Mackay School of Earth Sciences and Engineering
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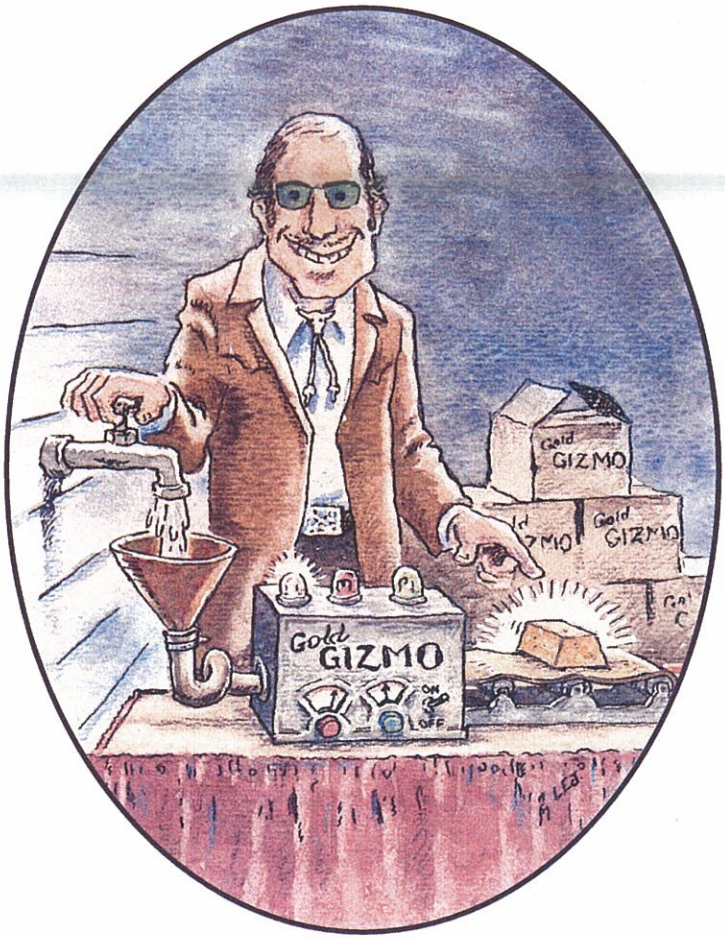
University of Nevada, Reno

Gold From Water
(and Other Mining Scams)



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Gold From Water
(and Other Mining Scams)

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"Investors lose $2 billion as mining-stock price plummets on news that Indonesian gold ore contains no gold!" The Canadian mining company Bre-X successfully attracted a range of investors, from unsophisticated individuals to savvy mining professionals, to invest in its Busang gold prospect, claimed to be the largest discovery of gold in history. After years of successful promotion, the truth about this worthless property slowly emerged early in 1997 and drove Bre-X stock prices nearly to zero. The boldness, sophistication, and magnitude of this scam is almost unbelievable, dramatically eclipsing previous schemes like this. It is the largest case on record, but only one of many such mining scams, both large and small, apparently unintentional or boldly deceitful, perpetrated on investors over the centuries.

Mining, when entered by a novice, can be a dangerous place to invest one's money. Mark Twain said, "A mine is a hole in the ground owned by liars." Mark Twain spent a number of years on the Comstock lode in Virginia City, Nevada, and through repeated experience, knew what he was talking about. Mining is a thoroughly respectable business, but the unwary investor can be duped by con artists.

Natural materials (rocks, minerals, soils, sediments, water, and vegetation) are complex. They contain at least trace amounts of all of the naturally occurring elements on the periodic chart from hydrogen (atomic number 1) through uranium (atomic number 92), except for technetium (number 43, which has not been found to occur naturally) and promethium (number 61, another short-lived radioactive element not found naturally). The complexity of these natural materials makes their analysis a difficult task, requiring extensive knowledge, experience, and expensive instrumentation.

That people might pursue prospecting or investing in mining projects comes from the perception that, with little financial investment and/or only very basic knowledge, one can successfully find a valuable mineral deposit just waiting for discovery. This is akin to a pot of gold at the end of the rainbow or finding a buried or sunken treasure. The problem is that when we explore a new field of knowledge that is unfamiliar it is very difficult to know just how ignorant we are. We can read books, magazines, and technical papers and feel that we have learned a tremendous amount and feel very knowledgeable about the subject. The problem is that we don't really know whether we now have a command of the subject or whether we have not even scratched the surface. This is one valuable feature of obtaining a formal education or even taking a class in a subject given by a specialist in the field: the professor or specialist knows the breadth and depth of the field and can answer this question for you.

