Mindat.org blog on Agate Formation with Comments by Donald Kasper

5-20-2017 responses from the blog of 2-13-2017, Rev 2, 52 pages.

Updated 7-6-2017

Posted as a PDF file at donaldkasper.com

Since the blog was shut down as some people became hostile to the concepts in geochemistry or volcanology and could not follow the discussion, I have copied the entire blog and provided my responses.

The overall tone is that there are some intrigued by the discussion and are willing to share ideas, some cannot follow anything for which they blame others, and some follow a typical political response to factual conversation by throwing out insults, while erecting various emotional barriers to learning. One group demands PhD reports, charts, and data in a blog as though others are indentured servants at their beckoning to contribute hundreds of hours of labor to write responses they probably won't read. Some responses comes from many attaching their personal sense of self-worth to what they believe to be true on a particular topic. That is to say they cannot learn as that would diminish their self-worth. This all while simply describing how agates form in volcanic systems.—Donald Kasper

Always remember, science is a series of approximations—Donald Kasper

Avoid cliché thinking—Michael Lebron, "Lionel" of Lionel Nation Broadcasting

Typos in my blog responses were corrected.

Daniel Bennett February 13, 2017 03:30PM

Picture if you will oil and water shook up with little balls of oil swirling in water. but instead liquid quartz balls swirling in liquid magma. like a red hot stone dropped in cold water liquid magma trembles and shakes as it surfaces to atmospheric temp. the bands in agates form when vibrations from rapidly cooling basalt cause "ripples" in the solidifying quartz balls. like moving water vibrating quartz takes longer to" freeze" so it freezes up layer by layer starting from the outside. in the case of so called "water level agates" when the magma first surfaces vibrations are coming from all direction and a little later the majority of vibrations start coming from below. by that time the outermost part of the agate is solidifying but the center is still fluid and so the perimeter bands turn in to flat parallel bands. which also points towards water level agates coming from the uppermost parts of the flow. agate "eyes" spherolites are from a higher temp melting point particle present in the quartz during the vibrations often finding its way to the outside edge while any gas bubble present will tend to gravitate to the center...

Reply · Quote · Report · Send a PM

Kasper >> “Picture if you will” should be followed with “the girl with kaleidoscope eyes.”

Kasper >> Vibrations make breccias in near solids, and disrupt structure formation in glass states, which is not what is observed in agates. The vesiculation with degassing and exsolution of fluids and minerals is the basis of agate formation in lavas. Agates form in lavas and not granites, for example, as lavas have dominantly K-feldspars and silica, which separate out of solution as the flow cools. This does not occur as commonly in plagioclase feldspars, found in granites, and I note that no volcanic geodes have plagioclase detectable in infrared in their shells. The feldspars are exclusively K-feldspars. Exsolution causes the silica accumulation.

Doug Daniels February 14, 2017 02:06AM

Interesting idea, except that quartz does not form from a melt that forms basalt - only after later weathering does the quartz get deposited. And, doesn't explain agates that form in rhyolitic rocks. Or in sediments.

Reply · Quote · Report · Send a PM

Kasper >> This is false. Agates are not found in granites, schists, coal, kimberlites, or serpentines, which are all exposed to groundwater and weathering. Therefore the weathering model of agate formation is false. Secondly, exsolution of K-feldspars is their major behavior in cooling melt systems with solvus curves that are well documented and replicated in laboratory furnace systems for rhyolites. In basalts for plagioclase exsolution from silica is less common, but is still documented. The exsolution separates silica in various phases from the lava melt.

Kasper >> Agates do not form in sediments. Go dig some in your yard, any yard. If your yard does not have volcanic ash, you won't be finding agates. We have to use our brains and realize what these concepts lead to. If you have weathering, the deeper you go in a soil profile, the longer weathering has taken place. Therefore, you must dig small agates at the surface and bigger ones with depth. Now go find one place on earth like this. There are none. So this model fails and should be discarded. Models must accurately predict our natural world and conform to observations of it.

Ralph Bottrill February 14, 2017 04:52PM

Yes, quartz is not immiscible in most magmas, so will usually react and intermix quite rapidly. It's quite well established that the agate is formed post-cooling by precipitation from low temperature hydrothermal solutions carrying dissolved silica.

Reply · Quote · Report · Send a PM

Kasper >> This is false. Silica is totally immiscible in all magmas below the solvus point of feldspars, and comes out of solution by exsolution as the bodies cool, forming alpha-cristobalite, beta-cristobalite, alpha-quartz, beta-quartz, alpha-moganite, beta-moganite, opal-C, opal-BC, opal-CT, opal-Q, opal-BQ, and tridymite. High temperatures and silica, namely temperatures over 870 C make silicates, not agates. Temperatures under 870 C cannot make most silicates. When the competition is removed from the system, agates can form. 200 C temperatures and zeolites with silica in magma makes zeolites. The zeolites consume all the silica. This is why no agates of this planet have zeolites. Reflectance infrared of agate inclusions proves this.

Gregg Little February 15, 2017 12:15AM

I wasn't aware that vibrations and rapid cooling basalt was the environment of agate formation. My understanding was that it was largely post solidification and in the much lower temperature regime. To bring in the chalcedony forming fluids, fracturing by shrinkage and circulating waters were needed. Am I missing something recent with the vibration concept?

Reply · Quote · Report · Send a PM

Kasper >> Uniform deposition of silica in voids cannot occur with groundwater unless you want your Nobel to describe this undocumented physics. It can only be deposited by vapor deposition, which requires supercritical fluid at a temperature over 374 to about 425 C.

Waterlines are prima facie proof of a supercritical to subcritical fluid transition in volcanic systems. There is no circulating groundwater as there is no humic acid from groundwater found in agate cores, only from weathering in their outermost shells. Most agate water is in the shells, and none in the cores. Most groundwater mineralization is calcite by a thousand times more than silica, so groundwater only deposits caliche, not agate. Caliche is a carbonate and trace silica mix with humic acid. No caliche is found in agates in the banding, only in the remaining voids. Caliche gets into the voids from weathering of the agate structures over long geologic timescales, as does selenite, mud, calcite, and sand.

Daniel Bennett February 15, 2017 12:27AM

i have to confess i don't know any of that to be true. it just seems reasonable and logical. apparently not so. why do they find little quartz/chalcedony nodules in Hawaii where the basalt is so fresh. doesn't it take a long time to happen the way you guys are talking about?

Reply · Quote · Report · Send a PM

Donald Kasper February 28, 2017 06:56AM [Paragraph spacing added]

Agates form in volcanic rocks or volcanic ash related to volcanism, only. So-called sedimentary agates are found under ash beds that was the silica source. Agates form in supercritical fluids. As magma comes to the surface, the feldspar and silica separate from each other. The silica under certain conditions forms agate in conjunction with supercritical fluid. The lower the silica content of the magma, the less agates are found. Silica and rhyolite intermix. Andesites have vein agates. Basalts have amygdules. It is not the net content of silica that is the sole driver, it is the catalyst to force it out of solution that also matters.

Agates are calcite-clay-silica-hydrate rocks. They have many species of opal, moganite, quartz, cristobalite. They are commonly included with calcite which plays a key role in their formation by creating alkaline conditions. The inclusions and shell structures are commonly clays. Celadonite and bentonite are the most common. Infrared spectroscopy equipment I have shows for example that the Union Road Missouri agates all have celadonite shells. Even though the host is sedimentary, celadonite cannot form from weathering. It forms only in volcanic rocks and their ash equivalents. Snakeskin agates have shells of bentonite and celadonite glaze, which disproves their magadiite precursor and weathering model. With infrared, no zeolites, no salts, no evaporites are found in agates. Sulfides are rare and only occur with a few types that can form in neutral pH systems. They form in agates when calcite is present. The calcite forms sulfate and neutralizes the acidity.

Overall, the inclusions tell us their temperature of formation. Chlorite and celadonite found in them are formed around 425 C and not with weathering. The glass state of rhyolite between hard rock and melt is the range of 374 to 575 C. Above 374 C is only supercritical water. A fluid gas with the solubility of water and diffusion of a gas. No surface tension exists. In this system, the charge on silica is negative, and you will note that only cation positively charged minerals or metals are found in agates. Anion mineral states are never found.

Groundwater does not dissolve silica and it does not just move around to and fro. It takes alkaline systems to dissolve silica. So, agates are rock, they are not varietal quartz, and they form very quickly (hundreds of years max time scale), and only in volcanic rocks. In fact, they are almost never found near water, near rivers, water tables, or lakes, or river mouths. They are typically found in deserts. You never go to the tropical rainforests of Brazil to hunt agates, you go to the Mojave Desert of California or Sahara of Morocco. This defeats a weathering water model for rocks not found with water. Where does their water come from? Right out of the melt. It is volcanic water, and not hydrothermal water. Hydrothermal water is rich in calcite, not silica. To get pure silica, you cannot have groundwater. Agates have no humic acid to show they were in contact with ground water. Humic acid is not found in agates cores in infrared, just the shells. That comes from weathering, not agate formation. As you look closely, no popular model of weathering has any scientific basis to be believable as no data fits a weathering model.

Edited 2 time(s). Last edit at 02/28/2017 07:01AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Donald Kasper February 28, 2017 07:03AM [Paragraph spacing added]

Most models of geologic formation of agates pick and choose what fits their concept of formation. All of the data must be taken into account. Inferior models are easily disproven. For example, granites have 30% quartz, have voids, and are exposed to weathering. Show me one agate in one granite of this planet. You cannot. Therefore the weathering model just dropped dead. Having quartz around to erode does not work. Quartz does not weather. It must be mechanically broken down. Germany has Permian age geodes with kaolinized lava and pure agate cores that are totally unaffected. If exposed to weathering in very wet conditions, the Permian agates are 100% intact and filled with kaolinite in the fiber bands as the bands are porous.

Agates are not quartz layers. They are groups of fiber bands of quartz and moganite, and occasional layers of pure crystal quartz. There are also microspheres in the agates. Inferior technology based on refractive index in the 1800's presumed these were opals. Infrared spectroscopy and Raman spectroscopy proves these are moganite structures. So you have one moganite in the fibers, and another immiscible form. Let me see. The moganite in the fibers makes a 555 cm-1 band, and the other moganite microspheres does not. Raman reports both are moganite. Perhaps one is alpha-moganite and the other is beta-moganite. We have now found our beta-moganite, only found in ignimbrite rocks or rocks exposed to pyroclastic flows. In essence, a galaxy of complexity reduced to stupidity for bland generalizations. The tubes making moss structures are not bacteria unless you can show a bacteria that precipitates celadonite, because that is what infrared shows them to be.

Edited 2 time(s). Last edit at 02/28/2017 07:10AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Jolyon & Katya Ralph February 28, 2017 09:51AM

> So-called sedimentary agates are found under ash beds that was the silica source.

Not true. There are plenty of examples of agate of entirely sedimentary origin, where biogenic silica (eg from radiolaria/diatoms) is the primary source.

Reply · Quote · Report · Send a PM

Kasper >> Radiolaria cannot exist in the world ocean without silica as the ocean has no silica. The only silica source is volcanic ash from ocean floor eruptions. Those eruptions cause radiolarian blooms. Note that not one river delta with its sand is a source of rich radiolaria. The ash and radiolaria die and go to the sea floor, forming chert with burial and compaction. Diatoms are carbonate. Diatoms in agates are exceptionally rare. They could occur in some cherts, but I have not seen that yet.

Ralph Bottrill February 28, 2017 10:16AM

Agates only found in deserts? I can think of dozens of locations, without really trying, in non desert climates, including Scotland, Germany, Tasmania, Queensland, Brazil, etc.

Reply · Quote · Report · Send a PM

Kasper >> Think continental drift. No one cares where your continent is today. We care where it was in Tertiary.

Larry Maltby February 28, 2017 03:16PM

“Agates form in volcanic rocks or volcanic ash related to volcanism, only.”

