Comentários sobre o Desmonte de Rochas com Explosivos

Blasting result evaluation (Part 01)

Por Bruno Pimentel.

Hello my friends, as always, we start by leaving here the link to our Newsletter, so that those who are new can have access to our previous articles, as well as ask you to subscribe, because this way you will be automatically notified with each new article:

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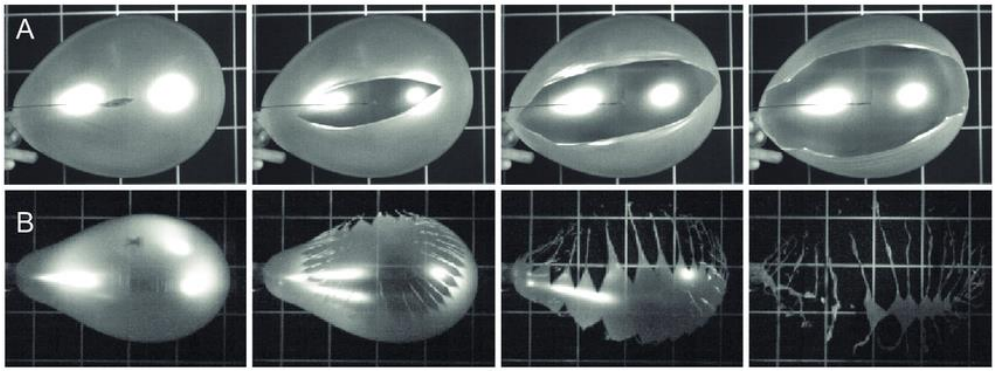
In the last article we commented a little on the two main ways of popping a balloon and the behavior of the balloon, or its material, after it pops, and we saw that when we pop the balloon with a sharp object, creating an escape point for the gases , all the internal air pressure inside the balloon is directed to that point, causing all the damage done to the balloon to be created from that point, whereas when we inflate the balloon until it bursts, we distribute the internal air pressure along of the entire balloon causing much greater damage, and we saw that this is very similar to the rock blasting process, where when we have points of weakness, we will have energy escape through these points, while when we have balanced confinement, the gases of the explosive will work longer, increasing energy consumption efficiency.



Thinking about this comparison, the examples of what many call a “perfect blast” always come to mind, such as the example in the photo below, where we see the material “just inflate” and then settle perfectly in the square, without big bangs, and the gases look just like a small cloud of dust that seeps out between the fragments after they settle out of the ground.

This type of blast is what aligns perfectly with the concepts related to the example of the balloon burst, where the energy of the explosive was equally distributed and confined, to the point of maximizing its use, so normally in these cases we have the maximization of the use. of explosive energy in rock blasting and lessening of unwanted effects. But we need to understand that this type of blast or result is much more focused on the balance of the parameters of the blast plan than for a perfect blast, because to evaluate the “perfection”, or better saying the result of a blast, we must first evaluate what we want from each one.

This is a very important point, because it's no use having a “balanced blast” or technically perfect, even if it maximizes the performance of explosives, if it doesn't deliver what we need.

To exemplify this better, please disregard the ideal scenario, and let's open a parenthesis here, and imagine a balanced, technically perfect blast, in which to facilitate understanding, we can say that it has 500 kilos of explosives, where we can take advantage of an 80 % of its energy, and so we can say that we took advantage of 400 kilos of explosive, but because of the need for greater fragmentation, or more specifically a greater % of fines, we decided to reduce the stemming and drill pattern, and now we have 1000 kilos of explosive, but that will generate greater ejections and waste, and this will make the use drop from 80% to 50%, but as we have a much larger quantity of explosives (1000 kilos), we will have the effective use of energy equivalent to 500 kilos, that is, 100 kilos more than the previous situation, and this, despite bringing us a great waste, can deliver a fragmentation or % of fines better than the balanced blast.

This may sound crazy, but this improvement in fragmentation or fines % can bring 10 times more benefits in the later stages of excavation, transport and treatment of the ore, so despite the great waste and the blast that is not technically perfect, we have a global situation that brings us more benefits and better results.

