Low-Grade and Nonconventional Sources of Manganese

David B. Brookes

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LOW-GRADE AND NONCONVENTIONAL SOURCES OF MANGANESE

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Low-Grade and Nonconventional Sources of Manganese

This book, first published in 1966, reports the results of a pilot study devoted to understanding the middle-term resource situation for one metal – manganese. Two factors bring the different parts of the manganese supply-demand picture together, one economic and the other political, both of which are examined in detail in this report. *Low-Grade and Nonconventional Sources of Manganese* will be of interest to students of environmental studies.

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Resources for the Future is a nonprofit corporation for research and education in the development, conservation, and use of natural resources. It was established in 1952 with the co-operation of the Ford Foundation and its activities since then have been financed by grants from that Foundation. Part of the work of Resources for the Future is carried out by its resident staff, part supported by grants to universities and other nonprofit organizations. Unless otherwise stated, interpretations and conclusions in RFF publications are those of the authors; the organization takes responsibility for the selection of significant subjects for study, the competence of the researchers, and their freedom of inquiry. David B. Brooks is an RFF research associate. His book is one of RFF's resource appraisal studies which are directed by Hans H. Landsberg. The manuscript was edited by Doris L. Morton.

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PREFACE

Whoever inquires into the future adequacy of metals finds himself looking at a wide spectrum. Though all metals are present at low concentrations in the crust of the earth and in sea water, only a small, widely dispersed, and not always easy-to-locate portion of any metal is at any time recoverable at prices set by current demand and with technology set by scientific and engineering progress.

To let the limitations of the present cramp his vision makes the analyst feel narrow-minded. But he feels no more comfortable being carried away on the wave of the future. More often than not, he compromises by adopting a suitably qualified optimistic view in which the burden of short-run constraints is eased with general references to the conquests of nature yet to come.

Resources in America's Future, RFF's book of projections to the year 2000, contains a number of instances in which such a stance seemed the only rational solution—a solution suggested, among other things, by the long and continuing history of technological advance in overcoming the disadvantages otherwise inherent in material depletion. But with the detachment gained through passage of time one experiences a certain discontent with generalizations of this kind. Not that the judgment may not eventually turn out to have been correct. But rather, one would like to move to somewhat firmer ground in supporting it.

This current study seeks to provide such underpinning in the specific instance of manganese, a metal that is (a) vital

to the U.S. economy, (b) largely absent from the United States, except in noncommercial concentrations, and (c) abundantly available in steel mill slag heaps and on the ocean floor. Without such a detailed study this combination could easily lead one to conclude that, while currently all U.S. needs are met from imports, in an emergency or in the long run, production from low-grade domestic deposits, or from slags and—most spectacularly—the ocean bottom, could come into play. Ergo (one might say): There is nothing much to worry about.

By gathering both published and unpublished data, listening to the judgment of participants in the various attempts to widen the supply base of manganese, and by dissecting the information with the tools of economic analysis, David Brooks has demonstrated a useful way of dealing with appraisals of adequacy that are encrusted with loose judgments, both old and new.

April, 1966

HANS H. LANDSBERG
Director of Resource Appraisals
Resources for the Future

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Organizations which at one time or another permitted me to use their libraries were: Office of Emergency Planning, The Materials Advisory Board, The American Iron and Steel Institute, and Princeton Econometric Research Program. Studies of this kind gain immeasurably from such assistance. Equally important were the often lengthy discussions and interviews held with persons who have interests in or knowledge of manganese. Among those who gave their time and provided me with much needed background and balance were:

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DAVID B. BROOKS

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CHAPTER I

INTRODUCTION

How does the supply of metallic minerals in the United States compare with the constantly growing demand for metals? This question has been the subject of a number of studies and no end of speculation, particularly since the United States began to shift from a net exporter to a net importer of mineral raw materials. On the one hand, it is well known that enormous quantities of almost all metals lie at low concentrations in the crust of the earth and in the sea. On the other hand, it is equally well known that our reserves—the quantities recoverable at present prices and with present technology—give no cause for complacency. Yet there is a dearth of systematic information about the amounts available between these two sets of estimates. Few studies go beyond a recognition that additional or lower-grade sources of supply do exist.