This is an extremely absolute statement. It leaves no “wiggle room”. It implies that all of the complex geological processes in the world have been investigated and this is the conclusion. The formation of agate remains as a highly controversial subject with some good points on all sides of the debate but as yet it is far from a conclusion. It seems to me that agates sometimes form in sedimentary deposits as a chemical process that is separate and apart from volcanism. It may well be that the silica in a sedimentary agate was derived from the decomposition of an overlaying layer of volcanic ash but the ash fall itself is a sedimentary process and the decomposition of the ash that frees the silica is not a volcanic process. There are other sources in sedimentary deposits that may provide silica to support the formation of agate such as plankton, diatoms etc.

Really, there is no such thing as a simple explanation of agate formation!

Kasper >> Agates form in volcanic systems and systems subjected to ash. Some form in medium grade metamorphic systems as byproducts of silicate mineral reactions. They never form in sedimentary systems on a macroscopic scale. Oceanic radiolarian sediment does have banded silica on a micron scale, but we don’t call 10 micron silica banding systems agates. Scale matters. That is, overgeneralization of all silica systems of the universe to one model of geochemistry interferes with clear thinking relating to the diversity of geologic systems observed.

Edited 2 time(s). Last edit at 02/28/2017 03:37PM by Larry Maltby.

Reply · Quote · Report · Send a PM

Gregg Little February 28, 2017 05:12PM

I find some strange and down right erroneous statements, oh dear where do I start;

1). "**Agates form in volcanic rocks or volcanic ash related to volcanism, only.**" The adjective "volcanic" can only mean from volcanism and its processes.

Kasper >> This is a blog, not a book. You get generalizations in blogs. Is this unfathomable to you? Yes, I do mean volcanic systems that involve volcanism.

2). "**Silica and rhyolite intermix. Andesites have vein agates. Basalts have amygdules.**" The void spaces that agate forms in is a function of tectonic stresses that create the void space, not a function of agate formation.

Kasper >> There is no proof voids come before agates and that agate geochemistry involving vesiculation does not form voids as a byproduct, namely, the agate formation makes the void. Matrix lava silica content determines the type of vesiculation, as does depth of burial relating to overburden pressure. Voids in lavas are typically made by fluid and gas exsolution, not tectonics, which is a brecciation process unable to explain round voids. Tectonics does not make round voids.

3). "**Agates are calcite-clay-silica-hydrate rocks.**" If you look in any book on mineralogy they all basically say "agate is a banded form of finely-grained, microcrystalline quartz". All other constituents are impurities, inclusions, etc. Agate is quartz.

Kasper >> "Impurities" control agate geochemistry. The whole specimen is a calcite-clay-silica-hydrate rock. Understanding that includes all minerals involved in agate formation. For example, you can then note that no galena crystal-agate exists in this world and understand why. Galena forms at pH 2 and calcite forms at pH 8.3. Agates are found with calcite not galena as agates only form in alkaline systems. This is beyond your understanding by dumbing down the discussion of agate formation to just quartz.

4). "**Groundwater does not dissolve silica and it does not just move around to and fro. It takes alkaline systems to dissolve silica.**" Since when does groundwater that becomes alkaline cease to be ground water? Sedimentary basins around the world can have and have alkaline waters. In my petroleum geology work have seen chalcedony (aka agate) in sedimentary rocks. I have also seen stylolites (pressure solution features) in quartz arenites (sandstones) which puts silica in solution which then precipitates as quartz overgrowths on quartz grains.

Kasper >> Styolites are granular quartz sediment tectonic compaction. Agates have no stylolites. Styolite banding is the direct definition of a chert.

Kasper >> Iospachous overgrowth of quartz grains with banded silica occurs on a scale of microns. When you see this, you are not in the principal conditions of agate formation. You are in the boundary conditions of marginal formation.

5). "**So, agates are rock, they are not varietal quartz**" Is Donald Kasper trying to dismiss the whole field of geological science?

Kasper >> Rhetoric. I use geochemistry in the study of agates and you don't. Your discussion is banal.

6). "**They are typically found in deserts.**". As Ralph B. stated and I reiterate British Columbia and Nova Scotia are not deserts, but a source of agate in volcanic terrains in a temperate climatic zone.

Kasper >> That is not typical. There is no relationship of climate involving more water for making more agates from weathering. Your inferred relationship is false.

7). "**no popular model of weathering has any scientific basis** ". I am not sure how weathering was brought up except by Donald Kasper; weathering is post depositional.

Kasper >> Weathering is the process of dissolution of rock and minerals such as silica and its deposition mechanically elsewhere. That was not the word weather, it was used in the sense of geomorphology where the term comes from.

8). "**Most models of geologic formation of agates pick and chose what fits their concept of formation.**". See my comment #5. Geologists in research do not pick and choose, they use the volumes of past research work and their evidence to support their research thesis.

Kasper >> Yes they do. The debate over agate genesis is based upon picking-and-choosing which makes each model unstable and subject to ridicule by others pointing out the omissions.

9). "**Quartz does not weather. It must be mechanically broken down.**". Weathering is both a mechanical and chemical process, again check the literature. Many, many water analyse show dissolved silica.

Kasper >> The beaches are full of quartz sand, not clay. The silica is mechanically broken down, not weathered to clay. This assumption of quartz dissolution from weathering is false. Rainwater cannot dissolve silica on a relevant timescale, meaning within a geologic age of 75 million years.

And last but probably not finally, 10). "**In essence, a galaxy of complexity reduced to stupidity for bland generalizations.**" Agate formation definitely has "a galaxy of complexity" but the latter part of this statement appears to be what you are advocating.

Kasper >> This is not a technical rebuttal. It is an immature response. Bland generalizations like weathering dominate popular literature. Discussing the physics of supercritical fluid migration is not using bland generalizations, but talking about agates formed by weathering, is a bland cliché, catch-phrase, propaganda, buzzword, hype, and generalization of no relevant or scientific meaning.

Edited 1 time(s). Last edit at 02/28/2017 05:14PM by Gregg Little.

Reply · Quote · Report · Send a PM

Alfred L. Ostrander March 01, 2017 02:51PM

Greg, very precise points. You beat me to several points but I will comment on the general quartz family of which agate has long been accepted as a variety. No need to upset the apple cart there as the different varieties have long been established. We will learn more but a radical overturn of the quartz group is highly unlikely. Simply saying that the presence of various phases in a sample along with some impurities makes it a rock is really an over simplification. By that reasoning any specimen with several minerals forming together and some impurities can be called a rock. So all those beautiful well crystallized specimens in our collections are reduced to being just rocks? There is truth to that statement but not in context.

Kasper >> Agate is not in the quartz group. Agates are rocks of calcite-clay-silica-hydrate composition. An agate specimen contains many mixed polymorphs of silica in different structures, and many inclusions typically from the clay and carbonate groups.

Kasper >> "Variety" is a gem term for a gemstone of a certain composition but different color. Agates are varieties of absolutely nothing at all by the proper use of the term.

Kasper >> "Impurity" is a social term used to contain unknowns into a social bin to be ignored. It is a social mechanism that supports ignorance and makes stupidity acceptable. The same logic is used in infrared research to classify the Restrahelen Region as "polarization effects" and "noise", which are additional catchphrases used to justify not studying this spectral region.

Kasper >> Over time, with higher resolution equipment, many of our minerals are becoming rocks. Only with generalization are they minerals. Various bin mechanisms to pretend rocks are minerals have been created to contain this trend including the acceptability of solution series. Essentially, all observation occurs at a certain level of resolution or detail that has to be spelled out.

Kasper >> To claim that a multi-phase specimen is a mineral simply stupidifies and confounds the discussion and hides the complexity of what is observed, and promotes misunderstanding. We need accurate terms to describe what we see. If we have instruments to discern different things, we need to use terms that include that understanding.

As to not collecting agates in the tropical rain forests of Brazil, think of the agates of Rio Grande Do Sul, Brazil. Although it is in the southern temperate zone it is humid and sub-tropical and forested. People go collect agates in areas with little or no vegetative cover because they are easier to see. That is all. Except for walking some beaches on Lake Superior. Or collecting amidst the pines at Teepee Canyon, South Dakota. Not desert and great agates can be found.

Kasper >> In Cretaceous Grande Do Sul, Brazil was a desert. It moved due to continental drift. We go to deserts to collect agates because that is where they were formed.

To Daniel, maybe we as geologists need to be more careful when speaking of geologic time. It runs from billions of years to the present. All geologic processes do not run at the same speed throughout all time. How long does it take to grow a quartz crystal in a lab? That does shed light on what many geologists once thought would take a far far longer amount of time. We do keep learning! I am now in my mid sixties.When I was young I thought someone that old was truly ancient. My thinking has changed: time needs to be kept in perspective.

Reply · Quote · Report · Send a PM

Michael Hatskel March 01, 2017 04:18PM

Speaking of time...
Donald Kasper stated that agates "form very quickly (hundreds of years max time scale)".
Could someone please comment on whether the growth rate data is available that supports that?

Disclaimer: I am certainly not trying to figure out how to grow baseball-sized agates. ☺ Just interested in the process kinetics.
A quick Google search on the subject returned the Min Mag 2009 paper titled "Crystallite growth kinetics in nanocrystalline quartz (agate and chalcedony)" [http://minmag.geoscienceworld.org/content/73/4/551]. It may have some data regarding the growth rates. I would appreciate if someone could send me the PDF.

Thanks in advance

Edited 1 time(s). Last edit at 03/01/2017 04:18PM by Michael Hatskel.

Reply · Quote · Report · Send a PM

Kasper >> Geochemical reactions are not a point, but a curve of temperature, and pressure. The more temperature and pressure, the faster reactions occur. However, for agates, the inclusions show that the best explanation of agate formation is colloidal chemistry. In this branch of chemistry, the dominant mechanisms of formation are pH, particle size, and particle charge.

Gregg Little March 01, 2017 09:58PM

Alfred;
Being of similar "vintage" and speaking of long duration processes, I remember a pre-eminent researcher speaking at my university on a recently accepted theory called continental drift. Long time ago for me, a nano blink of geological time.

Getting back to crystal formation, one of our recent threads was about inclusions and described growing small centimetre-size quartz crystals in a lab over 4 months using seed crystals. I imagine geological processes can match or exceed that given the right conditions. Part of the many variables would include favorable and stable fluid chemistry, high volume, constant temperature and pressure for the duration, etc, etc.

One thing to keep in mind too is that crystals can go through growth phases (ie phantoms) so that further complicates bracketing the time for formation. We humans seem to be time obsessed but the more important question geology asks is, what are the specifics that lead to crystal formation. Time usually is expressed in dating the preceding, concurrent and following processes around the time of crystal formation conditions. These time brackets are usually in the thousands to millions of years and don't necessarily describe when that particular crystal in your hand began and completed its growth.

One of the interesting time frames relates to diamond. It probably takes millenniums to eons for them to form, 10's of miles below the surface, but some of the literature describes their emplacement in kimberlite pipes to be in as little a period as days.

Reply · Quote · Report · Send a PM

Rick Dalrymple March 01, 2017 11:04PM

Donald,
I have agate nodules that have formed in shale--directly. They are clearly not formed from volcanic ash or even under an ash.

Why do you think they can only for as a result of vulcanism?

Kasper >> Your host is not shale, or it contains volcanic ash. Most people don't look carefully. Send me a specimen, I will scan the host rock in infrared.

Rick

Reply · Quote · Report · Send a PM

Donald Kasper March 02, 2017 03:20AM

It is quite well established that geodes have agates cores and that the plastic state of rhyolite is 374 to 575 C. Above that is a melt and below that is cold rock that only brecciates. So this is the temperature they formed at with silica migrating to the core and the exsolution and expulsion of feldspar. Studies that say agates are formed at 35 C are based on O-18/O-16 ratios which can say anything you like as migration of water with salt changes the ratio and the presumed temperature. In fact, minerals formed at volcanic spreading center trenches are mapped at this temperature by this method while the lava erupts at 1250 C. In terms of chlorite and celadonite, they form directly in volcanic systems and not from weathering and are found in agates consistently. More celadonite than chlorite.

