is further subdivided into two major genes which seem to be structurally and functionally similar to the *Ubx* gene.

Study of the abdominal region is hampered by the limited diversification between abdominal segments; segments A2 to A6 of the adult female are so similar that transformation of one to another would probably go undetected in a standard screen for mutants. Whereas dominant 'gain-of-function' mutations of abdominal genes have been recognized by their ability, for example, to transform the last thoracic segment to an abdominal segment or cause a male-specific A5 pigmentation pattern in A4, and some 'loss-of-function' mutations have been induced by reverting these dominant mutations, the *iab* genes have in large part remained hypothetical. Morata and co-workers have circumvented the problem of identifying abdominal mutants by employing a screening protocol that allows recognition of mutations in the ultrabithorax complex solely on the basis of their lethality (non-lethal mutations causing an easily-visible phenotype can also be picked). Whilst this may seem an obvious expedient, it is worth remembering that none of the *Ubx* subfunctions mutate to lethality and so the method is not guaranteed to identify all elements of the complex. Nor indeed have Morata and collaborators succeeded in isolating mutations corresponding to each postulated *iab* locus. But they have been able to identify two major genes, designated *abdominal-A* (*abd-A*) and *Abdominal-B* (*Abd-B*), which together control the development of all segments posterior to the *Ubx* domain. In both cases, and like the *Ubx* domain, the realms of action of these genes extend over more than one segment.

Moreover, the *abd-A* domain begins not at a segment border but rather at the boundary between anterior and posterior compartments in segment A1 (where the *Ubx* domain ends[13]) thus confirming that bithorax complex genes act on compartmental rather than segmental units[13,14]. Mutations in *Abd-B* affect the development of segments A5 to A8 but have no effect on more anterior segments; the *Abd-B* gene therefore subsumes the functions previously attributed to the *iab-5,6,7* and *8* genes. Similarly, *abd-A* apparently subsumes the functions of *iab-2,3* and *4* since *abd-A* mutations transform segments A2, A3 and A4 to A1. This is demonstrable in the case of *iab-2* because a mutant allele of this gene already exists[15]. As expected, in *iab-2/abd-A* animals, segment A2 is transformed to A1 whilst A3 and A4 are unaffected. Thus *iab-2* appears to represent a sub-function of the *abd-A* gene, in a way comparable to the relation between *bx* and *Ubx*. The analogy will be considerably strengthened if mutations in the elusive *iab-3* and *iab-4* genes also turn out to be allelic to *abd-A*.

The results of this study have considerable significance for the future analysis of the bithorax complex. They provide the comprehensive description of the structural and functional organization of the abdominal genes that will be essential to a full understanding of the region at the molecular level. One obvious inference is that the abdominal region contains two further major transcription units, each analogous to the *Ubx* unit. This prediction had been foreshadowed by the mapping of two homoeo boxes within the complex but distal to *Ubx*[1,4]. Whether the transcripts deriving from the *abd* genes are modulated in different compartments by *iab* analogues of the *bxd* unit remains an open question. The coming months should prove to be as exciting and revealing as the past year has been. □

1. Mc Ginnis, W. *et al. Nature* **308**, 428 (1984).
2. Scott, M.P. & Weiner, A.J. *Proc. natn. Acad. Sci. U.S.A.* **81**, 415 (1984).
3. Sánchez-Herrero, E. Vernos, I., Marco, R. & Morata, G. *Nature* **313**, 108 (1985).
4. North, G. *Nature News and Views* **311**, 214 (1984).
5. Lewis, E.B. *Am. Zool.* **3**, 33 (1963).
6. Lewis, E.B. *Nature* **276**, 565 (1978).
7. Lewis, E.B. in *Developmental Biology Using Purified Genes* (eds Brown, D.D. & Fox, C.F.) 189 (Academic, New York, 1981).
8. Lewis, E.B. in *Embryonic Development : Genes and Cells* (ed. Burger, M.) 269 (Liss, New York, 1982).
9. Bender, W. *et al. Science* **221**, 23 (1983).
10. Garcia-Bellido, A., Ripoll, P. & Morata, G. *Nature* **245**, 251 (1973).
11. Akam, M.E. *EMBO J.* **2**, 2075 (1983).
12. Ingham, P.W. *Cell* **37**, 815 (1984).
13. Struhl, G. *Nature* **308**, 454 (1984).
14. Hayes, P.H., Sato, T. and Denell, R.E. *Proc. natn. Acad. Sci. U.S.A.* **81**, 545 (1984).
15. Kuhn, D.T., Woods, D.F. & Cook, J.L. *Mol. gen. Genet.* **181**, 82 (1981).

