

JORC Table 1: Just answer the question!

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The JORC Code is one of the most popular reporting codes in use for reporting exploration results, mineral resources and reserves. RSC research (intel.rscmme.com) shows that globally, and perhaps surprising to some, about half of the public reports are written following the JORC Code (2012). Each day, about 5-10 public JORC reports are published by listed companies (and sometimes private companies) that deal with drilling results, mineral resources, and reserves. In the last 12 months, about 944 exploration results (drilling only), 416 resource updates, and 52 maiden resources were reported under JORC. The public JORC reports contained the signatures of around 781 competent persons covering 57 different commodities.

A key component and requirement of the Code, when material changes are reported, is a feature called “Table 1”. This table contains a long list of technical subject matters that are required to be commented on by the competent person, the person taking responsibility for the information contained in these reports.

This feature was introduced in 2012, and basically addresses the issue of public reports not being forthcoming on important technical matters that may have significant implications for the evaluation of a project. Addressing each issue in Table 1 is mandatory, and it follows the principle of “if not, why not?”, you can’t not answer a question or say “not applicable”.

I read a lot of these reports as I take an interest in the subject of “competence”, which, after all, is one of the three pillars of JORC. I am interested to learn what defines competence, how it is measured, and how it can be improved. Why am I interested in this? Naturally, I myself want to qualify to be regarded as a competent person, and in order for you to know whether you’re competent (and in absence of common-sense solutions like a simple competency test or something), all you can do is see what else is out there to get even the most basic framework to benchmark yourself against. In the absence of another common-sense solution to *find* these reports, I designed a custom-built system to harvest them so that I could form a proper and balanced opinion on the matter.

After having read a few hundred of them in the last year or so, it became clear to me that the quality and nature of the answers given in their Table 1s has a high degree of variability. And soon enough, instead of being worried where I sit in this framework myself, I started investing more and more time in trying to understand the source and nature of weaknesses in the system itself, so that perhaps in the future, others will find easier paths to answer the same questions.

Don’t get me wrong, in general I like the approach of the JORC Code better than various other Codes out there (those mostly incorporated in the legal reporting structure of NI43-101) and to put significant emphasis on the principle of “the competent person” as a central feature in the JORC Code makes a lot of sense. But if we cannot benchmark the competence of our people, it all falls over. Self-regulation is not the way to govern this important and very critical part of the Code (I will be writing more on this issue soon). With this article I aim to identify and get some discussion on the scale and nature of the problem first.

Some people are quite adamant the system is working well, and are worried about over-regulating it when trying to resolve these issues. Others are adamant that as long as the “complaints system” is followed properly, there is no issue. I will address these arguments in a different article, but please read on and form your own judgement on whether we have a problem or not and whether our current systems

to deal with these issues is working. I would also love to hear from anyone who has actually filed a complaint on a technical matter in Table 1, AND actually had their complaint upheld by the committee. I hear that we can't discuss complaints with each other (although if you read clause 26d(j) of the AusIMM bylaws carefully, you could very well argue against that!) but if we cannot identify and publicly discuss poor performance then we will never be able to establish clear frameworks for good performance. In other words: we can't see where the bar is set.

In order to understand the scale of the problem, and whether it is something we, as the professional mineral industry community, should indeed take note of and do something about, I will start by asking a few questions:

What would happen if as a competent person, I would just write complete gobbledegook in the Table 1? I am not breaking any rules, although you would like to argue that it's not really a display of competence, which, after all is one of the three key pillars of the JORC system. Would anyone actually complain to the various institutions? Would the complaints committees actually take action?

Hold on, one step back. Does it really matter whether all of the entries in these Table 1s stand up to scrutiny? Do we really need to get excited about someone mixing up accuracy and precision? Will it make a critical impact on the soundness of the investor's decision? Aren't there bigger fish to fry? My take on things is that if those fundamental issues are confused and misrepresented, then what else is not right? Projects fail for a number of reasons, often through a complicated chance effect of a few smaller issues occurring at the same time, or amplifying each other. I've done enough audits to know when you've hit an iceberg and to start digging a bit deeper once you see one or a few of these smaller issues; you usually find a whole cascading network of small errors, ultimately leading to project failure. We talk a lot about the need for innovating in this industry to be able to get our industry back up and into the 2020's. It's not that I disagree, but I think devolution of skill is a much, much larger problem than lack of innovation. But I digress.

