TO: Chinese Drywall Colleagues **Dec. 25, 2009**
FR: Gary Rosen, Ph.D.
RE: Toward a Unified Theory on Problem Chinese Drywall

In this final Technical Update for 2009 we summarize what would appear to be a number of heretofore unrelated facts established by recent government scientific research.

We next delineate our theory on Chinese drywall cause and effect.

We then explain how our theory provides a reasonable explanation for tying together this multitude of seemingly unrelated facts.

Note that our theory on Chinese drywall cause and effect was developed with not only inputs from the government funded studies but also based on our own studies and observations.

According to government research:

- ✓ Problem Chinese drywall off-gases malodorous corrosive gases as well as malodorous non-corrosive gases.
- ✓ H2S is one of the corrosive gases emitted by the drywall and it is at least in part responsible [probably plays a major role] in the copper and silver corrosion in homes.
- ✓ The level of H2S measured *inside of homes* is not high enough to account for levels of corrosion found *inside of walls*.
- ✓ The levels of H2S and other gases including carbon disulfide measured inside of homes are detectable but extremely low compared to measurements of these gases in chamber studies. Studies have concluded that chamber analysis does not provide a meaningful measure of levels of drywall off-gassing expected to be found inside a home.
- ✓ Similarly many more types of gases emitted from Chinese drywall are found in chamber studies compared to what is found inside of homes. Chamber studies do not provide a meaningful measure of the types of gasses expected to be found in homes.
- ✓ H2S off-gassing is a function of humidity and temperature. The higher the temperature and humidity, the more H2S is released by the drywall and subsequently measured inside of homes (and in chamber studies.)
- ✓ Copper coupons placed in various areas of problem homes show that at least in homes built in 2005/2006 the problem drywall continues to off-gas corrosive gases. [The copper corrosion found on wiring, plumbing and copper AC components is ongoing and not simply something that happened due to a sewer gas leak or flood or drywall off-gassing that occurred in the past.]
- ✓ Corrosion of copper coupons placed throughout homes is highest near the air handler.

- ✓ In the 51 Home Study (page 2 bullet 2), 3 of the 41 homes identified as complaint homes did not classify as having imported drywall based on XRF/FTIR analysis. As a result of this study, the CPSC concluded that the possibility of false positive and/or false negatives exist with this methodology.
- ✓ CPSC reported no indications of significant overheating of conductors or conductive parts due to the corrosion events.
- ✓ Intact electrical insulation on copper wiring appeared to protect the underlying copper conductor from corrosion.
- ✓ The overall thickness of the corrosion layer (copper sulfide) varied from almost zero to twenty micrometers [this is a very thin layer].
- ✓ Reduced sulfur compounds, such as hydrogen sulfide (H2S), were determined to be the most likely candidates to have caused this type of corrosion.
- ✓ The CPSC estimates that seven million sheets of Chinese drywall were imported between 2000 and 2009, but concludes that it is difficult to estimate the number of houses that might contain the drywall because a house could have just one or many sheets.
- ✓ *Upper airway, skin and eye irritation are common complaints of Chinese drywall homes but studies have concluded that the levels of irritant sulfur gases found in homes are below the threshold for irritation.*

Comments of these results:

We agree with ALL of these results as well as the CPSC interpretations. However, we take issue with the final bullet where their *studies have concluded that the levels of irritant sulfur gases found in homes are below the threshold for irritation.*

We believe that the actual level of sulfur gases in homes is somewhat higher than the levels found in the CPSC studies. We (and others) have determined that the sulfur gas sampling methods used in the 51 Homes Study, as well as the other government studies are not optimal for collecting unstable sulfur gases emitted by problem Chinese drywall.

The government studies ran controls on sulfur gas collection efficiency at 2 parts per million while looking for gas levels down to 5 parts per billion. This makes no sense. The lack of appropriate controls has led to erroneous results as well as a significant waste of time and money.

