Technical Bulletin

Information from Phibro Technical Services

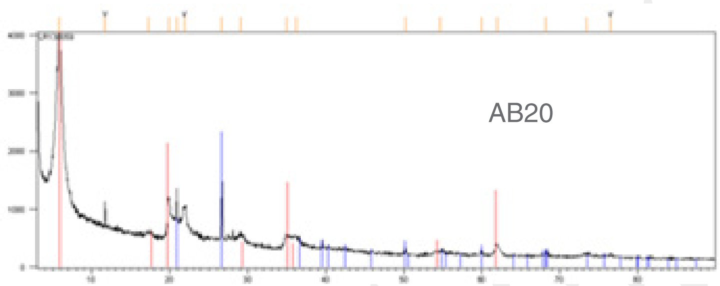
Not All Binders are Created Equal

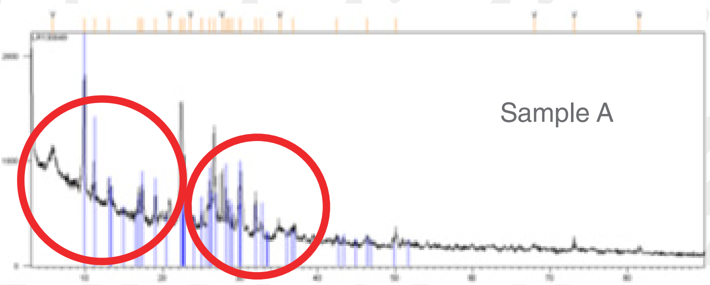
Overview

- Every HSCAS (hydrated sodium calcium aluminosilicate) deposit is different
- Efficacy is dependent on the crystalline structure that is present
- *In vivo* data is usually the best indicator that a particular product is efficacious
- Monitoring the crystalline structure of a proven deposit ensures consistent performance

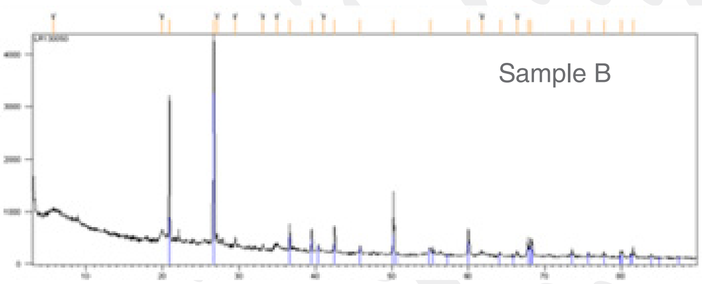
Typically, minerals can be characterized by describing their elemental composition and physical characteristics. Hydrated sodium calcium aluminosilicates are an exception. These parameters do little to reveal the properties that impact the efficacy of binders used as animal feed additives. When measuring parameters like cation exchange capacity (CEC), surface area or porosity, it is important to realize that these provide little information when trying to predict a binder's efficacy.

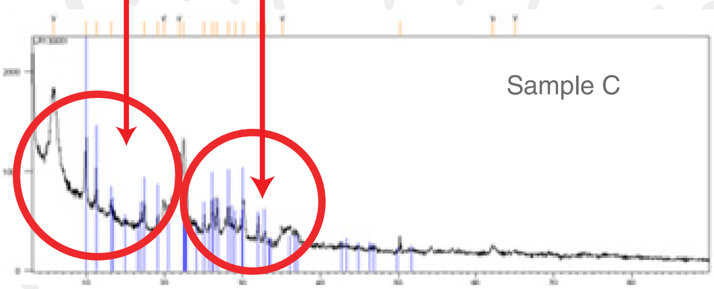
Physical Composition. Crystalline structure is a good way to characterize and differentiate HSCAS products. One of the best methodologies to evaluate crystalline structure is X-ray Diffraction (XRD). The diffraction patterns are indicative of the crystalline structure. XRD shows that AB20® contains one primary crystalline structure that is responsible for its efficacy, backed with *in vivo* data. The other samples tested did not contain the same concentration of this unique structure, as shown below.





The AB20 sample (above) shows a pattern indicating that the sample is primarily a single crystalline structure, whereas Sample A and C are made up of various incongruous structures.



