T-1400

AN ECONOMIC ANALYSIS OF FEDERAL LEASING POLICIES OF SELECTED MINERALS IN WESTERN UNITED STATES

By

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T-1400

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ABSTRACT

About half of the land in the eleven western states in the United States (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming) is owned by the federal government. The Bureau of Land Management (BLM) manages most of this land and receives a binding opinion from the United States Geological Survey as to mineral extent and workability. The future potential of mineral production from these states is greatly influenced by the leasing policies established by the federal government.

Private leasing systems and federal ones require the lessee to pay a production royalty or payment for using the owner's mineral resource, and a rental to insure production. Rentals are usually based on so many dollars per acre and royalties are usually a percentage of the value of the mineral sold. A minimum royalty is set up to prevent holding land without production. A bonus bid is a lump-sum payment at the beginning of a lease which may be used to decide who gets the lease, the highest bonus bid being the winner. Competitive leasing for known mineral deposits may be by oral or sealed bidding. A sealed bid is a function of the esti-

mated value of the resource, the desire for the resource, and the degree of expected competition.

Although coal, phosphate, potash, sodium, and sulphur have similar leasing requirements under the law, there are many differences. As a need has arisen, the laws have been changed to adjust to the problems on an individual basis.

Bureaucratic problems play an important part in policy formulation. Pleasing one's constituency may be as important as listening to economic logic. Where many agencies control the formulation of a policy, the result will probably be a compromise of many conflicting goals.

The present system of determining rental, royalty, and bonus bid payments for coal has grown out of the rapid expansion of fuel industries in the western United States. The fact that bids per acre have risen from $10.00 to $505.00 has opened the eyes of budget-minded federal employees. New rules soon evolved to increase the fair-market-value calculations to meet present market conditions. Linear regression techniques applied to data on royalty payments and production value showed that inequities exist in the present system.

Eliminating the minimum bonus bid, changing the royalty for all minerals to the same fixed percentage of gross value, and establishing a study group to evaluate the present leasing law system are some of the conclusions drawn from this study.

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Others not mentioned are not forgotten, but their number is too many to list. However, my thanks are expressed to all.

INTRODUCTION

One third of the United States is owned by the federal government. Mineral production on these lands is controlled and administered by many different government agencies, each with its own sometimes differing goals. Many mining engineers and mineral economists are concerned with the process of leasing because it directly affects costs and profits. But very little has been written concerning the leasing policies, terms, stipulations, laws, and how they are carried out. A better understanding of leasing can aid in a more efficient allocation of resources by saving time and money.

For the past year, I have worked for the Branch of Mining Operations, Conservation Division, U.S. Geological Survey, in Denver, Colorado. The Branch functions as one of the agencies which regulates leasing of minerals on federally owned lands. Prior to this, I worked for a private mining firm which mined potash on government leases in Utah. From these two occupations, lessee and lessor, I became interested in the subject of leasing policies.

Government leasing policies are constantly being

compared with private leasing systems, so I have chosen to begin this analysis with a look at private mineral land systems. The basic terms of any leasing system such as royalty, rental, and bonus bid are explained in this section so that the reader will be familiar with the concepts in later discussions.

Next, I discuss the historical background of the Mineral Leasing Act of 1920 and the events and laws leading up to its formulation. Competitive leasing is then explained and the practice of oral and sealed bidding discussed. The characteristics of a good leasing system will explain to the reader that what is often desired may be impractical to impose.

The section titled "Leasing in the Western United States" explains the location of mineral deposits in the eleven western states under study. It discusses why these states were chosen, what agencies have jurisdiction over the federally owned lands, and how important these states are as future mineral producers.

The Federal Leasing Laws for coal, phosphate, potash, sodium, and sulphur are next discussed in detail. These five minerals were chosen because they comprise the main solid nonmetallic minerals covered by the Mineral Leasing Act of 1920 for minerals on public domain land. Prospecting permits, preference right leases, and competitive leases are explained. The questions studied are: What is the duration

of a permit or lease? Who can apply? What does it cost? What are the bond requirements? How much land can one lessee hold?

Of the five minerals studied, coal is by far the most active. Leasing terms in connection with royalty, rental, and minimum bonus bid payments are constantly changing to try to reach a fair market return to the government. The unofficial guidelines for establishing these payments are discussed as an aid for future work in this field. There should be a clear understanding of the bureaucratic problems involved in trying to establish an equitable system.

The next section is an application of linear regression techniques in determining royalty payments. A short section of the theory is followed with the assumptions, the application, and then the conclusions.

The last section contains an overall summary of the thesis and conclusions drawn from the study. Throughout this paper the reader should remember that the role of the mineral economist in government planning is to act in an advisory capacity and leave the final decision for the policy makers.

PRIVATE MINERAL LAND SYSTEMS

To understand public mineral land systems better, a discussion of private mineral land systems in the United States will be given for background. Exploration, development, and production are separate concepts in most private mineral land systems. "Option agreements" can be entered into by prospective users of privately owned mineral rights under which the private land owner gives permission to do extensive exploration work before committing himself to a formal lease or purchase of mineral rights. The private exploration agreement has become a prevalent part of many private mineral land systems in the United States today. This type of agreement generally involves land that is not otherwise open for mineral exploration through state or federal public land.

For actual mining purposes and occasionally for exploration a "joint operating agreement" is proposed. This agreement is a contract between the mining firm and land owner whereby the mining firm is employed by the owner to enter and work the land for its mineral resources. Co-owners of private mineral lands may use the joint operating agreement to develop mineral deposits on a cooperative

basis. If separate mineral interest owners have adjoining lands, they may employ this agreement to mine their separate but contiguous resources.

Sometimes a private owner may suspect the presence of a valuable mineral on his land and will want to determine the feasibility of mining operations without giving up his mineral rights. The private owner has several basic types of arrangements which he can use. The first is the exploration option agreement under which the mineral seeker conducts exploration at his own expense, and if satisfied that a valuable deposit exists, can then exercise an option to lease the land for mineral production purposes. A second method is called the purchase option agreement; it differs from the first method in that upon completion of exploration work, the potential mineral producer's option may be to purchase the whole mineral interest or an agreed percentage of the landowner's mineral rights. In the latter case, the property is developed under a co-ownership arrangement. The purchase option agreement allows the mineral seeker the ability to explore before exercising or not exercising his option. A third basic arrangement is the lease contract. Usually the mineral seeker decides how much to explore and where to explore. Under this type of agreement the lease may be terminated for failure to pay rentals or failure to commence development or production operations. The fourth type of agreement is the straight

exploration contract; it is simply a contract for services to be rendered to the landowner and gives the exploration firm no interest in the minerals discovered.

These four variations have numerous objectives or standards which must be fulfilled. Some private mineral exploration arrangements have as a standard the drilling of a specified number of holes to a given depth. Others may require the removal of a certain quantity of overburden, driving a drift, sinking a shaft, or collecting a certain number of samples.

Under private exploration agreements payments may be for cash or payments in kind. Usually, payments in kind are limited to mining agreements. But sometimes payment may be in the form of corporate stock or other interest in the mineral rights. Payments can be in one lump-sum or in installments.

"Mineral development contracts" are similar to exploration contracts and are an employment contract between the owner of a mineral resource and an operator involved in actual mine development operations. These may involve a simple fee paid for services rendered or an agreement where the mine developer receives an interest in the mineral rights. Existing development contracts normally involve provisions regarding the rate of mining, use of surface lands, locations of excavations, supervision of work, and the manner and time of payment for the work.

Production royalty and land rental are common under private mineral land systems. These payments serve to assure the landowner a return in exchange for the utilization of his resources by others without incurring the risk. Production royalty is actually a share of production revenue usually without regard to the cost incurred in achieving that production. Sometimes the royalty agreement allows certain costs to be deducted from the revenues before the royalty is calculated.

The simplest form of royalty system involves periodic payments to the owner of the land (mineral rights) as the mineral is produced and sold. There is an innumerable variety of arrangements developed from this simple concept. These include overriding royalties, independent royalties, and production payments. Each has its own various legal and tax implications. Private mining leases may require the payment of a minimum royalty which is similar to land rent. It must be paid whether the mineral is being produced or not. "The possibilities are limited only by the imagination of the parties"(Helmich, 1960, p. 438).

There are many methods of calculating royalties, and a few will be discussed to demonstrate the variety. A landowner can base the royalty rate upon a given percentage of the value of the ore removed or on a sliding scale according to the quantity produced. The net figure used as the base to calculate royalties may be smelter returns, gross

value of output less specific expenses or some other figure. It also makes a difference if the royalty is to be paid where the material is mined, shipped, or sold.

Many factors dictate the base for computing royalties on private lands. The type of mineral being mined has a high influence because this affects the cost involved in beneficiating the product before marketing. The proximity of the mine to ore treating or marketing facilities is a second factor. The amount of profit contemplated can influence the royalty rate. Important to remember is that there is no standardized royalty rate throughout the mineral industry. There may be regionally accepted royalties and widely accepted royalty rates for particular commodities, but these rates may vary from one region to another and from one type of deposit to another.

Minimum royalties are payments made by the mineral producer to the lessor regardless of production. The basic purpose of a minimum royalty is to insure speed of mining and development to avoid the possibility of mineral producers tying up large areas of ground at little or no expense to themselves, simply to eliminate potential competition. Minimum royalty rates usually cover annual periods, but this is not fixed.

An overriding royalty is analogous to the amount of rent held out by a leasing tenant when he sublets his premises to another. The overriding royalty is normally cre-

ated when a mineral lease-holder transfers his operating rights by assignment or sublease, retaining his own or overriding interest. If a lease-holder does not have the capital to invest in the mine, he can assign the lease to a third party which does have sufficient funds, retaining for himself a percentage of production which overrides the landowner's royalty payments.

Leases of private mining land may contain provisions requiring the payment of advanced royalties or bonus payments at the time of the execution of the lease. Sometimes this advance amount may be credited against future royalties that become payable when production starts. If there is no provision for such credit, the lump-sum payment is usually termed a bonus payment and in effect constitutes the initial inducement to the landowner to award a mineral lease. The bonus payment may vary widely depending upon the anticipated value of the lease to the mine operator and the real or potential competition for the use of the land in question.

There is a lot of similarity between private and public leasing systems because the federal government has often used private leasing systems to determine the equitability of public leases. A letter from the Regional Mining Supervisor in Salt Lake City points out this comparison:

> Washington requested that I check into what the state of Utah charges as a tax for fee-owned coal lands where known reserves are being held for future use. It is thought the Government should

> reap a like amount by raising rentals on nontaxable Government lands to somewhat equal such a tax (U.S. Geological Survey, 1970a,p. 37).

More will be said on this subject later in discussing the present federal leasing policies.

HISTORICAL BACKGROUND OF MINERAL LEASING ACT

Originally the federal ownership of land was considered to be temporary. Under federal policy and laws the public domain passed into private ownership and became subject to state and local taxation. But the Act of 1891 (as amended, 16 U.S.C. § 471, 1964) made a major break with the past, and it became obvious that millions of acres of public domain would be retained and managed permanently by the United States government and would never pass into private ownership. This act set aside forest reservations, and today the Forest Service administers over 186.9 million acres in 44 states (Public Land Law Review Commission, 1970, p. 235). This is mentioned because it is the starting point for the change in retention of public domain by the federal government.

Leasing Laws

Federally owned lands are primarily concentrated in the West (excluding Alaska and Hawaii) and represent a large percentage of the individual state's total area. This is shown in Table I on the following page to illustrate the magnitude of the public domain in the western

TABLE I

FEDERAL LAND IN THE WESTERN UNITED STATES AS OF JUNE, 1966

PERCENT OF STATE'S TOTAL AREA

State	Area Owned by the Federal Government (acres)	Percent of Total State
Arizona	32,450,805	44.6
California	44,366,704	44.3
Colorado	24,038,439	36.2
Idaho	34,015,623	64.3
Montana	27,638,884	29.6
Nevada	60,971,262	86.8
New Mexico	26,726,733	34.4
Oregon	32,184,820	52.2
Utah	35,180,735	66.8
Washington	12,553,655	29.4
Wyoming	30,004,331	48.1

(Source: United States Department of the Interior, Bureau of Land Management, Public Land Statistics, 1967, p. 11)

states.

Until the beginning of the 20th century almost all minerals were included in the Mineral Location Law of 1872 (17 Stat. 91), with the exceptions of lead and salt deposits. Only coal had been included under a separate law (Act of 1864, 13 Stat. 343) that provided for the sale of known coal-bearing lands. Under the Mineral Location Act of 1872 there were many difficulties resulting from the fraudulent disposal of coal and oil lands and from prospecting for oil. Also the conservation movement was under way, and many people feared the dissipation of the nation's natural resources. The rapid growth of giant monopolies in the major basic industries (steel, oil, non-ferrous metals) increased the fear that the nation's resources would become monopolized, and the consumer would be at the mercy of the producer who could produce at whatever rate he desired. Probably the greatest single factor in adopting a new mineral law was the increasing importance of petroleum which was far different in geological and physical characteristics from gold, silver, and mercury for which the Mining Act of 1872 was designed.

Large areas of coal, oil, and phosphate were withdrawn in 1906 from entry under the Mining Act of 1872. Three years later laws were enacted which provided for the disposal of the surface of public domain under agricultural entries with a reservation of the minerals and the

right to remove them to the federal government. It wasn't long before considerable support grew for the disposition of coal, oil, gas, phosphate, potash, sodium, and similar sedimentary occuring deposits under a leasing system. With World War I came an emergency wartime measure (Potassium Leasing Act of Oct. 2, 1917, ch. 62, 40 Stat. 297) which provided for the leasing of potash on public domain land. Until this time most of the world potash supply came from Germany. World War I shut off this source of supply and forced countries to search for a domestic source. The Mineral Leasing Act of February 25, 1920 (41 Stat. 440; 441, 30 U.S.C. 211-214) included the leasing of coal, oil, gas, phosphate, sodium, and oil shale deposits. Sulphur in Louisiana was later included in 1926, and sulphur in New Mexico was added in 1932. The Potassium Leasing Act of 1917 was repealed in 1927, and potassium was then included with the Mineral Leasing Act of 1920. On August 7, 1947, the Mineral Leasing Act for Acquired Lands (61 Stat. 913; 30 U.S.C. 351-359) was passed which provided for the leasing of all minerals under the Act of 1920 on acquired lands.

Under the currently operating leasing system, the Department of Interior processes and evaluates applications for prospecting permits and leases. The BLM receives from the U.S. Geological Survey an opinion which is binding as to whether or not a valuable deposit of a leasable mineral is contained on the applied-for lands. The Geological

Survey also makes recommendations as to rentals, royalties, and minimum bonus bids and is contacted by the BLM before any permit or lease is assigned, relinquished, or cancelled. If an application has been made on lands under the jurisdiction of another agency such as the Forest Service, that agency with specific surface jurisdiction will recommend terms and conditions to be included in the permit or lease. If acquired lands in the national forests are involved, a permit or lease will not be issued unless the agency having surface jurisdiction consents.

Mineral Leases on the National Forests

Mineral leases on national forests are administered by the Bureau of Land Management (BLM) and can be either on public domain land or on acquired lands. Acquired lands are those lands which were at one time patented or otherwise in private ownership but have since been relinguished to the ownership of the government. For acquired lands the BLM collects the leasing fees and transfers the receipts to the Forest Service. The provisions of the Mineral Leasing Act for Acquired Lands state that twenty-five percent of the receipts are remitted to the states in which the national forests are situated (61 Stat. 915, 1947, 30 U.S.C. § 355, 1964).

Market conditions and especially prices received for

like quality minerals in the same area are criteria for determining the value of the mineral recovered on which the royalties are based.

> The actual or gross amounts received from rents, royalties, and bonuses are the amounts used in calculating the amount to be shared with the states (EBS Management Consultants Inc., 1968, p. LB-13).

The costs incurred by lessees in meeting the lease conditions and terms are not deducted from the rents, royalties and bonuses paid.

It is appropriate here to mention the disposition of money received from bonuses, royalties, and rentals from leases not on National Forests. The law (Pub. No. 146, 66th Cong, Sec. 35) states that 10% of the money received annually is paid to the Treasury of the United States and credited to miscellaneous receipts. Fifty-two and one-half percent is paid into the reclamation fund created by the Act of Congress, known as the Reclamation Act, approved June 17, 1902. A summary of these receipts is shown on the following page in Table II. Expenditures have totaled $16.5 million more than collections from the 11 western states studied. The remaining 37½% is paid to the state within the boundaries of which are located the leased mineral deposit. Of the money received by the state of Colorado, one-third goes to the State Department of Education, Public School System. Two-thirds go to the county in which the leased deposit is located up to a

TABLE II

SUMMARY OF RECEIPTS TO AND EXPENDITURES FROM THE RECLAMATION FUND BY STATE, 1902 - 1967

State	Total Collections	Total Expenditures	Excess Expenditures
Arizona	$16,091,654	$91,323,386	$75,231,732
California	131,548,738	526,853,955	395,305,217
Colorado	121,778,768	60,685,237	(61,093,531)
Idaho	15,532,420	54,281,729	38,749,309
Montana	61,895,266	12,618,275	(49,276,991)
Nevada	23,312,091	58,257,153	34,945,062
New Mexico	270,979,312	51,927,591	(219,051,721)
Oregon	26,535,570	52,229,304	25,693,734
Utah	103,573,002	94,448,947	(9,124,055)
Washington	4,213,966	166,983,362	162,769,396
Wyoming	417,786,395	40,286,940	(377,499,455)
Total	1,193,337,182	1,209,895,879	16,558,697

(Source: Table No. R-3, EBS Management Consultants Inc., 1968, p. 4) Appendix No. 2

maximum of $200,000 annually. Excess over $200,000, called spill-over, goes to the Department of Education, Public School System (Roberts, 1967, p. 1). Other states have similar arrangements but the distribution may be different. All the money for the state must be spent for public education or roads.

COMPETITIVE LEASING

The market structure of buyers is a very important factor in determining the sales policy employed in competitive bidding of leasable minerals. Perfect competition with many buyers may not exist because of geographical market restrictions. If only a few buyers are interested in the land an oligopsony would be present with the increased possibility of collusion. Sealed bidding would then have the advantage of discouraging collusion because all bidders would not be known by other prospective bidders. If the number of bidders is small, another principle can also be applied to obtain fair-market-value: the "minimum bonus bid" or refusal price is the lowest pre-established bid which will be acceptable for the resource. Whether bidding is by oral or sealed bid method, the bidder will usually estimate the value of the resource offered which includes a normal profit.

Characteristics of Good Leasing Systems

Characteristics of a desirable competitive bidding system are listed with reasons for their desirability. First, the lease should minimize any opportunity for holding mineral lands for speculation. It could be done by auto-

matically terminating the lease if minerals are not produced in paying quantities after a designated period which gives reasonable time for exploration, planning, construction, and testing. Another method is to provide for high annual rentals which begin to accrue a few years after the lease is issued, but which may be credited against royalties accrued during the same year. The award of the lease should be made on the basis of cash bonus bidding. If this were not so, and bidding were based on royalty rates, the high bidder could delay investment for a few years, surrender the lease, and try to get a new one at a lower rate when competition was less.

A second desirable feature would be to specify the duration of the lease and the size of the tract in advance so that unnecessary business uncertainties would be reduced. Advance notification would help in increasing the number of applicants willing to bid on the land and is presently in effect.

Third, the royalty rate should be based on a percentage of gross income rather than net income. A rate on gross income is a cost of doing business which is payable irrespective of the rate of profit. A royalty on net income would have the effect of penalizing the more efficient operator and rewarding the inefficient operator who has high costs. Royalty based on gross income is more equitable to all leaseholders. Gross income would be based on the selling price

at the point of shipment from the mine or washing plant. Also, the bookkeeping involved to determine net revenue can greatly increase the administrative headaches and work load in computing the royalty.

