Advanced Nugget Hunting With The Fisher Gold Bug Metal Detector

by

Pieter Heydelaar David Johnson

FISHER RESEARCH LABORATORY
200 W. Willmott Rd., Los Banos, CA 93635
PH.(209)826-3292, FAX:(209)826-0416

FRL870295A

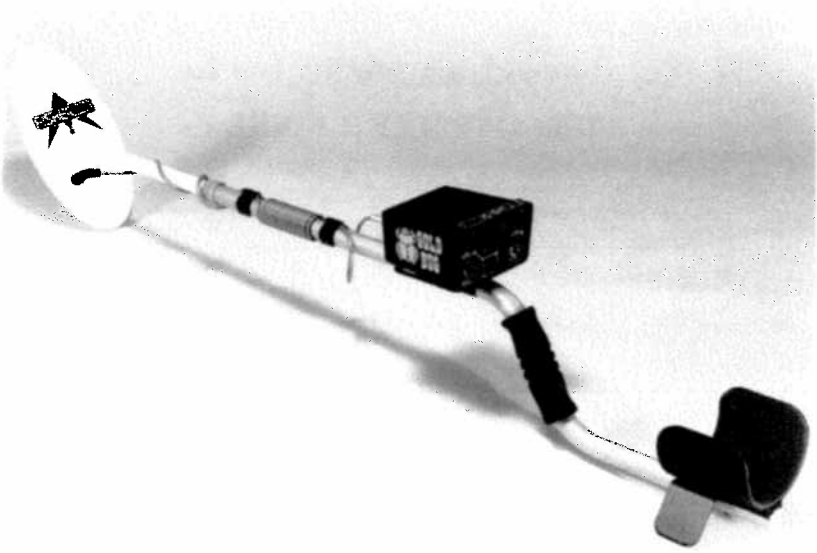
Respectfully dedicated to

DR. GERHARD FISHER

First Printing June, 1988
Second Printing May, 1989
Third Printing January 1993

ABOUT THE COVER

Just a few of the 800 nuggets and gold bearing rocks found by Pieter Heydelaar with his Gold Bug on a recent trip to Australia.



Fisher M-Scope Gold Bug Nugget Hunter

For more information on the Gold Bug or any other Fisher product, write to: Fisher Research Laboratory, Dept. ANH, 200 W. Willmott Road, Los Banos, CA 93635. PH. (209)826-3292, FAX(209)826-0416

TABLE OF CONTENTS

ABOUT THE AUTHORS

We still get requests for a 48 page booklet written over forty years ago by our founder, Dr. Gerhard Fisher, "Geophysical Prospecting For The Layman". It has been out of print for years, but the demand for this type of information has not abated.

When we recently introduced the Gold Bug - a metal detector designed specifically for gold nugget prospecting - two things happened: first, it was an overnight success. It truly did find gold nuggets and orders for it are still coming in faster than we can fill them. Secondly, Gold Bug users came back asking for more information regarding the use of their Gold Bugs. Many of them had gone in to "hunted-out" areas and left with literally hundreds of nuggets, either too small or too deep for earlier detector users. They concluded that there may be no such thing as a "hunted-out" gold patch;that it was just a matter of having the right equipment and know-how. They asked if we had any more "know-how" to pass along. In response, we've persuaded two of the most knowledgeable people in the business to share some of their expertise.

PIETER HEYDELAAR is a treasure hunter's treasure hunter. He's been swinging a metal detector for over twenty years and a professional since 1980. He makes a good living searching for treasure and prospecting for gold in Australia, Europe and the Western United States.

In Europe he often works with government archeologists in the search for ancient coins and artifacts. During a recent trip to Holland he uncovered a couple of gold coins so rare that the government immediately purchased them and put them on display in the provincial museum.

Pieter is also a published author, having written about his adventures for magazines and published a booklet, "Metal Detecting For Gold In Australia". More often than not, however, his exploits are written about by others and often appear in magazines and newspapers.

Pieter spends most of his time looking for gold. He often goes into the desert for months at a time. During his last trip into the Australian outback he found over 800 nuggets with his Gold Bug. He purchased one of the very first ones off the line and he's been using one ever since. But that doesn't mean he's a dyed-in-the-wool Fisher fan: he told me frankly that he relies on his detector for his living and his only loyalty is to whichever detector is best. He says that for right now the Gold Bug is best "but if something better comes along, you can be sure I'll get it."

Pieter knows as much about finding gold with the Gold Bug as anyone. When we asked him to write this booklet before "something better comes along" he readily agreed. His price? Two more Gold Bugs.

DAVID JOHNSON is uniquely qualified to discuss the Gold Bug; he designed it. And he probably knows more about the effects of ground minerals and man-made metals on metal detectors than anyone in the industry.

