March 20, 1945. E. McDERMOTT 2,371,637

METHOD OF PROSPECTING FOR BURIED DEPOSITS

Filed Jan. 22, 1940 2 Sheets-Sheet 1

Fig. 1

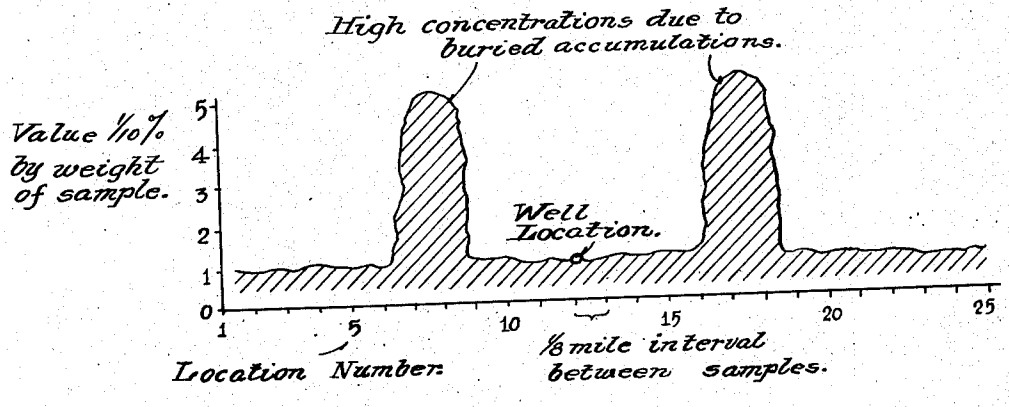
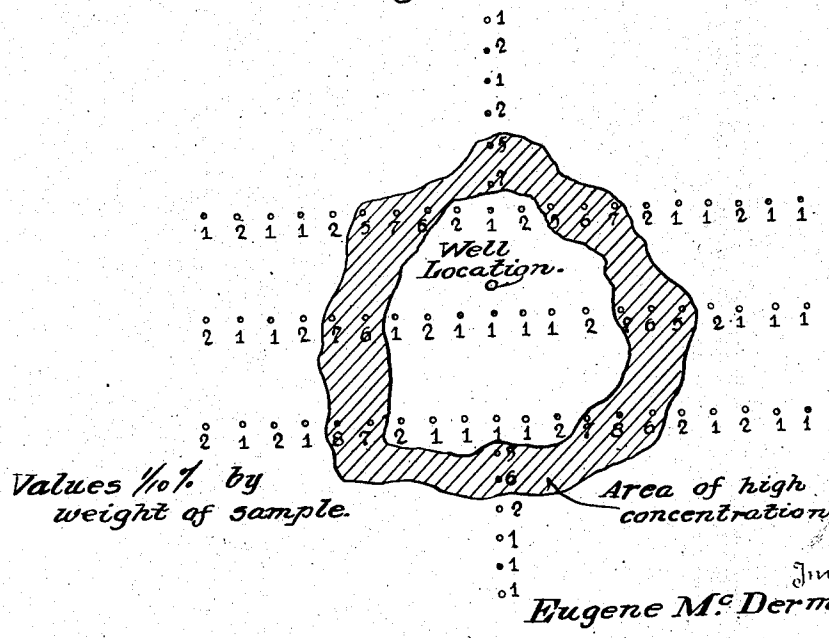