Mark A. Allessandroni, the Technical Director of Lakeland Labs who did all the analyses of sulfur gases for the State of FLA DOH study, reported at the Technical Symposium that the clear Tedlar sample bags used (by all the government studies) for collecting samples of unstable sulfur gases were problematic. Studies he presented at the Symposium showed that the clear Tedlar bags allow the contents to be exposed to light and such exposure accelerated the break down of the unstable sulfur gases. As a result, sampling with such collection bags will underestimate the levels of sulfur gases in homes.

Russell Pelligrino, the Technical Director at Centek Labs presented similar data at the Technical Symposium. He showed that when sulfur gases were collected in opaque quartz-lined stainless steel containers they remained stable for much longer than when collected in the clear Tedlar sample bags used in all the government studies.

Our studies that compared samples taken at the same time with both the Tedlar bags and opaque quartz-lined stainless steel collection canisters found that the indoor sulfur gas levels were higher when the opaque containers were used.

Given that the government studies have all underestimated the actual levels of sulfur gases in homes because they have used inappropriate sulfur gas collection techniques – it is certainly not clear to me that the CPSC should rule out that indoor gases emitted by Chinese drywall could be producing irritation in occupants.

Furthermore, the finding from the CPSC copper coupon testing, that the levels of corrosion and therefore the H2S levels vary depending on the location in the home will no doubt mean that exposure to irritant gases depends on the location in the home. It is premature to rule out irritation from Chinese drywall gases even though the statement (final on the list) is technically true in that the gas levels they have measured are not high enough to cause irritation.

During my many years of inspecting and fixing moldy homes, I have found that a home owner claiming to be irritated at home that feels fine at work or on vacation is almost always a much better indicator of mold problems than test results. I find that once the mold problem is identified and eliminated that people quickly stop complaining about irritations. I am reasonably sure that this will be the case with Chinese drywall.

We agree with the findings on the copper corrosion not damaging the copper plumbing and insulated electrical wiring. And find that the thin layer of corrosion is easily cleaned from copper with my wife's Copper Brite.

However the government testing on corrosion to smoke detectors is flawed. I have no confidence in that aspect of the study. Smoke detectors were harvested from known Chinese drywall homes but what needs to be tested are smoke detectors from Chinese drywall homes that have ceilings made of Chinese drywall and not just with Chinese drywall in the walls. Most homes (at least in Florida) don't have Chinese drywall on the ceilings because the imported problem Chinese drywall was never UL approved *Fire Rated* for use under attic spaces.

Our Theory on Chinese Drywall Cause & Effect:

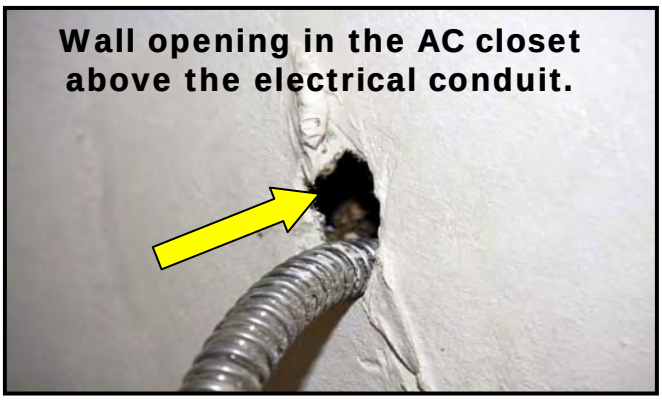
We believe (and our studies confirm) that most of the off-gassing occurs inside wall cavities.

There are several reasons for this:

1. The paint on the outside of the drywall and also the knockdown coating act as barriers (not perfect barriers of course) to gas release into the home.
2. The inside of the home is cool and dry, while the wall cavities in the summer are very hot and humid, conditions conducive to off-gassing.

