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GOALS AND STANDARDS OF PERFORMANCE FOR THE CONSERVATION OF MINERALS: A COMMENT

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In a recent issue of the *Natural Resources Journal*, my colleague Orris C. Herfindahl asked: "Are we and each of the generations that will follow us leaving enough minerals for later use?"¹ His carefully reasoned conclusion was that no a priori case can be made for intervention in either the markets for capital or the markets for ores, metals, and fuels; that in a world of advancing knowledge individual decisions about saving and about mineral consumption appear to make adequate provision for the future. I agree with this conclusion, but I wish to suggest that the case against intervention is considerably weaker for mineral byproducts than it is for the main products with which they are associated.² That this is no idle academic distinction can be seen in the nearly \$2 billion that the federal government will spend between 1963 and 1985 to conserve the helium that can be recovered as a byproduct of natural gas.³ As a matter of fact, separation of main products from one or more byproducts—at the mine, the well, the mill, the smelter, the refinery—is almost the essence of mineral production. Although it would, therefore, be convenient to find some rule of thumb for conservation of byproducts, my conclusion, to repeat, will be that the case against intervention is weakened, not that it is destroyed.

Before proceeding, it should be pointed out that the problem of conservation in the case of byproducts differs in one respect from that for main products. Herfindahl was questioning whether our consumption *in use* of minerals is too high. Many byproducts, in contrast, are consumed by *non-use*. That is, either they are potential byproducts

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1. By "enough" Herfindahl emphasized that he means that future generations should be "in a position to enjoy 'adequate' incomes," regardless of the actual quantities of individual minerals that might be available to them. Herfindahl, *Goals and Standards of Performance for the Conservation of Minerals*, 3 *Natural Resources J.* 78 (1963), reprinted from 57 *Q. Colo. S. of Mines* 153 (1962).

2. Herfindahl, of course, recognized that there are circumstances under which it would be reasonable to alter the rate at which some mineral is consumed. Herfindahl, *supra* note 1, at 93-95.

3. See U.S. Bureau of Mines, *Annual Helium Activity Report*, for fiscal years 1961 through 1963. For brief summaries of and comments on the helium program, see *J. Commerce*, Nov. 27, 1961, p. 7; *Chemical Week*, Oct. 5, 1963, p. 49.

that are not recovered from main products—helium need not be separated from natural gas and will just pass into the atmosphere when natural gas is burned—or they are byproducts that although actually separated from the main product—such as tailings, gas, flue dust, slag, etc.—are discarded as “waste” in such a way that later usage is extremely improbable.⁴ Nevertheless, the meaning of a conservative act, some action now in order to shift consumption of a given commodity to the future, is the same regardless of whether the commodity is consumed by being used or by not being used.

In a competitive economy, the value of the deposits of a mineral commodity will increase over time at the market rate of discount. This brings about an equilibrium situation in which the present value of the estimated profits from mining and treating that mineral are the same regardless of the year of production. There is good reason to believe that this process of adjusting the value of mineral deposits to the productivity of capital works reasonably well in the case of main products.⁵ However, because of the nature of joint production, there is much less reason to believe that it works in the case of by-products.

What is the economic meaning of a “deposit” of some byproduct? Usually there is little or no exploration for that commodity itself. Nor is any real decision made to remove the byproduct from its natural location in the earth. New sources of supply become available largely because of expectations of profit from producing a main product whose demand is independent of that for the byproduct. True, later decisions about processing the byproduct itself will be directly related to its own supply and demand conditions, but these conditions have only tenuous effect on the initial production decisions. Furthermore, the supply function may be highly discontinuous. By-product iodine from “waste” oil-well brines that suddenly appeared in large quantities in the 1930’s completely altered that market by breaking the Chilean monopoly. The supply of vanadium expanded manyfold when the demand for uranium (with which it is geologically associated) shot upward. Finally, the relatively small annual consumption of most byproducts makes it very difficult to estimate future levels of demand. Who would have predicted the widespread usage of exotic metals as semiconductors? In sum, not only is there

4. It would be possible to define the word “waste” to mean consumption through non-use. However, “waste” is such an emotive word that it will only be used in a loose sense, as it might be used in industry, and will be enclosed within quotation marks.

5. See, *e.g.*, O. C. Herfindahl, *Copper Costs and Prices, 1870-1957* (Johns Hopkins Press for Resources for the Future, Inc. 1959) (especially Part 1).

less reason to think that investment in byproduct production is systematic, but there is also less reason to think that the market can forecast future demands with acceptable accuracy.

The analysis of mineral production over time just presented derives from the conception of minerals as stock resources. An alternative is to treat potential byproducts as if they were flow resources. The analogy is close: the size of the flow is determined by forces that are largely exogenous; the flow can be defined in physical terms (the total content of the potential byproduct in each year's production of main product); more or less of this potential can be realized as actual byproduct production. Of course, some differences remain, most important of which is the fact that to some extent the present flow of a potential mineral byproduct does reduce future flow.

The analogy can be carried further. In the classification of natural resources proposed by Professor Ciriacy-Wantrup, potential mineral byproducts approximate flow resources characterized by a critical zone.⁶ Ciriacy-Wantrup defines a critical zone as "a more or less clearly defined range of rates [of flow] below which a decrease in flow cannot be reversed *economically* under presently foreseeable conditions."⁷ In the case of minerals, the critical zone is represented by that quantity of the annual flow that is not consumed for some purpose, for this quantity represents a physical loss of material which might have been available and desired in the future but which cannot be recaptured.

