Design for living

J. R. Cann £28

How to Build a Habitable Planet. By Wallace S. Broecker. *Eldigio Press, Box No. 2, Palisades, New York 10964: 1986. Pp.291. Hbk $30; pbk $18.*

IN *Nature* of 12 March 1987 Wallace Broecker described how he set about desk-top publishing, from the Lamont–Doherty Geological Observatory (Eldigio Press — got it?), to try to avoid what he sees as the stifling and unhelpful miasma of mainstream publishers. Here is the book of the article, an introduction to geology (based on Geology 1011X, Columbia/Barnard 1981–85) seen through the eyes of an isotope geochemist.

For Broecker, isotopes are the key to geology and he finds ways of approaching all sorts of problems from that angle. The book assumes little or no science background (it introduces powers of ten on p. 9, the visible spectrum on p. 13 and the Doppler shift on p. 17), and uses only the most elementary mathematics (the equation of a straight line on p. 105 is probably the limit). However, Broecker ingeniously manages to steer the reader from the Big Bang, through nucleosynthesis, planetary formation, planetary differentiation, moons, asteroids and comets, surface temperature and climate, to Earth resources. The final chapter is on man–environment interactions, especially the greenhouse effect.

It is, as you can see, a rather selective list, heavily biased towards the early stages of planetary evolution (it takes nearly half of the book before the planets are constructed, let alone differentiated), but containing a good proportion of those topics that catch the imagination of students. Most results from outside geochemistry are stated, rather than argued, so that the main intellectual content is the thread of isotopic geochemistry that connects one chapter to the next. The often rather subtle isotopic arguments are presented clearly, and build one on the other through the book.

The result is something very different from other introductions to geology for the student with limited scientific knowledge, which tend to concentrate on a specific range of the usual qualitative topics. Will it sell? Will Broecker dispose of the 2,200 copies he needs to recover his $30,000 outlay? It is a good text, well presented (but without the colour illustrations many of the big battalion of publishers seem to think necessary to attract the wilting student's attention). It is also unusual and interesting. Teachers with geochemical sympathies are likely to seek it out, rather than passively accept the latest colour-brochured offering.

In that, I think, is the answer. Conventional texts are probably best sold through conventional publishers with their excellent distribution and publicity systems for the passive purchaser. Unusual but good texts will be actively sought by people with special interests, and are the right medium for unconventional publishing. *How to Build a Habitable Planet* is a very good example of that sort of book. □

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An episode from Chicago's coldest day on record, 10 January 1982, when the temperature dropped to 26°F below zero, with a severe wind chill factor, and water from hoses playing on a burning house turned to ice almost instantaneously. The picture is reproduced from Weather *by B.W. Atkinson and Alan Gadd, a title in the new series* Earth Science Handbooks *published by Mitchell Beazley, London and Weidenfeld & Nicolson, New York. Price is £6.95, $12.95.*

Physical freedom

David Bohm £27

A Primer on Determinism. By John Earman. *Reidel: 1986. Pp.273. Dfl. 136, £42.50, $64.*

DETERMINISM has long been a key issue, not only in physics and philosophy, but also in a much broader context. It extends, for example, even to the question of whether human actions have any real freedom, in the sense of independence of the forces of nature. The subject has given rise to an unending controversy, to which there are as yet no signs of a clear resolution.

John Earman feels that what is most needed at this stage is a preliminary analysis, which at least brings out what is to be meant by determinism and describes the principal problems to which this notion has given rise. In doing this, he gives a survey of how determinism fares in various branches of physics, including classical mechanics, relativity theory (special and general), probabilistic theories, modern chaos theory and the quantum theory. He draws attention to the need to distinguish carefully between the self-determination of nature and its *predictability*, supporting his position by a careful analysis of the general notions of lawfulness and computability, on the one hand, and chaos and randomness on the other. Eventually, he comes to the conclusion that self-determination may well be compatible with unpredictability and even with randomness, provided that the motions are unstable and possess what are, in modern chaos theory, called strange attractors.

In my opinion, the most valuable feature of the book lies in its way of pointing out how complex and delicate is the question of maintaining determinism in physical theories. Even in classical, non-relativistic physics, there are a surprising number of assumptions needed to provide for determinism, beyond the acceptance of Newton's laws. Determinism is much easier to justify in special relativity, but to try to do this in general relativity raises a large number of further questions that have yet to be answered.

For the most part, the author accomplishes what he set out to do. However, I feel that the treatment of the quantum theory could have been improved. First, it is much too short to do justice to the subtlety of the questions that arise when one asks if the theory is compatible with determinism. Secondly, there is almost no discussion of the Copenhagen philosophy; this represents a novel approach to the whole question of determinism, which surely merited detailed consideration. In addition, there is no account of the causal interpretation (for a recent discussion see the article by B.J. Hiley and myself in *Physics Reports* **144**, 323–348; 1987). The causal interpretation has been shown to be capable of providing a consistent account of self-determination (as distinguished from predictability) in the non-relativistic domain, and there are arguments indicating how such an account may be extended to a relativistic context.

Nevertheless, this book makes a useful contribution to the subject as a whole. It is well worth reading, at any rate by those who are able to understand its moderately technical and mathematical language. □

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