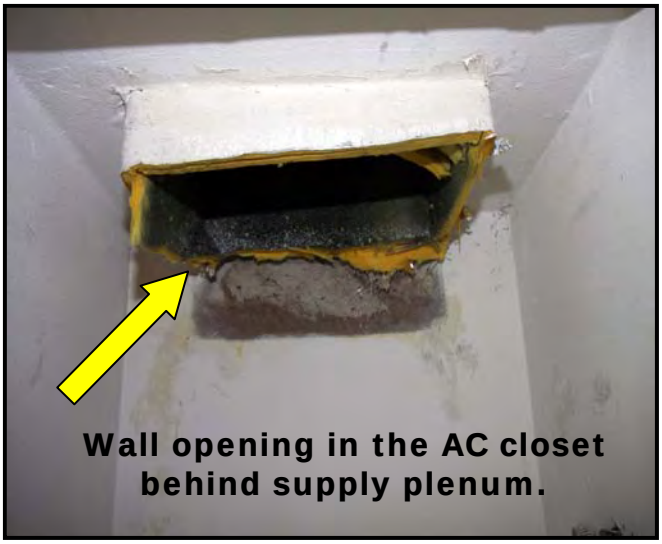
We believe (and our studies have confirmed) that levels of gases in the home are higher closest to openings in walls such as electrical outlets. And that the reason that corrosive gases are higher near the AC closet is that most AC closets are not well sealed and the air

handler (when there is not a ducted return) pulls humid and sulfur-gas rich wall cavity air into the home. See examples to the right of typical openings in AC closets that will result in copious amounts of sulfur gases originating in hot humid wall cavities being sucked into the home.



When the AC cycles on, it also pulls air from any other openings in walls including electrical outlets and from not well sealed baseboards.

We believe that corrosive gases coming from the wall cavities are quickly removed from the indoor air when passing thru the air handler where they are absorbed onto the wet coils. This is consistent with the high degree of corrosion on AC coils.



Chamber studies do not replicate the home environment and overstate the types of gases and the levels of gases due to several factors:

- ✓ The gases are not cleaned from the air by the AC.
- ✓ The drywall in the chamber has a large amount of exposed edges as a percent of the drywall present and more gases escape from non-protected edges than thru the paper.
- ✓ A home is typically not hot and humid like in the chamber. But is cool and dry due to AC.

Only the wall cavities are hot and humid which explains why there is so much corrosion inside of wall cavities that cannot be explained by the low levels of sulfur gases found inside of homes.

Due to the properties of the emitted inorganic sulfur gases such as H2S and CS2, they either quickly break down or are absorbed by the water covered AC coils. In either case they are found in large quantities in wall cavities but not in homes. It has been remarked often that the odor inside of Chinese drywall homes does not actually smell like H2S which has a distinctive rotten egg smell. And no doubt that is true. There are many stable organic sulfur compounds emitted by the CD that have extremely high odor indexes and are the actual cause for the distinctive Chinese drywall smell. H2S is not the cause of the odor.

I believe much of what one smells is due to elemental sulfur added to the drywall paper (and gypsum) to eliminate mold growth on Chinese drywall during the long and humid ocean

voyages. (Note: My studies have found Chinese drywall to be highly mold resistant like USG brand mold resistant drywall.) Buy a bag of sulfur fungicide - smells like Chinese drywall.

The 7 million sheets of Chinese drywall imported into this country are enough to produce tens of thousands of Chinese drywall homes. But only a fraction of this number has been identified as problem Chinese homes. Clearly not all the drywall imported from Chinese is problem Chinese drywall. More research needs to be done to define exactly what *problem* Chinese drywall is and how best to test for it.

To best answer these questions we need two things:

- We need to determine the source / cause of the problem sulfur gases. The government has made no progress on that front and we are not sure if they are even actively working on this.
- We need to have reliable and low cost non-destructive testing procedures that can be used to not only identify drywall made in China but also when Chinese drywall is not problematic, which is very often the case.

This concludes our theory and discussion.

