

Betwixt Two Worlds: A Search for Gemology in the 21st Century

ABSTRACT

This article looks at gemology from two different, but complimentary perspectives, drawing the following conclusions:

- Scientific gemology needs experimentation in addition to observation. Unassailable source material is the foundation upon which that experimentation should be based. Thus, the first-hand collection of samples at the source is essential.
- Gemology is not just science. Gemologists and gemological journals need to balance scientific study with that focusing on the more humanistic and artistic aspects of the field.

by John L. Emmett and
Richard W. Hughes

Introduction

The world of gemology is well documented. We have schools around the world devoted to its practice, learned journals detailing its progress. But like any human endeavor, sometimes it helps to step back, reflect on the past, ponder the present, postulate on the future. Consider what follows a bit of introspection in the service of something we both love: gemology.

John Emmett on Left-Brain Gemology

Gemologists are often hamstrung by not having a basic understanding of physical and chemical processes. The lack of this basic understanding means they have no framework in which to place their

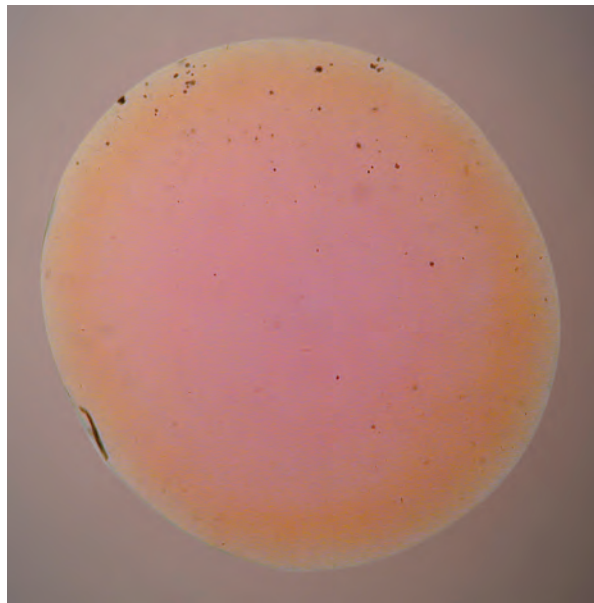


Figure 1. A beryllium-diffused sapphire. If it were not for the telltale orange color rim in immersion, this treatment may have gone unnoticed for many years.

Photo: Richard W. Hughes

observations to develop a self-consistent understanding of the material. Nor is there much literature on the matter tailored to gemologists that can help.

Significantly, most gemologists have this problem to a greater or lesser degree. Gemology is clearly one of the great observational sciences. I am continually awestruck by the quality of the observational skills and the incredible visual memory that seems to go with it. Those that make great gemologists are truly unusual people, and yet each one of those people has an entirely different educational background. And, with few exceptions, gemologists have not received formal scientific training.

A recent example of the challenges this creates was when beryllium-treated sapphires first appeared. Gemologists could clearly see the problem (in the form of a yellow color rim), but even with an electron microprobe they couldn't find it. They could not find it because they did not know what to

look for, and not knowing what to look for, they did not know the microprobe couldn't see it. If gemologists had had a basic understanding of the physical chemistry of sapphire and a familiarity with the literature, they would have quickly understood what was happening.

More important was the uncertainty and discomfort in declaring it to be beryllium diffusion (even after seeing the SIMS analyses) when all the treaters were loudly saying NO WAY. Without experiments reproducing the treatment in the lab, there might have been an even-longer delay in properly labeling it.

Beryllium-diffused blue sapphire is yet another example. While we demonstrated in a single article the lightening of dark blue sapphire via beryllium diffusion (Emmett *et al.*, 2003), we did not then go on and fully elucidate the matter by applying it to a wide variety of blue sapphire types and characterizing the resulting phenomena (such as the spiral decorated dislocations, etc.).

Similarly, while we have good guesses on the flux-assisted fracture healing of Mong Hsu (Burma) ruby (Hughes & Emmett, 2004), since we have never done the experiments ourselves, and since secretive treaters have not allowed us direct observations, we cannot say to date how to reproduce it. Nor can we be certain of the exact effect. Do the stones begin with completely open, unhealed fractures, or are they simply fingerprints further healed by heat/flux? Because we have never done the experiments, we cannot say.