Fourth, the government should conduct each sale by either sealed bid or oral auction bid depending upon the circumstances of the land in question. Under sealed bidding the bidder must not only estimate what he is willing to pay, but also what his competitor is likely to pay. Sealed bidding is more likely to reduce the margin between rigged-bid price levels and competitive price levels because of the chance of an outsider (outside the collusion) placing a bid.

Royalty bidding, whether on a flat royalty basis (lease awarded to the highest gross royalty offered) or a sliding scale basis (lease awarded to the highest multiple of a stated royalty scale), is frequently suggested as a means of attracting bidders who do not have the funds to compete on the basis of cash bonus or of interesting bidders in exploring unattractive property for minerals which are presently undeveloped. The drawback to royalty bidding is the inherent problem of resource economics which is associated with any form of royalty. Again royalty becomes a part of the fixed cost of mining and therefore contributes to diminishing the operator's incentive to produce as such costs approach the value of production. Flat royalty bidding increases the problem because as the royalty increases,

the incentive to prematurely abandon the mineral deposit also increases.

A sliding scale royalty is less of a problem because the royalty adjusts downward with a decrease in production, but this may cause the operator to produce at the lowest permissible rate in order to reduce royalty.

Fifth, only one lease should be offered at each sale. Multiple offerings at the same time might reduce the vigor of competition for each tract offered. If two companies are carrying the bidding up and finally one of them is the high bidder, the second high bidder can now bid on the second tract of land virtually without any competition.

Noncompetitive leasing leaves open opportunities for favoritism and offers no assurance that the United States Government will obtain fair-market-value for the resource.

Oral Bidding

Oral auction bidding facilitates collusion which results in buyers obtaining the resource at a lower price. If competition is present, the pattern of bidding will follow a stair-step procedure as shown in Figure I.

Figure I indicates that firm Y is less efficient than firm X because Y has a lower maximum bid to yield a normal profit than does firm X. Firm Y would not bid higher than point R if it wants to stay at a normal profit but may choose to sacrifice profit to obtain the resource. Bidding

ORAL BIDDING MODEL

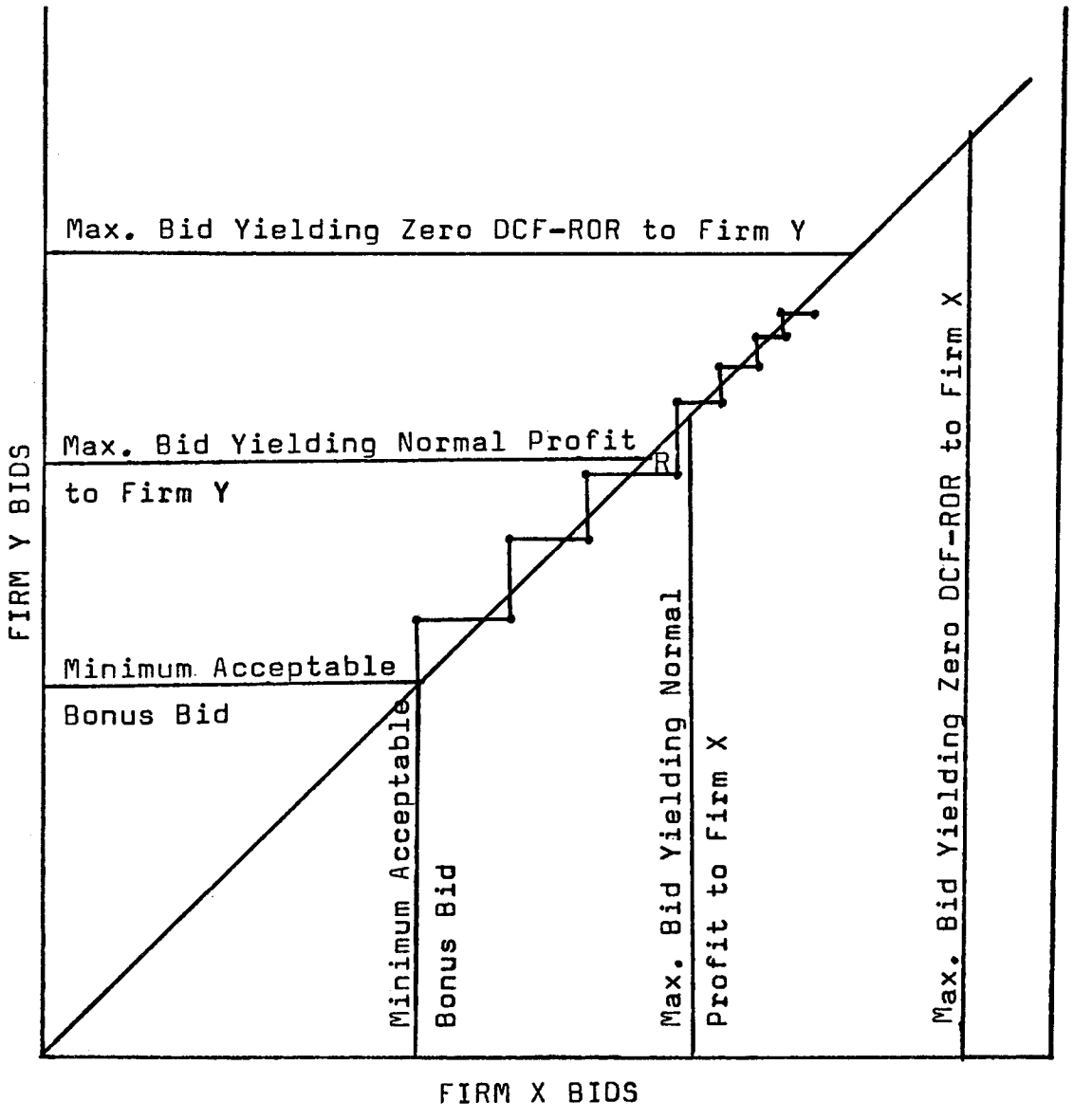


Figure I

(Source: Mead, 1967, p. 200)

higher than point R would probably be called desperation bidding. If firm Y were low on coal reserves and faced a possible shutdown of its operation it might bid above the maximum bid yielding normal profit up to the maximum bid based on zero discounted cash-flow rate of return.

Firms occasionally will bid higher than the maximum bid that yields a normal profit in order to prevent outsiders from establishing a position in the same area. This is a form of eliminating competition by denying entry at any cost. Oral auctions are subject to emotional bidding which may carry the bidding higher than what was originally determined as a maximum bid.

Large raises by one firm may convey a message of determination which is designed to let the other bidders know that they should stop bidding. If bidding continues, a challenge has been made and emotional tempers may carry the bidding higher than desired. If a firm stops bidding after a high raise, it may be asking the high bidder to return the favor by abstaining in a subsequent sale. Oral bidding allows each bidder to know his opponent, to know the amount bid, and to bid no more than necessary.

Sealed Bidding

Under sealed bidding, the bidder must file a separate bid for each lease sale. Bids cannot be raised or lowered once submitted. The concept of "leaving money on the table"

is the substantial gap between the high and the second high bid. A gap between the two bids reflects different estimates by the bidders of the maximum value of the resource or the expected degree of competition. It is interesting to note that "leaving money on the table" can lead to considerable embarrassment, and as one bidder stated, "I'd rather lose a lease than leave money on the table" (Mead, 1967, p. 212). Canada avoids embarrassing land men by publishing only the high bid and keeping secret second high and other bids. At present, sealed bids are being used in conjunction with competitive lease offerings of the five minerals under study as a qualification for oral bidding. The minimum acceptable bid usually is kept secret until all bids have been received and opened. Bidders over the minimum acceptable bid are then qualified to bid in the oral bidding.

A sealed bid is a function of three variables: the estimated value of the resource, the desire for the resource, and the degree of expected competition. The expected competition is purely speculative in sealed bidding. Sealed bidding allows disinterested buyers or speculators to obtain resources at a minimum acceptable price. Uncertainty may produce a premium over the minimum acceptable bid so that a bidder who has a strong desire to obtain the lease may bid very high. Sealed bidding thus becomes a strong deterrent to collusion. Also, emotional bidding is not likely to be present. Even if there is a lack of competitive interest,

the sealed bid procedure is likely to result in a bid which is closer to a competitive price rather than the often meaningless minimum acceptable bid.

A recent coal lease sale on Indian lands in Lame Deer, Montana, illustrates both oral and sealed bidding. On tract #14 three companies submitted sealed bids of $3,039.99; $2,339.45; and $100.00. Oral bidding was then started with the low bidder not entering into the bidding. This shows the "fish bid" aspect of sealed bidding in which a very low bid was submitted for speculation. The oral bidding started at $3,100.00, went up to $22,500.00 by $500.00 increments, and then a jump bid to $25,000.00 signaled that the high bidder was determined to get the bid. The signal was apparently received by the other bidder, because he then ceased bidding.

Tract #15 was more spectacular because ten sealed bids were submitted with the high bid being $23,265.44 and the lowest $100.00. Oral bidding then ran the bid up to $560,000.00. Both of these examples demonstrate the benefits of the combination sealed-oral bidding technique. A review of the bidding is in Table III and Table IV.

TABLE III

INDIAN LANDS MINING LEASE REPORT

COAL SALE

APRIL 22, 1971

TRACT #14

Tract No.	Total Bid	Per Acre	Acres
14	$25,000.00	$1.07	23,384.52

Sealed Bids

Gulf Mineral Resources Co.	$3,039.99
Belco Petroleum Corp.	$2,339.45
Wold-Jenkins	$100.00

Oral Bids

Belco Petroleum	Gulf Mineral Resources
$3,100	$3,500
4,000	4,500
5,000	5,500
6,000	6,500
7,000	7,500
↓	↓
22,000	22,500
25,000	

(Source: Mull, 1971, p. 7)

TABLE IV

INDIAN LANDS MINING LEASE REPORT COAL SALE

APRIL 22, 1971

TRACT #15

Tract No.	Total Bid	Per Acre	Acres
15	$560,000.00	$26.71	20,959.86

Sealed Bids

Consolidation Coal Co.	$23,265.44
Meadowlark Farm, Inc.	21,550.00
Norsworthy and Reger	18,000.00
W. H. Lang	15,000.00
Peabody Coal Co.	10,479.93
Gulf Mineral	2,724.78
Industrial Fuel	2,100.00
Belco Petroleum	2,096.99
N. B. Hunt	2,095.99
Wold-Jenkins	100.00

Oral Bids

Peabody	Meadowlark	Norsworthy
$400,000	$405,000	
410,000	415,000	
416,000	420,000	$425,000
	430,000	435,000
	↓	↓
	545,000	555,000
	560,000	

(Source: Mull, 1971, p. 8)

LEASING IN THE WESTERN STATES

Federal leasing policies on public domain, acquired, and Indian lands encompasses eleven western states: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. The purpose of this section is to answer the following questions: What portion of the land in the state is under federal ownership? What federal agencies have jurisdiction over this land? What leasable minerals are present in the state? What is the future leasable mineral potential of the state? The answers to these questions will help in showing the importance of having an equitable and well understood leasing system.

The importance of federal leasing policies is shown in Table V on the following page. This table shows the area of the state owned by the federal government in acres and as a percentage of the total state. The last three columns show the distribution of jurisdiction by different government agencies. Much conflict in the present system results from the many agencies involved and their differing land usage goals.

TABLE V

FEDERAL LAND IN THE WESTERN STATES
AS OF JUNE 30, 1966

AGENCY JURISDICTION

STATE	Area owned by the federal government (millions of acres)	Area owned by the federal government (percent of total states)	BLM	Forest Service	Other Agencies (millions of acres)
Arizona	32.4	44.6	13	11	8.4
California	44.4	44.3	15	20	9.4
Colorado	24.0	36.2	8	14	2.0
Idaho	34.0	64.3	12	20	2.0
Montana	27.6	29.6	8	17	2.6
Nevada	61.0	86.8	48	5	8.0
New Mexico	26.7	34.4	13	6	7.7
Oregon	32.2	52.2	16	15	1.2
Utah	35.2	66.8	23	8	4.2
Washington	12.6	29.4	.3	10	2.3
Wyoming	30.0	48.1	17	9	4.0

(Source: U.S. Dept. of Interior, Bureau of Land Management, Public Land Statistics, 1967, p.11)

Most of the existing mineral producing areas of Arizona are on privately owned lands in the southeastern and central portions of the state. Area underlain by coal-bearing rocks accounts for about 3 percent of the state. Strip coal is estimated at only 100 million short tons (Averitt, 1968, p.14). Arizona is known primarily for its copper resources, and at the end of 1969 there were no active properties of any of the five minerals under study.

The historical beginning of development of mineral resources in the West began in California on public lands. The eastern and southeastern portions of the state today are prime targets of mineral resource utilization. Large portions of mineralized land are presently controlled by federal agencies. The early production of gold, silver, and mercury took place on lands which have passed into private ownership, but the areas which have the greatest potential for future mineral resource utilization are still under federal jurisdiction. The potential area of the state which may contain coal is only 0.1 percent. But California has more active sodium properties (12) on public land than any of the other western states. It also has 5 active potash properties and 2 active phosphate properties on public land.

Colorado has significant rich mineral deposits of uranium, oil shale, and metals, but these minerals are excluded from this study.

It is important to know that the state has deposits of coal, potash, and sodium. At the end of 1969 there were 73 active coal properties, 2 active potash properties, and 9 active sodium properties on public domain. Coal-bearing rocks underlie 28 percent of the state's surface area, and "estimated stripping coal is 1,200 million short tons" (Averitt, 1968, p.14). There are an estimated "total remaining resources as of January 1, 1967 of 18,248 million short tons in Colorado" (Averitt, 1968, p.10). Mineral leasing policies are very important in determining the future of Colorado mineral production.

Base metals and phosphates are rich potential resources of Idaho. Most of the private land was developed for agricultural purposes. There remain sufficiently large areas under control of both the Forest Service and the BLM in the eastern part of the state where large phosphate fields exist. Federal land policies would be significant in the development of the mineral resources of this part of the state. The Columbia Plateau region in the western portion of Idaho is covered by extensive formation of extrusive igneous rock and may become an important source of minerals in the future. The prospects for coal, however, are very bleak as only 0.6 percent of the state's surface area is underlain by coal-bearing rock.

The mountainous regions of Montana attracted the attention of the early mineral exploiters and holds today

vast reserves of minerals under federal control. Of the estimated original resources of stripping coal in the United States in beds generally less than 100 feet below the surface, Montana ranks third with 15,000 million short tons (Averitt, 1969, p. 57) behind only North Dakota and Illinois. Table VI , "Active Properties on Public Land", shows 12 active coal, 28 active phosphate, and one active sodium property in Montana.

The mining areas in the eastern part of Nevada near Ely and Pioche, and the western part with its Sierra Nevada Mountains are suitable geologically and economically for future mineral resource utilization and are controlled by the federal government. As listed in Table VI, Nevada has seven active potash and five active sodium properties.

The development and utilization of mineral resources in New Mexico came relatively late, primarily because of the intensity of the resistance by the Indian tribes. The areas administered by the BLM are largely west of the Rio Grande and cover almost all of western New Mexico except for those areas in Indian reservations and national forests. A large block in the southeastern corner of the state is supervised by the BLM. The large potash resources around Carlsbad in the southeast are almost all federally owned. There were 20 active coal properties, 121 potash, and 16 sulphur properties on public land at the end of 1969. Twelve percent of the state is underlain by coal-bearing rock.

TABLE VI

ACTIVE PROPERTIES

FISCAL YEAR ENDED JUNE 30,1969

	Public Land				
State	Coal	Phosphate	Potash	Sodium	Sulphur
Arizona	0	0	0	0	0
California	0	2	5	12	0
Colorado	73	0	2	9	0
Idaho	0	23	0	0	0
Montana	12	28	0	1	0
Nevada	0	0	7	5	0
New Mexico	20	0	121	0	16
Oregon	1	0	0	0	0
Utah	24	4	1	0	0
Washington	0	0	0	0	0
Wyoming	50	5	0	4	0
Total	180	62	136	31	16

(Source: Turner, 1970, p. 43)

Gold placer deposits were an early mineral resource of Oregon, but other minerals have been left largely untouched. Most of the industrial mineral deposits are located in private land areas. Extrusive volcanics of the Columbia Plateau cover a large part of eastern Oregon and hinder exploration. This has resulted in a large part of the state's mineral resource potential being virtually unknown. Nickel-bearing laterite deposits occur in western Oregon on federally owned lands. There is one active coal property in Oregon, but the coal potential of the state is small as only 0.6 percent of the state is underlain by coal-bearing rock.

Significant potash and phosphate developments have taken place in the southeastern and northeastern part of Utah under BLM control. Utah had 24 active coal properties, 4 active phosphate properties, and one active potash property on public domain land in 1969. Eighteen percent of the state is underlain by coal-bearing rocks.

> The mineral resources of the western part of the state are in many respects unknown, but there is still a high potential for development of both base and precious metal resources in thos areas currently administered by the BLM (University of Arizona, 1969, p. 213).

Like Oregon, Washington has had very little mineral exploration. Two facts account for this. First, the Columbia Plateau volcanics cover and hide potentially valuable mineral resources; second, the extensive

vegetation cover on the Pacific slope of the Cascades makes exploration expensive. What little mineral activity that has taken place has been mostly confined to precious metals. As of June, 1969 there have been no active properties in Washington for any of the minerals studied. Only 2 percent of the state's surface area is underlain by coal-bearing rocks.

Most of the non-fuel mineral resource development to date in Wyoming has been in the southwestern portion of the state in areas administered by the BLM. Wyoming had 50 active coal properties, 5 phosphate properties, and 4 sodium properties on public domain at the end of 1969. In strip coal, the state has about 10,000 million tons of reserves (Averitt, 1968, p. 14), which puts the state fourth behind North Dakota, Illinois, and Montana. Beds up to 224 feet thick (Mapel, 1959, p.93) exist in some areas of the state. The state is underlain by coal-bearing rocks for over 41 percent of its area. Leasing policies of the federal government are expected to have a strong impact on the development of the state's mineral resources.

FEDERAL LEASING LAWS

The following chapter discusses the current leasing laws in effect at the present time for coal, phosphate, potash, sodium and sulphur.

Coal Permits, Leases, and Licenses

> The general objectives of coal leasing are to conserve the natural resources of any coal field and to permit an orderly, efficient and economic development of such coal fields (CFR Title 43, 1969, p. 403).

The regulations governing prospecting permits, preference right leases, competitive leases, and licenses are discussed in this section. Of the five minerals studied only coal involves licensing. The focal point of this thesis is on coal, with the other four minerals used primarily for comparison. The Branch of Mining Operations of the U.S. Geological Survey has formulated or attempted to establish more data on coal leasing than any of the other leasable minerals under study because most of the leasing activity has been with coal. The increased interest in leasing coal has brought about a requirement for more formalized methods of establishing rental, bonus bid, and royalty payments to eliminate the inequity inherent in personal judgment

decisions.

Prospecting Permits - The qualifications for holding permits or leases include being either a citizen of the United States, an association of citizens, a corporation under the laws of the United States, or a municipality. A permit is limited to 5,120 acres with a rule of approximation allowing a little more if irregular subdivisions of land are present. Since 1963 a rental of 25 cents per acre has been charged on prospecting permits. A compliance bond of not less than $1,000 per permit is also required.

Prospecting permits may be issued for two years where the existence of coal is unknown, or where the existence is known, but there is insufficient information available to determine whether it is workable. Workability involves the character of the coal (Btu value, ash content, sulphur content, etc.) and its accessibility, quantity, thickness, depth, and other conditions which would affect the mining cost. Priority of applicants for prospecting permits is determined by the time of filing of the application for a permit.