Source of Sulfur Gases: We have ongoing research as to the source of the sulfur gases which we believe to be the mineral Marcasite. See attached earlier report.

Chinese Drywall Testing: We also have ongoing research on new ways to easily, inexpensively and 100% reliably test for Chinese drywall based on physical characteristics of the drywall such as air void size and fiber content/shape that can be observed under a low power microscope. We have $1M E&O with explicit support for testing Chinese drywall.

See link at the Florida DOH web site for a copy of our testing procedures:
http://www.drywallsymposium.com/Posters/Rosen.pdf

In regard to Chinese drywall testing using XRF/FTIR technology, we agree with the CPSC assessment on the limitations of this technology (page 2 of Executive Summary Nov 23, 2009). While the source of the sulfur gases is not clear at this point, it is clear that neither strontium, nor elemental sulfur nor carbonate are the source of the sulfur off-gassing. Therefore relying on these non-essential contaminants as Chinese drywall markers has very limited applicability especially in legal cases.

Happy New Year!

Sincerely,

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Searching for the Cause of Chinese Drywall Off Gassing

Certified Mold Free Corp.
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We are investigating the cause of the sulfur gas release from problem Chinese drywall.

Our hypothesis is that the cause of the off-gassing is the impurity marcasite. Marcasite is identical in composition to pyrite but has a different crystalline structure. It is highly reactive compared to pyrite. We believe marcasite could be the catalyst for chemical reactions with the known organic contaminants in problem drywall that lead to the sulfur gas release. It may be that bacteria in the drywall are a catalyst for gas release, but our hypothesis is that the major release of sulfur gases is from a chemical and not a biological reaction.

To facilitate analysis, we are concentrating the drywall impurities by spinning crushed drywall samples in a centrifuge. Materials of different densities form bands inside the test tubes.

The heavier metal-containing materials, including any iron-containing marcasite, we hypothesize would settle in the bottom bands. At the top would be the lighter relatively pure gypsum.

In the next few weeks, we plan to analyze the concentrated materials in the lower bands under XRD, and SEM/EDS on samples with FeS_2. (Pyrite is cubic while marcasite is orthorhombic.) We expect to find significant concentrations of marcasite ... only in problem (corrosive) drywall.

What we have at this stage of this investigation is informative and interesting to those concerned about problematic Chinese drywall.

On pages 3-5 we see pictures of test tubes containing 6 different types of ground up drywall. The pictures were taken after immersing the samples in a dense liquid and then spinning in a centrifuge. This procedure results in the separation of materials based on density.

<u>This procedure produces a visual fingerprint that can be used to identify the different types of drywall. Clearly, all of these fingerprints are different. Knauf Tianjin is not the same as Knauf Natural, National Synthetic, or BNBM. Clearly there are two forms of BNBM one more pure than the other but neither looking like Knauf Tianjin.</u>

From the sound of this ... seems like Marcasite could be "our guy".

From Wikipedia:

