sediment deposition requires less exposure to sunlight. Thus it is to be expected that other types of sediment besides loess (e.g. riverborne) will be datable. In the first place quartz grains are being used.

ZIRCON DATING

With all the dating materials so far discussed the accuracy attainable is limited (to around ± 5 %) by uncertainty about the average humidity of the surrounding soil during the burial period; this is because of attenuation of the gamma contribution by the amount of water present, which of course depends on the climate. However within most sediment there are grains of zircon. Because of the high internal radioactivity of this mineral the gamma contribution to the annual dose is comparatively unimportant; hence the date is largely independent of climatic uncertainty (and also of geochemical disturbances too). This mineral is easily bleached and therefore it is to be expected that it will have an important role in sediment dating. Technical problems of measurement, due to zoning and anomalous fading, have now been largely solved (TEMPLER, 1986) and the prospects for its utilization, whether for TL or OSL are good.

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