His expertise in the field of metal detectors dates back to 1971 when he designed, built, and tested a VLF-discriminating car/truck detector for the California Department of Transportation. For the past seven years he has been a design engineer and research scientist for Fisher Research Laboratory.

Shortly after he came to work for Fisher, his interest in the earth sciences, physics and chemistry led him to launch a continuing investigation into the electrical and magnetic properties of rocks and soils. To this end he has designed and built analytical instruments to measure those properties, collected soil and rock samples from around the United States, chemically synthesized various magnetic minerals and chemically analyzed soils.

It was his research in 1981 into the statistical distribution of soil magnetic susceptibility and its effect on induction balance search coils that enabled him to prove that the performance of bandpass filter "motion machines" is limited by the Gaussian response of search coils and that attempts to improve their sensitivity or ground rejection capability by increasing the number of filters or decreasing their bandwidth are doomed to failure.

It was this realization that led to the development of the most successful series of treasure hunting metal detectors in our history (and most widely copied in the industry), the 1200-X series motion machines based on the principle of double differentiation rather than bandpass filtering.

Although Dave's work in Part II of this booklet was written with the Gold Bug in mind, much of it applies to metal detectors in general. Either way, it's fascinating and important reading for any dedicated nugget hunter.

Good Hunting. . .

Jim Lewellen
President and General Manager
Fisher Research Laboratory

PART I

How I use the Fisher Gold Bug to find gold nuggets.

by Pieter Heydelaar

INTRODUCTION

I became interested in gold prospecting about twenty years ago. Like most everybody else I started with a gold pan, then a sluice-box and on to a dry washer and dredge. I found a fair bit of gold but never enough to make a living at it, strictly a hobby.

When V.L.F. detectors appeared on the market many prospectors tried finding nuggets with them and the results were phenomenal. Some of us found enough to earn a living and in Australia a few became millionaires using nothing more than their detectors.

I started using one of the Fisher Gold Bugs only after testing all the latest nugget detectors on the market. When something better comes along, I'll get it, but in the meantime, Fisher has asked me to pass along some of my hard-earned secrets of success.

And don't forget, aside from the thrill of finding a nugget, detecting a desert wash or mountain stream is a great way to enjoy nature and observe wildlife. If you appreciate these things as much as I do, then even a nuggetless day will be a day well spent.

Good luck and if we ever meet in the field, let's compare nuggets!

1. AUTOTUNE MODE

Once you find a nugget producing patch, you'll want to clean it out. But, unless your Gold Bug is perfectly tuned at all times, you'll leave behind many of the smallest and deepest nuggets.

Hold the search coil in the air and turn the Bug on to maximum volume.* Flip the MODE switch to Autotune. This is the mode you will be using most of the time since it works best on mineralized soil which is where the nuggets are usually located.

Now turn the SENSITIVITY control to ten. I always use the highest setting possible, but some highly mineralized ground may cause excessive ground noise. In most cases, turning the sensitivity back to 8 will smooth it out considerably. In extreme cases a setting of 6 or 7 may be used but you should never go below 6 or you'll lose too many small nuggets. Better to put up with a little ground noise and not miss anything.

Next adjust the THRESHOLD control. Turn it up rather loud at first, this will help you during the following procedure.

You are now ready to tune out the effects of the mineralization in the ground. The GROUND REJECTION knob is a double stacked tuner. Set it at 5 using the top, coarse-tuning knob and ignore it. From then on, use only the large, fine-tuning base knob. Don't forget this is a 16 turn fine tuning control and you may have to rotate it several complete revolutions before adjustment is achieved. What has to be done now-and I can't stress this enough if you're in really bad ground - is to acieve perfect ground balancing or as close to it as possible.

Lower the coil to the ground and move it up and down rapidly - no more than six inches - and listen carefully. If the sound increases as the coil nears the ground, turn the

* *The Gold Bug boasts a very powerful audio circuit so be careful; maximum volume may not be for everyone or every headset.*

large knob to the left as you continue moving the coil. You will hear the sound gradually diminishing until there is no difference or very little difference in sound as you raise and lower the coil.

If the sound decreases when you move the coil towards the ground, keep turning the knob towards the right until there is no difference. Most people have trouble with this in the beginning and this adjustment is even harder to make over highly mineralized ground. A little trick that helps is to keep turning the knob until the sound starts going the other way. Then you know you have gone too far, so just back up a bit and you should be right on.

Now adjust your threshold tone so you can barely hear it. At this point the unit is at its most sensitive and you're ready to go.

2. MOTION MODE

In areas where low to moderate mineralization exists, the Motion Mode can be used. Like the Autotune Mode, the coil must be moving to detect a target, however there is no threshold tone to adjust. This mode is actually hotter than the Autotune Mode but unfortunately, it sounds off more over hot rocks and highly mineralized ground, making it difficult to recognize faint, positive signals.

Other users have reported success in the Motion Mode by turning down the sensitivity. I have found few gold bearing areas where this mode had the advantage.

