If indeed *Notch* does encode mitochondrial enzymes, then one factor affecting the determination of neuroblasts in insects may prove to be a critical balance in some metabolic state of the ectodermal cells. Most of the seven 'neurogenic loci' might then be genes whose products affect this balance. It is perhaps relevant that efforts to find the 'real' neural inductor in amphibians led to the conclusion that the ectoderm is finely balanced between epidermal and neural differentiation, and that many non-physiological stimuli could provide the trigger for neural induction[19].

If however, the products of the 'neurogenic genes' do encode such housekeeping products as flavoprotein enzymes, why is it that so many tissues of the *Drosophila* embryo differentiate apparently normally in their absence?

Whether or not the *Notch* gene makes an 'interesting' product, it is interesting to study the effects of mutation on this complex transcription unit. And lurking among the set of neurogenic loci that Campos-Ortega has identified, there may yet be a selector gene which monitors the state or position of each ectodermal cell, and mediates its developmental commitment. It remains to be seen whether the genetic and molecular analysis of these genes will elucidate their role in neurogenesis. ☐

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1. Artavanis-Tsakonas, S., Muscavitch, M.A.T. & Yedvobnick, B. *Proc. natn. Acad. Sci. U.S.A.* **80,** 1977 (1983).
2. Kidd, S., Lockett, T.J. & Young, M.W. *Cell* **34,** 421 (1983).
3. Artavanis-Tsakonas, S. *et al. Developmental Genetics* (in the press).
4. Poulson, D.F. *Am. Nat.* **79,** 340 (1945).
5. Wright, T.R.F. *Adv. Genet.* **15,** 261 (1970).
6. Jimenez, F. & Campos-Ortega, J.A. *Wilhelm Roux Arch.* **191,** 191 (1982).
7. Lehmann, R., Jimenez, F., Dietrich, U. & Campos-Ortega, J.A. *Whilhelm Roux Arch.* **192,** 62 (1983).
8. Welshons, W.J. *Science* **150,** 1122 (1965).
9. Welshons, W.J. *Genetics* **76,** 775 (1974).
10. Schellenbarger, D.L. & Mohler, J.D. *Genetics* **81,** 143 (1978).
11. Keppy, D.O. & Welshons, W.J. *Chromosoma* **76,** 191 (1980).
12. Foster, G.G. *Genetics* **81,** 99 (1975).
13. North, G. *Nature* **303,** 134 (1983).
14. Thorig, G.E.W., Heinstra, P.W.H. & Scharloo, W. *Mol. Gen. Genet.* **182,** 31 (1981).
15. Thorig, G.E.W., Heinstra, P.W.H. & Scharloo, W. *Genetics* **99,** 65 (1981).
16. Segraves, W.A., Louis, C., Schedl, P., & Jarry, B.P. *Mol. Gen. Genet* **189,** 34 (1983).
17. Lehman, R., Dietrich, U., Jimenez, F. & Campos-Ortega, J.A. *Wilhelm Roux Arch.* **190,** 226 (1981).
18. Campos-Ortega, J.A. *Wilhelm Roux Arch.* **192,** 317 (1983).
19. Slacke, J.M.W. *From egg to embryo* Ch.3. (Cambridge University Press).

Geochemistry

Chemical inhomogeneity of mantle above 670 km transition

from Don L. Anderson

WHAT chemical composition the mantle has and on what scale mantle convection takes place are related questions which require data from both seismology and petrology to answer. The mantle, which represents about 68 per cent of the Earth's mass, is usually considered, especially by petrologists, to be mostly homogeneous in composition. Discontinuities within it are generally assumed to represent isochemical phase changes in an olivine-rich material rather than chemical boundaries. Thus, the 400 km and 670 km boundaries detected by seismic means are taken to represent the 'olivine-spinel' and 'spinel-post-spinel' phase changes, respectively. The 670 km discontinuity is the more significant, for seismic velocities increase greatly at this depth. This boundary must be very sharp as it is both a good reflector of short-period seismic waves and is the lower boundary of earthquake activity — no reliably-located earthquake has ever been found below it. These observations can be used to argue that the '670' is a chemical interface that provides a barrier to convection.