I need to call on examples to make my point, of course, which is the whole point of this article. However, this gets me on thin ice. So I want to be clear: I am not interested in naming and shaming. We all need to learn and that includes me (on too many points!), of course. But if no one is addressing the issue then I feel my own professional career and that of new professionals wishing to develop in this branch of our industry gets compromised. I spent many tens of thousands of dollars on courses, books and time to educate myself on this stuff and if I hear recent would-be clients telling me they chose someone else because they were cheaper, then these sorts of things start getting to me. Another fact is that people copy each other. Who hasn't downloaded a report to see what other people do? We simply have to insert a quality check here, so that we don't keep perpetuating bad behaviour.

The examples I am calling on were all pulled out of a few hours of sifting through our database during a random week in the life of JORC reports. They're not difficult to find. In fact, of some 18 reports reviewed for a random recent busy week, almost all of them have some interesting Table 1's for one reason or another. I could easily fill another 50 pages with more examples for the rest of the year that will make you frown. For those who still argue that this system is robust and working well, please read on.

DISCLAIMER: The origin and identities of the reports and its authors are not made available as I have no interest in having even more people shouting abuse at me (although there are also plenty that support!). I feel these are important issues to address and I also feel that the formal channels are not often working very well to address them, as best as the intentions of the volunteers that man these important committees are. I have the utmost respect for my fellow members of the organisations that I am part of, as they try and secure work in this tough climate, and I hope that my comments below will be used to start a discussion. I should also note that none of the below comments mean or imply that

the work that has been carried out for these reports or the projects they relate to is necessarily insufficient, defunct or lacking quality. I am also not saying that the people who have written these comments are not good at what they do; we all know how hard it is to get out there and find a balance between budget (the real one, not the one they promised you when you started), time, expectations of people up, down and sideways, and skills of people around you and others that you rely on to get your job done.

Let's have a look. I'll limit this to Section 1 in Table 1-only as this is where most problems occur. For each subject matter I refer to quotes from the reports and, following this I provide some comments on my issues with the statement made.

On the point of sampling techniques and representatively of samples (point #1 in the Table 1)

Report: "The drilling samples are deemed to be representative of the rocks being drilled because representative sub-sampling of both the drillcore was achieved"

I can't see how proper sub-sampling can make the primary sample representative?

Report: "Sample representativity is ensured through careful logging, and by selecting samples according to their matching lithological units"

How can good logging ensure that the primary sample is representative?

Report: "All drilling core is geologically logged, photographed, and mineralised zones are sampled with lithological control. Sampling and QAQC protocols follow industry best practice".

Same as above, photographing core does not mean it is representative. The misuse of the term "industry best practice" is prevalent throughout all subject items for all reports. The problem is that many practitioners don't seem to understand what industry best practice actually is.

Report: "Duplicates, blanks and CRMs were inserted into the sample series at a rate of more than 15%. Additionally, several sample batches have been sent to an independent umpire laboratory for analysis, and the results support the original results."

It's quite amazing to see the ease at which "hey, we've thrown in some standards, blanks and dups, so shuush, our quality (whatever that means, really) is superb" is rolled out. This information doesn't belong here, inserting a CRM has absolutely nothing to do with the representativity of the primary sample. We are talking about the nature and type of sampling and the Table template even provides an example too.

Report: "Drill hole collar coordinates are accurately surveyed by qualified mine personnel and integrated into the local mine grid using a surveying tool. Deviation surveys are completed on all drill holes using a handheld device."

I don't understand how the location of the sample says anything about the representativity of the sample? And there is actually a special section in the Table 1 to address sample location, so why put it here?

Report: "Each sample was collected from its corresponding main sample representing a one metre drill interval bag using a PVC spear. The speared sample is considered representative of the material drilled within each interval"

I am pretty sure that spearing isn't a particularly representative tool and this was realised some 20 years ago? But again, this is about the representativity of the original sample, *not* the sub-sample.

Report: "RAB drilling was used to obtain two metre samples from target horizons. The hole spacing varied from 500m to 1000m"

No comments on representativity? Any aspects of the determination of mineralisation that are Material to the Public Report? What does hole spacing have to do with it?

