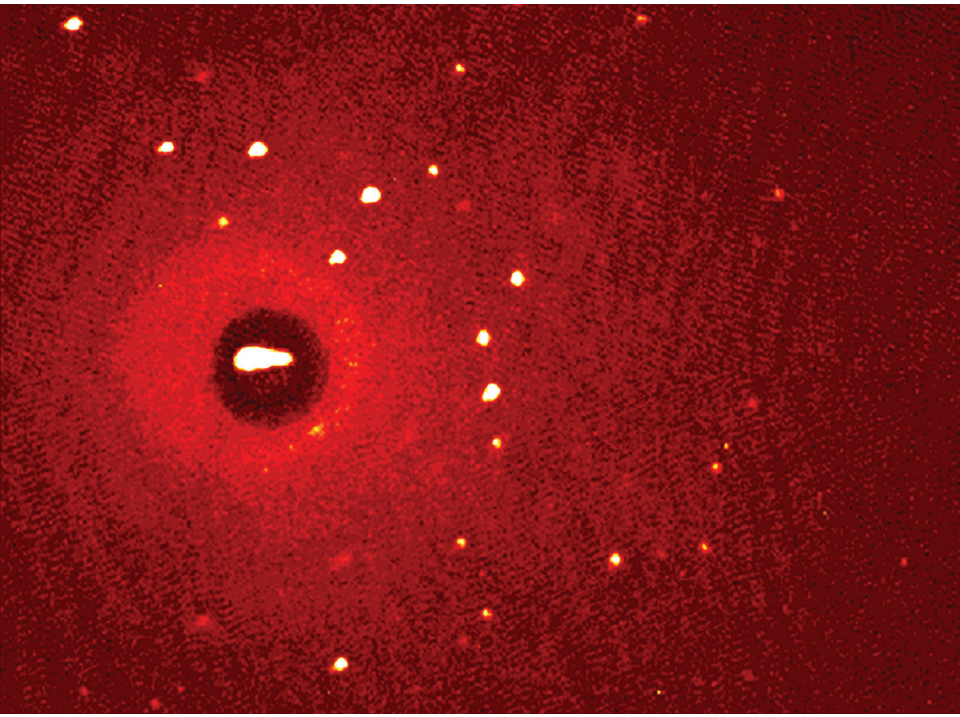
teenage kicks

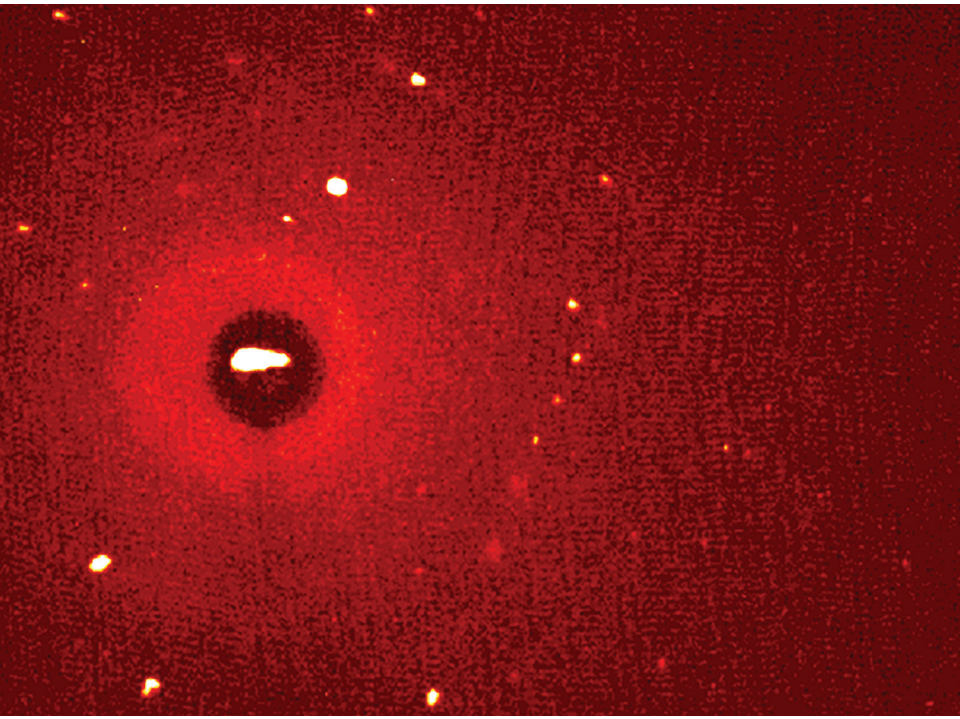
I take a small sledgehammer and a center punch, line them up on a slight promontory, and with a light tap sever a very small bit of the rock. I wrap this sample up in some electrical tape (it is unorthodox, I know, but I was on the boat and everything was gritty and iron-covered – I had been using an angle grinder most of the day and not only was that smell pervasive but iron and rust particulate had coated most surfaces in the workspace – so, concerned about contamination, I wrapped the sample up in the nearest-at-hand mildly hermetic package I could find). I put it in my back pocket, with my keys, and drive about 15 miles south-southeast. I walk into the lab, get reacquainted with the space (the hisspops of the NMR spectrometer in the corner, the chirp of the O_2 alarm), turn on the XRD, turn on the microscope light, turn on the image capture device. I sit down in front of the microscope and sift through the drawers containing sample mounting hardware. I pick out a clean Mitegen mount. I unwrap the sample – peeling apart the black tape very slowly – and use a tiny awl to dislodge the fragment from the adhesive; it falls onto a microscope slide. I put it under the lens. Through the lens, the sample looks like shit. A crusty, barely crystalline piece of dark grey grit. I see only its silhouette, ghosted at the edges from light bleeding around it. No light passes through the sample. I apply a drop of nail polish to the slide and push the sample into the pool using the awl. I affix the mount to a pencil-sized magnetic rod and slowly slide the end of the mount (a small circular region, barely visible to the eye; under the scope, it appears to be a ring of teeth facing inward) in and under the sample. I lift the sample out of the pool of nail polish and it remains attached to the mount in the center of the toothy ring. It takes a few minutes to dry, and I look at the images that were captured during the mounting process. They are pretty boring.

