Property rights for mineral resources

by Knud Sinding, Richard Poulin and Douglas MacDonald

Information problems associated with making efficient land use decisions are highlighted. The central problem is that information on the different possible land uses is not collected until the resource stock comes under some form of pressure.

The authors argue that one possibility is to exploit economies of scale and pool the resources of private investors and government to produce comprehensive assessments of the total resource base.

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The issue of property rights for mineral resources has received increasing attention in recent years as a result of efforts, particularly in North America, to protect wilderness areas from development. Similarly, ongoing efforts to reform mining legislation in a range of countries in all parts of the world has focused attention on the nature of mineral property rights.

A distinctive feature of mineral resources is that as long as they remain undiscovered there is little purpose in having ownership rights specifically allocated. On the other hand, once a discovery has been made, efficiency considerations point to a precisely defined and exclusive right to extract the resource under a private ownership regime. The problem of determining when the transition to private ownership should take place is further complicated by the fact that mineral resources exist alongside other environmental resources for which a private property regime is not necessarily preferable.

The different property rights regimes suitable for each type of resource must somehow be reconciled in those situations where a transfer from one to another is necessary in order to accommodate resource development. The timing of this transfer is also of great importance because of the link between security of ownership, exploration investment, and the information on which the decision to make the transfer is based.

In this paper we examine the characteristics property rights arrangements in relation to mineral and environmental resources. We then describe the special features, lack of information about location and extent (and by implication, value) of deposits which characterize mineral, and other environmental resources. Based on this analysis we propose a new approach to that aspect of mineral policy which concerns allocation of mineral property rights.

The first four sections below briefly introduces the concept of property rights, the specific nature of property rights to mineral resources and the steps involved in the sequential mine development process, followed by an examination of environmental resources from a property rights perspective. The fifth section describes the information gathering process as it applies to mineral resources, in terms of government efforts directed at land use planning, government financed exploration directed at assisting the mineral industry, and private exploration activities. The discussion in the sixth section develops the idea that both mineral tenure regulation and the policies of exploration companies need to take the attributes of other environmental attributes into account.

Property rights

Definitions of property rights and ownership arrangements highlights the different aspects of the institution. One emphasizes the fact that property is not something physical but rather a stream of income or benefits which are derived from a physical or financial asset. As a consequence of this view, a property right can be conceived as the right to consume, obtain income from, or alienate the asset.[1] Another view emphasizes the ownership institution or property right as part of an incomplete contract. Here, the central feature of ownership is possession of residual decision rights related to the asset, and the allocation of residual returns.[2] Residual control refers to the right to take any decisions regarding the use of the asset which are not already regulated, either by law or through a contract. The other feature which characterizes ownership or a property right is that the owner receives whatever returns are left when everyone else has been paid (the residual).

However, while the advantages of the property rights institution is intuitively clear, these definitions do not in themselves explain its existence or why it emerges. It is possible, as shown by Bush and Mayer, to have equilibrium in a situ-

ation where anarchy prevails and everyone steals from everyone else. In the same model it is shown that there are gains to be made from setting up and enforcing a framework which recognizes private property.[3] This model provides the foundation for explaining the existence of the state in advanced societies.[4] The "accountability" and "polluter pays" principles[5] are attempts to deal with externality problems arising from incompletely defined property rights.

The ownership institution can then be subdivided into four distinct categories or regimes under which the property rights of individuals or corporations are determined.[6] The first, common property regimes, involve collective management of an expected future stream of benefits rising from the resource, and may be found, for example, on a tribal hunting ground. The second, open access regimes involves resources which exhibits an absence of management, and for which no property rights have been allocated. Compared to common property regimes, this absence of property rights can result in sharp differences in extraction policies because withdrawal or harvesting is not regulated in any way. Fish stocks outside the 200 mile limit are examples of open access regimes, where overfishing cause depletion of stocks because each fisher is maximizing private profit, regardless of stock effects. If a resource is managed by government we have a state property regime. This removes most managerial discretion from the user and generally conveys no long-run expectations in terms of tenure security.[7] The harvester is granted usufruct rights on the land. The difference between state and common property regimes is that under the latter regime individuals are acting on behalf of a group in which they have a direct interest and some collective action duties, while under the state property regime collective choices are made by representatives who do not have a direct interest in the resource. Finally, if only one individual or corporation is alone responsible for the management of the resource asset, we have a private property regime. Private ownership is frequently the solution prescribed for solving the "Tragedy of the Commons" problem[8] which can be associated with open access (and some common property and state property regimes with elements of open access). The advantage of private property is that it allows exclusion of other users, and therefore may provide an incentive to manage the resource asset in such a way that it is not depleted, or in the case of non-renewable resources, extracted in a less than optimal way.