A.C. Lees, M.S.T. Bukowinski and R. Jeanloz (*J. geophys. Res.* **88**, 8145; 1983) have recently computed the reflection coefficient for a variety of plausible phase changes and conclude that mineralogical and seismic data are compatible with a two-layered mantle that has a discontinuous change in both phase and composition at 670 km, and that the change in material properties must occur over a region less than 3 km thick. Phase changes are typically spread out over a much greater depth interval and give reflection coefficients more than an order of magnitude less than those observed. This conclusion is not new but it serves to keep up the pressure on those who advocate that the mantle is chemically uniform and is involved in convection as a whole. Although the nature of the 670 km discontinuity is important, Lees and colleagues' results may produce a yet more significant conclusion.

They calculate the velocity in the transition region for olivine, for orthopyroxene and olivine and for garnet mineral assemblages, including the effects of phase changes. The velocities in all these minerals and assemblages are much greater than the seismic velocities in the transition region and there is no similarity in shape or depth between the mineralogical models and the 400 and 670 km mantle discontinuities. Taken at face value, these results would seem to rule out peridotite, pyrolite or any olivine-orthopyroxene rich assemblage for the 400–670 km depth interval and the olivine-spinel-post-spinel explanations for mantle discontinuities. Although the temperature and temperature gradient can be adjusted to give a fair match of olivine-rich aggregate densities with the seismically-determined density. the much more accurately determined velocities are poorly matched. The velocity and density gradients of the transition region are greater than calculated for the peridotite minerals. A spread-out phase change or a compositional gradient is implied.

Lees and colleagues do not pursue these discrepancies in the region above 650 km. They restrict themselves to conventional mineralogies involving $(Mg,Fe)_2SiO_4$, $(Mg,Fe)SiO_3$ and $(Mg,Fe)_3Al_2Si_3O_{12}$. They assume that the MgO, FeO and SiO_2 contents of mantle silicates control the physical properties and the locations of phase boundaries, but, as usual, the effects of CaO, Al_2O_3 and Na_2O are ignored. These are minor components of peridotite and pyrolite minerals, the presumed dominant minerals of the mantle. Eclogite, an alternative mineralogy for the transition region, is dominantly clinopyroxene (diopside and jadeite) and garnet, transforming gradually to garnetite (CaO–Al_2O_3–Na_2O-rich garnet solid solution) over the pressure interval of the transition region. Unfortunately, velocities in an eclogite transition region, including phase changes, are not treated, in spite of the obvious discrepancies with the peridotite minerals.

The idea of a peridotite mantle dominated by olivine is deeply entrenched in geology. Olivine and ortho-pyroxene are dominant minerals in xenoliths brought to the surface in alkali basalts and kimberlites and in upthrusted segments of the mantle exposed in fold belts and oceanic fracture zones. The most abundant rocks emerging from the mantle, however, are basalts. At high pressure, these rocks are composed mainly of garnet and clinopyroxene — they are eclogites. At one time it was thought that the upper mantle and the source region of basalts were primarily eclogite. More recently, it has been assumed that the basalt-eclogite fraction of the mantle is dispersed and is liberated by 20–30 per cent partial melting, leaving behind a refractory olivine-orthopyroxene-rich residue. The fact that olivine-orthopyroxene aggregates cannot explain the 400 and 670 km discontinuities, and the velocity and velocity gradients in the transition region, will force a reexamination of the basalt source region, the chemical uniformity of the mantle, and the composition of this region of the mantle.

It is also important to look at clinopyroxene-garnet-rich assemblages. Lees *et al's* inability to match the compressional velocity is particularly significant because theirs is not an *ab initio* calculation. They used the seismic data themselves to constrain the velocity-bulk modulus ratio. Those who would argue for a chemically uniform mantle and an olivine-rich transition region are now faced with a formidable array of contrary evidence. ☐

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