A two-year extension for prospecting may be obtained if the permittee can show that he has been unable to determine the existence or workability of the coal and has made a diligent attempt. The policy for extensions is rather liberal, especially where weather conditions such as snow cover limit the actual exploration time in the

field. A reward for finding coal in commercial quantity within the life of the permit will entitle the permittee to a preference right lease. Geological inference is not enough to support a finding of commercial coal. The exact requirements for proving existence and workability are not written down in black and white. Mr. J.D. Turner, Chief of Mining Operations for U.S. Geological Survey, has said that

> I believe workability would be accepted if the applicant can show that like quality products are being, or have been, produced elsewhere (U.S. Geological Survey, 1970, p. 16)

but that

> the amount of drilling to prove a commercial deposit will depend largely on the ground structure and will vary with each parcel of land (U.S. Geological Survey, 1970, p. 23).

Presently the decision rests with the Regional Mining Supervisor with final approval coming from Washington. The applicant submits a prospecting or exploration plan for approval by the Branch of Mining Operations and if the applicant fulfills the obligations of the approved plan, a preference right lease is usually granted. A list of what this plan must include appears in Appendix A.

Preference Right Lease - An application for preference right lease must be filed before the expiration date of the permit. However, in 1968, E.W. Danklef filed a month late, apparently due to a lack of knowledge of the

filing rules. He was awarded the lease because no one else filed for the land. The irony was that after winning the point, he failed to accept the lease when it was offered (Schmid, 1968, p. 134). The preference right lease requires no bonus payment, but it does have the standard provision for rental and royalty as determined by the BLM after consultation with the Geological Survey. The lessee has the right to relinquish part or all of the coal lease.

Competitive Lease - The Secretary of the Interior is granted discretionary authority to establish the size and shape of leasing units. Coal lease units must be continuous and in multiples of 40 acres. There is no statutory limitation on the acreage of a leasing unit. Leasing units may be established either upon application or when it is deemed advisable that additional coal units be established. The primary consideration in establishing leasing units is "the economic development of the coal resources of the area" (Schmid, 1968, p. 151).

Leases may be held by citizens of the United States, associations of such citizens, corporations organized under the laws of the United States, and municipalities. It is present Departmental policy that a partnership can hold leases in its own name if all the members of the partnership are citizens, and if under the state laws the partnership is able to hold interests in such realty as leases. A provision added on July 20, 1967 requires the applicant to

disclose interests in other coal leases, permits, and applications, and the estimated reserves of coal from these sources.

The present maximum acreage of federal land which can be held under a coal lease (excluding common carrier railroads) is 46,080 acres of public domain or acquired land and possibly 5,120 acres additional in any one state. The original Mineral Leasing Act of 1920 allowed one lease per state at any one time with 2,560 acres. In 1926 the single lease stipulation was eliminated but in 1948 the acreage limitation was doubled to 5,120 acres. In 1958 it was again doubled to 10,240 acres with a provision for a possible 5,120 additional acres. Six years later, in 1964, the acreage limitation was increased 4.5 times to 46,080 acres.

The increased acreage limitations were justified because of the large reserves now needed to justify the expenditures for electric generating plants, the extensive capital investments needed for new mine equipment, the large nonproductive acreages needed for access, and because western coals vary in thickness and dependability.

Companies and corporations operating common carrier railroads are under special and very restrictive acreage limitations. For all practical reasons the railroads are effectively precluded from leasing federal coal lands.

Three provisions in the statute deal with additional

acreage. Section 3 of the original act provides for adding contiguous acreage to the original lease upon approval of the Secretary of the Interior and upon a finding by him that it will be to the advantage of the lessee and the United States. In no event, however, can the total area embraced in the modified lease exceed 2,560 acres.

The other additional acreage provision of the original act is from section 4 and provides for adding land if all of the workable coal in a lease will be exhausted or worked out within 3 years. The new land and the area remaining in the original lease cannot exceed 2,560 acres. The new acreage does not have to be contiguous. Section 3 requires no competitive bidding, but section 4 does require competitive bidding.

The third additional acreage provision is part of a 1958 amendment and permits an applicant to hold 5,120 acres over the 46,080 acre limitation if it is in the public interest and is necessary to enable the applicant to carry on business economically.

Areas may be offered for competitive lease either because an applicant has requested it or because the Department of Interior has determined that it is appropriate. Public auctions may be a combination of sealed and oral bidding. The policy of the BLM is to try to evaluate all sales to see that an acceptable minimum bid is established prior to the sale and that a fair-market-value is

obtained for the mineral.

Lessees are required to furnish a compliance bond which is determined by the BLM (recommended by U.S. Geological Survey) and is not less than $1,000. It is intended to protect the interests of the United States in the faithful performance of the lease. A bond to protect the interests of the surface owner where the lease is for reserved coal deposits may be required depending on the statute under which the coal was reserved. Under 30 U.S.C. section 81, a lessee must either obtain consent of the landowner or meet the requirements as to security for damages as may be determined by a court of competent jurisdiction. Under 30 U.S.C. sections 83-85, the lessee is required to pay the owner for damages or post a bond. If the coal was reserved under the Stock Raising Homestead Law of 1916 (39 Stat., Part 1), the lessee has three options: (1) secure written consent or waiver of the landowner, (2) pay damages of crops or other tangible improvements, or (3) provide a sufficient bond to be filed with the manager of the land office where the land is situated.

Coal leases are granted for an indeterminate term, but the Secretary of the Interior has the right to readjust the terms and conditions of the lease at the end of each 20 year period.

Royalty payments are set by the Bureau of Land Management but are recommended by the Branch of Mining

Operations, U.S. Geological Survey. The statute provides that "the royalty shall not be less than 5 cents per ton of two thousand pounds" (30 U.S.C. §§ 207, 1964). As mentioned previously, there are no officially published guidelines for the purpose of establishing royalty rates although this thesis will deal with the unofficial and constantly changing guidelines which are currently in practice.

Under the statute, rental is fixed by the Secretary of the Interior prior to offering the lease, but it cannot be less than 25 cents per acre for the first year, not less than 50 cents per acre for the second, third, fourth, and fifth years, and not less than one dollar per acre for each succeeding year thereafter. Rentals for any year are credited against the royalties as they accrue for that year. Once rentals and royalties have become due to the United States, they are an obligation which cannot be waived by the Department of the Interior. Even in cases where billing mistakes are made by governmental employees the obligation to pay the accrued fees still remains. This is one reason for having a compliance bond, because there is no way to keep the government from collecting what is owed. Rental, bonuses, and royalty determinations will be dealt with in depth in a later chapter.

Coal Licenses - The Secretary of the Interior may issue licenses or permits to individuals, associations of individuals, or municipalities for the mining of coal on

federal lands for "strictly local domestic needs for fuel (30 U.S.C. § 208, 1964)." Licenses are issued without rent or royalty charges. Licensees cannot sell or trade the coal they mine.

The coal license is for a term of 2 years and for 40 acres or less. Municipalities are issued a license for 4 years but the coal can only be used for domestic fuel purposes. Relief agencies of any state may qualify to mine coal under a license for use as a fuel in the homes of people on relief. Except for those people on relief, applications for a license must be accompanied by a $10 filing fee. Coal is the only mineral covered under licensing.

Phosphate Permits and Leases

A lease or permit cannot exceed 2,560 acres and must be within a six-mile-square area. An individual person, corporation, or partnership is limited to 20,480 acres in the United States at any one time. This is equivalent to 32 sections or 32 square miles. Leases are effective for 20 years and can be renewed if the proper conditions are met. Prospecting permits are for 2 years and can be extended an additional 4 years. An applicant must be a U.S. citizen.

Prospecting Permits - The act of March 18, 1960 (Pub. Law 86-391, 74 Stat. 7), authorizes the issuance of

phosphate prospecting permits (Code of Federal Regulations, 1969, p. 430). The applicant must pay a non-returnable filing fee of $10, describe the lands applied for, and fill out a form with his name, address, etc. He must also pay the first year's rental of 25 cents per acre in advance; total rental for the first year cannot be less than $20. The applicant then has a two-year right to explore and prospect to determine the existence of or workability of the phosphate deposit. A bond of not less than $1,000 must also be filed (Circ. 2230, 32 F.R. 10655, July 20, 1967).

The applicant can relinquish all or part of the permit area. If he fails to comply with the law, his permit can be canceled after 30 days of written notice by the government. Failure to pay the rental fee within the established time will result in automatic cancellation of the permit.

Preference Right Lease - Reward for discovery of phosphate is given by a preference right lease. There is no bonus bid involved and no competition from others. The first year's rental of 25 cents per acre must be paid in advance but is credited against any production royalties occurring in the first year. Problems do arise, however, as evidenced by the holding-up of a phosphate preference right lease for U.S. Gypsum Company. The delay is caused by another ecological study "to determine the impact of the planned mining operation on the Condor bird and the environment" (Saarela, 1971, p. 3).

The terms and conditions of the lease will be readjusted at the end of each twenty year period. Prior to the expiration date the new terms will be sent to the lessee and he has the opportunity to voice his approval or disapproval and the terms may be renegotiated.

Competitive Leases - An applicant can file for a competitive phosphate lease on lands classified as known to contain a valuable deposit and pay a $10 filing fee. The applicant's name, address, and legal description of the lands are filed. He must give information as to the total amount of (federal and non-federal) phosphate acreage now in his ownership and a statement as to why he needs more phosphate.

A compliance bond of not less than $5,000 is required before issuance of a lease. The terms and conditions of the lease will be posted and the bidding will be either oral or sealed with the qualified person being the one who bids the highest. The officer conducting the sale has the right to reject any or all bids. The conditions of the lease will state the minimum annual production beginning with the fourth year from date of issuance.

Overriding royalty payments created by assignment cannot exceed 1 percent of the gross value of the output at the point of shipment to market, unless the assignor can prove to the satisfaction of the authorized officer that he has made substantial investments for improvements which

merit a higher royalty rate.

An applicant for a phosphate prospecting permit or lease may also apply for a surface use permit for not more than 80 acres for campsites, refining works, and other necessary mineral-related purposes. Such lands are not considered as a part of his lease or permit.

Potassium Permits and Leases

Sections 1 to 7 of the Mineral Leasing Act of 1920 were added on February 7, 1927, which authorized the leasing of chlorides, sulphates, carbonates, borates, silicates, or nitrates of potassium. The lease or permit must be within a six-mile-square area and may not exceed 2,560 acres. Lessees are limited to a total of 51,200 acres in any one state. The applicant must pay a $10 filing fee and furnish name, address, citizenship, and total acreage holdings. An important stipulation under potassium leases is that

> the lands must be chiefly valuable for the potassium compounds involved. This means more valuable than any or all other resources (Solicitor's Memorandum, May 11, 1966).

The only other nonmetallic mineral that this stipulation applies to is sodium.

Prospecting Permits - An applicant must pay a non-returnable $10 filing fee and the first year's rental of 25 cents per acre but not less than $20. Permits are

issued for a two-year period. A permit bond of not less than $1,000 must also be paid. The applicant, upon issuance of the permit, gains the exclusive right to explore and prospect to determine the existence of, or workability of, the potassium deposits. A two-year extension also costs a $10 filing fee.

Preference Right Lease - Reward for discovery of valuable potassium deposits is the issuance of a preference right lease. Rental is 25 cents per acre or fraction thereof per year paid in advance. The lease is granted for an unlimited time so long as payments are paid. At the end of twenty years, new terms may be readjusted by the government.

Competitive Lease - A $5,000 compliance bond is required before issuance of a lease. If the land is adjacent to the existing lease of the applicant and is determined not to warrant independent development as a single mining unit, the applicant may get the lease without competitive bidding. In this case, he must pay either a token cash bonus of $15 per acre or a production payment of one cent per mine-run ton in addition to the normal royalty. A cash-flow analysis could provide data to determine which method the lessee would choose. The time cost of money would probably favor the one cent per ton royalty if the land was going to be held as reserve for any substantial length of time.

Notice of offer of lands is published in a newspaper once a week for four consecutive weeks in the county in which the lands are located. The bidding can be either by sealed bids or oral auction. The high bidder is awarded the lease. The terms of the lease are readjusted every 20 years. The lessee can file an objection to the terms if he so desires. Failure to comply with the regulations may result in cancellation of the potassium lease. An overriding royalty created by assignment cannot be greater than one percent of the gross value of the output. This is a conservation practice to prevent premature abandonment.

Sodium Permits and Leases

Sections 23 through 25 of the Mineral Leasing Act of February 25, 1920, authorized the Secretary of the Interior to issue prospecting permits and leases for deposits of chlorides, sulphates, carbonates, borates, silicates, or nitrates of sodium in public lands. Individual leases and permits are limited to 2,500 acres and must be within a six-mile-square area. A corporation or individual is also limited to 5,120 acres in any one state unless he can prove that the deposit cannot be economically mined, and in this case he may be granted up to a maximum of 15,360 acres in any one state. To be qualified, an applicant must be a citizen of the United States and file in the appropriate land office.

Prospecting Permits - An applicant must pay a $10 nonreturnable filing fee. Upon receiving a permit the applicant may prospect for a period of two years with no extension of the term. A bond of not less than $1,000 must also be filed. The discovery of a valuable sodium deposit before expiration of the permit entitles the permittee to a preference right lease for all or part of the permit lands. Presently prospecting permits in western Colorado for sodium are being held up pending a decision of what to do with the oil shale associated with the sodium.

> One square mile of oil shale land in the center of the Piceance Basin in Colorado, containing the thickest, richest, but the most deeply buried of the evaluated reserves, has been estimated to contain about one billion barrels of oil, 40 million tons of soda ash (Miron, 1968, p. 633).

The soda ash, if recoverable, would represent about 13 times the nation's annual production of about 6.6 million tons in 1968 (Petkof, 1969, p. 1025). This is an unfortunate circumstance for the private companies which invested huge sums of money for exploration, found a valuable deposit of sodium, and are now delayed in being issued a preference right lease.

Preference Right Lease - Normally the fulfilling of the requirements for a prospecting permit and finding a valuable sodium deposit will entitle the permittee to a preference right lease. No competitive bidding is involved.

The exclusion of a bonus bid is the reward for exploration expenditures. Leases are granted for an unlimited time with readjustment of the terms every 20 years.

Competitive Lease - For lands known to contain valuable deposits of sodium a competitive lease is offered. The winner of the bidding is the highest bonus bid offered. A minimum $5,000 compliance bond is required per lease, or a minimum $25,000 statewide bond, or a $75,000 nationwide bond for all leases and permits issued. Leases require the payment of a royalty on a minimum annual production beginning with the sixth full calendar lease year. In a recent letter to the U.S. Geological Survey Branch of Mining Operations in Salt Lake City, it was explained that

> if monies have been expended on or for the benefit of the lease, or if the lease has produced in the past, but because of present market conditions is unable to operate except at a loss, a suspension of minimum production (royalty) may be granted (Turner, 1971a, p. 2).

Competitive lease offers are published four consecutive weeks or longer in a newspaper of general circulation in the lease area. The government reserves the right to reject any or all bids. Overriding royalties may not exceed one percent of the gross value of the output at the point of shipment to market. Rental is 25 cents per acre.

Sulphur Permits and Leases

The existing regulations (Code of Federal Regulations, Title 43, Chap. 2, Subpart 3180, p. 599) state that a given

lease or permit must be within a six-square-mile area and cannot include more than 640 acres except where odd size lots are involved. In a given state the applicant or lessee cannot have more than three sulphur permits or leases at any given time.

The qualifications of the applicant include being a citizen of the United States. Corporations or partnerships must submit a statement confirming the citizenship of each party, listing the state in which it is incorporated (if a corporation) and other related information.

Prospecting Permits - Each application for a prospecting permit must be accompanied with a $10 filing fee and the advanced payment of the first year's rental. The rental fee is 25 cents per acre or fraction thereof and no less than $20 total rental fee.

The applicant, upon prospecting approval, has two years to prospect and explore the lands to determine the existence and workability of sulphur deposits. The applicant must also post a surety bond of at least $1,000. This money is used to restore surface damage to its original state in the event the applicant defaults on the permit. If the applicant finds a valuable sulphur deposit within the two years, he is rewarded with a preference right lease for all or part of the land within the prospecting permit area. The applicant files within 30 days of the permit expiration date and encloses the first year's rental

of 50 cents per acre. In the event of death, the lease will be issued to the executor or administrator of the estate if probate of the estate has not been completed. If it has been completed, the lease will pass to the rightful heirs. Permits expire without notice to the permittee unless a lease application is filed.

Preference Right Lease - Prior to the issuance of a preference right lease, the applicant must deposit a compliance bond of no less than $5,000. The lessee must pay a 5 percent royalty on the quantity or gross value of the output of sulphur at the point of shipment to market. Royalty is particularly important in preference right leases since it represents the only opportunity for the public to recover the value of disposal of its mineral resources. Preference right leases are nondiscretionary provided the applicant has complied with the law and the regulations. They are issued for an unlimited time period with readjustments every 20 years.

The rental of 50 cents per acre is credited against any royalties which accrue under the lease during the year for which the rental was paid. The rental represents a return for the holding land when there is no production and should serve two purposes: (1) it should encourage early exploration and development and, (2) it should discourage speculative holding without development. To achieve these purposes a rental should escalate over time and credit

should be given for legitimate exploration and development expenditures.

The sulphur lease also requires the payment of royalty on a minimum annual production rate beginning with the sixth year of the lease. This provision also is aimed at discouraging speculative holdings.

Competitive Lease - An applicant can file for a competitive lease ($10 filing fee) for lands known to contain valuable sulphur deposits. He must accurately describe the lands by legal subdivision, section, township, and range. The notice of offer for lease will then be published once a week for four weeks in a newspaper in the county in which the lands are situated. A copy will also be posted in the appropriate land office. The successful bidder must pay for his share of the advertising cost and must submit a certified check, money order, or bank draft for one fifth the bid amount at the auction. The successful bidder must then pay the balance of the bonus bid within 30 days and also pay the first year's rental.

An overriding royalty interest may be created by assignment, but

> the total of the overriding royalty interests at any time cannot exceed one percent of the gross value of the output at the point of shipment to market, otherwise they shall be subject to reduction or suspension by the Secretary of the Interior (Code of Federal Regulations, 1969, p. 442).

UNOFFICIAL GUIDELINES FOR ESTABLISHING COAL PAYMENTS

This chapter discusses the bureaucratic problems associated with policy decisions and also includes a short historical evolution of the present system of determining royalties, rentals, and bonus bid payments for coal.

Bureaucratic Problems

Minimum bonus bid, rental, and royalty calculations for coal on public lands have not been fully understood by those outside the government ranks, because very little has been published concerning them. These determinations in the past have emphasized subjective judgment and experience, and therefore, could not be easily expressed openly and exposed to the public. But during the last 10 years, a change has taken place which has attempted to shift the task of determining these values from individual judgment to calculated facts. It is difficult to include all the important events leading up to the present calculating procedure, because no one has compiled all the letters, memos, telephone calls, etc. in chronological order to present a history of the evolution of present calculating techniques. However, this attempt will present a starting point for further research or additions. It is important

to understand this development in order to recognize the bureaucratic problems associated with government policy formulation. Where different government agencies each have a role to play in formulating policy toward land usage, the objectives of each agency are bound to clash.

Differences arise primarily from two major problems. The first is the problem of power. Agencies survive budget cutbacks by being powerful and demanding their "place in the sun". An agency which cannot justify its existence may find itself absorbed by another agency during a government reorganization program. The second problem is the differences in opinion between agencies in their concept of the government's role in administering the public's natural resources.

> The function of the Federal Government is different from that of the private landowner, and the Government's primary aim should be the development of its resources, rather than obtaining 'top dollar' now (Fishman, 1970, p. 1).

Most agencies agree that the objective is to obtain "fair-market-value" for the resource, but the interpretation of what constitutes "fair" may vary considerably.

Many bureaucratic problems in government work are not apparent to those working in private industry. The problem of obtaining economic efficiency through public administration goes beyond the question of insuring that external diseconomies (spill-over costs) will be taken into account by decision makers. Public management is not

merely private management without the profit motive. Governmental management must abide by the "rules of the game." These rules may not always be based on economic logic. "This often leads economists to regard politicians as parochial, and politicians to regard economists as naive" (Hall, 1967, p. 164). One rule of the game is that agencies require political support from private groups and may not make a desirable decision because it would be damaging to its constituency.