There are several types of people who become involved in mining imbroglios or promotions:

- The classic *con artist* who intentionally tries to sell a worthless mining property or ineffective machine or technology for extracting valuable metals from a deposit that cannot be otherwise worked at a profit.
- The *prospector with marginal knowledge* who inadvertently promotes a worthless property or process on friends, family, other investors, or himself, because he knows no better.

- The *devious small laboratory owner*, generally in a rural location, who intentionally reports high concentrations of valuable metals in almost every sample he analyzes to encourage customers to continue prospecting, sampling, and developing properties. In this way he guarantees himself more business as customers extend their sampling and chase their tails trying to outline a rich mineral deposit that is not there.
- The *incompetent assayer* or self-taught, but incompetent, extractive metallurgist who inadvertently causes others to develop a worthless property or process through erroneous analytical results. This he does out of incompetence, not malice, but the end results are the same disastrous ones.

Some people possess a natural savvy or personal cautiousness that leads them to seek a second opinion from a professional specialist before being drawn into a promotion or misguided project. More people, however, are already in trouble (financially and/or legally) when they come seeking professional, unbiased help. In either case, the victim wants to believe the incompetent or devious promoter rather than believe the professional who tells them that there is no value in the property or process that they are pursuing. Or they are reluctant to accept the truth when it is pointed out that they have submitted a sample containing a significant amount of gold, for instance, but that the small vein from which it came does not contain enough tonnage of this same material to constitute a valuable ore deposit, and it would cost more to mine and process the vein material than there is value of gold present in the vein.

But this is reasonable because the victim wants to believe that there are riches to be had from the project in which they have become involved. The alternative is to come to the realization that they have wasted their money and/or have inadvertently led others to throw their money into a worthless project.

Often, there is some aspect of the project that does not seem quite right or consistent, which is the reason that they eventually seek another opinion. This is often the point where a misguided or promoted extraction technique has been financed and a mill built, only to find that there are "low-recovery" problems with the mill. In actuality, there is generally no precious metal in the "ore" to be recovered. Once they are shown how to use scientific methods to control the number of variables with which they are dealing, to assess whether their rocks are ore or not, they reluctantly accept the obvious, agreeing that a careful, stepwise assessment has led to the unambiguous conclusion that the project is worthless.

Other people, however, consult and submit samples several times before they are persuaded to cut their losses and abandon the project. And then there are those who simply get angry and make accusations of close-mindedness and of being unwilling to consider anything new. Most professionals really are not unwilling to investigate unconventional techniques or ideas, however, and have often followed others' "menus" under controlled conditions in clean laboratories, to assess special assaying or extraction protocols that are said to release or liberate the gold in a sample that otherwise would report nothing when assayed. Without exception, in our experience, this has convincingly and unambiguously demonstrated that the "special" protocols or treatments are useless.

There are many varieties of scams and many claims, for one reason or another, that certain ores cannot be assayed by conventional methods. The story generally goes that the materials contain fabulous, ore-grade concentrations of precious metals but some peculiarity of the ore causes conventional assaying methods to fail to record their presence. Not only is the ore very high grade, there are tremendous quantities of it that will yield millions or billions of dollars in riches when using the new or secret methods of assaying and/or extraction. Many of these scams and claims are recurring, and professionals must have patience to deal with them over and over again. The types of scams will be reviewed below, and the claims of unassayable ores will be explained and dismantled.

This problem of promoting worthless properties and procedures is an old problem that is difficult to exterminate. People who become interested in investing in mining projects and look for tremendous returns by funding unusual new technologies or unusual new properties generally do not have the depth of knowledge required to properly assess these projects. Unless they realize this and hire an unbiased consultant to guide them, they are doomed to repeat this aspect of history. Mark Twain, in his book *Roughing It*, reported an interesting and not uncommon vignette:

> *Assaying was a good business, and so some men engaged in it, occasionally, who were not strictly scientific and capable. One assayer got such rich results out of all specimens brought to him that in time he acquired almost a monopoly of the business. But like all men who achieve success, he became an object of envy and suspicion. The other assayers entered into a conspiracy against him, and let some prominent citizens into the secret in order to show that they meant fairly.*

Then they broke a little fragment off a carpenter's grindstone and got a stranger to take it to the popular scientist and get it assayed. In the course of an hour the result came, whereby it appeared that a ton of that rock would yield $1,284.40 in silver and $366.36 in gold!.... Due publication of the whole matter was made in the paper, and the popular assayer left town 'between two days'.

