

but slightly less alkaline. In contrast, the well-known variation of volcanic petrochemistry across the arc is clearly present. Volcanoes on the Asiatic (western) side of the arc produce rock types that are alkalic compared to the main trend of the volcanic arc even though underlain by the same crust. Gorshkov comments, "These facts, based on indisputable geophysical and geochemical data, force us to question whether contamination and the assimilation of crustal rocks play any significant role in the volcanic processes and to look for a source of volcanism below the crust, in the upper part of the mantle." Oceanic basalts are clearly marked by most petrologists as mantle-derived, but the dominance of mantle material in andesitic volcanoes is a more tentative but ascending hypothesis.

Besides giving both the geophysical data on the roots of volcanoes and the geochemical data on the evolution of the volcanic products, this book is the first comprehensive source in English on the geology and volcanology of the Kurile Islands. The structure of the Kurile arc, the history of investigations, the stratigraphy (Cretaceous to Recent), and the Quaternary geology are summarized and documented by a comprehensive bibliography of both Russian and Japanese sources.

The largest chapter (180 pages) covers the description and eruptive history of 160 Quaternary volcanoes in the Kuriles, of which 104 have been active in postglacial time. Diagrammatic sketch maps prepared from aerial photographs are presented for many of the more prominent volcanoes. Most of these maps have no scale, probably a censorship rather than an oversight in the Russian edition. However, Gorshkov provides enough numerical data in the text on diameters of islands or calderas so that scales can easily be constructed. Their omission is my only criticism of the excellent translation by Charles Thornton.

The last two chapters deal with the petrochemistry of other island arcs and oceanic volcanoes and give Gorshkov's interpretations of the origin of volcanism in the upper mantle. These are a major bonus in an already classic work.

At the beginning of the chapter on the volcanoes of the Kurile Islands, Gorshkov comments that it is perhaps not modest but that "looking back at the road travelled, I cannot help but feel some satisfaction." His important

synthesis and interpretation of many years of rugged field work have certainly earned him this reward.

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Stars and Spectra

Stellar Atmospheres. DIMITRI MIHALAS. Freeman, San Francisco, 1970. xiv, 464 pp., illus. \$16. A Series of Books in Astronomy and Astrophysics.

The subject of stellar atmospheres may be logically divided into study of the continuous spectrum and study of the line or Fraunhofer spectrum, and in this book Dimitri Mihalas has devoted about equal space to each topic.

The author is well known for his calculations of model atmospheres of early-type stars, and the chapters dealing with such models are authoritative and complete. There is a good discussion of the comparison of the results of such calculations with observations. In particular, we note the section at the end of chapter 7 where the importance of deviations from local thermodynamic equilibrium (LTE) in stars with low surface gravities is demonstrated. This is probably the best discussion of model atmospheres of early stars in the literature today, and is essential reading for anyone who wishes to work in this area.

The portions of the book that cover the spectral lines are far more theoretically oriented, and for this reason of less use to the practicing astronomer. In any case, it would have been well to have a reproduction of at least one stellar spectrogram, just to let the theoretician know what he is supposed to be working on. In fact, one must look rather closely to find any observational data on spectral lines.

Much of the discussion is devoted to subtle effects which are often dwarfed by other phenomena in real stars. Bulk motion or turbulence, perhaps the most insidious of these mechanisms, has been given only a brief and callow discussion. Zeeman effect, hyperfine structure, and stellar rotation are not discussed, although they are well known to influence line shapes in stars.

There is a comprehensive discussion of the important work now going on in the nonequilibrium theory of spectral line formation. Mihalas discusses the

application of these techniques to the hydrogen lines in early stars, where the theory has had some success in predicting the cores of the line profiles. The cores of some strong solar lines are also discussed, but here the comparison of theory and observations is much less favorable because of severe inhomogeneities in the emitting gas which are traditionally ignored in the theoretical treatments.

For the majority of lines in the majority of stars, the practical worker falls back on "classical" methods which assume local thermodynamic equilibrium. These methods are also discussed by Mihalas, but only briefly, and it is unfortunate that he has chosen to stress the uncertainties of the method while largely ignoring its tremendous success in the measurement of stellar abundances. Indeed, the comparison of stellar abundances with predictions of theories of stellar evolution, galactic structure, and the origin of the chemical elements has been one of the most exciting and rewarding areas of research in stellar atmospheres over the past several decades.

In summary, *Stellar Atmospheres* is an essential contribution to the literature on model stellar atmospheres and the continuous spectrum of early-type stars. The later portions of the book, which deal with the line spectrum, will be of interest chiefly to those who are interested in the onerous nonequilibrium theory of spectral line formation per se.

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