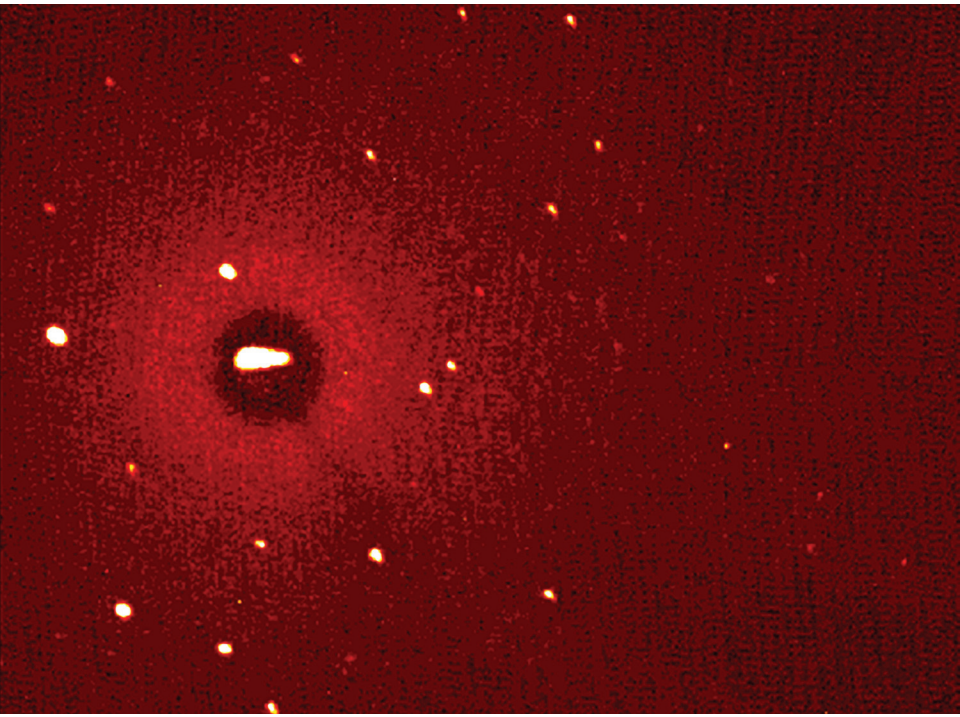
001
#
001

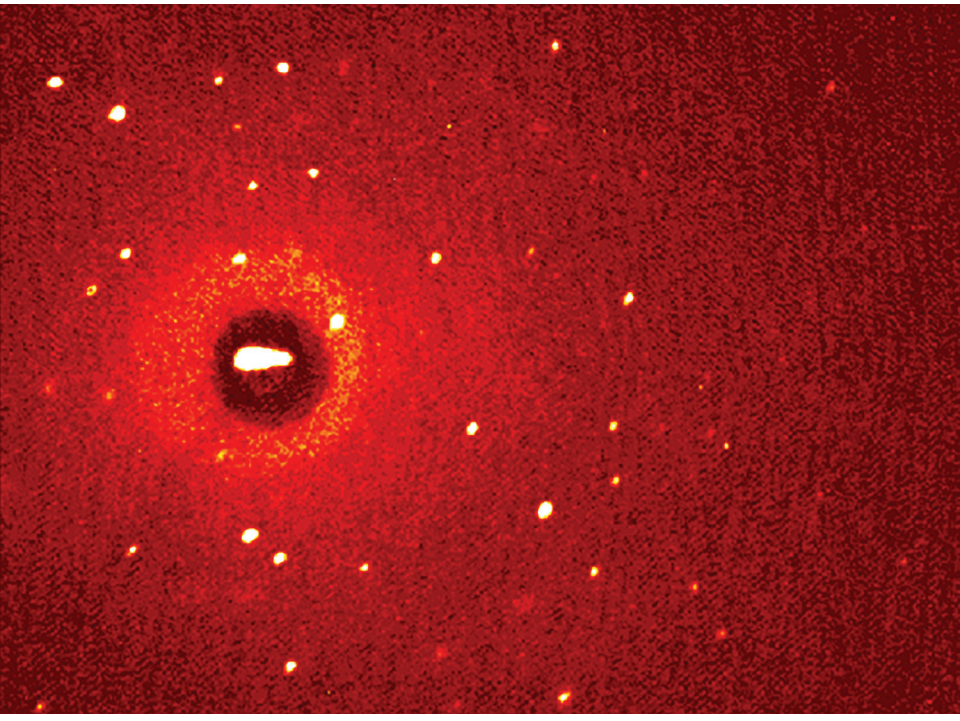
The XRD is warmed up. It is emitting flashing orange and green lights from its corners, one to warn of x-ray radiation and the other to signify that everything is in order. I place the mount on the sample loader. It takes about 4 seconds to recognize that a sample is waiting. The servos whine a bit, a circular port opens, and the sample disappears downwards. I work through a series of prompts on the touchscreen display: the sample is "rock", a "spherical" "black" "crystal" approximately "0.3 x 0.3 x 0.3 mm" in size. It asks for a chemical formula, either specific or approximate, and knowing very little about mineralogical classes I punch in the generic formula for basalt ("$NaFeSi_2O_6$") – this is fun, I feel like I am leading the XRD astray with my nonsense information and noncrystalline sample. I verify that I want to start collecting data. Within five minutes, the XRD decides that there is enough sample integrity to proceed with collection. The x-ray source irradiates the sample with monochromated high-energy light. The x-rays bounce through, off of, around the sample and strike a detector. The sample rotates one degree at a time, and the detector records the pattern of dots and grain and noise for each degree of rotation. It takes about 12 hours.

I come back to the lab after 12 hours. The XRD wants, or needs, more time to gather enough information to work with this imperfect sample. This takes another 12 hours, more light, more energy, and this second attempt will destroy the sample. This is why I have to approve it a second time. I come back after 12 hours and transfer the data from the XRD. I remove the sample holder and clean the Mitegen mount with isopropanol.









A complete description of a crystal structure includes (Pauling, *General Chemistry*):

1) the crystal system
2) unit cell axial lengths and interaxial angles
3) the space group
4) the types and quantities of the atoms in the unit cell
5) xyz coordinates of the atoms in a unique list that is sufficient, in combination with the space symmetry elements, to specify the positions of *all atoms in the unit cell*

As a comprehensive spatial representation of a material, this is the most reduced form. Although we are describing a segment of the sample that cannot exist – at the corners and edges of this geometry that is being drawn up there are fragments, eighths and quarters of atoms – when we add a few up and blur out the edges, we have a definite (and unimaginably pure) solid. From this set of data and definitions, the material can be completely described in terms of an absolute atomic space. This space and its contents are a whole, despite the cloven atoms at the corners.

But the positions of the atoms are initially relative. We impose structure, geometrical constraints – Bravais lattices, space groups, crystal systems – and order the atoms within, measuring them with respect to one another. If we are talking about salt and if the chlorine atoms are at (0, 0, 0), (0, 1, 0), (1, 0, 0), (1, 1, 0), (½, ½, 0); (0, ½, ½), (½, 0, ½), (1, ½, ½), (½, 1, ½); (0, 0, 1), (0, 1, 1), (1, 0, 1), (½, ½, 1), and (1, 1, 1), then there are sodium atoms at (0, ½, 0), (½, 0, 0), (1, ½, 0), (½, 1, 0); (0, 0, ½), (1, 0, ½), (0, 1, ½), (½, ½, ½), (1, 1, ½); (0, ½, 1), (½, 0, 1), (½, 1, 1), and (1, ½, 1).

