Oddities in the initiation of translation

from Peter Model

A report from Kastelein, Remaut, Fiers and van Duin in this issue of *Nature* (p.35) suggests that we may need to modify some of our ideas on how translation is initiated — at least in the particular case of the lysis gene of bacteriophage MS2. Most researchers have concluded that translation is initiated independently at each gene, even in multi-gene operons. It may be that mRNA structure will occlude the initiation site at a particular place, and in such instances translation of a preceding gene may be required for effective initiation at some cistrons, but this has generally been viewed as a secondary, complicating phenomenon which obscures the otherwise fundamentally independent nature of the initiation process.

Kastelein and his colleagues now present very persuasive evidence that initiation at the lysis gene requires translation of the preceding coat gene and a shift in the reading frame of at least some of the ribosomes into the +1 frame which, in turn, leads them to terminate at an *ochre* codon three nucleotides before the initiating AUG start codon. This termination is required for translation of the lysis gene for if the *ochre* codon is removed, translation is abolished. If by suitable manipulation of the cloned gene a frame shift is introduced which forces all or most of the ribosomes into the +1 frame, initiation is enhanced. Translation of the lysis gene is strictly dependent on active translation at the coat cistron; supplying coat protein in *trans* does not replce this requirement.

These data strongly suggest that there is something special about ribosomes that have just terminated at the *ochre* codon . . . that they are in a state which facilitates initiation at sites which would not normally be translational initiators. It is not yet clear what this special property might be; it could be a special state of the ribosome, or retention of the 30S ribosomal subunit on the RNA after termination of synthesis. It has been noted previously that termination at various chain-terminating codons within genes facilitates re-initiation at specific distal sites, although here too the mechanism (s) remains undefined.

These observations would at first glance seem to run counter to recent *in vitro* results from Kaji's laboratory. Ryoji, Berland and Kaji (*Proc. natn. Acad. Sci. U.S.A.* **78**, 5973; 1981) report that when they removed the ribosome release factor from *Escherichia coli* ribosomes and then supplied an RNA containing an amber mutation as template, these release factor-depleted ribosomes synthesize two fragments of the relevant protein. One starts at the usual initiating methionine and stops at the *amber* codon, while the other starts at the codon immediately after the *amber* codon and ends at the normal C terminus of the protein. Ryoji *et al.* argue that this result excludes 'special conformation' or 'sterile pass' models of ribosome initiation following termination. They conclude that when a ribosome terminates it either dissociates completely or else starts again at the very next codon. The characterization of the products of the release factor-depleted ribosomes was careful and thorough; the question that remains is whether there is any relationship between the behaviour of these release factor-depleted ribosomes *in vitro* and the phenomenon described *in vivo* by Kastelein *et al.* Kaji and co-workers have carefully characterized an experimental system of their own design which may shed light on the mechanism of termination/initiation, but which may not be relevant to the genesis of the phenomena described by Kastelein *et al.* They propose on the basis of their rather specific *in vitro* work that there are only two possible fates for a ribosome when it reaches a stop codon: release with no special state, or retention on the mRNA, in which case it will simply start protein synthesis at the next codon. The *in vivo* studies from Van Duin's lab suggest that other possibilities are available, and have been exploited by the RNA phages. □

Peter Model is in the Rockefeller University, 1230 York Avenue, New York, NY 10021.

Magnetic messages from the Earth's core

from David Gubbins

OVER the centuries the Earth's magnetic field has shown marked changes. This 'secular' variation, known even to the early navigators, almost certainly originates in the core of the Earth and provides one of the few sources of information about the physical processes that occur there. Shorter-duration magnetic field changes can also be recorded (on a time scale of a few years) but are hard to interpret because of the difficulty of separating changes in intrinsic magnetism from the short-term influences of the Sun and the upper atmosphere. The major problem at present is how best to make use of the information provided by the secular changes.

Alldredge[1] has recently proposed a model of intrinsic field fluctuation. The fluctuation propagates up through the Earth's mantle, which is a rather poor conductor of electricity, and his model produces surprisingly sharp changes at the surface. In consequence, if we are to decipher these signals from the interior of the Earth, we must measure and study even shorter-period wavelength variations than hitherto. This important conclusion stands quite independent of Alldredge's specialized and rather arbitrary models, and it is timely coming soon after the MAGSAT mission which has provided the most complete and accurate magnetic chart we have ever had[2]. Unfortunately MAGSAT only flew for a few months, not long enough to chart the secular changes with any accuracy. At present the best data for this purpose come from permanent magnetic observatories. A second MAGSAT, flown about five years hence, would yield vastly more accurate and complete information.

The liquid core of the Earth extends out to about one-half the radius, is made mainly of iron, has a viscosity rather like water and is a better electrical conductor than copper. The mobility of this liquid causes the magnetic field to change through electromagnetic induction. The phenomenon occurs very rapidly in geological terms, the fluid moving at a rate of a few millimetres per second.

Secular change was much discussed, even in the earliest days of geophysics. Halley, like others of his time, believed the magnetic field to be due to magnetized rocks. The secular changes could not be due to motion of rocks near the surface because the required speed would be too great, so Halley proposed that the interior of the Earth was hollow, and that an inner, magnetized sphere was rotating westwards, generating the slow westward drift of the magnetic field pattern[3]. This remarkable theory came 200 years before the discovery of a liquid core by seismology. With modern ideas of a 'hot' Earth and a liquid iron core we can now deduce a value of the core radius from magnetic measurements alone[4].

The big snag is that we do not yet fully understand the dynamo theory of the origin of the magnetic field itself, and therefore there are no really satisfactory models of the field changes in the core. Alldredge uses a very common mathematical device: representation by a distribution of dipole sources. These dipoles have no physical meaning whatever, unless one wants to adhere to Halley's ideas of moving magnetized rocks and represent them by little bar magnets in the core, which is not the intention. Granted a source of field,

David Gubbins is in the Department of Earth Sciences, University of Cambridge, Cambridge CB3 0EZ.

0028-0836/82/010015-02$01.00