Report: "Collar locations were determined by GPS. All holes were surveyed down the hole, with surveys undertaken every 24m and at bottom of hole. Drill core was sampled at 0.25m to 1.2m intervals and was guided by geology. Samples preparation was undertaken at ABC Laboratories in Kalgoorlie. Samples were weighed, assigned a unique code and logged into the laboratory information management system. Samples were dried and each sample was crushed to >85% passing a 2 mm screen. A 200g split was pulverised to >85% passing 75 micron."

Pretty much none of this belongs in this section, and it deters from the question that has been asked. More dazzling with BS.

Report: "CRMs, blanks, and duplicates, were systematically introduced in the batches to the lab at a rate of 5%. The location of each drill hole was logged with a hand-held GPS and the coordinates were recorded on UTM WGS84, zone 31 north."

More of the same: just because you insert some standards and blanks, doesn't mean that you are collecting representative samples. The location of data has nothing to do with this.

What is missing from pretty much all reports I reviewed on this point on sampling and representativity is an explanation on how duplicate field samples can aid with assessment of representativity. Representative means it must be accurate and precise within acceptable boundaries. Therefore, comments on the prevention of incorrect sampling errors (ISE) are important here (correct metre delineation by the drillers, plucking effect in diamond core, loss of fines, etc). But also, the insertion of duplicates after you've already collected the sample tells you nothing about the precision of the sampling itself (other than that you can subtract this variance introduced by later splitting from the field duplicate variance). Twin drill holes (where practical), or duplicate field samples (second trench channel cut at same site, second soil sample at same site) are the way to assess this precision. This distinction is very important but I haven't seen any comments along these lines in any of the reports analysed in the last year or so.

Let's skip a few rows and move on to the point of drilling recoveries. The question in the Table is: Describe the method of recording and assessing core and chip sample recoveries and results assessed.

Report: The method of recording and assessing drill core samples was on a hand held Tablet using a set of templates supplied by Consultant.

It's not what we're looking for. How have you actually calculated it? We are not interested in how you put it in the computer? Have you weighed the RC bags? Have you measured core loss in trays per metre or core run? Etc.

Report: "Core recovery was determined in the standard way."

That's comforting to know but it doesn't answer the question. And, what is the "standard" way anyway?

Report: "For all RC holes, the geologists recorded the sample recovery as "good".

Again, that's comforting to know but it doesn't answer the question.

The next question to be answered is: Describe the measures taken to maximise sample recovery and ensure representative nature of the samples.

Report: "The measures taken to maximise recovery are to measure drill core length drilled vs core length recovered"

..... So, as long as I measure it, it will be maximised? This is the answer to the *previous* question and to me doesn't demonstrate an understanding of the importance and the nuances of the recovery issues.

Report: "Sample recovery is maximised by using best-practice techniques, the hammer is pulled back at the end of each metre and the entire one metre sample is allowed to clear back through the string. The riffle splitter is cleaned with compressed air at the end of each drill interval and at the completion of the drill hole. In the case of one metre samples a riffle splitter attached to the rig is used to collect the sample. Duplicate samples and a CRM are inserted every 15 m."

Ok, there is actually one relevant line in this section in this report, but why is it buried in all this other stuff that has nothing to do with this?

Report: "A field tech is always on the drill rig to monitor and record the recovery. RC samples were visually checked for recovery, moisture and contamination."

Recovery is important. Measuring it is important. Many Table 1's state (at least somewhere) that all work has been done according to international best practice. It depends on the type of programme how important recovery is so I am not sure if visual checking by a field techy is as good as weighing the bags. If the competent person thinks it is not important at this particular stage of the exploration programme, then she/he should state this.

Report: "The cyclone was opened and cleaned at the completion of each drilling run"

What information does this give me on the recovery?

Report: "All the samples were logged by the duty geologist at the site field facilities."

As mentioned previously, this is not the information that is asked; it says nothing about recovery.

In the above reports, what we really need to be told here is what was done on the drill rigs to make sure the entire metre (or whatever interval) comes up and ends up in the tray or bag. Use of drilling fluids in difficult or broken ground, air pressure control and dust control on RC rigs, specific entries in SOP's for how to deal with specific ground that is known to be bad, that sort of stuff.