> It should be the function of economists to provide useful information about the effects of all important alternative policies and then permit policy-makers to decide the most beneficial social policy (Davidson, 1970, p. 9).

Governmental agencies with natural resource responsibilities may have one of four different policy goals to guide them. The "preservation goal" tries to minimize the impact of society on the ecological, geological, and other natural characteristics of land resources. The "development goal" is similar to the "infant industry" theory of tariffs in that it tries to develop resources which are not presently commercially profitable to utilize by saying that the national growth will later justify the investment. This development goal may be relevant to the federally backed oil shale industry which is currently undergoing considerable study. In the West, supporters of this argument think that "regional growth is an appropriate political objective which justifies national support of Western resource

development" (Hall, 1967, p. 174). However, economic growth also depends on favorable access to markets, available labor force, trends in consumption, and transportation costs. The "prevention of exploitation goal" advocates a resource policy directed at "preventing monopolists from using the national heritage for private gain" (Pinchot, 1954, p. 463). This policy had its roots in the conservation movement of Gifford Pinchot and T.R. Roosevelt. The fourth goal is the "attainment of efficiency" and attempts to achieve the optimal amount of goods and services from the resource. It is obvious that governmental policy in the future will be a mixed strategy that will try to achieve all four goals. The difficult question is what this mixture will or should be.

Historical Evolution

Prior to 1960, coal leasing on federally owned lands in western United States was carried out primarily by small mining companies supplying small domestic markets and by relatively few large operations. With the advent of environmental legislation, especially in the eastern United States, came the demand for low-sulphur coal, which is abundant in the west. Cheaper transportation modes such as unit trains and slurry pipelines, increased production by mechanization, the slowdown in orders for atomic power plants, and the near realization of liquefaction and gasification of coal have brought a tremendous increase in

demand for western coal. Jose de Varon, president of Rocky Mountain Energy Company, said recently that

> these coals offer practically unlimited potential for gasification and liquefaction and crude-oil-from-coal plants now are definitely forecast by many qualified observers as a practical certainty for the third quarter of the 1970's (Coal Mining and Processing, 1971, p. 25).

The increase in demand has caused an increase in the price of coal land, as seen in Table VII on the following page. This table shows the increase in bonus bids per acre for coal leased by the federal government in Wyoming since 1965. There was also a considerable increase in bonus bids per ton of estimated reserves from 0.1 to 23.0 mils. (U.S. Geological Survey, 1970, p. 71). The gradual increase in activity through the 1960's brought about a change in government thinking toward bonus bids, rentals, and royalties.

Royalties - In 1957 it was proposed that

> in particular, royalty could be used more to encourage the taking of lower grade material during mining, to encourage the mining of multiple seams, and to provide incentive to higher recovery, including recovery from fringe acreage (Wayland, 1957, p. 3).

Through the 1950's royalty payments for coal were set at about 15 cents per ton. That system of payment did not provide for any of the above suggested objectives.

As a result of a misrouting of some correspondence on

TABLE VII

RESULTS OF RECENT COAL LAND SALES IN WYOMING

Date	Successful Bidder	Lease	Bid per Acre
June 25, 1965	Wyodak	Wyo 0313666	$ 25.55
June 25, 1965	Ayrshire	Wyo 0313773	26.50
June 25, 1965	Ayrshire	Wyo 0317682	15.50
June 25, 1965	Kerr-McGee	Wyo 0312311	15.50
March 11, 1966	G. Tresner	Wyo 0321120	27.16
Sept. 27, 1966	Sentry Royalty	Wyo 0321779	30.05
Sept. 27, 1966	Faust	W 2313	31.33
June 23, 1967	Farmers Union	Wyo 0325878	50.77
June 30, 1967	Humble	W 3397	17.51
June 30, 1967	Atlantic Richfield	W 3446	53.13
Aug. 18, 1967	Bass	W 961	10.56
Aug. 18, 1967	Humble	W 5035	90.67
Aug. 18, 1967	Humble	W 5036	165.86
Dec. 1, 1970	Belco Petroleum	W 25406	240.00
Dec. 1, 1970	Ark Land Ashland Oil	W 16466	257.50
Dec. 10, 1970	Mobil Oil	W 23929	441.00
Dec. 10, 1970	Cordero Sun Oil	W 8385	505.00

(Source: U.S. Geological Survey, 1970, p. 71)

a coal lease application in North Dakota in 1961, the various district offices became aware of differences in royalties for the same quality coal. For example, a 9,000 Btu coal in the Carlsbad region was bringing a royalty of 17½ to 22½ cents per ton. The Billings, Montana, office "had no idea that any such royalty was being recommended by the Survey except perhaps in Utah" (Bottomley, 1961, p. 1). Shortly after this was brought to the attention of the Washington office, a memorandum went out to all seven regional offices requesting that each office send to the other offices a list of royalty payments now in effect. This was done so that supervisors would know what the other regions were doing; it might also enable the federal government to establish some comprehensive guidelines for future planning.

In 1966, the Branch of Mining Operations in Billings informed Washington that royalty rates for subbituminous coal were 17½ cents per ton for the first 10 years of the lease and 20 cents per ton for the second 10 years of the lease whether the coal was mined by surface or underground methods (Czarnowsky, 1966, p. 1). In contrast, the Branch of Mining Operations in Denver was charging 15 cents per ton the first 10 years and 17½ cents per ton the second 10 years of the lease for coal mined by underground methods, and 17½ cents per ton and 20 cents per ton for coal mined by surface methods (Storrs, 1966, p. 1). Here

was evidence of discrepancy between underground coal mines in one region and those in another. A 1-million ton per year underground coal mine in the Denver region would pay $25,000 less in royalties per year than the same size mine in the Billings region. The recognition of inequities in the system has led to changes which make the leasing policies fairer.

The statute provides that "the royalty shall not be less than 5 cents per ton of two thousand pounds" (30 U.S.C. § 207, 1964). Mr. Ernest Blessing from the Salt Lake City office proposed that

> For underground mining methods: Determine average coal value for that district.
>
> First 10 years of lease--
>
> Average value x 3% = royalty rate expressed in cents per ton of coal produced (to nearest ½ cent).
>
> Second 10 years of lease--
>
> Add 2½ cents to first 10 year royalty fee.
>
> For strip mining operations: Add 2½ cents to the respective underground mining rate per ton of coal produced.
>
> In all cases, royalty shall not be less than 15 cents per ton of coal mined (U.S. Geological Survey, 1970a, p. 73).

This proposal also shows a different royalty of 2½ cents per ton for strip coal versus underground coal.

The Chief of the Conservation Division, however, felt that with the present seller's market in coal, royalties

expressed in cents per ton, adjustable every 20 years, were too inflexible to adjust to changing prices. Therefore, on February 3, 1971, the following formula was adopted to determine coal royalties (Wayland, 1971, p. 2):

$5\%\ (U_i)$ = percentage royalty to be applied to the value of coal mined (i=1,2,3,4)

where the value of U varies as follows:

U_1=1.0 for strip coal

U_2=0.8 for underground mining to 1500 ft.

U_3=0.7 for underground mining to 1500-3000 ft.

U_4=0.5 for underground mining over 3000 ft.

With most underground coal being mined at less than 1500 feet, this formula gives a higher percentage value than proposed by Blessing. However, it distinguishes between strip and underground by charging a high royalty for coal mined by surface methods.

Another change came on May 3, 1971, which partially eliminated the advantage of lower royalty for coal mined by underground methods (Turner, 1971c, p.2):

Coal mined by strip or auger mining methods:

5% of gross value of the products produced but not less than:

1. $17\frac{1}{2}$ cents per ton for 1st 10 years
2. 20 cents per ton for 2nd 10 years

Coal mined by underground mining methods:

4% of gross value of the products produced but not less than:

1. 15 cents per ton for 1st 10 years
2. 20 cents per ton for 2nd 10 years

Gross value is the value of the coal mined at the point of shipment to market. It appears that the changes are designed to increase revenue for the government. Evidence of economic studies to determine the effects of higher royalty rates on coal companies has not been disclosed. Have profits increased to justify higher royalties? Have the small mines been considered? Is it the goal of the government to maximize its revenue? As the Honorable W. N. Aspinall, U.S. Representative from Colorado, has said

> There has been a growing tendency for the public lands to be administered by federal agencies as though they were purely a business enterprise; maximization or optimization of the Government's income from the sale of land and natural resources products are the objectives of management. But the laws under which these lands are administered basically reflect other objectives....(Aspinall, 1967, p. 151).

The Conservation Division of the U.S. Geological Survey is charged with aiding in the conservation of mineral resources. In order to achieve this goal, the division used in the past was a royalty policy which was of the trial and error type. If no one complained, this policy was adopted without determining the possible economic impact of this decision. One may wonder if this was a proper way to go. An economic analysis beforehand could point out alternatives, list their advantages and disadvantages, and estimate the possible impacts. The decision by the policy makers then

could be made on the basis of more economic information.

Rentals - Rental represents a return for holding a resource when there is no production. Rental payments should encourage early exploration and development and discourage speculative holding without development. Three of the minerals studied have their rentals fixed by law. Potassium and sodium rentals are 25 cents per acre or fraction thereof for the first calendar year, 50 cents for the second, third, fourth, and fifth years, and $1 for the sixth and each succeeding year. Sulphur rentals are 50 cents per acre for all years of the lease.

Phosphate and coal both have the words "not less than" in their rental requirements. Phosphate rentals are not less than 25 cents per acre for the first year, not less than 50 cents per acre for the second and third year, and not less than $1 per acre for each and every year thereafter (Federal Register, 1971, p. 7053). The abundance of privately owned phosphate deposits has satisfied market demands such that interest in federally owned phosphate deposits is minimal. Phosphate leases in the Montana area are mostly undeveloped or inactive. The majority of leases call for a $1 per acre rental fee. The Idaho area also has many phosphate leases but most are inactive and call for a $1 per acre rental fee. There has been little change in the method of calculation of phosphate rental fees. The present system is based on checking to see what the rental

rates have been in the area in the past and taking off from there with good judgment.

Coal leasing, however, has been very active, and new methods are constantly being formulated to establish rental rate determinations based on some type of equitable formula. Prior to 1960, most rental rates were based on the minimum amount established by law. Ernest Blessing, Regional Mining Supervisor in Salt Lake City, expressed his opinion on this subject by saying, "It appears to be discriminatory to charge higher rentals to coal acreage when other leases prohibit such increases" (U.S. Geological Survey, 1970a, p. 37). Mr. J. D. Turner, Chief of the Branch of Mining Operations, stated that "Increased rentals may deter speculation and excess holdings, but increased rentals will not increase production" (U.S. Geological Survey, 1970a, p. 30). No rental increase can force production if no market exists for the coal produced. But today the market for coal does exist. Coal lease W-031201 set a precedent by initiating an "upset rental" which was designed to increase rentals to keep speculators from holding coal lands. If the mine was producing, rental rates were applied to royalty payments, and the upset rental made no economic impact on the operation.

At the Regional Mining Supervisors' Conference held in Denver, Colorado, April 27 to May 1, 1970, several rental schedules were proposed. J. D. Turner proposed the

following schedule:

> Rental for each of the first five years of the lease at $1 per acre. After the first 5 years of the lease it would be:

Mineable coal Thickness-ft.	Value of coal up to $5/ton	$7.50/ton	$10/ton
5	$1.00	$1.50	$2.00
6	1.20	1.80	2.40
7	1.40	2.10	2.80
8	1.60	2.40	3.20
9	1.80	2.70	3.60
10	2.00	3.00	4.00
15	3.00	4.00	5.00
20	4.00	5.00	6.00
25	5.00	6.00	7.00
over 25	6.00	7.00	8.00

> Adjustment factor for depth (overburden)
> 0-1,500 ft - no adjustment
> 1,500-3,000 ft - $1 deduction
> Over 3,000 ft - $2 deduction

(Source: U.S. Geological Survey, 1970a, p. 67)

There are many inconsistencies in this table. Under the $7.50/ton column the values increase by 30 cents per foot of coal up until 10 feet and then for a five foot coal thickness increase the rental is only $1 greater or a 20 cent per foot increase. Under the $10/ton column the rental increases by 40 cents per foot and then again after 10 feet the increase is only 20 cents per foot. The adjustment factor for depth does not enter into most calculations because most coal mines are less than 1,500 feet in depth. The idea of charging rental by coal value will be more harmful to underground coal operations where value is based on a higher mining cost and not necessarily on the quality of the product. The greatest merit of the schedule

is the determination of rental from physical facts rather than personal judgment.

The next rental schedule was proposed by the Chief of the Conservation Division, Mr. R. G. Wayland:

> Rental for each of the first 5 years of the lease shall be $1/acre. Beginning with the sixth year the rental shall be:

Sum of Mineable Coal Thicknesses	Coal Value up to $5/ton	$5.00-$7.50 per ton	Over $7.50 per ton
up to 5	$1.00	$1.50	$2.00
5 - 10	1.50	2.00	2.50
10 - 20	2.00	2.50	3.00
20 - 35	2.50	3.00	3.50
35 - 55	3.00	3.50	4.00
55 - 80	3.50	4.00	4.50
Over 80	4.00	4.50	5.00

> Adjustment factor for depth (overburden)
> 0-1,500 ft - no adjustment
> 1,500-3,000 ft - $1 deduction
> Over 3,000 ft - $2 deduction

> (Source: U.S. Geological Survey, 1970a, p. 68).

The differences between the two schedules are numerous. The coal value headings have changed. Very little coal commands a price of $10.00/ton. Therefore, a higher rental could be obtained by lowering the value from $10.00 to $7.50. The introduction of the word "sum" in the first column clarifies the interpretation so that the rental rate will not be charged to individual beds of coal. Overall, there has been a lowering of rental rates when compared to the other schedule. The maximum rental in the second schedule is $5.00 for coal over 80 feet thick while in the first schedule the maximum is $8.00 for coal over 25

feet thick.

The Regional Mining Supervisors then proposed another schedule which was a mixture of the first two. From these three schedules Instruction File No. 44.1 was derived:

> Rental for each of the first 5 years shall be $1 per acre. Beginning with the sixth year the minimum or upset rental shall be $5.00/acre, unless production royalty of $5.00/acre is obtained. After production royalty of $5.00/acre has been achieved the following rates will prevail:

Sum of Average Mineable Coal Thickness	Value of Coal up to $5/ton	$5.00-$7.50/ton	Over $7.50/ton
Up to 5 ft.	$1.00/acre	$1.50/acre	$2.00/acre
5 - 10 ft.	1.50	2.00	2.50
10 - 20 ft.	2.00	2.50	3.00
20 - 30 ft.	2.50	3.00	3.50
30 - 40 ft.	3.00	3.50	4.00
40 - 50 ft.	3.50	4.00	4.50
50 - 60 ft.	4.00	4.50	5.00
60 - 70 ft.	4.50	5.00	5.50
70 - 80 ft.	5.00	5.50	6.00
over 80 ft.	5.50	6.00	6.50

> Adjustment factor for depth(overburden)
> 0-1,500 ft - no adjustment
> 1,500-3,000 ft - up to $1.00/acre adjustment
> Over 3,000 ft - up to $2.00/acre adjustment

Rental shall not be less than $1.00/acre in any event.

(Source: U.S. Geological Survey, 1970, Instruction File No. 44.1).

On February 3, 1971, a new formula was introduced which "has the advantage of ironing out the arbitrary step-like jumps inherent in schedules and...would be more equitable to everybody concerned" (Wayland, 1971, p.1). The formula is first applied using the known information

and then the evaluator must consider all other factors which cannot be put into the formula before reaching a final decision.

$$(T)\ \$0.20\ \frac{(Btu)}{7,000}\ (U_i)\ (C_j) = \text{upset annual rental/acre} \quad (i=1,2,3,4;\ j=1,2,3)$$

where \$0.20 = (1770 tons/acre ft.) (.113 mills/ton)

U_1 = 1.0 for stripping coal

U_2 = 0.8 for underground mining to 1,500 foot depth

U_3 = 0.7 for underground mining to 1,500-3,000 foot depth

U_4 = 0.5 for underground mining over 3,000 foot depth

C_1 = 1.5 direct coking coals

C_2 = 1.3 coking blends

C_3 = 1.0 non-coking coal

T = total thickness, in feet, of all mineable coal beds present

An attempt has been made to establish rental rates on facts which would tend to charge a lower rental to mines with harsh mining conditions (thin coal, thick overburden, low Btu value), but in reality many of these facts are unknown or are assumptions based on limited data. The \$0.20 value in the formula is based on a value of 0.113 mills/ton. Possible favoritism is eliminated by the introduction of factual data. These calculations are made because the law did not set the rental as it did for the other three minerals under study which treats all lease-holders as equal.

Because no two mineral deposits are exactly alike, there are many factors which must be evaluated to determine

a fair rental. The U.S. Geological Survey recognizes these factors and has continually worked toward achieving an efficient, reliable, and equitable method of rental calculation. The Washington office is constantly seeking new ideas from the field offices in an effort to achieve this goal.

Minimum Bonus Bid - One of the primary goals of the Department of Interior as manager of public mineral resources is to assure that disposals are at fair-market-value. Lands known to contain a leasable mineral in workable quantity and quality are disposed of by public auction which has previously been explained. But what should be the lowest acceptable bid? Who determines the minimum bonus bid? And how is it presently determined? The minimum bonus bid can also serve as a deterrent to speculators by representing a sufficient investment which would encourage early development.

On November 15, 1967, the BLM published Instruction Memo. No. 67-480 for the evaluation of acceptable minimum bids for mineral leasing to assure that fair-market-value is obtained. The method of minimum bonus bid determination called for evaluating production, quality, quantity, depth of overburden, competition, and other factors with past minimum bonus bid experience. The BLM then justified

> the difference in value from the recommended minimum and that actually received at the sale as the reward received by the company for

> exploring the reserve, thereby developing sufficient information to establish and demand the price received (Neuberg, 1967, p. 7).

Prior to this time in the early 1960's, competition was minimal and bonus bids were very small. Table VI, however, showed the rapid rise in magnitude of bids. But there are many problems in determining a minimum bonus bid when geologic facts are not well known.

> Our absolute knowledge of the thickness of coal and its continuity is unknown and until or unless we can obtain more positive knowledge all our recommended bonus bids should be a $1-$5 or so per acre and thus permit the bidder and subsequent lessee to assume the great risk of what he thinks the coal is worth to him (Blessing, 1967, p. 3).

The relinquishment of Utah coal leases 0148021 through 0148025 with a bonus bid offer of $450,000 proved this. These leases were put up for competitive bid with very vague knowledge of what was there, and subsequent drilling proved the geologic inference wrong. In 1967, the Chief, Branch of Mining Operations stated that

> You are aware that it is not practical to determine exactly what a minimum acceptable bid should be, for there are too many offsetting factors, such as immediate need for reserves, financial, and tax position of the applicant, all of which may change at least quarterly (Turner, 1967, p. 1).

This quote is in reference to companies having different advantages in bidding. The problem is to put aside the identity of the buyer and his ability to pay and formulate a method of establishing the price of the commodity based

on its fair-market-value. The BLM and Branch of Mining Operations have had many disagreements in the past over who determines the bonus bids, which is only normal between different agencies. A decision was reached, however, whereby "the BLM will accept and utilize the recommended royalty rates and acceptable bids, fixed by the Geological Survey" (Loesch, 1970, p. 1).