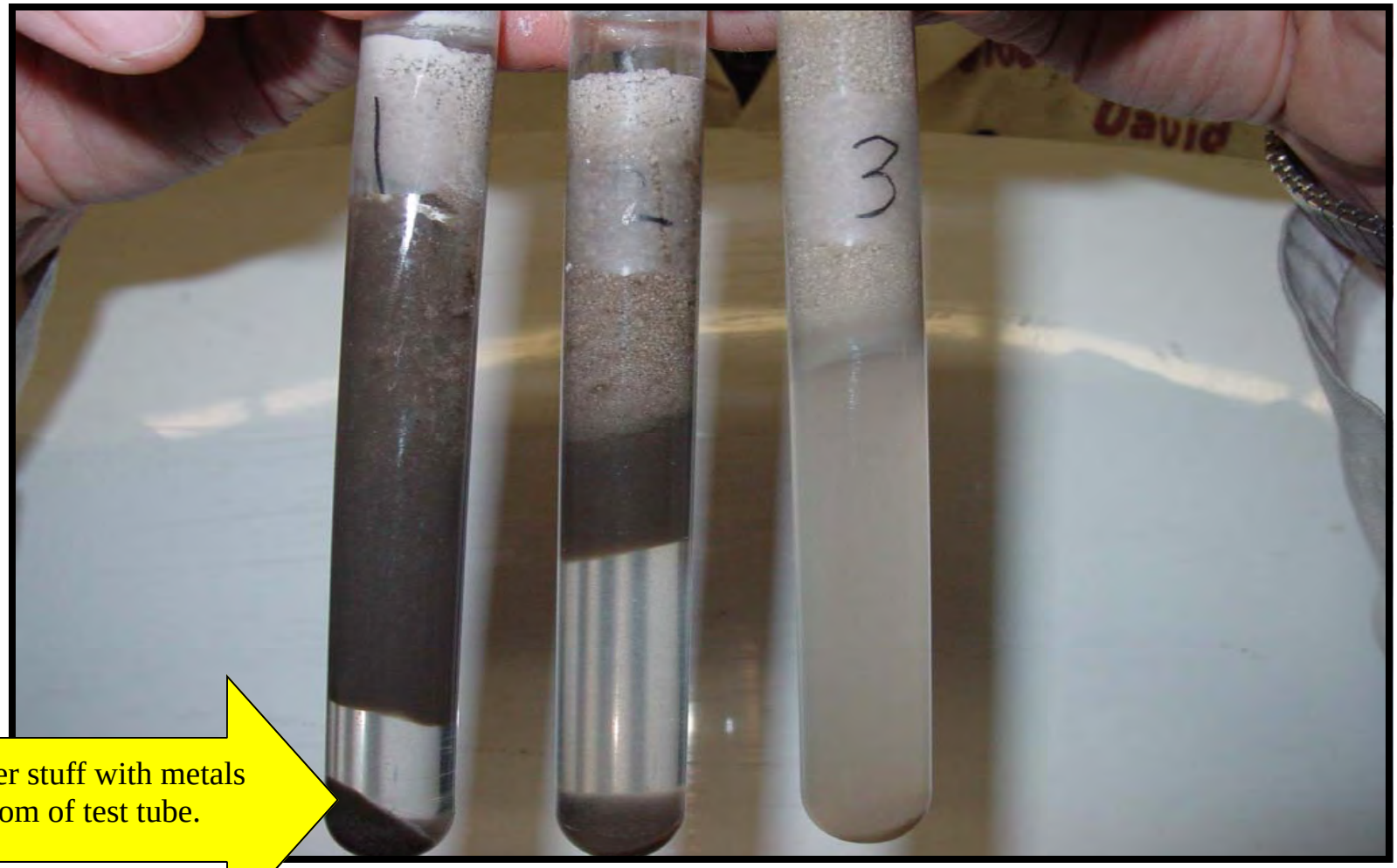
The mineral **marcasite**, sometimes called **white iron pyrite**, is iron sulfide (FeS_2). Marcasite is often mistakenly confused with pyrite, but marcasite is lighter and more brittle. Specimens of marcasite often crumble and break up due to the unstable crystal structure, and it is this crystal structure that is the main difference between marcasite and pyrite.

As a secondary mineral it forms by chemical alteration of a primary mineral such as pyrrhotite or chalcopyrite.

Marcasite may go through a condition known as "pyrite decay", in which a specimen slowly disintegrates into a white powder.

When a specimen goes through pyrite decay, the marcasite reacts with moisture in the air, the sulfur combining with water to produce sulfuric acid that attacks other sulfide minerals and mineral labels. It is most important to remove an afflicted specimen from other minerals to prevent this "disease" from spreading.

Some research has suggested bacteria may aid and accelerate this process by literally 'eating' the marcasite. What is known is that samples with a rough surface tend to decay faster than those with bright, shiny faces, probably due to the greater surface area to react with water in the air, and also it's clear that samples kept in a dry environment (low humidity) are less likely to decay.