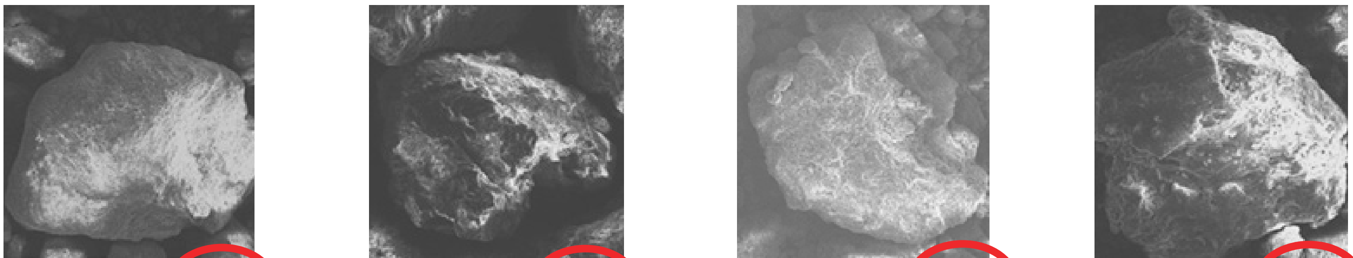


Sample B (above) XRD shows the primary presence of quartz. Further chemical analysis shows that this sample also contains clay but there is not enough of any one crystalline structure to show up on the XRD pattern. The analysis determined that this sample is primarily amorphous silica (a large component of diatomaceous earth), which is invisible to XRD.

Samples A & C (above) look very similar. The complex patterns, shown circled, indicate that there are a number of clay structures present. These are not pure samples as represented by the many peaks in the XRD results shown above.

Physical Characterization. Scanning Electron Microscopy (SEM) is used to determine a sample's surface topography and composition. An electron microscope produces images of a sample by scanning it with a focused beam of electrons, which interact with atoms in the sample. The images in Figure 1 show how much magnification it took to get one particle of each sample into a frame. AB20 is considerably finer than the other samples, as shown by the five-fold magnification needed over most of the other samples. This fine particle size improves the distribution of the product to better support efficacy.

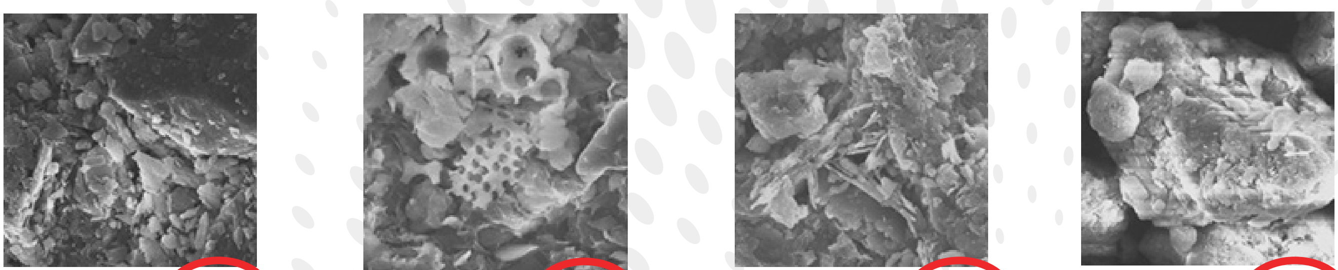
Figure 1. SEM at a magnification showing one particle of each of four different samples in a frame



Sample A 250x | Sample B 250x | Sample C 350x | ***AB20*** 1000x

Increasing the magnification to 8000x (Figure 2) allows you to see the details of the surface of the particles. As you look across the samples, you can see the platelets, like fish scales, that are characteristic of HSCAS. AB20 shows an ordered, compact, tightly layered structure that is indicative of high purity clay. Samples A and C show a variety of platelet sizes and shapes, confirming the XRD results that show the presence of multiple crystalline structures. Sample B, below, shows the presence of perforated particles that look like honeycombs or cylinders. These are particles of diatomaceous earth (DE). The SEM, combined with elemental analysis and XRD, tells us that sample B is primarily DE with measurable amounts of quartz and minerals of various crystalline structures. In summary, this SEM shows the consistent composition of AB20.

Figure 1. SEM set at a higher magnification to show platelets on the surface of each particle



Sample A 8000x | Sample B 8000x | Sample C 8000x | ***AB20*** 8000x

Quality. Part of our process to qualify our products involves our Dynamic Quality Assurance® (DQA®) program. Our raw materials are evaluated through a rigorous multi-step process to validate the quality and consistency of the products we stand behind. Through this process materials are either qualified or refused. The XRD analysis is just one of the tools we use to make decisions that help provide safe products that meet and exceed the expectations coming from our customers, as well as the regulatory bodies that govern our industry.

This information has been prepared for industry technical professionals.