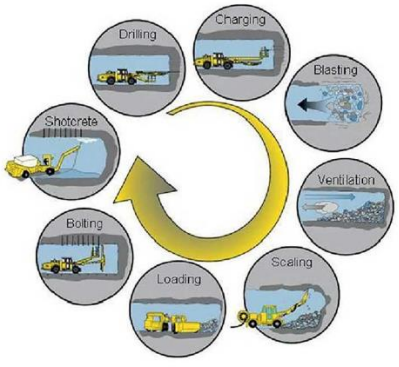
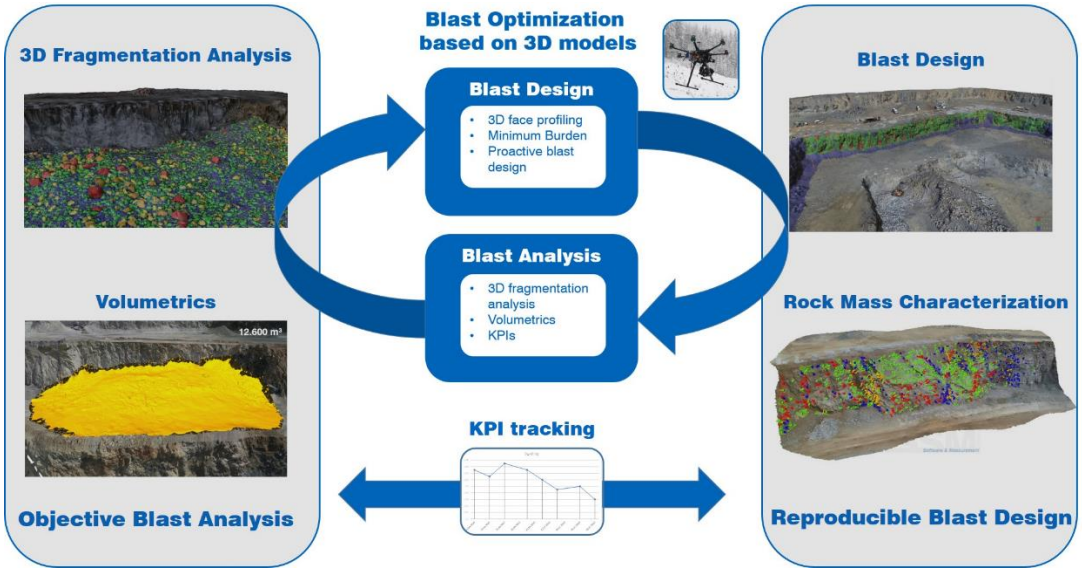


Figure 3: Typical mining drill & blast cycle

So in practice, we need to understand that there are two situations that refer to the quality of a blast, where the first refers to the technical quality of the blast, where the parameters are in balance and we maximize the use of explosive energy, and on the other, we have the quality of blast's results, which must be aligned with our needs and objectives. And this is important to be clear, because our improvement path must be to ensure that our blast delivers

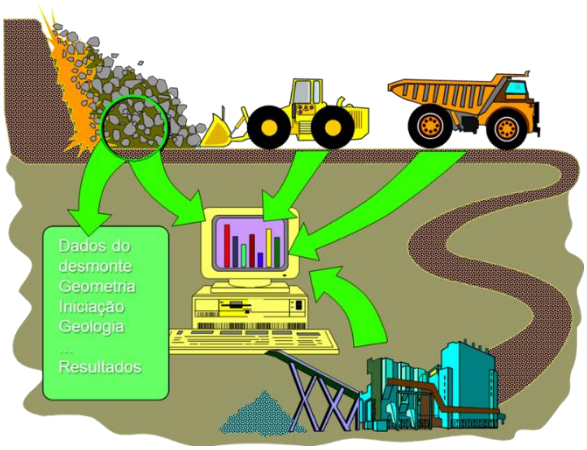
the results we need, such as fragmentation, stack format, damage control, etc., and after that, we need to seek the optimization or balance of the parameters, so that it delivers these results in the most optimized way possible, that is, at a low cost, maximizing the use of the explosive and ensuring safety.