The next question I do like because you see a lot of the same answers with clever word plays. The question is: Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.

Report: "No relationship is known to exist between recovery and grade, and no sample bias may have occurred due to preferential loss or gain of any fine or coarse material."

I like the way this is worded. Because the question allows you to avoid the question: did you actually assess it? Correct, if you don't investigate it, then it is not "known to exist". I guess the question could have been asked differently as this one opens the field for non-committal answers. You see this type of comment very frequently in Table 1's. There may be nothing wrong with it, but we're not helping ourselves here.

Report: "All the samples were dry, and all recoveries were all recorded as good".

Don't know what to say about this. Maybe this person was writing two reports at the same time?

Report: "There is no observable relationship between recovery and grade, and therefore no sample bias" (all other reports investigated made similar statements)

You would be happy to accept this of course, trusting the competent person's expertise and experience, but for the sake of that other important pillar called "transparency", I'd like to know what people have done to assess it and how confident they are that there is no issue.

I am not saying that this last statement is wrong or a breach of the code, etc. But what I do find interesting is the large percentage of reports that make this statement in comparison to what we know from our experience is a common issue: recoveries are quite commonly worse in the ore zone (depending on the deposit type, of course)! So, it doesn't gel for me and I would rather reword the question to make sure that competent persons state *what they have done* to review this.

The next question in the Table is: Whether core and chip samples have been geologically and geo-technically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies."

Report: "Samples were laid out in lines of 20, with chips collected and geologically logged for each 1m interval on a log sheet. The chips were then stored in trays and marked with hole numbers and depth intervals. Geological information was recorded directly onto hard-copy sheets, and later transferred to a spread sheet. The chip trays will be stored at the SriLanka office for future reference."

Report: "The detail of logging is regarded as appropriate for exploration drilling."

Report: "All RC chips and diamond drill core is logged. Logging records lithology, mineralogy, texture, mineralisation, weathering, alteration and veining...." (Etc, etc,.....)

Report: "Geological logging was completed for all holes"

Report: "Intervals were geologically logged directly into a laptop using a database designed to capture relevant data including grainsize, oxidation, rounding, mineralisation, colour, hardness and stratigraphy. All samples are photographed and chip trays are stored for future reference."

Report: "All holes were logged in full."

Report: "RAB samples have been logged considering the limitation of the drilling method".

Time and again, the question is simply not being answered. Ok, this particular one may not have as much as an impact but there are recent examples of how a misunderstanding of the geology has caused serious downgrading of resources (Rubicon) and that had to start somewhere. Geology is always the forgotten child and people run ahead of themselves without understanding the implications of the geological model. So, it seems fair enough that we, the readers of such reports, are informed of the quality of the logging. Sterk & Reid (2014) shows an example of how the level of detail of geological logging can have dramatic impacts on the mineral resource (available for download on our website).

The idea behind the question is for the reader to get an understanding of what the quality of the logging is to support geological continuity, and to be able to define appropriate domains, based on geology, for resource work.

The next section in Table 1 addresses sub-sampling techniques and sample preparation. Several points are required to be addressed here, such as: the nature, quality and appropriateness of the sample

preparation technique, the quality *control* procedures adopted for all subsampling stages to maximise representivity of samples, and measures taken to ensure that the sampling is representative. I should note that I believe there is a small error in the text in the Table 1 document here. Instead of “control” (see italic above) it should read “assurance”. This shouldn’t keep authors from making proper statements, however, it opens the doors to incorrect answers:

Report: “Quality control procedures were applied for all subsampling stages to maximise the representivity of samples by inserting commercial certified reference material (CRM)”

You can’t maximise representativity of sub-sampling by inserting CRMs (not the typical pulp ones that is). And *if* you could, then you can *measure* it, but then it is your quality assurance programme that instructs how to properly split and pulverise a sample that *maximises* representativity. This is not just a matter of tomato-tomato, these are important conceptual understanding issues. In addition, a CRM measures analytical accuracy (and can also be used as a measure of analytical precision, although it depends on what you interpret “analytical” to mean) and has nothing to do with the sampling and preparation stage that we are instructed by Table 1 to talk about here.