Even more concise (and even more relative): if there is one chlorine atom at (0, 0, 0) then there are 13 chlorine atoms at (0, 1, 0), (1, 0, 0), (1, 1, 0), (½, ½, 0); (0, ½, ½), (½, 0, ½), (1, ½, ½), (½, 1, ½); (0, 0, 1), (0, 1, 1), (1, 0, 1), (½, ½, 1), and (1, 1, 1), and 13 sodium atoms at (0, ½, 0), (½, 0, 0), (1, ½, 0), (½, 1, 0); (0, 0, ½), (1, 0, ½), (0, 1, ½), (½, ½, ½), (1, 1, ½); (0, ½, 1), (½, 0, 1), (½, 1, 1), and (1, ½, 1).

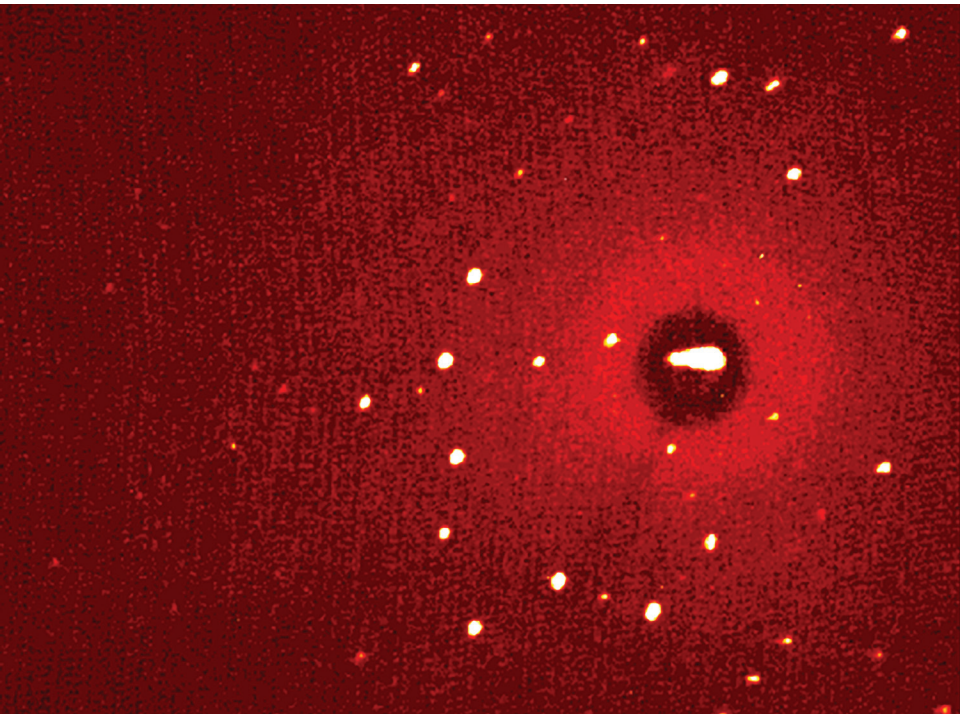
So here we are with an absolute space defined at first by relative atomic proximities. Any variations on the composition or spatial arrangement

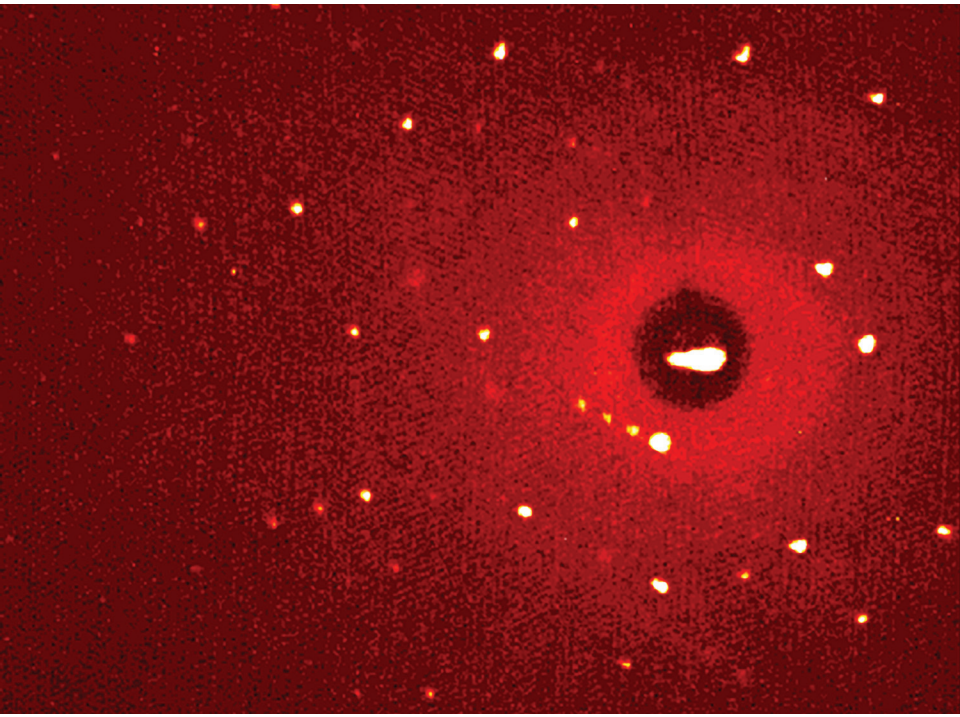
will invalidate the unique identity of this definition, will mean that we are talking about a different material (probably a nonexistent material). We have to stick with this, and all of our thoughts about sodium chloride, in solid form, must begin and end here. It's a dramatic statement but it's fucking true.