Mineral property rights

In an analysis dealing with aboriginal property rights arrangements Martin Bailey noted that high variance of individual success in hunting, and superior productivity of group techniques, produced a situation where public information about resources, and common property ownership arrangements over hunting grounds, was the most efficient resource management regime.[9] A similar argument can be applied to mineral resources, in the sense that there are efficiency gains to be obtained by pooling exploration efforts in the early stages of the exploration process[10]. As long as a mineral deposit remain undiscovered somewhere below ground there is no incentive for individuals or firms to secure [private] property rights to them, unless doing so is castles. Undiscovered in this case does not necessarily refer to individual mineral deposits, but can also refer to mineral provinces or areas in the vicinity of discoveries. However, before information on the [possible] presence of minerals becomes available there is little incentive to secure private property rights to the subsurface (assuming that this is separate from the surface, see below).

This all changes when information becomes available, and the incentive to secure private property rights becomes an issue of paramount importance before further investment in information gathering can take place. Once rights have been assigned investment can proceed, but the amount will depend on the quality of the property right in terms of the privileges it confers on the holder, and on how certain he or she is of keeping it.

In the period before the "race for property rights"[11] begins, mineral deposits may in principle be looked for by anyone, subject to property rights to other resources or assets. In this sense undiscovered mineral resources may be considered open access resources unless there are special regulations governing the early phases of exploration. Even then, there remains an open access element, since it is impossible to prevent anyone from analyzing existing publicly available data or data obtained without interfering with existing property rights (e.g. airborne surveys and remote sensing data).

In historical terms, there has not, until recently, been much conflict between competing land uses. Mining has usually been considered the "highest and best" use of the land.[12] That this has been the case was natural because for most mines the value of the orebody has greatly exceeded the market value of the land on which is located. It is only with the realization that wide ranging spatial externality effects occur in mining and that the size of the area effected has grown to an extent where it is no longer as obvious that mining is the best land use.

Property rights arrangements for minerals, which have partly been based on the "highest and best" land use assumption, have followed two distinct traditions. In the Anglo-Saxon common law tradition the surface and subsurface (mineral) estates are considered as being originally granted to one individual, although it may later be split into separate surface and mineral properties which can then be traded separately. In contrast, continental European law has always made a sharp distinction between the two estates and commonly vested minerals in the sovereign or the state, in a tradition which goes back to roman times.[13] More

recently the common law tradition has moved closer to the continental model, as in Australia, where land grants no longer include the subsurface, and where some state governments have re-expropriated previously granted mineral rights which were part of land grants.[14]

The other important aspect of mineral property tradition is the principle of "res nullius", according to which some things are owned by nobody until they are appropriated by someone. This principle, which also evolved in central Europe, underlies the mineral property allocation method known as claimstaking and widely used in Australia, Canada and the United States.[15] The result is that mineral rights are granted on a "first come, first served" basis. This type of system is usually complemented by obligations on the part of the holder of a mineral right to carry out exploration work, make payment to government, or both.