Report: “Three different grades of CRM for Vanadium mineralisation were inserted....”

Report: “CRMs were purchased at African Mineral Standards. The blanks samples were taken from a local barren basalt in a quarry near the mine”.

As above, this doesn’t have anything to do with the sampling and preparation stage.

Report: “CRMs, replicates, pulp duplicates, and blanks were routinely inserted at every 12 samples, and also immediately following visually identified mineralised intercepts to provide assay quality checks. Review of the standards and blanks show that results are within acceptable limits.”

Same as above, CRM’s don’t tell you much on sample preparation, we’re not looking for comments on “assay quality checks”, there is another section for that. I don’t know what they mean by replicate and duplicate samples, as a replicate is something different than a duplicate and explorers usually only deal with taking duplicates. Blank samples may add information on representativity but only if they’re coarse blanks (we’re discussing sample preparation stage here) and this information isn’t provided. The fact that the CRMs and blanks are within acceptable limits doesn’t tell you anything on the quality of the sample preparation process.

Report: “The sampled core is assumed to be representative of the core as a whole”

I can’t even begin to work out what this means, really.

Report: “blank.....” (x 2)

You can’t do that, you have to answer the question.

Report: “The RC samples were all dry and obtained using a cyclone splitter mounted on the drill rig, which is considered appropriate and industry standard.”

Can anyone tell me what a “cyclone splitter” does? I haven’t heard of it before. It doesn’t answer the question either. Ye ol’ “industry standard” is here again.

Report: “Field duplicate samples were collected at a rate of 5.6%, and consist of ¼ core taken from the remaining ½ core.”

People talk about “industry standard practices” and I guess that this gets done the world over (which indeed would make it “standard”, unfortunately), but it is not actually an appropriate way

to assess precision due to the volume variance issue. It is much better to take two ¼ cores and leave ½ core in the tray. You can simply average the two ¼ core values to get a primary assay value for your database. It is also not actually answering the question.

Report: “The sample collection methodology is considered appropriate for RC drilling and is within today’s standard industry practice. One metre sample split results are considered reliable. RC samples are split with a riffle splitter at one metre intervals. Analysis was done by ABC Laboratories in Townsville. At the lab samples are dried, crushed and pulverised until the sample is homogeneous. The analytical technique for gold is 50 gram fire assay with AAS finish.”

Saying that a one metre sample split result is simply “considered reliable” is not what the Table is asking us to provide. The analytical technique should not be discussed here, that is for the next section.

Report: “International best practice has been assumed for the historic sampling.”

Another very courageous statement. Proper QA and QC is something of the last 15 years, really, and it’s clear that even today you can’t just assume stuff. This is why we have the Table 1 for instance, and this is why I am still writing about this stuff. What would be better is to state that it is unknown, then at least you are not misleading investors and you’re being transparent. In absence of QC data for historic drilling, an idea of the QA at the time, or results of check sampling, I think you should really assume the opposite.

Report: “All subsampling was carried out by commercial laboratory and are regarded to be satisfactory”

If you’ve walked the floor of a few laboratories, this is another courageous statement. It may be fair enough to make some assumptions here if you’re working with an international ISO-accredited group with good management, but I would suggest that you at least add that the laboratory preparation process has not been audited or reviewed and that the proper implementation of otherwise sound SOPs by the lab could not be verified. The point is that if you just assume everything is ok, then why even bother with Table 1?

Report: “A cyclone was used for the collection of bulk samples for drilling interval (1 metre). Most samples were dry and were observed to be of good quality. Each sample was collected from bulk sample bags using a PVC spear. The speared sub-sample is considered to be representative of the material drilled within each one metre interval.”

I don’t know how it is possible to simply *observe* that a sample is of good quality. Good quality means accurate and precise. Accuracy and precision must be measured and you can’t just eyeball it. And I’ve mentioned the spear before. This is not industry best practice and most certainly doesn’t provide a representative sample.

Report: “Samples were split by rotary splitter mounted on the rig to a sample size of three to five kg for dispatch to the laboratory”

I haven’t worked with rotary splitters on an Aircore rig before, keen to see one in action! This was the only comment in this entire section and fails to answer another five questions.