Zen Science

The above examples clearly delineate the limitations of an observational science, and are a strong indication that it is time for gemology to graduate to being both an observational *and* experimental science.

Because of the profit motive, there are scores of people doing experimental research on corundum enhancement. Like firemen, the gemological community sits on the sidelines, content to wait for the alarm to be raised. This has left gemology playing a continual game of catch-up. Beginning with the large-scale heat treatment of sapphire in the 1960s, the gemological community has lagged behind process innovators anywhere from one to ten years.

In some cases, the early unmasking of treatments was luck. The detection of beryllium diffusion of otherwise pink sapphire to produce padparadscha occurred only because producers got greedy and the stones had a feature (yellow color rim) that could be spotted by traditional methods (Figure 1). But we have heard stories that the same producers had been selling similarly treated yellow stones into the market for years. Without a bit of luck and the sharp eyes of Ken Scarratt in 2001, it is

entirely possible that U.S. and European dealers' stocks would have been as full of treated goods as those of the Japanese. If that were the case, what would the response have been when the treatment was eventually detected? Would this treatment have simply been rubber-stamped "traditional trade practice" à la treated *geuda* sapphires and flux-healed Mong Hsu rubies?

Circle of Understanding

Today, many gemological organizations and labs are making a significant commitment to research. However, advanced microscopes, spectrophotometers and/or LA-ICP-MS machines represent merely a refinement of observational science. **Sadly, a commitment to experimental science and to the development of a self-consistent understanding of corundum has been largely missing.**

The instrumentation being purchased is in large part

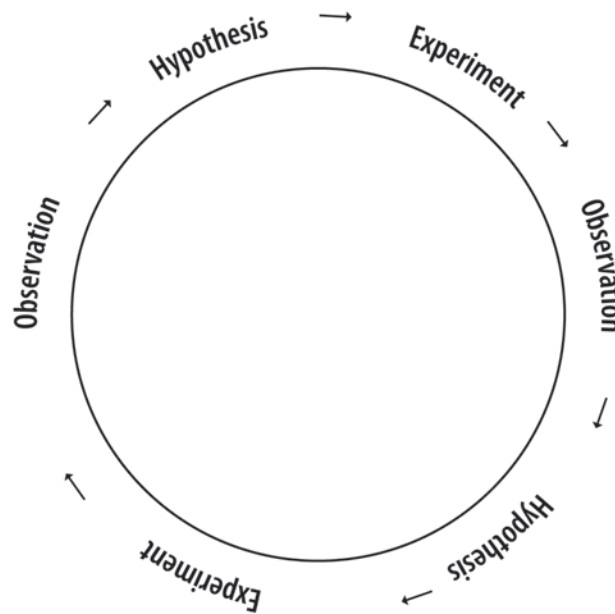


Figure 2. The circle of understanding. Too often gemology only includes the Observation and Hypothesis steps. Experimentation needs to become an equal part of gemology.

committed to the acquisition of a large gemstone database. While this is a necessary component to developing an understanding of a material, it is also wholly insufficient to complete that understanding. A self-consistent understanding allows one to project what might be coming down the line, and to immediately recognize it when one sees it.

Understanding is developed by repeatedly traversing the circle of: OBSERVATION→HYPOTHESIS→EXPERIMENT→OBSERVATION→HYPOTHESIS, etc. (Figure 2). And then documenting it. **Gemology fre-**

quently stops at the hypothesis step and thus does not finally reach the understanding phase – meaning an understanding sufficient to allow a sound guess as to the identity of a process or phenomenon that is being observed for the first time. Too much of current gemology is a process of OBSERVATION→HYPOTHESIS→END. Because gemologists have acute observational skills, their conjecture is often correct, but including experimentation could dramatically increase the success rate. Science starts with a hypothesis, but it remains a hypothesis until experiments offer proof that it is indeed true.

Sampling



Figure 3. Cuprian (Paraíba) tourmaline rough from Mozambique. Some observers suggested the stains in these stones were the result of lattice diffusion treatment (Federman, 2009), but the claim was easily disproved by experimentation (Saeseaw, S. & Scarratt, K., 2009). To answer the kinds of questions that face gemologists today, experimentation must become an integral part of gemology. Photo: Richard W. Hughes; specimens: Miranda Gems.