The commonly used alternative to claimstaking as the mechanism for property right allocation is discretionary allocation or some form of auction. Under discretionary allocation, the jurisdiction with control over the mineral resources can base the allocation on purely arbitrary criteria or on what is in it's own best interest. This approach is used in many countries for minerals as well as for petroleum resources. Auctions, either in the form of cash bidding or as work commitment bidding are less used (an exception is the US. outer continental shelf) although cash bidding is favoured by economists for efficiency reasons.[16] Furthermore, the use of cash bidding seems almost nonexistent in hard-rock minerals, one rare exception being state lands in Michigan in the United States.[17]

The mine development process

Once a discovery has been made the usual procedure is to investigate it in ever more detail, until a development decision is made. The mine (or reservoir) is then developed and production commences. This process is in itself quite complex, combining multivariate statistics for reserve estimation, a range of engineering studies and forecasting of the future price of the commodity to be produced. An integral part of the engineering design is compliance with detailed environmental guidelines concerning location of waste dumps and norms for other emissions from the operation. This latter element in mineral projects has grown in importance in recent decades, and has seemingly resulted in higher costs in the mineral industries. Given that these costs have to be added to other costs it is clear that, at least in a static sense, each unit of material extracted must have a higher value if an unchanged return on investment is to be maintained. The result is that mines select higher cut-off grades in order to increase the unit value of the ore.[18]

In some cases, however, the orebody may not be of a sufficient quality (in terms of grade distribution and tonnage) to support the additional environmental costs. Thus environmental constraints may result in some orebodies not being developed, while others are able to carry the additional cost of environmental protection. This is a consequence of environmental regulation which would be logical were it not for one problem.

When an exploration project has progressed to a point where environmental issues are considered, the amount of sunk cost in the project may be very considerable. The problem facing government decision makers is to balance the benefits of continuing development against the cost of environmental degradation. If development is prohibited, either directly through a government decision, or indirectly if environmental costs are sufficiently high to prevent development, the benefits of this decision has to be weighed against the costs, which includes both the foregone benefits of development and that part of the exploration investment which is a sunk cost. However, when the reason is too high environmental cost, technological development may change the situation by devising lower-cost production methods and methods to comply with environmental regulation that was initially detrimental to development.

This problem of loosing mineral assets or having them immobilized is probably not uncommon in countries with strict environmental policies. One of the more celebrated examples is the Windy Craggy copper-zinc deposit in the extreme Northwestern panhandle of British Columbia, a Canadian Province (for the moment). In this area a very large and rich deposit has been outlined on claims originally staked in the 1950s and reexplored in the 1980s. The Government of British Columbia has refused development permission for the mine and has, in order to create a provincial park, expropriated the claims hosting the deposit as well as a considerable number of adjoining claims. The matter of compensation for the expropriation is now under consideration.[19] A similar case in Australia (Coronation Hill and the Kakadu national Park in the Northern Territory) prompted Antony Cox to distinguish a trend where mineral and conservation interests increasingly clash over the same small areas of land.[20]

Much of the conflict can be traced to the traditional way in which mineral property rights are distributed, before knowledge about minerals and other resources has been obtained. However, the specific response of governments to such cases (especially those with a high public profile) has been marked by an ad-hoc approach which does not deal with the underlying problem of inefficient exploration investment.

Environmental impact of mining

Extraction of minerals may have a range of impacts on their surroundings, both locally and regionally.[21] The extent of these impacts depends partly on the nature of the mining operation, partly on the efforts made to reduce impacts, and partly on local conditions (climatological, geological and topographical). For the purpose of the present discussion it is

convenient to distinguish between those which occur in the immediate vicinity of a mine, and those occurring farther away, and between those impacts which occur during mining operations, and those which occur at a later time (sometimes for very long periods afterwards).

The most intensive impacts of mining occur close to the mine and during its operation. They include noise and vibrations (from blasting and equipment), dust emissions from mine ventilation and mineral processing plant, contamination of surface waters through surface runoff and process water discharge, groundwater contamination as well as visual impact. At greater distances, the impacts are less intense, with contaminated waters being diluted and some dissolved or suspended materials precipitating or settling out. Contaminated groundwaters may also eventually be diluted to a significant degree.

