SCIENCE

VOL. 82 FRIDAY, AUGUST 9, 1935 No. 2119

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

CONSERVATION OF MINERALS[1]

By Professor C. K. LEITH*

UNIVERSITY OF WISCONSIN

As an abstraction the idea of conservation of natural resources is widely accepted by the public. In fact, active opposition to the idea is almost non-existent. It is a safe and attractive phrase for publicists, politicians and party platforms, as well as a plausible caption for many laws. Yet for most people conservation remains a vague profession of faith, not tied down to realities or practical programs. To specialists in forests, parks, game, recreation, soils, water resources and minerals, conservation means many different things. In a recent survey at the University of Wisconsin it was found that conservation was receiving attention in twenty-seven different courses, in nearly as many departments, and that in no two of them was the subject defined in the same terms. The many so-called conservation laws in our state and federal statutes reflect an equally chaotic condition. Text-book definitions of conservation, in the very nature of the case, must be so generalized that they fail to convey any clear notion of the practical problems involved. To illustrate the difficulty of simplifying the concept of conservation I quote to you an attempt made by the twenty-seven units of the University of Wisconsin to agree on a general platform:

> Conservation is the effort to insure to society the maximum present and future benefit from the use of natural resources. It involves the inventory and evaluation of natural resources; calls for the maintenance of the renewable resources at a level commensurate with the needs of

[1] Address presented at symposium on conservation jointly sponsored by the University of Minnesota and the American Association for the Advancement of Science at Minneapolis, June 27, 1935.

* Vice-chairman, Planning Committee for Mineral Policy, Washington.

society; and requires the substitution, where the conservation of human energy permits, of renewable or inexhaustible resources for those which are non-renewable, and of the more abundant non-renewable resources for the less abundant ones. It not only seeks to eliminate waste of resources if use is economically feasible, but also looks forward to improvements in techniques of production and use, and requires that there be prompt and proper adjustments to advances in technology. It thus appears that conservation involves the balancing of natural resources against human resources and the rights of the present generation against the rights of future generations. It necessitates, moreover, the harmonizing of the procedures and objectives of conservation with the conditions of the present or future economic order, and calls for a careful allocation of duties and powers among private and public agencies.

To students of conservation this definition is comprehensive and tangible, but to the public it can scarcely be other than an euphonious abstraction. It is almost inevitable that plans and legislation must be developed piecemeal from many standpoints, and that the synthesis of the parts into a consistent program for natural resources as a whole must be a slow and difficult task on which we have barely started. Even within the special fields there are still large gaps between general concepts and workable plans.

I propose to-day to review briefly the practical problems of conservation of one group of natural resources—our minerals—a field in which we start from a well-established body of facts, sufficiently limited and defined to be studied with some degree of objectivity. Some of the ideas developed from the study of minerals may be found useful in approaching the problems of conservation of other natural resources.

I shall draw freely, but not solely, from the preliminary report recently issued by the Planning Committee for Mineral Policy, which was appointed by the President to formulate a national mineral policy. The Planning Committee is also acting as the Mineral Section of the National Resources Board. Its report was a part of a more general statement by the National Resources Board which was submitted to the President early in the year and by him transmitted to Congress with the statement that it constitutes "a remarkable foundation for what we hope will be a permanent policy of orderly development in every part of the United States."

Factual Statement of the Mineral Situation

First, a few salient facts of the mineral situation bearing on the problem of conservation. Ours is the age of the power machine, and minerals furnish both the power and machine. Minerals are a non-reproducible and exhaustible resource—a one-crop resource; they are limited in quantity; they are fixed geographically for all time; they are not distributed equally among the countries of the world. The United States stands far in front in the amount and variety of its resources, but still depends on foreign sources for part or all of its supplies of about 20 industrial minerals. The flush of discovery in the United States is passed, and the main geographic outlines of the ultimate mineral picture are now pretty well established. Reserves can be approximately measured. Discovery has not stopped, but the rate has been slowing down for a considerable time. Of 33 metal-mining districts that have yielded the greatest wealth to date only five have been discovered since 1900 and none at all since 1907. The coal and iron fields are pretty thoroughly mapped. The chance of finding another Mesabi Range or another Pittsburgh coal field is small indeed. The rate of discovery of oil and gas still continues high, but the geological limitations are pretty well understood, and the chances of finding another East Texas or Kettleman Hills are not promising.