3. NO-MOTION MODE

This mode is even more sensitive than the motion mode but not as stable. It's good for pinpointing and working in tight spots where coil movement - as required in the other modes - is not possible.

For searching in the No-Motion Mode, make sure you ground adjust in that mode and press the RETUNE button often. For occasional pinpointing however, just lower the coil to the ground - away from the target - flip to the No-Motion Mode and press and release the RETUNE button. Bring the coil back over the target as close to the ground as you can get it.

4. TUNING PIECE

This is one of the most important tips I can give you. Use a small nugget no larger than the size of a match head as a tuning piece. It will be a big help when you are in bad ground and you're not sure whether your detector is tuned just right. Just put it on the ground occasionally and see if your Gold Bug sounds off over it.

If not, your ground adjustment is probably off and you should make the necessary adjustments until you can hear it.

A good way to prevent losing your tuning piece is to drill a small hole in the center of a brightly colored poker chip and glue the little nugget in place with epoxy. If you don't have a nugget, a small piece of lead will do, it will sound similar to gold.

5. SEARCHING

Working in the Autotune Mode means that the coil has to be in motion at all times. If you hold it perfectly still over a target, the sound will just fade away. Fast sweeping or "whipping" isn't required, just keep it moving.

KEEP THE COIL AS CLOSE TO THE GROUND AS POSSIBLE AT ALL TIMES. EVERY INCH IN THE AIR IS AN INCH LOST IN DEPTH. Work slowly and concentrate on your signals. Check your ground adjustment every ten feet or so; mineralization changes very often in some areas. Just stop and move the coil quickly up and down a few times - a few inches will do - and adjust accordingly. If you're in very bad ground, use your tuning piece often.

You may have to readjust the threshold occasionally even though you are working in the almost drift-free Autotune Mode. Changing your sensitivity level or ground adjustment may affect your threshold tone. Also, a readjustment may be necessary as the day gets hotter or cooler.

6. GRIDDING

Once you find a nugget producing patch of ground, "Grid" it to insure that you cover every inch. Gridding simply means squaring off your patch and marking it with parallel lines no more than four feet apart. You can do this with a heavy tree limb or by dragging a piece of heavy chain on a rope back and forth. If the patch is very small, you should also rake it to remove surface rocks and other rubble; the closer you get the coil to the ground, the more nuggets you'll find.

7. PINPOINTING

Pinpointing is not difficult even with the standard ten-inch coil. When you receive a positive sound, move the coil back and forth over the target to get an idea where the approximate location of the target is. Next, loosen the soil with a pick and grab a handful of dirt and recheck the hole with the coil. If the sound is still there, repeat. If the sound is gone, you should have the target in your hand. Pour a bit of dirt on top of the coil. If you hear nothing, pour it off and trickle some more on top of the coil. When the nugget hits the coil you'll hear a distinctive "bleep". Now just blow the dirt away and there is your nugget.

Sometimes little ferrous targets, like bits of wire, will give you fits. A nugget is easily pinpointed, but small ferrous targets will sound off over a wider area and a lot of needless digging will result. If you use your Gold Bug often, you will easily be able to tell the difference in sound between a nugget and a piece of ferrous trash. For the beginner who can't, or pro who likes to dig everything, an easy way of pinpointing elusive targets is to tilt the coil on its side so that just the small rounded edge moves over the ground. This only works on shallow targets, but it's a fast way to zero in on small, surface trash items.

Once you've found your target, be sure you check the hole again. Sometimes nuggets are found in bunches; I've found as many as 36 small ones in one hole!

8. DIGGING

Use a small pick for digging. The ground can be very hard, especially where nuggets are found in caliche, a cement-like conglomeration of gravel and clay. A wide belt with one of those loops carpenters use to hang their hammers on is perfect; it will keep the pick out of the way and the weight won't bother you.

9. HEADPHONES

Always use headphones. The Gold Bug has a very crisp, loud target response but, without headphones, you'll miss a lot of small, deep nuggets. Especially where there is background noise like wind blowing through the brush. A one grain nugget will not make much of a sound and without headphones you'll usually miss it. Some patches have hundreds of detectable small nuggets but almost none of any size. In a place like that, you would be wasting your time without headphones.

Avoid the heavy type that completely cover the ears. They are uncomfortable, especially in hot weather, and have a tendency to slip. A lightweight pair of open-air phones is all you need. I prefer the German made Sennheiser HD410 SL. They are high quality, lightweight, and the stainless steel cables are almost unbreakable. Regardless of what you use, and depending on your size, shorten the cable to about 3½ feet. This is especially important when working in bushy areas where a long cable will snag on branches.

10. SEARCH COILS

Once you have become serious about nugget hunting you should consider getting a 14 inch and a 3-3/4 inch coil for your Gold Bug.