In terms of temporal distribution of environmental impact of mines the greatest intensity is also concentrated during mining, noise, vibration, dust and process water occurring only during the operating phase. Contamination of waters may, however, persist for very long periods in situations where large scale surface disturbance is involved. The most important aspect of this is the occurrence of acid rock drainage, where precipitation onto mine wastes can form highly acid liquids which in turn can leach out significant amounts of heavy metals and pollute rivers and lakes.

The impacts of mining can, in the absence of any regulation, cause very severe external effects, both during and after mining. The various forms of environmental regulation applying to mining operations are attempts to eliminate or mitigate these effects. However, the process of environmental regulation in this case is in a sense quite retroactive. Orebodies tend to be found in unexpected places and it is only after a discovery has been made that much attention is given to the environmental regulation of this orebody. This results in uncertainty about expected future environmental cost in the event of development and this uncertainty will be reflected in the decisions made in the exploration phase.

Public goods and property rights to other resource assets

One of the competing uses of land with mineral potential is as supplier of unspecified environmental goods and services, some of which have public good characteristics (non-rivalry in consumption and non-excludability). When use rates are low to moderate and the cost of exclusion high, the environmental resource must be considered close to being a pure public good for which the appropriate management form is open access. If congestion becomes a problem, some of the public goods character (non-rivalry) disappears. Introduction of a resource management system to solve the congestion problem removes the other defining feature of public goods, non-excludability.[22]

If a mineral deposit is known to exist in an area from which some public environmental good is derived, the problem facing the government is fairly straightforward. It is one of determining the costs and benefits of a planned mine development to those of retaining the area in a non-developed state. The development costs and benefits must be considered both without and with measures to minimize externalities, and it must be recognized that sufficiently strict environmental constraints effectively constitutes a development ban. As in all cost benefit situations, availability of information on the non-development environmental values is a major challenge.

Determining the optimal tradeoff between environmental protection measures and development benefits assumes that the fundamental decision to allow exploration and unspecified development to take place has been made in principle. Thus it is at the stage when the basic permission to allow exploration, and by implication, exploitation, that the government as overall resource manager has to decide whether development is desirable or not.

Information availability and allocation of mineral rights

When the basic decision on whether or not to allow exploration and subsequent exploitation is moved forward to the time when exploration is first proposed, the problem facing government as resource manager is lack of information, but now at a stage where even less is available. Before exploration commences nothing is known about the value of minerals possibly present, while at the same time the quantity of information needed about environmental values remain basically unchanged.

In their most extreme form, these information needs tend to create a Catch-22 situation. On the one hand investment in mineral exploration information will only occur when the investor has a reasonable chance of recovering the investment (and this is in a business where risks are already high for natural reasons – although this risk can be partly eliminated by diversification.[23] On the other hand, the government as owner and manager of the complete resource portfolio has to award exploration and exploitation rights without knowing whether a discovery will be made or what the alternative public goods value of the area affected by mining is.

The challenge facing government is to devise a structure of incentives which encourages applicants for exploration rights to provide sufficient information to allow government to determine whether or not development can proceed in the event of a discovery. as well as information required to determine specific constraints. Although this places a further burden on investors in terms of expenses they have to

undertake before they obtain any mineral right it has the advantage of making it possible to create mineral rights with a high degree of secure tenure.

Lack of information at the time when mineral exploration is initiated prevents the resource manager from making a well-founded decision about whether or not to allow exploration and possible later development in any particular area. The information the manager is missing concerns the nature and value of environmental resource assets present in that area, and the extent to which these can be adequately protected with normal environmental regulatory tools. The result of traditional mineral management procedures, lack of information, means that it is sometimes necessary to recind implicit or explicit commitments to allow mining when more information about the value of affected environmental values becomes known. This has unfortunate consequences both for investors and for society as a whole, in terms of higher risk and economic inefficiency.

The consequences for investors are twofold. First, the possibility that the development opportunity generated through exploration may be withdrawn adds to the uncertainty faced by investors. Second, if the uncertainties increase substantially, the level of exploration in the jurisdiction may be significantly reduced and in the process exploration firms accumulated human capital in the field of mineral exploration may be lost.