Finally, the United States leads the world in the speed with which it is exploiting and exhausting its resources. For the metals and fuels, despite a magnificent endowment, depletion is further advanced than even mining men generally realize. In gold the peak of American production was passed in 1915, and despite the enormous stimulus of falling commodity prices and devaluation of the dollar, production to-day is still far below the pre-war level. In silver, also, we seem to have passed the peak. The copper mines of Michigan have gone a mile below the surface, by far the deepest copper mines in all the world, and at those depths, despite the ablest of engineering, they are quite unable to compete with many low-cost districts here and abroad. Mining at Butte has reached deep levels and has long since passed its peak. The great tri-state zinc district of Missouri, Oklahoma and Kansas is no longer expanding, and no notable geographic extensions are in sight. In the oil industry the glut produced by east Texas makes us forget the hundreds of dead or dying pools in other areas. The Southwest gas production hides the decline of many eastern districts and the death of the Indiana gas belt. Even in coal, one of the most abundant of our resources, it is estimated that the anthracite fields of Pennsylvania are 29 per cent. exhausted. While the total supply of bituminous coal is huge, the exhaustion of the best of the bituminous beds, such as the Moshannon, the Big Vein, Pocahontas, New River and Pittsburgh, is well advanced. About half of the known high-grade iron ore of the Lake Superior region has already been produced.

The speed of our attack on mineral resources is indicated generally by the fact that the amount produced

since the opening of the century far surpasses the total of all preceding history of the United States. In this respect we are literally digging ourselves in to our natural environment on a scale which has no precedent in history.

In terms of years of measured reserves of present commercial grades the United States has supplies of oil, zinc and lead for from 15 to 20 years. Its copper supply is good for about 40 years. The total for iron ore, including its lower grades, such as Alabama, is good for hundreds of years, but the known reserves of high-grade Mesabi ores now supplying about half of our requirements will last about 40 years, and for the rest of the Lake Superior region, supplying about 30 per cent. of our requirements, the figure is less than 20 years. Coal reserves of all kinds, high and low grade, favorably and unfavorably located, will last 4,000 years, but the kinds we are now using in favorable location are measured in a century or two.

Minerals in which the United States is wholly or partly deficient include antimony, asbestos, chromite, manganese, mercury, nickel, tin, tungsten and ten or twelve others.

Further discovery and the use of lower grade resources will extend the life of most of these resources, but the range of possibilities is now pretty well understood, and with maximum allowance for such extensions, the figures are sufficiently small, when compared with what we hope to be the life of the nation, as to be matters of public concern.

The depletion of mineral reserves here sketched has been accompanied by huge losses, some avoidable and some unavoidable. It is estimated that not more than 50 per cent. of oil is recovered from a pool, even under efficient recovery practices; where extraction methods are wasteful of gas and reservoir energy, a commonly accepted average is 10 to 20 per cent. In one field a billion feet of gas are being blown into the air daily —enough to supply the United Kingdom twice over and forty times as much as all the Scandinavian countries use together. In twelve years in California the quantity of gas known to be lost was about one third of that produced for commercial use. The average loss in the recovery of coal is 35 per cent., as estimated by the Bureau of Mines. The mining of iron, copper, lead and zinc—in fact, of most minerals—shows waste, due to the necessity for selective mining to meet competitive price conditions or the burden of excessive taxation. In the Lake Superior region large tonnages of low-grade iron ores have been left behind in the progress of mining, many of which will never be recovered after the operations close down. The list of specific losses could be extended indefinitely. Loss of resource is not a theory or an insignificant incident; it is a demonstrable fact, which can be documented in detail and which runs into large figures.