Report: “The entire air core sample was collected and all material dried, crushed, screened, homogenised and split. Samples for analysis were prepared at intervals varying from one to four metres, in compliance with the geological description.”

This is all the information presented on this subject in this report. It is missing the mandatory comments on sample size suitability, quality of the process, and others. I am also not sure why samples get screened before they are split. What is screened and doesn’t that create a bias?

The information that is required here is in fact very important to get right. We have already addressed issues with accuracy and precision of primary sampling in an earlier section, now it is time to demonstrate that what we're doing with that large primary sample to get it to a small-enough size for the lab to suck an "assay value" out of it isn't actually going to affect its accuracy or its precision. As I mentioned in the various comments, we're therefore not looking for information on field duplicates or CRMs. If we take a classical example of a gold operation, drilled by RC, then the first split (on the rig through a cone or riffle splitter usually) is where a lot of "error" comes in. These can be classified as "incorrect" and "correct" sampling errors and we can measure some of these by taking duplicate samples each time the sample gets split. Even better, we can indeed *optimise* part of the precision by carrying out heterogeneity studies and working out how large our sample needs to be to minimise error. When the sample gets to the lab, it gets crushed, split, pulverised and split twice (usually). Each time an error gets introduced, and this error may affect accuracy as well as precision. Comments in this section should therefore contain comments on the second-split duplicates, sample nomograms to define proper splitting weights and grain sizes, proper application of laboratory SOP's, results of lab audits, etc.

There's also an important question on sample size in this section. Now, this is slightly confusing as we're addressing *sub-sampling* in this section and the Table 1 would be better to use "sub-sampling" (rather than "sampling") here to avoid confusion. From the review of reports:

Report: "No issues have been identified with sample representativity. The sample size is considered appropriate for this type of mineralisation."

Report: "With respect to the deposit type, mineralisation style and the sample size, the use of full core is considered appropriate."

Report: Drill sample size is considered appropriate to correctly represent the pegmatite mineralisation.

So, indeed, this doesn't discuss the actual *sub-sampling* size but the original sample size (or does it?). These statements also do not answer the question, or answer the wrong question. Some knowledge and understanding of the sampling theory is required here, and the key is to discuss the relationship of sample size and grain size of the sub-sampled material with the fundamental sampling error (FSE), which has a large impact on variance between samples, and ultimately on the confidence in estimation. We're not expecting people to roll out a sample nomogram or full-on heterogeneity study at early levels of exploration but as a minimum we need to know that extremely coarse grained gold or heavily clustered mineralisation styles (as was the case in one of the reviewed reports!) have been sampled with appropriate mass, or after sufficient reduction in grain size, both of which reduce the FSE. Just stating that they are considered appropriate may "tick the box" but requires the assumption that the competent person understands what is required here, and from the above report statements, to me it isn't clear if they do.

Report: "The sample size is considered to be appropriate to correctly represent the mineralisation style, the thickness and consistency of the intersections."

Same comment as before, but here I also don't understand what the last bit of that line means.

What is missing from pretty much all reports on this point on sample preparation is a demonstration of understanding of how duplicate samples aid with assessment of representativity. I made this comment earlier on about the representativity of the primary sampling (first item) and it applies here again. The point is: by just inserting the duplicates you are not doing anything to measure or maximise representativity. You need to actually analyse the data and then draw conclusions from it. In the case of sample preparation, for most situations this will mean the fairly standard "second split/coarse split" and pulp duplicates at the laboratory. Analysing this data will give you an understanding of the proportions

of the variance that get introduced at this stage, which will then allow you to optimise, or at a minimum improve the process. Fair enough, at early-exploration stage this is not really a done thing but I think we should then be clear about this in our commentary in Table 1.