There is a few problems with weathering models. First, all amygdules and geodes have an outer lining of silica in every agate of this planet. Groundwater cannot deposit silica films to do this. Groundwater will make laminar silica structures only, wall-to-wall. This so-called sticky physics to line all geodes/amygdules on earth does not exist with water. There is only one physical state where the voids can be lined uniformly with silica and that is called vapor phase deposition which only occurs in supercritical fluids.

Then you have that small problem with interior waterlines and vapor tops with crystal quartz or banded agate. Blow it off as coincidence as you wish, but if you want an actual model of the physics by which this occurs, weathering does not work. However, when the lava with its silica cools below 374 C and goes subcritical, the system must form two phases. One is water and the other is water vapor. Supercritical fluid and silica going subcritical form waterline floors and vapor phase crystal or banded tops is prima facie proof of a supercritical transition occurrence.

When rocks are exposed to ash only in sedimentary strata, those agates form only in subcritical systems. These are totally different, sinuous and concave structural agates and never have waterlines. These form at or around 150 C. There is no such thing as the one method of agate formation. There are the 70 geologic systems of formation with common themes.

Acicular morphologies of minerals are not accidents of nucleation. Acicular morphologies only form in supercritical fluids where there is no surface tension. There are 4 geologically important supercritical fluid types, each with its own transition temperature. Morphologies (shape-types) are treated in the literature as accidents of God, but are formed in very specific geochemical conditions.

Transition times from super- to subcritical matters and can oscillate depending on heat sources in the volcanics. Decompression in transition causes boiling where the fluid starts to cycle up the walls and drip down the center. This forms the silica pendant structures, always and only perpendicular to the horizontal waterlines.

So we can go through every major agate structural morphology and define it in terms of supercritical transit times and types. For example, rapid subcritical transitioning causes an implosion to occur, and sucks in the exterior volcanic rock around the void structure. When the shell celadonite comes in, its water is expelled. Anywhere water contacts these silica fluids, opal is formed. So the celadonite filaments are encased in opal.

If I am correct in identifying beta-moganite in infrared, this mineral forms at the lower supercritical transition start at 354 C. As such, I have only two populations of moganite, no intermediate forms, with the beta only found in the hottest pyroclastic rocks. Both populations are known to be moganite in Raman infrared, as specimens shared with NASA scientists have found. If correct, and I do collaborate with some planetary scientists at JPL Pasadena on this model, then your agates are filled with beta-moganite and your groundwater model drops dead. it occurs in a variety of very specific structures and is different than moganite in banding layers. These two populations of moganite have totally different spectral behaviors. That is not a conclusion based on 4 rocks like say, oh, Moxon might publish on, but based on 35,000 total agate and volcanic rock graphs with a set of 2500 moganite graphs to study.

Edited 1 time(s). Last edit at 03/02/2017 03:22AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Donald Kasper March 02, 2017 03:37AM

This is provably false.

The Union Road Missouri agates of sedimentary source rock scan in infrared with shells of celadonite. Celadonite cannot form from weathering.

That site sits on a fault and was subjected to Western orogeny volcanic ash deposition as its silica source.

Subsea volcanic eruptions do two things. First they dump ash into the sea. Second they cause a radiolaria bloom. Third the silica settles to the sea floor and the radiolarian bloom dies out and settles down as well. Then you get say, a Mookaite, found in 7 beds of volcanic ash with radiolaria in a bentonitc chert. So then smart PhD's conclude radiolaria make agate and chert. No. Ash makes the agate and chert and radiolaria.

The Keokuk Geodes are not sedimentary. They are found under a bentonite bed with radiolaria in the shells and kaolinite.

The Lake Magadii, Kenya chert, presumed to form by magadiite, is found by drill core under 45 feet of volcanic ash and 100 feet under the magadiite.

Magadii-type cherts from Rome, Oregon has crust shells of beta-moganite, bentonite, and celadonite. If I am correct in identifying beta-moganite in infrared, then they formed at or above 354 C. There are specific infrared reasons to make this presumption of moganite beyond discussion here, but my infrared has been calibrated in two blind studies to NASA Raman infrared from where moganite is defined. It is not defined by XRD, it is defined by what a Raman instrument says at 501 cm.

The sedimentary Dryhead agates are covered in celadonite and bentonite shells with the quartz/chert. You have to study the 4300 cm-1 phyllosilicate region in infrared to see it, or you just won't find it.

Edited 1 time(s). Last edit at 03/02/2017 03:39AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Donald Kasper March 02, 2017 03:49AM

You don't know what you have until you have a method of spectroscopy to scan it. Otherwise, you are guessing. Send me a sample, and I will scan it. All sedimentary sites with agate and cherty agate is overlain by bentonite. You just have to look. For older rocks, the looking is harder. It took longer to find the bentonite in the Kentucky agate geology, for example. But, armed with a detailed master key I worked out for 4300 cm-1 infrared clay minerals, I can see the clays despite their trace occurrence in silica rocks. it is the same spectral region used in planetary remote sensing and works for very specific physical reasons.

Reply · Quote · Report · Send a PM

Donald Kasper March 02, 2017 03:59AM

We can estimate agate formation by understanding they only form in lava flows and pyroclastic rocks. So we know the cool-down time of those flows based on their type and mass (thickness). So we can make estimates of formation time. So, you have an ash flow 30 meters thick. You have a certain cool down rate. This has been studied for Mono Lake flows. Then you take a theory of formation at 374 to 575 C which is both a rhyolitc and quartz state polymorph transitions. From that, you have 8 days. I don't call that weathering.

Then you go over to marine rocks. You get opal-A from forams. You slows bury this in muck and heat it to form opal-CT, linked to agate formation. You have up to 70 million years for the very coldest conditions of formation. That is it. So the relation is time-temperature dependent. But, the agates in those sedimentary rocks take a microscope to see. You have to understand that a 100 micron agate is not the same as a volcanic agates. For example, no dilation tubes of exit/escape exist on this scale. In fact, don't exist for any agates under about 3/8th of an inch. So the silica banding is different in these sedimentary "agates" which are more like veinlets of banded silica on a mm scale.

Since these form in subcritical conditions, these "agates" never have waterlines. They never have the calcite and celadonite and other mineral inclusions. They are another class. The scale of your classification matters, and overgeneralizing causes confusion because as you overgeneralize, you combine different geologic systems and then get a confusion of superficially conflicting data.

Overall, in volcanic systems, agates are forming in under 30,000 years. This is why you cannot dig in your back yard to study the soil weathering profile and find bigger agates with depth. There are no agates in weathering profiles.

Reply · Quote · Report · Send a PM

Donald Kasper March 02, 2017 04:07AM

When the Russians formed banded silica structures in platinum vessels in supercritical fluids in a few months using quartz sand, I wrote and asked if they could use bentonite instead. They laughed at me. I mean, why use silica with 800 grams per square meter surface area when they are perfectly happy using sand with 1 gram per square meter. Because surface area relates to reaction rate. This is why massive quartz and sand cannot make agate. The reaction chemistry is colloidal and in a colloid world it is all about chemical charge, surface area, concentration, and temperature.

Reply · Quote · Report · Send a PM

Kasper >> The reaction chemistry is colloidal and in a colloid world it is all about chemical charge, particle size, surface area, concentration, and temperature.

Donald Kasper March 02, 2017 04:19AM

A variety is a gem term of a colorized mineral of the same overall chemical composition.

Agates are full of calcite, clay, opal, moganite and silica polymorphs.

In infrared, agates have opal-CT and opal-C and I model three new species of opal. No agate on this planet has opal-A. Why not? Opal-A is the only opal formed with hydrothermal solutions and from weathering. I have a very specific key to identify opals in infrared and can see mixed forms which occur all the time.

In infrared, agates have two populations of moganite. I model one is alpha-moganite, the other is beta-moganite. Raman reports they are both moganite and cannot tell alpha from beta. The alpha is only in the banding, and the other is immiscible in the agate, and found in specific structures such as microspheres.

In infrared, I have proposed that beta-silica minerals can be found, and have shared that data with Caltech, Pasadena Planetary Science group. If correct, agates have beta-quartz. No beta-cristobalite, but that is found in geode shells. But waterlines can have opal-BC (opal-beta-cristobalite). In fact, the only place geologically you can ever find an opal-C in volcanic systems, is in the waterline structures of geodes/amygdules. Nowhere else. The opal is a supercritical transition opal form and lives right there.

Agates have celadonite and bentonite. Foggy white agates can be beta-moganite rich or can be calcite-agates.

So these are multi-mineralic and as such are rocks. They are very complex rocks of mixed composition of many quartz and clay polymorphs. The minerals occur in specific structures that you can find if you use spot reflectance infrared to aim specifically at them.

Claims agates are 99% quartz is a farce, and Moxon needs to stop promoting that. He is saying that if you bash you agate to bits and pick out the quartz, it is very pure quartz. But, this is not what an agate structure specimen is, and falsely dumbs down the conversation to promote this varietal garbage. Agates have as little as about 40% quartz, which makes them rocks. This means I am talking about the actual, whole specimen, not the banding only. The inclusions tell the rest of their story of formation as each included mineral has specific, known conditions of formation.

Edited 1 time(s). Last edit at 03/02/2017 04:21AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Donald Kasper March 02, 2017 04:25AM

Very good. The southern Brazil/Paraguay region is full of big amygdules, I must be wrong and you proved it. How old are these lavas? Cretaceous. Okay, where was South America in Cretaceous? Farther south in a desert belt. Okay, what is the brown staining? Humic acid leaching from being moved up to the equator where plant matter in groundwater stained them. Now you know.

Would you like for me to tell you where Germany was in Permian? Okay, if the shells of geodes are kaolinized and the agates are full of kaolinite, those are 300-400 million year old agates and that was weathering.

Reply · Quote · Report · Send a PM

Donald Kasper March 02, 2017 04:31AM

Go to any hydrothermal vent site on this planet spewing out silica and hot water, and show me an agate. You cannot. Your hot water and silica model just died. I collect for myself. When I get BS in the literature I can check it in the field as I live just south of one of the largest agate trends in the world. Beware of PhD's writing about agates in playa lakes while living in Pennsylvania in coal country. Really, they should study ferns and leave that [the study of] agates alone.

The Milford, Utah vent site is world famous. I have been there. I have samples. Opal-CTA and Opal-CT. No agate. No agate or jasper on this planet has opal-A, the only opal formed by weathering and surface hydrothermal deposition. Infrared proves it. You just have to look.

Reply · Quote · Report · Send a PM

Jolyon & Katya Ralph March 02, 2017 07:43AM

Donald,

That's a lot of messages but you haven't addressed yet (or rectified) your provably false statement:

"Agates form in volcanic rocks or volcanic ash related to volcanism, only. So-called sedimentary agates are found under ash beds that was the silica source. "

note: in your MANY previous messages you seem to reference previous statements by people without quoting what you are actually replying to, hence it's impossible to follow the thread of your responses. Remember the 'REPLY' button under a message simply replies to the whole thread, not an individual message.

I do, however, support your proposal to redefine agate as a 'rock' rather than a variety of chalcedony! It's no more pure chalcedony than flint is.

Reply · Quote · Report · Send a PM

Kasper >> I have 22 books that address the issue of agate geochemistry that covers this. I am not going to upload them here. Presuming that I should is very immature and presumptive.

Jolyon & Katya Ralph March 02, 2017 07:45AM

There are also plenty of sedimentary agates with no celadonite association, Perhaps you'd prefer to call them banded cherts, but they exist and are generally classified as agate by most people. If your intention is to redefine the nomenclature of agate to exclude those of purely sedimentary formation then that's an entirely different battle.

Reply · Quote · Report · Send a PM

Kasper >> Mixed cherty-agates occur. This confuses a lot of people. Volcanic ash and radiolaria are found in sedimentary agate systems all the time. The comment that celadonite is not found in sedimentary agates is false. This is a claim based on lack of reporting caused by a lack of study. In infrared I can detect celadonite in sedimentary agates you cannot see by eye looking for only green coloration all the time. It is identified in the 4300 cm-1 region. There are 3 celadonite minerals.

Jolyon & Katya Ralph March 02, 2017 03:27PM

Thinking about this further, although there are some reasons for categorizing agate (and chalcedony in general) as a rock rather than a variety of quartz, there are equally good reasons for keeping it as it is.