In 1967, a comparison of western coal bonus bids was made with coal east of the Mississippi River as to Btu value, overburden, and recovery rates. From this comparison, a suggested minimum acceptable bonus was 3-1/3 percent of the estimated present retail value of about one-third mill/ton of coal (Turner, 1967, p. 2). During this time, discounted cash-flow analysis was being used as a tool to determine a minimum bid value. The main problem in using this system was the abundance of unreliable assumptions. "The one-third mill per ton figure appears to be reasonable and just" (Storrs, 1967, p. 2). "The one-third mill per ton of coal in place as a base appears to be suitable at this time" (U.S. Geological Survey, 1970, p. 6). But the surprising increase in bonus bids in the Wyoming coal fields changed things again. "Further adjustments are in order" (Wayland, 1971, p. 1). Therefore, the following formula was created which, when applied to recent coal sales in Wyoming, gives a higher minimum bonus bid which more nearly approximates the actual bonus bid received. The method is...

> ...to apply the following empirical formula and then to modify the result according to our best judgment, taking into account factors which cannot be put into the formula.

$$T\ (\$2.00)\ \frac{(Btu)}{7{,}000}\ (U_i)\ (C_j) = \text{min. accepted bonus/acre} \quad (i=1,2,3,4;\ j=1,2,3)$$

T = total thickness, in feet, of all mineable coal beds present
$2.00 = 1,770 tons/acre ft. times 1.13 mills per ton
Btu = average Btu of mineable beds
U_1 = 1.0 strippable coal
U_2 = 0.8 underground mining to 1,500 foot depth
U_3 = 0.7 underground mining 1,500-3,000 foot depth
U_4 = 0.5 underground mining over 3,000 foot depth

C_1 = 1.5 direct coking coals
C_2 = 1.3 coking blends
C_3 = 1.0 non-coking coals
(Source: Wayland, 1971, p. 1-2).

The major change in this formula, as compared to that previously presented on page 80, is the 1.13 mills per ton figure, up from one-third mill per ton. It appears that if competition continues to increase the bids, this figure will again rise.

There are two major thoughts in bonus bidding. One is the idea that everyone has the opportunity to purchase the land and that bonus bidding therefore serves as a fair method to allocate the resource. Secondly, the minimum bonus is established to guarantee a fair return in the case of a few bidders. The recent trend to bring minimum acceptable bids up to the level of actual established bids

appears to emphasize the maximization of revenue which may or may not be a primary goal. One fact is certain: methods of determining the acceptable minimum bonus bid will continue to change as the U.S. Geological Survey and the BLM attempt to arrive at an optimum method of assuring that the bonus bid reflects fair-market-value.

LINEAR REGRESSION TECHNIQUES

The following section demonstrates the application of linear regression techniques for determining trends for royalties on government land for the minerals studied.

Theory

In linear regression, one tries to estimate a theoretical relationship between Y and X of the form

$$Y = a + bX + e$$

where "e" represents an unknown random-error term. This random-error term approaches zero when using the method of least squares to determine the intercept (a) and slope (b) of the straight line equation $Y = a + bX$. The problem of bivariate regression is that of estimating or predicting the expected value of one variable on the basis of observed values of another.

In order to solve for the value of (a) and (b), two equations with two unknowns are needed. These equations can be found in any statistics book. (See for example Kane, 1968, p. 221). It is not the purpose of this paper to reiterate the derivation of these equations.

Normal Equation I $\Sigma Y = Na + b\Sigma X$

Normal Equation II $\Sigma XY = a\Sigma X + b\Sigma X^2$

The N represents the number of sample observations and the symbol Σ(Sigma) represents a summation sign. Regression merely attempts to pass a line through an observed scatter of bivariate data points which minimizes the sum of squared deviations of the individual points in a given direction.

The coefficient of determination (r^2) is a generalized measure of statistical "goodness of fit" and is a measure of the percent of the explained variance. The square root of this value is the coefficient of correlation (r) and merely states whether two variables do or do not habitually move together. Are they co-related? The coefficient of correlation is simply a measure of linear association. It enables one to determine whether or not the hypothesis that X and Y are mutually related is valid.

When r = 1, all observed points lie on a straight line. It says nothing of the slope or steepness of the line. It only describes the degree of scatter about the regression line $Y = a + bX$. When r = 0, X and Y are uncorrelated in the sample. However, they may still be correlated by a more complicated, nonlinear relationship. High correlation merely suggests linear association. One must always be wary of observed correlations between variables which cannot be justified by any reasonable theory. These spurious correlations must be viewed as

mere coincidence. The formula for calculating r is

$$r = \frac{\Sigma(X-\bar{X}) \cdot \Sigma(Y-\bar{Y})}{\sqrt{(X-\bar{X})^2 \cdot (Y-\bar{Y})^2}}$$

where $\bar{X} = \frac{\Sigma X}{N}$, $\bar{Y} = \frac{\Sigma Y}{N}$, and N = number of samples or observations. This formula can also be found in most statistics books (Kane, 1968, p. 244). Again, it is not the purpose of this paper to reiterate theory which can be found in a statistics text.

Assumptions

The application of linear regression techniques to royalty payments can result in helpful information leading to the formulation of an improved method of royalty calculation. In the linear equation $Y = a + bX$, the coefficient "b" represents the slope of the straight line or $\frac{\Delta Y}{\Delta X}$. In applying this equation to royalty payments, I have taken data for the past 15 years for royalty payments (Y) as compared with the actual value of the mineral (X). In this case "b" represents the percentage of the value of the mineral that is paid as a royalty payment.

An attempt has been made to establish if a correlation exists between royalty and mineral value. If correlation exists, what is the percentage? The raw data for this analysis are located in Appendix B. A computer program (MNSQUARE.F4) was run through the Colorado School of Mines computer: the printouts for each run and a copy

of the program which performs the calculations are in Appendix C. Graphs of the data points and a plot of the calculated straight-line equation are in Appendix D. A linear regression line was used because the dispersion of points plotted (royalty versus mineral value) indicated the application of a linear relationship.

Application

Data were available for coal and phosphate on public lands, acquired lands, and Indian lands. Potassium, sodium, and sulphur had information available only for public lands.

Coal - The value of coal mined on public land increased from $30.6 million in 1955 to $36.8 million in 1969 while at the same time royalty payments increased from $699,184 to $1,070,000. Graph I in Appendix D clearly shows the dispersion of data points for royalty payments versus value of coal on public land. Except for sulphur, this correlation gave the lowest coefficient of correlation of any of the other minerals. It is evident from the previous discussion on methods of royalty determination used in the past and at present that this was to be expected. All of the linear regression results are in Table VIII on the following page. From this table it can be seen that royalty payments over the 15 year period represented only 3 percent of the value of the coal mined, while for coal mined on acquired lands and Indian lands royalties were 4 percent

TABLE VIII

LINEAR REGRESSION RESULTS

Mineral	Classification	b	Coefficient of Determination (r^2)	Coefficient of Correlation (r)
Coal	Public Lands	.03	.522	.722
	Acquired Lands	.04	.992	.996
	Indian Lands	.06	.997	.998
Phosphate	Public	.04	.908	.953
	Acquired Lands	.04	.784	.884
	Indian Lands	.10	1.000	1.000
Potassium	Public Lands	.05	.988	.994
Sodium	Public Lands	.05	.991	.995
Sulphur	Public Lands	.06	.496	.704

and 6 percent respectively.

There was a high degree of correlation for coal on acquired and Indian lands. The Indians set their own royalty stipulations and have often used a percentage of mineral value as a basis for royalty determination. No explanation can be advanced for the good correlation for coal mined on acquired lands. The production activity on acquired lands tapered off to nothing in the past two years, and royalty values and coal values have been only 1 percent of those mined on public lands.

Phosphate - The production of phosphate has been about the same from public and Indian lands with royalties of about $500,000 in 1969. A perfect coefficient of correlation of 1.000 was calculated for Indian lands because the Indians use 10 percent of the value of the phosphate as the royalty payment. The percentage of royalty for both public lands and acquired lands calculated at 4 percent of the value of phosphate.

Potassium - The activity of potassium production has risen and then fallen over the past 15 years. It reached a peak of $5.0 million in royalty payments in 1965 and then fell to $2.9 million in 1969 on public lands. The coefficient is .05, which represents 5 percent of production value as being paid for royalty payments.

Data for production and royalties on acquired and Indian lands has been inconsistent over the past 15 years,

so no correlation was attempted. Graph VII in Appendix D shows the good correlation of points plotted.

Sodium - The production value of sodium mined on public land has risen consistently from $22.5 million in 1955 to $53.2 million in 1969, with royalty payments increasing from about $747 thousand to over $2.1 million. The coefficient of correlation was again high at .995, with a value of 5 percent of the production value being paid as a royalty. Sodium production from acquired and Indian lands was not consistent so no correlations were run.

Sulphur - Sulphur production was grouped together for the years 1950 - 1957. Data were taken for the years 1958 - 1969, and as seen in Graph IX in Appendix D, the data do not correlate well. The coefficient of correlation was the lowest for the five minerals at .704. As compared with coal which had royalty payments of over $1 million in 1969 for coal mined on public lands, sulphur's 1969 royalty of $21 thousand is very insignificant. The important point is that royalty payments represented 6 percent of the production value of sulphur, which is twice that for coal.

Conclusions

There is a definite linear relationship between the royalty and value of the five minerals studied. Differences in the degree of correlation exist, but in most

cases the correlation coefficient was very high. The difference in the slopes ("b" in Table VIII) of the various trend lines indicates possible inequity within the mineral leasing system. The application of linear regression was used to prove past correlations. However, future projections of royalty payments derived from these equations are not an objective of this derivation because of the existing inequalities. Suggestions to eliminate these inequalities are mentioned in the final conclusions.

SUMMARY AND CONCLUSIONS

The following section includes a brief summary of the thesis and final conclusions. Again, conclusions derived from this study of federal leasing policies of selected minerals in western United States are the expressed opinion of the author and do not necessarily reflect the thinking nor the policies of federal and state agencies.

Summary

The many statutes and court decisions that make-up the public land mineral system of the United States have resulted in certain weaknesses and strengths. Early legislators recognized that there were certain differences between various types of mineral commodities and therefore created legislation designed to promote the effective development of one mineral without impeding that of another.

Although cash bonuses for competitive leases may reduce the amount of money available for exploration and development of the mineral resource, other monetary features have strengthened the system. Sliding scale rentals where a minimum per acre fee is charged the first year with an increase during the next few years has tended to encourage

early development for production. The offsetting of rentals against royalties from production has also been advantageous in promoting production.

The acreage allowances for prospecting permits and leases are large enough to accommodate most mineral producing activities but at the same time are small enough to offset monopolistic tendencies. The requirement that prospecting permits and leases be defined in terms of the public land survey has also been a definite advantage of the system.

The preference right lease arrangement to determine the existence and workability of a leaseable mineral in little known geologic areas is another advantage of the system. However, the determination of what criteria proves existence and workability is still clouded. Workability involves a mixed concept of marketability and profitability.

In most recent times, the attention attracted to leaseable minerals has been brought about by the large bonus bids for competitive leases. The result of large bids has been the elimination of small and medium-size producers of coal, phosphates, potash, sulphur, and sodium minerals. The high capital requirement of speculative land acquisition has prevented the small company from acquiring mineral resources. Oligopoly has resulted from this elimination. High cash bonuses may tend to promote

rapid mine development accompanied with selective mining in order to rapidly pay back the high initial investment. This would lead to a poor conservation practice which is contrary to the goals of the Conservation Division of the U.S. Geological Survey.

One of the most serious weaknesses in the existing system involves the restriction of disputes between private individuals and the government to arbitration and final decision by Department of Interior personnel within the department. This does not allow for an impartial hearing and the equitable adjudication of such disputes. The delaying tactics of recycling disputes for review is adverse to the small mine company. "In some cases, appeals involving six to ten years have elapsed before a final decision has been reached" (University of Arizona, 1969, p. 821). Only major size companies would have the time and financial resources to endure such lengthy proceedings.

Many changes could be made in the leasing laws to improve the present system, but each change has advantages and disadvantages which depend on policy decisions. Perhaps the most important policy decision is one of whether the government wants to maximize its revenue from leaseable minerals.

> Economists should not deceive policymakers into believing that economic analysis relieves them of the responsibility of making value judgments about such questions as what rate of time use of mineral resources is in the public interest (Davidson, 1970, p. 5).

The five leaseable minerals studied demonstrate the complexity of mixing economic and political reality. The methods of achieving government goals are constantly changing with time.

> In the trona area, we have advanced a long way from experimental work and now have a going expanding industry. We no longer need to continue low royalty rates to encourage industry to move into the trona or the phosphate areas (Duncan, 1966, p. 2).

The linear regression analysis proved a definite linear relationship between royalty and value of the mineral mined. The different slopes of the regression lines showed inequity between the various minerals studied.

This paper has attempted to answer many questions concerning leaseable minerals, yet it has probably raised many unanswered questions. Of prime importance is the recognition that no laws made by man are perfect. Improvement of the federal leasing system will come about only through federal and private cooperation in achieving the maximum utilization of this country's natural resources.

Conclusions

The objectives of mineral leasing policy should be reviewed by the appropriate government agencies in order to establish goals compatible with today's economic conditions and technology. The chapter which discussed the historical background of the Mineral Leasing Act of 1920 emphasized the lack of an overall mineral leasing policy. As the need

arose, changes were made to solve the immediate problem. The laws of the past may not be adequate for solving the problems of today. With this in mind, the following conclusions are made in the hope that improvements may develop within the mineral leasing system.

Economic studies should be employed regularly to help in determining the possible economic impact of changes and adjustments in the leasing laws. Consistency in the leasing laws of the various minerals should, if possible, exist.

Because the required minimum bonus bid is often based on incomplete geologic information, no such minimum should be set. Competitive atmosphere should be allowed to function freely and establish its own fair-market-value.

The minimum standards for proving a preference right lease should be clearly explained in writing to the permittee before exploration monies have been expended. Early notification will eliminate complaints and disappointments at a later date.

Royalty payments for all the minerals studied should be set by law at the same fixed percentage of gross value of the mineral at the point of shipment to market. Further economic study would be needed in order to determine the percentage value to be used. In part, it is also a function of government objectives.

Policy makers should decide on the objectives, and upon approval by the legislators, the government should

employ geologic and economic studies in order to establish the proper regulations needed to accomplish these goals. These studies should be periodically reviewed and up-dated to adjust to changing economic and technical conditions.

The author is well aware of the fact that these conclusions are very general and their formulation requires much more detailed analysis. Therefore, it is recommended that a study group composed of government and industry representatives be established to work out an overall policy beneficial to both parties and in line with government objectives.

APPENDIX A

PROSPECTING OR EXPLORATION PLAN

PROSPECTING OR EXPLORATION PLAN

1. Approximate time drilling or exploration is to commence, and approximate duration of exploration.

2. A written general description of the permit lands, and aerial photograph, quadrangle map or other suitable map showing approximate drill hole locations and the sequence of drilling or other exploration activity.

3. Method of prospecting:
   - A. Open-Cut
   - B. Drill Hole

4. Type of drilling and/or other exploration equipment:
   - A. Size and weight
   - B. If open-cut methods or prospecting are used, make a statement as to how the open cuts will be made (backhoe, pick and shovel, etc.)

5. Drilling Information:
   - A. Size of drill core to be recovered.
   - B. Type of electrical or mechanical logs to be run.
   - C. Depth of drill holes (through coal-bearing formation).

6. Drilling Media:
   - A. Water
     1. Source
     2. Storage (amount needed at the drilling site)
     3. Pollution control.
   - B. Air
     1. Source
     2. Pollution control.

7. Drilling or Exploration Site:
   - A. General description of site (area, layout, etc.)
   - B. Method of preparing site -(leveling, excavation, etc.)
   - C. Reclamation and reseeding procedures.
   - D. Soil erosion control.

8. Roads:
   - A. A general road location should be shown on maps wherever possible.

B. Use of existing roads.
C. Soil erosion control.
D. Reclamation and reseeding procedures.

9. Burning of Debris: Air pollution control if applicable, depending on the area.

10. Controls to be used where excessive gas or water pressures are encountered in drill hole.

11. Noise: Blasting or other noise factors. (Is blasting anticipated in prospecting, etc.)

12. Safety Features to be used:
    A. For people.
    B. For livestock or wildlife.
    C. Fire:
        1. Gas (methane if encountered in drill hole.
        2. Range
        3. Forest

13. Coordination and cooperation should prevail with the federal, state, regional and local authorities including (a) county planning and land use controls; (b) municipal planning and land use controls.

Note:

The stipulations written into your permit contract relative to surface mining, exploration and reclamation, CFR 43, Part 23, are a part of the prospecting requirements.

A prospecting permit is given to prove existence or workability (quality, quantity, thickness and continuity) in any undeveloped or unclaimed lands. Commercial quantities of coal must be proven to qualify for a preference right lease.

One copy of the approved prospecting plan and reclamation requirements of your permit must be posted in a conspicuous place on or near the exploration site

APPENDIX B

PRODUCTION TONNAGE, VALUE, AND ROYALTY DATA OF MINERALS STUDIED

COAL - PUBLIC LANDS

Year	Tons	Value	Royalty
1920-1944	92,084,163	$167,172,330	$ 9,941,407
1945	8,808,381	23,717,035	844,315
1946	8,521,914	27,923,087	884,736
1947	7,405,760	28,010,736	767,978
1948	8,376,264	34,033,775	844,592
1949	7,458,699	36,154,907	790,088
1950	9,128,531	39,861,368	1,010,999
1951	7,883,624	38,526,371	910,835
1952	7,384,308	38,125,749	864,613
1953	7,182,304	36,339,839	853,425
1954	5,725,873	30,879,149	709,519
1955	5,703,419	30,683,807	699,184
1956	5,690,911	32,461,428	705,534
1957	5,201,532	31,441,864	657,761
1958	4,807,152	29,928,160	603,494
1959	5,090,995	31,265,590	616,494
1960	5,131,625	31,818,274	642,486
1961	5,733,181	31,077,596	737,833
1962	4,936,100	25,467,936	630,178
1963	5,408,671	27,870,665	704,292
1964	5,480,621	27,260,892	741,270
1965	6,079,343	32,704,457	813,256
1966	6,985,928	40,091,589	913,802
1967	6,698,413	33,983,807	911,330
1968	7,481,739	34,902,185	1,079,035
1969	7,444,581	36,815,946	1,069,925
Through 1969	257,834,032	978,518,542	29,948,381

COAL - ACQUIRED LANDS

Year	Tons	Value	Royalty
1946	55,969	$ 171,038	$ 26,510
1947	27,027	83,937	4,776
1948	7,732	22,955	1,364
1949	68,733	311,126	9,623
1950	66,450	300,876	9,303
1951	54,843	246,775	7,682
1952	9,978	48,856	1,403
1953	85,500	394,766	12,022
1954	96,364	426,632	13,862
1955	25,225	90,389	3,784
1956	21,495	83,098	3,224
1957	16,860	57,377	2,523
1958	33,707	129,722	4,890
1959	30,302	112,061	4,547
1960	17,687	71,166	2,527
1961	15,446	62,750	2,264
1962	29,329	118,076	4,343
1963	92,123	368,996	13,768
1964	242,226	970,220	36,287
1965	151,160	604,638	22,673
1966	128,568	514,272	19,285
1967	93,956	375,822	14,093
1968	-	-	-
1969	-	-	-
Through 1969	1,370,680	5,565,548	220,753

COAL - INDIAN LANDS

Year	Tons	Value	Royalty
1927-1944	5,822,928	$16,777,606	$ 578,912
1945	560,093	2,608,907	59,362
1946	367,867	1,587,816	43,664
1947	944,183	5,894,539	122,755
1948	1,071,698	6,369,479	156,262
1949	150,121	714,030	14,599
1950	126,460	623,489	12,197
1951	136,204	679,902	15,034
1952	144,887	737,049	16,289
1953	126,506	736,256	13,137
1954	119,424	706,896	11,769
1955	75,948	483,541	8,238
1956	26,447	168,506	2,794
1957	76,784	663,486	7,459
1958	30,631	259,568	4,326
1959	63,886	479,240	10,805
1960	21,366	151,847	2,607
1961	17,870	122,654	2,287
1962	474,489	1,060,117	70,286
1963	1,622,992	3,442,207	224,846
1964	2,454,893	5,768,706	367,160
1965	2,070,202	4,923,101	310,530
1966	2,394,434	5,857,127	358,814
1967	2,356,227	5,931,815	353,431
1968	2,624,955	6,663,623	393,546
1969	4,599,577	11,247,645	689,937
Through 1969	28,481,072	84,659,152	3,851,046

