

mechanism to make social choices". Tisdell warns: "We may all know that collectively we are heading for tragedy but individual self-interest of nations and of individuals may necessitate the tragedy to be played out". In a sensational pamphlet on doom such a sentence as this might be shrugged off. In an economist's sober report to the Australian Science and Technology Council, the sentence has a

ring of integrity and conviction; for Tisdell offers an antidote to despair: "A fall in exports and in living standards *could* be worthwhile from the point of view of achieving more basic ends". □

Lord Ashby was formerly Master of Clare College, Cambridge. His most recent book, written with Mary Anderson, is The Politics of Clean Air (Clarendon/Oxford University Press, 1981.)

From myth to methodology

C.K. Brain

Bones: Ancient Men and Modern Myths. By Lewis R. Binford. Pp. 320. ISBN 0-12-100035-4. (Academic: 1981.) £24.20, \$36.50.

It is perhaps surprising that a new book by one of the most influential of archaeologists should deal, not with cultural remains, but with bones. By way of explanation, Lewis Binford observes that almost all of our ideas on the behaviour of prehistoric men have been based on interpretations of faunal remains and their depositional context — not, as so many textbooks would lead one to believe, of stone tools. So, in discussing reconstructions based on bones, Binford has significant things to say about the proper conduct of scientific enquiry as well as about the behaviour of early man.

Most of the inferences that have been drawn about the nature and activities of our prehistoric ancestors are seen by Binford as little more than "myths of prominent men". Some of these concepts may well have been accurate, but unless they were the products of a robust and reliable methodology for giving meaning to bones, they remain myths based on the opinions and perhaps even the biases of the investigating archaeologists. In traditional archaeology, Binford believes that concepts about early man have often been judged in accordance with the status of the archaeologist who propounded them. "We desperately need to abandon the technique of evaluating men and adopt the strategy of evaluating ideas", he writes, for in the absence of methodology it is people's reputations that are reshuffled.

The kind of methodology proposed by Binford as an alternative to myth-making is embodied in what he calls "middle-range research". A crucial characteristic of theories resulting from such research is that they are intellectually independent of the arguments about the phenomena they are used to illuminate. As an example, Binford cites the case of carbon-14 analysis, where independent physical research had established a reliable body of theory about the relationships between living organisms, atmospheric ^{14}C and rates of degeneration of the radioactive isotope. Such relation-

ships have been put to good use by archaeologists wishing to date organic remains preserved at their sites.

Apart from philosophical considerations of myths and methodologies, the main aim of the book is to provide a set of objective criteria for the recognition of human influence in the accumulation of a bone assemblage. What are the characteristic patterns of bone modification produced by non-human agents and how can these be distinguished from human modes of bone alteration? In attempting to answer these questions, Binford has drawn on his own extensive observations of Nunamiut Eskimos and their dogs in Alaska, as well as of wolves that inhabit those parts. He has provided a wide-ranging review of relevant work done elsewhere and has set up a convincing array of diagnostic criteria for separating hominid- from non-hominid-built bone accumulations.

Finally, in the third part of the book, Binford applies his methodology to bone assemblages from Olduvai Gorge, making use of data provided by Mary Leakey in Vol. 3 of *Olduvai Gorge*. As Clark Howell has pointed out in the foreword to Binford's book, these data were not collected for this specific purpose and so are not ideal. Nevertheless, some bold conclusions have been reached by Binford, such as that there is no evidence that Olduvai hominids hunted, or that they made use of base camps to which food was carried to be shared. Instead, our hominid ancestors are seen as having been scavengers at discarded carnivore kills where hammerstones were used to break open leg bones to extract marrow.

Binford's book is a major, if controversial, contribution to the rapidly expanding literature on the new science of taphonomy. Already his conclusions are being challenged, for example by H.T. Bunn (*Nature* 291, 574-577), and it will be interesting to follow the fortunes of his ideas under the impact of the rigorous methodology that he so eloquently advocates. □

C.K. Brain is Director of the Transvaal Museum, Pretoria, South Africa.

Nature's plumbing

Philip England

Geysers and Geothermal Energy. By John S. Rinehart. Pp. 223. ISBN 3-540-90489-1. (Springer-Verlag: 1981.) \$22.50, DM 38. *Geothermal Resources: An Energy Alternative.* By Harsh K. Gupta. Pp. 227. ISBN 0-444-41865-2. (Elsevier Scientific: 1981.) \$61, Dfl. 125. *Geothermal Systems: Principles and Case Histories.* Edited by L. Rybach and L.J.P. Muffler. Pp. 359. ISBN 0-471-27811-4. (Wiley: 1981.) £22, \$52.25. *Geothermal Systems.* By John Elder. Pp. 508. ISBN 0-12-236450-3. (Academic: 1981.) £20.60, \$49.50.

STATED simply, a geyser is a water system to which mass and/or heat are added until a portion of the column is super-critical. At some stage nucleation of boiling occurs in this region and the consequent expansion partially empties the water column, reducing the pressure within it and leading to further boiling in the decompressed system, with spectacular eruptions of steam and water at the surface. The diversity of style and periodicity of geyser eruptions results from the almost endless variations on this theme which are possible given the multiple recharge-discharge systems occurring in nature.

In *Geysers and Geothermal Energy* John Rinehart has provided a detailed — one might say an affectionate — catalogue of these idiosyncrasies, together with the complex hydrological interpretations of them, when available. He also discusses briefly the geochemical and environmental aspects of geysers. One disappointing aspect of the book is that not enough attention is paid to the central process of geyser eruption: the problems of boiling initiation and bubble nucleation are dealt with in a cursory fashion. In other respects the book provides all the information on geysers that the layman or student could reasonably ask for. There is, in addition, one chapter of 15 pages on geothermal energy.

The remaining three books reviewed here all approach geothermal systems by way of an outline of plate tectonic theory, mantle convection and the present distribution of tectonic activity, and then diverge along lines that are to be expected from their formats. Gupta's *Geothermal Resources* is one of Elsevier's series on Developments in Economic Geology, and attempts to cover every aspect of the subject at the expense of the brevity which a 200-page format imposes on such an approach. The book is a review of the subject, covering everything from Earth structure and the basics of heat transfer (although convection is treated solely in terms of Newton's law of cooling) to production technology and world energy problems. The level and quality, however, are considerably lower than either of the two remaining books. The section on