For society as a whole there are several undesirable effects. One is that, as a result of withdrawal of mineral rights for reasons of environmental protection, investment in exploration is likely to decline, leading to a lower utilization of the jurisdiction's natural capital stock. Another effect is that ex-post withdrawal of mineral rights involves a social loss in that exploration investments are to a large extent very site-specific and therefore sunk costs.

Incentives for provision of comprehensive information in mineral exploration

Mineral exploration is a sequential process in which information is gathered in stages primarily determined by the various investigative methods used. At the end of each stage the available data are assessed before a decision is made to proceed with the next stage, which is almost invariably more expensive and always more detailed in focus than the previous stage.

For exploration to proceed a permit may not be necessary. Airborne geophysical surveys and remote sensing methods which are important tools of the trade, do not interfere with anything on the ground.[24] Once on the ground, however, some form of official sanction is frequently required, if nothing else to regulate relations with surface owners and users. It was argued above that such a sanction should include a basic right to explore and exploit, subject to more detailed constraints to be determined during the exploration process and the project assessment period (the time when the mining company analyzes the data to determine whether a development decision should be made).

The initial land use decision allowing access, and thereby accepting mine development in principle, cannot rely on information produced by exploration firms. The risks these firms face in obtaining the additional environmental data are likely to preclude investment in such data, and if these date were required to gain entry, little or no investment would occur. At the same time the resulting information may be unreliable as firms interested in being allowed entry may misrepresent or suppress adverse items of information.

However, just as there is a case for using state sponsored research and geological mapping in the very early stages of exploration[25], there is a similar case to be made for including environmental information in this type of research effort (thereby possibly also gaining economies of scale).

Providing incentives for acquisition of more detailed environmental data as exploration proceeds will depend on the extent to which the environmental constraints are known in advance. If these are well established, for example in terms of maximum allowed emissions from a site to various media (surface waters, ground water, air, soil), then the mining firm will have the incentive to obtain the data required to determine, at each stage of the exploration process, whether or not it is feasible to proceed to the next stage.[26]

If the environmental constraints are not, or cannot be defined a different approach is needed to produce the information required to determine whether or not exploration should be allowed or not. This information will be of interest to individual firms as well as to government in the same way that exploration information is of general interest because information on one area contains an indication of conditions in adjoining areas. This public goods characteristic[27] is one of the arguments in favour of government funded exploration investment (the other argument is that uncertainty about the future leads private firms to underinvest in mineral information gathering.[28]

Conclusion

Mineral rights have evolved to promote economic efficiency by eliminating the costs of protecting mineral assets from appropriation by others, but not for purposes of land use planning. However, the emergence of competing land uses has highlighted the information problems associated with making efficient land use decisions. The central problem is that, except in rare cases where the information base already exists, information on the different possible land uses is not collected until the resource stock comes under some form of pressure (mining proposals, national parks and any options in between).

The information problem results in a Catch-22 situation where mineral investment in information production requires a transfer of property right, but where lack of information on environmental resources must be in hand before the property right can be transferred. The observable symptoms of this problem is a scramble to devise ad-hoc solutions when contentious cases appear and the possibility of inefficiency when investment in exploration is made redundant by these solutions. Derived from this is a downward pressure on investment in jurisdictions which embark on the ad-hoc approach.

The traditional way of assigning mineral rights needs to be modified to take these information problems into account. One incentive is provided automatically if environmental constraints are set in general, i.e.. if allowable emissions and impacts have been defined and are applicable in all cases[29]. When the constraints are known, rational investors will evaluate each step in the exploration investment process based on expected costs and benefits, including those generated by environmental constraints.

It is more likely, however, that constraints will be vague and information lacking. Under these conditions the incentive to produce the information required before property rights are assigned is more difficult to design. One possibility is to exploit economies of scale and pool the resources of private investors and government to produce comprehensive assessments of the total resource base.

References

Bailey, M.J., Approximate optimality of aboriginal property rights, *Journal of Law and Economics* 35 (1 1992), pp 183–198.