It is essentially a 'monomineralic' rock with impurities that can be significant, but the presence of such impurities doesn't specifically exclude it from being regarded as a variety of the mineral species.

Kasper >> The word “impurity” is a cultural assignment to bin things people don’t understand, and to justify ignoring them. Other words like “noise”, and “contaminant” are used for this social purpose to constrain thinking to data that conforms to a viewpoint, and ignore data that does not.

For example: sand calcite, desert rose gypsum / baryte all have significant SiO2 included, but to notthat doesn't necessarily mean they should not be classed as varieties of their parent species. Even old favourites such as 'rutilated quartz' are clearly not themselves a rock (they are a component of a larger rock, eg a pegmatite) but are not entirely monomineralic either.

Kasper >> The reason why calcite and silica are found together is called geochemistry, and ignoring that keeps you ignorant. You appear happy to be ignorant. Rutilated quartz recognizes the two mineral component instead of calling it varietal quartz, then you call a rock with opal-C, beta-moganite, calcite, iron hydroxide, celadonite, and quartz as varietal quartz because this allows you to socially connect to the Age of Dana, an 1850’s world you live in. Lastly, desert roses have quartz and gypsum, but no agate. Agates do not contain gypsum. Again, the confusion is the equivalency of quartz and agate in mechanisms of formation.

So, we are left with "where does it fit best into mindat?" And at least for now that is as a variety of quartz.

Jolyon

Reply · Quote · Report · Send a PM

Alfred L. Ostrander March 02, 2017 05:15PM

Thank you Jolyon for reconsidering your statement about agate as a rock. This is a situation where petrology and mineralogy should act hand in glove for the betterment of our understanding of quartz and its polytypes.

To the point of this posting. Mr Kasper, you have written a number of books about agates, geodes, etc. Many of your positions are well known and not agreed with. You do seem to have a habit of dropping some interesting lines.

Kasper >> This is propaganda and is based on lies. Alfred Ostrander, you have not purchased one book I ever wrote, so you are a Fascist pig making things up as you go.

Here is what Mr Kasper thinks on a few things.

Hardness and specific gravity have not been used in science since 1910 to identify minerals or rocks reported in the scientific literature.
There is a reason, and the reason is that those methods are grossly inaccurate.
Feb 21, 2013, Yahoo Group
Here is what Mr Kasper thinks of Mindat and Dana.

Oh well. I guess Mindat and the IMA is stuck in 1830, the age of Dana. It was such a simple world then. I see increasingly that our geology
books are more like history books of old science than real science. Many authors are lazy pigs, and quote that ancient data because it
keeps things simple, but the goal of science is to describe what we see and understand and understand with our best available data and
instrumentation, not the data of 1830. Dana is dead and the science has moved on.
Feb 20, 2013, Yahoo Group

Mr Kasper finished his post of Feb 21, 2013:

Lastly, I have never been ashamed of being smart.

I will also point out that on another posting, and I paraphrase, Mr Kasper made it clear to a researcher that when he had finished publishing as many books as he had, then they could compare notes.

Jolyon, if you wish, you can remove this. I am wondering if this thread should be closed.

Reply · Quote · Report · Send a PM

Kasper >> Alexander Ostrander, you must be proud of being stupid. You want the thread closed based on nothing stated here by me. Again, immature people resort to name calling when their arguments have no merit. Lastly, I have never been ashamed of being smart. I deride blatantly false dogma pretending to be facts in geology in specific instances by PhD's promoting drivel, which is not the same thing as hurling insults to bloggers. To wit:

1. Dr. Peter Heaney went to Gran Canaria, dug in an ash flow on the flank of a volcanic caldera at a 65 degree angle in Mogan Canyon, and found tabular snakeskin chalcedonies rich in

moganite up to 90% as measured by Raman spectroscopy. From this he concluded that the highest moganite content rocks in the world are evaporites. Excuse me, Gran Canaria has no evaporites. He also is unable to grasp that infrared spectroscopy clearly shows two moganite populations, identified only as “moganite” as per Raman, which have different graphs in reflectance infrared. (One Raman response, two infrared responses, with Raman moganite found for both, which is a 501 cm shift band). One is linked to all ballen quartz (fused overlapping quartz hemispheres) in the world, presumed to be from impactites while these are dug out of supervolcanoes.

2. Dr. Peter Heaney cites Lake Magadii with magadiite as a precursor to agate, perhaps via kenyaite. However, infrared shows no magadiite or kenyaite can be located in any agate, and the British drill core from the early 1950’s in the lake sediments shows the chert there is under 45 feet of volcanic tuff and 100 feet removed from overlying magadiite. His belief agates form in playas is preposterous as there are none in the Western United States I have studied with an agate. Agates cannot form in hypersaline systems, with zeolites, or by weathering, so nothing Dr. Heaney proposes for agates is remotely viable as a model of agate genesis.
3. Terry Moxon in England proposes that moganite is found with a 650 cm-1 spectral peak and moganite content can be calibrated to this as it drifts from 555 cm-1 to 650 cm-1 with higher moganite content. This is total bunk. The 555 cm-1 alpha-moganite band never drifts in my archive of 1000 moganites, and I have exactly zero 650 cm-1 infrared bands, except when I have quartz veins with the zeolite mineral heulandite, which is also found in the tuff shells that coat Gran Canaria, Spain type locality for moganite.
4. Terry Moxon in England proposes that agates are 99% quartz. This is bunk science and degenerate thinking. Agates as whole specimens contain as little as 40% quartz, but note Moxon is never talking about whole specimens in his published commentary, a slight of hand and twisting of words that confuses amateurs. He filters his agates for a specific look, and concluded cores of agates are mostly quartz by excluding all other agate specimen mineralization which is “not quartz” to use his words in corresponding with him.
5. Parthasarathy published a paper defining moganite with a 605 cm-1 band while digging in the Deccan Traps basalts in drill cores filled with zeolites. The 605 cm-1 band is a master band for clinoptilolite, not moganite.

Gregg Little March 02, 2017 09:06PM

Jolyon;

I find Mr. Kasper ramblings very difficult to follow as he jumps around in the geological realm going from snippets of scientific investigations to depositional environments to post-depositional processes with very little in research back-up or references or collaborating visuals. As Alfred points out he is absurd in attempting to discredit foundational work and basic analytical procedures successfully used by hundreds to thousands of trained field geologists in the resource exploration industries to this day.

Kasper >> I use thousands of research citations in my books. You do not as you are illiterate, Gregg Little. This is an amateur blog. Graphs and citations only go in books. To keep the discussion simple, you get the conclusions here, at least a few of them.

Mr. Kasper also confuses geological terminology through out the thread; as you pointed out with mono-mineralic and poly-mineralic rocks. In the ground water segment he appears to readily dismiss all but magmatic waters. In near surface environments the complex chemistry of "mixed" magmatic or juvenile, hydrothermal, connate and meteoric waters is well know for influencing mineral deposition. To further cloud the conversation he keeps introducing weathering which in the context of agate formation here is irrelevant (post depositional). Sweepingly introducing continental drift and geological ages to conveniently support his climate assertions is another ruse.

Kasper >> “mono-mineralic rock.” There is no such thing. This is an oxymoron, that is, the term is self-contradictory. A mono-mineralic specimen is called a mineral. Poly-mineralic specimens are rocks. Poly-phase specimens of the same mineral are rocks.   Why? If you have a specimen with opal-C and opal-CT how do you pick what to call it as a mineral? Do you define a new mineral name, opal-C-CT? No. It is a rock with multiple opal phases. A mineral is usually a concept not common in specimens, as most are not exclusively a single mineral, but you can say that a specimen is an ore, such as a silver ore, where we understand you are extracting an element from a mixture of minerals, some with silver. Amateurs also use slang, to define a specimen based on its dominant composition, but in science, we want to be as exact as what our instruments show us, and so in science, we don’t tend to throw around slang, unless some are calling agates a variety of something.

Kasper >> That is your confusion. This is a blog and the discussion is restricted. Agates do not typically form by hydrothermal waters, and there is no evidence of formation from connate, or meteoric waters. They typically form with magmatic water that exsolved out of the melt. Weathering in agate formation is irrelevant as it has nothing to do with agate formation. The

San Gabriel Mountains of California are 350 miles long, made of granite, 30% quartz, full of voids, and have been exposed to 150 million years of weathering. Their agate count stands at zero. You need to come to grips with the fact that weathering explains nothing for agates. Standard chemistry explains very little. Most of it is well described with colloidal chemistry.

And finally one more absurd derision. Mr. Kasper appears to think that where you live determines what you can be an expert on "**Beware of PhD's writing about agates in playa lakes while living in Pennsylvania in coal country.**". Until reasoned discussion returns, Mr. Kasper's writings are becoming untenable.

Kasper >> To report on how agates form you have to collect for yourself. Agates formed in playa lakes proposed by Dr. Peter Heaney out of the University of Pennsylvania is as stupid as his claim that 90% moganite he collected on the 65 degree flank of Gran Canaria volcano in an ash flow in the Canary Islands is proof of evaporites. This man has problems. I live near Western United States playa lakes. Their agate count is zero. The Lake Magadi chert sits under 45 feet of volcanic ash, not 45 feet or 1 mm from magadiite. His magadiite-agate link is based on no agate of this planet containing residual magadiite.

I am with Alfred as he has offered, "**Jolyon, if you wish, you can remove this. I am wondering if this thread should be closed.**".

Reply · Quote · Report · Send a PM

Kasper >> Any thread that causes excessive thinking should be closed. After all this is a British blog. Derogatory trolls like Gregg Little should be blocked, stop trolling Mindat, so we can have an informative conversation.

Daniel Bennett March 02, 2017 09:52PM

they say you truly understand something when you can explain it to a kindergartener. i realize no one agrees about this then they have to try and outdo each other with jargon. for fun lets try to keep it simple here?

Kasper >> I used no kindergartener reference in this blog. You made that up.

i propose not closing it yet because i have more simple questions and pictures to talk about but i need a little time to articulate them. also other people may appreciate it. and does it really

solve a problem to close it?
thanks for your tolerance.

Reply · Quote · Report · Send a PM

Gregg Little March 02, 2017 11:26PM

Sorry Daniel, carry on asking and articulating as that's what we are up for, as opposed to violent eruptive discourse, ranting in a geological vein or depositing absolutes. We take a lot for granite but the discussion should have a gneiss demeanor.

Reply · Quote · Report · Send a PM

Kasper >> This is an amateur blog, not a technical journal. You get the free time I grant you. The conversion has now sputtered off into name calling. Back to the Age of Dana. Gregg Little is an ill-behaved, immature troll.

Alfred L. Ostrander March 03, 2017 01:21PM

Daniel,

My comments were tough. I will ask you this: Do you want good science or not? And are you in an informed enough position to understand some of the complexities of the arguments against some of the broad and sweeping statements that have been made?

Kasper >> This is a blog, not a research report or book. You get the conclusions only.

As to understanding something so thoroughly that you can easily explain it to kindergartners, I don't think this applies to the the very real complexities of agate formation. Initially you proposed what you considered a logical and workable hypothesis. As logical as it sounded it was not based on good geologic evidence. At least you asked and I respect that. Parts of this thread have involved sweeping statements that even Jolyon questioned. Some really sharp geologists have raised serious questions in response to these sweeping claims.

Kasper >> I used no kindergartener reference in this blog. You made that up. Yet, it is clear that I could explain to a kindergartener that there is no evidence of agates from weathering.

Kasper >> Lack of understanding of others is not my issue, it is their issue. Clichés and dogma from the Age of Dana is not modern science. No research report of the modern era identifies minerals by refractive index, for example, but you still do.

The difficult part of this lies in the fact that Mr Kasper has done a lot of work and has a lot of data. What is in question is his interpretation, his presentation and apparent disdain for the foundations of mineralogy and geology in general. Shall this continue without question and what would you really learn if such tenuous premises are left standing? What would anyone else learn if they come across this thread and accepted unproven conjectures as sound science?

Kasper >> Note that not one "sweeping claim" is cited. More name calling. Insults are not science. Alfred Ostrander is an immature troll.

