Stellar abundance

Stuart Ross Taylor

An Introduction to Cosmochemistry. By Charles R. Cowley. *Cambridge University Press: 1995. Pp. 490. £50, $79.95 (hbk); £19.95, $29.95 (pbk).*

COSMOCHEMISTRY is a science that has flowered only in the past 50 years as the wealth of information from geochemistry, planetology, astronomy and astrophysics has enabled us to contemplate the chemistry of the cosmos. We are now able to understand the composition and chemical evolution of much of the observable Universe. In an astonishing synthesis of nuclear physics and astronomy, the origin of the chemical elements themselves, surely one of the great intellectual triumphs, was explained a generation ago. The composition of interstellar matter and stars has slowly become intelligible. Buried within meteorites that we can examine in terrestrial laboratories are isotopic signatures of events that happened before the formation of the Sun. By now we understand much about the origin and evolution of the Solar System, from the early separation of the solar nebula from a molecular cloud to the formation of the Moon with its strange and unique composition. I therefore opened this book with a great deal of anticipation. Regrettably, it did not live up to the promise of its title.

The book is really a mixture of geology and astronomy with only a thin bridging section on cosmochemistry. The author, who in 1970 wrote *The Theory of Stellar Spectra* (Gordon and Breach), is an expert both on that topic and on the composition of peculiar stars. Astronomers will find the sections on the interpretation of stellar spectra and stellar abundances, clearly the area of most interest to the author, a useful summary, but the information is too detailed for most geochemists. In turn, the geologists and geochemists among the advanced undergraduates and graduate students at whom the book is aimed will find the geology too simple and the astronomy too difficult. Most of the geochemical data come from old or secondary sources. The early sections contain brief summaries of mineralogy, petrology, thermodynamics and isotope geology. It is not really clear what purpose these sections serve except perhaps to introduce the subject to astronomers. Better treatments are available in standard texts, and these sections could well be deleted in subsequent editions. What is missing is an in-depth discussion of geochemistry and cosmochemistry as currently practised. Only three rather brief chapters cover these topics. These sections give only a short summary of a rapidly developing field and the author sometimes loses his way. He repeats the familiar error that the material in the Moon came from the mantle of the Earth, although current work derives it from the mantle of the impactor. This model, motivated by the failure of the lunar compositional data to match that of the terrestrial mantle, was spectacularly confirmed by the Clementine Mission.

When the author starts to deal in later chapters with his own speciality, stellar spectra, he leaps into very detailed discussions that will rapidly lose most students. These sections are written at a considerably more advanced level than those on geology, petrology and mineralogy. But in many cases, just as the discussion is becoming interesting, the reader is abandoned to consult the original literature. Curiously there is no mention that I could find of the famous discrepancy between the meteoritic and solar iron abundances that bedevilled geochemists ever since Urey and that has only recently been resolved. Holweger and colleagues at Kiel, using the Fe II lines in the solar spectra, established the equivalence of the iron abundances in the Sun and the type 1 carbonaceous chondrites. That was a considerable relief to cosmochemists, as cobalt and nickel, the two elements most closely associated with iron, had never shown any discrepancy.

The text often comes across as a pedagogical exercise, and this is heavily reflected in the style. The author seems most at ease with sentences beginning with such well worked phrases as "let us consider a well mixed gas" and then launches into a detailed mathematical treatment. The elegance of this approach, although well suited to a class exercise, is unfortunately diminished by the many uncertainties surrounding the subject.

The dangers of moving outside one's sphere of expertise are sometimes apparent. The author is reduced to accepting, at face value, many controversial topics in geochemistry, on occasion being moved to lament that "it is beyond the competence of the present writer to comment on the relative merits of the different approaches", for example, on the composition of the Earth. Indeed, the complexity of that topic might daunt the most accomplished geochemist. But writers of textbooks, having surveyed the relevant literature, are in a better position than the average reader of their works to form an opinion. Without it, textbooks become merely a trackless listing of current problems that readers must attempt to unravel without guidance. Of course, the solution is that the experts in the particular disciplines should write the books, just as Jeans, Eddington and Hubble did earlier this century for astronomy. □

Stuart Ross Taylor is in the Department of Nuclear Physics, Research School of Physical Sciences, Australian National University, Canberra, ACT, Australia 2600.

PERSIAN planispheric astrolabe of brass, engraved and inlaid with sliver, made for Shah Hussain in 1712 by Abd-al-Ali. From the lavishly illustrated *Sir Hans Sloane* (see over the page).