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**On Borrowed Time: Assessing the Threat of Mineral Depletion, by
John E. Tilton**

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REVIEWS

On Borrowed Time: Assessing the Threat of Mineral Depletion. By John E. Tilton. Washington DC: Resources for the Future Press, 2003. Pp. 158. \$55.00 hardcover; \$21.95 paperback.

For more than two centuries, economists have considered the question of long-run resource availability. Chapter two reviews early writing on this topic by Malthus, Ricardo, Mill, and Hotelling and provides clear verbal explanations of their analyses. The pre-Hotelling article of L.C. Gray^a is not mentioned—a further oversight of his pioneering analysis. The chapter briefly reviews three waves of concern over resource availability: the Conservation Movement 1890–1920, World War II and the Early Postwar period 1940–1965, and Limits to Growth and Social Costs 1970–2000. The chapter provides non-economist readers an excellent foundation of concepts (present value, opportunity costs, user costs, future prices) that are frequently used in subsequent chapters.

Chapter three reviews the types of scarcity measures available to us and comments upon their usefulness as long-run scarcity indicators. The McKelvey box, and data on Reserves and Life Expectancy in years for selected materials are reviewed before attention is directed toward economic measures of long-run availability. Real marginal costs of extraction and processing, real market prices of mineral commodities, and real user costs are critiqued and a good case made that economic measures are more useful than are physical measures. The chapter succinctly outlines some recent challenges to this view advanced by Norgaard^b and Myers and Simon^c respectively. The argument that cost and prices may reflect ignorance is given plenty of air and readers are invited to consider if this is a plausible description of the long run. The argument of Myers and Simon that costs and prices for minerals reflect private but not external costs and that the social costs of production may be increasing is also considered and Tilton directs readers to the primary literature for further reading on these topics.

Many economists are familiar with the work of Barnett and Morse published by Resources for the Future in 1963 and chapter three reviews the historical record on real costs and prices of minerals. The early evidence clearly shows that minerals have become economically

a. L.C. Gray, *Rent Under the Assumption of Exhaustibility*, 28 Q.J. ECON. 466–89 (1914).

b. R.B. Norgaard, 1990. *Economic Indicators of Resource Scarcity: A Critical Essay*. 19 J. ENVTL. ECON. & MGMT. 19–25 (1990).

c. N. MYERS & J.L. SIMON, SCARCITY OR ABUNDANCE? A DEBATE ON THE ENVIRONMENT (1994).

less scarce. The work of Hall and Hall^d and Slade^e created plenty of interest when published, as they provided evidence of U-shaped price paths. But Tilton explains how recent developments in econometrics have enabled researchers to subject the data to more stringent tests including for trend stationarity. Chapter three carefully reviews this evidence and the debates over several technical issues, including choice of deflator, impacts of market power on prices, whether the results are time period dependent. In a useful Appendix to *On Borrowed Time*, Howie provides 13 graphs of real prices 1870–1997. Tilton draws a reasonable conclusion (p.54), “the past 130 years have been quite benevolent from the perspective of resource availability.” The future need not be like the past, of course, and Tilton rightly cautions readers that the long-run trends observed to date may change in response to technology changes, world growth rate changes, and other influences on supply and demand for world minerals.

The uncertain future is considered in chapters five and six. King Hubbert curves are considered and dismissed as unlikely to be reliable indicators of mineral availability. The cumulative long-run supply curve for minerals is introduced to see what light can be shed on future mineral availability. Some basic geology, including the proposition of Skinner^f that mineral availability has a bimodal distribution, is reviewed as is evidence on the energy requirements to obtain minerals from decreasing ore grade. Neoclassical economists, and Tilton is certainly one, believe that demand forces will play a role in determining how fast society moves up the cumulative supply curve. Population, income per capita, and intensity of minerals use are all analysed to see how demand for mineral commodities might grow in 50-plus years time. Cumulative supply curve shifters – technology and input costs – are also discussed as they are likely to play some role in determining future mineral availability. Tilton concludes that there is great uncertainty about the availability of aggregate minerals, but it is probably possible to assess the shape of the cumulative supply curve for individual minerals.

Chapter six moves on from sources to sinks. Long-run availability of minerals does not seem to be an issue for several decades, but places to deposit the by products of mining and minerals use are much more pressing concerns. The chapter provides easy to follow explanations of marginal external costs and marginal net benefits of

d. D.C. Hall & J.V. Hall. 1984. *Concepts and Measures of Natural Resource Scarcity with a Summary of Recent Trends*, 11 J. ENVTL. ECON. & MGMT. 363–79 (1984).

e. M.E. Slade, *Trends in Natural Resource Commodity Prices: An Analysis of the Time Domain*, 9 J. ENVTL. ECON. & MGMT. 122–37 (1982).

f. B.J. Skinner, *A Second Iron Age Ahead?*, 64 AM. SCI. 158–69 (1976).

minerals use. Pigouvian taxes are briefly considered as a means to force producers toward socially optimal production, but of more interest is the evidence provided of improved environmental performance by minerals producers in Chile and Canada. Technology clearly has improved the environmental performance of some firms and the gap between best practice technology and artisanal production is highlighted.

Internalising the environmental and other social costs of minerals production is a textbook recommendation, but Tilton cautions that it will be a long struggle to achieve such an objective. Thirty-plus years of intense effort have resulted in major improvements in the accuracy of non-market valuation techniques that are used to assess how large are environmental and social costs, but persuading politicians to act on the knowledge generated about the magnitude of external costs may be a major challenge.

Major industrial countries, particularly the United States, are often berated for their profligate use of mineral commodities on grounds of inequity and injustice. Tilton argues that these criticisms are misguided. The high income countries are high consumers of these products, but they are also high investors in research and development, and arguably are in a much stronger position to develop new technologies that can offset decreasing minerals availability for all countries. This last argument nicely illustrates a main feature of this excellent, carefully written book. Deductive logic and basic resource economics are used to review the evidence, analyse issues, and draw sometimes surprising conclusions.

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Irrigated Agriculture and the Environment. Edited by James S. Shortle & Ronald C. Griffin. Northampton, MA: Edward Elgar Publishing, Inc., 2001. 272 pages. \$110 hardback.

Irrigated agriculture (versus rain-fed agriculture) is one of the great achievements in bettering the health and well being of a large portion of the world's population. In the twentieth century, as population expanded and irrigation engineering became more refined, the total irrigated acreage expanded by a factor of about seven to a total land area of over one million square miles. The benefits of this achievement do not come without costs, however. Some of these costs are directly related to the environmental impacts on soils, water, and aquatic species. How can one account for these costs or utilize them in decision making? The editors of this book bring together previously published journal articles to help answer this question.