I seriously doubt the positions taken here are simply efforts to outdo each other with jargon. However, it might be difficult to follow what is going on if you do not have the background in things geologic. How then do you sort out the false from the true? I presented comments from researching Mr Donald Kasper relating to his own statements to help clarify that he can get off point and venture off into unsubstantiated rhetoric.

Kasper >> Discussing volcanology is not unsubstantiated rhetoric. Be specific. Oh right, you cannot. So you are spouting rhetoric.

That is why I asked if this should come to an end. Please do not think for a moment that I take any pleasure or fun calling out bad science. I mostly find it onerous. Quite frankly, I far prefer being out in the field wearing out another good pair of boots.

Kasper >> Don't let your brain explode Alfred Ostrander. Read that book by Dana again. Go identify minerals by refractive index. The opal in agate banding identified in the mid 1800's by refractive index was false. The mineral is beta-moganite.

Please continue to ask more questions. If not directly related to agate formation might I suggest new threads to clear the deck, so to speak. Just a thought to consider. J. D. Dana is physically dead. Science has progressed. J. D. Dana and his work still stand as an example of fine work. I ask no pardon for being a bit prickly in light of claims regarding his "death".

Kasper >> The death of Dana is a fact not an allusion to a concept, and therefore does not get put in quotes. So what does “An age of Dana” mean? It means mineral identification circa 1850. No infrared or Raman or X-Ray spectroscopy, no mass spectroscopy, or other equipment was available. Mineral identification by refractive index that he used, does not work definitively, and is not part of modern mineralogical research, for example. So books written on mineralogy or agates in particular, citing the data and conclusions from the Age of Dana, is incompetent, retrograde writing that is put into books all the time because it is fast and cheap and simple. It is dogma and cliché writing, not science. Heddle wrote at that time of volcanoes erupting by describing them in terms of tea pots. Is this carried forward to current research? Is his statement of tea pots considered modern volcanology? Certainly not. Yet this is the type of obsolete technological discussion that dominates common mineral literature to this day.

Reply · Quote · Report · Send a PM

Daniel Bennett March 03, 2017 06:11PM

please know I mean no offense to anyone with this. here is a bad picture of many air pockets in basalt with every ten or so being filled in as an agate. I would think a quartz ball makes a similar pocket as a gas bubble in basalt. if the agate formed from water/silica mixture penetrating the basalt then I would expect all air pockets should be filled in with agate. instead this picture implies that the quartz balls were swirling around in lava along side with gas bubbles.
it could be that they were all filled in and most have fallen out already but I don't think so. some pockets are %75 intact and empty.

basalt.jpg

Reply · Quote · Report · Send a PM

Kyle Beucke March 03, 2017 07:03PM

Daniel, I don't agree with that assumption. I have seen porphyritic, volcanic rock that has been hydrothermally altered and where some open spaces have been filled with hydrothermal minerals (sulfides, quartz) and others were not (or less-so). Altered rocks with replacement minerals or minerals filling open spaces are not uniformly filled-in with these minerals. The fluids travel through minute spaces (between crystals/grains?), not necessarily forming distinct veins, so it can be impossible to know where the fluids traveled.

Plus, chalcedony is a low-temperature silica phase, right? Not something I would expect to form in lava/magma.

Kyle

Reply · Quote · Report · Send a PM

Kasper >> 135 million years of weathering should have filled every last void, Kyle. The fact it did not disproves your weathering model. If my ID of beta-moganite is correct, agates are full of it in specific structures, where it forms at 354 C. That is 330 C more than weathering. Quartz crystals do not form in dripping water, Kyle.

Gregg Little March 03, 2017 09:16PM

Good question Daniel. There are at least a couple of overriding factors at play here and a little background helps clear this up. To start with it is generally acknowledged that chalcedony is formed or deposited in liquid or, gas to liquid phases (THE AMERICAN MINERALOGIST, VOL. 46, JANUARY_FEBRUARY, 1961., SYNTHESIS AND ORIGIN OF CHALCEDONY). This usually means the lava flow has solidified, freezing the gas bubbles in place. The lava can still be hot as fluid basalt has been recorded at 750 to 1000 C at Kilauea.

Generally chalcedony deposition occurs at relatively low temperature (180 to 300 C) and pressure (near surface) in what is usually termed a hydrothermal system which is the plumbing system that allows fluids to flow through the rock via fractures and voids like the gas bubbles (vesicles) in your picture.

Kasper >> Hydrothermal water does not make agate. Venting systems in very specific circumstances with bacterial mediation makes silica banding on a very small scale, on the order of microns. Micron banding specimens are not considered agates.

That said, the liquid or gas bearing the silica in solution has to have access to the vesicles which is normally by fractures often form during cooling (shrinkage) of the lava flow. It is plausible that not all the vesicles would be intersected by fractures so when the hydrothermal system kicks in, some of the vesicles would be by-passed. Even if later the vesicle was fractured (further cooling, tectonic movement), the hydrothermal fluids could be depleted in dissolved silica and then other minerals, like calcite, could deposit instead or the space could just be devoid of minerals.

Kasper >> Hydrothermal water is recirculated and heated ground water. Ground water contains vastly more calcite than silica, contains humic acid, and contains salts. Meanwhile, agates have vastly more silica than calcite, no humic acid unless the shells are weathered, and no salts, no evaporites, no borates, no magadiite, no kenyaite, and no sulfides beyond pyrite and marcasite. Your hydrothermal groundwater model as is the Heaney playa evaporite model are bunk, and very trivially provably so.

Kasper >> We know when and where hydrothermal fluid flows because it alters the host rock it contacts. Kyle is now describing spooky physics where hydrothermal fluid moves around with no alteration of the host rock. Agates are found in lavas with no hydrothermal alteration of the host rock except where it was altered after the agate formed. Zeolites show hydrothermal alteration, and are not existent within agates but can fill the remaining voids in a few sites in the world. Calcite is 1000 times more soluble than silica in solution, so 99% of voids should be filled with calcite. Sorry, this is not observed. Groundwater circulation and amygdule mineralization don't match basic solubility chemistry. But, magmatic water and silica can exclude calcite. That happens to be the only way apparent.

So there are multiple conditions to be met for chalcedony formation least of which is temperature, pressure, fluid chemistry, opportunity (fractures) and lava composition. Even the water that drives the hydrothermal system is complex with at least two possible sources; juvenile or magmatic (from the lava itself) and precipitation (meteoric). Meteoric water is usually neutral to mildly acidic so it would have to be changed by the rock it flows through to a mildly alkaline solution which is what chalcedony forms in. Very complex so I hope I wasn't too wordy or convoluted.

Reply · Quote · Report · Send a PM

Daniel Bennett March 03, 2017 10:32PM

thanks well that makes sense if it gets there through cracks rather than just flowing "through the rock". shouldn't there be seams on the agates from the cracks ? or agates nearby each other might be connected by excess chalcedony still filling the cracks. has that been observed in basalt? I haven't seen it but that would confirm what your saying for me. it would prove it...

Reply · Quote · Report · Send a PM

Wayne Corwin March 03, 2017 10:59PM

Daniel

It doesn't need cracks, the water can pass right thru the rock 😉

Reply · Quote · Report · Send a PM

Donald Kasper March 04, 2017 12:03AM

You can advance infrared spectroscopy, and identify refractive index in the graphs of all minerals, in two places. Then from that, you can map all the silica minerals with those spectral effects. Then you will discover that you have about twice as many spectral band positions as you have silica minerals. I will name all of these after members of my family as new mineral species polymorphs of silica, else, these are the beta mineral polymorphs. Then once you find them, you go over to ceramics research and get their graphs of high temperature silica polymorphs in infrared. Everything matches. The volcanic rocks and the ceramic glasses have the same bands linked to refractive index. They are invariant. You get one, you know what you are seeing. This is called modern infrared. You have to advance the technology, then an artifact of that is you can advance the study of volcanic systems and the agates they contain.

So that disproves the consensus that beta-mineral forms all invert to alpha. In fact, discussing this with the senior professor of mineralogy at Caltech, I did ask if he had any proof all inversion is 100%, and nothing can be left behind as beta. He said no. Of course, we have coesite in the Alps, still identified with spectroscopy such as infrared, and I have such a specimen with a signature coesite band. Up 20 km, still coesite. So the notion high temperature and pressure polymorphs do not exist at the surface, is false.

Okay, you have a problem. There is beta-quartz in your agate dilation structures. 1 millimeter away it is 10% alpha-quartz in the banding. Explain that.

Tubes of escape from exothermic heat.

Tubes of entry to leach in silica sitting in dilation structures was just disproven. Beta-quartz forms at 575 C.

Some have beta-moganite, formed at 354 C.

The least squares regression graph correlation infrared spectral data in a linear fit has been generated, and has a correlation coefficient of 0.998 correlating refractive index to spectral data of all silicate minerals, and silica ones themselves as well. This statistical number ranges from 0 (random noise) to 1 (perfect fit to the line). This is a discovery of a law of physics. Fight it if you want, but you are going to lose. Armed with that, we have beta-silica minerals in agates in specific structures.

Two polymorphs of quartz in one specimen is the geologic definition of a rock. The varietal bunk has to go. We need to upgrade the conversation.

Edited 2 time(s). Last edit at 03/04/2017 12:09AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Gregg Little March 04, 2017 12:37AM

True fluids can pass through seemingly solid rock. In the basalt flows on the Bay of Fundy (Nova Scotia) we often see seams of agate/chalcedony filling larger fractures. The agate may actually be in your location but because the fracture space is so small and the rock weathering, it might be overlooked in the crumbling material.

Reply · Quote · Report · Send a PM

Kasper >> Water does not go through rock. But supercritical fluid does. That is fluid over 374 C. The picture here is a cooling crack and silica fill from degassing. You need to bother to observe critically. When you get to that point you will understand that these vein agates are always within 10 degrees of vertical. There are zero horizontal vein agates. Why? These are cooling structures in volcanic lava piles, and as such they degass and cool, forming only vertically. You have zero horizontal agate veins from weathering on this planet unless it was tectonically shifted after formation. Even then, the count so far is still zero. Now you know.

Donald Kasper March 04, 2017 09:07AM

The purpose of science is to create conceptual models that explains the natural component under study for purposes of predicting natural systems behavior. If I develop a complex geologic model that explains everything seen, accounts for the literature of what others have seen, and explains it all, then I consider my model a superior model.

To achieve this, when you hit roadblocks in understanding it can be that the science itself has not advanced enough to provide an answer. Understanding agates is a byproduct of a superior understanding of volcanology, petrology, and instrument data such as the nature of the behavior of infrared spectroscopy.

So, when they say supercritical fluids start at 374 C and don't say what the upper temperature limit is, I know there must be an upper limit as supercritical fluids are not found on the sun. So I work down from there. Then I ran across chemical engineering and metallurgy research that defines yet another state of fluid matter they named ultra-supercritical water. It starts at 575 C, and they have coal boilers using this up to 610 C. Okay, what is the upper limit of supercritical water? 575 C. Okay, that is a quartz transition. Let us pen in that the crystal structure changes on fluid transitions, and this is why it does so. What is the next silica transition? 870 C. Okay, let us pen in an upper limit of ultra-supercritical water at exactly 870 C.

We just explained key silica polymorph transitions. Things are looking interesting.

Then we roam over to ceramics research and study the formation of optical quartz in a lab. They use high pressure autoclaves. What is the temperature they use to make optical quartz? 354 C. Right on the beta-moganite transition on the low end of the supercritical fluid transition. Why no higher? Because then you get contaminated quartz. What is contaminated quartz? Quartz with Brazil twinning. Okay, what is documented in all the literature is a key component of making banded agate? Brazil twinning. Okay, how does this jive with your weathering model? Not well.

Then if you heat the quartz, it changes to another twinning state, Dauphine twinning. Where does this live? Its temperature is well documented, and lives at exactly 575 C. Okay, what is the upper limit of making an agate? 575 C. Agate has no Dauphine twinning. This is the end of the line for agate. You have no physics to explain Brazil twinning at 10 C surface conditions, and ceramics chemists already know where it lives.