PHOSPHATE - PUBLIC LANDS

Year	Tons	Value	Royalty
1920-1944	784,034	$ 2,802,505	$ 95,784
1945	105,939	664,538	15,469
1946	126,432	752,448	18,167
1947	144,079	891,885	20,441
1948	264,814	1,738,826	40,058
1949	263,875	1,765,336	43,908
1950	96,468	541,437	15,589
1951	206,618	911,541	34,886
1952	508,888	1,953,747	118,113
1953	591,382	1,938,093	133,820
1954	548,097	1,842,393	114,509
1955	1,069,781	2,593,435	219,486
1956	910,060	2,091,708	181,783
1957	1,198,106	3,681,474	267,542
1958	1,030,347	3,406,151	218,134
1959	1,347,539	3,810,489	276,550
1960	1,283,280	3,960,358	279,336
1961	1,040,962	3,552,397	233,936
1962	1,034,370	3,494,997	247,138
1963	1,214,935	3,914,496	259,683
1964	1,546,620	5,055,659	314,154
1965	2,603,086	10,104,746	511,104
1966	2,405,670	8,636,866	460,939
1967	2,154,289	7,625,824	451,912
1968	1,835,887	6,467,012	444,727
1969	1,724,594	5,578,987	434,507
Through 1969	26,040,152	89,777,348	5,451,675

PHOSPHATE - ACQUIRED LANDS

Year	Tons	Value	Royalty
1950	160	$ 480	$ 24
1951	3,604	10,812	541
1952	2,948	8,844	442
1953	4,428	13,284	664
1954	3,390	10,170	509
1955	4,308	12,922	646
1956	4,070	13,197	660
1957	3,745	15,282	829
1958	3,510	15,808	833
1959	7,565	22,263	1,346
1960	5,295	15,493	945
1961	6,260	15,206	986
1962	4,455	13,808	825
1963	4,805	15,448	909
1964	3,185	7,357	478
1965	4,365	10,083	655
1966	2,130	4,920	320
1967	1,140	2,633	171
1968	415	959	62
1969	2,875	6,641	431
Through 1969	72,653	215,610	12,276

PHOSPHATE - INDIAN LANDS

Year	Tons	Value	Royalty
1947	408,434	$ 1,094,232	$ 109,423
1948	153,367	381,972	38,197
1949	250,495	232,334	23,233
1950	545,006	753,578	75,358
1951	361,178	530,614	53,061
1952	703,003	802,631	80,263
1953	744,263	872,741	87,274
1954	610,604	738,979	73,898
1955	723,618	1,031,789	103,179
1956	694,361	1,018,092	96,575
1957	1,068,667	1,418,808	152,602
1958	1,106,952	2,021,939	202,194
1959	1,142,302	1,976,647	197,664
1960	894,353	1,614,226	161,423
1961	1,001,757	1,723,492	172,349
1962	953,758	1,688,828	168,883
1963	1,403,078	2,576,364	257,636
1964	1,717,982	3,223,758	322,376
1965	1,776,090	3,149,403	314,940
1966	1,489,214	2,725,588	272,559
1967	1,944,225	4,663,486	466,349
1968	2,368,100	6,166,613	616,661
1969	1,974,142	5,169,665	516,966
Through 1969	24,034,949	45,575,779	4,563,063

POTASSIUM - PUBLIC LANDS

Year	Tons	Value	Royalty
1920-1944 a/	18,580,081	$ 117,586,343	$ 3,026,846
1945	3,984,743	26,038,303	669,730
1946	4,121,113	26,611,215	679,550
1947	4,862,428	34,238,211	887,760
1948	4,952,930	35,594,012	898,991
1949	4,422,892	32,982,086	1,065,704
1950	5,437,729	40,100,638	1,528,652
1951	5,450,479	41,190,025	1,301,202
1952	7,462,130	53,088,540	1,979,780
1953	7,775,727	52,163,101	2,084,062
1954	8,602,953	58,098,292	2,453,676
1955	9,416,428	58,584,558	2,421,121
1956	8,755,543	59,764,782	2,367,328
1957	9,992,356	55,882,090	2,334,707
1958	10,838,455	69,393,210	2,945,816
1959	13,017,318	78,986,868	3,403,957
1960	12,868,931	72,919,663	3,225,897
1961	12,549,883	88,173,204	4,049,901
1962	13,596,144	90,433,941	4,204,603
1963	14,620,160	94,863,262	4,413,249
1964	16,680,768	108,572,498	5,023,861
1965	18,255,752	107,963,038	5,011,845
1966	17,549,290	94,445,022	4,357,430
1967	13,810,587	69,230,669	3,198,150
1968	12,161,530	56,733,449	2,594,285
1969	13,842,129	65,479,668	2,879,731
Through 1969	273,608,479	1,689,116,688	69,007,834

a/ Includes 4,208 tons Magnesium chloride.

SODIUM - PUBLIC LANDS

Year	Tons	Value	Royalty
1920-1944	1,476,673	$ 23,051,954	$ 664,112
1945	302,074	5,012,361	150,748
1946	371,396	6,788,943	204,045
1947	497,972	11,190,411	336,038
1948	556,683	12,417,820	372,459
1949	491,751	10,973,834	329,159
1950	675,304	15,286,064	455,581
1951	612,511	14,128,783	421,693
1952	634,506	15,198,286	453,983
1953	666,943	16,521,526	496,677
1954	765,939	19,322,122	616,850
1955	855,885	22,568,319	746,963
1956	901,807	23,238,686	769,989
1957	865,911	22,724,102	765,198
1958	972,775	25,245,099	833,609
1959	1,010,156	25,305,013	847,584
1960	1,023,222	26,447,649	922,165
1961	961,026	24,001,429	891,689
1962	1,039,178	25,102,949	957,110
1963	1,559,227	35,773,875	1,330,509
1964	1,491,773	34,027,848	1,316,894
1965	1,522,378	34,618,060	1,392,380
1966	1,604,651	36,134,057	1,454,631
1967	1,766,194	39,462,514	1,602,772
1968	2,535,947	55,936,343	2,260,236
1969	2,390,360	53,180,613	2,189,377
Through 1969	27,552,242	633,658,660	22,782,451

SULFUR - PUBLIC LANDS

Year	Oil and Gas Operations		
	Tons	Value	Royalty
1950-1957	218,474	$ 622,911	$ 88,182
1958	101,724	1,151,540	70,925
1959	129,978	470,217	41,852
1960	58,571	583,125	37,188
1961	42,852	353,566	22,372
1962	35,401	297,740	18,315
1963	35,979	289,403	16,364
1964	24,166	77,011	3,364
1965	1,688	(290,439)	(12,827)
1966	37,480	518,371	17,430
1967	37,296	688,541	28,776
1968	39,845	752,199	35,742
1969	29,299	519,016	21,675
Through 1969	792,753	6,033,201	389,358

APPENDIX C

MNSQUARE.F4 COMPUTER PRINTOUTS OF MINERALS STUDIED

COAL PUBLIC LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 30879.15/709.52

TYPE X(2) AND Y(2) 30683.81/699.18

TYPE X(3) AND Y(3) 32461.43/705.53

TYPE X(4) AND Y(4) 31441.86/657.76

TYPE X(5) AND Y(5) 29928.16/603.49

TYPE X(6) AND Y(6) 31265.59/616.49

TYPE X(7) AND Y(7) 31818.27/642.49

TYPE X(8) AND Y(8) 31077.60/737.83

TYPE X(9) AND Y(9) 25467.94/630.18

TYPE X(10) AND Y(10) 27870.66/704.29

TYPE X(11) AND Y(11) 27260.89/741.27

TYPE X(12) AND Y(12) 32704.46/813.26

TYPE X(13) AND Y(13) 40091.59/913.80

TYPE X(14) AND Y(14) 33983.81/911.33

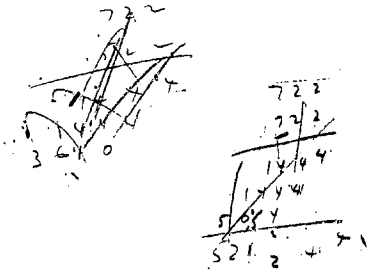
TYPE X(15) AND Y(15) 36815.95/1069.92

THE STRAIGHT LINE EQUATION IS --Y= A + BX
A= -86.20 B= 0.03

THE STANDARD ERROR OF THE ESTIMATE IS 94.152

THE VARIANCE IS 8864.587

THE COEFF. OF DETERMINATION IS 0.522



THE COEFF. OF CORRELATION IS 0.722

THE -T- TEST ON THE -B- COEFF. IS 0.137

COAL - ACQUIRED LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 90.39/3.78

TYPE X(2) AND Y(2) 83.10/3.22

TYPE X(3) AND Y(3) 57.38/2.52

TYPE X(4) AND Y(4) 129.72/4.89

TYPE X(5) AND Y(5) 112.06/4.55

TYPE X(6) AND Y(6) 71.17/2.53

TYPE X(7) AND Y(7) 62.75/2.26

TYPE X(8) AND Y(8) 118.08/4.34

TYPE X(9) AND Y(9) 368.99/13.77

TYPE X(10) AND Y(10) 970.22/36.29

TYPE X(11) AND Y(11) 604.64/22.67

TYPE X(12) AND Y(12) 514.27/19.28

TYPE X(13) AND Y(13) 375.82/14.09

TYPE X(14) AND Y(14) 394.77/12.02

TYPE X(15) AND Y(15) 426.63/13.87

THE STRAIGHT LINE EQUATION IS --Y= A + BX

A= -0.03 B= 0.04

THE STANDARD ERROR OF THE ESTIMATE IS 0.915

THE VARIANCE IS 0.837

THE COEFF. OF DETERMINATION IS 0.992

THE COEFF. OF CORRELATION IS 0.996

THE -T- TEST ON THE -B- COEFF.IS 1.458

COAL - INDIAN LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 483.54/8.24

TYPE X(2) AND Y(2) 168.51/2.80

TYPE X(3) AND Y(3) 663.49/7.46

TYPE X(4) AND Y(4) 259.57/4.33

TYPE X(5) AND Y(5) 479.24/10.80

TYPE X(6) AND Y(6) 151.85/2.6

TYPE X(7) AND Y(7) 122.65/2.29

TYPE X(8) AND Y(8) 1060.12/70.29

TYPE X(9) AND Y(9) 3442.21/224.85

TYPE X(10) AND Y(10) 5768.71/367.16

TYPE X(11) AND Y(11) 4923.10/310.53

TYPE X(12) AND Y(12) 5857.12/358.81

TYPE X(13) AND Y(13) 5931.82/353.43

TYPE X(14) AND Y(14) 6663.62/393.55

TYPE X(15) AND Y(15) 11247.64/689.94

THE STRAIGHT LINE EQUATION IS --Y= A + BX

A= -10.61 B= 0.06

THE STANDARD ERROR OF THE ESTIMATE IS 12.676

THE VARIANCE IS 160.677

THE COEFF. OF DETERMINATION IS 0.997

THE COEFF. OF CORRELATION IS 0.998

THE -T- TEST ON THE -B- COEFF. IS 3.984

PHOSPHATE -PUBLIC LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 2593.44/219.49

TYPE X(2) AND Y(2) 2091.71/181.78

TYPE X(3) AND Y(3) 3681.47/267.54

TYPE X(4) AND Y(4) 3406.15/218.13

TYPE X(5) AND Y(5) 3810.49/276.55

TYPE X(6) AND Y(6) 3960.36/279.34

TYPE X(7) AND Y(7) 3552.39/233.94

TYPE X(8) AND Y(8) 3494.99/247.14

TYPE X(9) AND Y(9) 3914.50/259.68

TYPE X(10) AND Y(10) 5055.66/314.15

TYPE X(11) AND Y(11) 10104.75/511.10

TYPE X(12) AND Y(12) 8636.87/460.94

TYPE X(13) AND Y(13) 7625.82/451.91

TYPE X(14) AND Y(14) 6467.01/444.73

TYPE X(15) AND Y(15) 5578.99/434.51

THE STRAIGHT LINE EQUATION IS --Y= A + BX

A= 100.09 B= 0.04

THE STANDARD ERROR OF THE ESTIMATE IS- 34.176

THE VARIANCE IS 1167.966

THE COEFF. OF DETERMINATION IS 0.908

THE COEFF. OF CORRELATION IS 0.953

THE -T- TEST ON THE -B- COEFF.IS 0.530

PHOSPHATE -ACQUIRED LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 12.92/.65

TYPE X(2) AND Y(2) 13.20/.66

TYPE X(3) AND Y(3) 15.28/.83

TYPE X(4) AND Y(4) 15.81/.83

TYPE X(5) AND Y(5) 22.26/1.35

TYPE X(6) AND Y(6) 15.49/.94

TYPE X(7) AND Y(7) 15.21/.99

TYPE X(8) AND Y(8) 13.81/.82

TYPE X(9) AND Y(9) 15.45/.91

TYPE X(10) AND Y(10) 7.36/.48

TYPE X(11) AND Y(11) 10.08/.66

TYPE X(12) AND Y(12) 4.92/.32

TYPE X(13) AND Y(13) 2.63/.17

TYPE X(14) AND Y(14) .959/.62

TYPE X(15) AND Y(15) 6.64/.43

THE STRAIGHT LINE EQUATION IS --Y= A + BX
A= 0.20 B= 0.04

THE STANDARD ERROR OF THE ESTIMATE IS 0.142

THE VARIANCE IS 0.020

THE COEFF. OF DETERMINATION IS 0.784

THE COEFF. OF CORRELATION IS 0.886

THE -T- TEST ON THE -B- COEFF. IS 0.346

PHOSPHATE - INDIAN LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 1031.79/103.18

TYPE X(2) AND Y(2) 1018.09/96.58

TYPE X(3) AND Y(3) 1418.81/152.60

TYPE X(4) AND Y(4) 2021.94/202.19

TYPE X(5) AND Y(5) 1976.65/197.66

TYPE X(6) AND Y(6) 1614.23/161.42

TYPE X(7) AND Y(7) 1723.49/172.35

TYPE X(8) AND Y(8) 1688.83/168.88

TYPE X(9) AND Y(9) 2576.36/257.64

TYPE X(10) AND Y(10) 3223.76/322.38

TYPE X(11) AND Y(11) 3149.40/314.94

TYPE X(12) AND Y(12) 2725.59/272.56

TYPE X(13) AND Y(13) 4663.49/466.35

TYPE X(14) AND Y(14) 6166.61/616.66

TYPE X(15) AND Y(15) 5169.66/516.97

THE STRAIGHT LINE EQUATION IS --Y= A + BX

A= 0.75 B= 0.10

THE STANDARD ERROR OF THE ESTIMATE IS 3.277

THE VARIANCE IS 10.739

THE COEFF. OF DETERMINATION IS 1.000

THE COEFF. OF CORRELATION IS 1.000

THE -T- TEST ON THE -B- COEFF. IS 17.709

POTASSIUM - PUBLIC LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 58584.56/2421.12

TYPE X(2) AND Y(2) 59764.78/2367.33

TYPE X(3) AND Y(3) 55882.09/2334.71

TYPE X(4) AND Y(4) 69393.21/2945.82

TYPE X(5) AND Y(5) 78986.87/3403.96

TYPE X(6) AND Y(6) 72919.66/3225.89

TYPE X(7) AND Y(7) 88173.20/4049.90

TYPE X(8) AND Y(8) 90433.94/4204.60

TYPE X(9) AND Y(9) 94863.26/4413.25

TYPE X(10) AND Y(10) 108572.50/5023.86

TYPE X(11) AND Y(11) 107963.04/5011.84

TYPE X(12) AND Y(12) 94445.02/4357.43

TYPE X(13) AND Y(13) 69230.67/3198.15

TYPE X(14) AND Y(14) 56733.45/2594.28

TYPE X(15) AND Y(15) 65479.67/2879.73

THE STRAIGHT LINE EQUATION IS --Y= A + BX

A= -532.95 B= 0.05

THE STANDARD ERROR OF THE ESTIMATE IS 106.144

THE VARIANCE IS 11266.462

THE COEFF. OF DETERMINATION IS 0.988

THE COEFF. OF CORRELATION IS 0.994

THE -T- TEST ON THE -B- COEFF.IS 1.716

SODIUM - PUBLIC LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 15

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 22568.32/746.96

TYPE X(2) AND Y(2) 23238.69/769.99

TYPE X(3) AND Y(3) 22724.10/765.20

TYPE X(4) AND Y(4) 25245.10/833.61

TYPE X(5) AND Y(5) 25305.01/847.58

TYPE X(6) AND Y(6) 26447.65/922.16

TYPE X(7) AND Y(7) 24011.43/891.69

TYPE X(8) AND Y(8) 25102.95/957.11

TYPE X(9) AND Y(9) 35773.88/1330.51

TYPE X(10) AND Y(10) 34027.85/1316.89

TYPE X(11) AND Y(11) 34618.06/1392.38

TYPE X(12) AND Y(12) 36134.06/1454.63

TYPE X(13) AND Y(13) 39462.51/1602.77

TYPE X(14) AND Y(14) 55936.34/2260.24

TYPE X(15) AND Y(15) 53180.61/2189.38

THE STRAIGHT LINE EQUATION IS --Y= A + BX

A= -272.97 B= 0.05

THE STANDARD ERROR OF THE ESTIMATE IS 49.678

THE VARIANCE IS 2467.923

THE COEFF. OF DETERMINATION IS 0.991

THE COEFF. OF CORRELATION IS 0.995

THE -T- TEST ON THE -B- COEFF.IS 1.732

SULPHUR - PUBLIC LANDS

ENTER THE VALUE OF-N, USE FORMAT-I2-THEN TYPE A CARRIAGE RETURN 12

TYPE X(1), SLASH AND Y(1), USE A PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER 622.91/88.18