The 14 inch is excellent for checking large tailing piles where depth is very important. It will go deeper than the 10 inch and is almost as sensitive to small bits. It's also very good for quick-scanning new patches since it covers a lot more ground with each sweep.

The 3-3/4 inch does not go as deep but it's sensitive to bits of gold as small as a pinhead. Mine paid for itself many times over in reworking patches that I had worked first with the ten inch coil. The smaller coil would pick up the tiniest pieces which are sometimes present in very large numbers. It also works very well in creeks with shallow bedrock; it gets in between and under rocks where the larger coils just won't fit.

11. HOT ROCKS

Unfortunately, a lot of rocks have a higher iron content than the dirt they are found in. Since you adjust your machine to the surrounding ground, these rocks will sound off as a positive signal. They are quite plentiful in some areas but you can easily deal with them. Listen very carefully to the sounds they make. They will all sound alike in the same patch, but a nugget among them will give a much sharper sound.

Some nugget hunters ground balance over a hot rock until it no longer sounds off. This procedure may eliminate hot rock noises in a particular area but it will also eliminate small nugget response since the detector is tuned to the rocks and not the soil which is where the nuggets are. Large pieces can be found in this manner but don't forget, for every good sized nugget, there are many, many small bits. Don't pass them up, they are your bread and butter!

Hot rocks can be identified by their lack of strength in

the signal. When receiving a sound, raise your coil slowly while moving it back and forth over your target. If it is a nugget, the sound will gradually fade away. A hot rock, however, will sound very strong at ground level, but when you raise the coil the sound will die rapidly. Most hot rocks cannot be detected at any distance.

In areas that are really littered with hot rocks, pay attention to the way they look also. They are usually the same color in any given area; brown, red, black or grey. In an area where they are all red for instance, check any rock that sounds off but looks different. Especially the ones that show quartz. It may not be a hot rock, but a gold specimen.

If your target doesn't look like gold you can determine if there is gold inside with your Gold Bug. This procedure works in autotune only. Turn your Ground Reject to 4, lift the coil in the air and bring the rock towards the bottom of the coil and then jerk it quickly away. If it is a hot rock the threshold sound will first null out, then when you jerk it away the Gold Bug will overshoot as the automatic tuning resets itself and give off a kind of wailing sound. If gold is present, however, the rock will cause an increase in sound as you move it towards the bottom - like a solid nugget - and the sound will disappear as soon as you jerk it away.

12. WHERE TO FIND GOLD

"Gold is where you find it" is a popular saying but even better advice is to look where someone else has found it.

The early miners missed a lot of gold and they threw away a great deal of it in their tailings, especially in dry diggings. The most productive places to detect are areas in the dry regions where the gold was recovered with the aid of dry washers. There are two reasons for this. First, the early miners could work these placers profitably only by mining the richest concentrations. They knew that there was more gold scattered around these areas, but they could not mine the whole desert with pick and shovel for the odd nugget. You can, with your detector. Secondly, dry washers only work when the gold bearing dirt is classified to a certain size. Usually one-half inch screen was usually used which means that any nugget larger in diameter than one half inch slid off with the larger rocks and fell into the tailings.

In areas where gold was found in caliche, it was not broken up properly and large chunks ended up in the tailings, sometimes containing many small nuggets. So, when you find a dry washed area, always detect the tailing piles first.

There are two kinds, coarse and fine material. The fine is the dirt that went through the riffles. Detect the coarse piles only. When you have done that, detect the fringes of the area; nuggets can be found quite a distance away. If the diggings were in a wash, check the exposed bedrock. They missed many small nuggets in tiny crevices. Also, when flashfloods roar through it they wash away the tailings, depositing any lost nuggets on the bedrock again.

Detect the sides of the wash above bedrock and any flat area above it that will trap nuggets as well as any low spot. Don't overlook hard rock mines. Many rich specimens were thrown in the tailings, as the old timers often visually checked the quartz they blasted loose and only kept the pieces that showed gold. Oftentimes a chunk of quartz would have a yoke of gold but none visible on the outside, so it would end up in the tailings.

Detect below mines as well. Many veins were shedding rich float for thousands of years before they were found and most of these pieces still dot the hillsides.

In areas like Northern California where gold was found in the rivers, it is a little more difficult to find a good nugget hunting place. Most remaining nuggets are on bedrock, deep underwater and out of reach of a detector. Still, some good finds have been made on exposed bedrock above water level. These rivers ran much higher in ancient times, slowly carving their way into the earth and some nuggets were left high and dry on the banks. In places where the old miners hydraulically mined the ancient river channels, they left large areas of exposed bedrock. Many small flakes and some good sized nuggets have been found in these areas.

Many areas now have the reputation of being "worked out". Don't let that stop you. If you master your Gold Bug and search carefully with a great deal of concentration, you will be successful. No patch ever gets worked out. Flash floods and winds constantly expose new nuggets.

