In conclusion, we feel that the experimental data given here and in our previous publication[1] support the "transition probability" model[6] for cell-cycle initiation, though admittedly additional variables may have to be taken into account. Discussions about the exact kinetics of cycle initiation, however, should not obliterate our main conclusion about 'start'[1], namely that it is the rate-limiting step of the yeast cell cycle.

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1 Shilo, B., Shilo, V. & Simchen, G. *Nature* **264**, 767–770 (1976).
2 Nurse, P. & Fantes, P. *Nature* **267**, 647 (1977).
3 Hartwell, L. H., Mortimer, J., Culotti J. & Culotti, M. *Genetics* **74**, 267–286 (1973).
4 Wolfner, M., Yep, D., Messenguy, F. & Fink, G. R. *J. molec. Biol.* **96**, 273–290 (1975).
5 Wheals, A. E. *Nature*. **267**, 647–648 (1977).
6 Smith, J. A. & Martin, L. *Proc. natn. Acad. Sci. U.S.A.* **70**, 1263–1267 (1973).
7 Johnston, G. C. Pringle, J. R. & Hartwell, L. H. *Expl Cell Res.* **105**, 79–98 (1977)

Fission-track dating of pumice from the KBS Tuff, East Rudolf, Kenya

HURFORD, Gleadow and Naeser[1] claim to have fission-track dating results supporting the controversial 2.61-Myr value for the age of the KBS Tuff in East Rudolph, Kenya as determined by K–Ar dating[2–4]. The fission-track age does not, however, contribute substantially to solving this controversy, particularly since the authors[1] have not drawn attention to two important points, namely the error limits of the age and the current uncertainty about the spontaneous fission constant of uranium-238.

First, the quoted error of about 3% seems unrealistically small and probably represents only precision. The authors should give also the age accuracy which is necessary for comparing different radiometric ages. Second, many fission-track specialists no longer use the 6.85×10^{-17} yr^{-1} value, but now use as the decay constant 8.46×10^{-17} yr^{-1}; there are good reasons for this preference[5]. If this higher value for the decay constant is used, the fission-track age of the pumice in the KBS tuff recalculates to 1.98 Myr, which would lend support to the K–Ar age measured by Curtis *et al.*[3]. For stratigraphic use of fission-track ages one has to be critically aware of, and draw attention to, the present uncertainty of the spontaneous fission constant of uranium-238.

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1 Hurford, A. J., Gleadow, A. J. W. & Naeser, C. W., *Nature* **263**, 738–740 (1976).
2 Fitch, F. J., Findlater, J. C., Watkins, R. T. & Miller, J. A. *Nature* **251**, 213–215 (1974).
3 Curtis, G. H., Drake, R. F., Cerling, T. E., Cerling, B. L. & Hampel, J. H. *Nature* **258**, 395–398 (1975).
4 Fitch, F. J., Hooker, P. J. & Miller, J. A., *Nature* **263**, 740–744 (1976).
5 Wagner, G. A. *et al. Geochim. cosmochim. Acta* **39**, 1279 (1975).

NAESER, HURFORD AND GLEADOW REPLY—We feel that the age we reported is a reasonable estimate for the age of the zircons separated from the pumice lumps in the KBS Tuff[1]. If our age is wrong, it is wrong for reasons other than our choice of the decay constant[2] for the spontaneous fission of ^{238}U. Two possible sources of error in this age are geologic in origin:

(1) The samples were collected in a sedimentary sequence. In this type of occurrence, contamination by detrital zircons is always possible and, in fact, is quite common. One advantage of the fission-track dating method is that the age of single crystals can be determined. A detrital zircon having an age greater than 10 Myr can easily be excluded from the population being dated. The problem occurs when the contaminating zircons are only a little older than the zircons being dated. The statistics of individual grains are such that a zircon having an age of 6 Myr would be included in the data because it cannot be reasonably separated from the rest of the population. In this case, however, five different determinations were made by three different individuals, and it seems highly unlikely that all three would choose the same relative numbers of contaminating grains. For this to happen, the detrital and pyrogenic zircons would have to be present in equal proportions, and the age of the detrital zircons could not be much greater than about 3 Myr.

(2) These zircons contained many small needle-like inclusions. Some of these could possibly have been counted as tracks, and this would result in an older age. As was true for the first source of error, this type of counting error would have to have been made by all three laboratories to the same extent.

Wagner[2] has questioned our choice of a decay constant, $\lambda_F=6.85\times10^{-17}$ yr^{-1} (ref. 3). When it is used in conjunction with the fission track glass standards of the U.S. National Bureau of Standards[4], we get the best agreement with the K–Ar ages of co-existing minerals and we use it for this reason. This agreement has been found for minerals such as zircon, apatite, and sphene, as well as natural glasses that have not suffered track annealing. Figure 1 shows the results of 34 zircon fisison-track ages plotted against the average K–Ar age of one or more minerals from the same rock. These ages are all from volcanic or subvolcanic rocks in which annealing should be absent or minimal. Alternatively we could have chosen an empirical method[5] to calculate the ages of the KBS Tuff zircons. This method is independent of λ_F and neutron-dose calibration, simply requiring a number of samples from well-dated rocks. Had we chosen this method, our results on the zircons from the KBS Tuff would have been the same.

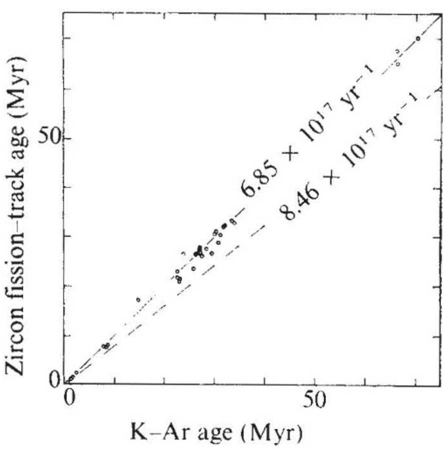

Fig. 1 Zircon fission-track ages and the average K–Ar ages of minerals from volcanic and subvolcanic rocks. λ_F values 6.85×10^{-17} yr^{-1} (solid line) and 8.46×10^{-17} yr^{-1} (broken line).

Wagner has also questioned our statistics[2]. The precision of a single fission-track age determination is not equal to that of a K–Ar age, and probably never will be, but five separate determinations can produce a mean that has a reasonably small error associated with it. The accuracy of any age can only be guessed at, in that we do not know the true age of any geologic sample. We can only strive for the best agreement with K–Ar and the other dating methods.

We therefore think that our age of 2.4 Myr is a reasonable estimate of the age of zircons separated from the pumice lumps present in the KBS Tuff. If Wagner feels that we must use $\lambda_F=8.4\times10^{-17}$ yr^{-1}, then he must show us where we have a corresponding 20% error in our method that compensates for our choice of decay constant and that will account for our close agreement with K–Ar ages.

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1 Hurford, A. J., Gleadow, A. J. W. & Naeser, C. W. *Nature* **263**, 738–740 (1976).
2 Wagner, G. A., *Nature* **267**, 649 (1977).
3 Fleischer, R. L. & Price, P. B. *Phys. Rev.* **133**, 1363 (1964).:
4 Carpenter, B. S. & Reimer, G. M., NBS Sp. Pub. 260–49 (1974).
5 Fleischer, R. L., Price, P. B. & Walker, R. M. *Nuclear Tracks in Solids* (University of California Press, Berkeley, 1975).