So, going back to our example, what we will do is try to adjust our parameters again, so that the use of explosive energy increases from 50% to 60%, then to 70%, and so we can reduce the amount of explosives or increase it even more fragmentation, which will bring us even more benefits in the process, I increase the ratio from 10 times to 20 times or more.



So at another time we will talk about the process of optimizing the parameters of our blast, that is, about the technical quality of our detonations, where we will talk about the “perfect blasts” or “balanced blasts”, as they are a model type of blast to be evaluated and taken as a reference, where we normally have all the parameters of our blast in balance, but we must always keep in mind that in all detonations there are a number of uncontrollable factors, such as when we have an extremely hard rock and fractured, with open and interconnected fractures (like a balloon that suffers several punctures), where naturally we will already have an uncontrollable escape of gases, and thus it becomes very unlikely that we will be able to perform “balanced or perfect blasts”, so we will not always be able to reach this kind of blast, and that doesn't mean our blast is bad. So I ask the "perfectionists" to have a little patience with me, because in today's article we are going to make some comments about the practical way of evaluating a blast, which is based on the concept we call "ideal blast".

So in this article we will leave the technical quality of the blasts on hold, and we will focus on evaluating the results of our blast, and for that, first it needs to be clear that we can evaluate the results of our blast in several ways, from simpler examples, as in civil works, where we can have very specific blasts, to remove a block of hard rock, in the middle of a road construction, which the objective is only the removal, or we can have more complex processes, as for example, in mining, where the blast can represent the main step to enable the extraction of rock, as well as being directly related to the performance of the production chain, and its results will influence all subsequent processes, and therefore we will need to carry out a much more complete evaluation, to ensure that we are reaching the minimum objectives for the entire process.



With that in mind, to determine the proper way to evaluate each blast, we first need to be clear about the scenario and type of blast we are going to perform, and especially the needs and objectives of our blast, which can vary completely from one blast to another. That is why we will consider the “ideal blast” to be the one in which our objectives, previously defined for the rock blast carried out, were achieved, without having any unwanted impact or that exceeds acceptable limits. And taking this as a principle, the optimization process of any operation must first focus on delivering the objectives and needs, and then on optimizing the parameters, but of course, the two processes can go in parallel, ensuring increasingly efficient blasts.

Thus, the evaluation of a blast will always be linked to the scenario, needs and objectives of our operation, where these points are decisive in the choice of factors and techniques that we will use to evaluate the results of any blast. So we can have two very similar blasts, even in the same operation, which can be evaluated differently, according to their goals, and in the same way, we can have two very different blasts, which have the same goal, and so the criteria assessment can be the same.

Our blast objectives should serve as a guide, both when preparing our blast plan, as well as in determining the factors considered for the evaluation of a blast, and it is the fulfillment of these objectives that will indicate whether we have a “perfect or ideal blast”, because in practice it is useless to have a blast that complies with all the theoretical precepts and does not deliver the necessary results.

Depending on the operation, we may have variable or specific objectives, which will be more important, and so in each blast we can carry out different evaluations, based on the objectives of each one. A typical example of this situation is when we evaluate some civil works, such as the construction of a road, where we can do a simple blast to remove a rock head that is in the middle of the road, and the objective will be to remove the material from the local, but at another time we may want to make a similar blast, only this time we are going to use the material to make a landfill, and so we may want the material to have a coarser fragmentation, or we can still make another blast in which we want to take advantage of the material to produce gravel, and thus in the same operation, we can have blasts with very different and specific objectives, so in each of them, we will evaluate its performance according to these objectives.

