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Session Seven

Forensic Applications of Assaying

Stewart Murray

Thank you very much Roger. When I worked for GFMS I can remember being told that the theft in various forms from the South African gold mines was something like 25 tons a year, which I thought was an incredible amount, and Roger you are saying that at times it has been even greater than that? It is quite mind-boggling. I remember hearing about many different ways in which this could have occurred, so clearly this is the empire striking back, and trying to beat the criminals. One question that occurred to me was the fact that South African gold contains very small traces of elements like uranium – the quite exotic elements that might still be there in very small proportions after refining.

Roger Dixon

Well, I did not want to include all of those things in my talk, because it would have gone on for hours. However, now that you bring it up, uranium is present in the gold from the Wits Basin, yes, you can see that. What is even more distinctive – and this is why you need an ICP-MS – is that in the gold from the Wits Basin, due to the various geological processes that have happened over time, it has an isotopic enrichment in the lead. It has a lead 206 spike, which is totally, shall we say, unnatural, and this is because when the gold was deposited and the uranium was deposited way back when around about 2.73 billion years ago in the Basin, they had microbial mats, and the uranium and the gold and the cobalt and the nickel and so on were settled in this microbial mass, which is carbon rich. Now, with time and diagenesis, the uranium 238 breaks down; one of its daughter products is radon, which is a gas, and that moves, but it does not move far because the carbon is there and it traps it. Of course the radon then breaks down to lead 206, but there was no lead deposited at this time, so you are ending up with this big spike, which everybody says cannot happen, but actually it is very distinctive. You would not find it in your refined gold that has been through a legal refinery, because of course lead goes out easily. However, as I showed, the illegal guys do not heat it up very much, so that lead is all there. So, you just need a spike. It is not about how much is in there, because that will vary; it will vary whether you have diluted it or anything else; it is looking at the distinctive isotopes and elements which you obviously would take out in your refining, but until you refine it they are there, and they are very indicative of source.

Stewart Murray

If you look at the gold, say, coming out of the Kivu province in DRC, which may be transmitted through Uganda or wherever, and ends up in a refinery anywhere in the world, does it have a fingerprint that could be used to identify it?

Roger Dixon

Yes, unfortunately, in the South African Police we have been unable to obtain certified samples of gold from the DRC. We have been unable to acquire certified samples of gold from a number of countries, because you have to go through the legal channels, and either it is an administrative problem, or else there is an unwillingness on the part of the people in the government structures to allow samples to go out. The only African samples that we have in the South African Police database have been obtained by the major South African gold producers who actually then mine in other parts of Africa as well. That is mainly from West Africa and Tanzania, though. Their gold is distinctly different; the gold from West Africa has more in common with the gold that I showed in the case from South America, because originally West Africa and South America were actually joined together, before Gondwanaland broke up. So, one has to look at time as well. That is why you need certified samples: you cannot trust the person who is bringing it in the country.

Richard Rubin, Republic Metals Corporation

My question relates to how these people even got to your doorstep if you have an anti-money laundering, know your customer type of policy in place. Also, if they are bringing gold in from other countries do you not require them to have the proper paperwork: government stamps, exportation documents and so forth?

Roger Dixon

They have all of that. It is brought in legally, with the official documents. However, those documents do not refer to the material they are bringing in; they are complying with the requirement that they have the paperwork, but they are in the business of making additional profit. So, a lot of the gold that comes from places from West Africa and is imported officially and legally with the right paperwork actually comes from the DRC and places like that, and we suspect too that we are getting South American gold coming in to South Africa, which is also stolen. So, it is a big problem.

Richard Rubin

It is stolen with proper paperwork?

Roger Dixon

Yes, if you can produce the paperwork; for instance, take Zambia: according to the United States geological survey their annual gold production officially is around about 15 kilograms; they are not a known gold producer. But, their Department of Mines supplies the correct paperwork to exporters who bring it in to South Africa – or it was the case a while back. So, here the person is with the gold; they do not even bother to melt it into bars or anything it is like those buttons I showed to you in the shoe. They come in like that, but the paperwork is correct. So, unless you can prove that stuff is stolen, can you tell the guy he is breaking the law? He has got the paperwork as required. And, in fact, in that particular case, we identified the material as coming from the Wits Basin. It is stolen in South Africa, exported across the border, and then shipped back in again legally so it can be submitted to a refinery

and laundered, because if you have got a refinery on your doorstep, why take it overseas? A lot of it now is exported overseas.

Interestingly – we had one talk on platinum and palladium – there was a large project done for the platinum producers. The main people who suffer from platinum or PGM theft are South Africa and Russia. So, Norilsk Nickel and the South African platinum producers actually got together and developed a validated method for determining the origin of stolen platinum material, because in the processing of platinum intermediate products, which are stolen from refineries – they are not stolen form mines, they are very distinctive – it costs too much to process them further; so, a methodology was validated and implemented so that wherever you go, if you use this method, you can actually say, 'We have got 25 producers of platinum around the world, each one is in a distinct geological area, each one uses a distinct processing methodology, so we can identify products'. And the criminals got very sophisticated. What they do is they take material from different places, they grind it up and mix it and think, 'Ha, now we have mixed the material; you cannot identify its source', but with electron microscopy each of those grains can be analysed separately, and you can determine where the material comes from. Gold is a different matter because it is a metal that can easily change shape, but that is why the paperwork comes in, because gold looks like gold; platinum material you can easily see if it is stolen.

