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GEOHERMAL ENERGY

H.C.H. Armstead (Editor), 1973. *Geothermal Energy*. UNESCO, Paris, 186 pp., U.S. \$14.00.

General interest in geothermal science and engineering has increased greatly during the past one or two decades. Pioneering development in Italy, Iceland, New Zealand and the U.S.A. has demonstrated that geothermal resources can be harnessed for the generation of power and space heating at comparatively very low cost per unit energy produced. Moreover, the present difficulties with regard to the supply of reasonably clean fossil fuels have contributed to the interest in alternative resources. From the technological and economical point of view geothermal energy appears in many respects to be an ideal replacement for fossil fuel.

There is already available a considerable literature on the geothermal sciences. However, this material consists mostly of individual rather specialized papers. There are not available many systematic informative and educational papers or monographs. It is therefore to be very much welcomed that Mr. H.C.H. Armstead has edited a collection of review papers on various important aspects of the geothermal sciences and engineering. These papers have been published by UNESCO, Paris, in a volume entitled *Geothermal Energy*. The volume is divided into five main sections: (1) General, (2) Exploration, (3) The Winning of Geothermal Fluids, (4) The Utilization of Geothermal Fluids, and (5) Miscellaneous.

Section 1 includes two papers. The first one is by H.C.H. Armstead on: *What is Geothermal Energy?*, giving a short introduction to the history and other general aspects of geothermal energy utilization. The second paper by Sir Edward Bullard on: *Basic Theories*, reviews current theories on global thermal processes.

Section 2 commences on a paper by J.R. McNitt on: *The Role of Geology and Hydrology in Geothermal Exploration* reviewing various practical geological aspects of the exploration for geothermal resources. C.J. Banwell contributes a paper on *Geophysical Methods in Geothermal Exploration*. Moreover, a paper on *Geochemical Methods in Geothermal Exploration* has been written by G.E. Sigvaldason. The three papers by McNitt, Banwell, and Sigvaldason furnish a brief review of methods and concepts applied in geothermal exploration.

Finally, there is a paper by G. Facca on: *The Structure and Behaviour of Geothermal Fields*, describing geothermal systems from a geological rather than physical point of view.

Section 3 begins with a paper by K. Matsuo on: *Drilling for Geothermal Steam and Hot Water*. There follows a paper by N.D. Dench on: *Well Measurements* and a paper by J.H. Smith on: *Collection and Transmission of Geothermal Fluids*. These three papers review in considerable detail many of the important technological aspects of the production and transmission of energy from geothermal areas.

In section 4 we find a paper by B. Wood on *Geothermal Power*, a paper by S.S. Einarsson on *Geothermal District Heating* and a paper by B. Lindal on *Industrial and Other Applications of Geothermal Energy*. These papers deal with their subject matters in substantial detail and contain much useful information.

Section 5 contains a paper by T. Marshall and W.R. Braithwaite on *Corrosion Control in Geothermal Systems*, a paper by H.C.H. Armstead on *Geothermal Economics* and a paper by R.S. Bolton on *Management of a Geothermal Field*. Again, these papers are quite detailed and contain useful information.

More space and emphasis is devoted to the technological and engineering aspects of energy production and utilization than to the geoscientific aspects of geothermal resources including the exploration techniques applied in the field. Sections 3-5 are the stronger and more useful parts of the book. The present reviewer finds that the papers in section 2 are rather sketchy and that there should have been a separate paper devoted to the physics of geothermal systems. The literature on geothermal phenomena has tended to place more emphasis on geology and geochemistry than on physics. Finally, it appears that the material presented in some of the papers is not of very recent origin. The reader should be aware of this since the technoeconomics of energy production and utilization is now a very rapidly developing and changing field.

However, in spite of some shortcomings, this review volume is an important publication in the field of geothermal sciences and technology. It can be warmly recommended as an informative and useful source on the subject.

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