CIRCULAR 41

THE MAKING OF A MINE

by

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NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

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THE MAKING OF A MINE

The prospector and the investing public may not always be fully aware of the complex steps usually found necessary in transforming a mineral discovery into a profitable mine. Whole libraries of books and articles in periodicals are available on all aspects of mineral discovery and development, but it was thought that a brief statement of the various steps and the possible costs involved might have some value for the layman who is interested in getting into the mining business.

The usefulness of the prospector with rudimentary training in the recognition of valuable minerals has been demonstrated amply in the intensive search for uranium ores still in progress. True enough, many prospectors quickly acquire professional skills in the use of instruments such as the geiger counter or the scintillator in the search for uranium, or the ultraviolet lamp in the search for tungsten, and in their ability to recognize and follow favorable formations which have been pointed out in geological maps and reports. Nevertheless, blind chance has led to notable discoveries, owing in part to large numbers of prospectors fanning out over wide areas without waiting to find out the best place to look. Also, the mineral industry still needs the cowboy or Indian who brings in a "funny-looking rock" to a state survey laboratory for testing.

Though the prospector may make the discovery, the technically trained geologist and engineer, and later the metallurgist or the testing laboratory, commonly play major roles in the succeeding steps that lead to profitable exploitation of a mineral deposit. Even many discoveries of uranium have been made by the skilled and experienced geologist or engineer, and it has been pointed out that for many other materials the easily discoverable deposits have been found. Nevertheless, most mineral deposits are segregated in rather restricted geological environments, whether they be certain rocks or certain structures or certain stratigraphic horizons. Therefore, state and federal geological surveys carry on geological mapping programs and basic studies which, though they may not result in the immediate discovery of ore, eventually will prove useful to the prospector who may be looking for minerals which today have no value. Scientific research, even of the long-range or "long haired" variety, almost invariably is found eventually to have practical dollars-and-cents value. This has been pointed out so often that it is unnecessary to belabor the point.

The subject which does require emphasis, however, deals with the steps which must be taken before an initial descovery can be transformed into a profitable mining enterprise. It is here that more fortunes, even in the bonanza days, have been lost

than have perhaps been won! Unless certain logical steps are carefully followed, even the most favorable-appearing mineral deposit may prove a failure, with discouragement to the operator and, possibly, tragedy to the investor. Unless all the factors of value of the ore, cost of beneficiation, availability of market, permanence of market, distance of transportation, and many others have been taken into consideration by those interested in developing the deposit, that deposit may prove to be a failure and a disappointment.

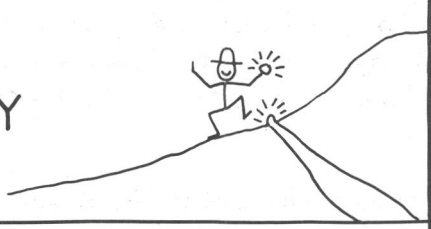
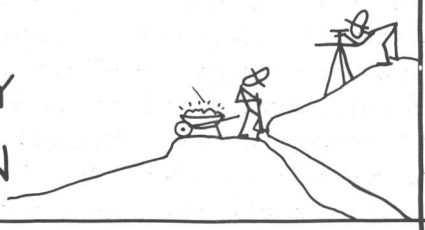
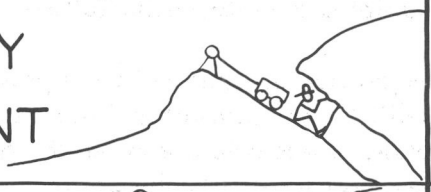
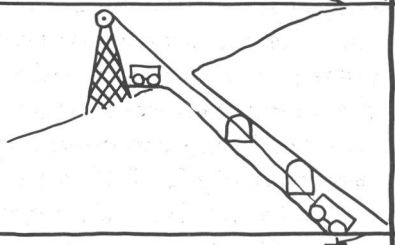
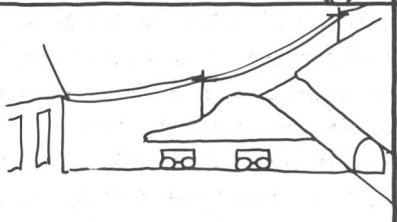
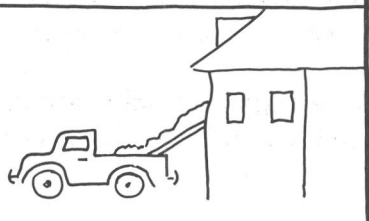
In the field of metallic ores, such as those of gold, silver, copper, lead, zinc, and many others, these carefully thought-out stages in development are of importance, of course, but it is in the field of development of the nonmetallic or industrial minerals and rocks, with which modern industry is becoming more and more concerned, that careful consideration of each of these steps becomes imperative. Most nonmetals are low-cost products, hence the margin of profit may be very slight indeed. The difference of a few cents in the market price and the difference in a few miles of transportation may mean the difference between red and black in the ledger. Comprehensive appraisal of these factors in mining has been obscured only too often by the lure of the bonanza. In these days of "uranium fever" especially, we must remember that mining is a tough business and that only one out of a thousand claims will ever be a mine! The successful enterprise today must be thought out and run like any other business, with the gambling factor reduced to a minimum.