Fig. 2



Inventor
Eugene McDermott,

By Bailey & Larson
Attorneys

March 20, 1945. E. McDERMOTT 2,371,637

METHOD OF PROSPECTING FOR BURIED DEPOSITS

Filed Jan. 22, 1940 2 Sheets-Sheet 2

Fig. 3

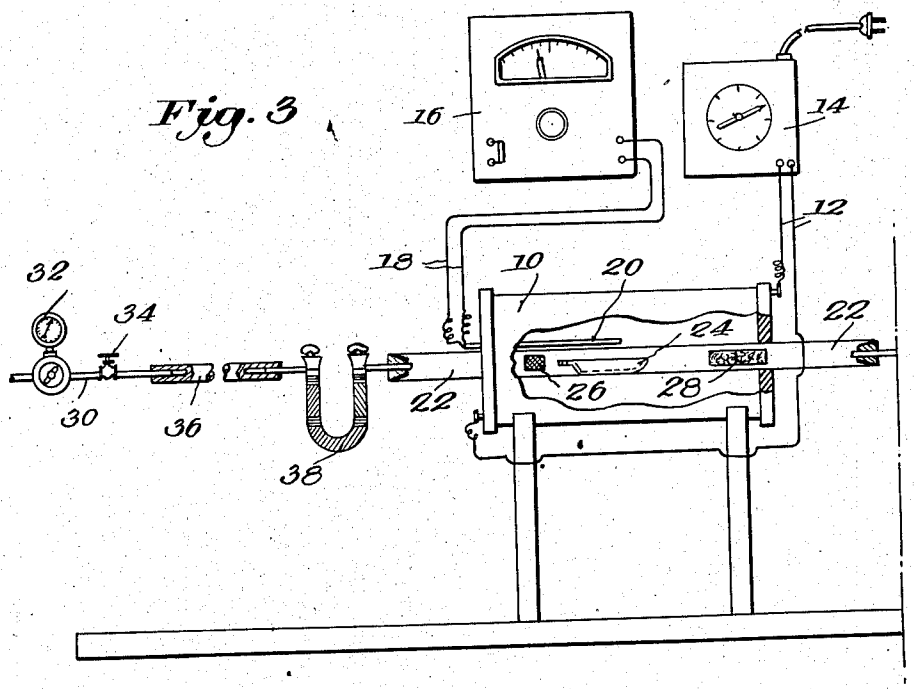
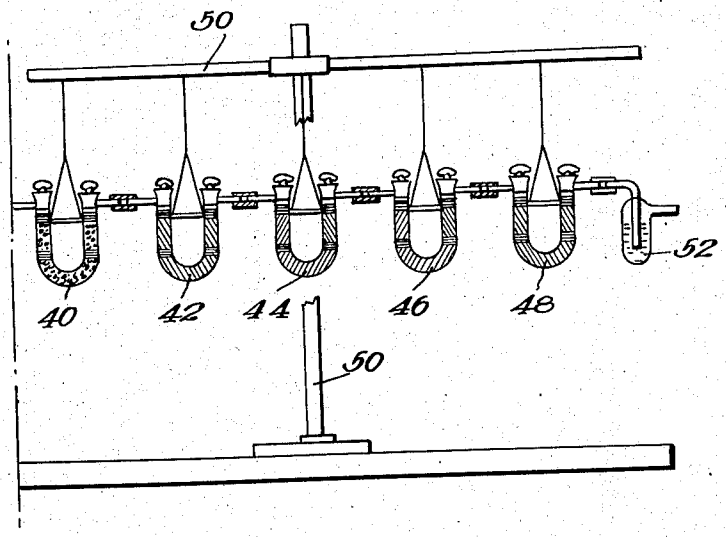


Fig. 3a



Cotton.
Zinc.
Ascarite.
Calcium Chloride.
Copper Oxide Gauze.
Asbestos Impregnated with $FeSO_4$, Ignited to Fe_2O_3

Inventor
Eugene McDermott,
By Bailey & Larson
Attorneys

Patented Mar. 20, 1945 2,371,637

UNITED STATES PATENT OFFICE

2,371,637

METHOD OF PROSPECTING FOR BURIED DEPOSITS

Eugene McDermott, Dallas, Tex.

Application January 22, 1940, Serial No. 315,061

11 Claims. (Cl. 23—230)

This invention relates to a method of prospecting for buried deposits such as oil or gas. This application is a continuation-in-part of my application Serial No. 257,328 filed February 20, 1939.

The invention is based on the discovery that high concentrations of combustible carbon exist in the earth near its surface over buried accumulations of oil and gas.

I have found that the concentration of certain combustible carbon (as later defined) near the surface of the earth bears a significant relation to the location and size of buried oil and gas deposits. By determining the quantity of such combustible carbon present in the earth near the surface, and plotting the relationship of such determinations, it is possible to locate buried oil or gas deposits.