One of the biggest challenges of advanced gemology is the collection of samples. Far too many studies have been done on samples of unconfirmed origin. And even when the origin is known with good certainty, not enough samples were tested to clearly establish population boundaries. Having visited mines repeatedly over a period of decades, we are constantly seeing new specimens that force us to rethink our own ideas on what constitutes a “typical” stone from certain deposits. Many gemologists never get into the field and thus are forced to rely solely on second or even third-hand reports. This can be crippling when it comes to determining origin or treatment, since it feeds already-engrained prejudices.

Where does this leave the dealer? As one told us, lab reports are supposed to represent science, not fortune telling. Why should labs that have adopted the cloak of science refuse to show their clients the data that backs up their findings? Why should labs base their conclusions on data that is unpublished and thus suspect in so many ways?

Knowledge has no owner. Gemologists and gemological organizations need to work to spread information, not lock it up like what was previously done with the Dead Sea Scrolls (Wikipedia, n.d.).

To the Future

This long story is just to indicate that there are fundamental flaws in gemology. It is not a question of gemologists having scientific degrees, but rather a question of whether or not gemologists apply scientific discipline to their work.

Really, it is that simple. If your predecessor did not clearly present data that convinces you, then you have to take the data and draw your own conclusions. Do not make statements that you cannot back up with good work that you reference, or your own good data. Too often gemologists’ explanations are downright embarrassing in the presence of physical scientists. So there it is. Gemology has been a business where no one demands scientific rigor. No one, that, is with the exception of Alice Keller, Editor-in-Chief, *Gems & Gemology*, who does her best to demand that statements be backed by references.

But the point of view I argue for is making headway. GIA has hired Vincent Pardieu to travel the world and collect verified samples, and in significant quantity. A major corundum database is being assembled from these samples. Calibration standards are being developed for the major diagnostic instruments. I will soon begin teaching a few young gemologists the physics and chemistry of corundum with the hope that they will be lead gemologists in the 21st century. Perhaps in a year or two we can start a comprehensive experimental program. If we all put our shoulders to the wheel, gemology can emerge into the 21st century being all that we would hope it could be.

Richard Hughes on Right-Brain Gemology

If ever there was a schizophrenic field of scholarship, it is gemology. Not only would Freud want this patient on the couch, but after a few sessions, the good doctor himself would be in need of sofa time.

Gemology is a funny business, at times wholly rational – at others, seemingly indecipherable. Some might term this classic psychosis, and I won’t dis-

agree. But while this bipolar nature can divide the best-laid minds, it can also unite, bringing together the best of both sides of the human psyche. Gemology is such a fabulous thing, for it has the potential to unite the disparate hemispheres. Geography and religion, science and art, culture and politics – left brain and right – gemology has the potential to realize that holy grail – fusion of the human experience.

Animate Gemology

As humans, all of us possess certain common attributes that transcend differences in ethnicity, culture or religion. These are the most base, instinctual urges. Call them what you will. They are the basis for the manner in which we interact with the world and are largely unchanged from the earliest humans. Here they are:

1. Hunger
2. Sex
3. Ego

Hunger is foremost. If this urge is not satisfied, the human organism dies. Sex is no less important. Once hunger is satisfied, if reproduction is not possible, the human organism dies. But ego, where did that come from? Honestly, I do not know. Perhaps it is a primitive coping mechanism that allowed the species to become stronger? These are questions for others to examine. What is clear is that such emotions are real and govern our lives, from every waking hour to the deepest depths of our dreams.

These are fundamental emotions hard-wired into each of us, a primordial plumbing system that governs the decisions we make from one instant to another. Science can and is making great strides in explaining the how's and

why's, but understanding urges does not minimize or remove them. Look at the evidence. We have entire industries devoted to the satisfaction of these instincts. Indeed, it can be argued that *all industries* are in this service.

What is Gemology?

Which brings us to the gem industry and the question of why humans are attracted to gems. In my opinion, the decision to purchase a gem is based more on emotion than analysis. Such a question might seem trivial, but this definition is crucial to the arguments I am about to make. Unlike pure sciences such as chemistry, physics and crystallography, gemology does not exist in a vacuum. Its quests are not knowledge for knowledge's sake, but knowledge with a purpose.