TYPE X(2) AND Y(2) 1151.54/70.92

TYPE X(3) AND Y(3) 470.22/41.85

TYPE X(4) AND Y(4) 583.12/37.19

TYPE X(5) AND Y(5) 353.57/22.37

TYPE X(6) AND Y(6) 297.74/18.32

TYPE X(7) AND Y(7) 289.40/16.36

TYPE X(8) AND Y(8) 77.01/3.36

TYPE X(9) AND Y(9) 518.37/17.43

TYPE X(10) AND Y(10) 688.54/38.78

TYPE X(11) AND Y(11) 752.20/35.74

TYPE X(12) AND Y(12) 519.02/21.68

THE STRAIGHT LINE EQUATION IS --Y= A + BX

A= 0.67 B= 0.06

THE STANDARD ERROR OF THE ESTIMATE IS 18.038

THE VARIANCE IS 325.356

THE COEFF. OF DETERMINATION IS 0.496

THE COEFF. OF CORRELATION IS 0.704

THE -T- TEST ON THE -B- COEFF. IS 0.278

MNSQUARE.F4 PROGRAM

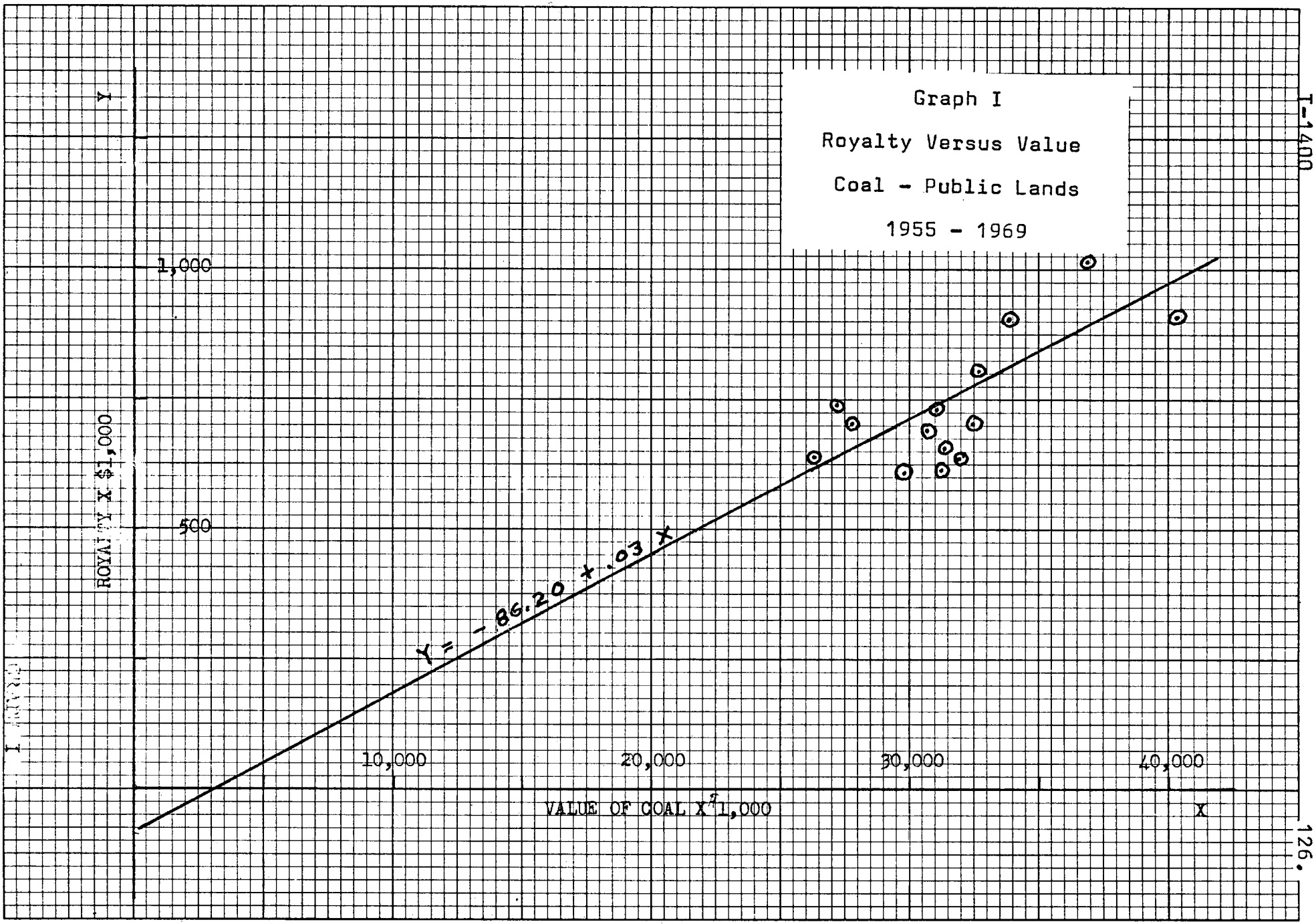
```
.TYPE MNSQUARE.F4
      DIMENSION YY(50),XX(50)
      SX=0.0
      SY=0.0
      SX2=0.0
      SXY=0.0
      SY=0.0
      WRITE (4,30)
   30 FORMAT(1H-' ENTER THE VALUE OF-N, USE FORMAT-I2-THEN'
     1        '  TYPE A CARRIAGE RETURN    '$)
      READ (5,6) N
    6 FORMAT (I2)
      YMEAN=0.0
      DO 20 I=1,N
      IF(I-2) 36,31,31
   36 WRITE (4,35) I,I
   35 FORMAT(' TYPE X('I2,' ), SLASH AND Y('I2,' ), USE A'
     1       ' PERIOD AT THE END IF ANY OF THE VALUES IS INTEGER    '$)
      GO TO 9
   31 WRITE(4,33) I,I
   33 FORMAT(' TYPE X('I2,' ) AND Y('I2,' )    '$)
    9 READ(5,10) X,Y
   10 FORMAT (2F)
      XX(I)=X
      YY(I)=Y
      SX=SX+X
      SY=SY+Y
      SX2=SX2+X**2
      SXY=SXY+X*Y
      SY2=SY2+Y**2
      YMEAN= YMEAN+Y
   20 CONTINUE
      B=(N*SXY-SX*SY)/(N*SX2-SX**2)
      A=(SY*SX2-SX*SXY)/(N*SX2-SX**2)
      WRITE(4,25)
   25 FORMAT(1H-' THE STRAIGHT LINE EQUATION IS --Y= A + BX')
      WRITE(4,32) A,B
   32 FORMAT(' A='F9.2,'            B='F9.2)
      STDERR = SQRT(( SY2 -A*SY-B*SXY)/(N-2))
      WRITE(4,40) STDERR
   40 FORMAT (1H-' THE STANDARD ERROR OF THE ESTIMATE IS 'F10.3)
      VARIAN=STDERR**2
      WRITE(4,45) VARIAN
```

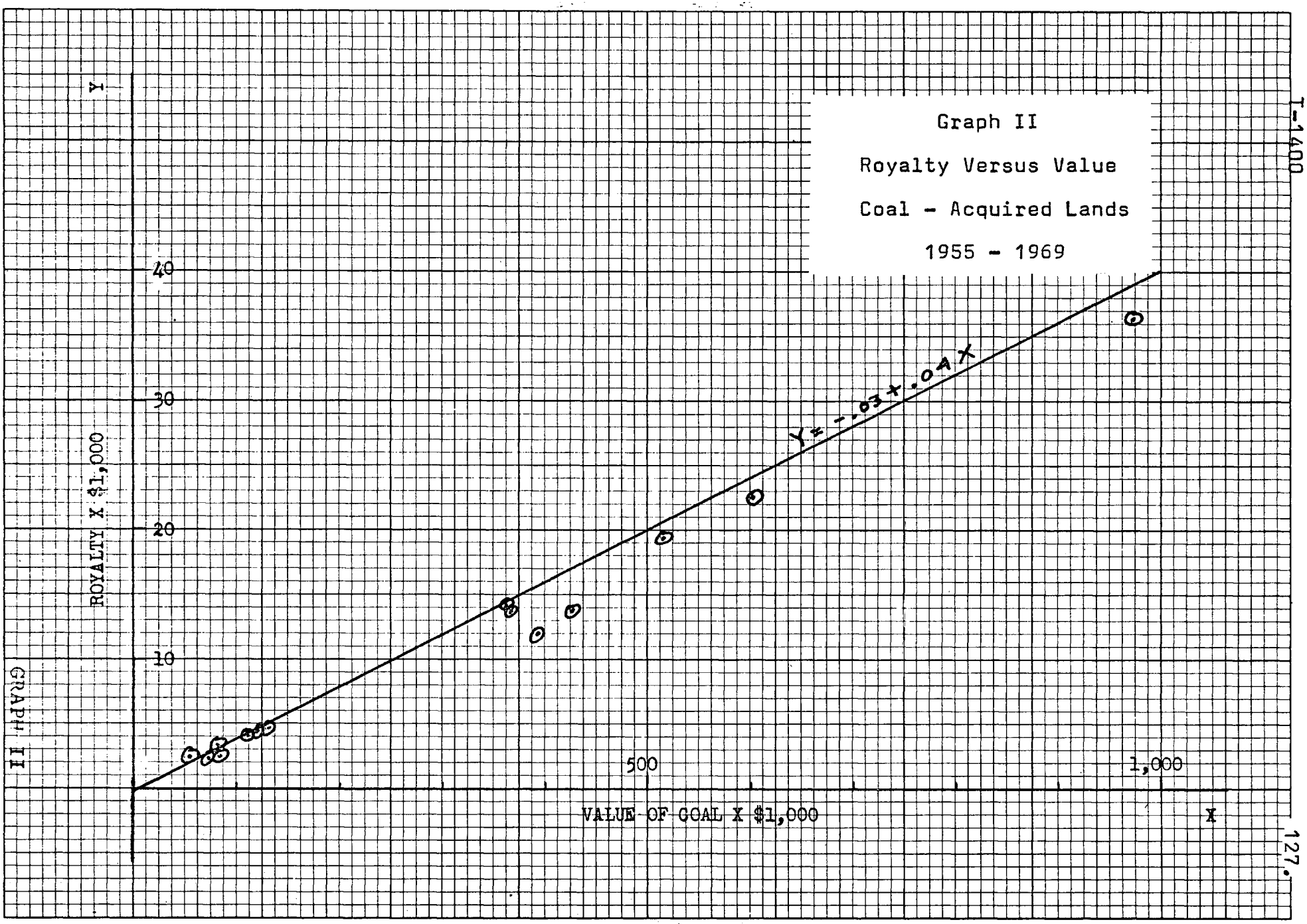
```
   45 FORMAT (1H-' THE VARIANCE IS 'F15.3////)
C     CALCULATION OF THE DETERM. AND CORR. COEFF.
      SYYBR=0.0
      SYCYBR=0.0
       YMEAN=YMEAN/N
      DO 50 J=1,N
      YCYBR=A + B*XX(J)
      YCYBR=YCYBR-YMEAN
      YCYBR=YCYBR**2
      SYCYBR=SYCYBR+YCYBR
      YYBR= YY(J)-YMEAN
      YYBR=YYBR**2
      SYYBR=SYYBR+YYBR
   50 CONTINUE
      DET=SYCYBR/SYYBR
      WRITE(4,55) DET
   55 FORMAT(1H_' THE COEFF. OF DETERMINATION IS 'F10.3////)
      CORR=SQRT(DET)
      WRITE(4,60) CORR
   60 FORMAT(1H_' THE COEFF. OF CORRELATION IS 'F10.3////)
C     -T- TEST ON THE SLOPE OF THE STRAIGHT LINE
      ZN=N
      T=SQRT(ZN-2.)*B/SQRT(1.-CORR**2)
      WRITE(4,62) T
   62 FORMAT(' THE -T- TEST ON THE -B- COEFF.IS   'F10.3///)
      WRITE(4,65)
   65 FORMAT(1H_' DO YOU WANT ANY PROJECTIONS OF YOUR EQUATION?'
     1      ' TYPE -1- IF YOU DO AND -2- IF YOU DONT'///)
      READ(5,70) NSWITH
   70 FORMAT(I1)
   72 IF (NSWITH-2) 75,95,95
   75 WRITE(4,80)
   80 FORMAT(' TYPE THE VALUE OF -X-,USE A PERIOD IF INTEGER    '$)
      READ(5,10) X
      Y=A+B*X
      WRITE(4,85) Y
   85 FORMAT(' THE ESTIMATED VALUE OF -Y- IS 'F15.3///)
      WRITE(4,90)
   90 FORMAT(' MORE PROJECTIONS?, TYPE 1 OR 2    '$)
      READ(5,70) NSWITH
```

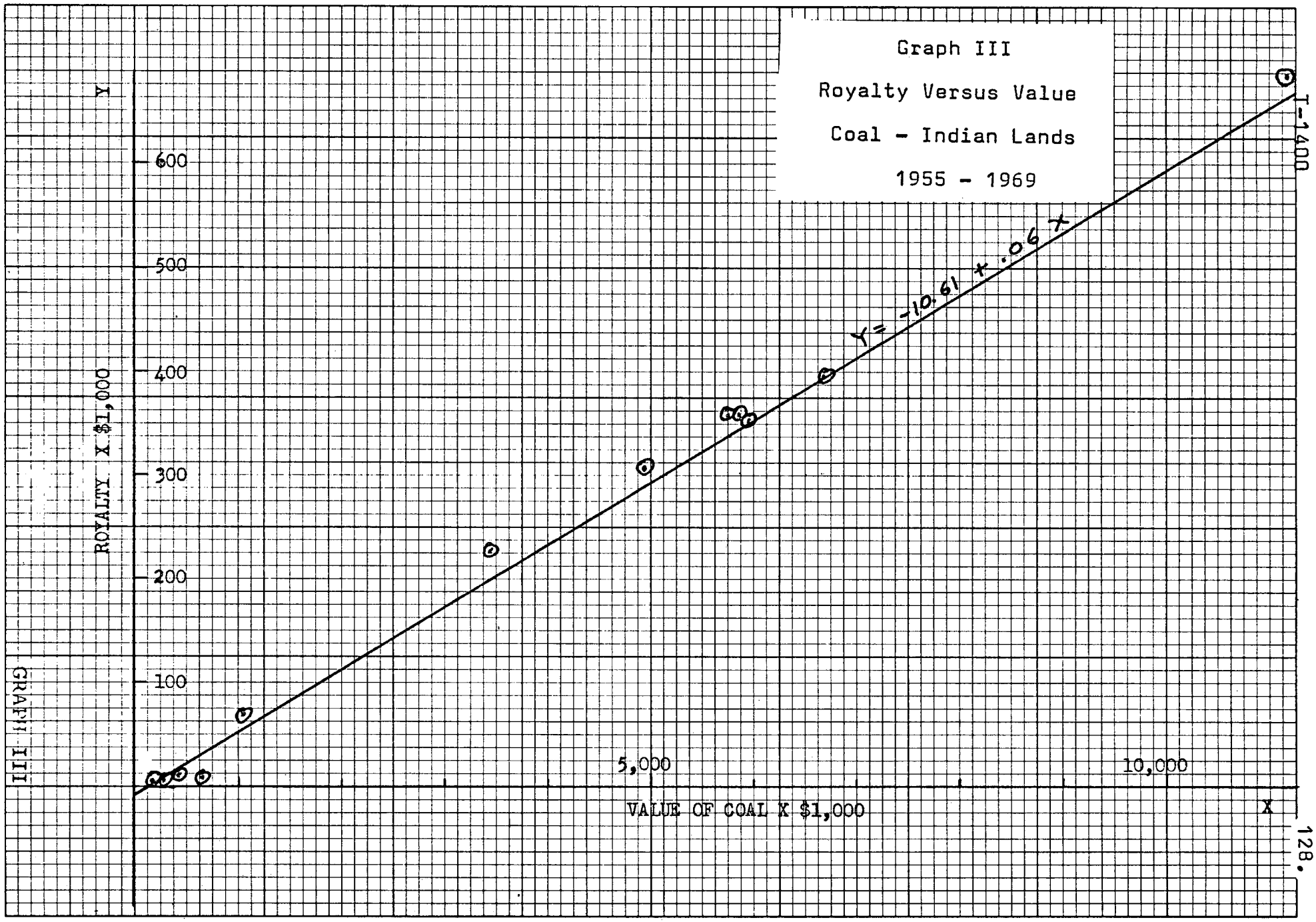
APPENDIX D

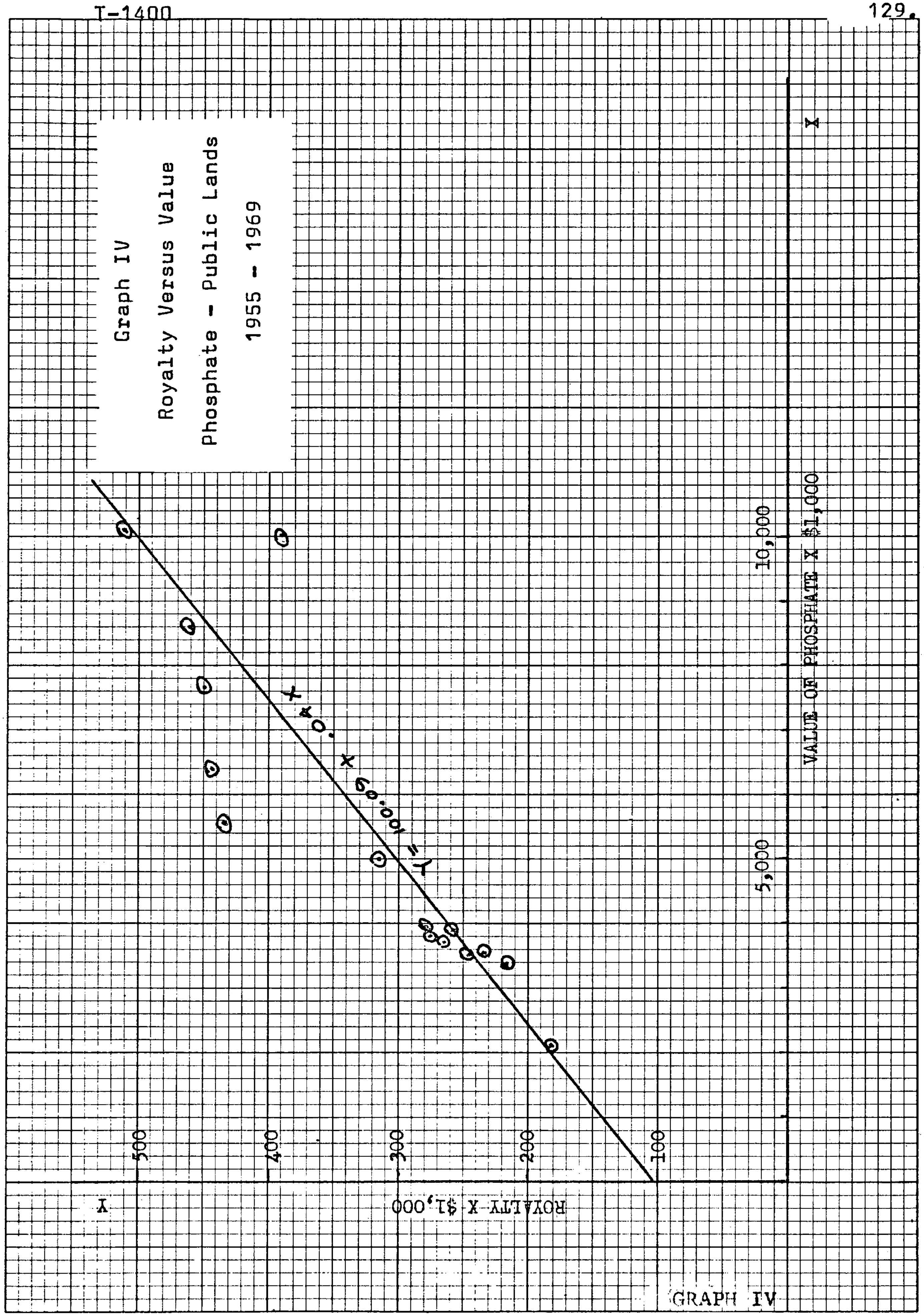
ROYALTY VERSUS VALUE GRAPHS OF MINERALS STUDIED