Phil Ingham is at the Imperial Cancer Research Fund Laboratories, London NW7 1AD, UK.

Dating techniques

Lighting up the past with lasers

from Ann G. Wintle

THE same basic property of common minerals, such as quartz and feldspar, that enables pottery and sediments to be dated by thermoluminescence has now been exploited in a new optical dating method, described by D.J. Huntley, D.I. Godfrey-Smith and M.L.W. Thewalt on page 105 of this issue. The build up of electrons trapped at defects in crystals of the minerals when they are exposed to ionizing radiation is the basis of both techniques. Provided that the electrons already trapped in the minerals had been removed in the firing of pottery or the deposition of sediment, then the electrons accumulated thereafter and experimentally untrapped by thermal or optical means will provide a measure of the sample's age.

The new optical-dating method has been applied to quartz grains from several sedimentary environments. The trapped electrons which have built up in the grains since they were last exposed to light at deposition are optically excited from their traps by the 514.5 nm beam from an argon-ion laser. A portion of these electrons recombine within the crystals and produce luminescence. The emission spectra of naturally-occurring quartzes are complex and vary with temperature, the origin of the samples and their previous exposure to radiation (McKeever, S.W.S. *Rad. Protect. Dosimetry* **8**, 81; 1984). At room temperature the spectra of most samples are dominated by a broad blue emission in the region 450–470 nm. Using suitable filters both for the argon beam and in the detection system, the luminescence in this region can be detected with a high signal-to-noise ratio whilst the sample is being optically excited.

This development has come at a particularly interesting time in the application of thermoluminescence dating to sediments. In Europe, most dating has been carried out on the feldspar grains from loess thought to be less than 130,000 years old (Wintle, A.G., Shackleton, N.J. and Lautridon, J.P. *Nature* **310**, 491; 1984). But it has recently been shown that the thermoluminescence signal from feldspar is unstable, cannot be used at all for samples older than about 120,000 years (Debenham, N.C. *Nuclear Tracks*; in press) and would result in underestimating by greater than 10 per cent the age of samples that are older than 30,000 years.

This problem will result in a move to quartz as the more suitable mineral for thermoluminescence dating, despite the fact that it has a lower thermoluminescence sensitivity and is less easily bleached than feldspar. Because quartz loses its trapped electrons relatively slowly on exposure to light, there is always the worry that extended laboratory bleaching, either with a sunlamp or sunlight, may not give the correct assessment of the trapped electron population at the time of deposition. This is most likely to be true for glacial melt-water sands or river sediments. If the laboratory bleach is too long, then the signal obtained by thermoluminescence measurements will be too large and result in an over-estimate of age.

The new optical dating method avoids this problem, because the signal observed immediately after exposure to the laser beam is that from the most light-sensitive electron traps, which would also have been the first to be emptied at the time of deposition. These electron traps appear to be much more light sensitive than those on which thermoluminescence measurements depend; a ten-second exposure to sunlight severely depletes them of electrons. The new method should therefore be a means of dating water-lain deposits and glacial sediments, which are likely to have had only a short exposure to light. □

Ann G. Wintle is at the Godwin Laboratory, Sub-department of Quarternary Research, University of Cambridge, CB2 3RS, UK.