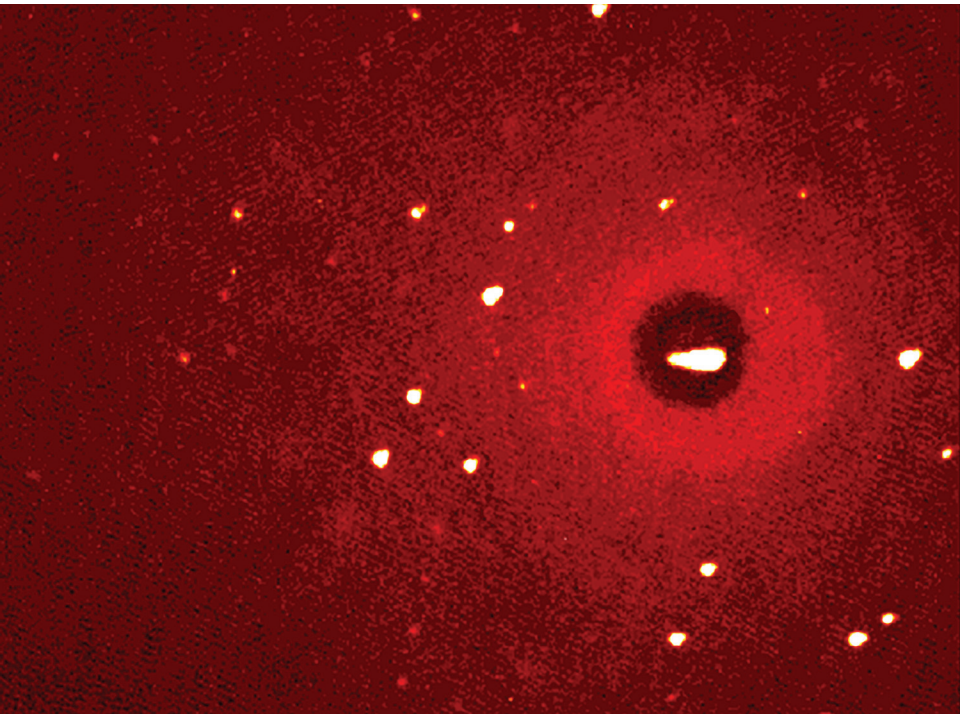
The most direct way to determine the unit cell (i.e., crystal structure – I'm using these terms a little loosely and interchangeably) of a solid is to run a very nice crystalline sample of the material in a single-crystal x-ray diffractometer (SC-XRD). This machine, and this type of analysis, typically requires a sample in which a single, homogeneous crystal can be isolated and cut into a small enough piece to fit on a sample holder. If the crystal is impure, has a few different phases, weird inclusions and miscellaneous crystal fuck-ups, the diffraction pattern analysis algorithms (or the user) won't be able to solve for the atomic structure of the sample. At best, we receive a non-crystal structure, an imperfect solid that could likely never exist – not in the laboratory, and certainly not in nature. The interaxial angles will be wonky, the atomic distances illogical, and the shitty ball-and-spoke digital model that it produces from the diffraction data will look like (and signify) a physical impossibility. But the data that produces such an impossibility will be valid(ated) if we remove the logic of the sample. The virtual structure, the relationship between diffracted x-rays and imagined structure, will be sound and direct. If the material is absent from the array, then perhaps this junk data and its progeny form a complete pair that exists somewhere outside of the real.

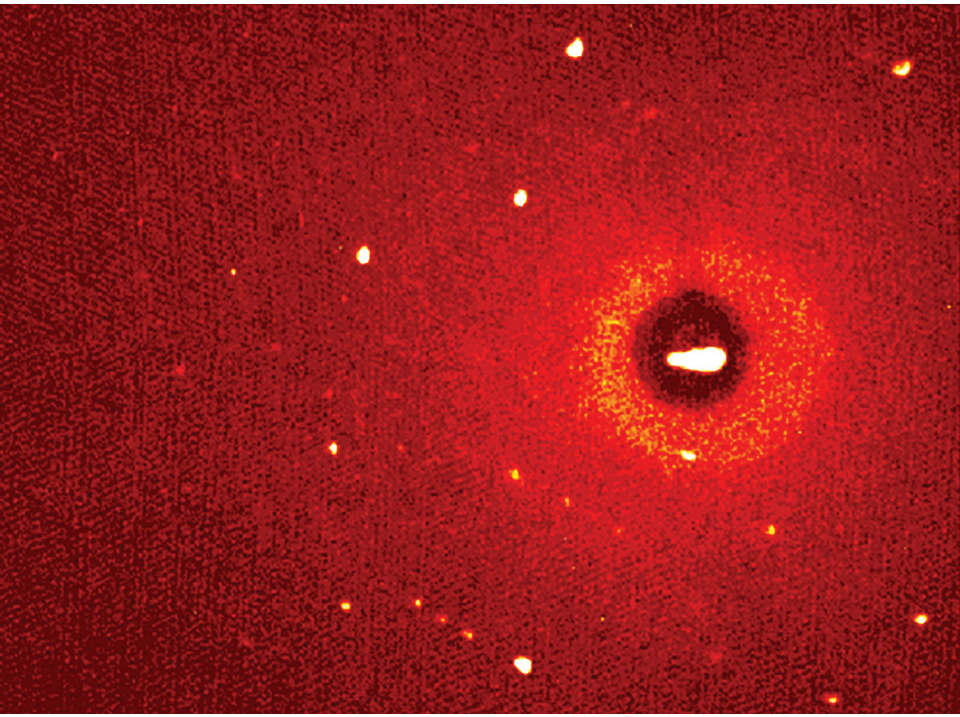
Here, a crystalline but impure sample of a rock has been run through the SC-XRD and the rote mechanics of the inbuilt data parsing logic have generated a virtual rock. This is a virtual rock established in high-empirical terms, and created from the interference and marginalia of the precise and exacting processes that define the laboratory as a workspace. A simple interjection of material anarchism turns into a generative tool – the sample, the *subject*, misuses the architecture of the experiment while simultaneously being analyzed by it.

This is glitch chemistry and junk data and also a very specific way to destroy a rock.









Error report for file: rock_run_02.cif

Type 2: indicator that the structure may be wrong or deficient
Type 3: indicator that the structure quality may be low
Type 4: improvement in methodology, query or suggestion
Level A: in general, serious problem
Level B: potentially serious problem
Level C: check & explain

The following alerts were generated:

023_ALERT_3_A Resolution (too) low, [sin(θ)/λ < 0.6]: 20.19°
027_ALERT_3_A *_diffrn_reflns_theta_full* (too) low: 20.19°
061_ALERT_3_B T_{max}/T_{min} range test RR' too large: 0.68
080_ALERT_2_B Maximum shift/error: 0.19
241_ALERT_2_B Check high U_{eq} compared to neighbors for C8
088_ALERT_3_C Poor data / parameter ratio: 8.02
220_ALERT_2_C Large non-solvent C U_{eq}(max) / U_{eq}(min): 3.07 (ratio)
222_ALERT_3_C Large non-solvent H U_{eq}(max) / U_{eq}(min): 3.28 (ratio)
242_ALERT_2_C Check low U_{eq} compared to neighbors for C6
242_ALERT_2_C Check low U_{eq} compared to neighbors for C9
341_ALERT_3_C Low bond precision on C-C bonds (x 1000): 10 Å
802_ALERT_4_C CIF input record(s) with more than 80 characters: !
911_ALERT_3_C Missing FCF reflection between θ_{min} & sin(θ)/λ = 0.486
913_ALERT_3_C Missing very strong reflections in FCF: 1

ALERT_023 Type_3: Structure quality may be low
Check resolution of the data set. Alert is issued when sin(θ)/λ < 0.6.