MINERAL CONSERVATION DEFINED

I have briefly summarized these few salient facts as a basis for defining the problem of conservation of mineral resources. When the nation became conscious, about the turn of the century, that its mineral reserves were not inexhaustible, men pictured a day of wrath when all the coal and oil and iron would be consumed. Then, when the looked-for shortage did not occur, a feeling rose that conservation was a cry of "Wolf!" and a reaction set in. The popular concept of conservation had been over-simplified, and it still is. As we see it now, conservation means not hoarding, but orderly and efficient use in the interest of national welfare, both in war and peace, without unnecessary waste either of the physical resources themselves or of the human elements involved in their extraction. The central idea of mineral conservation is that the impetuous expansion of the pioneer days should, in the public interest, give way to more orderly and less wasteful development. The danger is not absolute exhaustion in some indefinite future, but rather an early increase in cost through unnecessarily early depletion of the rich and accessible deposits. Already signs begin to appear that domestic industries are feeling the pinch of competition and finding it difficult to meet the pressure emanating from younger countries, which are still discovering new resources.

Large losses of raw materials are accelerating this trend. The conditions that are causing the physical losses are also causing human losses—irregularity of employment and low standards of living. Likewise these conditions are causing capital loss. The physical, human and financial losses are closely interrelated, and no one of them can be effectively treated without consideration of the others.

It does not follow that all the known losses are avoidable wastes; that they are principally due to incompetent, careless or selfish exploitation. Examples of such exploitation of course are known, but they are not typical of mineral development as a whole. With few exceptions, the record is one of honest effort to do the job as efficiently as circumstances have permitted. The conservation problem is not principally one of punishing scapegoats, though this very human tendency to personalize and dramatize pervades much of the popular discussion of the subject. It is too bad for the cause of conservation that the scientist has to deal with the subject in unemotional terms.

In the early stages of the development of a mineral deposit, before all the conditions are known, losses are inevitable, and even when the conditions are

known, financial pressure may limit the application of known processes for better recovery. In some cases it may be good conservation to save two dollars' worth of human energy at the expense of wasting a dollar's worth of raw materials. Man's interests are, after all, paramount in his adaptation to his physical environment. However, the first crude adjustments to environment inevitably point the way to more skilful adjustments, in which the physical losses may be lessened without excessive cost to the human elements involved.

It is only since the war that the conservational problem as we now know it has really emerged in definite form. Up to the war, expansion of capacity for mineral production was more or less proportional to consumptive demand. Since then, capacity has outstripped consumption for several minerals, intensifying competition for markets, with consequent reaction on conservational standards. The principal problems of conservation are now centered in this group of minerals.

Practicable Steps in Conservation

What, specifically, can be done to advance mineral conservation as thus defined? To state our general conclusion first, the principal wastes are not due to lack of advancement in technological and scientific methods but to maladjustments in the economic and political conditions under which the industries are operating. The great opportunities for advances in conservation therefore lie in the economic and political fields. After brief mention of the technological and scientific gains, I shall call your attention particularly to the necessity of control of production, to the effect of taxation, to the desirability of extending the Leasing Act to all public lands and to international considerations affecting the problem.

(1) *Technologic and Scientific Attack:* Splendid conservational advances have been made by engineers and scientists in their attack on the physical problems of conservation. Recovery and efficiency in mining, concentrating and smelting have been greatly improved. The process of flotation has recovered large quantities of metal formerly wasted. Oil technology has greatly lessened the wastes in extraction from the ground and has doubled and trebled the amount of gasoline obtained from the crude. New methods and machinery have reduced costs of mining and concentration in nearly all fields. The record is a long and impressive one. The American mining industry has led the world in technological advances, which have furnished the American consumer his raw materials at the lowest unit prices available anywhere in the world. Physical conservation has pressed forward about as fast as economic conditions have allowed.

The driving power for this impressive advance has for the most part not been any social concept of conservation but the practical urge toward efficiency, lower costs and higher profits. The financial rewards to such efforts have been great and will doubtless continue to be so if given a chance to function by the conditions of the industries. Public encouragement of these efforts through scientific and technical bureaus has been an important contributing factor, and continuance of these efforts is, of course, a necessary element in any positive program of conservation.

(2) *Control of Production:* However, the great hurdles in the way of conservational advance are now the economic and political conditions under which the industry operates, which are damming up the effective application of technologic and scientific processes and which must be removed if we are to realize the results known to be possible. The practical problem of conservation is now one of finding new methods of stabilizing the conditions of the mining industry in a way which will allow of the effective application of these methods.