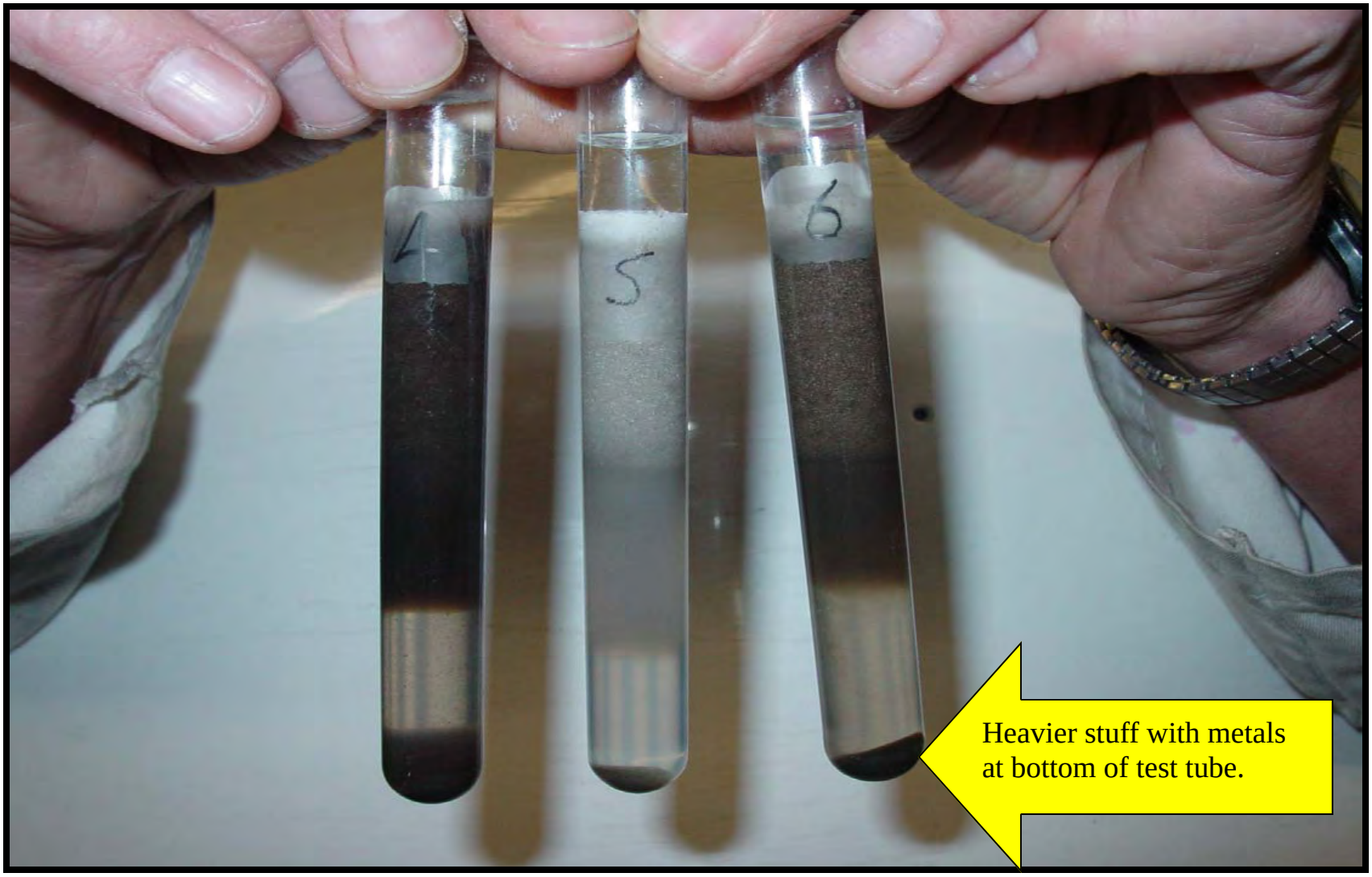


Heavier stuff with metals at bottom of test tube.

