Great interest is being exhibited in bog ores in Pennsylvania. The idea of realizing an additional income from a natural resource is appealing, and bog-ore deposits cost little to prospect and work. The only tools usually required are such as most farmers possess. Bog-ore deposits are usually so different from the surrounding soils as to immediately advertise their presence to even the most casual passer-by. This Survey has received many requests for information on various phases of the industry and this bulletin has been prepared for the use of persons interested in developing new deposits.

Where bog ore is found and how. The name "bog ore" originated from the occurrence of the ore in bogs, but deposits have been found on hillsides and in bottom lands, in marshes, meadows, and woods, in all situations, in fact, except on the tops of hills. The use of the name has been extended in commercial dealings so that now it includes all material of its type regardless of the place where found. Most of the deposits now known and all the large recent commercial developments are in Mercer, Venango, Forest, Clarion, Elk, Jefferson, and Clearfield counties. It is believed however that future developments will considerably increase the area of production, for many deposits have been found outside these counties, including the eastern part of the State.

Search for bog ore therefore is not restricted to any special topographic position. The principal point is to look for iron-red earth, for iridescent scum on standing water, or for yellow slimy deposits on vegetation and rocks in water courses. The best place to search is in or below a rock formation containing some form of iron-bearing minerals scattered through it.
Search may be hampered in summer by brambles and foliage concealing deposits, and in the fall and winter by leaves or snow on the ground. In the spring before foliage is developed is a good season for hunting bog-ore deposits but at that time of year the ground is soft and wet in many places.

Character of ore. Bog ore is characteristically "iron-red" in color. When formed in bodies of still water an iridescent scum is usually a prominent feature. The red color of the ore is so different from the colors usually displayed by soils that it immediately attracts attention either when exposed as a soil or when it stains the clothing or shoes of hunters or others tramping over the deposit. Bog ore may be so wet as to be like a soft mud, or it may become very dry and have an earthy consistency. A forest fire or other conflagration may considerably alter the surface portions of the deposit, and it is not unusual to find the colors ranging from yellows and browns to reds and purples all in the same deposit.

All bog ores have been precipitated from underground waters. When first formed bog ore is a slimy, yellowish-red mass which coats the rocks, trees, twigs, soil, etc., upon which it is precipitated. As long as it remains wet and uncompacted it retains these characteristics. As the deposit increases in size the additional weight may compact the mass; or the spring which deposits it may fluctuate from month to month or year to year, permitting portions of the deposit to drain or to become partially dry. Or, the deposit may build up so that the course of the water is slightly changed, whereupon the same draining or drying action may take place. The spring may become diverted to some new direction, or may even cease to flow, in which case the bog ore will become well drained.

Size of Deposits: To persons accustomed to thinking of ore deposits in millions of tons the size of bog-ore deposits in Pennsylvania will be disappointing. Several of these deposits have been profitably worked although the entire quantity shipped from each deposit was only one or two railroad carloads. The largest deposit which the writer has seen in Pennsylvania probably originally contained less than 500 carloads. The average deposit probably contains about a dozen carloads of ore.

Value of Deposit: The value of a deposit depends upon many factors. Obviously, the larger the deposit, the more valuable it is. A small deposit will not warrant the expenditure of much money for tools and equipment, whereas a larger deposit (under the same circumstances) might permit considerable expenditures for such items.

It must be remembered that when a deposit is worked out all accounts must be balanced, for then that particular operation is ended.

The nearness to railroad facilities has much to do with the value of deposits. Under ordinary conditions the ore must be hauled to the railroad by wagon, and the longer the haul the more it costs to deliver the ore. Under prevailing conditions the limit of haul is considerably under ten miles, and in most cases is probably not much over five miles.
Uses: A small quantity of bog ore is used in the manufacture of paint pigments, but this is an unsatisfactory market for bog ores both because it is small and erratic and because the requirements are necessarily rigid. By far the larger and more satisfactory market is that of the artificial gas industry.

Gas manufactured from coal contains much gasified sulphur. If this were allowed to go through the distributing system the gas would be inferior for domestic use because of its very disagreeable odor when burned. By passing the gas through one or more layers of bog ore, however, the sulphur is largely removed without affecting the heating quality of the gas. Inasmuch as there are several other methods by which the sulphur can be removed from the gas, and other materials which can be used, it follows that any bog ore which is sold for this purpose must meet the competition of the other methods and products. These other products frequently exert a controlling influence on the bog-ore market.

Method of Working: Bog-ore deposits are always on the surface. Because they are of small extent no single deposit will justify a large expenditure for equipment.

The simplest equipment is all that is necessary to work most of the deposits. Shovels, spading-forks, hoes, and rakes serve to loosen the material. To remove the stones, twigs, and roots, the ore is thrown against an inclined screen like that used in screening sand. The ore which passes through the screen is shipped. Wheelbarrows and wagons serve to move the material from the screen to the railroad cars.

During wet weather care should be taken that the ore does not "ball" into large lumps which, failing to pass through the screen, might be thrown away. Because of this tendency of the ore to ball, and because of the general unpleasant conditions in a deposit in stormy weather, it is practicable to work bog-ore deposits only for about five months in the year. During the rest of the year users of bog ores must carry enough stock to supply them until the next season, or else they must use material other than bog ore.