Imagine a triangle (Figure 4). At the base are the attributes of a gem, split between left- and right-brain features. At its apex is the transaction where the gem changes hands. Be it in the form of a rough specimens or finished pieces of jewelry, there is always a transaction at the end. Without this transaction, gemology would not exist. Gemologists often sit between the buyer and seller; gemology facilitates these transactions.

A major part of gemology *should be* to explore the factors that influence these transactions, for this knowledge is essential to the field's survival. Instead gemologists busy themselves with only one point of the triangle (the left-brain activities), largely ignoring the other two.

So what is gemology? In our opinion, gemology is simple. It is knowledge – knowledge of a certain type of merchandise, specifically that used by the gem and jewelry trades (Lenzen, 1970). To our way of thinking, gemology is a rich tapestry of interwoven disciplines. Its threads include not just mineralogy, physics, chemistry, crystallography and geology, but also history, trade, economics, decorative arts, religion, romance, mysticism and magic. Yes, even magic.

Rational Gemology

Far too often we left-brain gemologists reach for the chemistry set when confronted with questions that are far better answered by the opposite hemisphere. Emerald is a classic

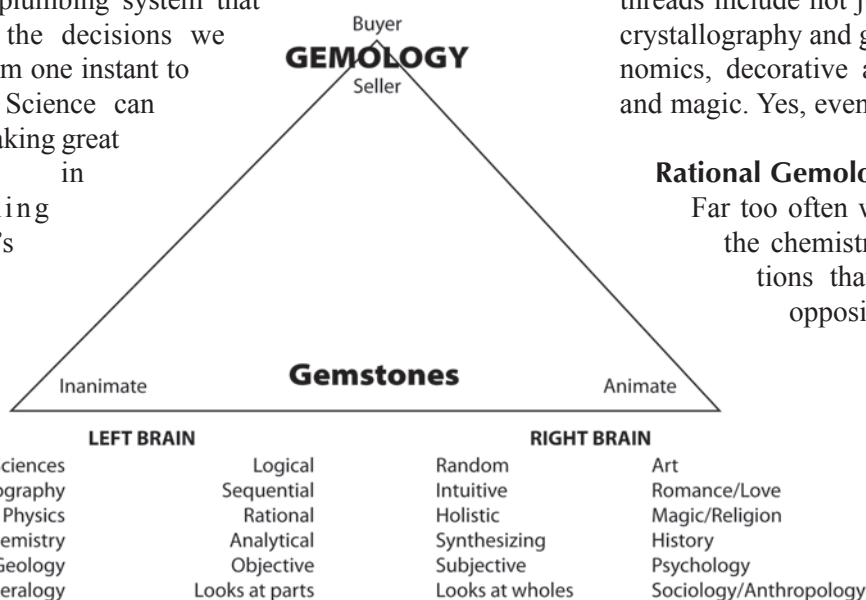


Figure 4. The gemological triangle. At the base are the attributes of a gem, split between left- and right-brain features. At its apex is the transaction between buyer and seller. Without this transaction, gemology would not exist.

example. Known from the dawn of time for its verdant green color, at one time, any gem that had a similar hue was given this name. Eventually, as science progressed, it was decided that true “emeralds” were an intensely green form of beryl. And since chromium was thought to be the cause of this intense green color, we gemologists made the logical leap to equating the emerald definition with chromium content.

Not so fast. Science is nothing if not relentless. In the process of analysis, it was later found that many gem beryls possessing an emerald-green color were actually colored by vanadium. This illustrates one of the paradoxes of gemology. If it is purely science, then we should continue to analyze and whenever we discover a new coloring agent – *voilà* – a new gem variety should appear. *Right?*

Thankfully, no. Gemology is not simply science. Gemology is a combination of fields in service of a trade. Again, back to the triangle. Gemology serves as a foundation to support transactions between the sellers of gems and their purchasers. If gemologists require that jewelers do a chemical analysis on every intense green beryl that crosses the counter, then gemology is no longer serving the trade, but impeding it.

But while gemology should not get in the way, it also cannot become a rubber stamp. For if one party is unequal, if an imbalance exists, future transactions will be affected. Gemologists are the referees. They are there to provide balance, to ensure that each party is treated in a fair manner. As such, the referees should try to avoid becoming players.