Ore vs. Mineralization, a Fundamentally Critical Concept

Traditional wisdom would suggest that one cannot obtain gold from water. This is not entirely true. Water, like other natural substances, contains at least trace amounts of all of the elements found on Earth, including gold. The critical point is that, given current technology, one cannot extract gold profitably from seawater or most other water because the concentration of gold is very small (it has been tried repeatedly, notably by the Germans during World War I to help fund their war machine, unsuccessfully, of course). Very large volumes of water would have to be processed to recover a small amount of gold. It has always cost more to process the water than the value of gold in that water. The more water we process, the more money we lose. If one could find a reservoir of water somewhere that, for some reason, had a much higher concentration of gold than normal, we could indeed make money by extracting gold from water (this is exactly what some promoters try to sell to unwitting investors). This is akin to the concept of an

orebody (which can be profitably worked) as compared to mere mineralization (which cannot currently be worked profitably). Let's analyze this critical concept further.

Natural processes recurring over the history of the Earth have caused some minerals to become concentrated in extraordinary amounts in rocks in certain places. These areas of concentration of minerals are where we go to extract minerals at a profit. Finding areas of exceptional mineral concentration is the realm of prospecting or mineral exploration.

In order for the extraction of minerals to be profitable, the proper minerals generally must be:

- Highly concentrated by natural processes
- Located in rocks near the Earth's surface
- Located in an environmentally insensitive spot, with relatively easy access, with water available, power not too far away, inexpensive transportation available to ship the extracted minerals, in an area of hospitable climate, etc. This type of mineralization is referred to as an orebody because the minerals constituting ore can be processed and sold for a profit.

The discrimination between mere mineralization and an orebody requires three-dimensional information about the volume of mineral-rich rock available for extraction. This requires drilling, tunneling, or trenching, combined with sampling the rocks and assaying them. This is the only way to determine how many tons of mineralized rock are present and what concentrations of the metals are present. After calculating the value of the minerals in the ground, we must determine the costs to extract a certain percentage of the minerals from the ore (it is generally not possible to extract 100% of the ore mineral). The value of the minerals in the ground minus the costs to extract the minerals, minus the up-front costs of prospecting and constructing and permitting the mine, minus the end costs to decommission the mine and reclaim the area, tells us how much net profit might be available to earn over the life of the mine. Only at this point can we rationally make a decision whether to pursue the project or investment. It can be very expensive to get to this decision point, and most individuals cannot afford to get there on their own.

Some Recurring Assaying Scams

The assaying scams are essentially limited to the precious metals, largely gold, silver, platinum, palladium, and rhodium. There are reasons for this. Many elements are mined from the Earth, but only the very valuable elements (precious metals) can be profitably mined at very low concentrations in their ores. At these very low concentrations, the precious metals or minerals are generally very finely and widely dispersed throughout the rock. They are so finely dispersed that they are often difficult or impossible to see with conventional microscopes even when their concentrations are high enough to be mined profitably. This forces one to rely on the results of chemical assays to determine whether economic concentrations of these precious metals are present, without being able to verify their presence with a microscope. This is where the incompetent and the

unscrupulous find fruitful ground to err, to misconstrue, and to deceive. These problems and scams do not arise with other metals because the erroneous or fraudulent assay results could quickly be verified or dismissed through microscopic examination of the ore by a competent mineralogist, either professional or amateur.

Salting of samples. While the salting of samples (covertly adding a small amount of metal to a sample that a potential investor would then have assayed) still occurs, it is not as common as it once was. It is not generally difficult to tell microscopically the difference between the manner in which nature and man normally add precious metals to rocks. Knowing this, Bre-X employees, in manipulating the apparent gold grades in drilling samples from the Busang prospect, blended in small portions of very high-grade natural ore material from other properties with the Busang samples. This made the Busang samples appear to be moderately mineralized with gold and effectively delayed the discovery of salting of the samples for years.

Garage assays. Those prospectors who are on a really tight budget (and there are many) will often try to perform assays at home, generally in a garage lab, because they cannot afford the ten dollars or so that it costs to get a commercial assay done. When prospecting for precious metals, assays are necessary or one is limited to looking only for very high grade deposits in which the metals are visible. With home assays people generally run astray almost immediately, because of insufficiently-clean conditions and minimal knowledge, and will often call a professional to discuss their findings or send in a sample for verification. Those who check their results early generally have not lost much when they are confronted with their errors.