These two common views of what can be called the economic dimensions of our mineral resources are precise but insufficient. Many problems relate to intermediate time periods, to the supplies of metals beyond those in deposits recoverable at a profit today yet well within the costs of "blue-sky" techniques. For which metals will foreign sources of supply have a cost advantage compared with domestic sources? Are there resources in this country that represent alternative sources of supply for these metals? If so, what are the implications of turning to them? For which metals will

we probably need to exploit alternative sources in any case by the end of the century? How might the existing and projected supply-demand situations be altered with foreseeable technologic advances? What do such advances portend for the primary producing nations? And how do they affect the longer-term projections of supply and demand? These rather neglected questions stem from the problems that may be the most important in coming years.

All of these questions relate to a single one: Is it possible to clarify the presently vague picture of domestic resource adequacy for metals and minerals? This is not the sort of question that will be susceptible to much generalization from one metal to another. It does seem that for every metal there are alternative sources. Furthermore, these sources can be divided into two categories. First, there are mineral deposits that are similar to those being mined today, but in which the metal is less concentrated. Second, there are different types of sources from which metal has not in the past been recovered in significant quantities. In general, both categories are referred to as low-grade sources, but they might better be distinguished as low-grade and nonconventional sources, respectively. Beyond this level of generalization, however, one must turn to individual metals in order to come to any conclusions about resource adequacy.

This paper reports the results of a pilot study devoted to understanding the middle-term resource situation for one metal—manganese. Manganese is an ideal metal for a pilot study, because with manganese a supply-demand situation that appears to be uncomplicated turns out to be far more complex once the parameter of technology is permitted to change.

Two facts are responsible for the deceptively simple picture of manganese in the United States. First, 95 per cent

of manganese consumption is accounted for by a single industry—steel. Second, the United States is virtually devoid of high-grade manganese ore deposits and (except for brief periods) has relied on imports for nearly all of its needs. But this is an incomplete picture. The demand for manganese is not fixed at so many pounds per ton of steel. The demand can be changed by reducing the manganese lost in waste products, by substituting other metals for manganese, and by developing steelmaking processes that reduce the need for manganese. More important, there are alternative sources of supply for manganese. These include both huge low-grade deposits in Minnesota, Arizona, Maine, and South Dakota, and two nonconventional sources—the manganese-bearing slags produced as a waste product in steelmaking and the manganese-bearing deep sea nodules that cover much of the deep ocean bottom. The development of an economic process for using any of these sources would completely alter supply conditions for many years.

Two factors bring the different parts of the manganese supply-demand picture together, one economic and the other political. The economic factor is, of course, the cost-price relationship. At present, it is not profitable to employ alternative sources of manganese or to reduce consumption per ton of steel significantly below current levels. The political factor is security. There are few metals in which the United States is so deficient in terms of current production-consumption ratios. Given the relatively large quantities required each year, it has been said that if there is such a thing as a strategic metal for the United States, that metal is manganese. At numerous times in the past fifty years, a change in one or the other of these factors—that is, a cost-reducing technologic innovation or a price-increasing support program—has seemed to place the domestic manganese

mining industry near a point of takeoff.[1] But takeoff has never been attained. Apparently no scheme for sustained domestic production that would satisfy more than a small fraction of our manganese consumption has turned out to be viable, even when the strategic factor was given heavy weighting. Thus, the questions posed above in general terms are quite relevant to manganese and can be particularized to it:

1. To what factors can we trace the apparent present cost advantage of foreign manganese deposits: geology, ease of mining, ease of processing, proximity to ocean shipping, or what? Are other factors needed to explain why domestic steel and ferroalloy firms have invested in exploration for, and development of, foreign manganese mines?

2. Can the dependence on foreign manganese deposits be expected to continue? Do these deposits have adequate low-cost reserves? What explains the resurgence of domestic manganese mining at several periods in the past?

3. What are the cost implications to the United States if we turned to low-grade mineral deposits, to slags, or to deep sea nodules, or if we restricted manganese consumption in steelmaking? How might these costs change with foreseeable technologic advances?

[1] Throughout, the term "manganese mining" should be understood to include the secondary recovery of manganese from slags as well as primary recovery from ores. The history of the domestic manganese mining industry is extensively documented in Congressional Hearings. See especially *Strategic and Critical Minerals and Metals,* Hearings before the House Subcommittee on Mines and Mining of the Committee on Public Lands, 80 Cong., 2 sess. (1948), 496 pp.; and *Beneficiation and Utilization of Manganese Deposits in the United States,* Hearings before the Senate Subcommittee on Minerals, Materials, and Fuels of the Committee on Interior and Insular Affairs, 84 Cong., 1 sess. (April 12, 13, and 14, 1955), 264 pp.