We just impugned on your weathering model, explaining a huge chunk of the physics we see and we are building a model of volcanology.

Let us not forget petrology. What is the meaning of metasomatism, medium grade metamorphism, and fluid-rock interaction? They are synonyms for supercritical fluid geochemistry. Look up the temperature ranges studied for this metamorphism. This is where it lives.

What is the meaning of high-grade metamorphism? Ultra-supercritical fluid geochemistry. Above 870 C, the water dissociates completely into H and OH. This is the end of high-grade metamorphism, and it is controlled by what water does.

So, where does rhyolite live? Ultra-supercritical fluid. This is why rhyolite lives here. The state of rhyolite from liquid to glass, the crystallography of the silica, the twinning that occurs, the metamorphism we see, is all the same story.

Edited 4 time(s). Last edit at 03/04/2017 09:35AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Donald Kasper March 04, 2017 09:39AM

Any model of agate formation has to account for vein agate, amygdule, and geode formation.

Amygdules and geodes form in geologically closed systems on a scale of inches. Vein agates form in open systems, and can form in contact with the surface. As such, the fluids are not expected to be supercritical, and formed at and just under supercritical temperature. Except for a small handful of vein agates in the world, they will not have waterlines. When they do, they form perpendicular to the outer wall surface in vertical veins or nearly so. Algal structures can be found in some, along with surface mud, clay, and sand. Yet, the exterior shells are celadonized in all these systems.

Reply · Quote · Report · Send a PM

Donald Kasper March 04, 2017 09:50AM

Lava degasses upon coming to the surface from decompression, and the silica and feldspar separate. The silica comes from the melt. If you classify all silica minerals in infrared, then all the feldspars, you will see that lavas are primarily silica-feldspar exsolution systems. These are the two overwhelmingly dominant minerals seen with a method of spectroscopy such as infrared. Trace mineralization is not apparently controlling these lava systems.

After classifying all the feldspars in infrared, I studied the geodes. The lava shells represent silica capture of the magmatic host rock they formed in, so those shells tell us the lava and conditions the agates formed in. Armed with infrared spectroscopy, you will discover no plagioclase feldspars in volcanic geodes. Only potassium feldspars.

In a weathering model, the host rock is irrelevant, and therefore this behavior is not explained by a weathering model of silica and water dumped about in opportunistic voids of any kind, but we already know that 1300 miles of the Sierra Nevada granites have zero agates, so water, silica, and voids cannot explain this omission.

In the geode lava shells, there is just one group of feldspars to be found in infrared--potassium feldspars. All except microcline, which is only found in granites. Why potassium feldspar? This group is the exsolution king, and when you talk about lava exsolution you are talking about potassium feldspars. For example, the solvus point for sanidine to exsolve is 575 C, at the liquid to glass state transition of rhyolite. This changes the viscosity of the lava and accounts in part for the changes from liquid to a fluid glass.

So, if you have a geologic world that only has potassium feldspar lava shells, known for silica-feldspar exsolution behavior, why do you have to worry where the silica came from? It is right there.

Edited 1 time(s). Last edit at 03/04/2017 09:51AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Donald Kasper March 04, 2017 09:59AM

If you collect geodes from Fallen Tree, Oregon, the shells and voids are filled with mordenite and clinoptilolite. The agates however, do not contain them, in their silica. They are in their central voids, but again, not in the agate silica. The hydrothermal action came after the agate formation dropped dead. No silica came later to fill those central agate vugs and mordenite with more silica. Not one. How so in a weathering world of 10 C deposition? You tell me. I don't model agates formed from weathering.

Reply · Quote · Report · Send a PM

Donald Kasper March 04, 2017 10:11AM

Where hydrothermal fluids flow, you get bleaching of the host rock, which shows the channelways. This does not exist in lava flows with geodes. No alteration, no flow. Period.

When hydrothermal fluids do, in very exceptionally rare cases, enter into silica systems such as agate structures, we can see it, because we get supercritical fluid etching of embayments of the quartz, and the hydrothermal fluid with 1,000 times more carbonate than silica in solution, dumps a load of massive calcite as its calling card to let you know it was there. There are Scottish agates with embayments chopping perpendicular through the agate banding, and filled with calcite, for example. This observation has confused people back to the time of Heddle, who pondered over this problem.

Hydrothermal fluids dump calcite, not silica. Silica is almost insoluble in water. Calcite is highly soluble. This is why surface and groundwater circulation makes caliche, not agate. Caliche is not found in agates. The Baker Mine, NM has caliche pendants in the central vugs inside the agate and waterlines, but never in any of it. I did find, in 20 years study, one agate from the Santa Monica Mountains, CA with a floor of caliche. That is as close as I have gotten. However, the Baker pendant silica is crystallographic quartz crystal jumbles, every one apparently connected to a fissure and the area also has cones from venting silica into the voids. Vented silica makes cones, bigger becomes "chalcedony roses" which are really agates, and full coating in voids becomes Ocho agates from Paraguay. These are feather agates, where the banding formed, then deformed and tore into curled segments with very strong Brazil twinning sitting between banded agate and stockade quartz structures.

To have groundwater you must have humic acid. Hydrothermal water is heated groundwater. Therefore, universally, agates should be filled with a humic acid signature, which infrared is very sensitive to. I have bad news. Only a few rare sites, and only in the shells from weathering leaching into formed agate. Most agate water is in the shells, not the cores. Humic acid is in the shells, not the cores. The observations dispute a weathering model.

Primary magmatic calcite is never massive, it is scalenohedral, a form documented as the key state in mixed calcite-silica systems going back to observations geologist made in the early 1900's in New York.

Edited 1 time(s). Last edit at 03/04/2017 10:16AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Knut Eldjarn March 04, 2017 10:24AM

Interesting discussion even if somewhat confusing. Banded chalcedony with a quarz/moganite composition seems to occur in different geological environments - and could probably be caused by different processes even if a vulcanic origin seems to be the vastly most common.
I just returned from a week in sunny Gran Canary and visited the type locality area for moganite. The silica-minerals quarz and moganite seems to be more sequencely separated in these ignimbrite localities. I wonder if this could be caused by the combination of under-cooling of parts of the silica containg fractions causing the crystallization of purer moganite, and if such under-cooling and low-temperature solidification could be caused by the physical forces of the pyroclastic flow creating the ignimbrite? In the case of these localities with many layers of lava flows below and above the ignimbrite, it is clear that the chalcedony/moganite/"agate" formation in the ignimbrite must have been related to this specific lava flow since I did not find a similar mineralization in the lava flows above or below the ignimbrite flow - even if their were many voids and cracks that could have been subject to such silica-formations if caused by post-vulcanic hydrothermal processes.
Any ideas or comments to these observations?

Knut

Edited 2 time(s). Last edit at 03/04/2017 03:45PM by Knut Eldjarn.

Reply · Quote · Report · Send a PM

Kasper >> First, only tabular snakeskin chalcedonies have high moganite content. Lobate, orbicular snakeskins do not. Lobate specimens are at 15%, and tabular to 90%, even in the same flow site (Fort Irwin, CA). This infers that heat exposure is related to the moganite formation. My infrared model indicates the high moganite content rocks are mixed alpha-beta-moganite. This would set the temperature just under 354 C. Also, as you correctly pointed out, Gran Canaria high moganite content is not related to evaporites and the Canary Islands are not evaporite sites, they are volcanoes.

Larry Maltby March 04, 2017 04:29PM

Knut,

I agree, much of the dialog above is confusing, some interesting insights mixed with strange conclusions. As you point out moganite likely plays a significant role in what we observe in agates. For me, the formation of agate that I observe in sections cut through basalt is the sum total of all of the processes that it has been exposed to over geologic time including secondary depositions and alterations. I became interested in moganite about three years ago and researched as much information as I could find. One professional paper stated that moganite was seven times more soluble than regular quartz. Another study regarding the solubility of quartz suggested that as a solvent exceeds a PH of about 9 the solubility of quartz increased significantly.

I do see much evidence of dissolved or leached bands in agates in the Copper City Flow in Houghton County, Michigan. Sometimes the bands remain open and sometimes the leached bands are replaced with hydrothermal copper. It would seem that a reasonable geological environment would be dissolution of moganite bands in agate by a hydrothermal base and then a change in the hydrothermal solution resulting in the deposition copper and the recrystallization of quartz.

You can see the amazing diversity of mineralization in the amygdaloidal basalts of the Copper City Flow at this location:

https://www.mindat.org/article.php/1801/+St.+Louis+Mine%2C+Houghton+Co.+Michigan

Kasper >> Agate is porous. Cations leach in and out after formation all the time. The typical intrusion is clay. It involves no dissolution of the agate mineralization.

Daniel,

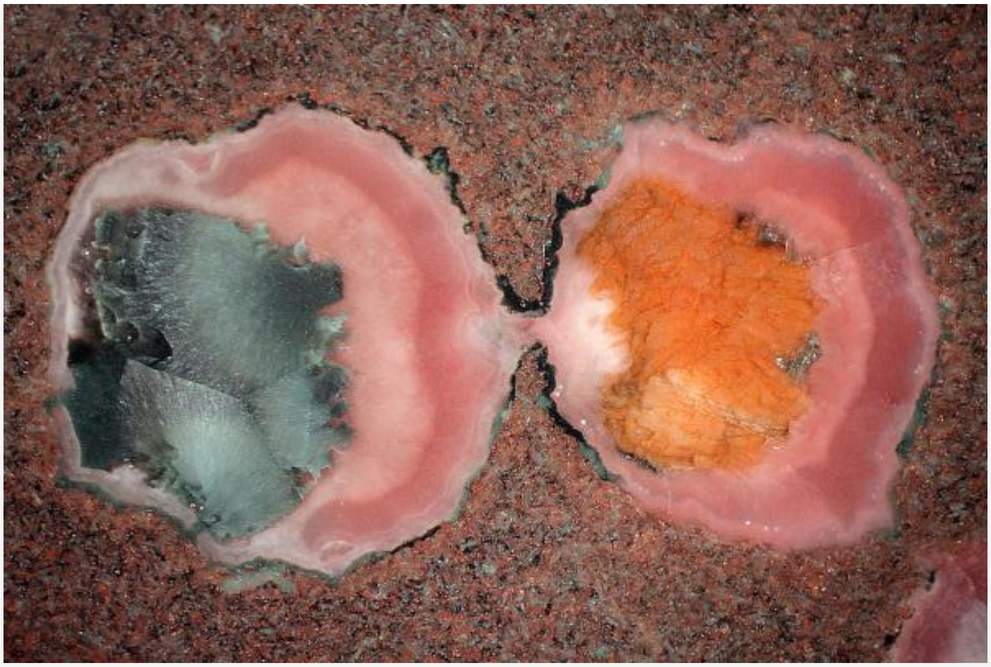
Here are some photos that may help you understand how fluids move through rocks and agates. The first one shows a micro fracture in basalt that passes through an agate and transports hydrothermal copper and quartz resulting in a “healed” fracture in the agate. Note that there are minute dots of copper throughout the basalt matrix indicating as Wayne said that fluids can pass through microscopic openings in the rock.
(Tom Rosemeyer specimen)

The second one shows a passage between two amygdales. Both have pink quartz rims but the lower has secondary pumpellyite and the upper has secondary laumontite. (Larry Maltby specimen)

Kasper >> Pumpellyite and laumontite are indicators of medium grade metamorphism, not weathering. These two minerals can be in association with, but are never inside of, an agate.

5.0AgateinbasaltwithcopperveinFOV18.0mmSt.LouisMineHoughtonCo.Michigan2.jpg

Kasper >> This is a post-mortem facture and copper intrusion long after the agate formed.



47.1AgateFOV10.0mmSt.LouisMinewithpumpellyiteandlaumontiteW3.jpg

Kasper >> These two amygdules are internally connected, not externally connected to intrude silica.

Edited 2 time(s). Last edit at 03/04/2017 05:17PM by Larry Maltby.