Special ores. In general, assaying scams involve convincing everyone that the "ore" in question is complex or, for some other reason, cannot be assayed by normal methods. Often some special pretreatment is required (such as adding a roasting step and then treating the ore with water, leaching first with sulfuric acid, subjecting the ore first to an arc similar to an electric welder, and/or pretreating with sugar or salt, or many other variations) before fire-assaying the sample. Another unsubstantiated claim is that some "ores" are time-dependent: good results can be obtained by fire assay shortly after crushing the sample but values will decrease with time afterwards. This is very convenient, of course, to help explain why verification or referee assays do not confirm a promoter's claims. It has even been claimed recently that better assay results can be obtained on rainy days. In a recent U.S. Department of the Interior case in Nevada, the promoter claimed that they could not recover gold using water from Las Vegas, but could using water from the fabled, secretive Area 51, at Groom Lake. The promoter didn't mention how they were actually able to obtain water from Area 51.

Sometimes it is said that the ore cannot be fire assayed at all because the gold is in a volatile form that would be burned off from the sample and lost during fire assaying. While this is not true in practice, such samples can always be analyzed by standard wet-chemical methods which do not involve heating the samples in high-temperature (1050°C) furnaces. Some would promote the concept that one can only extract precious metals from solution if the mixture is first spiked with the metals of interest. This "seeding" of the sample is supposed to extract the metals that cannot otherwise be

extracted from solution. But trying to extract and accurately weigh the subtle addition of the sample's metal to the much larger "seed" is not good analytical procedure, resulting in large errors, and this procedure, like so many others, fails to validate the concept.

It has been argued that very special temperature programming is necessary during the fire assay fusion step or the precious metals will be missed. While this may not hurt the assay, the chemical driving force for precious metals to partition into the molten lead phase is so strong, and the fusion melt so turbulent, exotic temperature profiles are completely unnecessary. Others would say that clay coatings on precious metal particles in their ore armor the particles, and the coatings will not melt at normal fusion temperatures. Nonsense. Any such coatings are not melted, they are chemically attacked and dissolved by the flux.

Repetitive Fire Assay. Some promoters claim that their special ore must be fire assayed repetitively before the gold will "appear" on the cupel. This method is sometimes known as a "corrected assay" or a "replicate" fire assay. The method involves first completing a normal fire assay, then grinding up the resulting slag and cupel, and fire assaying them again, using fresh flux chemicals. The process may be repeated up to eight times or more. The problem with repetitive fire assays is that the flux chemicals themselves contain a minuscule amount of gold as an impurity. That infinitesimal amount of gold is of no consequence when a fire assay is done once. However, repeating fire assays using the slags from prior assays has a cumulative effect. The gold impurities from the ever-increasing amount of flux chemicals in the fire assay fusion melt appear to be from the ore being tested, when in fact they are just contamination.

Wet chemistry and instrumental analysis. Along with fire assay, spectroscopic instruments are widely used by reputable commercial laboratories and include atomic absorption spectrometry (AAS), inductively-coupled plasma-optical emission spectrometry (ICP-OES or, simply, ICP), and direct-coupled plasma-optical emission spectrometry (DCP-OES or, simply, DCP). In fact, when used properly, these methods are very accurate and reliable. The problem usually arises when a wet-chemistry step in the preparation of the samples is eliminated (the organic extraction of the precious metals into methyl iso-butyl ketone [MIBK] and the washing of that organic solvent with hydrochloric acid to remove iron from the organic layer; iron interferes with the spectrometric determination of most precious metals). Without thorough knowledge of precisely what the individual steps in a documented procedure accomplish, and what a modification of a step will actually do, one must not deviate from published analytical methods.

Good wet-chemical methods of determining the quantity of gold in a sample are used routinely by competent laboratories. However, the incompetent or unscrupulous labs do not use the standard, scientifically established methodology, but modify methods until they get results indicating to them that large quantities of precious metals are present. In fact, what they generally do is totally invalidate a good procedure and arrive at results which they misinterpret as indicating the presence of precious metals. Sometimes this is a consequence of having received sketchy details of the methodology, anecdotally for instance, and unknowingly conducting the analysis incorrectly. Some dabble with developing their own methods of assaying for precious metals but do not have the

necessary background and do not understand the quality assurance procedures required to assess the validity of what they have done.