Wherever you go, stay out of private property and areas where metal detecting is not allowed.

13. RESEARCH

You can save yourself a lot of time and money by thoroughly researching the area you plan to prospect beforehand. Not all places where gold was found have potential for detecting. In some patches only very fine size gold was found, obviously not places to detect. Search for placers that were known to produce nuggets and better yet, where the gold was found fairly shallow with little overburden and mined with dry concentration methods.

Buy topographic maps of the area you plan to prospect and learn how to recognize landmarks on them. Most topos will show locations of mines simplifying the search.

I recommend you buy the books written by Maureen G. Johnson, printed by Del Oeste press.* Her books list all known placer deposits of Nevada, Arizona, New Mexico and Utah. She gives a brief history of each patch, with total production and size of the gold found. Also a large map showing the approximate location of each patch is included.

Your local library is an excellent place to find information about mining in your area, photocopy everything that might be used and file it. Do the same with every bit of useful info you read in magazines or newspapers, no matter how insignificant it may seem. I have found at least one good producing area checking out just a casual mention in a newspaper article.

* *Available from Research Unlimited, 210 N. Main St., Ames, Nebraska*

14. NUGGETS VS. FINE GOLD

One of the many advantages of using a metal detector to look for gold is the fact that you will find nuggets which bring a much better price than fine gold. For instance if you are dredging, most of your gold will be very fine, which is worth 75 - 85 percent of the spot gold price, depending on the purity. Nuggets however command a higher price. If they have a nice shape or resemble something, like a bird for instance, you might get as much as twice the gold content. Also, pieces of quartz with visible gold in it bring high prices from mineral collectors.

15. UNEXPECTED FINDS

Searching for nuggets in areas where they have been mining since the 1800s often rewards the detector operator with unexpected finds: hand forged tools, old bottles and gold and silver coins of the early miners.

I have quite a collection of artifacts all found while looking for nuggets. One of my most unusual finds came from a tailing pile near Quartzite, Arizona. It was a .38 caliber shell filled with placer gold and plugged with a piece of wood. Somebody used it as a container for gold and somehow lost it.

Also, when walking the desert searching for patches I often find Indian artifacts and sometimes meteorites, all welcome and sometimes valuable additions to my collection.

16. MORE TIPS

1. Your Gold Bug comes from the factory with a plastic bag around the Control Housing to protect it during shipping. Save it. On moist days, slip it over the Housing and you'll still be able to adjust the controls easily through the plastic. The coil by the way is waterproof; you can stick the whole thing in water up to the cable connection at the control box.
2. Just use regular batteries. Buy them on sale or in bulk. Alkalines last almost twice as long but may cost three times as much. Rechargeables have a shorter life and will quit without warning, plus you may not always be able to recharge them when you are out in the bush.
3. Get a larger knob, no bigger than 3/4 inch diameter and slip it over the THRESHOLD shaft and tighten it with the screw in the side of the knob. This will make it a little easier to adjust.
4. Hipmount the control housing. The unit does not weigh much but if you swing it all day long like I do, it will eventually tire you. In brushy areas however, you're better off to leave the box on the stem so the cable won't be constantly getting snagged.
5. Use one of the Velcro straps to keep the cable snug around the lower stem about six inches above the search coil. A loose, moving cable will be detected by the coil which is just as sensitive on top as it is on the bottom.

17. THE LAST WORD

Make sure your Gold Bug is perfectly tuned. Keep the coil down low. Don't go too fast. Concentrate on the signals.

Above all, don't give up too quickly. With practice and persistance you will find gold. I've found enough to know that there is plenty for all of us.

Good Luck and Happy Hunting...

Pieter Heydelaar

PART II

The effects of ground minerals, native metals and man-made metals on the Fisher Gold Bug.

by David Johnson

INTRODUCTION

The Fisher Gold Bug was designed for one purpose only: to find gold nuggets in rock and soil. The environments in which gold is found usually contain a variety of minerals which influence the operation of metal detectors, causing "ground pickup" and false signals over certain types of rocks. The Gold Bug has been designed to minimize "ground pickup"; however, because of the Gold Bug's extremely high sensitivity and the unpredictable character of ground minerals, you will probably experience at least some "ground pickup" in most areas. The information in this section is intended to explain the various effects you may observe, and to describe ways in which you may minimize any confusion they may cause.

1. IRON MINERALS

MAGNETITE is the most magnetic mineral you are likely to encounter. Its chemical composition is ferrosic oxide, a naturally occuring ferrite mineral. It is black, hard, dense, and is a common mineral in igneous and high-grade metamorphic rocks. Magnetite is the primary constituent of the "black-sand" that commonly occurs in gold placer deposits. It is readily attracted to a magnet.