Prior investigators have determined the hydrocarbon content of soil and preferably the gaseous hydrocarbon content. The particular methods used by such investigators, however, have been subjected to a number of disadvantages. In the first place they have been complicated and expensive to carry out. Moreover, such investigators failed to take into account the fact that such hydrocarbons are generally liberated from vegetable matter. If the hydrocarbons liberated from the vegetable matter are not first eliminated, then no true significant results can be obtained. Even if soil samples are taken at a distance of ten feet or even more, it is still not certain that the soil sample will still not contain some vegetable matter carbon content. Moreover, according to prior investigators, the results obtained are rather difficult of measurement since quantities such as methane measure in parts per billion by weight.

The present invention avoids these disadvantages and constitutes a simple and inexpensive method of prospecting for buried oil deposits. The method takes into account the presence of vegetable matter carbon content in the soil samples and then eliminates such vegetable matter carbon content before the results are plotted. Moreover, according to the present invention it is possible to take your sample at a much shallower depth which results in a great saving of time and expense. Still further, the measurements in accordance with the present invention are made not in parts per billion but in parts per thousand.

Furthermore, if measuring for the gaseous content, as some prior investigators have, there is no feasible manner known whereby the vegetable content may be removed from the sample without removing at least the major proportion of the gases.

It has been found that there are mineral concentrations near the surface of the earth which are caused in part by migration from greater depths. The gases leaking to the surface will carry with them some water which is present in the substructure of the earth. In passing through a water rich in minerals appreciable quantities of these will be carried to the surface of the earth. En route some of the minerals will be deposited. Where the rate of leakage from the buried deposit is greatest, the concentration of minerals at or near the surface will also be greatest. This applies to the significant combustible carbon indicated above as well as to mineral concentrations, it being understood that, strictly speaking, carbon is not classified as a mineral.

Because of the fact that heavier hydrocarbons accumulate in the cap rock, usually shale, above the oil or gas deposit, the cap rock becomes less permeable to the passage of the hydrocarbon gases. This is especially so where chlorine is present as it tends to oxidize and polymerize the hydrocarbon gases which leak from the deposit and migrate to the surface, and thereby produces liquid and solid hydrocarbons which fill the pores of the rocks just above the oil or gas deposit and render such rocks impervious. This causes the migration to move to the edge of such impervious section, and then upwardly. The resultant effect is that the concentration of the significant combustible carbon near the surface directly above the oil or gas deposit may be normal, while around the edges there will be a band pattern of high concentration. There is a high probability that the oil or gas deposit would thus be located at a central point spaced inwardly from the inner edges of the band pattern.

In some cases, however, the greatest concentration at the surface will be directly over the oil or gas deposit. This situation occurs, for example, when folds in rock shale have caused fissures over the top of the accumulation. This is a rare occurrence.

It is, of course, true that there will be small variations in the concentrations at the surface in a given locality which may result from recent leaching such as may occur from drainage because of the particular topography of the area being tested. However, much larger variations have been found by quantitative measurements in many areas to be due to the presence of buried petroleum deposits and as a rule the small var-

iations due to leaching are negligible as compared to the larger variations resulting from the presence of buried petroleum deposits.

I have discovered that by systematically taking a plurality of samples of the earth near the surface at predetermined locations and then analyzing each sample for its significant combustible carbon content, and then plotting the results, either in profile or plan, or both, it is possible to determine the probable location of a buried deposit. Such a procedure in most instances will disclose a band pattern of a high concentration area, as mentioned above, or occasionally a high concentration area directly above the oil or gas deposit, in cases where the folding is rather intense.

Generally speaking, I analyze the soil samples for their significant combustible carbon content, after which I plot the results of such analyses. Where the results of the plotting, either in plan or in profile, or both, show a band pattern of high concentration surrounding an area of low concentration, or a high concentration area bounded by areas of low concentration as caused by a fissure, it is highly probable that an oil or gas deposit can be located. In the first instance the oil or gas deposit should be located in the area of low concentration which is surrounded by the band pattern of high concentration. In the second instance, the oil or gas deposit is probably directly beneath or directly adjacent the area of high concentration.

In accordance with the invention I have devised a method which is simple and comparatively accurate. The invention takes into account that near the earth's surface there may be carbon present in vegetable matter, the presence of which carbon, of course, is not indicative of an oil or gas deposit. Such carbon content is negligibly small in some areas if the soil sample is taken deep enough, say ten feet, but even if there be some there in vegetable matter the method employed by me eliminates any such carbon and results in a true reading of the significant combustible carbon due to the presence of buried oil or gas deposits only.