It can be difficult to prove that others have intentionally developed methods that can trick the less-knowledgeable into believing that there is value in rocks that actually have none. This is a common error, or scheme, which causes an erroneous indication of the presence of precious metals when conducting the analysis instrumentally. It is notable that many scams are promoted at iron-rich sites such as basaltic cinder cones and magnetite-rich black sand placers, for instance.

Laboratories that don't perform precious metal assays on a regular basis. Some promoters use water testing laboratories and other environmental laboratories to perform precious metal analyses. Such water testing and environmental laboratories are often well-respected, but only in the areas where they do the majority of their work. Usually, that work is the testing of water for pollutants. These laboratories often use chemical methods that are similar to those used by proficient precious metal laboratories. Unfortunately, when applied to precious metals, these methods require that iron be removed from the solution being tested. Precious metals aren't considered to be pollutants, so that step isn't needed for environmental and water testing, and the lab technicians leave the step out. The otherwise reputable laboratories report high concentrations of precious metals, when in reality, they are not present.

Emerging scientific knowledge. The con-men and promoters receive very lucrative returns on their fraudulent concepts and are always searching for new ones. Thus, when new scientific concepts or principals surface in the literature, such as the recognition that metals can cluster into small discrete groups of 8 to 20 atoms at the nanoscale, for instance, the promoters may seize on such a concept to explain the peculiarities of their favorite "ore", even if to a trained scientific mind their application of the concept makes little or no sense. They would say that these gold clusters, for instance, are not soluble during conventional assaying, leading a commercial laboratory to report little or no gold in the ore when, they say, abundant gold in the form of clusters is present. Carefully conducted research by highly skilled physicists, however, clearly indicates that gold is more reactive and less "noble" in clusters of 8 to 20 atoms, completely the opposite of what was promoted. When this emerging knowledge is new, however, most people are ignorant of the subject and can be confused by a promoter. In reality, scientists around the world performing research in nanoscale gold rely on exactly the same conventional methods as reputable gold assayers.

Buckminster fullerenes (bucky balls), carbon nanotubes, and other emerging concepts have been mentioned and promoted as affecting conventional assaying methods. Nano-chelation has recently surfaced as a selective extraction protocol for discrete precious metals that have been leached from ores. Specific chemical functional groups are attached to nanoscale materials to perform extractions and separations. The concept may be valid and may become commercially useful, but it will not be surprising to see promoters making fraudulent use of this complex concept in their own ways.

One promoter actually claimed that his nanoparticulate gold was encapsulated with "graphene," which is a microscopically thin layer of graphite. He asserted that the layer

of graphene resisted fire assay fluxes and even the most aggressive acids. He also claimed that the graphene layer absorbed or reflected gamma rays, so that neutron activation assays wouldn't work. If that were true, the nuclear power industry would be completely transformed. In reality, gamma rays are absorbed most effectively by heavy metals such as lead or a considerable thickness of earth or concrete. In fact, neutron activation analysis (NAA), or instrumental neutron activation analysis (INAA), is one of the best ways to double check gold analyses conducted by fire assay or other techniques. It requires no pre-treatment of the sample or selective extraction of gold prior to analysis. When combined with a fire assay pre-concentration, INAA is one of the best techniques for detecting ultra-low concentrations of gold in rocks.

Sometimes, a promoter will claim that the nanoscale gold in his special ore can only be found using an electron microscope. That is nonsense. Nanoscale gold researchers report that they can't reliably detect gold using electron microscopy unless the sample contains at least 0.5% gold, by weight. That amounts to about 140 troy ounces per ton, which is fabulously rich. Even a poorly undertaken conventional assay would report gold in such a sample.

When confronted by a knowledgeable scientist, however, that their inappropriate misuse of valid scientific concepts is ridiculous, the promoter will often quickly switch to another gimmick to support his assertions and avoid being trapped. They also sometimes collect volumes of technical papers (generally mis-applied) and hundreds of assay reports, mining plans, budgets, letters, etc. to overwhelm an investor and make a project appear legitimate.

Laboratory-specific ore-grade assays

Certain laboratories repeatedly produce unreasonable data, indicating, in almost any rock, exceptionally high concentrations of one or more precious metals. Some of these assays have been carefully and repeatedly checked by other, reputable laboratories and, to our knowledge, without exception, they have been unable to substantiate claims of very high, ore-grade, concentrations of the precious metals. In fact, professionals in the mining industry have come to be leery of, if not simply to dismiss, assays from certain towns, mainly in the American West, because of the dismal reputations of certain laboratories there.