Reply · Quote · Report · Send a PM

Kasper (earlier inserted response)>> Just before your post on agates last Sunday, I sent over to infrared scientists at Caltech what could be the first master calibration graph of regular infrared to Raman infrared. Moganite is defined by what a Raman machines sees and no other. Yet a spectral effect appears in infrared that can be calibrated to this Raman data. I just have regular infrared and Caltech has both. They also have the same model of infrared machine I do, so we share specimens.

Based on that, the only agates that exist with high moganite content over 15% in the world are a class of crustal chalcedonies. Monday I received from a German collector, a specimen of moganite from the type locality on Gran Canaria, which matches a graph Caltech generated for me of their one specimen. From that, I have in my own collection a site of moganites of the level of a Gran Canaria at 90% moganite.

No agate and no other chalcedony in the world has yet been found by myself, others I correspond with, or Caltech that is over 15% moganite, which is a hard limit, other than these chalcedony crusts found in tuff flows.

When you read of higher moganite concentrations in the literature, this is based on the attempt to calibrate Raman to X-ray spectroscopy, which takes the 15% reported by a Raman machine by which moganite was discovered, and converts that to an 80 to 90% value. Those are adjusted numbers.

Since moganite is a silica polymorph and as such is almost totally insoluble in water, we need to constantly find moganite residues in our agates as miscellaneous globs and blobs and crusts for all the times the conversion was not complete or else a conversion model has no physical support in the specimens we see.

If moganite is inverting to quartz, I have 135 million year old agates from Kentucky filled with moganite microspheres in banded quartz that are totally unaltered. When you see a shadow agate, the shadows come from moganite deposited as plates on banding planes.

These leads me to conclude to far that a moganite precursor is unjustified. That is based on my collection of agates at some 40 tons, and access to thousands of pounds and tens of thousands of specimens of avid collector friends I have borrowed specimens from and scanned in infrared, and not from one site alone. I also get specimens regularly from collectors around the world from China to Turkey.

Moganite structures residing today in agates makes a moganite precursor model untenable. As for opal, the tubes in Oregon geodes are opal-CT, therefore opal as a precursor when it has sat in Tertiary volcanic agates for 75 million years, is also unjustified by the data.

What you get fed in popular literature are generalities. What you see in research papers are conclusions based on about 10 or less rocks. This is insufficient to catalogue what agates have by 4 orders of magnitude, and leads to overgeneralized conclusions derived from undersampling.

Gregg Little March 04, 2017 10:53PM

I concur with Larry Maltbywhen he says, "I agree, much of the dialog above is confusing, some interesting insights mixed with strange conclusions.". Again, no supporting visuals, tables, graphs, charts, scientific references, etc. Again Mr Kasper brings up the extraneously issue of weathering and once again I don't understand why a post depositional process is invoked then discounted when it is not involved in the agate forming process in the first place.

I offer quotes from scientific abstracts;

From "Contributions to Mineralogy and Petrology, March 1993, Volume 115, Issue 1, pp 66-74, A Proposed Mechanism for the Growth of Chalcedony":
The structural disparities that distinguish chalcedony from macrocrystalline quartz suggest that different crystallization mechanisms are operative during the growth of these two forms of silica. Although the paragenesis of chalcedony has provoked marked disagreement among researchers, a review of previous studies supports the idea that chalcedony can precipitate from slightly saturated aqueous solutions at relatively low temperatures (<100° C).

THE AMERICAN MINERALOGIST, VOL. 46, JANUARY_FEBRUARY, 1961 SYNTHESIS AND ORIGIN OF CHALCEDONY* J. F. Wurrn eNo J. F. ConwrN, Departments of Geology and Chemistry, Antioch

College Yellow Springs, Ohio. Ansrn.qcr: Synthetic chalcedony has anomalous properties similar to those of natural chalcedony. These properties have been explained by submicroscopic holes and inferred disordered regions between fiber interfaces. The properties and origin of synthetic chalcedony are compatible with these concepts. The chalcedony was made by transformation of solid silica in the presence of hydrothermal solutions at moderate temperature and pressure. Chalcedony was not directly precipitated from solution, but formed only by transformation of silica glass or cristobalite. In general, no conversion took place in slightly acid solutions, while complete, rapid conversion occurred in slightly alkaline solutions. The transformation proceeds indirectly by way of cristobalite and keatite. Chalcedony is regarded as a secondary, metastable, transitional phase' The peculiar properties differentiating chalcedony from ordinary quartz may be a result of nucleation and growth in solid material (silica glass, opal, silica gel, or cristobalite).

Reply · Quote · Report · Send a PM

Kasper >> Chalcedony is stable up to Permian, 350 million years, which means that it is not transitional. No keatite exists in agate. Making something in a lab does not prove how it is made in nature, it only presents a possible pathway. There can be more than one pathway. Natural agate (chalcedony with banding fibers) has moganite, which cannot be made in a lab. Silica can be precipitated by radiolarians at 4 C with enzymes. This is however, not agate and your structures will never have waterlines, which are supercritical-subcritical transitional features only. Agates do not form at a time, pressure, alkalinity, temperature point. They form on curves of these relations. The temperature is up to 425 C.

Ralph Bottrill March 05, 2017 02:54AM

Donald you raise some interesting questions and ideas, but they get lost in a hyperbolic diatribe against other researchers not here to defend themselves. You indicate there is a lot of supporting data, so you really need to collate this systematically and submit it to a scientific journal for peer review. Despite you feeling you are the only person in the world who understands the subject properly, most scientists are very interested in new concepts and interpretations and will welcome such research if it can be logically presented and substantiated. But you will have to carefully review the opposing views and refute them if you can. There seems to be an overwhelming support for relatively low temperature formation, but if you can support beta quartz formation in agates, supercritical fluids in sediments, no groundwater in deserts, etc, then the data needs presenting in a peer-reviewed journal, not in long rambling posts in Mindat. Though we welcome seeing some photos, references, etc.

Kasper >> Blogs get conclusions, not research data. Time is limited. I have low opinions of PhD's promoting lies, clichés, urban myths, and juvenile chemistry as research.

It's instructive to compare agates with related materials. They are often difficult to distinguish from other chalcedony, except for the banding, and notably chalcedony often seem to replace opal. Agate and opal can form in cavities in petrified wood, and in cavities in silicified dolostones with no sign of volcanics. Chalcedony can infil and replace many permeable or reactive sediments, sometimes in hydrothermal systems, sometimes due to kaolinisation of feldspars releasing silica, or recrystallisation of volcanic glass, with no sign of high temperature alteration.

Kasper >> Chalcedony has none of the mineral inclusions of agates. Chalcedony lacks celadonite, strongly linked to agates. Petrified wood only forms in volcanic tuff, nowhere else, so the comment that they have quartz and no volcanics is false. Kaolinization of feldspar would link agates to kaolinite, which is not found. Kaolinite is only found in agates in wet climates, so that intrusion is from weathering. In my books, I do review a number of low to medium grade metamorphic systems that may be related to agate formation such as feldspar dissolution. The silicate reactions are at higher temperatures and occur in the lava melts already before the agates form. I have zero feldspar graphs captured in infrared within any agate. So the link is not direct, it is precursor to agate forming conditions.

But the banding in agate is the difference. It often seems to start as small botryoidal to stalactitic growths on the wall of the vesicle or cavity, (though often predated by clays), eg. https://www.mindat.org/photo-301303.html, which coalesce to form bands mostly parallel to cavity walls. Or horizontal, presumably due to a gas/water interface. But you can very commonly see a spot or two where the bands join at a feeder point, where the silica-bearing fluids entered the cavity, eg. https://www.mindat.org/photo-84206.html. In thin section you can see microfracturing in the host rock with commonly some fine chalcedonic filling. None of this proves a high or low temperature of course, but does indicate a slow, sustained, rhythmic (seasonal?) growth, with fracture control of permeability as Larry indicated. There is no evidence for exsolution or rapid dumping of masses of silica as far as I know. You might expect supercritical fluids to exsolve rather rapidly from volcanics and form coarse crystals, not hugely protracted microcrystalline growth.

You can get agate like textures in calcite in travertine, cave formations and in volcanic rocks. Those are usually considered very low temperature. Ditto malachite, siderite and many other carbonates, plus goethite, hematite etc. These seem to be due to slow growth in a damp, but not water-filled, environment, while we find in permanent pools in caves we often get, in contrast, well-formed crystals. So I guess that's an appropriate analogy for agates, damp cavities relatively rapidly getting coated in silica (maybe opal at first), and sometimes when later filled with water, the macrocrystalline quartz may grow more slowly?

But I'm no expert, so welcome other ideas, preferably with supporting data?

Whether agate is a rock or mineral is another important discussion. Its like travertine, chert, flint, jasper, limonite, marble, serpentine, manganese oxides, etc., these can all vary from monominerallic to complex mixtures. It does seem inconsistent to call something a mineral when it can contain sub equal amounts of two or more distinct minerals, while eg. quartzite is usually called a rock even when 99.9% pure quartz. The distinction on a specimen or field basis usually comes down to a definition of minerals being visually homogeneous materials forming small scale structures (eg crystals, geodes, veins, phenocrysts, porphyroblasts, etc) generally post dating the main host rock. (Yes I know phenocrysts predate the host rock!). If it forms large rock units then it's just a rock. But materials called a mineral in this field classification may actually be mixtures when analysed, so then should then really be labelled a rock. Though we make exceptions for things like sand calcite, or rutilated quartz, where the host crystals are prominent and dominate the mineralogy. We could probably make a similar exemption for agates, based on morphology, but this gets very subjective and maybe we could include it as both a rock and a mineral, along with chert, flint, etc? In reality it's no different to listing marble and limestones under calcite, sometimes that's all they are, just on a large scale. Someday we may have a problem when we find agates dominated by moganite!

Reply · Quote · Report · Send a PM

Kasper >> What you get told in an amateur online forum are the general conclusions of 8 year infrared spectroscopy study and 20 years field collecting. As the data is enormous, it cannot be posted online and the time to assemble it would be vast.   Books I have written on the subject have been reviewed by a host of mineralogists in Europe, particularly Germany where some reviews have been published in German there. If I post data online, by definition it cannot be used in a research paper as that has removed its value for the journal to use. They want unique and new data, not public domain data in their papers. Publication does nothing for me as I talk to PhD's around the world all the time. Several have reviewed books in the past. They are all busy, but we collaborate from time-to-time.

Finally, today I received a Gran Canaria moganite to scan with my optical infrared configuration, and now I know I have at least one site of my own that also has 90% moganite. Moxon and others put out papers based on 10 specimens. I have over 2000 moganite graphs of volcanic and sedimentary rocks. Latest work infers another class of archived graphs are also moganite in lower concentration, and may produce another 500 or so. Moxon and pals overgeneralize while undersampling and not being able to see enough, start erroneously merging graphs into series. The disinformation continues, however, I think I did convince him to stop publishing that 99% quartz rubbish.

Donald Kasper March 05, 2017 11:32AM

This is an amateur forum and is not sufficient for complete geologic answers. I think I cover my case in 22 books on geoscience, some 4000 pages, which I cannot condense here. Publication on infrared involved a paper submitted to a journal whose review was poor. It was rejected based on the apparent slight of a research paper cited that was perhaps the editors colleague, while no rebuttal of a single statement in the paper was provided. Let me see. I proved the existence in natural systems of negative refractive index. While this prompted a call from a research fellow and world expert on infrared at NASA I sent this paper to personally review, the journal reviewer was uninterested. There is an issue of intellectual property rights granted to journals. In addition, it takes about 400 man-hours to write a paper, and one flippant review to reject it, in my case, apparently by skip reading the top sentence of each paragraph, then asking questions answered in the next sentences. Your experiences may have been better. I propose some ideas here for others to consider, to expand their range of thinking.

Okay, here is one.

You have geodes with lava shells. There is a class of geodes with crystallographic structural cores. Some have biconoids, two radial cristobalite blooms attached on a common surface. Then you have cubic cores (box cores), each with a cristobalite bloom on each face. Then you have triconoids, each with a cristobalite bloom on a tetrahedral face. We know this as these cores can weather out of the shells for us to study. Central buttons and radial structures are typical of acicular cristobalite structures. Now, things get interesting.