In accordance with the above dictates, the principal object of my invention is to provide a convenient method of prospecting for buried oil and gas deposits by measuring soil samples for their significant combustible carbon content and then plotting the results in profile and plan to indicate the probable location of such deposits.

Another object of my invention is to provide such a method which will eliminate from consideration any vegetable matter carbon and still permit the measurement of appreciable quantities of the significant carbon content.

Still another object of the invention is the provision of such a method as will permit the use of samples taken from holes of shallow depth.

These and other objects and advantages will be more apparent from the following description and claims when read in conjunction with the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of an area which has been plotted in profile.

Fig. 2 is a diagrammatic representation of an area which has been plotted in plan.

Figs. 3 and 3*a* together comprise a diagrammatic showing of an apparatus for testing soil samples for their significant combustible carbon content in accordance with the invention.

In Fig. 1, the location of the samples is shown horizontally where the interval between sampling points may be one-eighth mile. In some cases it may be desirable to use a smaller or larger interval. The vertical scale in the figure indicates the concentrations of significant combustible carbon in one-tenth of a percent by weight of sample. High concentrations are shown to occur at two spaced intervals. The proper location of a well to test the results would be between these two high concentration areas.

In Fig. 2, the results of a survey are shown in plan. The numbers represent concentrations in one-tenth of a percent by weight of soil samples. The area of high concentration shown in Fig. 2 forms a band pattern of the type discussed above. In accordance with the theory of the invention, and as verified by actual surveys made in accordance with the invention, since the area of high concentration shown in Fig. 2 will occur over the edges of the buried deposit, it is obvious that the proper location for a test well should be in the low concentration area which is inside the high concentration area. In the area of high concentration, values of greater than 5, 6 and 7 tenths of a percent are frequently found, whereas outside of this area values of 1 and 2 tenths of a percent usually exist. The ratio of the values in the high concentration area to those outside of it is, therefore, very appreciable.

For a reconnaissance survey samples may be taken at approximately one-eighth mile intervals along approximately parallel lines about one mile apart. For detail work lines one-half mile apart will generally suffice. It is not requisite, of course, to take the samples at regular intervals. In general for reconnaissance surveys, a density of four points per square mile will be sufficient.

By soil sample is meant any sample of the earth taken near its surface. It has been found that a depth of ten feet is quite satisfactory, though samples may be taken at a smaller or greater depth. The exact depth of sampling is not critical, but where, because of the particular topography drainage has been heavy, or where there has been excessive weathering or leaching, the samples should be taken a sufficient distance below the surface to obtain soil not materially affected by such conditions. The same holds true where the earth at or near the surface may contain surface vegetable matter carbon, although the method I employ eliminates this carbon from consideration while permitting the measurement of appreciable quantities of the signficant carbon content. Vegetable matter carbon as herein referred to is carbon contained in the parts of plant growths as severed from a plant or as found in the soil in various stages of decomposition. It may be free carbon or chemically combined carbon of vegetable origin.

The chemical or physical natures of the other significant or combustible carbon in the soil, from which carbon determinations are made for obtaining plotting data, are not definitely known or understood. It is merely known that in the present process the latter carbon, combined or uncombined, whichever it may be, is apparently less readily combustible and is removable from a soil sample at a higher temperature than that required to remove vegetable matter carbon or the more readily removable carbonaceous matter.

In accordance with my invention soil samples taken in the manner prescribed above are preferably first heated at or below a temperature of 500° C. in an oxygen atmosphere, for example, temperatures of from 400 to 500° C. In some

cases temperatures up to 550° C. may be employed. The oxygen is blown over the sample in a gentle current to remove the products of combustion. It is not sufficient to heat in a still atmosphere. This procedure will remove the carbon contained in the remains of vegetable matter. It will also decompose any magnesium carbonate, sodium bicarbonate or potassium bicarbonate that may be present. The CO_2 liberated thereby will thus be removed. Usually these materials are present in negligible quantities, but if present they will be eliminated.

In some areas the surface vegetable contamination is negligible, and in such areas the preheating need not be employed, though generally it is advisable to preheat since it is never certain that a sample taken at ten feet or below may not have some vegetable contamination therein. The reason for raising the temperature on preheating as high as possible is to make sure that magnesium carbonate as well as the end products of vegetable matter such as coal are removed. While such preheating may remove some of the significant carbon, this preheating makes the final determination more definite as such determination will not include a determination of the significant carbon which has been removed.

