

Apart from microscopy, do you use XRD?

Yes, we use XRD, XRF, and occasionally SEM, among other chemistry related techniques.

Are lightweight aggregates used for other purposes in concrete?

Also included besides reduction in dead loads would be improved thermal properties, improved fire resistance, savings on transport of materials, among others

Are there methods for detecting problem minerals (like pyrrhotite) using GIS? Do we have to rely on extrapolation or waiting until these materials are out of the ground to identify potential problem areas?

I am not familiar with anyone using GIS to detect these minerals, it seems as though they are typically found when they have been discovered in the source. Hopefully, a good potential aggregate exploration program would hit some these minerals during coring/sampling and identified by a project geologist.

Are you aware of many cases in the USA where deleterious materials in aggregates have been serious enough to lead to court cases? I have been expert witness in a couple of cases of damage to houses but I think usually difficulties are sorted out earlier.

Yes, most times it is worked out prior to litigation. However, we have been involved as expert witnesses in several court cases.

As we move away from coal burning, is there a substitute for fly ash in concrete?

Yes, a lot of talk about that currently. I would say slag cement (byproduct of steel making) and silica fume are the other more common SCMs. There are also other materials that are currently in development such as finely crushed glass.

Besides the ASTM standards, what other references would you recommend for aspiring material petrographers?

There are great Concrete Petrography textbooks available for purchase online.

Can you address the staining issue on the rock surfaces by sealing them first? Or is this too short term a solution?

I believe sealers could work. You'd have to be careful on what sealer to use (get recommendations from the supplier) and also be diligent about reapplication

Cement of what type can withstand weathering and erosion better: with small cavities or one characteristic is not sufficient for forecasting? Is there any treatment?

Concrete with a lower w/cm ratio is typically denser and less porous. That being said, if you have a concrete driveway for example, you should apply a recommended sealer to help protect the surface.

Did you use only petrography to match the rock in the crime lab's case or were you able to use some kind of geochemistry?

I believe matching came about through microscopic techniques and matching the chemistries of the concrete

Do you agree that the crushed stone aggregate industry gets a bad rap from high alkali cement, the underlying cause of ASR & ACR?

I'm not sure I've heard the aggregate industry taking the brunt of it, nor do I think they should, as concrete as a whole is a system of many parts/ingredients. Aggregates are a necessary ingredient of concrete. Physical testing should be done prior to a construction using the same ingredients planned in the mix design. Then the mix design can be corrected and additional SCM's added if the tests show ASR potential

Do you consider strained quartz to be a quartz grain that has subgrains or a monocrystalline quartz grain with undulatory extinction?

Strained quartz is typically a monocrystalline grain with undulose extinction. Several microcrystalline quartz grains would be recrystallized quartz, which can also contribute to ASR

Do you distinguish marcasite from pyrite? Is marcasite more reactive than pyrite in terms of rust staining?

I have only identified marcasite in thin section once and it was due to the crystal habit. It is far less common than pyrite, but I'm sure marcasite would contribute to staining as it is an iron sulfide.

Do you hydrate your concrete sample during thin section preparation?

The concrete does not hydrate during sample preparation

Do you use image analysis software (such as Image-J) to determine proportions of constituents, phase analysis, or shape and fabric determination?

No we do not, we typically stick with visual analysis using the petrographic microscope

Does sea water cause faster damage in concrete structures with reactive aggregates?

Sea water can cause damage to structures. If there is cracking in the concrete (could be from reactive aggregates or other), those cracks leave openings in the concrete for the chlorides from sea water to penetrate, which could start to corrode the steel rebar reinforcement. At that point the structure could start to fail.

Does steel rebar in concrete have a similar effect in terms of iron staining as minerals present in the aggregate?

Typically not unless it starts to corrode from exposure to atmospheric conditions. If it is at depth in the concrete it is protected by the alkaline environment. Steel rebar is also commonly coated with epoxy.

First of all, thank you for transmitting your valuable experiences. the course was very useful for me. also, I want to ask you how to use this method in mining exploration or mineralization outcrop.

Petrography related to mineralization for mining potential is a bit different than what we do. You would still use petrographic microscope, but the interpretation of the minerals would be reported differently. There are many excellent resources for mineral exploration petrography.

For an unfractured concrete slab how deep into the slab do you see hydration of the portland cement particles changing through time?

This may only come about in very large concrete structure pours called "mass concrete". When constructing those, temperature is recorded from the center outward as the chemical reaction taking place can produce quite a lot of heat also called "heat of hydration", which you could possibly see differences in hydration.

Otherwise, in typical concrete pavements or structures, you may only see a difference in hydration at the surface based on how the surface was finished and if there was proper curing.

Have you had experience with cement made with untreated sea sand to eliminate the saline fraction? And if so, what damage does salty sand cause in concrete?