ALERT_027 Type_3: Structure quality may be low
Ideally (and a requirement for publication in *Acta Crystallographica*), the dataset should be complete, as defined by *-diffrn-measured-fraction-theta-full* (close to 1.0), up to sin(θ)/λ = 0.6 (i.e. 25.24 degrees MoK_{α}). The three major causes of incomplete data sets are: 1) A missing cusp of data due to data collection by rotation around the spindle axis only (standard on

some image-plate systems). Cure: remount the crystal. 2) The DENSO-tap image processing package has problems with certain strong reflections, which are often excluded from the data set. Cure: Add an additional scan at a lower power setting in order to include strong low-order reflections. 3) Incomplete scans.

ALERT_061 Type_3: Structure quality may be low
See IUCR webpages.

ALERT_080 Type_2: Structure model may be wrong or deficient
Convergence of the refinement is established with a close-to-zero shift/error value for all refined parameters. Such a convergence is easily achieved at little cost.

ALERT_088 Type_3: Structure quality may be low
The data/parameter ratio should in general be higher than 10 for a high-quality structure determination. This ratio can be improved by not refining C-H parameters other than those riding on their carrier atom.

ALERT_220 Type_2: Structure model may be wrong or deficient
This test reports on a larger than usual U_{eq} range for the specified element type in the non-solvent/anion part of the structure. Values too high or too low may be an indication of incorrectly identified atomic species.

ALERT_222 Type_3: Structure quality may be low
This test reports on a larger than usual range of U_{eq} values for hydrogen atoms in the non-solvent/anion part of the structure. Possible causes are: 1) disorder; 2) poor data; 3) misplaced hydrogen atoms.

ALERT_241 Type_2: Structure model may be wrong or deficient
The U_{eq} value of an atom is compared with the average U_{eq} for non-hydrogen atoms bonded to it. Large differences may indicate that the wrong atom type was assigned.

ALERT_242 Type_2: Structure model may be wrong or deficient
The U_{eq} value of an atom is compared with the average U_{eq} for non-hydrogen atoms bonded to it. Large differences may indicate that the wrong atom type

was assigned. False alarms may occur for terminal groups such as the t-butyl moiety.

ALERT_341 Type_3: Structure quality may be low
The average s_u for X-Y bonds is tested. X-Y will generally be C-C bonds, unless there are none. There are three test ranges: one for structures with the largest element Z < 20, one for the largest Z in the range 20 to 39, and one for structures with Z = 40 or higher (_340, _341, and _342 respectively).

ALERT_802 Type_4: Improvement in methodology, query or suggestion
The CIF file contains records longer than 80 characters. The CIF-1.1 definition specifies a maximum of 2048 character per record.

ALERT_911 Type_3: Structure quality may be low
Possible causes: Missing cusp of data (due to rotation about one axis), deleted (overflow) reflections or improper strategy (orthorhombic for monoclinic crystal etc.).

ALERT_913 Type_3: Structure quality may be low
High number of missing reflections with Fc2 values greater than the largest Fc2 value in the FCF. Possible causes: Missing cusp of data (due to rotation about one axis), deleted (overflow) reflections behind the beamstop or improper strategy (orthorhombic for monoclinic crystal etc.).