Perhaps the modern definition of "ore" will give us a start on this analysis. "Ore" is any rock or mineral substance which can be mined, treated, and sold at a profit. What may not be ore today may become ore tomorrow; the main factor here is supply and demand. Yesterday the uranium deposits of the Colorado Plateau were not ore. Many of them were known and passed over, since there was no market for uranium. Conversely, what is ore today may not be ore tomorrow. When the United States was unable during World War II to obtain quicksilver from the mines in Spain and Italy, many deposits in the West became ore, and mines were developed. When the war was over and we again imported cheap quicksilver, those mines closed down.

The first step in the making of a mine is, of course, discovery of the deposit. This may be accomplished by the prospector, by a state or federal survey, or by private-company operations. The discovery may have cost a few hundred dollars, or it may have cost many thousands of dollars; it may have taken only a few weeks, or it may have taken many years.

Some of the items to be considered seriously in a prospecting campaign, aside from locating the deposit, are, of course, the status of the land to be examined (each different category of land ownership may involve entirely different kinds of legal approach and degree of expense) and the laws which apply to the location of new deposits and to their development (different in many states - a proposed new

BUILDING A MINERAL INDUSTRY

STAGE OF DEVELOPMENT	COST	TIME
1 DISCOVERY 	Less than 1	1 - 20 YEARS
2 PRELIMINARY EXAMINATION 	Up to 2	WEEKS or MONTHS
3 PRELIMINARY DEVELOPMENT 	Up to 3	½ - 3 YEARS
4 UNDERGROUND DEVELOPMENT 	30	2 - 5 YEARS
5 BUILDING THE PLANT 	83	2 - 3 YEARS
6 TUNE-UP & PRODUCTION 	7	1 - 6 MONTHS

Texas law is designed to prevent aerial prospecting without permission from the owners of the land:).

On the chart is indicated the "cost" in terms of "units," which may vary considerably with the type of deposit. For small, high-grade ore deposits which require little or no milling, treatment, or beneficiation, such as lode gold, chromite, and pegmatite minerals, the unit may be as low as $5,000; for larger, lower grade deposits, it may be $10,000-$50,000; for the great porphyry coppers, it may amount to half a million dollars or more.

The second step is the preliminary examination of the deposit. This is divided usually into two parts designed to determine, first, the presence of potentially valuable mineral in amounts sufficient to justify further investigation, and second, whether that mineral can be mined and treated or beneficiated at a profit. The geological or mining expert makes an examination in the field and samples the accessible parts of the deposit for assay, maps the outlines of the inferred ore body, and from these data makes tentative estimates of the value of the ore. He then considers the economic factors which affect the possible value, such as distance to market, cost of mining, the need of treatment to enrich the material, and a multitude of other factors which must have a favorable balance to justify further investment and expenditure

As early as possible the composition and nature of the prospective ore should be determined, as well as its amenability to treatment and recovery of the potentially valuable constituents. In this phase cooperation between the geologist, engineer, and metallurgist is necessary. Assays reveal only the presence and amount of the element for which the test is made. The ore-dressing and metallurgical laboratories must determine if the valuable material is in a form for which economical recovery is possible. Some potential ores contain other elements which may prove to be valuable byproducts. On the other hand, all examining engineers and geologists are familiar with the prospector who has secured an analysis of his ore and has calculated the value of each item, including the silicon and the calcium: Some metal deposits, such as those of copper, may be weathered to a considerable depth, and a zone of secondary sulfide enrichment may lie between the weathered and unweathered ore. Each of these three classes of copper ore may require radically different treatment methods, all of which have a pronounced effect on the economic conclusions as to the exploitation of the deposit. For deposits of industrial minerals and rocks, such as limestone, the presence or absence of impurities or deleterious constituents may be critical. Material which cannot meet specifications cannot be exploited. It is obvious that the earliest possible determination of these factors may save useless subsequent expenditure.

The examining engineer or geologist not only must analyze the deposit itself, but should take into consideration such business factors as supply and demand,

competition, market location, labor conditions, government policy, tax structure, tariffs, etc., before he can decide whether this particular deposit contains "ore." Usually a report of this sort, if favorable and made by a reputable expert, then can be used to interest those who can finance further steps. The cost of this stage in the development of a given deposit ranges from a few thousand dollars to tens of thousands of dollars, and may be accomplished in a few weeks to a few months. If the decision is favorable, and it is decided that all these conditions seem to allow a reasonable profit on further investments, step three then may be taken.