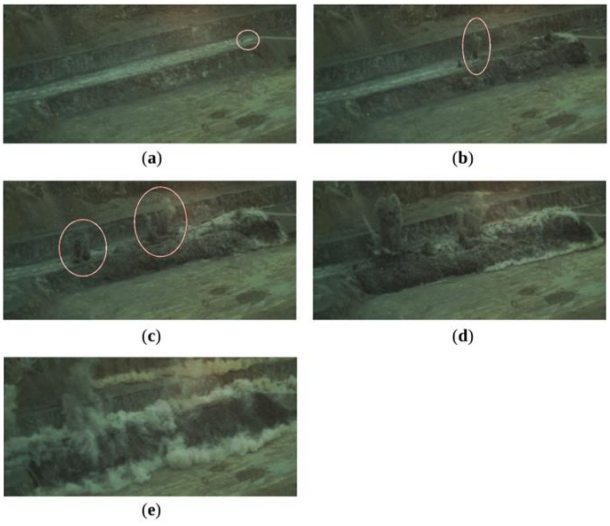
On the other hand, in addition to these specific goals, we can have some constant goals, where for example, we can have the goal of not exceeding a certain vibration limit or controlling the shape of the material pile to suit the equipment that will do the excavation, and so we can have variable goals and others that remain constant, regardless of the blast we perform.

Unlike civil works blasts, which usually tend to vary greatly in scenario and objectives, in mining it is common to have fixed primary objectives to meet the demands of the process, so for example, in an operation we may have the need to deliver a specific fragmentation range, in an underground mine we may have an acceptable limit of damage to the massive remaining in the development blasts, and in another, we may have to perform launch blasts, with the aim of launching the material great distances to discover the mineral layer of interest, so that in all blasts we will have to comply with the primary objectives established and we will need to monitor these parameters in all of them. But also, in addition to these primary objectives, we can have variable objectives, where for example, we can perform some blasts closer to a structure or installation, and so we will need to control the levels of vibrations, so what we will have, is that in all blasts we will evaluate our primary objectives, and in blasts close to risk areas, we will also assess vibrations or damage to structures.

Just to reinforce that we can have several primary and fixed objectives, not just one, and in addition to them, we can have a series of variable objectives for each blast, such as avoiding the release of material in a certain direction, so as not to close an access, or separate parts of the blasted mass, aiming at dilution control.

We need to know well what our objectives and needs are, in order to establish the evaluation methodologies that we will use, as well as remember that some of the objectives of our blast can be contradictory, such as the need for greater rock fragmentation, while we need to limit vibrations and damage to the massive remnant, so we will need to determine a balance between the objectives, so that we can conduct our blasts in a way that we have that balance in the results.

Although we will talk about this in other articles, in addition to evaluating the results of our blast, we always recommend carrying out a general evaluation, no matter how simple the blast, which aims to make us have a better understanding of what we do, and so we can evaluate what we will do for the next blasts.



In this way, at the end of each blast, we must review the records we made, analyzing the blast plan, additional information about the blast, the observations, images and videos that we have available, so that we can compare what we had planned, with what actually performed, and what the results of that were.

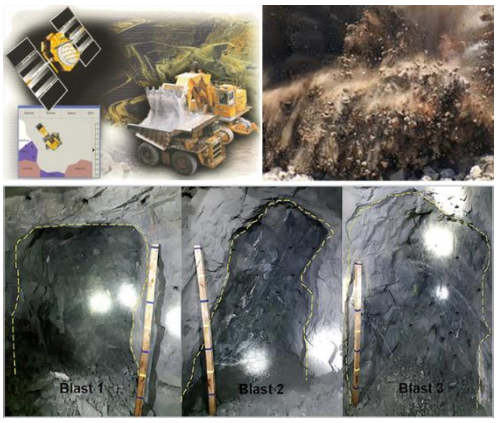
Then we cannot forget that an efficient operation will be monitoring the entire process, so we need to follow the excavation of the material, because the inner part of the pile of fragments can reveal much more information about its result, than just the external part, in the same way that we must evaluate the contour of our blast, the processing of this material and the performance of all the following steps. And as we always say, the blast is only finished when all material is excavated and processed, to ensure that we provide the following steps a safe operation and within the necessary specifications. Remembering that the results we deliver will be decisive in the performance of these activities.