Because it is so magnetic, magnetite has a powerful effect on metal detectors, even in small amounts. With a concentration of only 1% magnetite in sand, an imbalance signal is created that is thousands of times stronger than that caused by a small gold nugget. Your Gold Bug's GROUND REJECT control can eliminate about 99.9% of this imbalance signal, but where there is a lot of magnetite you won't be able to entirely eliminate the effect of magnetite. You can either reduce the SENSITIVITY control setting or learn to ignore the magnetic sounds. The Gold Bug has a shutdown circuit which prevents it from "sounding off" over a large chunk of magnetite or high concentration of placer magnetite sand. The purpose of this is to protect your eardrums. Where there is more than about 5% magnetite by volume, as in some placer pay streaks, you will have to hold the search coil a couple inches away from the surface in order to search the area.

The ground reject point of magnetite is usually about 7.5 on the dial, though it can vary from 6.0 to 8.5 depending on the type and concentration of impurities present (particularly titanium).

MAGHEMITE is gamma ferric oxide. It is red or reddish brown in color, and usually has an earthy texture. It commonly occurs in rocks which have been chemically altered by fire (forest fires, campfires, etc.) or weathering, and in red and red-brown soils. Some tropical and sub-tropical clays may contain more than 10% maghemite and may be so magnetic that they will be drawn to a magnet. In many gold prospecting areas, "hot-rocks", which are of ordinary appearance but sound like gold, owe their obnoxious behaviour to their maghemite content.

Maghemite can be quite magnetic, but it is not as magnetic as magnetite. It usually "comps out" about 5 on the ground reject dial, though the compensation point may vary from about 3.5 to 6.5. When you are searching an area where rocks containing maghemite are present, you should break them open to check for gold if their compensation point is more than ½ unit lower on the dial than the compensation point of the soil in which you are searching, or if the compensation point is lower than 4.0.

LEPIDOCROCITE is gamma ferric oxide hydrate. It is yellow to brown in color and occurs as a component of some yellow clays. It is sometimes rather magnetic (but not as magnetic as magnetite) and usually "comps out" between 5.5 and 7.0 on the ground reject dial.

HEMATITE is alpha ferric oxide. It can occur as a black crystalline rock, a red amorphous or crystalline rock, or as a reddish earthy powder. It occurs as a component of some red and brown soils. Red hematite rock is the most common ore of iron. Hematite in the soil is almost impossible to distinguish from maghemite except on the basis of its magnetic properties: hematite is only weakly magnetic and usually "comps out" between 6.0 and 7.5 on the dial. Hematite "ironstone" is very common in some Australian gold areas and is also common in areas where sulfide ores are present. Some jasper is colored by maghemite, and some is colored by hematite-often both kinds can be found in the same area. Most books in the field of soil science and geology fail to distinguish between hematite and maghemite.

LIMONITE is a mixture of hydrated ferric oxides, predominantly goethite (ferric oxide monohydrate). Limonite occurs as an amorphous rock ranging from brownish black to brownish yellow in color, and as a yellow earthy powder. It is an important ore of iron. It occurs as a constituent of some yellow, brown and gray soils. Like hematite, limonite is weakly magnetic and "comps out" between 6.0 and 7.5 on the dial. Limonite "ironstone" is uncommon in most gold areas, but it is common near sulfide ore deposits. Books in the field of soil science and geology often confuse limonite, goethite, and lepidocrocite.

FERROMAGNESIAN SILICATES AND ALUMINOSILICATES. Some common minerals contain iron in a form other than the oxide; for instance olivine, hornblende, pyroxene, biotite, garnet, chlorite, serpentinite (crysotile asbestos), and plagioclase feldspar. These minerals contain varying amounts of iron in chemically reduced form, hence their generally black to green color. These minerals, when not contaminated by magnetite (a common contaminant especially of biotite and serpentinite) are weakly magnetic and "comp out" at 6.0 to 8.0 on the dial.

Iron is commonly found as an impurity in the crystal lattice of clays, which gives the clay a blue color if the iron is reduced (ferrous) or red if the iron is oxidized (ferric). Iron which occurs as an impurity in the crystal lattice of clays renders those clays weakly magnetic, with a compensation point between 6.0 and 7.5 (ferric iron) or 6.5 to 8.0 (ferrous iron). It should be noted that many clays contain much iron in free oxide or hydroxide form (i.e., maghemite, limonite, etc.) external to the clay crystal lattice, and in such cases the magnetic properties of the free oxides and hydroxides will tend to dominate the magnetic properties of the clay.

Most soils contain several percent iron by weight, and most of this iron is usually associated with the clay fraction of the soil both as an impurity in the crystal lattice of the aluminosilicate portion of the clay, and as free oxide and hydroxide.

SIDERITE is iron carbonate. It occurs as a grayish colored rock, and is a minor ore of iron; however, it is rarely found in gold mining regions. It also occurs in alkaline soils which are gray in color, particularly in colder regions. It is weakly magnetic and "comps out" between 6.0 and 7.5 on the dial.