Now we get on to the analytical section. Here we are supposed to put information on the analytical techniques, which for most people is a copy-paste out of the laboratory quote and probably sufficient. I note though that there is a requirement to comment on the *appropriateness* of the technique and this doesn't usually get answered, or at least nothing more than our old friend "this is industry standard", which for me isn't good enough for reasons outlined earlier. For instance, a standard 30g fire assay on a potentially very coarse-gold containing deposit could well be very biased and a screen fire assay may be more appropriate. Or, material containing a lot of copper may well need a different flux at the lab for fire assaying and the commercial laboratories have no obligation to work this out for you. Confusion exists on the charge weight for a fire assay: explorers often swear by large charge weights (50 grams) instead of 25 grams because they have heard that a larger sample is better (reduces FSE). However, a larger sample in the same pot reduces the flux and may cause fusion problems. You need to do some testing before you decide on what is best. These are the issues that need to be addressed here and in my opinion, just stating "industry standard" is simply not enough.

The next section involves comment on the nature of quality control procedures adopted (e.g. standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (i.e. lack of bias) and precision have been established.

Report: "CRMs with a range of values, and in-house blanks are inserted at a ratio of 1:20. No duplicate samples are taken as half core samples are submitted for assay."

Just inserting them doesn't tell us much about the accuracy or the precision of the analytical process. You need to analyse them and then present the public with your interpretations or conclusions. I don't understand the last line and don't know how it answers the question, so I am not sure if an investor does: Duplicates of core are not relevant for analytical precision. And as mentioned earlier, it depends on one's interpretation of "analytical precision" to see whether pulp duplicates provide this information.

Report: "All samples were assayed for gold by 30g fire assay at the ABC laboratory in Perth. At the lab, regular repeats, standards, checks, CRMs and blanks were inserted and analysed."

This does not answer the questions in this section. It says the results were analysed but there are no comments on the results. Also, a repeat is something different than a duplicate and doesn't get "inserted". I also don't know what the difference between a "check", a standard and a CRM is. To me these are all the same.

Report: "QA/QC samples (blanks, standards and duplicates) were inserted in the sample sequence at a rate of better than 15%".

Other than it not actually answering the question, the other comments in this particular report were passable but I have a problem with the term "QAQC sample" that many people use. It is a QC sample, QA is something different.

Report: "QA/QC samples, including CRMs, blanks, and duplicates were systematically introduced in the sample series to the laboratory at a nominal frequency of 5%.

Same as before, a "QAQC sample" doesn't exist but more importantly, it doesn't answer the question or provide the required information.

Report: "Internal laboratory QC procedures have been adopted."

This is vague, and it doesn't even remotely answer the question. There is nothing in this statement to give readers an overview of the company's understanding of the quality of its assays. You may as well delete all comments in all sections of the report and say: "the work was carried out by a competent person and followed industry standards".

Report: "Analysis was carried out by ABC Laboratory using the AB1 method. Internal laboratory checks were reported with assays"

This is all that was provided by this report. Doesn't answer any of the questions.

Every week I see several reports where the concepts of accuracy and precision are poorly understood and sometimes even mixed up. These principles go to the core of the evaluation of a resource and must be understood to be signing off on such reports. Monitoring of laboratory accuracy starts by an understanding of process control charts, which I only in rare cases see applied correctly. There are still many practitioners that use incorrect statistical methods to assess whether their CRMs are actually showing that the process was in control and that no special cause variation was present. Following this crucial step, the determination of bias doesn't often go further than arm-waves based on experience and eyeballing a process control plot. Calculation of actual precision figures almost never gets presented and scatterplots and maybe sometimes HARD or MAPD plots are provided. These are all very basic tools to quantify precision and we can do much better than that.

Next follow the section on data verification, where the questions are not complicated and just require people to state whether they have used twin holes or whether they had independent auditors review and verify the data. Most of the information I reviewed for this random week was passable, if not very marginal. There are still occurrences of questions not being properly answered in this section.

This is then followed by the section on location of data points. These are also easy questions and don't require much technical reasoning. However, various reports do not include statements on downhole surveys and that is an important requirement to understand quality of locations of samples. There have been several studies demonstrating the huge deviation of deeper drill holes and also the difference between various methods of measuring this. If it is not important because it is green fields scout drilling, then that may well be so, but in this case: state this so that things are transparent and we are informed!

The next section on data spacing is also relatively straight forward; no technical reasoning required and just answering simple questions. These get answered by most reports I reviewed, but on the important question whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied, the answer provided by one report was:

Report: "No resource or reserve estimation procedure has yet been applied."

