that the working metallurgist will not wish to be limited to a circular camera technique which involves the reduction of his specimens to the form of filings or powders. He would soon require an arrangement to take normal whole specimens, preferably permitting of metallographic as well as X-ray examination. One also misses reference to the X-ray methods for measuring internal strains, which are finding extensive application, for example, in the examination of welds and problems of stress relief. In his treatment of radiography, Dr. Hirst has again emphasized the practical side. Industrial radiography has grown rapidly since the War began, and now consumes photographic film at a rate which would surprise the cinema industry. The standard is not uniformly high, and the practical points made by the author are not out of place. A clean radiograph, especially of an awkwardly shaped component in heavy metal, is often simpler in theory than in practice, and in this connexion, perhaps more reference would have been made to the use of filters in the primary beam, and to devices other than the use of lead paste to ensure the vital screening from unwanted radiation.

Whether the treatment of the principles and practice of X-ray diffraction is sufficiently comprehensive, as Dr. Hirst suggests, will depend on the work with which the practitioner is likely to be most concerned. In many fields it will certainly suffice for anyone to make a confident beginning, in which he will be aided by the initiative of certain manufacturers in putting reliable X-ray equipment on the market. Experience has shown that various types of work can be reduced almost to routine and undertaken by personnel without highly specialized training. On the other hand, there will always be investigations calling for considerable experience and versatility in interpreting and adapting the X-ray work. There will also be firms who may wish to use the method occasionally but not so often as to justify the expenditure on equipment and staff. Then there is a real case for the work to be undertaken by a central organization. To some extent this has been met in Great Britain by the facilities provided by the Department of Scientific and Industrial Research and by university laboratories. But the problem would repay systematic study, for the issues involved are not peculiar to X-ray work, and are likely to be encountered more frequently with the increasing complexity of scientific development and the growth of specialized techniques.

W. A. WOOD.

MAP PROJECTION

An Introduction to the Study of Map Projection
By Dr. James Mainwaring. Pp. viii+114. (London : Macmillan and Co., Ltd., 1942.) 5s.

IT is a common complaint that examination syllabuses exert an undue influence on the school curriculum; but it is a chastening reflexion that, in the case of map projections, the regulations of examinations boards have, to a considerable extent, saved a valuable subject from unmerited oblivion, though not from neglect. One of the worst reasons for the study of a subject in schools is that "questions are set on it", because it produces an attitude which leads to cramming.

The fact is that we have not hitherto evaluated the subject as an educational instrument, and there is now a danger that utility in the limited sense may

receive too great prominence; those who feel most strongly would stress rather its educational value.

What we teach in the subject will be conditioned by our reasons for teaching it; the kind of textbook required will emerge from these decisions. It is clear that books written to meet the needs of the cartographer are only suitable in schools for purposes of reference. The school should aim at giving a sound grasp of principles to as many pupils as possible and, in any event, as those specializing in geography may be on the arts side, we must regard the basic mathematical equipment as of school certificate standard only.

Dr. Mainwaring has made a noteworthy contribution to the teaching of the subject: his book, ostensibly written as an introduction to map projections, aims at Higher School Certificate standard; actually he presents to us a well-considered scheme, admirable in plan and execution, likely to develop interest and to provide a suitable foundation for more advanced work.

He writes under headings: (a) the problem; (b) the process; (c) the application. The first deals with the relevant properties of the sphere, explains such terms as great circle, loxodrome and orthomorphic, and leads up to the aim of map projections. The explanations are accompanied by effective diagrams, the most striking showing great circle and west to east routes from Madrid to Peiping on Mercator and gnomonic nets; the section ends with six different nets between longitudes 0° and 15° .

Describing processes, projections are classified and dealt with as cylindrical, conical, zenithal, modified and arbitrary. Again the method is comparative and in each case a formula is obtained. In this connexion, it may be noted that the equation for the position of Molleweide parallels is proved but does not provide a ready means of solving the problem; may I suggest that a graphical solution has educational advantages over the use of the table? In the case of Mercator, it is suggested that the distance of a parallel represented by $R \int \sec \theta d\theta$ may be found by performing the summation $\sum_n^n \sec(x - \frac{1}{2})^\circ$, where n is integral, using the 30' column in four-figure tables of secants. Up to 80° this gives 139.56 equivalent equatorial longitude degrees, that is, $2.436 R$.

The third section considers the choice of projection in relation to its use; it begins with a useful summary of the properties of those studied and is illustrated by well-chosen diagrams. The world is shown on four maps the uses of which are critically examined; two other world maps illustrate the advantage of interrupted projection. Africa and South America are exhibited on four nets with the same equatorial scale. North America is used to compare Bonne's and Lambert's, while the U.S.S.R. illustrates the use of two standard parallels.

It is to be hoped that those who adopt the book will spread the work over the two-year geography course; the contents will be best absorbed gradually, if their full implications are to be appreciated. Perhaps also the mathematical staff would like to make use of the book.

As a final note, there are still worlds to conquer in the field of useful projections; to encourage such research we cannot have too many interested students.

The author is to be congratulated on producing a book so uniformly good in text, diagrams and questions; the publishers, too, have done justice to it.

A. HINCKLEY.