Bromley, D.W., *Environment and economy*, Oxford: Blackwell, 1991.

Bush, W.C. and L.S. Mayer, Some implications of anarchy for the distribution of property, *Journal of Economic Theory* 8 (1974), pp 401–412.

Cornes, R. and T. Sandler, *The theory of externalities, public goods, and club goods*, Cambridge, Cambridge University Press, 1986.

Cox, A., Land access for mineral development in Australia, in *Mining and the environment: International perspectives on public policy*, ed. R. Eggert. pp 21–56. Washington, D.C., Resources For the Future, 1994.

Eggert, R.G., Exploration." In *Public policy and competitiveness in the nonferrous metal industries*, ed. H.H. Landsberg, M.J. Peck, and J.E. Tilton, 1992.

Gilbert, R.J., The social and private value of exploration information, In *Economics of exploration for energy resources*, ed. J.B. Ramsey, pp 173–215, Greenwich, Conn., JAI Press, 1981.

Hardin, G, The tradegy of the commons, *Science* 162 (1968), pp. 1243–1248.

Kuehne, G. and F. J. Trelease, The new West Greman mining law,19 (2 1984), pp. 371–394.

Leshy, J., *The mining law. A study in perpetual motion*, Washington D.C., Resources For the Future, 1987.

Mead, W., Oil and gas leasing alternatives, in *The environment of oil*, ed. R.J. Gilbert, Dordrecht, Kluwer, 1993.

Milgrom, P. and J. Roberts, *Economics, organzations and management*, Englewood Cliffs, NJ, Prentice-Hall, 1992.

Smith, B and A. Ulph, Property rights issues in the extraction of Australia's exhaustible resources, in *Industrial economics – Australian studies*, ed. L.R. Webb and R.H. Allen, pp 395–409, London, George Allen and Unwin, 1982.

Stevenson, G.G., *Common property economics: A general theory and land use applications*, Cambridge, Cambridge University Press, 1991.

Tilton, J.E., Mining waste and the polluter-pays principle in the United States, in *Mining and the environment: International perspectives on public policy*, ed. R. Eggert, pp. 57–84. Washington, D.C., Resources For the Fututre, 1994.

Notes

1. Bromley 1991.
2. Barzel 1989.
3. Milgrom and Roberts 1992.
4. Bush and Mayer 1974.
5. Cornes and Sandler 1986.
6. Tilton 1994.
7. Bromley 1991.
8. Bromley 1991.
9. Hardin 1968.
10. Bailey 1992.
11. This reason must be distinguished from the argument based on uncertainty about future market conditions, which indicates that government should invest in provision of resource information (Smith and Ulph 1982.
12. The term was used by in relation to the homesteading movement in the Western United States, Anderson and Hill, 1990.
13. Leshy 1987.
14. Eggert 1992; Kuehne and Trelease 1984.
15. Crommelin 1988.
16. Kuehne and Trelease 1984.
17. Gilbert 1981; Mead 1993.
18. At regular intervals announcements of auctions appear in trade journals such as the "Northern Miner" weekly newspaper.
19. Footnote: This assumes no change in other costs or in productivity. An alternative strategy might be to expand the production rate, but this assumes that the available capacity can accomodate this.
20. Northern Miner Newspaper, June 27, 1994.
21. Cox 1994.
22. Global impacts are not considered here. However, in relation to mining, the most important would be emissions of greenhouse gasses from mining equipment and from the use of explosives.
23. Stevenson 1991.
24. Gilbert 1981.
25. We will, for the sake of argument ignore questions of air space sovereignty.
26. The argument supporting this is that risk in this area is suficiently high to preclude private investment. International competition for investment may also support this argument.
27. Relying on this incentive means that the exploration firm must have a general idea about the cost of compliance in their specific case.
28. Gilbert 1981.
29. Smith and Ulph 1982.
30. This is likely to conflict with the prescriptions of environmental economics which suggest that regulation should seek to equate marginal environmental cost with marginal abmarginal benefit. Given the complexity and variability of mining projects creating such rules may be very difficult. ■