A review of the economic and social conditions affecting the mining industry reveals one dominating factor which is the cause of much the largest part of the wastes now going on. I refer to unrestricted competition, made compulsory by our anti-trust laws, which has led to overdevelopment, irregularity of production, prices and employment, and which has forced from time to time robbing of the best of mineral reserves to meet competitive conditions, and has thereby prevented the orderly development, with the use of all known technical knowledge, necessary to prevent huge wastes. Just a few cases to illustrate what I mean. Competition in the coal industry has always been intense because of the widely scattered reserves and the thousands of producing units. For years the industry has worked in surroundings of poverty. Testifying in the Appalachian Coals case in 1932, Howard N. Eavenson, who has recently been president of the American Institute of Mining and Metallurgical Engineers, stated:

> I think I could make the broad assertion that there is not a single bituminous mine in the country to-day that is not mining the very best coal that it has, and the cheapest, and is allowing portions of the mine to get into shape where a lot of the coal will never be recovered, because they can not afford, at present prices, to mine it.

The Bureau of Mines has estimated that failure to use the standards of engineering already shown to be feasible by the better companies accounts for a loss in recovery of 20 per cent., which means an avoidable loss of 150,000,000 tons per year, or enough to supply the entire requirements of Germany.

The headlong exploitation of oil under unrestrained competition has caused large overproduction, collapse of prices and the elimination of even elementary conservational practices of recovery. Some of the results are: (1) Operation of oil wells with improper gas-oil ratios; (2) actual physical wastage at the surface of prodigious quantities of vitally important gas, resulting in lower ultimate recovery of oil from the reservoir; (3) underground losses, resulting from migration of oil and gas through defective wells, from productive strata to beds from which the fluids can not be reclaimed, and also from invasion of water into the oil sand; (4) erection of excessive storage facilities above ground, resulting in needless expense and actual physical losses due to leakage, evaporation and fire; (5) use of inefficient equipment, resulting in losses of oil, gas, reservoir energy and, at times, loss of life; (6) consumption of distress oil, forced on the market by over-rapid development, for purposes in which other fuels should be used; and (7) premature abandonment, as a result of demoralization of crude-oil prices, of thousands of small pumping wells; these, if allowed to continue to produce, would still yield a large aggregate of oil.

A large contributing factor to overdevelopment of oil is the so-called "law of capture," which makes it possible for any operator to extract all the oil he can drain from a pool, regardless of property lines. When a pool is opened competing operators are forced into a wild scramble to see who can draw the most from the common pool. Gas is wasted in huge quantities, and gas pressures, so necessary for the effective recovery of the oil, are destroyed. The possibility and desirability of changing this law are being vigorously discussed.

To offset the effects of the law of capture, unit operation of pools by cooperative agreement has long been recognized as a desirable procedure. This method has been applied in a few cases on the public lands, with notably successful results. However, voluntary cooperation to this end has usually failed, and the authority has not existed for legal coercion.

Copper mines are laid out with a certain price level in mind and with a certain anticipated life. When prices collapse, due to unrestricted production, the initial plan of operation must all too often be discarded. Operators are driven to neglect the most elementary work of maintenance and are driven to "selective mining," thereby reducing the average value of the ore left behind and at the same time increasing future cost of recovering it. When pillars previously left for support contain bodies of high-grade ore, operators are forced to take them out, thereby allowing old levels and stopes to cave. As the shut-down continues, the damage grows progressively worse. Shafts and main haulage-ways collapse. Barren rock and ore are crushed and mixed together, making future separation difficult or impracticable. In Michigan and elsewhere mines are filling with water. If the present shut-down of our copper mines continues for many years more, there will be huge tonnages of ore hitherto counted as 10-cent or 12-cent copper that will actually cost 15 cents or 17 cents. Since the upset in copper-mining conditions, the actual grade of copper-bearing ore which it has been necessary to mine to meet the market has been over twice as rich as that recovered under normal conditions.

Similar conditions may be cited for the iron, lead and zinc industries, but the illustrations cited will serve to indicate the nature of the problem. It is to the possible remedies to which I want more particularly to direct your attention.