Finally, regardless of any objective we have to achieve, we need all blasts to be carried out safely, without causing material, environmental or people damage, and this is the only objective that is non-negotiable. So we will definitely talk about this specifically in several other articles, despite being a topic that needs no comments, as ensuring a safe blast should be an imperative point in the decision to perform any blast or not.

So in summary, it needs to be clear that we must use it to evaluate a blast, these are the objectives that were previously established, and that we cannot compare the result of two blasts that have different objectives. Likewise, it is necessary to find a balance between the different objectives, considering those that are a priority in each blast, as this should influence both the design and the evaluation of the final results.

Therefore, we bring here a list, with the main practical criteria used to evaluate most blasts, and we will make a general comment about each one of them in our next article, considering that there will be numerous possibilities to relate them.

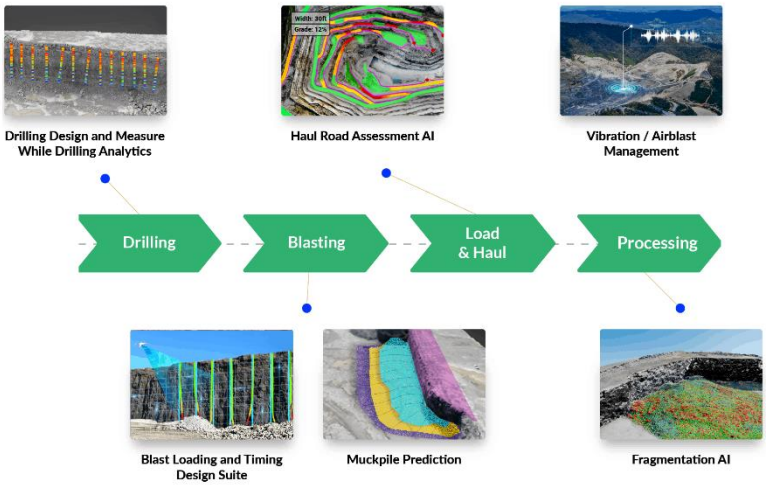
- Fragmentation
- Secondary Blast
- Excavator productivity
- Truck filling factor
- Treatment Plant Performance
- Dilution
- Remaining rock massif
- Safety and Environment
- Costs



For this, it is important to keep in mind that the same objective can have several evaluation criteria, some quantitative and others qualitative, and this will be related to the specificity of the objective, and in addition, that we may have the need to always improve some of these objectives, such as fragmentation, which some processes may need to be increasingly thin, and as much as we have a good result, we will always have room to improve, while other objectives may be more specific, where, for example, we can have a maximum productivity of the excavation equipment, according to its capacity, so when reaching the maximum point of this productivity, any extra effort can only harm the other objectives, such as the generation of unnecessary costs.

Forgive me, but I will open a comment here, because it is incredible the number of operations that in general are not clear about their objectives, and this makes the “ideal blast” pattern impossible to achieve, because if I I don't know what I want, I won't know what to do to get it, just as if we don't know the destination, we can't choose the path to get there. So, for example, thinking about mining, the first step to design, evaluate and optimize any blast is to have clear objectives, where ideally we will start at the end of the processes, evaluating what the final product is, what are the steps that are carried out and the that each step needs to be maximized, and from there I determine the goals of my blast, then based on them, we design, execute, evaluate and optimize, until we reach a balance point.

This of course is related to the concepts of “Mine to Mill” or “Mine to plant”, which is a very broad topic that we will cover in other articles, but it is the basic principle for defining the objectives and evaluation of any blast, which can be limited to basic initial goals, such as just material removal, or it can be as broad as maximizing all processes in a mine.



Well, that's it my friends, we don't want to extend this initial part too much, so as not to seem like a " stuffing the bag", in our next article we will be talking about each of the main objectives that we can have as a reference to evaluate our blasts.

As always, we hope that these articles are being useful and that they awaken operations to better evaluate your blasts and thus optimize your processes. We are also open to suggestions for topics that you believe can help improve the standard and safety of blasts.

Please comment and share, so that we have more and more safe and quality blasts!!

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