I'm not aware of seeing untreated sea sand. If there is too much chloride in the concrete system there could be corrosion problems with the steel reinforcement.

How about expandable clay minerals like smectite/montmorillonite causing cracks?

Yes, we do look for those as well. These minerals can greatly affect stone used for dimension stone and riprap when exposed to atmospheric conditions

How do you sample when preparing your thin sections of fine aggregates, and how do you assure that the sample is representative of the sieve?

A sample is received and split using a sample splitter for gradation, once the sieve sizes are separated. The material retained on each sieve is then sent through a microsample splitter until we get enough sample to fill our epoxy plugs. If a sieve doesn't have much material retained, then we use all of it.

How has QEMSCAN (automated mineralogy) enhanced the field of forensic geology? With that, what level of chemical analysis is relevant for this field? Major, minor, or down to trace element level?

We have not used QEMSCAN, but we have used SEM, XRD, and XRF along with other chemistry techniques. Most of what we identify, we can identify with petrographic microscopes. XRF is generally used when we are asked to identify the elements comprising cement or if the client wants to get the elemental breakdown of their rock source.

How much automation or machine learning have you used in your petrographic work?

For petrographic work, not much. Our chemistry lab has automated machines to assist, but I'm not really familiar with their equipment.

I have seen animal bone fragments used in concrete (South America). Would that be problematic?

Typically, aggregate should meet some minimum physical testing requirements, but people also have to use what they have. We have seen horse hair used as fibers in older concrete.

I normally purchase geochemical standards from USGS or NIST, and consult EPA methods...so are these actual physical samples or SOPs?

Not sure on the question, feel free to email me.

I suspect that other sulfides, such as chalcopyrite, would also be problematic...true?

Yes, that is correct.

Is there a difference between petrography and petrology?

Petrology is the study of the origin, composition and structure of rock while petrography is the branch of petrology that deals with the scientific description and classification of rocks

Is there a way to estimate % complete of ASR?

Not sure on the question, feel free to email me.

Just to clarify: According to the IUGS Initiative on Forensic Geology - 'Forensic geology is the application of geology to aid and assist law enforcement, including the police and allied agencies, so they may investigate and solve crimes.' For this (excellent) presentation, engineering would be 'allied agencies'?

I'm not entirely sure, but that would make sense. I personally have not been involved with a criminal case assisting law enforcement.

Please elaborate more in how chert is deleterious?

Hydrous chert (a very soft and porous form) can cause popouts at the surface. Chert itself can be very hard, but is composed of cryptocrystalline to microcrystalline quartz, which is a known alkali silica reactor in concrete.

Pyrrhotite is magnetic. Do you use that property to identify it?

Yes, though pyrrhotite can also be associated with other magnetic minerals within the rock, such as, magnetite and hematite. So, it would be used with discretion.

Road salts are very corrosive to concrete. Does it matter if we use NaCl or CaCl₂?

Generally speaking salt can cause problems when chlorides get into the concrete system from other issues such as microcracking, then the chlorides can cause corrosion problems of the steel reinforcement. Salt also causes more freeze thaw cycles, so if the concrete is not properly finished or is not air entrained, the continual use of salt to melt ice could cause cyclic freeze thaw damage.

So are there more problems overall in the north due to snow and ice issues with stone compared to other areas in the country?

Typically not, in the north we typically have freeze thaw cycles during fall and spring. Other states in the middle of the country or to the south can have a lot more freeze thaw cycles through the entire winter.

What are practices/requirements for saving slides and hand samples after analyses are complete?

We typically save samples for a few months, unless told otherwise by the client.

What is your opinion of self-healing concrete use?

I have heard about it and it sounds cool, but I do not know enough about it to have an opinion on its use.

What kind of concrete (material and/or mixture) you might suggest in/adjacent to a location with Quick clay material?

I would suggest researching soil/cement stabilization

What pH makes a concrete slab happily reach age 75+ and is your pH determination specific to the aggregate, matrix, cement, or combination of all?

The concrete should stay at a high pH for its life. The majority of concrete does lose pH at the surface over time. If that happens quickly it means something went wrong with finishing or curing of the concrete. That being said, there are many other factors involved to help the concrete reach its design life.

When investigating concrete that failed by ASR, how do you take samples? Do you ever take core samples?

Yes, the majority of the concrete samples we get are cores. We recommend four inch diameter cores reaching the full depth of the concrete if possible.

Would you be able to provide a link for the USGS pyrrhotite map/inventory that you mentioned?

<https://www.usgs.gov/news/new-usgs-map-helps-identify-where-pyrrhotite-a-mineral-can-cause-concrete-foundations-fail-may>

You mention pyrite and pyrrhotite...would marcasite also be flagged as problematic?

I would guess yes. Yes, it is just far less common. I have only identified it once.