1 BNBM 3-22-09 date code. The original drywall was a very slight grey color. The drywall had no smell.

2 BNBM No date code. The original drywall was a white color. The drywall had no smell.

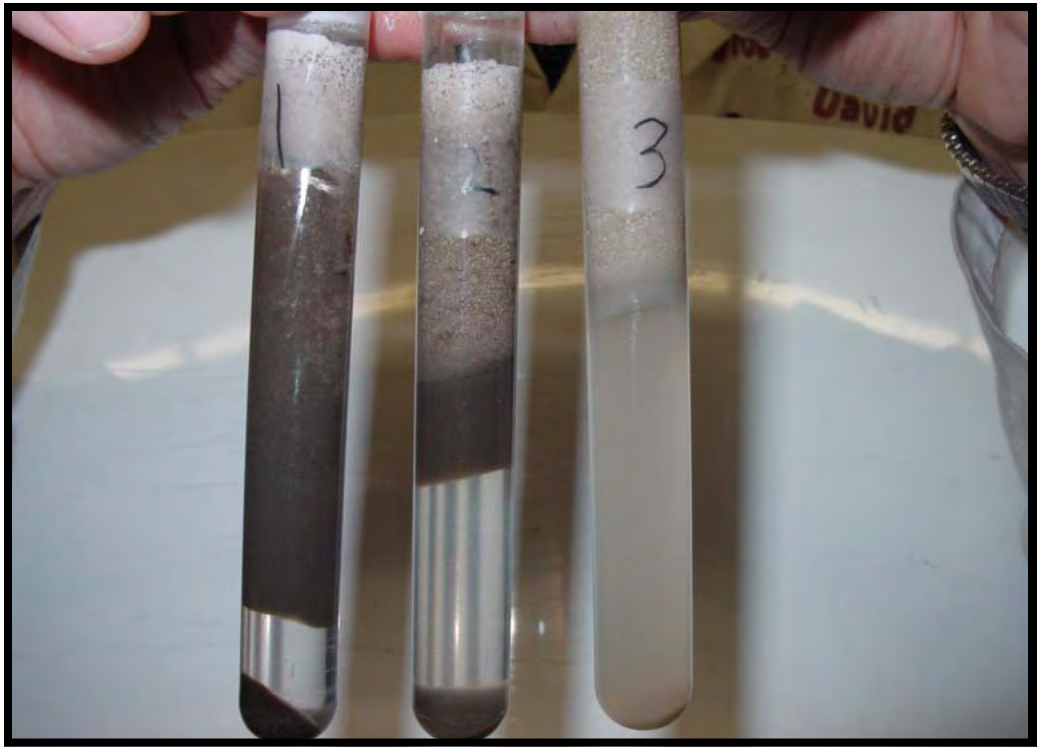
3 USG 1/2" Very white color. The drywall had no smell. Not much impurity at the bottom of the USG drywall. Very clean.



4 National Synthetic. Original drywall is grey in color. The original drywall had no smell. Bands are very dark in color.

5 Knauf Natural. Original drywall is very slightly grey in color. The drywall had no smell.

6 Knauf Tianjin. Drywall is grey in color. The drywall had a strong smell. Dark color to the bands.



Clearly no two samples have the same material composition based on this analysis. All have different fingerprints. The bands are different in size and the colors are different. Next we will look to see what is in each of the bands. Results expected next month(Dec. 2009)

1 BNBM 3-22-09 date code.

2 BNBM No date code.

3 USG 1/2"

4 National Synthetic.

5 Knauf Natural.

6 Knauf Tianjin.

Work being done under contract to Certified Mold Free Corp.
by Biostratigraphy.com, LLC

Marcasite