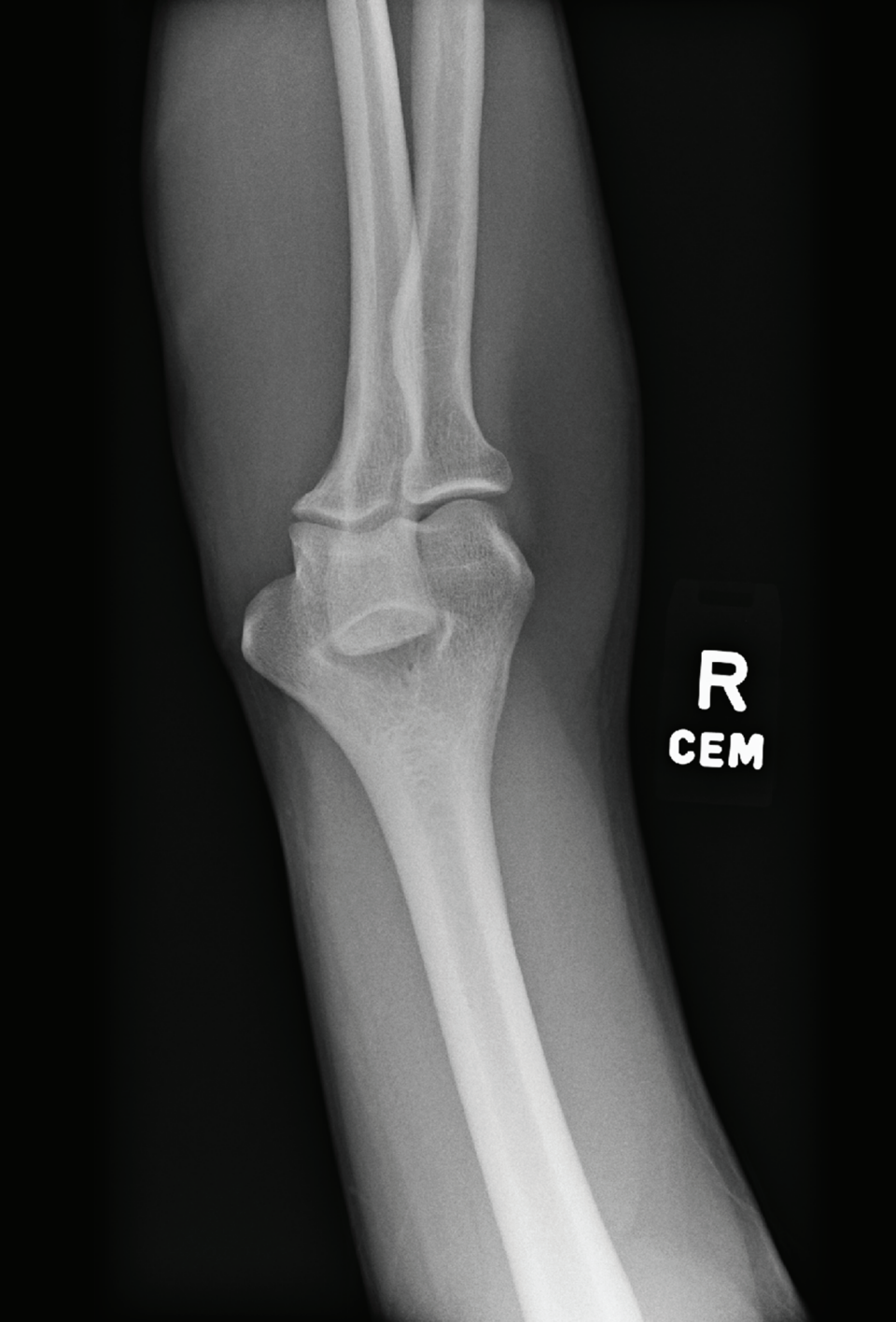
tom tells me

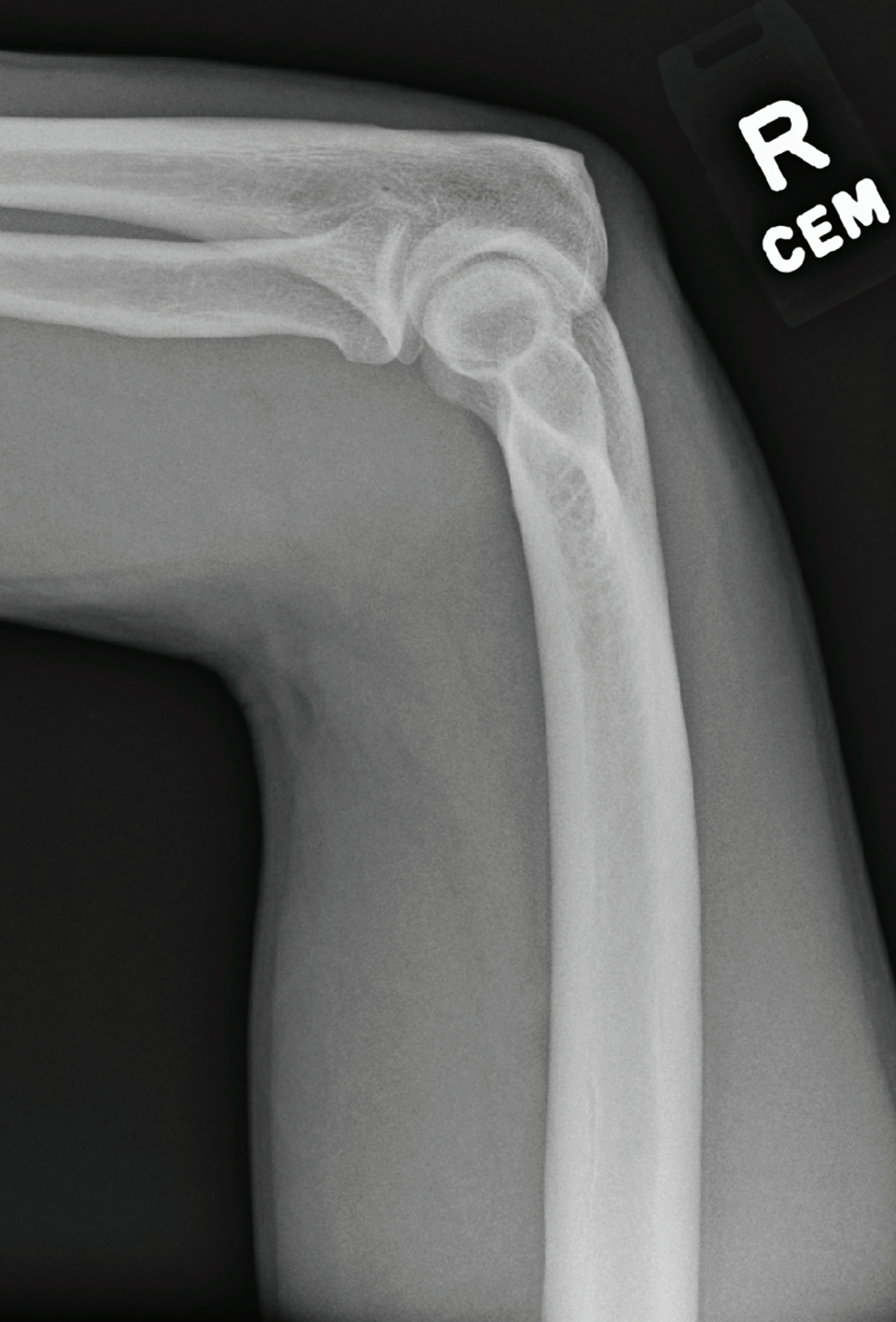
Tom tells me that I may be flirting with a singularity. The apparent positioning of three of the mill's six physically-connected axes – A4, A5, and A6 – indicates that they are approaching the same value at the same time.