If one were to propose that gas expansion makes these structures and then the voids fill with agate over a geologic age, say 75 million years since Tertiary, what physics can be proposed to explain a gas making crystal structures in lava? There is no such physics. Okay, this model is dead.

If one were to propose that there was a mineral that made these structures, which cannot be silica by a weathering model, what is it, and where did it go? No residue of foreign mineralization can be found in any void fill lining, and I have the instrumentation to aim and look. So prior mineralization and dissolution and void fill since Tertiary does not work. Okay, this model is dead.

So, what are we left with? These structures are consistent as morphologies in the same class as beta-cristobalite and beta-quartz. The cores are now agate. The silica went nowhere. What does this mean? That class of agates are low temperature inversion polymorphs of beta-cristobalite and beta-quartz. All that happened was the structure cooled down, and its crystal structure reorganized. Nothing went anywhere. Now all the data fits.

There was no weathering. There was no void stage. However, the shells of Oregon geodes commonly have beta-cristobalite and beta-quartz remnants.

Edited 1 time(s). Last edit at 03/05/2017 11:34AM by Donald Kasper.

Reply · Quote · Report · Send a PM

Donald Kasper March 05, 2017 11:46AM

How do you get lower temperature agates? You mix supercritical CO2 and supercritical water. The inversion point is based on the ratio of the mix of each supercritical fluid. Calcite cannot be defined without stating the partial pressure of CO2 when discussing its formation geochemistry. CO2 supercritical point is 32 C. CO2 in water lowers the supercritical point.

We have dozens of variables going on, and to conceptualize can only describe two at a time. So no item discussion of two things at a point in composition and conditions covers the whole story.

There is a class of agates formed subcritical. They form slightly differently. None form from weathering. Crystal quartz does not form at 10 C. Brazil twinning does not occur at 10 C. There is no sticky physics to attach silica in water to any wall surface.

Agates cannot occur with boiling. They cannot form in saline systems. Then occur around pH 8.5, which is not groundwater pH. They cannot form in playa lakes. They have no evaporites or salts. If your silica system has salt, you get chert, and not agate.

When you have a basalt flow over a tuff flow and you want to hunt for jasper or agate, where do you look? Anywhere in flow because weathering made it? You look at the 2 inch contact of the basalt to the tuff and nowhere else. If not there, it is not in that flow. That is where the silica went supercritical. In fact, there is a class of jaspers/agates that have sediment capture floors and quartz tops. I have collected those for myself here in the Mojave Desert. All tuffs do not have the same composition, and as such agates and jaspers are not in all tuffs and all tuffs were not exposed to the same conditions, but all have been exposed to weathering since at least Tertiary.

Reply · Quote · Report · Send a PM

Donald Kasper March 05, 2017 12:09PM

Kaolinite only forms in acid systems, and from weathering. It can leach into the fiber layers of agates in wet climatic regions. Kaolinization is a key indicator of very old agates, usually Permian. More recent volcanics does not have kaolin. The clay in agates is from the smectite group only. Sepiolite is linked in many sites to purple chalcedonies. You cannot dig for agates in kaolinite tuffs to find agates.

You found agate, you look in the reported stratigraphy for the bentonite. Let me see, someone found agate in shale. The Pierre Shale of South Dakota probably has agates as it also has 7 bentonite beds.

Any geochemical reaction that releases silica at a temperature too low to make silicates, is a candidate to make agate if water is also released in the process. For example, tuff zeolitization.

Agate vs chalcedony. Chalcedony is chert. These are sulfide-rich systems where agates cannot typically, and usually marginally form. Chalcedony is granular quartz. I don't recall seeing a chalcedony with opal.

Opal precursor and alteration. 75 million year old opal is still here. I think that is a good enough test for the spontaneous inversion theory. Let me see, Moxon proposed that moganite inverts to quartz, and put a limit on this. Few tens of millions of years as I recall off hand. Sorry Moxon, I have moganite in Kentucky agates of Mississippian age, 135 million years, in an agate. Was that enough time to invert? Apparently not. There is zero alteration and difference from modern moganite sites.

Agate in travertine. Yes. On a millimeter scale. As the CO2 load changes, calcite or silica comes out. There is that issue where that was on the surface, and probably was not. In cave aragonite? No, that is preposterous.

Goethite captured in agate of volcanic origin? No. In the outer aureoles of volcanogenic massive sulfide deposits mediated by cyanobacterial mats? Yes. These are supercritical water vents. Think Missouri agates around galena deposits, a long way from the galena. Outer aureoles are alkaline, but still hot to 95 C. Forms with barite. Sulfate is key, neutralizing the acid. These are not weathering systems. They are bacteria mediated systems.

Reply · Quote · Report · Send a PM

Donald Kasper March 05, 2017 12:10PM

Correct. This is not a research forum. Sharing some ideas with those interested. Those not interested can move along. Hundreds of man-hours to show scientific proofs here is just goofy and presumptive.

Reply · Quote · Report · Send a PM

Donald Kasper March 05, 2017 12:34PM

If you label agate, quartz, the consequence is that the conversation becomes stupid. All the study of the inclusions that tell the rest of the story of agate formation drops out. To say a structure formed with celadonite, calcite, moganite, and opal is a chalcedony as quartz, then occurs. Then you get confused what the difference could be. Then someone comes along and calls agate 99% quartz when this almost never occurs and so again, all the inclusions drop out. Calcite chemistry is key to agate formation, that drops out.

What has occurred is that Moxon and colleagues, who I have corresponded with say, inclusions are not agate. Okay, study the quartz only in agate and see if it is pure. So what. This is irrelevant research. It also confuses one part of the agate with the whole specimen, which amateurs cannot discern in Moxon's/Frondel's definition. If you have an agate in your hand and it has inclusions where it is 40% quartz, why pretend it is a 99% pure variety of quartz, when this is false?

The definition gets at what you have collected as a specimen and what you want to study. The specimens we collected are almost never 99% quartz. This is a lie. It is a disgusting fraud and should stop. It is equivalent to saying houses are quartz because they have windows with quartz. The reason why the story of agates is not finished is due to this problem that the inclusions are irrelevant when they are totally relevant to the discussion.

To call an agate a chalcedony when chalcedonies lack most of the inclusion in agates creates a false equivalency. There is no opal-C in chalcedony (massive, granular quartz). No opal-CT. No scalenohedral calcite. No moganite microspheres or microdiscs on silica banding planes. No beta-moganite from supercritical fluid migration (ellipsoids). No beta-quartz. No celadonite, bentonite, nontronite, glauconite. No plumes, no tubes, no opal dendrites. Meanwhile the chalcedonies are rich in radiolaria, which is rare in marine influenced agates and nonexistent in volcanic agates. So what occurs is that when you overgeneralize terminology to overlap dozens of geologic systems, you cannot ferret out what is going on as the literature and discussion becomes confused. Because chalcedony has silica, then this approach means that cristobalite, another form of silica, is just a bunch of silica, and as such should be called a variety of chalcedony. Can you see the problem with that? Chalcedony is a rock of silica and sulfides. Agates are rocks of silica and a suite of opals, moganites, cristobalites, clays, carbonates. There is no merit to combine the two.

Edited 2 time(s). Last edit at 03/05/2017 12:38PM by Donald Kasper.

Reply · Quote · Report · Send a PM

Luís Martins March 05, 2017 04:21PM

This is starting to sound like a Trump speech...

Edited 1 time(s). Last edit at 03/05/2017 04:49PM by Luís Martins.

Reply · Quote · Report · Send a PM

Kasper >> Luis Martins has mentally immature overload, and deficit in understanding simple things. He has a stark unwillingness to learn and has established barriers to understanding.

That is, Luis Martins is an illiterate troll.

Peter Nancarrow March 05, 2017 04:23PM

I find agates an interesting subject, and I started to read this thread trying (with increasing difficulty) to understand just what concept was being discussed here, whether there was a substantive new theory of agate formation to be assesed and taken seriously, and if so could I learn anything from it.

However, having stumbled through a maze of geologically erroneous statments, circular arguments and irrelevant ramblings, the final straw which confimed beyond reasonable doubt that I was wasting my time reading this thread were statements such as:

Two polymorphs of quartz in one specimen is the geologic definition of a rock.

I see no point in taking a thesis which bases its arguments on defintions blatantly and absurd erroneous as that at all seriously or engaging in debate with it!

Pete N.

Edited 3 time(s). Last edit at 03/05/2017 04:41PM by Peter Nancarrow.

Kasper >> Peter Nancarrow, so, you were incapable of understanding anything. Okay. You also have a spelling problem. You are rude, and a troll. You contribute nothing of value to this conversation.

Kasper >> Two polymorphs are two minerals. Two minerals in a specimen makes it a rock. The rage here concerns the fact that agates are rocks representing typical rage when a technical argument that is competent is not being proposed by an emotionally immature person.

+++

Epilogue:

Kasper >> Agate formed in supercritical conditions by Wang and Merino, my emphasis on supercritical underlined, abstract below. Note that lava slopped onto wet ground causes the water to go supercritical as the lava is erupted at up to 1200 C, and supercritical only needs 374 C and moderate overburden pressure. This is why agates are found in flow bottoms, not anywhere in lava flow profiles. They are also found in flow tops from rapid degassing of fluids where rapid decompression forces silica out of solution, but agates are not in flow centers. This cannot be explained by a weathering mechanism other than to ignore the problem that weathering predicts more agates in flow tops, less in flow centers, and little to none in flow bottoms, which is not observed. Essentially nothing that weathering predicts is observed in agate geologic systems.

"Paper No. 158-0 ***HIGH-TEMPERATURE, CLOSED-SYSTEM ORIGIN OF AGATES IN BASALTS: NEW EVIDENCE*** **MERINO, Enrique**, Geology, Indiana Univ, Bloomington, IN 47405, merino@indiana.edu, DUTTA, Prodip, Geology & Geography, Indiana State Univ, Terre Haute, IN, RIPLEY, Edward M., Deparment of Geological Sciences, Indiana Univ - Bloomington, 1001 E 10th St, Bloomington, IN 47405-5101, and WANG, Yifeng, TRU Waste System Engineering Department, Sandia National Laboratories, 4100 National Parks Highway, Carlsbad, NM 88220

Crystallization of the self-organizational chalcedony textures and trace-element compositions typical of many agates requires that the growth be from a glob of silica gel (Wang & Merino, GCA 1990, AJS 1995). Globs of silica gel must form instantaneously as a hot basalt flowing on the ground traps water puddles: the water goes supercritical, reacts with silica chains in the melt, and forms silanol-ended silica polymer chains that attach at T junctions -- a gel. (If gel blobs form by puddle trapping, agates should occur near the bottom of the basalt flow. Agates do occur only in the bottom 3 meters of a 14-meter-thick basalt flow/agate quarry in the Parana Basalt at Rio Jacui, NW of Porto Alegre, Brazil, whereas the basalt vesicles, which occur only in the top meter, are all empty.) Each glob of silica gel, as a closed system, quickly crystallizes into an agate upon cooling, as the surrounding basalt crystallizes too, at high temperature. The last quartz (often coarse amethyst) to grow inside the agate may contain coprecipitated fibrous goethite: The measured lack of 18-Oxygen fractionation between the amethyst and the goethite indicates that the crystallization of both is at several hundred degrees C. The water of the initial gel glob collects in the agate's central void, itself resulting from the density difference between gel and quartz. The water leaks or flashes out and isotopically alters a shell of basalt around the agate. In a sample of fresh Deccan basalt + agate we measure delta 18-Oxygen values of 22 %o at the edge of the agate, 15 %o in basalt at 2 mm from the agate, 10 %o at 1 cm, and 6 %o at 2 cm from the agate - that is, down to fresh basalt. The same 1995 theoretical quantitative model that accounts for the self-organizational textures and compositions of agates and for their fibrous, length-fast quartz also accounts for a score of geochemical, mineralogical, microstructural, isotopic, and chromatic features of agates.

GSA Annual Meeting, November 5-8, 2001
General Information for this Meeting Session No. 158
Mineralogy/Crystallography
Hynes Convention Center: 202
8:00 AM-12:00 PM, Thursday, November 8, 2001"