It is a big problem. In South Africa, because it was costing the state so much in lost tax and jobs in the mines and so on, that is why it introduced changes to the law that every supplier must supply a sample; and now it has reached a stage where if you do not supply a sample to the database, then you do not get a licence to export or to import; so people are being forced to submit samples.

Richard Rubin

And are these companies that have gone through your KYC?

Roger Dixon

Well, I was in the police; our customers are all criminals. I do not want to go further and explain the other side. The police had a responsibility to legal companies who are doing their job, so we worked closely with the gold mining companies, Rand Refinery and so on. So, yes, as a refiner you would know your customer in a different way as we in the police would know them. But, sometimes, unusual and interesting things come to light, because with a documentation process it is relatively easy to obfuscate facts, like your sources.

Stewart Murray

But I am sure KPMG could spot the difference. Is KPMG still in the room and would they like to comment?

Esther Rodriguez, KPMG

Of course we can spot the difference. That presentation and that answer have made me think. It all goes back to the point of the bigger work that you get, as an auditor. We will see all those reports could be legal, but the bottom line is the gold has been stolen, so I think also the role of the auditor really, inside, is to add additional procedures to detect those cases as well.

Roger Dixon

Just one thing: that gold that is sold from the original producer can go through many hands. By the time you buy it there might be paperwork going back quite a number of steps, so, it

would be very difficult to be able to follow that all the way. And there are many different suppliers of those small bars that they brought in and amalgamated, but the one thing so far that helps us in investigating is that there are no intermediate factories where they take all the gold bars from different places and melt it together and then maybe enrich it slightly. In South Africa some of these people with the recovery licence have obtained a licence and are allowed to buy scrap, and melt it and maybe enrich it slightly and sell it on to another refinery; they buy in quite a lot of stolen material, we know that for a fact, and then they try in their processes to enrich the gold as much as possible, and get rid of the dirt. However, they still do not go to the extent of refining it properly, because that is too costly and they do not have the expertise, so there are always those traces left behind. One of the things we have seen is, as we have analysed plenty of gold in the Southern African context, that gold that is mined, the legal stuff, does not contain much tin at all, whereas a lot of the stolen gold contains tin, and that tin stays there until quite far in the refining process, so if you just see those sort of things, then you can know. They are putting up a refinery in Maputo, in Mozambique; they are not large producers of gold, but they get their gold, from South Africa, from the Congo, from various other places, so they are going to refine it so that it comes out as bars that are reasonably pure, and then you would not be able to trace it further. So, often you have got to look at the country's legal system; in Peru, they did not realise they were losing so much gold. I think it was last year they introduced a law to control gold, because they realised they were losing more than 40-50% of their total gold production through illegal exportation. I see a lot more countries are going to introduce laws to play catch up.

Esther Rodriguez

I think it is also quite interesting reflecting again on what you are saying. Going back again to the question from Emirates Gold about the difference between ISO and ISAE 3000, these are fantastic examples, because with my auditor hat on actually I used to do ISO certifications with KPMG. I think the main difference in this case would be that the ISO audit would be very much looking at the paperwork, the evidence, because it is all very much specified in the guidance; if you go to the audit guidance you will see that, for ISAE 3000, you do not really have that box to tick, or elements that you have to go through – it is very much up to the assurance provider, to the auditor to determine what procedures you have in place, based on the risks that you face with a client. I think in a case like this, it is the auditor's duty to determine that the major risk here might not be in the quality or authenticity of the paperwork, but actually that the gold has been stolen and therefore the question is: to what extent does the auditor need to go to re-determine and find that gap. Going back to what Lynton said before, it is very much about finding somebody that really understands the supply chain, and loves metal and can really trace accountability of that metal.

Jonathan Jodry

Could you give some information on the level of lanthanum or cerium that was identified on a ppm level? What was the quantity of those trace elements?

Roger Nixon

In forensic work we often are not too worried about the absolute amount. In this case, the cerium had a very low ppm to a high ppb, but the rest was gone. You do not normally find many rare earth elements present in gold; it usually is in the inclusions, because the rare earths do not go into the gold lattice. So, in the alluvial process where the gold has been hammered into flakes that float along, the minerals that are hammered in to it actually tend to give you that, because those flakes are then amalgamated with mercury. That whole lot is

then heated up with a blowtorch or something so you get a lump of gold, and you contain all that material. Using laser-ablation ICP-MS, while it is not good for giving absolute amounts, will show you the presence of everything. We can detect easily things at levels of very low ppb in the gold; so you will get a relative amount. We do use Certified Reference Materials, but more to ensure that analyses over a period of time are all normalised to the same level, so everything is comparable. In the South African police, there are two reasons for analysing precious metals. One is to determine the exact amount of precious metals present, to determine the value of the material stolen in order to pass sentence; but if you are looking at the fingerprinting side, we are not too interested in the quantity of gold, we are interested in the relative proportions of all the other elements to give us that fingerprint. As I said earlier, people are saying in their assaying, they do not see many elements present in the gold; a lot of them are there but they are at very low levels. So, we use laser-ablation because it does not dilute the sample, it takes the pure metal up so those low levels are recoverable. Another thing about laser-ablation ICP-MS is with a time-resolved signal you can actually detect the inclusion – the inclusion then can also be an additional fingerprint, because, instead of gold with so much cerium in and so much aluminium in, you will see there is clean gold, and then suddenly a spot, maybe a micron or two in size, which contains aluminium and cerium and silicon and so on, and then you know it is inclusion of mineral, and that could be a fingerprint of the original deposit, if the mineralogy of the deposit is different to where it is stated to come from; so those are the levels that you go to.