By considering potential mineral byproducts as flow resources characterized by a critical zone, they are placed within that group of natural resources for which Ciriacy-Wantrup proposes a "safe minimum standard" as the objective of conservation policy.⁸ The safe minimum standard is based on the premise that choices must often be made between accepting larger but less likely losses or accepting smaller but more likely ones. Applied to resources with a critical zone, the standard suggests the acceptance of the losses entailed in avoiding the critical zone in order to forestall much larger losses that might result from resource depletion.

6. S. V. Ciriacy-Wantrup, *Resource Conservation: Economics and Policies* 37-43 (Univ. of Cal. Press 1952).

7. *Id.* at 39. (Emphasis Ciriacy-Wantrup's.) The analogy cannot be complete, of course. In particular, the lack of recovery of the n th potential unit of some mineral byproduct does not impair the ability to recover the $n+1$ st unit. In the cases that Ciriacy-Wantrup mentions, it is often true that failure to act now impairs the efficacy of action later.

8. *Id.* at 251-67.

Does the safe minimum standard of conservation have any applicability to mineral byproducts? It would seem that it does. First of all, there is great uncertainty about whether the undeniable physical losses are also economic losses. This depends on future technology and future desires. Second, there is even more uncertainty about the size of any economic loss. Most countries would be willing to expend great efforts to conserve uranium that might prove recoverable in the future because of their estimates of the dangers of being short of this metal. However, the possible loss need not be immoderate before a decision to avoid the social risk of depletion becomes reasonable. Third, it is quite feasible to avoid this risk by action now, and the costs of such action are usually (not always) fairly small. On the other hand, every "waste" product contains a variety of elements in amounts down to trace quantities. Obviously, it is impossible to recover or to save everything. Moreover, each increase in the range of substitution made possible by technologic advance reduces the potential losses that might be incurred as a result of depletion.

The safe minimum standard, therefore, provides a rationale, but it does not indicate appropriate action in any particular case. However, the concept can also help to develop criteria for determining which groups of byproducts are most likely to need attention from the standpoint of conservation. First, as implied above, little attention needs to be paid to byproducts that are actually being consumed in use. For the most part, Herfindahl's conclusions appear to be applicable to them as well as to main products.⁹ Second, many potential byproducts are separated from the main product in a form that permits saving of relatively small amounts of byproduct-bearing material. Most metallurgical "wastes" fall into this group. In such cases, the safe minimum standard indicates that attention should be paid to the possibility of storing such material. As a matter of fact, the larger metallurgical concerns commonly save metal-bearing "wastes" so that they will be available if demand for the metal shifts upward. Stockpiled cadmium-bearing flue dust and stockpiled tellurium-bearing anode slimes have both proven to be valuable resources in the past few years.¹⁰ Still awaiting appropriate conditions are the heaps of high-manganese slag that are segregated and stockpiled by many steel companies. Thus, as Ciriacy-Wantrup suggests, many pri-

9. Even with byproducts that are consumed in use, the situation is not always unambiguous. Is the use of manganese-bearing slag for aggregate in the interests of society?

10. *Engineering & Mining J.*, Feb. 1963, vol. 164, p. 120 (cadmium); *N.Y. Times*, June 16, 1960, p. 45 (tellurium).

vate resource owners are themselves fulfilling the requirements of a safe minimum standard.¹¹ Perhaps the only social policy necessary for these materials is periodic reporting to (or analysis by) the Bureau of Mines of the chemical content of the "waste" products of mineral plants around the country. Full knowledge might well be an adequate inducement for the appropriate social action.

The most important field for social policy intended to maintain a safe minimum standard will be among a third group of byproducts, those for which a decision about conservation cannot be postponed. The helium case is one of these. If the helium is not extracted from the natural gas, it is carried with the gas and lost to the atmosphere when the gas is burned as fuel. Another instance is the natural gas that is produced at oil wells along with petroleum. If this gas is not marketed, it can either be conserved by reinjecting it into the oil pool or it will be flared (burned).¹² Some methods of disposing of metallurgical wastes, such as pumping them into mined-out zones of the mine, also involve physical losses. It is clear that public conservation attention should be focused on this group of potential byproducts because there is no possibility for later reconsideration. However, in many cases the costs of conserving the byproducts of this group will not be small, as evidenced by the helium program.

Professor Ciriacy-Wantrup has stated the case for a safe minimum standard of conservation most succinctly as "essentially an increase of flexibility in the continuing development of a society."¹³ We have found that the concept has broad application to mineral byproducts in spite of the fact that they are not truly flow resources. Further, we have found that it has particular application to those byproducts for which conservation decisions cannot be postponed. It is also apparent that tools are available to effect byproduct conservation, though these tools are not always cheap. In short, we have been able to establish a framework for observation and analysis of mineral byproducts, but we have not been able to eliminate the need for the observation and analysis itself.

11. S. V. Ciriacy-Wantrup, *op. cit. supra* note 6, at 260-61.

12. When byproduct natural gas is reinjected into oil pools, it generally helps to maintain underground pressure and also improves the total recovery of petroleum. Thus, it represents an ideal example of reduction in the costs of maintaining a safe minimum standard because the required action (in this case reinjection) is complementary to the supply of another commodity (petroleum). The same would be true if the required action contributed to other goals, such as the reduction of air or water pollution. It is possible, however, that the required action, say storage of wastes, might compete with other goals, say recreational use of land, in which case the costs of maintaining the standard are increased. See Ciriacy-Wantrup, *op. cit. supra* note 6, at 262.

13. Ciriacy-Wantrup, *op. cit. supra* note 6, at 253.