Several years ago, the Nevada Securities and Exchange Commission (SEC) asked referee laboratory professionals to help them determine how one laboratory was apparently salting samples from a cinder-cone property that they were promoting by way of inviting people to invest in their project. After being unable to duplicate the results produced by the laboratory in question through umpire assays at other laboratories, the SEC visited the lab and videotaped their procedure for assaying samples. They were then advised to obtain a sample of all chemicals that were added to samples during the course of the assay so that they could be checked for gold contamination. Had it been detected in one of the chemicals (which it was not), it could have been argued that the "salting" was inadvertent and that we were dealing with mere incompetents. Results of the contamination check led to the conclusion that gold apparently was being added covertly and intentionally, and that apparently an intentional scam was being perpetrated on

investors. The SEC went so far as to have other laboratories duplicate exactly the assaying steps of the questionable laboratory, which included the unusual step of adding sugar to the sample at one point, to confirm that their slightly different procedure was not actually responsible for liberating some unassayable gold in the samples. Using the exact methodology of the questionable laboratory, the umpire laboratories found that the samples did not, of course, contain significant gold, apparently because someone was covertly salting the samples in the questionable laboratory during assaying. Even careful screening of the videotape of their assaying steps did not reveal at which step they were doing the salting, however. Unfortunately, the SEC determined that they had insufficient evidence with which to prosecute the apparent con artists and reluctantly stopped pursuing the case.

Some Recurring Property Scams

Property promoters are not stupid people. They often conceive their scams so as to be at least partially believable, even to knowledgeable professionals. The difference between the typical victims of these scams and the knowledgeable professional is that the professional knows how to quickly evaluate and verify or discredit the claims. He does this by calling on extensive knowledge about geology and ore deposits and through the use of the scientific method to avoid being confused and duped by the promoter.

A couple of examples of attempts to promote supposed platinum-bearing properties in southern Nevada and a silver property in Texas illustrate the nature of these endeavors to deceive and extract money from gullible investors. These investors are gullible in this context if they are not fully versed in economic geology, are not particularly savvy and do not use principles of the scientific method, or are not alert enough to realize that they need to employ a consultant to help them effectively evaluate the property and investment. They often are otherwise intelligent, sensible people who can be deceived about mining claims simply because of their unfamiliarity with the subject.

Playa deposits/Moapa lakebed deposits

Southern Nevada is one of a few areas in the United States where platinum mineralization is known to occur. The mineralization occurs in the lower elevations of a couple of mountain ranges southwest and northeast of Las Vegas. From time to time, promoters try to convince investors that platinum has washed out of the exposed occurrences in the ranges and has built up to ore grades in the adjacent closed basins in the valleys. In the semiarid West, these normally dry lakebeds in closed basins are called playas, and playa scams concerning gold and the platinum-group elements (platinum, palladium, rhodium, ruthenium, osmium, and iridium) recur regularly. The Moapa playa, regionally adjacent to the platinum-bearing Bunkerville mining district northeast of Las Vegas, is a favorite area in which to attempt to promote platinum properties. Although it is at least possible that such enrichment processes occur, there is absolutely no reliable evidence that they have. Knowledgeable professionals have assessed and discredited these scams more than once. Assays from reputable labs, on samples for which the chain

of custody has been assured to avoid salting, prove that precious metals do not occur in ore-grade concentrations.

Silver in Texas—a variation on the theme

One of the boldest and richest mining scams ever recorded occurred in 1976. The amount extorted from eager investors was estimated to have exceeded $30 million! Three con artists enticed investors with a phony proprietary technology which was to extract substantial silver from vast reserves of ore near Llano, Texas (never mind that there was actually no silver in the rocks to be extracted).

Up-front money was needed from the investors to secure the mining property in Texas and to attract a $10,000,000 loan to build the needed refinery. Investors were told that they would double their money in one week, and some were enticed to invest substantially. A widow from the South invested $450,000, and a former corporation president invested $150,000. Needless to say, investors never realized any profit from their investments and, in fact, lost essentially everything that they had invested. Was it the con artists' skill and charisma or the investors' eagerness to see unbelievable returns (or both) that resulted in this debacle? The money was funneled into a bank in the Bahamas, where it was essentially out of reach of American officials who eventually were brought into the scam to investigate the broken promises. Indictments were obtained, but Bahamian officials refused to cooperate and resisted extradition attempts. Investors never recovered their money.