This doesn't answer the question. It leaves room for interpretation. Maybe more drilling needs to be carried out before there can be a resource. This will have a major impact on the budget and to make the decision whether to invest in a junior company, this can be decisive.

Following this, the orientation of data in relation to geological structure is required to be discussed. The question is whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which is known, considering the deposit type. Most of this comes down to common statements that the drilling was pretty much perpendicular to the strike-dip plane, or variations thereof. Although some reports are not that clear:

Report: "The sheared sediment sequence displays a SSW trend. The tenements are contiguous and the sampling programme was designed to provide, as best as possible, an unbiased location of drill sample data."

I am not sure how to interpret this answer and I can't see how the contiguous nature of the tenement package is relevant.

Report: "The RAB holes were located at the eastern side of Blanketville Range within the potential geological unit, which is sub-horizontal."

Apart from the definition of the "potential geological unit", it doesn't answer the question. Yes, it may be deduced and easily assumed but there is a lot that goes missing in translation with these matters and it is important to be clear.

The section on sample security is also pretty straight forward, so not a lot of surprises there, you would think. The task is to simply describe the measures taken to ensure sample security. However, the following statements were interesting:

Report: "Samples were bagged in appropriately numbered bags and then sealed. A sample ticket with the sample identification was put inside the sample bag"

This doesn't answer the question at all.

Report: "Samples bagged and provided with a label by ABC personnel"

Report: "Company contract geologists and technicians conducted all sampling and storage in the field. Samples were then delivered via road freight to ABC laboratories in Townsville."

Report: "Samples were dispatched from site using a reputable commercial courier service to deliver samples directly to the laboratory."

None of this tells much about the security. I recall a certain geologist who used to work for a certain company starting with the letter B, who would have also bagged and stored his own samples.

It is fair enough to not have to write a book here but when it comes to security, it is important to establish who may have had access to the samples at any stage and how accountability works in the chain of custody of the samples. Only two out of 18 reports mentioned the term "chain of custody".

I'll stop here.

Section 2 on Exploration results follows and there are plenty of points to talk about here too. I have focussed here on some purely technical issues that are critical in the proper evaluation of exploration or resource development results.

At worst, some reports have pretty much failed to answer most of the questions correctly or sufficiently. Of course, it should be said that there are examples of some exemplary Table 1 submissions out there, but, after this research, I am quite amazed to see the number of reports where comments can be made. This review only involved reports for a bit more than a week! From my experience with reviewing hundreds of reports in the last two years, I would say at least 60% have issues with the following:

- not answering the question at all;
- providing comments, but actually failing to answer the question;
- providing the wrong information in the wrong section;
- statements of "industry standard" as an answer on quality related issues; and
- technically incorrect statements.

As I explained, the current way the system is supposed to work is that:

1. someone (anyone) who is technically competent reads the Table 1 in enough detail and identifies the issues;
2. that person files a complaint with the relevant institution of which the competent person is a member;
3. the complaints committee reviews the complaint and takes action.

In my view, all these steps are designed for this system to not work, at all.

Step 1: we're talking about competent people who have time to review Table 1s. Where's the incentive? Who has time to do this, really? Who has the skill? Who has skill AND time? It's just not going to happen.

Step 2: filing a complaint takes time and is terribly dissatisfying as you don't get any feedback on your complaint and that's not very rewarding, nor does it build any understanding of what the complaints committee deems acceptable or not. There's not tangible incentive here either, really. I should add though, that the AusIMM seems to have recently upped their game and has been providing feedback to complaints.

Step 3: the complaints committee requires the effort of volunteers. They all have busy jobs. Are they going to reason with a competent person on what accuracy and precision is? Do all of them know themselves?

I therefore conclude that you can write whatever you want in Table 1 and no-one will take action. As long as you fumble an "industry standard" in there every now and then and sound nice and technical, you'll be fine.

Table 1 was supposed to be the improvement to the Code but without appropriate enforcement of technical compliance there is a lack in the effectiveness of the Code.

Our standards for just about any little component or sub-step in the entire resource process are ridiculously high. It is interesting that our limits for that critical last step (reporting standards) are very low to non-existent. I just don't get that.

Maybe we should introduce gobbledegook as a proper "JORC term" and give it a capital G. Then it will all be fine (unless you don't use a capital of course!).

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