alone up to date. The data given here, however, seem to have been extracted from the dusty files of international organizations and are in places woefully inaccurate. Pakistan claims 34 pages, Turkey 23 and Egypt 15: dozens of institutes and research centres are listed yet one wonders how many actually function.

If one turns to Turkey, many more research projects on solid fuels and solar energy are under way than the author suggests. He is clearly impressed by Saudi Arabia and not very *au fait* with North Africa, otherwise he would not describe northern Algeria as having "thickly forested" mountains — nor would he suggest that some of the newer universities, such as Constantine, are more technically minded than older ones dominated by social sciences: Constantine is a real dump, where the Muslim fundamentalists have nearly wrecked the atmosphere necessary for real study in an institution of higher learning.

It is difficult to know how many inaccuracies the book contains as no observer can be familiar with every Muslim country — but the chapter on Egypt, for instance, is full of mistakes: it is simply not true to say that the Aswan High Dam has brought about a raised water table. That is rather the result of poor management, bad drainage of the canals and over-irrigation now that water is freely available; and if the author believes any figures for the reclaimation of land in Egypt one can only wish him luck. He is also unreasonably harsh on the Gezna scheme in Sudan: its design is technically Victorian and for years it provided Sudan with the bulk of its foreign exchange.

In many ways the book reads like a series of hand-outs from universities and international organizations. It is out of date, riddled with errors and one gets the impression that the author has not set foot in some of the countries he describes — I cannot guess at the publishing strategy behind the book, nor can I see to whom it could be of any use. □

*Francis Ghiles is a specialist writer for the* Financial Times.

### Pagels in Britain

Heinz R. Pagels' *The Cosmic Code: Quantum Physics as the Language of Nature* is now available in Britain. The UK publisher is Michael Joseph, price is £10.95. For review, see *Nature* **296**, 503 (1982).

### India's environment

*The State of India's Environment 1982: A Citizens' Report* (reviewed in *Nature* **302**, 92; 1983) is available from Earthscan, 10 Percy Street, London W1P 0DR. Prices, which include postage and packaging, are £12.50 for Europe and $22 for North America.

### Corrigendum

In the review of three geology textbooks (*Nature* **302**, 182; 1983) line 13 of the second column should have read "anchoring the geotherm".

# Satellites, by Jove!

## S.R. Taylor

**Satellites of Jupiter.**
Edited by David Morrison.
*University of Arizona Press: 1982.*
*Pp.965. $49.50.*

"THE sense of novelty would probably not have been greater had we explored a different Solar System", remarked one observer after seeing the first fruits of the encounters of Voyager with the Jovian system. That sense of novelty is captured well in *Satellites of Jupiter*, a comprehensive account of what we have learned from the pictures sent back by both Voyager and Pioneer.

Contributors to the book concentrate mainly on the lunar-sized Galilean satellites, the 24 chapters providing a feast of information. Topics discussed range from the dark faint Jovian ring (showing that planetary rings are common, not rare) through orbital parameters, surfaces, cratering histories, geology, thermal evolution histories, and atmospheres, concluding with the origin and evolution of the system. Each account is written with the sophistication and expertise of post-Apollo planetary science, contrasting strongly with the literature of 20 years ago.

Much attention is given to the spectacular sulphur volcanism of Io, driven by tidal heating from Jupiter; the same phenomenon is probably responsible for resurfacing the thin icy crust of Europa. Ganymede, perhaps the most fascinating of the satellites, shows evidence of a few per cent expansion in radius following accretion. Melting of high density polymorphs of ice in the deep interior (about 50 per cent of Ganymede consists of water) and refreezing of the water at the surface as the familiar Ice I accounts for this expansion.

Cratering history is most clearly preserved on Callisto (resurfacing of Io and Europa has removed nearly all the craters). The population of objects which struck Callisto appears to differ from that in the inner Solar System, where the Moon, Mars and Mercury all record an early post-accretional bombardment by a similar suite. Still in dispute, however, is the question of whether all these heavily cratered surfaces are saturated, or reflect the total post-accretion impact history; most of the recent craters are thought to be due to cometary impact. Attempts to simulate cratering of an icy surface are described, but as recorded in Chapter 11 the problems of extrapolation are immense. (Incidentally, it is curious to note that one of the more successful target materials consisted of walnut shells, ground to sand size, lying on a clay slurry.)

Impressive though *Satellites of Jupiter* is, it is sad to note that the quality of reproduction of many of the pictures — which provide so much of the primary information — is poor to the point of being useless. In addition the book inevitably represents a beginning rather than an ending. The new evidence is largely photographic, enabling the construction of geological maps, the establishment of cratering histories and so on, but we lack the compositional evidence to understand origins fully. This becomes clear in the final chapter on origin and evolution. The Galilean satellites show a decrease in density with distance from Jupiter — inferred as an increase in their content of water and other volatiles, probably due to an initial thermal gradient in a proto-Jupiter nebula. All the regular satellites are thought to have formed in this nebula on short-time scales ($10^5$–$10^6$yr), while the irregular satellites were most likely captured.

We are thus closer than was Galileo to understanding the origin of the Jovian satellites. But one is reminded of the pre-Apollo debates over lunar origins — for the vital information we must await future missions. □

*S.R. Taylor is a Professorial Fellow at the Research School of Earth Sciences, Australian National University, Canberra. His most recent book is* Planetary Science: A Lunar Perspective *(Lunar and Planetary Institute, 1982.)*

# The positive and the negative

## Brian Coe

**The Origins of Photography.**
By Helmut Gernsheim.
*Thames & Hudson: 1982.*
*Pp.280. £25, $50.*

PHOTOGRAPHY was introduced to an astonished world in 1839 by two individuals. One, L. J. M. Daguerre, was a French artist-showman who had perfected a process invented by his late predecessor Nicéphore Niépce. The Daguerreotype technique, the first to be announced, was out of general use within 20 years. It was replaced by other processes based on the discoveries of the Englishman W. H. F. Talbot, whose Photogenic Drawing process was announced soon after that of Daguerre.

Talbot was a very different character from Daguerre; he was a talented mathematician, a botanist of some distinction, a classical scholar and noted Assyriologist. But above all he was an experimental scientist whose painstaking and systematic researches led to the discovery in 1835 of a photographic process in which a negative was produced, from which unlimited numbers of copies could be made. Modern photography has