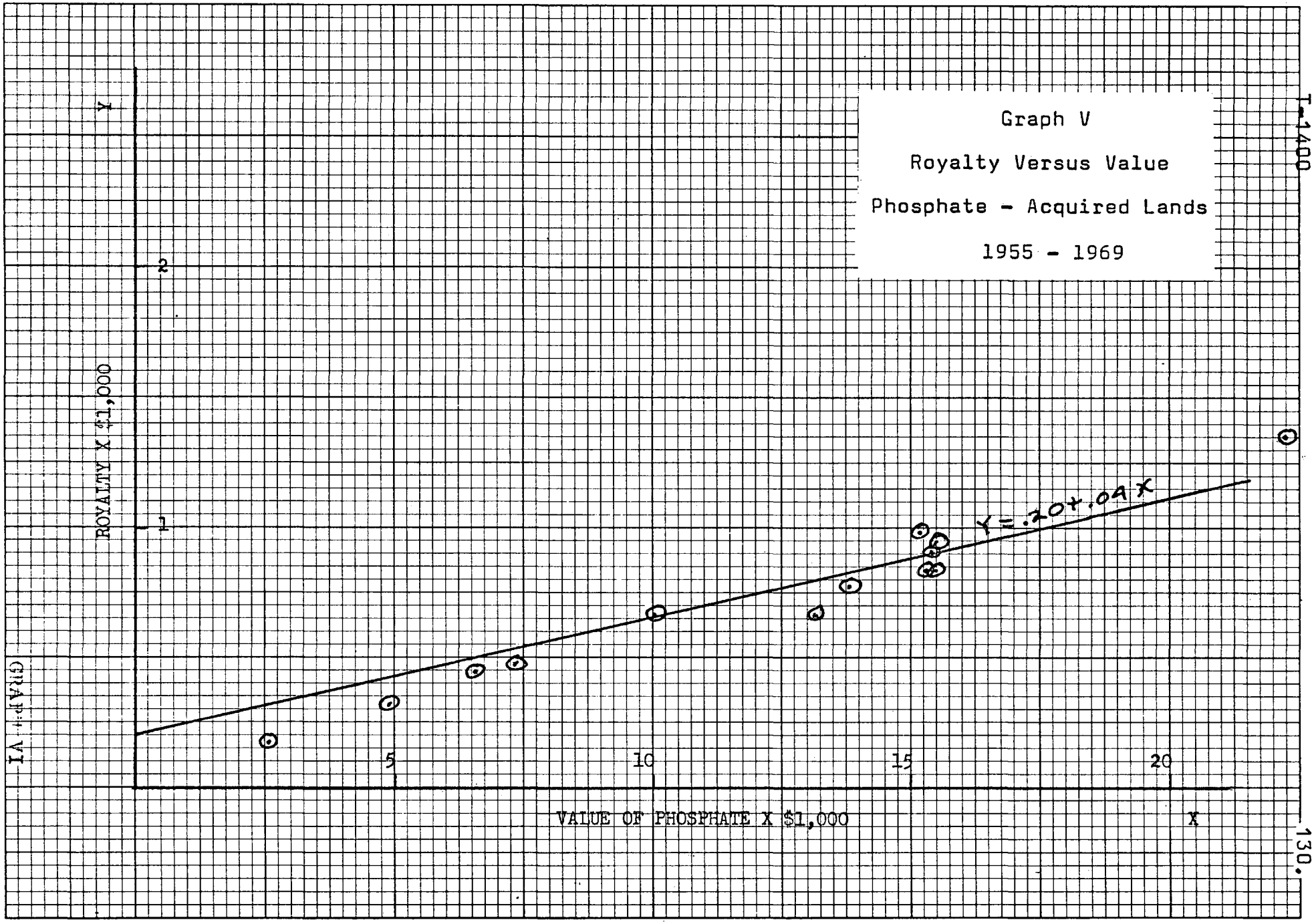
1955-1969

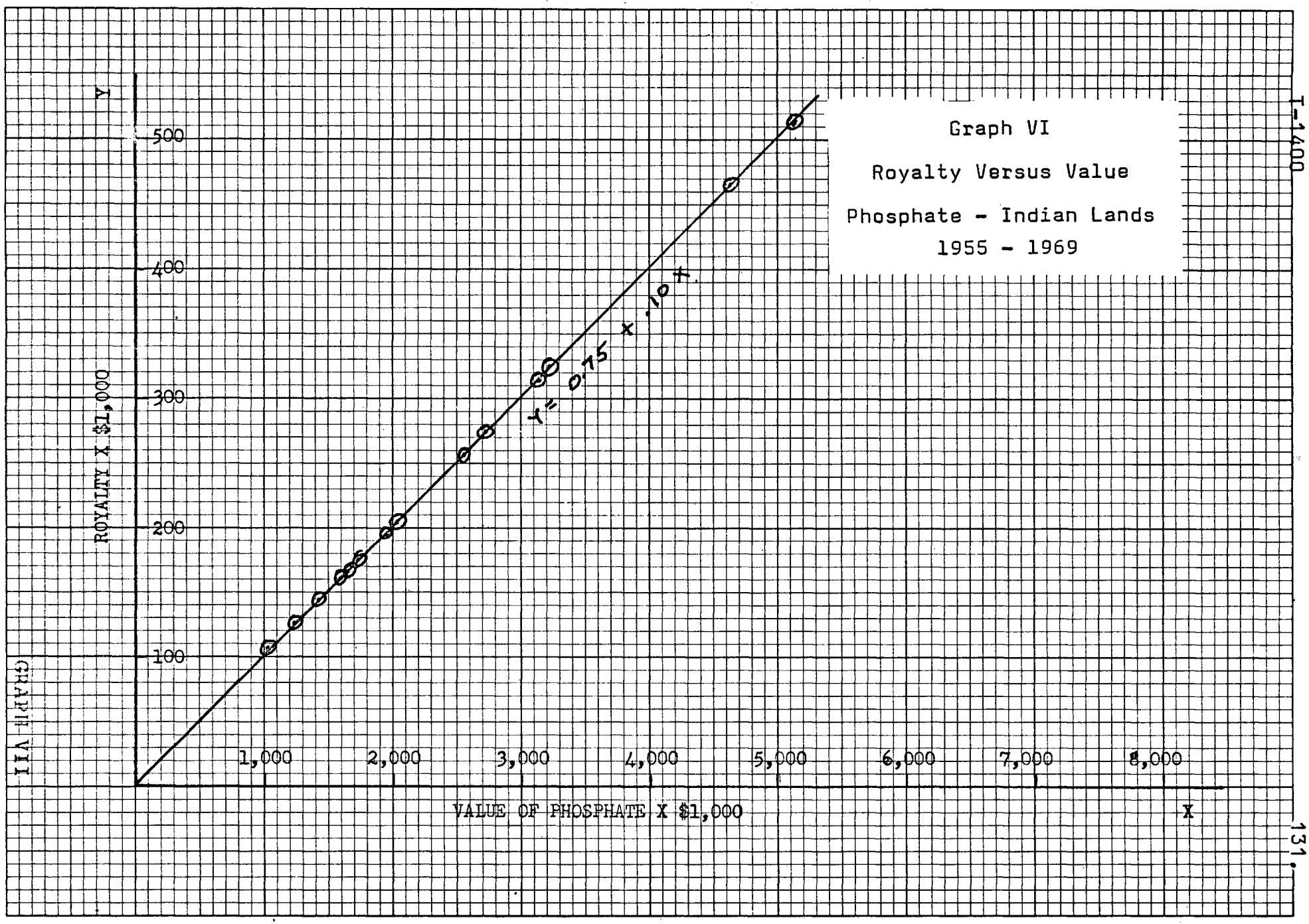

Graph I
Royalty Versus Value
Coal - Public Lands
1955 - 1969
Y
1,000
500
ROYALTY X $1,000
Y = -86.20 + .03 X
10,000
20,000
30,000
40,000
VALUE OF COAL X $1,000
X

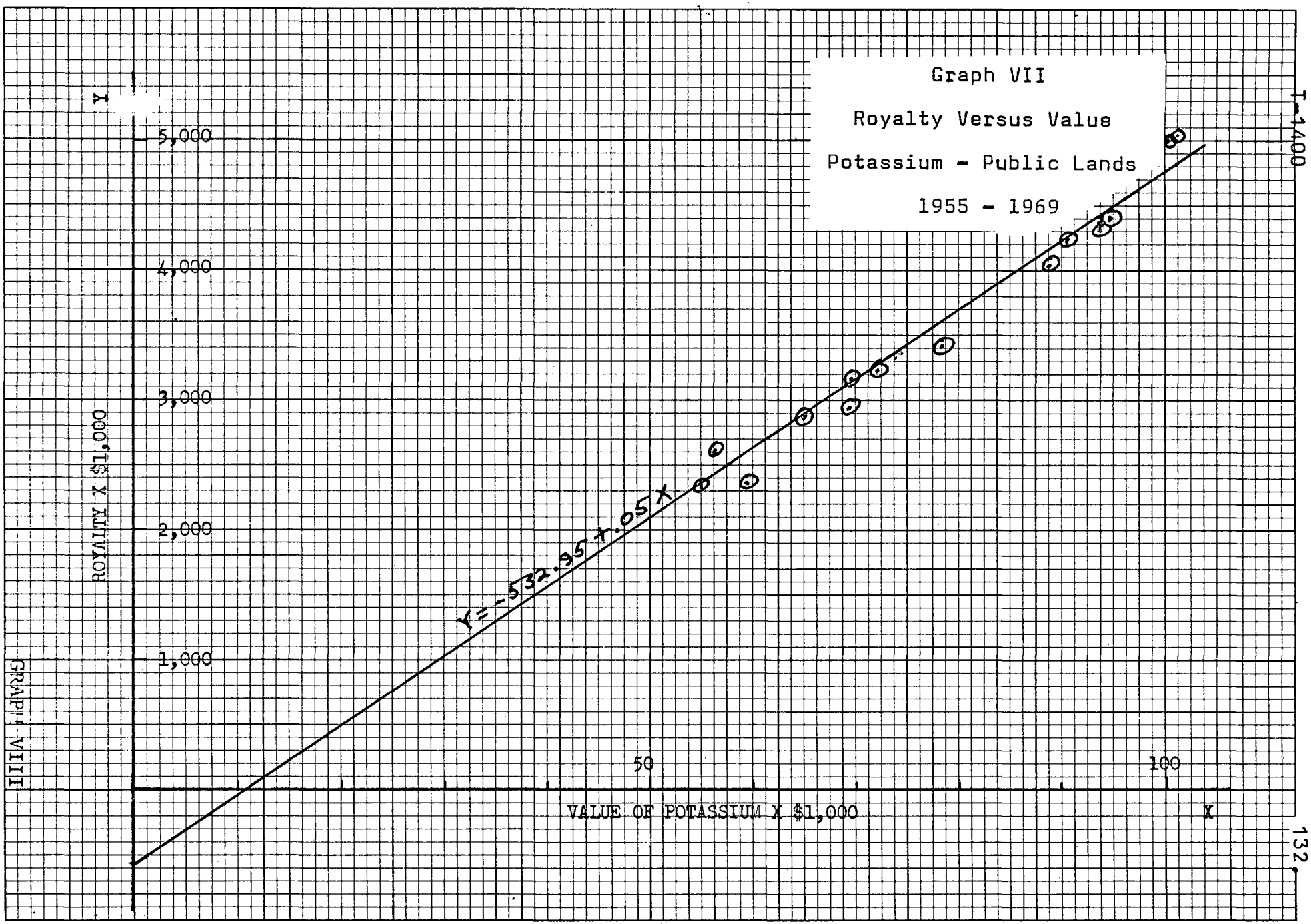

Graph II
Royalty Versus Value
Coal - Acquired Lands
1955 - 1969
Y
40
30
20
10
ROYALTY X $1,000
Y = -.03 + .04X
500
1,000
VALUE OF COAL X $1,000
X
GRAPH II

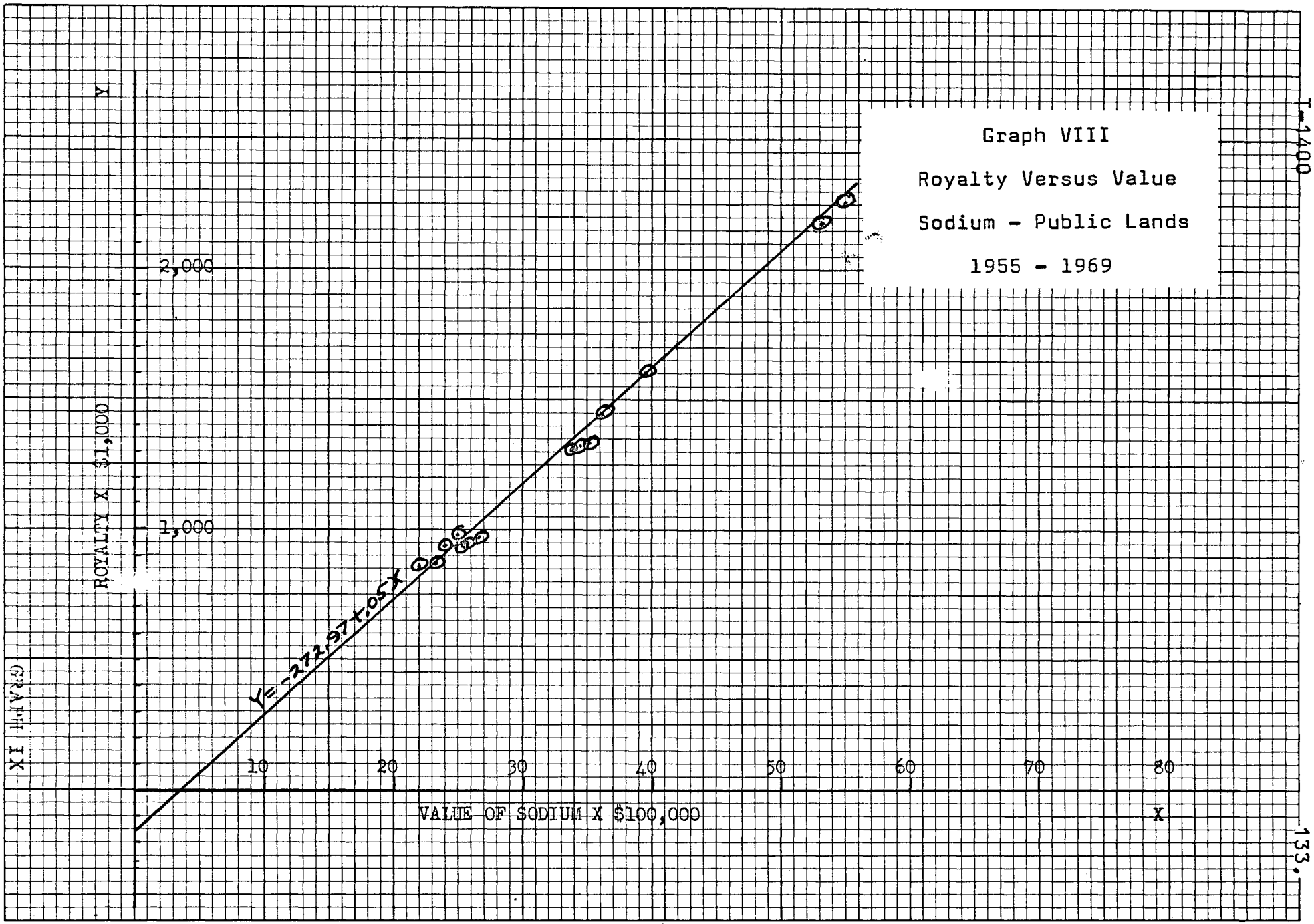

Graph III
Royalty Versus Value
Coal - Indian Lands
1955 - 1969
Y
600
500
400
300
200
100
ROYALTY X $1,000
Y= -10.61 + .06 X
T-1400
5,000
10,000
VALUE OF COAL X $1,000
X
GRAPH III

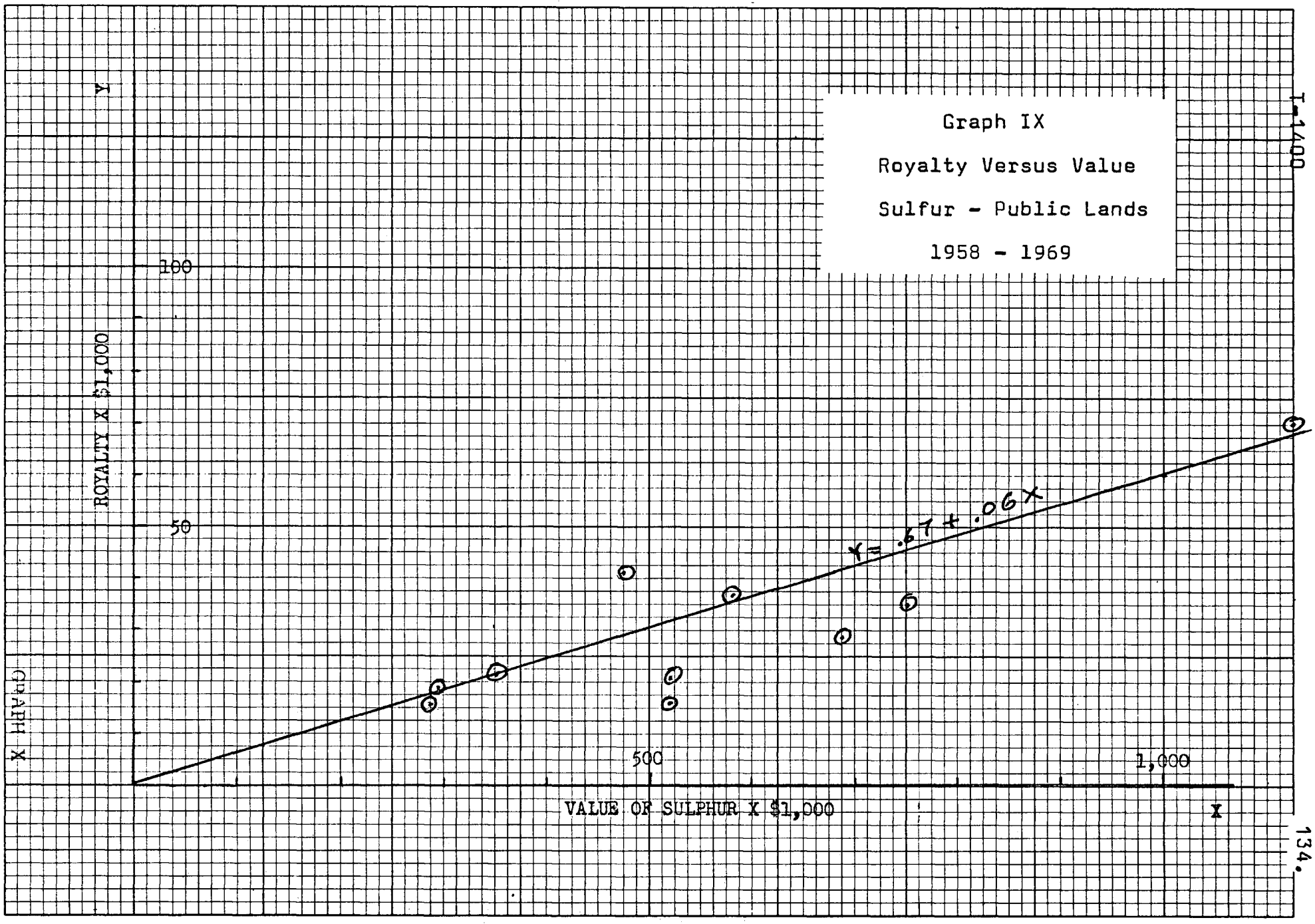

Graph IV
Royalty Versus Value
Phosphate - Public Lands
1955 - 1969
VALUE OF PHOSPHATE X $1,000
5,000
10,000
X
ROYALTY X $1,000
Y
100
200
300
400
500
GRAPH IV


Graph V
Royalty Versus Value
Phosphate - Acquired Lands
1955 - 1969
Y = .20 + .04 X
ROYALTY X $1,000
VALUE OF PHOSPHATE X $1,000
Y
X
1
2
5
10
15
20
GRAPH VI
T-1400
130.


Graph VI
Royalty Versus Value
Phosphate - Indian Lands
1955 - 1969
Y = 0.75 x .10 +
Y
500
400
300
200
100
ROYALTY X $1,000
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
VALUE OF PHOSPHATE X $1,000
X
GRAPH VII
I-1400
131.


Graph VII
Royalty Versus Value
Potassium - Public Lands
1955 - 1969
Y
5,000
4,000
3,000
2,000
1,000
ROYALTY X $1,000
Y=-532.35+1.05X
50
100
VALUE OF POTASSIUM X $1,000
X
GRAPH VIII


Graph VIII
Royalty Versus Value
Sodium - Public Lands
1955 - 1969
Y
ROYALTY X $1,000
2,000
1,000
Y= -22.97+.05X
10
20
30
40
50
60
70
80
VALUE OF SODIUM X $100,000
X
GRAPH IX
I-1400
133.


Graph IX
Royalty Versus Value
Sulfur - Public Lands
1958 - 1969
Y=1400
100
50
ROYALTY X $1,000
Y = .67 + .06X
500
1,000
VALUE OF SULPHUR X $1,000
X
GRAPH X

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