After being treated as described above for approximately one hour (the time may be varied) the sample is next placed in an oven at a temperature in the neighborhood of 600° C. and a gentle current of oxygen circulated over it for a period of about one hour. Here again the time may be varied. The range between 500° C. and 600° C. has been found to be quite satisfactory, though it is understood that reasonable variations are permissible. Preferably the range should be between 550° C. and 600° C., and as a practical matter temperatures nearer to 600° C. are preferred. The significant carbon content is eliminated from the sample between 500° and 600° C. 600° C. is the practical upper limit because above that temperature calcium carbonates and the other carbonates may be liberated.

The stream of oxygen will combust the remaining significant carbon in the sample and will carry the CO_2 formed with it. This stream of oxygen carrying the CO_2 is then passed through a tube containing ascarite which will adsorb the CO_2. The ascarite tube is weighed before and after the passage to determine the CO_2 formed from which the significant carbon content of the sample may be determined.

If there is water vapor in the sample, it may be removed by passing the stream through a tube containing a desiccating agent such as calcium chloride before passing through the ascarite tube.

Instead of combusting at the higher temperature, the same sample that has been combusted at the lower temperature, duplicates may be used combusting one at the lower temperature and the other at the higher temperature, and computing the difference in the CO_2 determinations.

It has been found that different types of soil will adsorb and polymerize the hydrocarbon gases at different rates and therefore it is desirable in some cases to make a correction for the combined adsorption and polymerization abilities of the soil samples. Where the type of soil is the same over the complete area from which the samples are taken, such a correction is not necessary but where, for example, the type of soil changes in the sample taking area, then such a correction is desirable.

One way, though not the only way, of accomplishing this is to place a measured quantity of the sample in a tube and pass a measured quantity of a hydrocarbon gas, preferably an unsaturated gas such as ethylene, through the sample in a measured time. A gently moving stream for a day's time will suffice. This gas will be adsorbed and polymerized to heavier hydrocarbons in the liquid phase. The quantity of such heavier hydrocarbons formed will be a measure of the combined adsorption and polymerization abilities of the samples. The quantity of hydrocarbons heavier than ethane and ethylene formed may be measured in a standard gas fractionating apparatus. In such an apparatus the sample is heated at approximately 100° C. to drive off the hydrocarbons formed. Water vapor and CO_2 are removed. Those heavier than ethane may be condensed in a trap at a temperature of minus 150° C. By reducing the temperature of the trap they will evaporate into the evacuated apparatus. They may then be burned and the quantity of CO_2 formed may be measured. This quantity will be a direct measurement of the heavier hydrocarbons formed and consequently of the combined adsorption and polymerization ability of the sample. Before the above measurement is made, the sample should be heated at a temperature of 600° C. to remove any hydrocarbons present.

If some sample is taken as a base of reference other samples may be corrected by multiplying the significant carbon content measurement of the various samples by a factor which is the ratio of the heavier than ethane hydrocarbons formed in this reference sample to those formed in any of the other samples to be corrected.

In Figs. 3 and 3*a* there has been illustrated diagrammatically an apparatus for testing the soil samples for the significant combustible carbon content. In this figure the reference numeral **10** indicates an electric oven which is connected by wires **12** to a suitable control mechanism **14** connected with a source of current. A temperature indicating instrument **16** is connected by wires **18** to a thermo-couple **20** disposed in the oven.

The oven has a large tube **22** passing therethrough and in this tube is disposed the soil sample in a receptacle **24**. Also in the tube is a piece of copper oxide gauze **26** and a piece of asbestos **28** impregnated with $FeSO_4$, which has previously been ignited to Fe_2O_3. The elements **26** and **28** act as a catalyst to assure the complete combustion of the material in the sample.

Leading to the tube **22** from the left is a conduit **30** adapted to be connected to a source of oxygen not shown. A manometer **32** and a valve **34** are disposed in the conduit for obvious reasons. The conduit **30** is connected by a removable tube **36** to a U-shaped tube **38** which in turn leads directly to and is removably connected with the tube **22** which passes through the oven. The U-tube **38** has ascarite and calcium chloride therein separated by layers of cotton (see the legend). The ascarite and the calcium chloride is for the purpose of removing water and any CO_2 which may be present in the oxygen supply.