To make a long story short, the situation requires a more stable adjustment of production to demand and more uniformity of price and production conditions to make possible the planning and application of conservational practices. The industries concerned have long desired this, but have been handicapped in cooperative effort to this end by the anti-trust laws. Ineffective steps were taken under the Appalachian coal decision and under an agreement of oil-producing states, but the effect in both cases was slight. Sporadic collective efforts, skirting the edge of the anti-trust law, have temporarily improved conditions. With the enactment of the NIRA, production, capacity and price control became openly possible. The coal code effected a certain measure of production control through control of prices. Under the oil code production was controlled by the states under allocation of quotas from the central administration in Washington, later supplemented by special control of interstate commerce in oil shipped in excess of state allotments. The copper code contained provisions for reduction of stocks which in effect was a measure of production control. The lead and zinc codes contained provisions for production control which were not utilized. There is no question that the efforts to control production and prices aided greatly in the stabilization and improvement of conditions in the coal, oil and copper industries. Whatever the merits or demerits of the NIRA as a whole, the opportunity for cooperation which it offered to the natural resource industries was a definite gain for conservation.

With the destruction of the NIRA by the Supreme Court decision, production, price or capacity control becomes illegal, and the mineral industries most concerned are casting about for legislation which will permit their efforts toward cooperation for production control. While all the mineral industries most concerned have objected to some phases of the NRA

control, it is an interesting fact that without exception they are now asking for legislation which will reinstate production control, either by the Federal Government or, as in the case of oil, by the legalization of interstate compacts. Bills are now before Congress for accomplishing this result for coal and oil, and one is proposed for copper. Agriculture has long enjoyed the certain privileges of cooperation, such as those allowing cooperative marketing in the McNary-Haugen bill of 1926.

The Planning Committee for Mineral Policy, in its report to the President of December 1, 1934, in view of the emergency nature of the NRA, had recommended consideration of permanent legislation which would make possible the balancing of supply and demand in mineral resources in the interest of conservation. This is the problem that is now squarely before us. Its solution is now called for both in the interests of national welfare and for the preservation of the mineral industries. In essence the question is one of creating exceptions to the anti-trust laws for certain specified reasons and with specified controls.

What we have in mind is briefly, first, a statement of need and purpose of conservation of certain natural resources, calling attention also to the fact that the mineral industries, by their very nature, are partly interstate, because they are so largely consumed in states where they are not produced, and that conservation is clearly a matter of federal interest. It is proposed that the President should be given the right to allow voluntary cooperation to industries engaged in extraction of limited natural resources where the President finds (1) that unregulated competition has caused and will cause serious waste of an irreplaceable resource; (2) that stabilization of supply and demand by control of production, price and capacity will aid in reducing waste; (3) that the proposed code contains such additional provisions for the improvement of technical standards and the elimination of wasteful practices as seem to him reasonably attainable; and (4) that the proposed code contains provisions for the fixing of maximum prices, if necessary, by a public authority sufficient to protect consumers against unreasonable advance in price.

In other words, if an industry can make an affirmative case that its wastes are large enough to be a matter of public concern; that they are due to a lack of cooperation; that they can and will be remedied by cooperation, and if the industry will accept sufficient public supervision to insure that cooperation will be used for this purpose and not misused to collect excessive profits, the President may authorize these specific exemptions from the anti-trust laws. If the conditions for exemptions are not carefully specified, there is likely to be a rush for exemption on the basis of generalizations and promises. It would be easy to use the word conservation as a mere expression of good intentions. So far as we can now see, the only mineral commodities likely to qualify for exemptions as thus defined are coal and oil, and less certainly iron, lead, zinc and copper.

I do not go into the question of the relative merits of the various devices for cooperative control of production which are now being vigorously discussed. These vary for different industries, and it is altogether likely that false starts will be made before an effective procedure is found.

We further believe that we should look for the real driving power to enforce cooperation in the self-interests of the industries rather than in compulsion from the government. The natural urge toward efficiency and self-preservation, so clearly manifest in the mineral industries, coincides to a marked degree with the requirements of conservation. Also so much of the power for public compulsion now resides in the scattered police powers of the states rather than in the Federal Government that it is difficult to see how it can be effectively utilized in any uniform plan of compulsion. Under these circumstances voluntary cooperation seems to promise much the best chance of early and successful conservational results.

Of course such a program as here recommended would involve the establishment of some sort of a federal conservation board, with flexible power within the limits imposed by the general enabling act.

