quencies is not unrealistic, because my experience with other geological data sets indicates that such close frequencies can occur in analyses of both observed and ideal time series. Proceeding as in my original paper but now using frequency, I still find that $< 0.1\%$ of the random sets of ordered frequencies show a correlation coefficient exceeding the value obtained by using the ordered frequencies derived from an ideal time series having a 30.1-Myr generating period, namely, r=0.9988.

Regrettably, Stigler ignores all the other important statistical evidence that favours a basic magnetic period of ~30 Myr, such as the occurrence of the highest spectral peak at this period and the basic period's robustness under various processes like truncation, data culling, and prewhitening of the record[1]. It is possible, that better tests of significance can be devised and implemented in the future.

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P. L. MCFADDEN COMMENTS—Stigler[1] claims that Stothers'[2] use of a correlation coefficient between two monotonically increasing sequences is inappropriate as a formal test for the existence of a 30-Myr period in the magnetic reversal sequence. I agree with Stigler on this point and Stothers'[3] response (regarding the number of cycles covered in a time series of fixed length) does not overcome Stigler's criticism.

Stothers[3] accepts Stigler's[1] criticism regarding his original Monte Carlo testing, but rejects Stigler's suggested remedy as impracticable. He notes that not all random time series produce the observed structure (12 high spectral peaks) and suggests that "rejection of nonconforming cases would make the test less random". Here Stothers makes a fatal mistake that has permeated the whole question of periodicities in the magnetic reversal and other records, a point that I return to below. Stothers[3] then chooses, as the basis for further Monte Carlo sampling, a process that cannot mimic the process he is (by implication) attempting to test as his null hypothesis. Thus his result is of little relevance to the problem at hand.

But the validity of this particular test is a red herring. Stothers[2] uses a filter that seeks out a particular form of structure. By applying this to the magnetic reversal record he finds a structure with a periodicity ~30 Myr. He shows that this structure is robust to truncation, prewhitening and so on. There was really no need for the 'formal' test of a periodicity that Stothers[2] attempted and that Stigler criticized.

The crucial and fundamental question that has not been addressed is "What is the source of this particular structure: has it been externally imposed upon the reversal sequence or could it have arisen merely by random processes?". To test this properly is not simple and requires the following steps.

(1) Form the null hypothesis that the structure is merely a consequence of the random process. This requires a careful and complete specification of what is meant by 'the random process'. Based on the available evidence I would suggest a gamma process with $k \sim 1.3$ (ref. 4) and with the rate λ reducing linearly from ~ 165 Myr ago to zero at ~ 120 Myr ago, and then increasing linearly from zero ~ 83 Myr ago to ~ 5 at the present time. The precise values will vary with each set of random numbers.

(2) Use a random number generator to create, through the designated random process, a set of 'pseudo-reversal sequences'. (Note that it is incorrect to take the present sequence and reorder the intervals in a random fashion — as has been done in some previous testing — because this does not mimic the process under investigation.) Apply the filter to these sequences to see if it can locate structures similar to the one observed in the actual geomagnetic reversal sequence. By similar I mean that it is not necessary to have a periodicity of 30 Myr, one should merely be identifying whether the random process can produce structures of that form.

(3) If the random process does produce such structures then, on each occasion, there will have to be some specific periodicity that appears as the 'highest spectral peak'. At this stage we must move to the working hypothesis that the actual observed reversal sequence is merely a specific realization of the random process for which the structure happens to have a periodicity of 30 Myr. The important question then becomes "how does the norm (in this case Stothers' residual index) of the observed structure compare with the norms in the pseudo sequences when the pseudo sequence has its highest spectral peak at 30 Myr?".

(4) To answer the question from (3) we must reject all those that do not have 30 Myr as their highest spectral peak and look only at the distribution of those that do. This is then the distribution conditional upon the observed structure and will lead to a properly conditioned test. This is why I stated earlier that Stothers[3] makes a fatal mistake (shared by many others) in not wanting to reject the nonconforming cases. To perform the conditional test sensibly we must obtain a large enough sample of pseudo sequences with the highest peak at 30 Myr to ensure a sensible definition of the conditional distribution: only then will we have reasonably reliable 95% or 99% confidence limits. Typically, this will require generation of a vast number of pseudo sequences, most of which will be rejected (even if one is pragmatic and accepts a range of say 29.5–30.5 as being 30), before being able to determine sensible confidence limits. This places severe constraints on the random number generator used, and, in particular, one must be careful that one is not merely cycling through a long sequence of apparently random numbers.

If the observed norm exceeds the critical value of the conditional distribution then either the structure is large enough that it must have been externally imposed, or our model for the random process must be severely wrong (either of which is very interesting). Otherwise the information contained within the reversal sequence does not of itself require any further explanation than the null hypothesis. Whatever filter[2,5–7] (including any future filters suggested) is used to isolate a structure in the sequence, a properly conditioned test must be performed before it can be claimed that explanation of the data requires an externally imposed structure. As yet no properly conditioned test has been performed and so the question of an externally imposed structure remains open.

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Optimization problems

SIR—David Bounds' article "New optimization methods from physics and biology"[1] may leave the reader with the false impression that methods based on simulated annealing, neural networks, and genetic algorithms perform significantly better than traditional optimization methods on *NP*-complete problems such as the travelling salesman problem. Although the article begins with a discussion of *NP*-complete problems, the methods described in the paper do not solve any of the problems in this class.

The travelling salesman problem serves as an example. The difficult (*NP*-complete) version of this problem is to find the optimal route traversing a set of points. A fast solution to this would be of extraordinary interest, since it would lead directly to fast solutions to many other puzzles. Unfortunately, the algorithms described in the article do not solve this problem, but rather the far easier problem of finding a near-optimal route. Conven-