Other favorite areas in which to try to deceive investors include basaltic cinder cones, lavas in general, the Mancos Shale, the Humboldt Sink, purportedly platinum-rich brines in Nevada, and purportedly gold-rich water in any area. Some promoters try to obtain large loans using barrels of mineral concentrates as collateral (or mining properties themselves). Often the contents of the barrels or properties are essentially worthless and are simply variations on themes presented above. Occasionally, material actually containing high concentrations of precious metals will be sent to a refinery (generally in Europe) to obtain a letter indicating that the refinery will purchase bulk quantities of such material for a given price. The promoter will then represent that the refiner had assayed material from the property or barrels being promoted and that there is, therefore, a ready buyer for the material.

One company donated its vast mineral claims to a church, presumably to take an IRS tax deduction. The claims were worthless, and the church had to invest a moderate amount of money with a consulting geologist to find this out.

The Problem of Quartz Veins

There have probably been more prospectors confused by quartz veins than any other type of mineralization. There are many examples in the western United States where early prospectors found outcropping quartz veins containing gold. These miners constructed vertical shafts or burrowed into hillsides to extract the gold-bearing quartz. Many times, however, while the quartz vein continued underground, it eventually no

longer carried gold with it and the miner would abandon the pit or adit. Modern prospectors happening upon these prospects will obtain good assays on residual, high-grade samples that they grab from the wall of the hole near the entrance. Thinking they have found a valuable vein, they will begin mining the quartz at depth only to find that they cannot recover any gold from it.

The problem is that the geologic processes that have deposited quartz in the fracture in the rock are different than the processes that normally cause gold to be deposited. Because of this difference in depositional mechanisms for quartz and for gold, the fracture may be filled with quartz to great depths but the gold may only have been deposited in the shallow portions of the vein. Thus, while the shallow, previously mined portion of the quartz vein contained gold, the modern prospector can persistently follow the vein underground until he goes broke without encountering any more gold. A vein that is pinching and swelling with depth, however, may have deposited gold in several of the wider parts of the vein while depositing none in the narrow zones. This can make it difficult to determine whether a barren zone in the quartz vein may carry gold in a deeper, wider part of the vein. Eventually even these pinching-swelling veins will generally run out of gold at some depth, however. Prospectors can waste a lot of time and money unjustifiably pursuing gold in barren quartz veins below productive horizons. Devious promoters can likewise make a worthless vein appear to be exceptionally valuable by guiding one to sample remnants of the gold-rich, shallow vein material and indicating that the quartz vein continues with depth. It may indeed continue to some substantial depth but it may have no precious metals accompanying the quartz and may be of little value at all. Be careful!

In *Roughing It*, Mark Twain wrote:

"The Sagacious reader will know now, without being told, that the speculative miner, in getting a "fire assay" made of a piece of rock from his mine (to help him sell the same), was not in the habit of picking out the least valuable fragment of rock on his dump pile, but quite the contrary. I have seen men hunt over a pile of nearly worthless quartz for an hour, and at last find a little piece as large as a filbert, which was rich in gold and silver—and this was reserved for a fire assay! Of course the fire assay would demonstrate that a ton of such rock would yield hundreds of dollars—and on such assays many an utterly worthless mine was sold."

The Scientific Method and Reliable Data: How to Avoid being Duped!

Scams generally involve attempts to convince someone that a rock is enriched in gold and/or other precious metals when it is not. Using principles of the scientific method, we can confirm or discount this assertion in an unambiguous, accurate, and reliable way. Let's look at a probably familiar analogy to review how the scientific method works and why its results have come to be trusted.

We are probably all most familiar with medical studies that make use of the scientific method. We have probably all heard (more than once) about blind studies in which one

experimental group is administered a new medicine while another group is not. The researchers are looking for differences between the two groups that are unambiguously attributable to the treatment. So the scientists have gone through the mental exercise of hypothesizing that a medicine will cause an effect in patients and then designing an experiment to demonstrate conclusively that the medicine does or does not cause the anticipated effect. Because some results may be psychosomatic, the group not receiving the treatment is not told that they are the control group and may be given a placebo (for instance a pill that looks like the real medicine but is not). This is called a blind study. However, because the treated group may respond psychosomatically because they know they are being treated with the experimental medicine, they may also not be told. When neither the research subjects nor the administering researchers know who is receiving the real or fake treatment, it is referred to as a double-blind study. These scientists are going to great lengths to be certain that the effects that they see or measure between the two groups are the result of the treatment alone. They are using the scientific method to ensure the accuracy and reliability of their results and thereby avoid misinterpreting the results of their experiment because of unforseen effects or by studying one variable when some other variable or variables are actually producing the measured results. They make every attempt to control the number of variables that could affect the experimental results and, by using a large number of individuals in both groups, they average out any residual variables that are still affecting individuals in both groups.