This step consists of preliminary development of the deposit by surface trenching, diamond drilling, detailed geological mapping of the deposit itself, and perhaps geophysical or geochemical prospecting, all to determine the outline and borders and probable total available tonnage in a preliminary way. This step usually is financed by a partnership, syndicate, or mining company, or by sale of stock in a company formed to develop the deposit. It may take from 6 months to 3 years to complete such preliminary development, and may cost from $10,000 to as much as a million dollars.

The fourth step in a well-planned and conservative program consists of development by pits and shafts or tunnels, or perhaps by closely spaced drilling, to determine more definitely and block out ore reserves, and to appraise their grade and character. The ore body is classified in three ways: ore measured, ore indicated, and ore inferred. The value of the mine must be sufficient in the first and second categories to amortize the total investment. The possible profit lies in the third category. This is the step, the omission of which so often in the past has led to grief: The mining camps of the West are dotted with the ruins of costly mills which were constructed to treat ore that wasn't there. Step four is financed usually by funds of the mining company or by sale of company capital stock. It may take from 2 to 5 years to complete, and it may cost, depending upon the grade and size of the deposit, tens of thousands of dollars more. This step in the development of the great new San Manuel copper deposit of Arizona has been completed recently at a cost of over $10 million.

Now, if you are becoming optimistic about the cost of changing a rock or mineral deposit to an operating mineral industry, we come to the fifth and frequently most expensive step of all, that of installing a mining and treatment plant. This includes the further development of the mine for mining operation, power and water supply, transportation facilities, and, in the case of large isolated deposits, the townsite. This again may be financed as was the previous step. It will take from 2 to 3 years to complete, and its cost may be anywhere from one hundred thousand dollars to many millions of dollars.

For milling uranium, it has been estimated that the capital investment necessary per ton of capacity per day is about $10,000 to $15,000, and that the smallest

assuredly economic mill will have a capacity of at least 400 tons per day ($4-$6 mil l ion!).

The sixth and final step, involving the period of tuning up the mine and mill and transition into the production state, is less costly and may take from 1 to 6 months.

You will note that all but the last step involve investment of increasing amounts of capital, and that after or during each of the first four steps the enterprise may be abandoned with minimum loss, should progress prove at any stage that further investment would be unprofitable. Successful businessmen today certainly operate their own enterprises on this basis, but investors in mining enterprises still frequently forget these principles, with disastrous consequences. Beware of the stocksel ler who is building a mill but can't give at least the minimum extent and grade of the ore body:

An article in the September 1954 issue of the Engineering and Mining Journal reemphasizes, in terms of the mining of uranium, these fundamental principles of development, and points out some new ones. They are summarized under seven headings:

1. Over the long pull, the biggest profits lie in a well-planned, long-term exploration program.
2. Regardless of quantity or quality of experience elsewhere, the record shows that it takes about two years for engineers, prospectors and geologists to become effective in uranium exploration.
3. Make sure that you learn both state and federal mining laws, and equally important, find out what is the prevailing local custom regarding the mining laws.
4. Think of mining in terms of pounds of uranium rather than necessarily in tons of ore but don't get the idea that this eliminates large enterprises.
5. There is generally more profit in mining than in milling.
6. If you seriously intend to explore for and mine uranium, you can get a lot of helpful information and save yourself time and money by talking with on-the-spot AEC officials first [and one might add, the New Mexico Bureau of Mines and Mineral Resources].
7. If you are going into the uranium business by buying uranium stocks, be careful!

It is only on such sound business principles that the mining industry, like any other industry, can hope to gain and retain the confidence of the investing public. In recent years such confidence has been deserved by the great majority of mining developments.

PROSPECTOR'S ROAD-GUIDE FROM PROSPECT TO MINE

I. Discovery of ore-mineral ($1,000-$5,000)

a. If on public domain, set up discovery post, fill out location papers, and file the latter at the county courthouse (Fowler and Talmage, 1941). Set up claim corners and dig discovery cut within 90 days.
b. If on private or state land, arrange lease from the owner with the help of a competent mining lawyer.

II. Preliminary examination ($2,000-$5,000)

a. Sample outcrops thoroughly (Gunther, 1932) and have samples assayed by a competent analyst (Klahold, 1954). If favorable, have:
b. Examination and mapping by competent economic geologist or mining engineer, who will give tentative outlines of the ore body and initial calculation of reserves, and will recommend either abandonment or further development. Then make:
c. Preliminary consideration of economic factors favorable and unfavorable to continued development.

This is about as far as the average prospector, without outside capital, can expect to go. The next step, that of preliminary development, will cost from $10,000 to $50,000, depending upon the type of deposit and the thoroughness of examination. Financing a mine is not an easy step (Bailey et ul, 1953), and the prospector usually leases or sells his property at this point, retaining a small royalty or interest. Most prospectors aren't interested in going beyond this point anyway:

RECOMMENDED READING

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