Ask yourself this: does a buyer care what element or subatomic particle causes an intense green color in beryl? Does a seller care? *Attention!* We are told if a Paraíba tourmaline is really a “Paraíba tourmaline” we must analyze it. And yet no one has ever gazed upon a fine Paraíba stone and declared: “*Oh sweet Jesus, look at that copper!*”

Gemologists are privileged to work with some of the most stunning and romantic objects on the planet – singular marvels of extraordinary wonder. And yet all we do is analyze, torturing beauty until the extraordinary is reduced to an entirely ordinary set of chemicals, numbers and digits, abstractions with no relation to the reasons why people purchase precious stones. At this point, we have broken the butterfly upon the wheel.

Does the Gem Trade Really Need Gemology?

This is simple: with but few exceptions, beautiful natural gemstones have absolutely no utility that is not served equally well by synthetic, imitation or treated gems. The left brains long ago cracked this puzzle.



Figure 5. Once thought to be colored solely by chromium, many gemologists argued that the definition of emerald must include the presence of chromium. When vanadium-colored emeralds were discovered, the problem with this definition was clearly revealed. In reality, jewelers have no easy way of determining a gem’s coloring agent. What they do have are eyes that can see green in a variety of nuances. Gemology cannot live solely in a test-tube environment. It must take into account commercial realities and aesthetic factors. Photo: Wimon Manorotkul; specimens: Palagems.com.

When it comes to precious stones, we have arrived at tomorrow today. Gemology is the slender filament that holds this business together.

Gem traders and jewelers need to get behind the science. We do not expect you to understand it, but you need to support it, for the survival of the natural gemstone business may depend upon it.

Does Gemology Need More Than Science?

By now, the answer should be obvious. Gemology cannot exist without the trade, and the trade cannot survive by science alone. But despite this obvious truth, the “serious” gemological world makes little if any room for art, romance, emotion or opinion. It’s science only at this fair, which means that gemological publications are ignoring a major portion of gemology. If one of the founders of modern gemology, George F. Kunz (1915), could appreciate and write about the magical and mystical aspects of precious stones, why can’t our major gemological journals broaden their reach to include such works?

No instrument can see with our eyes, none can detect our emotions, and yet we surrender our senses to these abstractions simply because they possess the faint whiff of “science.” Which instrument feels feeling? What tool measures emotion? Few gemologists are willing to ask

these questions because the answers fall outside the realm of scientific gemology. And yet feelings and emotions are crucial to our field.

Gemology is not simply science. People acquire precious stones because of passions, not properties. If we wish to understand desire, which is at the heart of the transaction, we must look not just to the empirical sciences, but also to the speculative fields such as the humanities. Nothing less than the very survival of gemology is at stake.

Between Heaven and Earth

"Ah, there are so many things betwixt heaven and earth of which only the poets have dreamed!"

-Friedrich Nietzsche

There is a little puzzle floating around the Internet, designed to separate us into left- and right-brained individuals. It shows a dancer spinning and the question is simple. Does she spin with the clock or against it? You can see it here:

No instrument can see with our eyes, none can detect our emotions, and yet we surrender our senses to these abstractions simply because they possess the faint whiff of "science."

<http://www.news.com.au/perthnow/story/0,21598,22492511-5005375,00.html>

Left brain or right? Clockwise/counterclockwise, spin, spin, spin.

Gemology is a special child. Beatific, bipolar, sublime, psychotic. Geography/geology, crystallography/culture, science/sociology – left brain and right. Does gemology need more left brain or right? Inanimate or animate? More science or more of the humanities? More heaven or more earth?

Our answer is simple. Yes.

There is no contradiction in feeling love and emotion for a fine gem's external beauty, while possessing a thirst to learn what nature has put into its interior. Gemology must be open to, and synthesize, both points of view. Only then will gemology become whole. ♦

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Acknowledgements

The authors would like to thank William Larson of Pala International for a careful editing of the manuscript and Stuart Robertson of the GemGuide for prodding us to finish it off.

About the Authors

Dr. John Emmett is one of the world's foremost authorities on the heat treatment, physics, and chemistry of corundum. He is a former associate director of Lawrence Livermore National Laboratory and a co-founder of Crystal Chemistry, which is involved with heat treatment of gemstones.

Richard Hughes is the author of the classic Ruby & Sapphire and over 100 articles on various aspects of gemology. Many of his writings can be found at www.ruby-sapphire.com.