Before placing the bog ore in gas-purifying apparatus the ore is mixed with wood chips, crushed limestone or other material to insure the easy passage of the gas through the mass. This mixing is occasionally done by the marketing agent but it is usually done by the gas-plant operator.

Sampling: The methods of sampling differ with each operator. In sampling a new deposit it is obviously an exhibition of foresight and economy to determine as accurately as possible the tonnage, extent, and the quality of material present. Almost invariably a deposit will have irregular streaks either of very rich portions or of sandy and undesirable portions. By determining these data before operations are commenced it is possible to plan the methods of working in such a manner that the most profitable result can be had.
One method of doing this is to dig small pits 25 feet apart over the entire deposit, forming squares. Examination of the material coming from the pits will show its quality and uniformity, and the measurements will indicate the tonnage present. Loose, screened bog ore weighs from 60 to 80 pounds per cubic foot. Ore in the ground will weigh somewhat more than this, the weight varying with the compactness and with the amount of moisture the ore contains.

During loading operations it is a wise precaution to take "grab" samples of each cartload of material, adding together those samples from the carts which form each carload. Such a combined sample (which may weigh several pounds) thus forms a permanent record of the quality of material shipped in a particular car, and may be referred to in case any question arises.

Testing:  In the matter of having standards by which the ores can be classified, the industry is in a chaotic condition. Each gas plant has operating problems which differ from those of other plants; consequently each purchasing agent must buy material which is best suited to his plant's particular needs. In order to secure at least a semblance of uniformity various methods of analyzing and testing have been proposed. Bog ores are sometimes purchased on a basis of chemical analysis, although the usefulness of an ore for gas purification purposes cannot be determined from such data. In other methods of testing small portions of the ores are tried to determine how much sulphur they will absorb. To do this it is customary to pass hydrogen sulphide (HgS) through the sample, or to use some of the gas as actually made in the gas plant.

The U. S. Bureau of Mines is cooperating with the American Gas Association in an endeavor to systematize methods of testing bog ores. The completion of such work will be of great benefit to all concerned.

Prices and Demand:  Several years ago an urgent demand arose for bog ore for gas purification purposes, and inexperienced operators shipped a considerable quantity of ore which was not properly screened or was otherwise unsuitable for immediate use. The industry as a whole is still feeling the effects of this abuse, and purchasers are wary.

As has been remarked, other materials may be used in place of bog ores under favorable price conditions. For example, when steel scrap (borings) is low-priced, (as was the case following the war), it can be bought, exposed to the weather and allowed to rust, and the rust used for purifying gas. Again, a by-product in the refining of aluminum ore (bauxite) is a chemical precipitate which may be used in place of bog ore. External factors such as these influence the selling price of bog ore.

The freight rate on bog ores from the northwestern counties to Atlantic Seaboard points is about $7 per ton. This is the largest single item of expense, and if reduced, would materially benefit the industry.
The selling-price of good quality bog ore at Atlantic Seaboard points during the past season (1922) is reported to be $10-$15 per ton; but the price received is always a matter of bargaining between seller and buyer.

Pennsylvania bog ore has been shipped to Fondulac, Chicago, Keokuk, Washington, Baltimore, Philadelphia, New York, and to many of the plants in the smaller cities and towns of New York, New Jersey, Pennsylvania, Delaware, Maryland, and Virginia. The possible markets embrace those plants in the eastern part of the United States which manufacture gas for domestic (household) use.

Leases and Royalties: It frequently happens that the owner of a bog-ore deposit would like to market his ore but hesitates because of inexperience, lack of time, or for some other reason. There are several firms and individuals who will purchase suitable ore deposits or will work them under lease. In such circumstances the firms or individuals take all responsibility of working the deposit and of finding market for the product, and pay the owner a stated royalty on each ton taken out.

The royalty paid per ton varies, and depends upon the size of the deposit, its availability, market conditions, and upon the shrewdness of the parties interested. Royalties reported to this Survey are from 10¢ to $1.00 or more per ton, but it does not follow that either the highest or the lowest of these figures represents the maximum profit to either the owner or the lessee.

The following is a list (perhaps incomplete) of individuals and firms who are interested in developing suitable deposits.

Allegheny Ore & Manufacturing Co.,
American Mineral Products & Color Co.,
American Oxide & Chemical Co., 402 Fulton Bldg.,
B. F. Brundred, Trust Estate,
C. F. Burkhardt,
J. W. Landers & Company,
F. P. Lanson,
Eph Lyon,
W. S. Moore,
National Ore and Mineral Company,
Natural Oxide Corporation, 345 Fifth Avenue,
Pennsylvania Salt Manufacturing Company,
Punchios Lumber Company,
Standard Silicon Company,
J. W. Whited & Company,
S. C. Wiant,

Oakmont, Pa.
Noblestown; Pa.
Pittsburgh, Pa.
Oil City; Pa.
Oil City; Pa.
Tionesta, Pa.
Kennerdell, Pa.
Franklin, Pa.
New Castle, Pa.
DuBois, Pa.
Pittsburgh, Pa.
Natrona, Pa.
Curwensville, Pa.
Ridgway, Pa.
Emlenton, Pa.
Hawthorne, Pa.