Whether legislation will take the form of a general enabling act for all minerals or special acts for different minerals remains to be seen. At present the trend in Congress is toward separate enactments.

May I remark parenthetically that a considerable part of this program, at least, seems to be possible without amendment of the Constitution, because it hinges essentially on exemptions from the anti-trust laws. Congress has already provided several exemptions from the anti-trust laws. Farmers and laborers were exempted by the Clayton Act, approved shipping agreements by the Shipping Act, agricultural associations by the Capper-Volstead Act, cooperative marketing agencies by the Cooperative Marketing Act, export associations by the Webb-Pomerene Act, railroad consolidations by the Transportation Act and AAA marketing agreements by the Agricultural Adjustment Act.

The plan of production control by voluntary cooperation under government supervision, which I have briefly sketched, is one generally favored by the Planning Committee for Mineral Policy, but there are other plans. A considerable part of the oil industry is now turning toward a wider use of the police powers of the states to restrict production, and is

asking Congress to legalize interstate compacts and to supplement them by control of interstate commerce in oil produced in excess of state allowances. The difficulty is that only five of the states have oil conservation laws—Texas, Oklahoma, Kansas, New Mexico and Louisiana. California and Michigan and other oil-producing states have none. Furthermore, the states have no control, of the kind exercised by the NRA, over refineries, where much of the trouble is focused. Generally speaking, this looks like a stop-gap procedure based more largely on compulsory state powers than on voluntary cooperation, and the view of the federal oil administration is that sooner or later the industry may find it necessary to turn to the Federal Government for aid in stabilizing the industry by voluntary cooperation under government supervision. An administration bill of this kind is now before Congress.

Finally, there is the drastic alternative of outright nationalization of mineral resources to accomplish the desired results. Since the war there has been a rapid spread of nationalization in other countries, and it requires no gift of prophecy to predict that there will be increasing discussion of the possibilities of nationalization in this country. Certainly it will gain impetus if less drastic methods fail. In the space of this address I can merely mention this alternative as one which the Planning Committee for Mineral Policy regards as unnecessary and undesirable. It seems possible to accomplish the desired results by a method which will preserve a very large measure of private initiative which has so successfully developed the mineral industry.

(3) *Taxation:* Another important political factor in conservation is taxation. It is coming to be realized the world over that mineral resources are precious national assets, and the concept that they are a special heritage of the people is being reflected in rapidly multiplying special taxes applied to natural resources. In addition to the usual ad valorem and income taxes, there are royalty taxes, severance taxes, occupation taxes and tonnage or production taxes. In the state of Minnesota the heritage principle is frankly recognized not only in the multiplicity of taxes on iron ores but in the ad valorem taxation of iron ores at 50 per cent. of their value as against 40 per cent. for the next highest class of property. I state these facts not in the spirit of complaint against high taxes *per se*—all industries have this complaint—but to indicate its bearing on the problem of conservation. Whatever its purpose, special taxation of natural resources, without corresponding reduction of ad valorem taxes, is resulting in mounting costs, which for some minerals and some districts constitute a direct barrier to the best conservational practice. To get by, under the existing price conditions, it is necessary to mine only the best and cheapest ores. To-day on the Mesabi Range taxation is a large factor in forcing the concentration of mining on the cheapest open pit ores and holding back production from underground mines and from the class of low-grade ores that need beneficiation, which ought to be proceeding simultaneously if the Mesabi Range ores are to be fully recovered at reasonable costs.

The taxation problem is a complex one, with no easy solution in sight. It may well be that the needs of uniform revenue should to some extent override conservational considerations, but I think there are few students of the problem who do not feel that corrections and adjustments are possible in the interest of conservation. The most promising line of attack, as suggested by the report of our Planning Committee for Mineral Policy, would seem to be the possible abolition of ad valorem taxes on natural resources or more flexibility to adjust them to capacity to pay, and the substitution of production taxes of one kind or another, to be paid on the ores as they come out of the ground. The deadly repetition of ad valorem taxes on unused ore in the ground through a long series of years is piling up charges against reserves which are not likely to be compensated for by increasing prices in the future, and which will have to be absorbed to whatever extent is possible in cheap and wasteful methods of recovery, which will hasten extraction of high-grade ores.