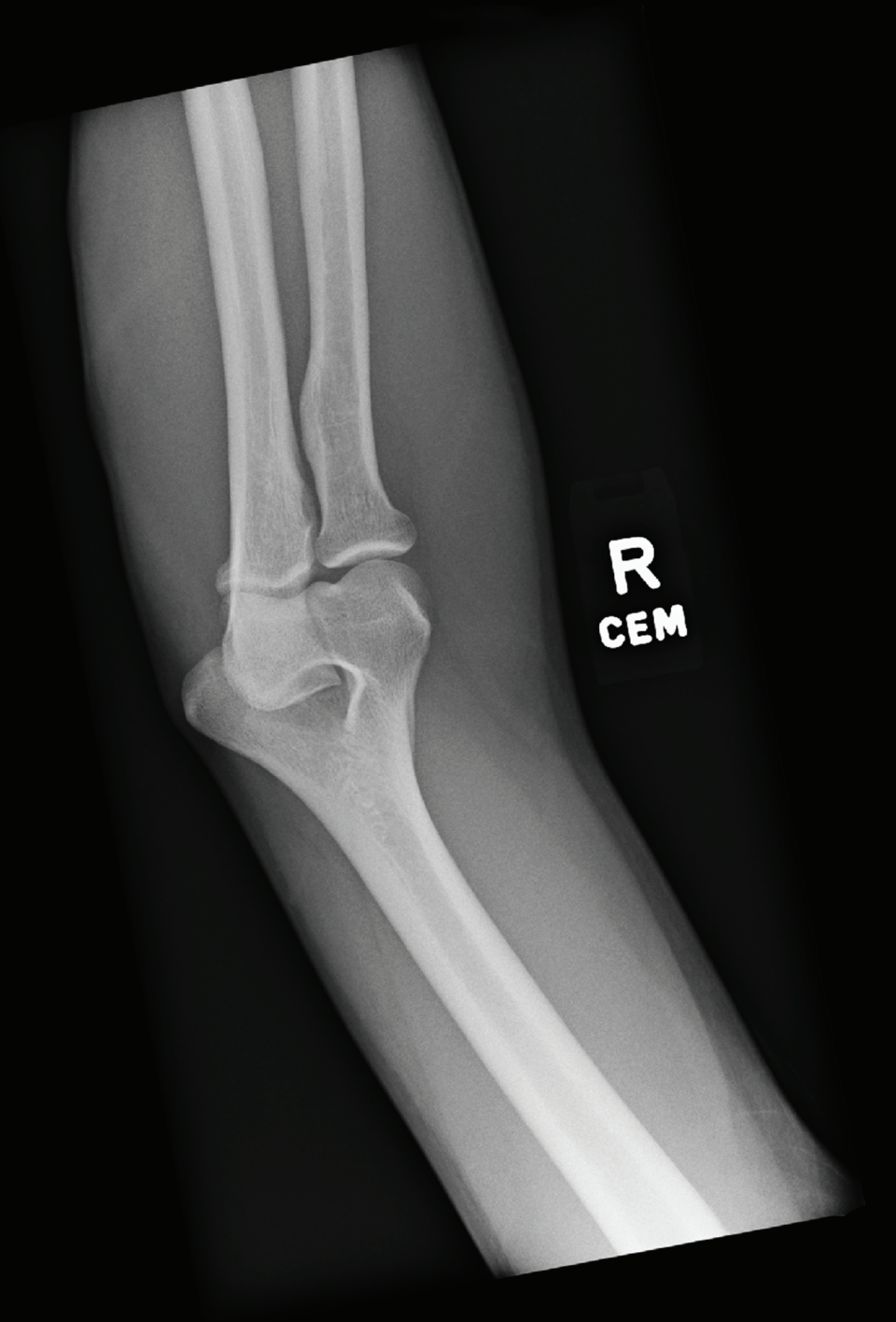
The mill locks up when this happens. I am just finding this out, the connection between locking up and singularity. Axis A4 has a rough time, and I have not yet been able to explain either its condition (frequently surpassing commanded velocities, exceeding parameterized torque values) or the cause of its condition. But A4 is always the one to fuck up. Now I know that this is a translation issue, a compounding of multi-axis movement, a rotational misfire, a singularity, etc., etc. …

The way that I understand this is something like the difference between 0˚ and 360˚. I imagine these axes rotating almost imperceptibly and increasingly slowly from 359.9˚ to 359.99˚ to 359.999˚ to 359.9999˚, and then suddenly realizing that the next step is 0˚. Two of the axes (A5 and A6) transition normally from 359.9999˚ to 0˚, but the other axis (A4) sees it differently. Suddenly there is an alternate path to 0˚, a path that recognizes the value "360" instead of "0". So A4 tries to do this as quickly as possible. It suffers from moving too fast and moving too forcefully and taking the wrong path. A4 is a heavy curveball pitcher in an improbable world of knuckleballers.

I try really hard not to think about some sort of anthropometric equivalency for the condition of the mill. I try not to think about what the zero position of each of the joints in my arm could be, and what it would be like to try and set them all to zero. I try not to think about what one degree of motion for my elbow would be. I try not to think about the software limits and mechanical stops that prevent my shoulder from going all the way around. I try not to think about commanded velocities and what sort of persistent joint and servo damage could arise from exceeding these specifications. I definitely try not to think about this when I am throwing rocks.


R
CEM

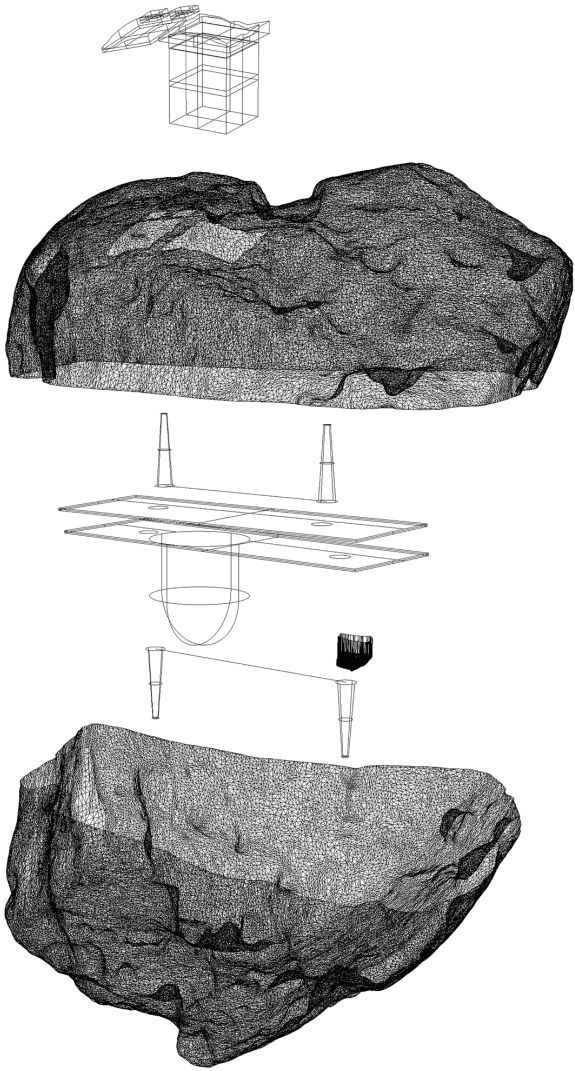

R
CEM


R
CEM

N.B.: There is a 0.1875-inch thick plate of 6061-T6 aluminum that occupies a shallow cavity about 20- by 30-inches along the axial center of the rock. Four lengths of 0.5-inch stainless steel threaded rod are anchored to the plate with nuts, washers, and epoxy embedments on the relative underside of the plate. They run to a point on the surface of the rock where a coupling nut is threaded on to the rod. There are two of these points (four total) on each facial surface of the rock – the top and bottom, loosely. The aluminum plate forms a sort of invaginate equator from which all of the other pieces of hardware and structural, mechanical, and electronic elements can be located. Below the plate is a half-spherical cavity eight inches in diameter that has been covered with two layers of 20-ounce fiberglass combination mat. Inside of this cavity there are about 95 pounds of lead rattlesnake shot, small polished microspheres plated with graphite, 0.8-mm in diameter. For rattlesnakes, I guess. The other half of the sphere is formed by a similarly fiberglassed styrofoam "cap" that seats in over the lead shot, flush with the bottom surface of the aluminum plate. It has small tabs, about 0.5- by 2-inch, that overlap the central plane underneath the plate. This cap piece completes the 8-inch diameter sphere that encases the lead shot. Below the utmost minima of the ballast sphere there is nothing but styrofoam until the fiberglass skin of the rock.