In a similar way, in establishing whether or not a rock contains gold, for instance, we must take steps to ensure that the results of our assay accurately reflect only the presence or absence of gold. We generally do three things during the analysis. First, we carry a blank through the entire analysis, treating it as though it were a sample by adding to it all of the chemicals that we add to the real sample in the course of the assay. In this way, we would measure any small amount of gold that we might inadvertently add to the sample because we would also add it to the blank as we add the chemicals to them both. Ideally we want to measure zero gold in the blank, indicating that we have been very clean in our analysis. If we do measure a small amount of gold in the blank, we subtract that same amount of gold from the unknown sample result, thereby carefully monitoring this contamination and correcting for it.

Secondly, we carry a standard reference material along through the analysis. This is a natural sample, similar to the unknown, in which we already know the gold content with high confidence. At the end of our analysis, after treating the standard like just another unknown sample, we expect to find the certified amount of gold in the standard, indicating that our assaying method was an accurate one (precious metal standards are available from the Nevada Bureau of Mines and Geology and other sources). And finally, we analyze more than one replicate of a sample, carefully assessing the variation in results between the duplicate or triplicate determinations of gold in a given sample to ensure that we can repeat our results time after time and getting a measure of how precise our analysis is. After having taken these precautions during our analysis, we have high confidence that we know the concentration of gold in the unknown sample. We have monitored the analysis for inadvertent contamination by including a blank, we have verified the accuracy of the analysis by including a standard (or even several different standards), and we have demonstrated the reproducibility of our method. We can further assure ourselves that we have the proper answer by conducting the analysis by two or

more entirely different analytical methods and by sending samples to two or more reputable labs. All methods and laboratories should give similar results.

Final Advice

As metal supplies and demands vary over time, individual metal prices can spike dramatically. Promoters often take advantage of such price spikes and investor excitement to promote properties represented as containing vast resources of these newly-valuable metals or minerals. Before investing money in any mining-related endeavor, seek advice from a knowledgeable friend or hire an unbiased consultant to help you assess the risks inherent in the venture. Spending a little money on a consultant in the beginning may save a lot of money in the long run. The rise of the internet has made it possible for some websites to portray a company as having some substance, when in fact it does not.

If you are having material assayed, take it to a reputable laboratory (make some telephone calls to mining companies, state geological surveys, the Better Business Bureau, etc.). If you think that you have found samples that contain ore-grade concentrations of precious metals, have them re-assayed at a second commercial laboratory to confirm the results; a significant investment may hinge on these numbers. If the two laboratories do not agree within some reasonable margin of error, after you have provided them with identical, carefully split samples, seek a third, fourth, etc., until you are satisfied that you know what the concentrations are with high confidence (samples can be submitted for assay to the Nevada Bureau of Mines and Geology; see www.nbmg.unr.edu for details).

While many are attracted to mining because of the potential to obtain riches from rocks, prospecting or investing in mining is an expensive and risky venture. But in this business, there are indeed some valuable ore deposits left to be discovered, so proceed with great care and assistance, if necessary. Be systematic, apply liberal doses of common sense, and control your "gold fever."

If it sounds too good to be true, it probably is.

Some Additional Resources:

Nevada Division of Minerals' list of permits required of mining operations:

http://minerals.state.nv.us/formspubs_mining.htm

Nevada Division of Minerals' publication on mining scams:

http://minerals.state.nv.us/min_diggingdeep.htm

Nevada Secretary of State's website to confirm Nevada business registration:

https://esos.state.nv.us/SOSServices/AnonymousAccess/CorpSearch/CorpSearch.aspx

Also check for permits with:

Nevada Division of Environmental Protection

http://ndep.nv.gov

U.S. Bureau of Land Management

http://www.blm.gov/nv/st/en.html

U.S. Forest Service

http://www.fs.fed.us