(4) *Extension of Leasing Act to All Public Lands:* The slowing down of mineral development on the public lands, which started with the passage of the Leasing Act in 1920, has been a salutary step in the direction of curtailment of production to balance consumption. For instance, 15 per cent. of our measured oil reserves are to-day covered by the Leasing Act on the public lands, but only 3 per cent. of the production comes from this source. Our committee believes that the extension of the Leasing Act over all minerals in the public lands, except possibly for Alaska, would be a step in the direction of conservation and a necessary corollary of any general plan of production control.

(5) *International Considerations:* I have indicated some of the political elements of the conservation problem in our domestic field, but these alone will not solve the problem. The United States does not exist in a vacuum. Our minerals are involved in international trade and are influenced by tariffs, international trade agreements and cartels, and the so-called "open door" or "closed door" policies for mineral development.

The world-wide flare of economic nationalism has resulted in the overdevelopment of the world's min-

erals in the attempt to make each country as nearly as possible self-supporting, both in war and peace. This has lessened international trade in minerals and the products into which they are made. The pressure of surplus production and capacity has tended to lower world prices. At the same time, the domestic consumer of some minerals in some countries is paying excessive prices for the development of low-grade and marginal supplies under the protection of tariff walls. From a world standpoint there is the same need, in the interest of conservation, for balancing supply and demand as in the domestic field. Various international trade agreements and cartels are to be regarded as the first step in this direction, and on the whole as conservational in their effect.

In analyzing the practical effect of the world situation on our domestic problem of conservation it should be remembered that our principal wastes are confined to a small group of minerals which are developed in surplus—oil, coal, copper, lead, zinc and iron. The stabilization of these industries at a high enough price level to permit proper conservational practice will undoubtedly limit our export trade in competition with the rest of the world. This trade, however, is already being rapidly lost through the growth of competitive centers elsewhere, and could be recovered, if at all, only by cheapening our products so greatly as to intensify the already great wastes inherent in unregulated competition. Our export of coal has always been a negligible part of our production. Export of oil has been large, but is rapidly disappearing under foreign competition, and probably should disappear because our known reserves are already small for our own future use. Our former large copper exports have dwindled almost to the disappearing point, except for a recent flurry which can be traced to war preparations abroad, and it seems likely that most of this market is permanently lost because of competition of new great sources abroad in Chile and central Africa. Export of lead and zinc has been negligible. Export of iron ore has been limited to very small amounts to Canada, though our manufactured iron and steel products have enjoyed a considerable foreign market. This market also is diminishing because of intensified competition abroad.

In short, the export trade in minerals is disappearing anyway, and the further loss which might result from stabilization of domestic industries on a plane which would permit of conservation would seem to be a relatively small sacrifice to offset the gains in conservation which are possible in adjusting the industries to our own markets at reasonable and steady price levels and the lengthening of the life of our own limited supplies. However, we must face the fact that it is a sacrifice, and the gains and losses must be carefully weighed.

Such a program involves the maintenance of tariffs for the surplus minerals and their adjustment to protect whatever standard of domestic economy we may set as our goal. Tariffs should be regarded as supplementary measures to protect situations built up in this country, and not as the principal instrument for such building. History has shown that some of our mineral tariffs designed to raise domestic standards, as in oil and coal and copper, have not in themselves brought about the desired result. By deciding first on our domestic program of conservation, we can then better judge the size of tariffs necessary to protect the situation.

There remains to mention another group of about 20 industrial minerals for which this country has always been dependent, wholly or in part, on foreign sources, and is likely to remain so. Much can and should be done in the way of development of some of the low-grade and marginal supplies of these minerals which we possess, but again history has shown that tariffs have been an ineffective method of bringing about this result and have merely expedited our raid on the few high-grade deposits available. Some of these minerals, like mercury and manganese, are very essential for war purposes, and the early exhaustion of very limited high-grade deposits existing in this country would be disastrous to future preparedness. If further discoveries of raw materials and development of technological processes to make them available should largely increase our supplies, then tariffs might be necessary to protect the industries, but only then. As a substitute for tariff our committee has recommended direct expenditures or subsidies by our government and states as likely to bring better results, as illustrated by the successful development of potash and helium by this method.