2. DIAMAGNETIC MINERALS

Most minerals which contain absolutely no iron exhibit a very weak "negative" magnetism known as diamagnetism. The Gold Bug is probably the first metal detector sensitive enough to "see" diamagnetism.

QUARTZ. The only common mineral you are likely to encounter in gold mining regions which will exhibit noticeable diamagnetism is white or clear quartz. The compensation point of quartz is between 7.0 and 8.0 but its effect is opposite in polarity to that of magnetite. Since diamagnetism is a weak effect, it will usually be masked by the effects of iron-bearing minerals and will not ordinarily be noticed except perhaps when crossing a vein of "clean" quartz. In this circumstance you may notice a very weak "positive" signal which will be broad and impossible to pinpoint. You are not likely to confuse it with a signal from gold, which is usually more distinct.

3. CONDUCTIVE NON-METAL MINERALS

SULFIDE ORES. These ores are conductive sulfides of heavy metals, including the familiar iron and copper pyrites and galena. Sulfide ores are immediately recognizable because of their metallic luster and crystalline glitter, though they are sometimes confused with native metals (especially gold) and with muscovite mica. Conductive sulfides "look like metal" to a metal detector.

In some gold regions, iron pyrite is commonly associated with gold, and produces a signal similar to that of gold. Some chunks of pyrite may have value as mineral specimens.

SALT. All soils contain mineral salts and moisture, which together cause the ground to be slightly conductive. In humid climates the rain leaches out most of the salt and so conductivity is low; however, in dry climates the soil may contain as much as several percent salt, and when this is moistened by rain the soil may become so conductive that it is almost impossible to search it. The conductivity of the soil mimics the effects of metallic conductivity, making it "look" to a metal detector like the ground is full of metal. When searching an area where soil conductivity is causing problems in ground comping (especially in desert areas when the soil is wet) you will usually get better results by using the smallest search coil available. A small search coil will dramatically reduce the effects of conductive soil.

Soil conductivity tends to lower the ground comp point below the comp point of the iron minerals in the soil. If the ground comp point is below 4, you are working in soil which is primarily conductive rather than magnetic, and you should probably switch to a smaller search coil. And if the ground comp point is substantially lower than you expect for a soil of the character you are working in, or if the ground comp point seems to be highly variable from spot to spot or varies substantially as the search coil is raised or lowered, than you are probably fighting conductivity problems and you should try a smaller search coil to see if that will improve the situation.

The human body contains dissolved salts, and because of this the Gold Bug will "see" your hand if it is brought near the search coil. This effect is <u>not</u> due to "body capacitance" or improper electrostatic shielding, as the Gold Bug search coils are carefully designed to eliminate capacitance and electrostatic coupling effects.

4. NATIVE METALS

GOLD usually occurs in the form of veinlets or nuggets in rock (most often within quartz), nuggets in loose rock "float" or soil, and nuggets and flakes and dust in alluvial "placer" deposits where it is usually associated with magnetite sand.

There is also microscopic gold in some rocks in concentration sufficient to warrant mining. Metal detectors cannot detect this gold.

In virtually all gold deposits, most gold is small gold. Massive nuggets like the "Hand of Faith" nugget found in Australia get a lot of media attention, but if you're looking only for large nuggets and passing up the small stuff, you are passing up paydirt. In the past, metal detectors designed originally for "coinshooting" or relic hunting were used by prospectors for finding gold; because of their lower operating frequency these detectors missed much small gold and left users with the impression that not much small gold was present. The Gold Bug operates at a frequency of 19.17 kHz, the highest frequency of any serious metal detector on the market at this time. The higher frequency allows detection of tiny nuggets and flakes that would be missed entirely by other detectors. Despite anything that someone may have told you or even seemed to show you, there is no metal detector on the market which will detect dust or flour gold.

SILVER. Silver is usually found within a matrix of rock, not in the form of loose nuggets or in alluvial deposits like gold. In places where silver occurs in economic quantities, the "pieces" or veins are much larger than the size of comparable formations of gold. Most of the native silver found by metal detectors is found in old hardrock mine workings. In some gold mining regions, silver sometimes occurs in the same places that the gold does, and if you are searching for gold you should not throw away any rock that acts like metal until you have determined that it is worthless. Gold miners have thrown away millions of dollars worth of silver - don't follow their example.

COPPER. Native copper is rarely found outside of known copper mining regions. If you are interested in locating specimens of native copper, restrict your search to those areas which are known to have produced specimens of native copper in the past. Native copper has little value as metal, but nice specimens have value as things of beauty.

PLATINUM. Platinum and related metals may occur either in rock or in alluvial (placer) deposits. These deposits may be associated with gold, or there may be no gold present. If you are searching for gold and find a "nugget" or vein which acts like metal but is not gold, don't throw it away until you have verified that it is worthless material.