It is assumed that prior to treatment in this apparatus the soil sample has first been preheated in the manner described above to remove the carbon contained in the vegetable matter and also to remove the CO_2 contained in any magnesium carbonate, sodium bicarbonate or potassium bicarbonate that may be present.

It will be manifest from the drawings that when the valve **34** is opened oxygen will flow

through the conduit 30, the tube 36, the tube 38 and then into the tube 22 passing through the oven. In the tube 22 the oxygen passes through the copper oxide gauze 26 and thence over the soil sample in the receptacle 24. The oxygen then passes the impregnated asbestos 28.

The sample should remain in the oven for approximately an hour although the time may be varied. The temperature should be in the neighborhood of 600° C. As stated above, if a temperature greater than 600° C. is used, CO_2 from the calcium carbonates and other carbonates may be liberated. The stream of oxygen will combust the remaining significant carbon in the sample and will carry the CO_2 formed with it as it leaves the tube 22.

To the right of the oven 10 in the drawing figures (see Fig. 3a), there are a series of connected but individually removable U-shaped tubes 40, 42, 44, 46 and 48. These tubes are supported from a support 50. The arrangement is such that oxygen, with the CO_2 leaving the oven through the tube 22, passes successively through these U-tubes. At the end of the passage is a liquid seal 52.

In the first of the tubes, namely, tube 40, the oxygen and CO_2 contacts with zinc particles disposed in the tube. The zinc particles remove acid fumes. The next tube 42 is filled with calcium chloride which removes water vapor. The third tube 44 and the fourth tube 46 are each filled with ascarite and calcium chloride to take up the CO_2. The last tube 48 has calcium chloride therein to prevent water vapor from the liquid seal 52 from reaching the tubes 44 and 46.

In carrying out an analysis of a sample, the U-tubes 44 and 46 are weighed before and after the stream of oxygen carrying the CO_2 has been passed therethrough. It is thus possible by computing the difference to obtain an indication of the amount of CO_2 present in the sample being tested. This indication is then plotted in the manner described above. The CO_2 values which are obtained for the various samples may be plotted directly or the carbon content of such CO_2 values may be calculated and these values plotted.

After the samples are tested in this manner, the results are plotted as shown in Figs. 1 and 2, and if the plotting discloses, for example, a low concentration area bounded by a band pattern of high concentration, it is highly probable that a buried deposit of oil or gas will be located in the surrounded low concentration area.

By combustible carbon is meant a carbon which is in such form as to be oxidizable to carbon dioxide. This, of course will not include the carbon contained in carbonates.

It appears obvious that some changes in the procedure may be made while still remaining within the invention. Other methods and apparatus for testing the individual soil samples may be employed. The invention should not be limited to the exemplary disclosure given except within the scope outlined by the following claims.

I claim:

1. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, heating the samples, substantially free from vegetable matter carbon and containing other less readily combustible carbon matter found in said soil, in the presence of oxidizing gas containing free oxygen, converting to carbon dioxide by the resulting combustion substantially only said less readily combustible carbon matter in a measurable quantity in a sample, determining substantially only carbon so converted, applying to the carbon values thus determined a correction for the adsorption abilities of the respective samples, and plotting from the results of the corrected determinations contrasting high and low values representing relative measures of said latter carbon content against distances between corresponding sample locations to show a configuration indicating the probable location of the buried deposits.

2. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, heating the samples, freed from vegetable matter carbon and containing other less readily combustible carbon found in said soil, in the presence of oxidizing gas containing free oxygen at a temperature at which said latter carbon is removed by oxidation from the soil samples but below the temperature of decomposition of calcium carbonate, and determining the latter carbon content, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

3. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, subjecting the samples containing vegetable matter carbon and other less readily combustible carbonaceous matter to a preliminary heating in the presence of oxygen gas at a temperature at which vegetable matter carbon is oxidized and removed from the samples but at which said other less readily combustible carbonaceous matter remains in said samples, removing thereby said vegetable matter carbon substantially completely, subjecting the said samples to further heating in the presence of oxygen at a higher temperature than in said preliminary heating but below the temperature of decomposition of calcium carbonate, thus removing carbon of said other carbonaceous matter from the samples and determining the latter carbon content, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

4. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not mate-

rially affected by excessive drainage, weathering or leaching, subjecting the samples containing vegetable matter carbon and other less readily combustible carbonaceous matter to a preliminary heating in the presence of oxygen gas at a temperature up to but not exceeding substantially 550° C. at which vegetable matter carbon is oxidized and removed from the samples but at which said other carbonaceous matter remains in said samples, removing thereby said vegetable matter carbon substantially completely, subjecting the said samples to further heating in the presence of oxygen at a higher temperature than in said preliminary heating but below the temperature of decomposition of calcium carbonate, thus removing carbon of said other carbonaceous matter from the samples and determining the latter carbon content, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

5. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, subjecting the samples to a preliminary heating in the presence of oxygen at a temperature ranging substantially from 400° C. to 500° C. to remove vegetable matter carbon, subjecting the said samples to further heating in the presence of oxygen at a temperature ranging substantially from 500° C. to 600° C., to remove carbon remaining after the first heating from the samples and determining this carbon content, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

6. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area approximately ten feet below the surface of the earth, subjecting the samples to a preliminary heating in the presence of oxygen gas at a temperature of substantially 500° C. for approximately one hour at which vegetable matter carbon is oxidized and removed from the samples but at which other less readily combustible carbon remains in said samples, removing thereby said vegetable matter carbon substantially completely, subjecting the said samples to further heating in the presence of oxygen at a temperature of substantially 600° C., thus removing said other less readily combustible carbon from the samples and determining this carbon content, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

7. In a method of prospecting for petroliferous deposits in which samples of soil are collected in the area to be investigated and are analyzed for combustible carbon content of less readily combustible carbon matter than vegetable matter carbon in said samples and which is indicative of the presence of oil in a subterranean formation in said area, the step of determining the relative sorptivity of the various samples, whereby the data obtained from such determinations may be utilized in the interpretation of the results.

8. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, heating the samples, substantially free from vegetable matter carbon and containing other less readily combustible carbon matter found in said soil, in the presence of oxidizing gas containing free oxygen, and converting to carbon dioxide by the resulting combustion substantially only said less readily combustible carbon matter in a measurable quantity in a sample, and determining substantially only carbon so converted, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

9. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, heating the samples, freed from vegetable matter carbon and containing other less readily combustible carbon found in said soil, while oxidizing the latter carbon in the samples to convert substantially only the latter carbon to carbon dioxide in a measurable quantity, determining quantitatively the carbon dioxide emanating directly from the samples, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

10. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, subjecting at least a portion of each sample containing vegetable matter carbon and other less readily combustible carbonaceous matter to a preliminary heating in the presence of oxygen gas at a temperature at which vegetable matter carbon is oxidized and removed from the samples but at which said other less readily combustible carbonaceous matter remains in said samples, removing thereby said vegetable matter carbon substantially completely, subjecting at least a portion of each sample to heating in the presence of oxygen at a higher temperature than in said preliminary heating but below the decomposition temperature of calcium carbonate, thus removing at said higher temperature carbon of said other carbonaceous matter, and computing the difference between the carbon content of each sample as removed by said heatings, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

11. In the art of exploring for buried oil or gas deposits from which leakage occurs, the method of prospecting for the location of such deposits which comprises, taking a soil sample from each of a plurality of points spaced a predetermined distance apart over a predetermined area of the

earth's surface at depths depending upon local conditions and sufficient to obtain soil not materially affected by excessive drainage, weathering or leaching, subjecting a first portion of each sample containing vegetable matter carbon and other less readily combustible carbonaceous matter to a heating in the presence of oxygen gas at a temperature at which vegetable matter carbon is oxidized and removed from said first portion but at which said other less readily combustible carbonaceous matter remains in said samples, removing thereby from said first portion said vegetable matter carbon substantially completely, subjecting a second portion of each sample to a heating in the presence of oxygen at a higher temperature than said heating temperature for said first portion but below the decomposition temperature of calcium carbonate, thus removing vegetable matter carbon and carbon of said other carbonaceous matter from said second portions of said samples, and computing the difference between the carbon content of the first and second portions of each sample as removed by said heatings, whereby valuable information is obtained concerning the location of said buried oil or gas deposits.

EUGENE McDERMOTT.