Above the plate – the plane of which approximates the waterline and floating orientation of the rock – are four cavities that each house a different element. Three of these cavities are located at the upper surface of the rock, milled into the fiberglass encasement that is laminated onto the rock surface.

The first is an 8-inch deep, 6 x 6-inch square volume that houses the GPS transmission electronics. About two inches down from the surface of the rock, this cavity reduces in x-y dimension by 0.125-inch. This forms a lip on top of which is seated a 6 x 6 x 1-inch 6061-T6 aluminum plate. The central 16 in^2 of this piece of aluminum have been milled out to form a square ring with 16 threaded blind holes that accommodate #8-32 stainless steel socket head machine screws. These screws, which bolt through a 6 x 6 x 0.5-inch aluminum plate with correlating countersunk clearance holes, are fitted with individual EPDM o-rings and tighten against the plates. The topmost plate has two 0.01875-inch deep grooves, 0.5-inch apart, milled into its underside.



These grooves accommodate two o-rings (size -162 and -155) that form a watertight seal with the underlying plate. Adjacent to the GPS housing is a 4 x 5 x 1-inch cavity that houses a solar panel. An epoxy embedment and three coats of urethane clear coat hold it in place. Next to this cavity – actually, next to but rotated 90˚ from the axis established by the relationship between GPS housing and solar panel cavity (I think of this as "upward" on the "upper" surface of the rock) – are two 2 x 2 x 1-inch cavities that provide embedment forms for the two antennae that complete the electronic portion of this rock. One is an antenna that is used to transmit data through the Iridium short-burst-data network; the other obtains GPS coordinates and passes them to the Iridium chip at each transmission event. They both possess an identical form – black plastic rectangular volumes with chamfered edges – and are also embedded with epoxy and coated with urethane clear coat. The cables from each of these three elements – solar panel, GPS antenna, Iridium antenna – run down at roughly 30˚ angles from their housing cavities through holes bored in the styrofoam, converge at the same point on the wall of the electronics cavity, and protrude through to make their respective connections with the primary electronics board. Each penetration through the skin of the rock is packed with an ample amount of 3M 5200-FC, a urethane based high-adhesion and high-stretch marine sealant. It cures in 24 hours and sticks tenaciously to clothing, skin, and Fiesta Ware.

The fourth cavity is located below the upper skin of the rock. It is a fairly accurate inverse rendering of one-half of the rock, milled directly into the styrofoam with a 0.125-inch diameter ballend machine tool. It has a "cap" similar to the ballast cap which is also a fairly accurate inverse rendering of one-half of the rock. The real rock is placed inside this cavity.

This is mesoscale shit and advanced fabrication coupled with brutish methods of making things fit and it is a very specific way to produce a virtual rock.

This is also a very specific way to destroy a real rock.

TEN SELECTION CRITERIA

1) It will be fist-sized, with a tolerance of +/- 25 percent. I understand that this depends strongly on individual physicality. This is part of it.

2) It will be heavy for its size. It will be dense.

3) It can be thrown, but it may be just above the desirable mass for throwing. It will not be below the desirable mass for throwing. This limit works in conjunction with (1).

4) It will have hard edges and soft pockets. It will not be water-worn, smooth, or cultured in any way.

5) [redacted].

6) It will have a distinct orientation – a top and a bottom, and a way to rest.

7) It will not have a highly regular or too pervasive pattern of pockets (gas bubbles). The patterning of surface features will be irregular enough to assign specific and distinct regions to the surface.

8) It will not be a fragment.

9) It will not be round, flat, or pyramidal. It will be a loose rhombohedron with identifiable faces and a very approximate height-width-length ratio of 2:2:3.

10) It will lend itself to being considered in terms of hydrodynamics.

TEENAGE KICKS is a multimodal project that describes certain problems that lie within the margins of human thought, time, material, and rocks. It focuses primarily on the decay function that is established when these components converge around a specific set of actions. The actions are nodes in constant flux, the time is expandable but not compressible, the material is molecularly fixed, and the thought behaves as a generator governor does when it begins to fail. The rock, of course, is inert. The oscillation itself starts oscillating and eventually a new superfrequency arises – removed by at least three orders of magnitude from the baseline 60 Hertz – that describes how we produce and destroy material whose half-life outstrips any of our physical terrestrial limits.

X

TEENAGE KICKS begins with a small, fist-sized rock, probably basalt, found on the side of a two-lane highway in Arizona. The ground was strange, aerated and soft, quite dry. As a 175-pound mass distributed onto two size-10.5 boots, my body sank perhaps 1 to 1.5 inches with each step. Rocks were scattered around, maybe five rocks per square meter. This rock fit well in my hand, although I could not quite resolve it as a good throwing rock.

Some years later the rock was laser-scanned at a resolution of 268,000 points/in^2. The resulting point cloud was sampled and meshed with a Poisson function to produce a digital object with a topography that approximated – to 0.000001 inch – the surface of the rock.

A small fragment (about 0.027 mm^3) was dislodged from the rock and used for data collection in a single-crystal x-ray diffractometer. This fragment did not survive.

The digital rock was scaled up volumetrically by a factor of about 8000 (resulting in a dimensional form about 4 x 4 x 6 feet). The digital model was then separated into eight pieces that were individually milled from 2 x 2 x 3-foot blocks of extruded polystyrene on a seven-axis robotic CNC milling machine. These eight pieces were assembled around a central plate of aluminum, coated with modified twill-weave fiberglass cloth and multiple coats of epoxy resin, and spray-coated with epoxy-based automotive primer and urethane-based clear coat.

This virtual rock will be launched into the North Pacific Ocean at a location roughly 1,200 miles south-southwest of Cape Flattery (the northwesternmost point of the contiguous United States – the tip of the Olympic Peninsula in Washington). This location is at the interface of two major oceanic currents – the Alaskan gyre and the North Pacific gyre. Within the North Pacific gyre is an area larger than the state of Texas where some of the highest concentrations of neustonic plastic can be found. It is colloquially referred to as the "Great Pacific Garbage Patch", and it forms a disperse field of trash. The garbage patch represents a Valhalla for the unanticipated reduction of material permanence: a repository for the things that will never break down further than they already have.

Whether this rock finds its way to the garbage patch, and the timescale of such a journey, is indeterminate. As a cohesive floating mass it will be susceptible to forces that minuscule particulate matter is not – wind, wave motion, and short timescale surface currents will dictate its movement across the oceanscape in ways that will often trump the persistent circulation of the gyre currents. Regardless of the physical, corporeally-based events and interactions that this rock will endure, the matter that it is composed of will inevitably come to rest at a known point in the Pacific, either as a virtual rock or as mesomolecular detritus. There's comfort in this.

…what god means to me –The Germs