METEORITES. There are several kinds of meteorites, but the kind most likely to be found with a metal detector is the nickel-iron type. A nickel-iron meteorite will usually look and feel like a lump of iron. It will usually have a thin layer of rust, but because of the nickel content these meteorites rust very slowly and in fact are very durable rocks. Meteorites are very valuable, so if you find a rusty-looking rock that acts like metal, and its "ground" compensation point is between 1.5 and 3.0 on the dial, do not throw it away until you have determined it is worthless.

It is usually a waste of time to search for meteorites except in areas which are known to be meteorite fall areas, or if a meteorite impact has been witnessed (a very rare phenomenon). However, there are probably a lot of meteorites scattered throughout the world outside of the known meteorite fall areas but they go unrecognized since there is little about them that would attact attention. If you use a metal detector a lot, it's entirely possible that you may encounter one or more meteorites while searching for other things, and if you recognize it for what it is you may have a bonanza on your hands.

For more information on meteorites, see the September 1986 issue of National Geographic.

5. MAN-MADE METALS

COINS, JEWELRY AND RELICS. The Gold Bug was not designed to find these items; however it has been used for this purpose quite successfully. It does exceptionally well on small non-ferrous objects (such as earrings and bullets) and its ability to find American nickels and small foreign coins is on a par with the best "coinshooting" metal detectors. On larger and more conductive coins however, some top notch "coinshooting" metal detectors will probably go deeper. On small gold objects of course, the Gold Bug is hard to beat.

METAL TRASH. The Gold Bug has no trash rejection ("Discrimination") circuitry because at the present time there is no way known to build a metal detector which will provide this capability without some sacrifice in its ability to detect gold. With practice however, many operators have learned to distinguish between ferrous and nonferrous items merely by paying close attention to the various ways in which the Gold Bug responds to different targets.

METALLIC ITEMS IN CLOTHING. Belt buckles, knives and canteens carried on the belt, and large metal items in trouser pockets can cause false signals when operating the Gold Bug at high sensitivity levels and/or with the large search coil. If this is a problem, remove these items from your person, rotate them to your back, reduce the sensitivity setting, or use a smaller search coil.

The use of steel-toed shoes or boots is not recommended when using any kind of metal detector. They put too much metal too close to the search coil. Metallic eyelets for the shoelaces have been known to cause problems unless the search coil is held well forward away from the feet. We have not observed nails or staples used to hold the heels on boots to be a problem.

6. SUMMARY

In using the Gold Bug to search for gold in gold mining areas, you may experience problems with "ground pickup". Magnetite, a black iron oxide, is a problem primarily in placer deposits, and usually comps out at approximately 7.5 on the ground comp dial. Maghemite, a red iron oxide, is a problem particularly in subtropical and tropical red clay soils (including many soils of the California Mother Lode belt) and "hot rocks", and typically comps out about 5.0 on the dial. Other iron minerals and soils are usually weak in their effects (compared to magnetite and maghemite) and typically comp out between 6 and 7 on the dial. In desert areas, salt in the soil can lower the ground comp point especially when the soil is moist, this usually results in very erratic ground compensation. This problem can be minimized by using a small search coil.

7. AUTHOR'S NOTE

I wish to thank the many people who have sent us soil and rock samples and descriptions of field conditions. These samples and descriptions in combination with our own field research, literature research, and laboratory work including chemical synthesis of various iron minerals, have enabled Fisher Research Laboratory to lead the industry in fundamental knowledge of ground effect. The Gold Bug could not have been produced in its present form without this knowledge.

David Johnson

Dr. Gerhard Fisher has often been called the Henry Ford of metal detectors. He was the first to patent one and the first to design one that could be manufactured in quantity without sacrificing quality or performance.

FISHER HISTORY

Dr. Gerhard Fisher founded Fisher Research Laboratory in 1931 in his Palo Alto, California garage. He and four employees began producing the "Metallascope", a metal detector consisting of two flat wooden boxes containing simple copper coils, five vacuum tubes, and a few assorted components. It was big and awkward but it worked. The "Metallascope" captured the imagination of the world and in 1937, Dr. Fisher was granted the first metal detector patent.

The "Metallascope" was soon nicknamed the M-Scope, and as such, became the accepted standard for all types of electronic metal detection: geologists located ore, treasure hunters found treasure, utility companies located buried pipes, and law enforcement agencies used it to locate abandoned or hidden weapons.

Over the years Dr. Fisher and his team of engineers designed and produced such sophisticated products as geiger counters, radio communication systems, voltage detectors and cable fault locators.

In 1967, Dr. Fisher retired, having firmly established his name in the annals of electronic history. The company continued to grow, and in 1974, Fisher Research Laboratory moved to Los Banos, California, still maintaining the same traditions of innovation and quality. Today, the company offers a complete line of underground detection devices, ranging from water leak detectors to hobby metal detectors, with customers all over the world.