Conclusion

In briefest summary, then, the mineral conservation problem of the United States comes down to the following elements:

(1) Continuance of technological and scientific improvements already under way.

(2) The balancing of supply and demand in our so-called surplus industries at a price level which will permit of proper conservational practice; this to be accomplished by voluntary cooperative efforts of the industry under government supervision, through legislation which will exempt them from the anti-trust law; the exemptions from the anti-trust law in the interest of conservation to be specifically defined and public supervision to be provided to make sure that the wastes on the basis of which exemption is claimed can and will be eliminated.

(3) The legalization of some method of coordinating

the highly chaotic efforts of the individual states under their police powers, and support any collective efforts the states may attempt. Much of the authority necessary for production control now exists only in the police powers of the states. Since the Supreme Court decision, Washington is now struggling with the problem of finding authority for any national control. On the outcome of this major issue of federal versus state rights will depend largely the success of any effective program of conservation.

(4) Federal control of interstate shipments of minerals shipped in excess of quotas set by the state police powers.

(5) Possible abolition of ad valorem taxes in favor of taxes of one kind or another on current production.

(6) The use of tariffs for the surplus group which will protect any domestic economy built up in the interest of conservation, which may result in some further sacrifice of our already dwindling export trade because of the necessary maintenance of domestic prices above the world level.

(7) For the deficient group of minerals derived in part or in whole from foreign sources, to desist from a tariff program which merely hastens the exhaustion of our limited high-grade supplies and to substitute direct expenditure by the government on the problem of finding additional supplies.

In the last analysis, the practical basis for mineral conservation is voluntary cooperative effort under permissive legislation, which will carry safeguards against its misuse. The natural evolution of the industry, under the driving power of self-interest, has been in the direction of larger commercial units and cooperation. The relatively few large sources of mineral supply create a situation which lends itself to concentration of commercial control and even monopolies for some of our minerals. As the units of the industry, commercial or cooperative, grow in size and power, there is an inevitable growth of public interest and concern. Cooperation and public supervision are complementary and parallel developments which are not in conflict unless one or the other proceeds too fast. It is the hope and belief of our Planning Committee, based on the history of the few cooperative efforts thus far tried, that in the long run enlightened self-interest of the industries and the public interest may be made to coincide in a common program, which will avoid, on the one hand, the extreme of nationalization now gaining so generally in other countries, and on the other, the extreme of unregulated competition which is proving so disastrous both to the industries and to national welfare.

We recognize the fact that private industry has successfully developed the minerals of the United States to an extent never before approximated in the world; that the job on the whole has been done efficiently and without greater wastes or mistakes than were more or less inevitable under existing conditions of enforced competition and widely scattered ownership of the resources; that the record of the mineral industry in the United States warrants the presumption that it should continue to develop so far as possible under private initiative. However, we also believe that our mineral heritage is vested with a public interest in those specific conditions which are distinctly detrimental both to the public and to the industries themselves and which seem beyond the power of the industries themselves to remedy. To be frank, some of us do not think that the brains exist which are competent to produce a fool-proof plan broad enough to cover all the shifting variables of the problem, but, on the other hand, we are not content with a defeatist or drifting attitude, and hope that cooperative planning will produce some if not all of the desired results. Rugged individualism, with all its merits, seems ill-adapted to realize, unaided, the present political and economic requirements of conservation.

OBITUARY

CHARLES ROBERTSON

CHARLES ROBERTSON is a well-known name in ecological and entomological circles. He was born at Carlinville, Ill., on June 12, 1858, and died on June 17, 1935. He was the son of the community doctor and after a selective course of study at various institutions began an intensive study of the flower and insect relations in an area twenty miles on a side around the city of Carlinville. This study was carried on intensively through a period of forty years and is perhaps the most detailed of any work of the kind ever done. It involved a minute study of the flowering plants and of their insect visitors together with the climatic conditions which govern their growth. In order that this might be done Robertson was called upon to describe some plants and many species of hymenoptera, diptera and lepidoptera. His collections are models of neatness and completeness. His type species are still within his collection. The results of his work are mainly presented in a series of articles entitled "Flowers and Insects," which appeared at irregular intervals for a period of thirty years, being printed in the *Botanical Gazette,* Transactions of the St. Louis Academy of Science and *Ecology.* His numerous descrip-